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Wild Turkey Responses to Forest Management

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INHS Technical Report 2015

Prepared for IDNR Division of Wildlife

Issued on 8/31/2015

Release online immediately;

Final Report for W-183-R-1

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- Project Number: W-183-R-1
- Legal Name of Entity doing the Project: The Board of Trustees of the University of Illinois
- Period of Time covered by this report is 07/01/2014-06/30/2015
- Due Date of the Final Report is 12/15/2015
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Summary

- We captured and banded 49 turkeys across two study locations and fitted every hen (n=31) and one male with a microGPS transmitter.
- On average each transmitter recorded over a thousand locations accurate enough to allow us to know where and when hens were nesting, the fates of those nests, and seasonal habitat use at fine- and larger-scales. This will allow us to model how land use and habitat (i.e. forest) management affect the nesting success, survival, and habitat selection of hen turkeys.
- All 9 of the known mortality events for the hen turkeys resulted from predation following the onset of incubation because the carcasses were found near nest locations. This demonstrates that hen turkeys are particularly vulnerable to predation during the incubation phase of the nesting period.
- Only one of 19 nests successfully made it to the poult stage and we now need to determine the predator(s) responsible for predation of hens and/or nests during the incubation phase.
- Preliminary results indicate that turkeys may select nest locations based on stand-level characteristics, rather than local-scale factors (i.e. there was little difference between all of the various measures of vegetation associated with nests compared to paired random non-nest locations 80 m away from nests).
- Finally, the data that we can get from the microGPS transmitters will allow us to use Brownian Bridge Movement Models to assess the effects of land-cover and burn/management history on seasonal and annual home range sizes and habitat use.

Overview and Objectives

Lack of disturbance has led to the degradation of Illinois forests and open woodlands. As with forests throughout the Midwest, these historically oak-dominated systems are transitioning into closed-canopy forests that are dominated by shade-tolerant species such as maples. Much of this transition has been attributed to the exclusion of both anthropogenic and natural fires from contemporary landscapes (Nowacki and Abrams 2008). Beyond encroachment of shade-tolerant native species, the understory layers of many Midwestern forests and open woodlands have become encroached with exotic species such as honeysuckle (*Lonicera* spp.) or buckthorn (*Rhamnus* spp.). These large-scale alterations of forest and woodland ecosystems have adversely impacted numerous conservation-priority wildlife species that have historically depended on relatively open oak-dominated systems, including Red-headed Woodpeckers, Whip-poor-wills, and Wild Turkeys.

Aside from being potential indicators of ecosystem health, Wild Turkeys are an economically important game species. Accordingly, considerable research attention has focused on understanding broad-scale habitat associations of turkeys and estimating demographic parameters. Forests or woodlands with mature trees are known to provide habitat that is preferred by turkeys for parts of their annual cycle (Miller et al. 1999), but turkeys have extensive and seasonally variable home ranges (e.g., <1 to 32 km^2; Porter 1977, Badyaev et al. 1996a, Thogmartin 2001). The importance of different habitat components is likely seasonally dependent, with food availability and safety from predators being important year-round, but with quality nesting and brood-rearing habitat being important during spring and summer. Aspects of vegetation structure and composition, including understory density, are known to influence nest-site selection and reproductive success (e.g., Badyaev 1995, Badyaev et al. 1996b, Locke et al.

2013), but quantitative information on important habitat characteristics during other stages of the annual cycle is generally lacking. Beyond influencing habitat use, the structure and composition of vegetation may influence the frequency and distance of movements, quantities negatively associated with survival (Hubbard et al. 1999). However, despite the numerous links between vegetation structure and aspects of Wild Turkey habitat use and demography, information on turkey responses to management actions is generally lacking.

To better understand the response of Wild Turkeys to forest management activities, The objectives of Segment 1 of the Wild Turkey Responses to Forest Management research project were to:

1) Use a combination of conventional and more-advanced telemetry to examine the effects of forest management, habitat and landscape features on Wild Turkey habitat use, survival and reproductive success in east-central and western Illinois (at least 2 study areas);

2) Use Global Positioning Systems (GPS) telemetry to understand variation in fine-scale movements and habitat use of up to 50 Wild Turkey hens throughout their annual cycle;

3) Use these results to inform/modify stand- and landscape-level forest and open woodland management plans and actions to benefit turkey populations in Illinois.

Methods

Given the importance of adequate nesting and brood rearing habitat to Wild Turkey (WITU) demographics (Badyaev 1995, Roberts and Porter 1996, Thogmartin 1999, Thogmartin and Schaeffer 2000, Spears et al. 2007, Fuller et al. 2013), our primary focus is on the movements, habitat selection and survival of WITU hens throughout their annual cycle in areas where forests are actively being managed in ways that are intended to promote favorable nesting and brood rearing habitat.

Study Sites. We conducted this research in two locations in central Illinois: Stephen A. Forbes State Park (Forbes), and Lake Shelbyville – including U.S. Army Corp of Engineers land along with Eagle Creek and Wolf Creek State Parks (Lake Shelbyville). Forbes is approximately 1256 ha of forest surrounding a large impounded lake, of which 465 ha are actively managed oak and hickory forest. Management at Forbes is focused on maintaining open woodlands with intact canopy through the use of prescribed fire and occasional selective (undesirable and mesic species) sapling removal. This management is intended to promote structure and composition of understory vegetation that is beneficial for wild turkeys during the breeding season. At Lake Shelbyville, oak, hickory and hard maple flourish in the uplands. Improvements to the forest which consist of thinning the trees to enhance mast production and understory growth (e.g. 40-160 ha per year), nesting cover establishment, prescribed burning (e.g. 20-80 ha per year), and invasive species eradication (such as bush honeysuckle and autumn olive). The active management at Lake Shelbyville is distributed in small units spread out over a large area, mostly on U.S. Army Corp of Engineers land.

