

Short Note

Gregory P. Detweiler, Stephen N. Harris*, Colleen Olfenbittel and David S. Jachowski

First tracking of an eastern spotted skunk litter from birth to independence

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Abstract: We tracked a female eastern spotted skunk *Spilogale putorius* in North Carolina, USA, that gave birth to a litter of three kits in summer 2020. Using camera traps and radio-collars, we were able to monitor the movement and behaviors of the female and litter. We observed behaviors including food provisioning, play-fighting, and interspecific interactions. We tracked the movements of the kits past independence from their mother and documented dispersal events for two kits. This is the first known successful attempt to track eastern spotted skunk kits from birth to independence, providing new insights into the ecology of this cryptic species.

Keywords: dispersal; eastern spotted skunk; juvenile; *Spilogale putorius*.

The eastern spotted skunk *Spilogale putorius* (Linnaeus, 1758) is a small omnivore in the family Mephitidae that ranges across much of the central and southeastern United States (Gompper and Hackett 2005; Kinlaw 1995). Within the Appalachian Mountains, the Appalachian spotted skunk *S. p. putorius* (Linnaeus, 1758) occurs in forested environments ranging from high-elevation spruce *Picea rubens* (Sarg.) – fir *Abies balsamea* (L.) forests to low-elevation hardwood – pine (*Pinus* spp.) forests (Diggins et al. 2015; Thorne et al. 2017; Wilson et al. 2016). While dedicated monitoring and research on eastern spotted skunk occupancy, habitat and den site selection, zoonotic disease impacts, and survival have increased since 2015

(Jachowski and Edelman 2021; see *Southeastern Naturalist* Volume 20 [Special Issue 11] for recent examples), there is little known about the species' ecology during the juvenile life stage. The only estimate of juvenile survival for eastern spotted skunks comes from the Ouachita Mountains of Arkansas, where average annual survival over two years was 31.3% (Lesmeister et al. 2010). This low estimate reinforces the importance of studying juvenile eastern spotted skunks range-wide to determine what factors affect juvenile survival and whether rates are similar across populations. In addition, litter sizes have been documented for the Plains *S. p. interrupta* (Rafinesque, 1820) and Florida *S. p. ambarvalis* (Bangs, 1898) subspecies (5.5 kits; Mead 1968), as well as the Appalachian subspecies (2.8 kits; Butler et al. 2021), but there is a knowledge gap regarding juvenile dispersal and movement ecology. The objective of our study was to track the timing and movements of a litter of eastern spotted skunk kits from dependence on their mother to independence and dispersal.

Our observations occurred as part of a study on Appalachian spotted skunks in the South Mountains of western North Carolina. We conducted our research on a private preserve in the Eastern Blue Ridge foothills ecoregion in Burke County, North Carolina that was primarily comprised of mixed oak (*Quercus* spp.) or mixed forests consisting of oak, hickory (*Carya* spp.), and pine (*Pinus* spp.) (Griffith et al. 2002). The terrain at the study site was mountainous (~350–650 m elevation) and contained valleys associated with stream drainages where the dominant understory species were *Rhododendron* spp. These areas became more dominated by mountain laurel *Kalmia latifolia* (L.) as elevation increased, culminating in mature mixed hardwood forests with little to no understory.

On 2 April 2020, we captured an adult female Appalachian spotted skunk (Study ID: F6) and fitted it with a radio-collar (Model #: M1740; Advanced Telemetry Systems, Inc., Isanti, MN). Specific details on our capture methods can be found in Butler et al. (2021). We subsequently attempted to track F6 to her den sites one or more times (mean = 3) weekly. On 26 May 2020 we began placing two infrared, motion-activated camera traps (Strike Force HD Pro, Browning, Morgan, UT) at F6's dens in anticipation

*Corresponding author: Stephen N. Harris, Department of Forestry and Environmental Conservation, Clemson University, Clemson, SC 29634, USA, E-mail: esenaitech@gmail.com. <https://orcid.org/0000-0002-2901-9448>

Gregory P. Detweiler and David S. Jachowski, Department of Forestry and Environmental Conservation, Clemson University, Clemson, SC 29634, USA

Colleen Olfenbittel, North Carolina Wildlife Resources Commission, Pittsboro, NC 27312, USA



Figure 1: A collared, female eastern spotted skunk *Spilogale putorius* (Study ID: F6) emerging with three mobile kits in the South Mountains of North Carolina, USA, in July 2020.

