Eastern Wild Turkey Response to Hunting Feral Hogs with Dogs

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Abstract: Impacts of feral hogs (*Sus scrofa*) on native plant and animal communities have increased as feral hogs have expanded in geographic range. Wildlife managers use a host of tactics to manage population growth of feral hogs, including recreational hunting with dogs. However, hunting with dogs can cause disturbance and behavioral changes to non-target species. We monitored 161 eastern wild turkeys (*Meleagris gallopavo silvestris*) over 147 days during 2014–2018 in South Carolina to evaluate turkey movement behaviors and range sizes before, during, and after spring feral hog-dog hunts. The average daily distance traveled per bird in the two-week period preceding hunting was 1940 m (SD = 899; range 158–10,048 m). Average daily distances traveled decreased by 0.3% on days during hunts but increased 15.6% during the two-week period following hunts. Daily distance traveled decreased by 9% on hunted days compared to non-hunted days. Average distance between consecutive roost sites in the two-week period before hunting was 512 m (SD = 483; range 0–3484 m), and increased 22% during hunts. During the two-week period following hunts, average distance between consecutive roost sites decreased 15%. We found no difference between range sizes of wild turkeys in the two-week period before compared to the two-week period after hunts. Our results showed movement response of wild turkeys to disturbance from feral hog-dog hunting was highly individualistic and may depend on the frequency of interactions individual turkeys have with dogs and hunters. Short duration, high intensity feral hog-dog hunts had limited impacts on wild turkey movement ecology.

Key words: movement ecology, disturbance, roosting, dog hunting, hog hunting, wild turkey

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Disturbance affects wildlife in a variety of ways, often resulting in both local and population-level impacts. Anthropogenic disturbances that impact wildlife include resource extraction (Northrup and Wittemyer 2013), infrastructure development (Wilcox and Murphy 1985), wildlife viewing (Blumstein et al. 2005), and noise (van der Ree et al. 2011, Lackey et al. 2012). Additionally, some hunting activities (White and Pickett 1985, Brøseth and Pedersen 2000, Ciuti et al. 2012) are often identified as potential mechanisms for disturbance (D'Angelo et al. 2003, Stillfried et al. 2015), especially for non-target species (Kilgo et al. 1998, Zaccaroni et al. 2012, Mori 2017). For game species, the impact of anthropogenic disturbances are primarily direct mortalities and behavioral adjustments (Northrup and Wittemyer 2013, Mori 2017).

Feral hogs (*Sus scrofa*) have expanded across the southeastern United States and can have considerable impacts on native species (Campbell and Long 2009). Feral hog activities influence a variety of vegetative communities (Jones et al. 2018), cause economic damage to infrastructure and agriculture (Weeks and Packard 2009), and spread diseases to wildlife, livestock, and potentially humans (Pedersen et al. 2018). Management efforts to reduce feral hog abundance have included trapping, poison, aerial shooting, and recreational hunting (Campbell and Long 2009, Keiter and Beasley 2017, Engeman et al. 2019). Currently, recreational hunting is the primary source of feral hog mortality in the United States (Keiter and Beasley 2017). Recreational harvest of feral hogs is generally separated into two categories, passive and active hunting. Passive hunting includes harvest during other activities, such as deer or upland hunting (Keiter and Beasley 2017), whereas active hunting (hereafter, feral hog-dog hunting) is the specific targeting of feral hogs with trained hunting dogs (Campbell and Long 2009).

Feral hog-dog hunting occurs widely across the United States on both public and private lands (Keiter and Beasley 2017). However, hunting using trained hunting dogs can alter behaviors of non-target species (Grignolio et al. 2011, Zaccaroni et al. 2012,

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Mori 2017) by increasing range sizes, movements (Grignolio et al. 2011, Mori 2017), or avoidance behaviors (Janis and Clark 2002). As such, management activities on public and private lands should incorporate knowledge on potential impacts feral hog-dog hunting has on non-target species. To date, little information on relative impacts of feral hog-dog hunting on non-target species is available in the United States, and no data are available for use in management planning on the impact of feral hog-dog hunting on distribution, density, or demographic responses to non-target species. As part of a larger study on eastern wild turkey (*Meleagris gallapavo silvestris*) ecology and management, we evaluated behavioral responses of wild turkeys to high intensity, short duration, spring feral hog-dog hunting on a public wildlife management area in South Carolina during 2014–2018. Our objectives were to determine if wild turkeys exhibited biologically relevant changes in movements, roosting, or range size prior to, during, or after feral hog-dog hunting activities that could potentially influence wild turkey distribution on the landscape.