Capture and tracking. We captured wild turkeys using magnetic-release drop nets at sites baited with cracked corn during winter (January – March) of 2015. Each captured bird was

banded with an aluminum rivet leg band. Age of each captured individual was determined by evaluating the shape, wear, and barring on the 9th and 10th primaries (Leopold 1943), and sex was determined using a combination of morphological features (e.g., caruncle coloration, beard presence, leg spur presence and length, breast-feather coloration; Dickson 1992). Each hen was weighed in a sling with a 10 Kg spring scale, and then fitted with a MiniTrack GPS transmitter (Lotek Wireless Inc., Ontario, Canada). Transmitters were programmed to record a location every two hours during daylight hours (e.g. 0500-1900 hours) and one location at midnight (i.e., 9 locations daily). Based on this configuration, we expected the units to collect data for up to approximately one year. The location data is stored on the transmitter, and may be uploaded remotely from a distance (at most approximately 1 km). Remote downloads allow us to collect the data without disturbing nesting hens or influencing turkey movements. We released all birds at the capture site immediately after being processed. Each GPS-marked hen was relocated every two weeks using a 3-element Yagi antenna and a receiver (R-1000, 148-160 MHz, Communications Specialists Inc.). Upon relocation of a bird, we positioned ourselves within approximately 500 m of the hen to facilitate use of a Handheld Command Unit (HCU; Lotek Wireless Inc., Ontario, Canada), which allowed us to remotely download location data from the GPS unit. These methods were approved by the University of Illinois at Urbana-Champaign Institutional Animal Care and Use Protocol (#15010).

Home-range analyses. We are currently working on these analyses and provide some sample information in the results section below. In general, to evaluate the seasonal and annual range of wild turkeys, we will develop and evaluate Brownian Bridge Movement Models (Fischer et al. 2013) using the 'adehabitatHR' and/or 'move' packages in R. We will determine the amount of each land-cover type (including management history) within each turkey range in

order to determine preferences for particular habitat types/structures during the various seasons (winter, spring, summer, and fall) within the annual cycle of hen turkeys. We will evaluate home range size as a function of age (juvenile or adult) and condition (weight) at time of capture, and include these as random variables in all models if the correlation coefficient is significant at $p<0.05$. Finally, we will model the response of seasonal and annual home range size as a function of land-cover and burn/management history.

Hen, Nest, and Brood Survival. We will use known-fate or other appropriate models (Allison 2004) to estimate the survival rates of hens and nests. Survival of hens will be modeled once all hens from this current captured cohort die, or all radios stop working. We will use capture-recapture imperfect detection models (Lukacs et al. 2004) to estimate brood survival for any radioed hens that had broods, but during this first year of our ongoing project, only one radioed hens had a nest that made it to the brood stage. So in the results we currently report summaries of the fates of hens and nests, and during the coming months will continue to develop the survival rate models for hens and nests.

Nest-site Vegetation Surveys. Several parameters were measured at each nest site as well as a paired "non-nest" location (80 m from each nest, in a randomly-determined direction) associated with each nest. At each nest bowl and non-nest location, we measured the distance to horizontal obstruction (stems ≥4 cm) above the location (maximum distance of 1.5 m), and distance to vertical obstruction (maximum distance of 5 m) from the nest (Nguyen et al. 2004). At 1 m in each cardinal direction from the nest bowl edge and non-nest locations in each cardinal direction, we measured stem density of woody and herbaceous vegetation <1 m high, and visually estimate understory cover (<1 m high) to the nearest 5% (Fuller et al. 2013).Within a 15-m radius of the nest bowl and non-nest location, we counted all tree and shrub stems, and placed

each into the following categories (Badyaev 1995): small tree (<25 cm in dbh), medium tree (25-45 cm dbh), large tree (>45 cm dbh); small shrub (<3 cm in diameter at 0.1 m height), and large shrub (>3 cm). We also recorded visual obstruction at 15 m from each nest and non-nest location using a density board (Nudds 1977) placed at the nest or non-nest location and viewed from each cardinal direction. Understory cover was estimated using 6 categories (Badyaev 1995) ([1] <2.5%, [2] 2.5-25%, [3] 26-50%, [4] 51-75%, [5] 76-95%, and [6] >95%) at three height classes (0-50 cm, 51-100 cm, and 101-200 cm).

Results and Discussion

General. During late January through February we monitored 4 bait sites at Forbes (Figure 1) and 6 at Lake Shelbyville (Figures 2-3). Initial baiting consisted of 50-100 m long lines of cracked corn spread across open areas adjacent to forest with trail cameras monitoring visitation. Corn was supplemented every week. Once turkeys were observed at bait, then larger quantities of corn (Figure 4A) were placed in a smaller part of the open areas to concentrate turkeys (Figure 4B) in location of where net would be constructed (Figure 4C). Once turkeys were coming in to bait regularly, the drop net and rigging were put in place (Figure 5 A-C) to allow turkeys to become accustomed to walking beneath the net. Nets were set up at one location each at Forbes (Pipeline; dropped three separate times; Figure 1) and Lake Shelbyville (Eagle Creek Site Headquarters; dropped once; Figure 3). All captured birds were processed and received a rivet band on the leg, all captured females and one male were fitted with microGPS telemetry units, and all birds were released where captured (Figure 6 A-C).

Capture Information. We captured and banded a total of 49 turkeys. Of the 42 captured in Forbes, 16 males were banded (12 juveniles and 4 adults) and 26 females were banded and fitted with microGPS units (13 juveniles, 11 adults, and 2 of unknown age). Of the seven captured in

Eagle Creek State Park at Lake Shelbyville, five females (four juveniles and one adult) and one adult male were banded and fitted with microGPS units, and one juvenile male was only banded. Three of the males (two adults and one juvenile) captured and banded at Forbes were subsequently harvested at Forbes during the turkey hunting season in April of 2015.