of the birth of a litter (see Supplementary Table 1 for notable events recorded and associated video footage). We focused the cameras on the den entrance (the one that appeared to have the most activity if the den had multiple likely entrances), placing the cameras 0.5–1 m high on stakes and ~5 m away from the den entrance. We set the cameras to record 30 s of video with a 3 s delay between recordings. We checked the cameras every 2–3 days and moved the cameras as soon as we observed that F6 had moved to a new location. On 2 June 2020 video footage showed F6 moving three small, sparsely-furred kits from the burrow to another ground burrow ~170 m away. Developmentally, the kits appeared to be newly born based on their small size, sparse fur, closed eyes, and apparent lack of mobility (Crabb 1944). On 11 June 2020, F6 relocated her litter to a ground burrow ~75 m from the previous den. F6 and the kits were observed at this burrow until 4 July 2020, at which point the kits were old enough (~32 days old) to emerge from the den under their own power (Figure 1).

For the remainder of July 2020, F6 and her kits utilized a new den location every 4–8 days. At this point, based on our review of video footage during this time period, the kits appeared mobile enough, at ~32–53 days old, to traverse between den sites primarily under their own power. During July, F6 would often leave the den at night, with the kits sometimes exposing their heads outside of the den entrance while F6 was gone. We first observed the kits leave a den completely while F6 was away on 10 July 2020. On 14 July 2020, we tracked F6 to a new den in a rocky outcrop that was ~400 m from the last known den location. Also, on 14 July 2020, we observed F6 emerge from the den at 2236 and return with a possible food item, likely a frog, in her mouth at 0132 on 15 July 2020. This was the first occasion we observed of food provisioning by F6, a behavior previously documented in

eastern spotted skunks (Sprayberry and Edelman 2016; Thorne and Waggy 2017). We also observed other instances of food provisioning by F6, with video footage showing her returning to the den with frogs, lizards, and snakes. In most cases, F6 brought the presumed food items into the den, even if the kits themselves were outside of the den at the time. The kits never immediately followed F6 into the den on these occasions, and we never observed the kits eating any of these food items outside of a den. While occupying this den site, with F6 presumably absent, we observed play behavior by the kits as they roamed outside the den entrance (generally >20 m from the den entrance) on multiple occasions. We observed the kits dig and appear to pounce on arthropods in the leaf litter, play-fight, and practice handstands. In the early morning of 16 July 2020, we observed an adult Virginia opossum *Didelphis virginiana* (Kerr, 1792) approach and briefly place its head inside the entrance of the den before retreating from the area.

On 24 July 2020, we tracked F6 to a ground burrow ~230 m from the previous den site. Based on video footage we believed that the kits weighed enough to be fitted with 6-g radio-transmitter collars at this time (Model #: M1630; Advanced Telemetry Systems, Inc., Isanti, MN). On 26 July 2020, we surrounded the den with 12 metal live traps (Tomahawk Live Trap, Pro Series Model 103SS, Hazelton, Wisconsin) in an attempt to capture the kits and F6. We set up six of the traps to form an inner circle ~5 m from the den and the remaining six to form an outer circle ~10 m from the den. We hung ball-shaped cat toys that made noise, to potentially attract the attention of the kits (Kendyl Hassler, Florida Fish and Wildlife Conservation Commission, and Chuck Waggy, West Virginia Division of Natural Resources, pers. comm.), inside the inner traps and baited the traps with wet cat food. We baited the outer traps with wet cat food only to capture any skunks that may have passed by the inner traps.

On 27 July 2020, we captured F6 and one kit, which we determined to be a female (Study ID: F7). We recollared F6 with a new 16-g radio-collar and F7 with one of the smaller 6-g radio-collars. On 28 July 2020, we captured all four skunks and collared the remaining two kits, which we determined to be one female and one male (Study IDs: F9 and M32). We ensured that the radio-collars were <5% of the body weight of each skunk before collaring them (Sikes and the Animal Care and Use Committee of the American Society of Mammalogists 2016)—the three kits weighed 286 g, 265 g, and 280 g, respectively, when collared. We subsequently monitored the body weight and condition of the kits and checked that the collars were not too tight on their necks as they grew by recapturing them approximately every two weeks. We continued doing this until we

determined that the kits weighed enough to be fitted with 16-g radio-collars. F6 and the litter remained at the ground burrow where they were captured and collared until 31 July 2020 when we tracked them to a ground burrow ~145 m away.

On 7 August 2020, F6 and the litter denned in a burrow within the root system of a tree. On 8 August 2020, F9 continued to utilize this den site while F6 and the two female kits denned in a ground burrow ~100 m away—the first instance of a kit denning away from F6. On 9 August 2020, we tracked the entire litter to the same den F6 had used on 8 August 2020, confirming that F9 was still alive and had rejoined the litter. On 11 August 2020 we observed an opossum approach the den as a kit was outside the den facing away from the opossum (Figure 2). The kit noticed the opossum and retreated into the den, as the opossum briefly pursued the kit before sniffing around the den entrance and leaving the area.