Study Area

We conducted research on three contiguous wildlife management areas (Webb, Hamilton Ridge, and Palachuchola WMAs; hereafter, Webb WMA Complex) managed by the South Carolina Department of Natural Resources in Hampton and Jasper counties, South Carolina (Collier et al. 2017, Wightman et al. 2018). Hamilton Ridge WMA was 5374 ha composed of approximately 2664 ha of bottomland hardwood wetlands with typical southeastern river floodplains vegetation and 2710 ha of upland industrial pine forest consisting primarily of loblolly pine (*Pinus taeda*), slash pine (*P. elliottii*), and longleaf pine (*P. palustris*). Palachucola WMA was 2734 ha with roughly half (1618 ha) planted loblolly pine under active harvest and conversion to longleaf pine, and half (1092 ha) bottomland hardwood swamp. Webb WMA was 2373 ha composed of 1458 ha of upland pine including longleaf, loblolly, and slash pines and 917 ha of bottom land hardwoods. Overall, the Webb WMA Complex encompassed 10,438 ha with approximately 22 km bordering the Savannah River on the southern border. It was being managed intensively using dormant and growing season prescribed fires, timber harvest, fallow field management, and maintenance of agricultural food plots.

Methods

We captured wild turkeys during January to March 2014–2018 using rocket nets at sites baited with cracked corn. We sexed and aged turkeys based on barring of the ninth and tenth primary feathers (Pelham and Dickson 1992). Each individual was banded with a uniquely numbered aluminum rivet band (National Band and Tag Company, Newport, Kentucky) and radio-tagged with a backpack-style GPS-VHF combination backpack (Biotrack Ltd., Wareham, Dorset, U.K.) (Guthrie et al. 2010) All turkeys were released at the capture site immediately after processing. Animal handling procedures were reviewed and approved by the Louisiana State University Agricultural Center Animal Care and Use Committee (permits A2014-013 and A2015-07). We programmed GPS transmitters placed on females to collect hourly locations between 0500 and 2000 daily and one location nightly (23:58:58 hours; Chamberlain et al. 2018). We programmed GPS transmitters placed on males similarly, except that during 1 March to 30 June, locations were recorded every 30 minutes between 0500 and 2000 hours (Collier et al. 2017, Wightman et al. 2018).

Table 1. Study periods used for analysis of eastern wild turkey movements defined as pre-hunt (two weeks before feral hog hunt occurred), hunt (days of feral hog hunt), and post-hunt (two weeks after feral hog hunt occurred) on the Webb WMA Complex in South Carolina during 2014–2018.

Year	Pre-hunt	Hunt	Post-hunt	Hunter days (*n*)	Feral hogs harvested (*n*)
2014	20 Feb–5 Mar	6 Mar–8 Mar	9 Mar–22 Mar	307	54
2015	19 Feb–4 Mar	5 Mar–7 Mar	8 Mar–21 Mar	161	99
2016	18 Feb–2 Mar	3 Mar–5 Mar	6 Mar–19 Mar	183	60
2017	20 Feb–1 Mar	2 Mar–4 Mar	5 Mar–18 Mar	472	134
2018	15 Feb–28 Feb	1 Mar–3 Mar	4 Mar–17 Mar	686	130

Feral hog-dog hunting dates occurred during the first week of March each year (2014–2018) and ended no later than 8 March (Table 1). Feral hog-dog hunts occurred between sunrise and sunset over three consecutive days each year on the entire Webb WMA Complex. The number of feral hog-dog hunter days, which is the total number of permitted hunters that accessed the Webb WMA Complex during the three-day hunting period (e.g., hunter density was not specific to day), ranged from 161–686 over the five-year course of the study (Table 1). As our inference window, we defined the pre-hunting period as the two weeks before the hunts, the hunting period as during active hunts, and the post-hunting period as the two weeks after hunts.