Hen Survival. As of 1 September 2015, 12 of the 31females fitted with microGPS units were still alive, 9 were known to have died, and the status of 10 was unknown (issues with telemetry units) (Table 1). The one male wearing a unit was still alive. All deaths were presumed to be due to predation following the onset of incubation because the carcasses were found near nest locations. This demonstrates that hen turkeys are particularly vulnerable to predation during the incubation phase of the nesting period. The cumulative proportions of turkeys alive, dead, or of unknown status at the end of each season (winter, spring, and summer) are provided below for Forbes (Table 2) and Lake Shelbyville (Table 3).

Table 1. Age, sex, and status (as of 1 Sept 2015) of wild turkeys captured and fitted with microGPS units (n=32) in central Illinois during late winter 2015.

Age	Sex	Status	Frequency
Adult	F	Alive	6
Adult	F	Dead	2
Adult	F	Unknown	4
Adult	M	Alive	1
Juvenile	F	Alive	5
Juvenile	F	Dead	7
Juvenile	F	Unknown	5
Unknown	F	Alive	1
Unknown	F	Unknown	1

Table 2. Cumulative proportion of microGPS-tagged turkeys (n=26) alive, dead, or of unknown status in Stephen A. Forbes State Park at the end of winter, spring, and summer of 2015. Date ranges were modified from Badyaev et al. (1996a) to reflect the time periods for which we had data: winter (16 Dec – 15 Mar); spring (16 Mar – 15 Jun); summer (16 Jun – 15 Sep); fall (16 Sep – 15 Dec).

Date range	Alive	Dead	Unknown
1 Jan-15 Mar	0.92	0.00	0.08
16 Mar-15 Jun	0.58	0.12	0.31
16 Jun-31 Aug	0.42	0.23	0.35

Table 3. Cumulative proportion of microGPS-tagged turkeys (n=6) alive, dead, or of unknown status in Eagle Creek Recreation Area at the end of winter, spring, and summer of 2015.

Date range	Alive	Dead	Unknown
1 Jan-15 Mar	1.00	0.00	0.00
16 Mar-15 Jun	0.83	0.17	0.00
16 Jun-31 Aug	0.33	0.50	0.17

Turkey GPS Locations and Home Ranges. The mean number of GPS locations recorded through 31 August 2015 for the turkeys was 1035 and ranged from 91-1609 (Table 4). An example of the distribution of a hen turkey's locations (including the nest location) overlaid on satellite imagery is given in Figure 7 for one hen at Forbes. An example of seasonal space use and home range sizes (95% minimum convex polygons) for one hen is provided in Figure 8 and Table 5. The seasonal home ranges overlap substantially (Figure 8) but are expanded during spring and summer, likely due to seeking suitable nesting locations, and later seeking foraging sites with a brood of poults.

Of the nine hens from which we are still collecting data in Forbes, only two were detected within recently-burned (i.e. during the fall/winter just prior to the current breeding season) areas during the breeding season (mid-April through May). Hen 60424 (juvenile at time

of capture) was located in a burned area on 51 occasions (16 separate days) spread throughout April and May. Hen 60434 (adult at time of capture) was also detected within a burned area, but appeared to only briefly use (47 occasions; 7 separate days but just during the first week of April) the burned areas. Several other individuals were located in these recently burned areas, but mostly during winter, early spring, and late summer. The main point here is that hens did not spend much time in recently burned areas during the breeding season, and no nests were placed in recently-burned areas. Moving forward, we will create 95% minimum convex polygons of seasonal home ranges for every hen which will be used to evaluate the proportion of landcover types used throughout the year and compare this to what is available. We are also determining the best analytical method (adeHabitatHR vs. move, in R) to develop Brownian Bridge Movement Models for each hen throughout its annual cycle.

Table 4. Summary statistics of number of GPS locations recorded for wild turkeys (n=27) in central Illinois during 2015 (through 31 August). Turkeys that were not relocated, due to technical error with microGPS units, are not included.

Min	1st Quart.	Median	Mean	3rd Quart.	Max
91	732	1031	1035	1574	1609

Table 5. Seasonal home range information for hen 60434 in Stephen A. Forbes State Park during 2015.

Season	Range area (in hectares)
Winter	71
Spring	225
Summer	176
Fall	88

Nesting Information. Turkey hens initiated (commenced incubation of) their first nests between 12 April and 8 June in 2015 (Table 6) with the hens starting a bit earlier on average at Lake Shelbyville (Table 7) compared to at Forbes (Table 8). Of the 19 nesting attempts, we only documented one that made it to the poult stage. Nine of the nesting attempts resulted in predation of the hens during the incubation stage of the nesting cycle. This accounted for all of the known mortality of hens in our study so far, and illustrates the risks that hens (and their nests) face during incubation. The other nine nests that failed did so without the hen being killed (true nest predation or hen desertion of following predator attack). We have yet to determine the primary predator(s) responsible for this result, but it was apparent that nesting failure and female mortality often went hand in hand.

Preliminary comparisons of visual obstruction (Table 9) and vegetation within 15 m, between nests and paired random locations (80 m away), indicate that turkeys may select nest locations based on stand-level characteristics, rather than local-scale factors (i.e. there was little difference between all of the various measures of vegetation associated with nests compared to random locations 80 m away from nests). Our results also confirm findings from prior research that suggests turkey hens like to nest in tracts of forest with numerous small trees, and generally high visual obstruction in the lower understory (0-50 cm). Oak, hickory, and elm trees were the most frequently detected tree species within 15 m of nests. There was a tendency for nests to have more woody stems and fewer grass stems within a 1-m proximity compared to the paired random (non-use) locations (Table 10), but given the amount of variation in these measures, a larger sample of nests is needed to adequately test for differences. We expect that with additional years of data, we will be able to better evaluate the relationship between habitat, nest-site selection, and reproductive success of wild turkeys.

Table 6. Temporal summary of first-nest initiations (n=17) by wild turkey hens in central Illinois during 2015.