When we tracked the skunks on 12 August 2020 we found that F7 and F9 were denning on their own while M32 was denning with F6. From this date onward, F7 was never tracked to the same den as F6 and appeared to be independent at this point, at least 71 days after birth. F9 was first observed denning away from F6 on 8 August 2020, and M32 was first observed denning away from F6 on 17 August 2020. However, these kits continued to den with F6 sporadically over the following weeks (F9 on 18 occasions, M32 on 12 occasions). F9 and M32 also denned together without F6 on three occasions before becoming fully independent. M32 was last tracked to the same den as F6 on 4 September 2020 (at least 94 days after birth) and F9 was last tracked to the same den as F6 on 20 September 2020 (at least 110 days after birth). We stopped placing cameras on F6's den sites in mid-August when the kits began to den

independently, but we continued to track F6 to den sites until we recovered her slipped collar on 30 October 2020.

F7 continued to spend time within ~500 m of the natal area for almost a month after becoming independent. She appeared to disperse out of this area between 9 October 2020 and 12 October 2020 when she was tracked to a ground burrow 1.8 km from her last known location on 9 October 2020 (Figure 3). F7 spent 3–4 days in this area before being tracked to a new area ~3.6 km away on 16 October 2020. From the den F7 had occupied on 19 October 2020, she dispersed ~4.4 km away in one evening as she was tracked again on 20 October 2020. F7 stayed in this area until we tracked her to a den for the last time on 27 October 2020. We recovered her slipped collar on 4 November 2020 and did not observe any indication of a mortality event at the site. We were unsuccessful in attempts to trap this skunk around its previous den sites and the area where we found the collar.

F9 remained in the natal area after becoming independent until we last tracked her to a den site on 12 October 2020. After this date, we were unable to locate F9 again until 27 October 2020 when we tracked her to a den site ~6.5 km from the previous known den location, suggesting that she dispersed out of the natal area between 12 October 2020 and 27 October 2020 (Figure 3). We next attempted to track F9 on 30 October 2020, but we found her to be occupying a private property that we did not have permission to access. Over the next five months we monitored F9 by triangulating her location, as she appeared to remain on the private property. We eventually obtained permission to access the property and tracked F9 to a tree cavity on 24 March 2021. As our study was ending, we set traps and captured F9, who had no collar-related injuries and appeared healthy, and removed her collar on 25 March 2021.

M32 appeared to remain near the natal area for over a month after independence (Figure 3) and on 14 October 2020 we found M32's radio-collar. We were unable to determine whether he had slipped the collar or was predated or scavenged on as we found no carcass, but a predation was possible as we found spotted skunk hair around the collar recovery site. We trapped in the area the collar was found and at M32's previous den sites, but never recaptured him.

Our study represents the first monitoring of juvenile eastern spotted skunks from birth through the early months of independence, providing new information on the ecology of this species during a vulnerable life stage. Our observations suggest that eastern spotted skunk kits remain with their mother for about two months before they begin quasi-independent stints denning without their mother for short periods of time. The kits left their mother



Figure 2: An interspecific interaction between an eastern spotted skunk *Spilogale putorius* kit and a Virginia opossum *Didelphis virginiana* outside of a den site in the South Mountains of North Carolina, USA, in August 2020.