First, for each male and female GPS tagged wild turkey, we estimated daily distance travelled by summing the sequential distances between GPS locations using R version 3.2.5 (R Core Team 2019) and package dplyr (Wickman et al. 2019). Next, for each male and female wild turkey, we extracted roost locations collected between 2300 and 0100 hours (one per day) and calculated the distance between sequential (daily) roost sites for each individual during the pre-hunting, hunting, and post-hunting periods. We used a dynamic Brownian bridge movement model (dBBMM; Kranstauber et al. 2012) to create utilization distributions (UDs) for male and female wild turkeys for the pre- and post-hunting periods. We did not build UDs for the hunt period due to data limitations

(three days of spatial data). For each wild turkey, we created 50%, 75%, and 99% utilization distributions (UDs) using package move (Kranstauber et al. 2019) with a margin size of 5, a window size of 21, and locational error of 15 (Cohen et al. 2018, Wightman et al. 2018). We kept window and margin size constant to account for changes in GPS sampling frequency because we failed to see any measurable effects of altering these values in our analysis (Cohen et al. 2018). We used *t*-tests in R (R Core Team 2018) to evaluate potentially statistically significant changes in movements of wild turkeys prior to and after hunts, and also consolidated pre-hunting and post-hunting into a non-hunted period for broader comparisons to turkey movements during hunted periods.

Results

We monitored 161 wild turkeys during 2014–2018 on the Webb WMA Complex during March feral hog-dog hunts over 147 days ($n = 132$ non-hunted days, $n = 15$ hunted days; Table 1). We monitored 47 adult males, 62 adult females, 21 juvenile males, and 31 juvenile females. Across all years, the average daily distance traveled per bird in the pre-hunt period was 1940 m (SD = 899; range 158–10,048 m). Average daily distances decreased by 0.3% ($t = 0.07$, $P = 0.94$, df = 560.1) on days during hunts (1935 m, SD = 1372; range 155–16,896) but increased by 15.6% during the post-hunt period (2291 m, SD = 1040; range 210–12,806; $t = -5.23$, $P < 0.01$, df = 577.4) compared to the hunting period. Daily distance traveled during the pre-hunt period was on average 350 m less than daily distances traveled in the post-hunt period ($t = -11.3$, $P < 0.01$, df = 3890). We observed that daily distance traveled decreased by 9% on hunted days (1935 m, SD = 1372; range 155–16,896) relative to non-hunted days (2128 m, SD = 993; range 157–12,085; $t = 2.92$, $P = < 0.01$, df = 514.7; Table 2), but there was considerable variation in movement response across age/sex classes (Table 3).

Average distance between consecutive roost sites in the pre-hunt period was 512 m (SD = 483; range 1–3484), which increased by 22% (133 m, $t = -5.18$, $P < 0.01$, df = 711) during hunt periods (645 m, SD = 610; range 3–3886). In the post-hunt period, distances between consecutive roost sites significantly ($t = -3.54$, $P < 0.01$, df = 799.7) decreased by 15% (88 m) compared to hunt periods (557 m, SD = 591; range 2–8866). Distances between consecutive roost sites in the pre-hunt period were 9% (45 m) less ($t = -2.44$, $P = 0.01$, df = 3357) than during the post-hunt period. Distance between consecutive roosts increased 18% (115 m) on hunt days (654 m, SD = 29; range 4–3885) compared to non-hunt days (539 m, SD = 9; range 1–8866; $t = 4.54$, $P < 0.01$, df = 630.1), but there was considerable variation during the pre-hunt, hunt, and post-hunt periods (Table 4).