Nesting parameter	Date
Mean first-nest initiation	5-May-15
Median first-nest initiation	4-May-15
Earliest first-nest initiation	12-Apr-15
Latest first-nest initiation	8-Jun-15

Table 7. Temporal summary of first-nest initiations (n=4; one adult and 3 juveniles) by wild turkey hens in Eagle Creek State Park at Lake Shelbyville during 2015.

Nesting parameter	Date
Mean first-nest initiation	22-Apr-15
Median first-nest initiation	22-Apr-15
Earliest first-nest initiation	12-Apr-15
Latest first-nest initiation	30-Apr-15

Table 8.Temporal summary of first-nest initiations (n=13; eight adults and 5 juveniles) by wild turkey hens in Stephen A. Forbes State Park during 2015.

Nesting parameter	Date
Mean first-nest initiation	8-May-15
Median first-nest initiation	6-May-15
Earliest first-nest initiation	21-Apr-15
Latest first-nest initiation	8-Jun-15

Table 9. Mean distance (m) to horizontal and vertical obstruction, and obstruction (see vegetation sampling methods) of the nest bowl at three height ranges, for wild turkey nests (n=19 including 2 renests) and paired random locations (n=19).

	H_OBST	±SD	V_OBST	±SD	0-50 cm	±SD	51-100 cm	±SD	101-200 cm	±SD
Nest	2.91	2.97	1.25	1.29	4.68	1.60	3.96	1.81	3.29	1.82
Random	3.28	2.13	0.80	0.45	4.54	1.96	3.53	2.03	2.58	1.87

Table 10. Mean number of large (>45 cm dbh), medium (25-45 cm dbh), and small (<25 cm in dbh) trees surveyed at wild turkey nest locations (n=19 including 2 renests) and paired random locations (n=19) in south-central Illinois during 2015.

	L	±SD	M	±SD	S	±SD
Nest	0.25	0.70	0.89	1.96	7.43	11.73
Random	0.50	1.14	0.92	2.03	8.08	14.13

Table 1. Mean and standard deviation values of woody plants, forbs, and grass within 1 m radius of nest bowl at used and non-used (random point 80 m away) locations in 2015 (Nest, n=13; Non-use, n=13).

Nest / Non-use site	Woody	SD ±	Forb	SD ±	Grass	SD ±
Nest	16.8	10.0	18.5	11.6	63.2	163.8
Non-use	9.2	12.2	22.0	25.0	94.1	174.2

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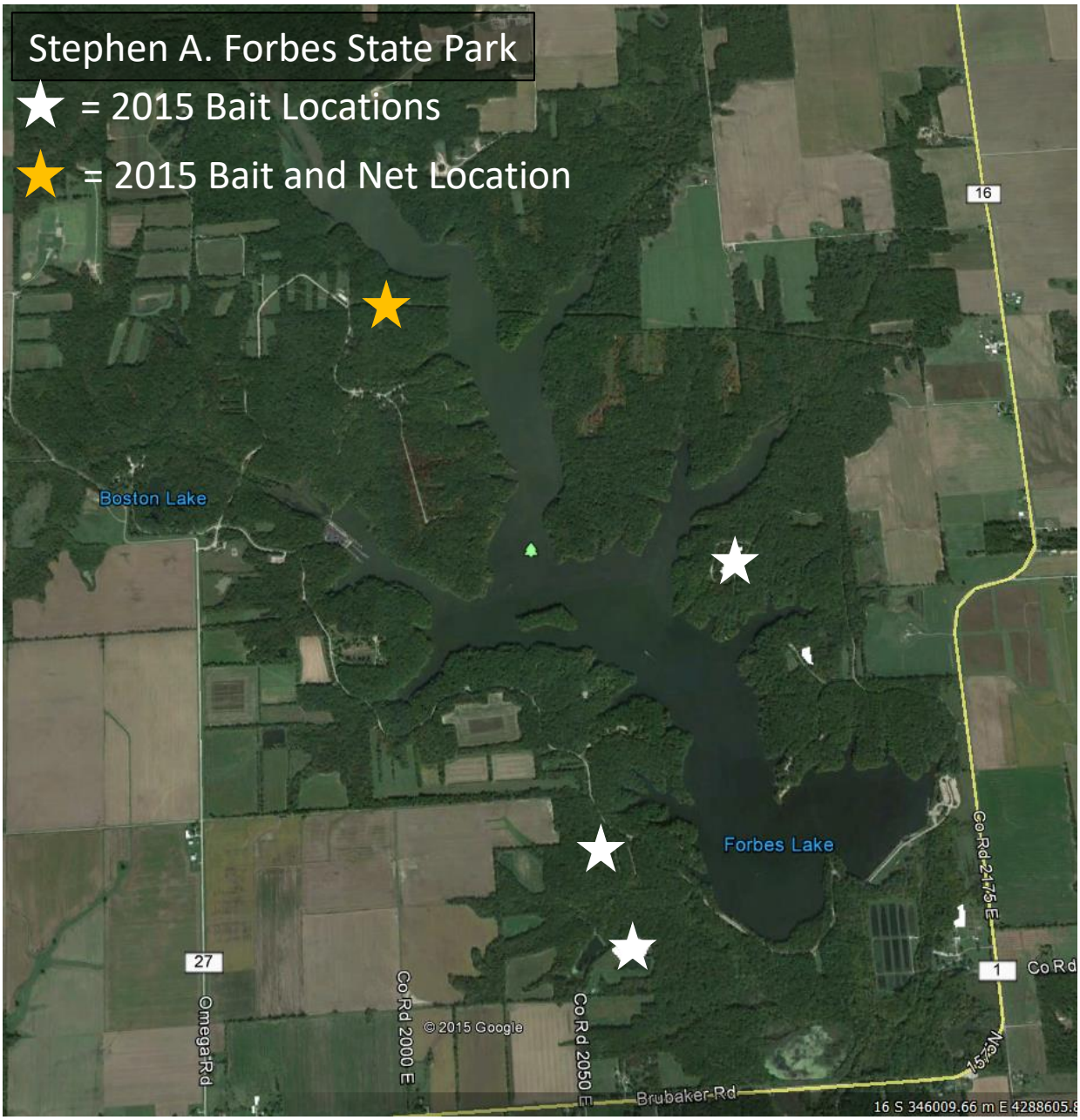

Figure 1. Bait and net locations at Stephen A. Forbes State Park for 2015 Wild Turkey research project.