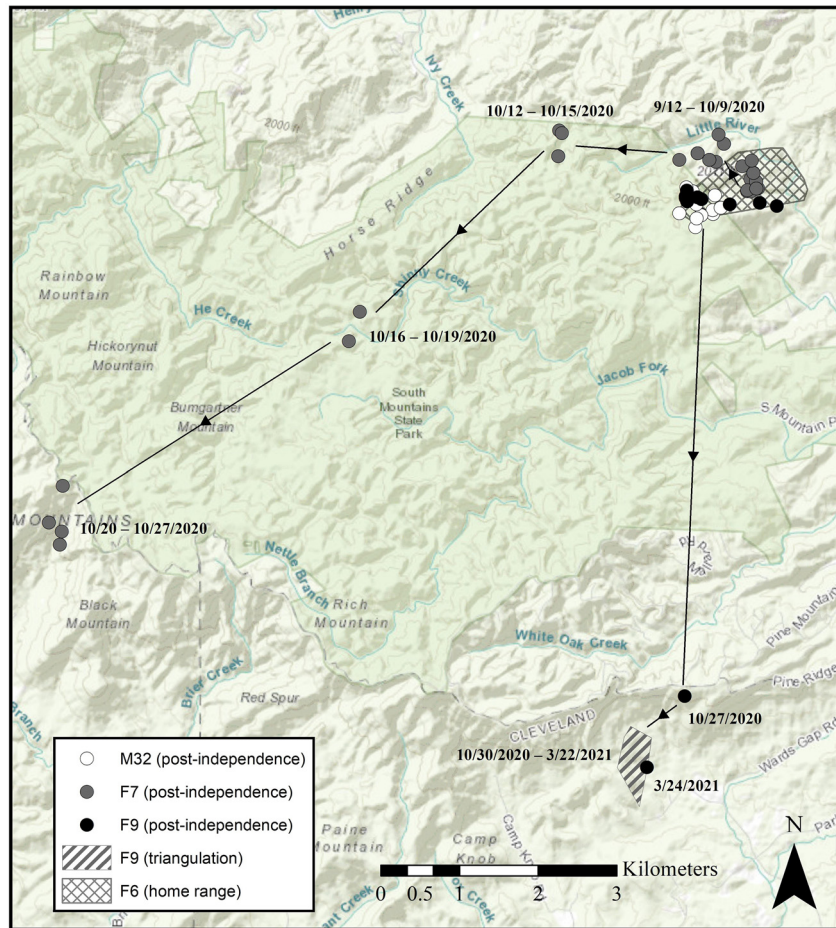


Figure 3: Post-independence movements of two female (F7, F9) and one male (M32) radio-collared eastern spotted skunk *Spilogale putorius* kits in the South Mountains, North Carolina, USA, 2020–2021. Circles represent den sites to which kits were tracked. The polygons represent a 100% minimum convex polygon (MCP) of the mother's (F6) den locations before and after parturition of the litter and after kits became independent, and a 100% MCP of F9's triangulated locations, respectively.

asynchronously and there appears to be much variation in when the kits become fully independent from their mother (between 2 and 4 months for this litter). While we lost track of the male kit (M32) before we could observe if and how far he may have dispersed, we did observe what we believe to be dispersal events by the two female kits. These two kits became fully independent more than a month apart, but they both appeared to disperse during mid-October 2020. F7 moved more than 8.5 km from the natal area before slipping her collar and F9 moved more than 6.5 km from the natal area before we removed her collar in March 2021. Lesmeister et al. (2009) reported female eastern spotted skunk home ranges between 0.54 km² and 1.35 km² and the estimated home range of F6 falls within this range (~0.97 km²). The long-distance moves made by the two female kits suggest that they did not remain near their natal home range and did not stay inside of any established home range immediately after independence. F9 appeared to

have settled into the area we had triangulated her to, but we cannot say whether she would have moved again before possible parturition of young in May–June. Future monitoring of eastern spotted skunk kits from birth through their first breeding season would be useful in better understanding how female spotted skunk territories are determined, especially in relation to their natal home range, littermates, and other known adult spotted skunks in an area.

Our observations highlight the complete dependency of eastern spotted skunks on their mother in the first 2–4 months of their lives. This time period appears critical for the kits as they explore their surroundings, engage in play behavior, interact with other species, and learn to handle and consume food provisioned by the mother. During this period, we observed two surprisingly antagonistic encounters between the kits and opossums, highlighting the need for a better understanding of potential competitive or predatory interactions between

juveniles and other mesocarnivores. Based on the movements we observed in the two female kits, it does appear that kits disperse from the natal area in which they were raised in the late summer/early fall. However, further research is warranted to determine if the dispersal patterns we observed hold true in other portions of the eastern spotted skunk's range, and whether male kits differ in timing and distance of dispersal.

From a technical perspective, our study shows that eastern spotted skunks kits can successfully be fitted with appropriately-sized radio-collars without apparent harm, as long as the kits can be frequently recaptured to assess collar fit, allowing for novel insights about the species. We do not believe that our frequent tracking, camera checks, and recaptures affected the behaviors or movements of the skunks outside of those days in which they were trapped—the skunks often stayed in the same area, and even the same den, they were trapped at for days following capture. We urge other spotted skunk researchers to consider our methods and place more emphasis on studying juveniles in the future to expand upon the initial data we have collected here on a single litter.

Research ethics: We followed the American Society of Mammalogists guidelines for wild mammals (<https://doi.org/10.1093/jmammal/gyw078>) and complied with Clemson University Institutional Animal Care and Use Committee protocol (# 2017-065) for all skunk trapping, processing, collaring, and radio-tracking for this study.

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Conflict of interest statement: The authors declare no conflicts of interest regarding this article.

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