For range estimation, we excluded males captured in 2017 because they were captured within the pre-hunt period and we could not build comparable annual range estimates. Additionally, we excluded any bird whose data were not complete for the full study period due to either mortality or tag failure ($n = 38$). We therefore developed ranges for 123 individuals (41 males, 82 females). For males, core area (50%) size increased 27% (2 ha) on average ($t = -2.44$, $P = 0.02$, df = 71.5) between the pre-hunt period (5.25 ha, SD = 3.05; range 0–13 ha) and the post-hunt period (7.23 ha, SD = 0.66; range 2–27 ha, Table 5). We found that 75% UDs during the pre-hunt period averaged 29.5 ha (SD = 2.83; range 1–67 ha) which increased 19% (7 ha) to 36.8 ha (SD = 3.25; range 7–117 ha) on average ($t = -1.61$, $P = 0.09$, df = 77.27) by the post-hunt period (Table 5). Conversely, 99% UDs for males were larger pre hunt (251 ha, SD = 32.4; range 4–1172, Table 5), declining by 3 ha ($t = 0.08$, $P = 0.93$, df = 67.13) by post hunt (248 ha, SD = 20.4; range 33–676; Table 5). For females, core (50%) area size increased 39% (4 ha, $t = -6.10$, $P < 0.01$, df = 155.1) between the pre-hunt (5.9 ha, SD = 0.4; range 1–25.6) and post-hunt periods (9.7 ha, SD = 0.5; range 2.3–23.0). We found that 75% of the pre-hunt UDs averaged 26.6 ha (SD = 1.5; range 2.4–60) increasing by 27% (10 ha, $t = -4.27$, $P < 0.01$, df = 153.7) by the post hunt (36.6 ha, SD = 1.8;

Table 2. Mean daily distances (SD) traveled by eastern (male and female) wild turkeys during the pre-hunt, hunt, and post-hunt periods on the Webb WMA Complex in South Carolina during 2014–2018.

Year	Pre-hunt (SD)	Hunt (SD)	Post-hunt (SD)
2014	2322 (1167)	1924 (910)	2664 (1217)
2015	1695 (774)	1882 (866)	2193 (973)
2016	1967 (798)	1687 (1206)	2215 (905)
2017	1493 (651)	2486 (2615)	2144 (1135)
2018	2209 (973)	2109 (1079)	2539 (1139)

Table 3. Average daily distances (SD) traveled by eastern wild turkeys by age and sex class during the pre-hunt, hunt, and post-hunt periods on the Webb WMA Complex in South Carolina during 2014–2018.

Age and sex	Pre-hunt (SD)	Hunt (SD)	Post-hunt (SD)
Juvenile males	1870 (1127)	2443 (2612)	2335 (1138)
Juvenile females	1949 (762)	2099 (1480)	2059 (837)
Adult males	2044 (1085)	1839 (947)	2703 (1292)
Adult females	1874 (748)	1741 (842)	2082 (748)

Table 4. Average consecutive roost site distance (m) for eastern wild turkeys during the pre-hunt, hunt, and post-hunt periods on the Webb WMA Complex in South Carolina during 2014–2018.

Year	Pre-hunt (SD)	Hunt (SD)	Post-hunt (SD)
2014	673 (593)	787 (528)	699 (690)
2015	392 (376)	629 (557)	543 (482)
2016	563 (495)	531 (544)	540 (570)
2017	572 (454)	644 (673)	445 (761)
2018	558 (557)	906 (765)	608 (619)

Table 5. Average dynamic Brownian Bridge movement model utilization distributions (UD; 50%, 75%, and 99%) in hectares (SD) and associated percent change (%Δ) for eastern wild turkey UDs for March 2014–1018 pre- and post-hunts of feral hogs on the Webb WMA Complex in South Carolina.

	Pre-hunt	Post-hunt	%Δ mean UD size
Male UD size			
50%	5.25 (0.5)	7.23 (0.7)	+ 27.4
75%	29.50 (2.8)	36.78 (3.3)	+ 19.4
99%	251.68 (32.4)	248.54 (20.4)	− 1.25
Female UD size			
50%	5.9 (0.4)	9.7 (0.5)	+ 39.3
75%	26.6 (1.5)	36.6 (1.8)	+ 27.6
99%	152.9 (7.9)	175.6 (8.1)	+ 12.9

range 7.0–75.1). Likewise, 99% UDs increased by 13% (t = -2.02, P = 0.05, df = 161.2) post hunt (175.6 ha, SD = 8.1; range 40–411.5) compared to pre hunt (152.9 ha, SD = 7.9; range 23–387).