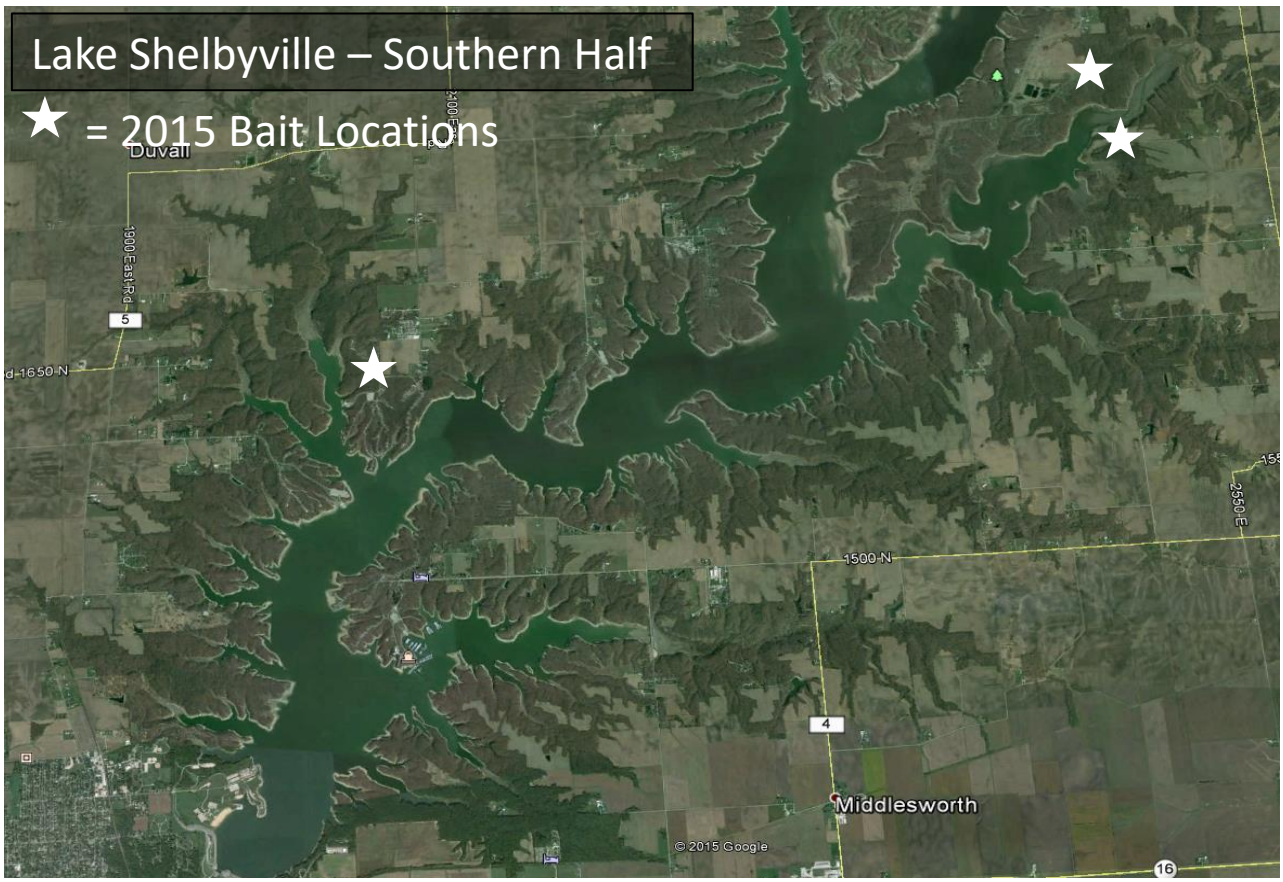

Figure 2. Bait locations in the southern portion of the U.S. Army Corp of Engineers Lake Shelbyville Management Area for 2015 Wild Turkey research project.

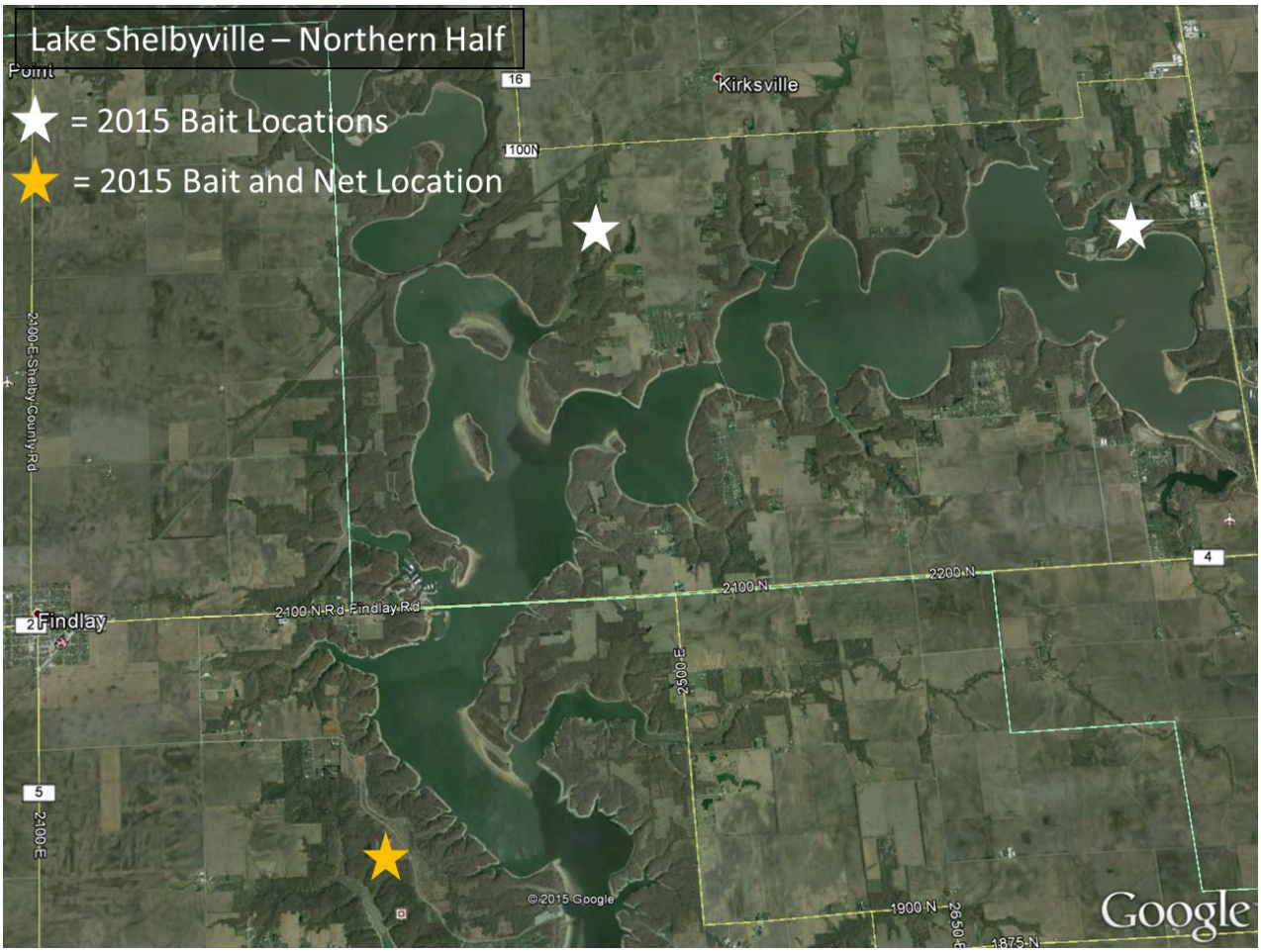

Figure 3. Bait and net locations in the northern portion of the U.S. Army Corp of Engineers Lake Shelbyville Management Area for 2015 Wild Turkey research project.

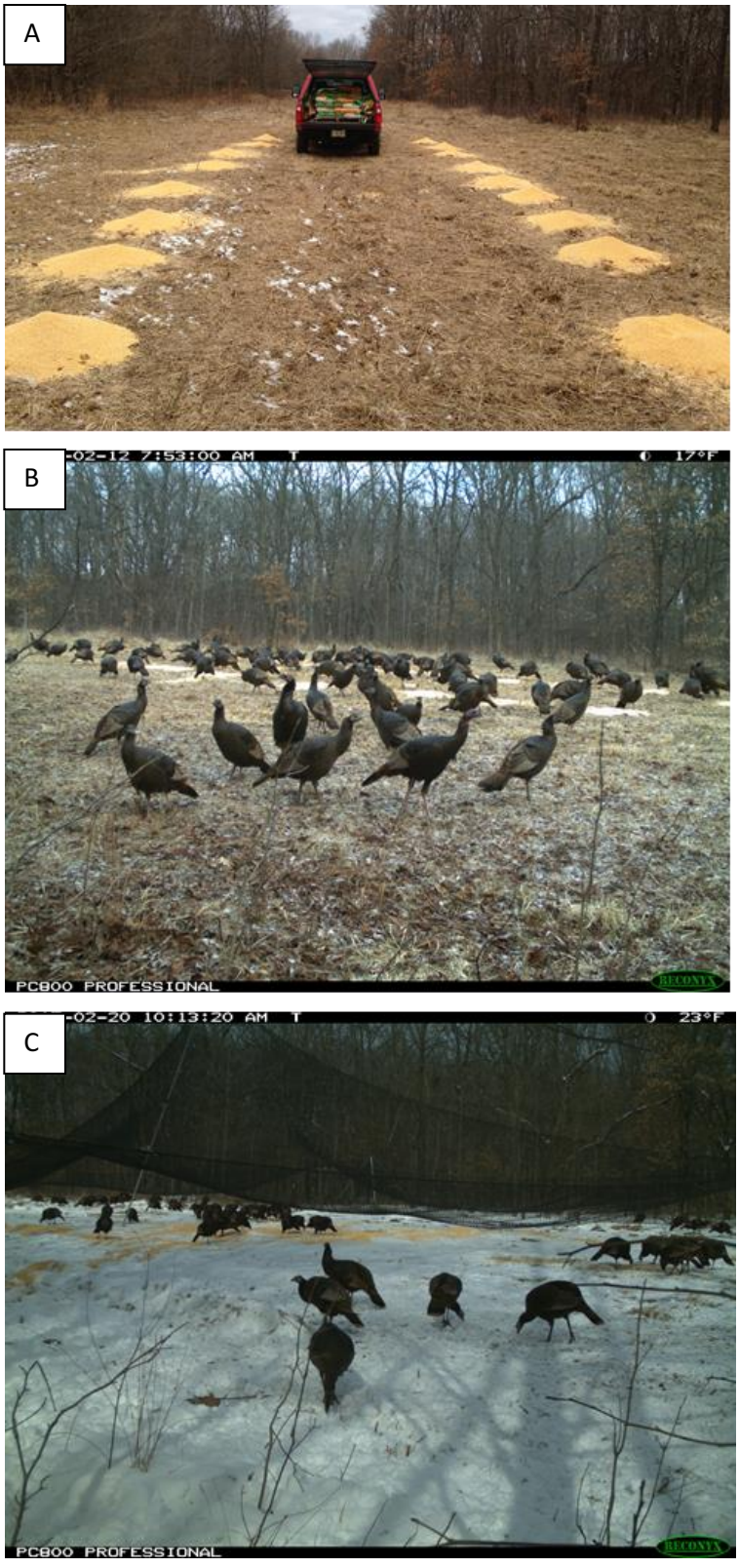

Figure 4. Example of A) bait piles, B) trail camera image of turkeys on bait, and C) trail camera image of turkeys on bait under drop net during the 2015 field season of the wild turkey research project.