Discussion

Previous studies have noted that wild turkeys show individualistic behavioral responses to a variety of disturbances and individual responses vary temporally as well (Gross et al. 2015, Collier et al. 2017, Wightman et al. 2018). At the sample population level, our analysis suggested that changes in mean daily movements, distances between roost sites, and range sizes between age and sex classes were statistically significant, but in reality represented <350 m of movements or <20 ha of change in range size (at the 99% UD level), which are likely not biologically relevant for wild turkeys (Collier et al. 2017, Wightman et al. 2018). Additionally, our observations of turkey movements during the post hunts could be confounded by the onset of the reproductive season in April, as males are known to increase daily movements during the last two weeks of March through April (Collier et al. 2017, Chamberlain et al. 2018).

We did not expect to see acute demographic impacts to wild turkeys (e.g., mortality due to feral hog-dog hunting) as juvenile and adult wild turkeys would be able to effectively avoid interactions with feral hog-dogs and hunters. Likewise, the feral hog-dog hunting on the Webb WMA Complex occurred during March, so we offer that the hunts had little potential to impact initial reproductive activities as the hunts occurred well before (>30 days) the earliest average date of wild turkey nest incubation on the Webb WMA Complex (19 April; Chamberlain et al. 2018). We acknowledge that potential impacts to nesting females and broods could occur during the May feral hog-dog hunting period as it overlaps potential brooding activities which could, in turn, potentially lead to mortality of broods (additional feral hog-dog hunts occur on the Webb WMA Complex during the second and third week of May and the last week of August). However, the feral hog-dog hunting period in May occurs when <20% of females are actively incubating (Chamberlain et al. 2018) and hunter density is significantly lower (<20% of the March hunting period). There are significantly lower hunter densities during this time and impacts are unknown; further investigation is appropriate. The August hunting period is outside the nesting period for wild turkey on Webb WMA Complex, and all broods would be flighted by this time (Wood et al. 2018), so we suggest direct demographic impacts affecting recruitment would be limited.

Our results suggest that while most wild turkeys in our study were fairly consistent in their movement ecology (~2000 m per day) during the feral hog-dog hunting periods, we did see several individuals make unique, extensive daily movements exceeding 10 km. Thus, we suggest that the level of interaction individual turkeys have with feral hog-dog hunting activities (e.g., trained dogs) will most likely drive responses to the disturbance, similar to works on turkeys exposed to hunting by humans (Gross et al. 2015). However, we also note that wild turkeys have shown significant long-distance movements during periods where disturbance was not expected (Collier et al. 2017), thus separating the relative impact of disturbance due to feral hog-dog hunting activities relative to disturbance due to environmental or alternative anthropogenic factors is difficult.

There are a suite of potentially fruitful areas of research that we did not have the ability to evaluate, including topics such as spatial intensity of hog-dog hunting, distribution of alternative species pursued by hog-dog's, and the possible relationship of density and distribution of feral hogs on hog-dog hunting. With the increase in popularity of feral hog-dog hunting and associated changes in geographic expansion (Weeks and Packard 2009), there has been considerable discussion on what management activities may be appropriate for reducing the suite of impacts caused by feral hogs (Campbell and Long 2009). Although multiple studies have found that feral hog harvest via hunting alone is ineffective for decreasing population size (Campbell and Long 2009), the advantages of feral hog-dog hunting include both recreational engagement and associated economic benefits to state agencies via permit hunting on private and public lands (Keiter and Beasley 2017). Our findings suggest that the short duration spring feral hog-dog hunts in March on the Webb WMA Complex have little influence on wild turkey movement ecology. Hence, managers should consider whether similar hunts may be appropriate on public lands where interest exists to pursue feral hogs with dogs.

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