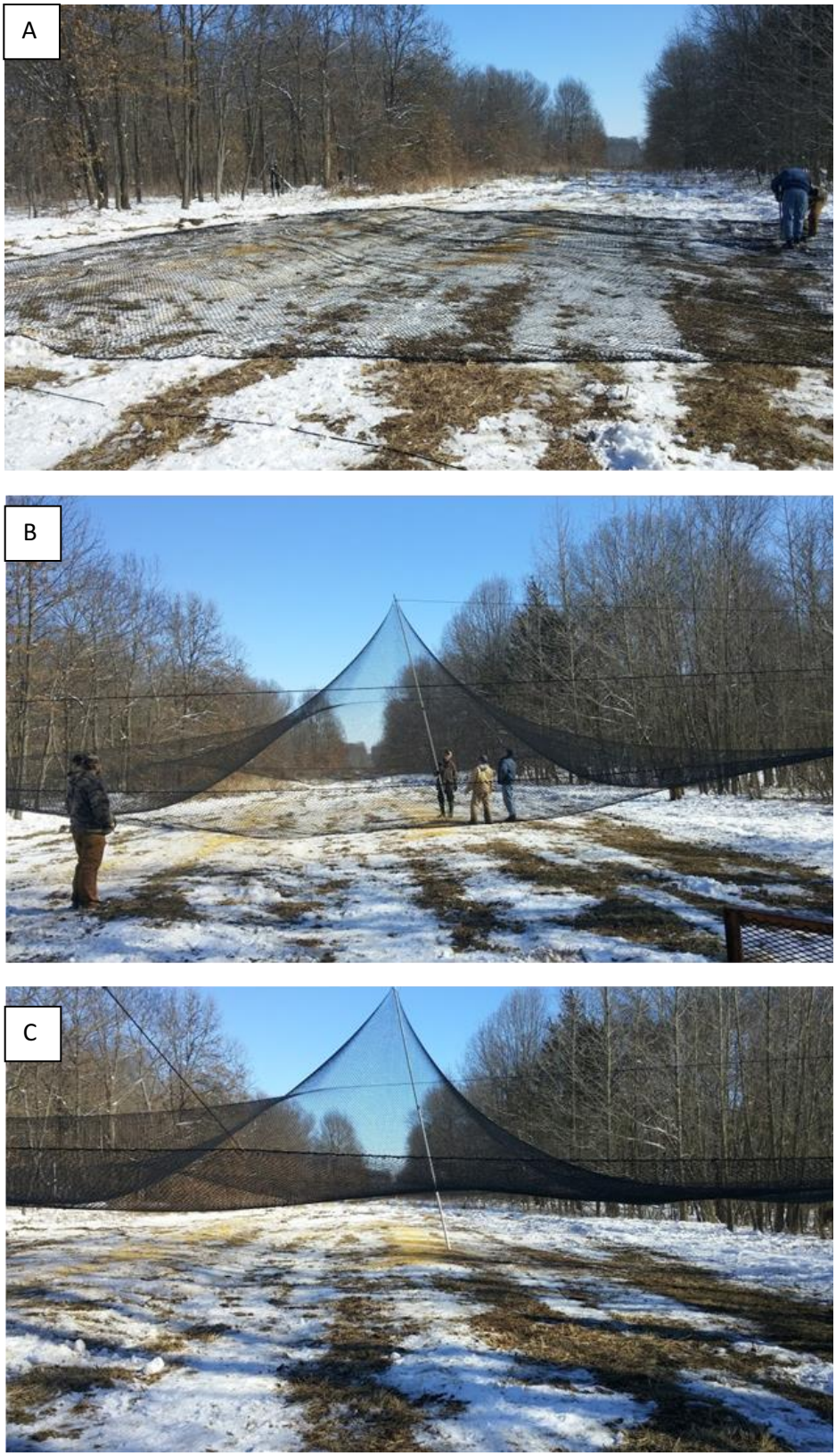

Figure 5. Images of A) spreading out, B) lifting, and C) final positioning of drop net during the 2015 field season of the wild turkey research project.

Figure 6. Example of A) rivet leg band on turkey, B) fitting hen turkey with microGPS transmitter, and C) hen turkey ready for release during the 2015 field season of the wild turkey research project.

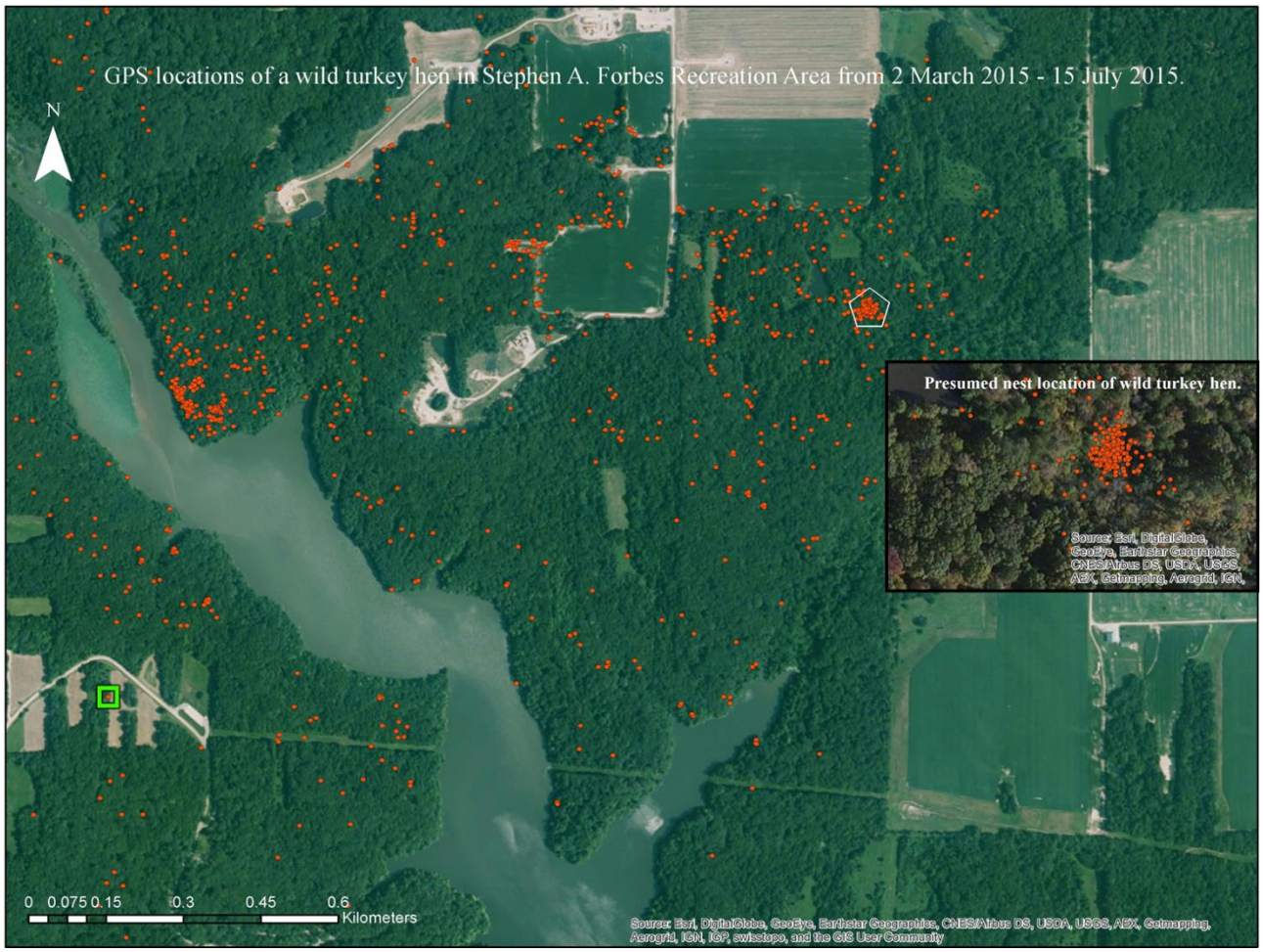

Figure 7. Example of GPS locations (including GPS-indicated nest site) for one of the hen turkeys at Stephen A. Forbes State Park during the 2015 field season. Locations include 9 points per day during the period 2 March to 15 July, 2015.

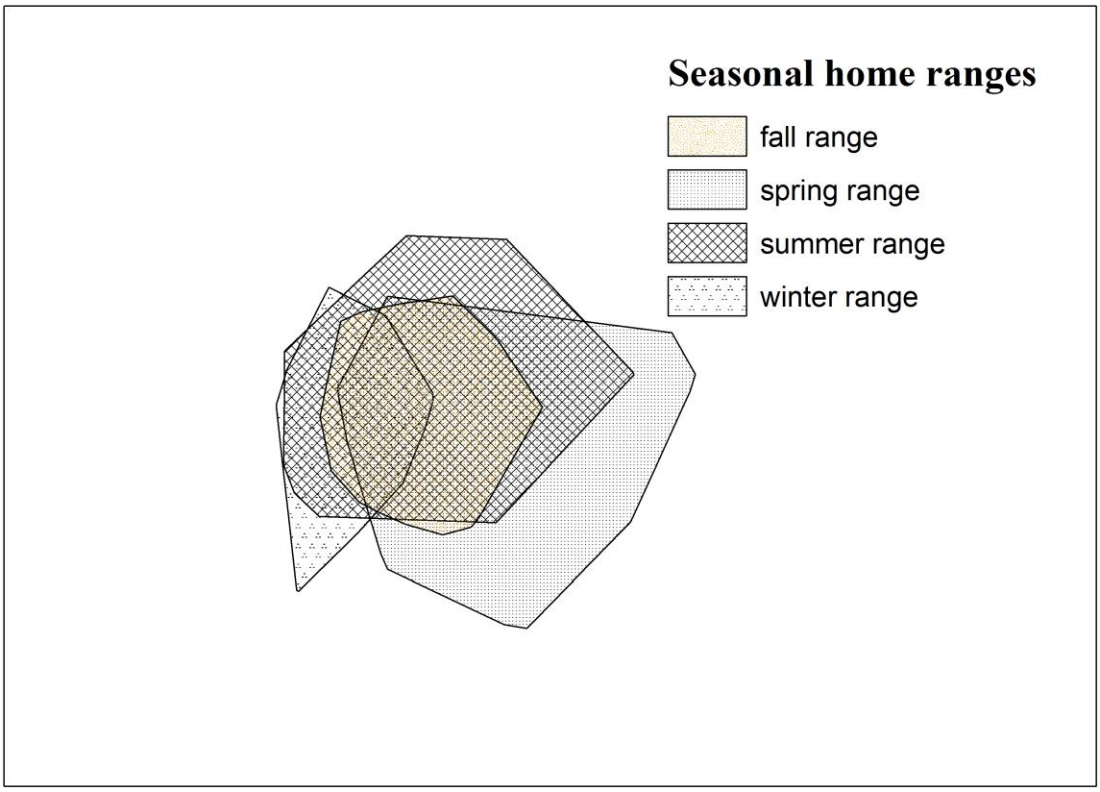

Figure 8. Example of overlapping seasonal home ranges (95% minimum convex polygon) for one of the hen turkeys at Stephen A. Forbes State Park during the 2015 field season. Home ranges vary in size from 70 (winter) to 225 (spring) hectares.