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Wild Turkey Responses to Forest Management

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Wild Turkey Responses to Forest Management

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Summary

- We continued to document locations and fates of Wild Turkey hens captured in the winter of 2015 whose radios continued to function into the fall/winter of 2015 and winter spring of 2016.
- During the winter/spring of 2016 we captured and banded 46 Wild Turkeys across two study locations and fitted every hen (n=38; 21 at Forbes and 17 at Lake Shelbyville) with a μGPS transmitter.
- On average each transmitter has recorded over a thousand locations to date that are accurate enough to allow us to know where and when hens were nesting, the fates of those nests, and seasonal habitat use at finer- 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.
- Of the 2016 cohort of new hens, 8 of the 9 known mortality events resulted from predation following the onset of incubation because the carcasses were found near nest locations. This pattern has repeated for 2 consecutive years and demonstrates that hen turkeys are particularly vulnerable to predation during the incubation phase of the nesting period. We still do not know what predators are responsible.
- Accelerometer data (index of hen turkey motion collected every 5 minutes) from the radios on hens allowed us to determine that of 19 hen mortality events, 7 occurred during overnight hours and 12 during daylight hours.
- Six of 25 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). Additional analyses will be forthcoming.
- Finally, the programming and database structure are now in place to allow us to begin using the data that we get from the μGPS transmitters to create 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 2 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 40 Wild Turkey hens (split among study areas) 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, and beginning in 2016 some tree thinning as well (Figures 1-2). This management is intended to promote structure and composition of understory vegetation that is beneficial for WITUs 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 (Figures 3-4).

Capture and tracking. We captured WITUs using magnetic-release drop nets at sites baited with cracked corn during winter (January – March) of 2016. 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 μGPS 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). Each μGPS unit is also equipped with a dual axis activity sensor which records forward-backward (x-axis) and left-right (y-axis) movements (Lotek user manual, revised on 21 Aug 2014). Activity is measured simultaneously on each axis four times per second, and recorded as the difference in acceleration between consecutive measurements within a range of 0 – 255. These measurements (x and y) are averaged over five minute intervals. Values < 15 are not considered active movement.

Based on this configuration for transmitters, we expected the units to collect data for up to approximately one year. The location and activity data is stored on the transmitter, and may be uploaded remotely from a distance (at most approximately 1 km) allowing 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 μGPS-marked hen was relocated every week during the breeding season and bi-weekly during the non-breeding season, 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), and remotely downloaded location and activity data from the µGPS unit. These methods were approved by the University of Illinois at Urbana-Champaign Institutional Animal Care and Use Protocol (#15010).

Nest, Hen, and Brood Survival. Once we have all of the complete data from the current cohort of hens, we will use known-fate or other appropriate models (Allison 2004) to estimate the survival rates of hens and nests. In the results we currently report summaries of the fates of nests and hens, and during the coming months we will continue to develop the survival rate models for hens and nests and will provide those as they are completed.

Nest fate. We used location and activity data from µGPS-monitored hens to determine nest locations. Hatch dates were estimated based on the date when activity data first indicate a hen had low movement values (i.e., ≤ 15) for about 23 hours per day, indicating incubation had begun. After 28 days of incubation (Paisley et al. 1998), each nest was located to determine nest fate. Nests where egg shells remained mostly intact (i.e., not crushed or scattered) were classified as successful and attempts were then made to obtain visual confirmation of poults with the hen. Nests were classified as failed, and presumed predated, if egg shells were found smashed and scattered, and no poults observed with the hen during the following week. If a hen terminated incubation early (< 28 days), the nest location was visited immediately to determine nest fate, and was classified abandoned if eggs were intact, or predated if eggs were destroyed.

Hen fate. During the breeding season, hens were monitored once weekly to download data and check for a mortality beacon. During the upcoming 2017 research effort, each µGPS will be programmed to emit a mortality beacon after 48 hours of inactivity. Unpublished data suggest that hens may sometimes remain on the nest for ≥ 24 hours during inclement weather which produces a false mortality signal. Following detection of a mortality signal, hens were located, and intact carcasses collected for necropsy at the University of Illinois Veterinary Diagnostic Laboratory. Any signs observed at the carcass location, indicating predation by a specific animal (e.g., fur, feathers, tooth or claw marks, etc.), were noted. Due to the difficulty of identifying predator species without direct observation, we were only seeking to determine if predation was the cause of death.

Hen activity data. We collected some observational data from domestic µGPS-tagged turkey hens to facilitate the identification of incubation versus recess behaviors from within the activity sensor data output. During fall of 2016, we tagged and video-recorded the behaviors of five domestic turkeys in a pen at Caveney Farm in Monticello, Illinois. We will also attempt to observe some of the WITU hens that were tagged during the spring of 2016 during the fall and winter to collect additional behavior/activity data.

Brood Surveys. For hens with successful nests, brood surveys were conducted weekly for up to 16 weeks. Telemetry was used to locate these hens each week following a successful hatch. Each week hens were directly observed one time when possible to determine whether there were any poults with her (yes, no, uncertain) and to record the maximum number of individual poults observed. Care was taken to not unnecessarily prolong observations or "harass" any of the hens.

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. To evaluate visual obstruction around turkey nests, we measured the distance to the nearest obstruction (e.g. foliage or stems) above the nest up to 1.5 m, and outward (horizontally, in any direction) from the nest up to 5 m. Visual obstruction at 15 m from a nest was also recorded whereby a technician held a density board (Nudds 1977) at the nest bowl facing the direction of a 2nd technician located 15 m from the nest. The 2nd technician then estimated and recorded an index of vegetation cover for each height class represented on the density board, including 0-50 cm, 51-100 cm, and 101-200 cm above ground level. Cover index values are [1] < 2.5%, [2] 2.5 – 25%, [3] 26 – 50%, [4] 51 – 75%, [5] 76 – 95%, and [6] > 95%. This visual obstruction at 15 m survey was conducted in each the cardinal direction from the nest bowl.

To evaluate vegetation cover around turkey nests, we estimated and recorded cover (to the nearest 5%) for small (< 3 cm in diameter at 0.1 m height), and large shrubs (> 3 cm in diameter at 0.1 m height) within 15 m of the nest bowl. Within 1 m of the nest bowl, in each cardinal direction, we estimated vegetation cover ≤ 1 m high, to the nearest 5% (Fuller et al. 2013). Vegetation surveyed within 1 m was classified as either woody or herbaceous.

Ongoing Data analyses. To calculate individual measures of incubation recess duration and frequency, we will use machine learning algorithms to recognize and classify incubation patterns within activity data (Nathan et al. 2012, Brown et al. 2013). Behavioral observations and activity data collected from domestic and WITUs will be used to train and create the algorithm decision rules. We will calculate daily measures, and an average (over all the days of a given nesting attempt), of incubation recess duration and frequency for each nesting hen.

We will use model selection to evaluate the support for general linear mixed models of daily nest and hen survival (Burnham and Anderson 2002). We will use capture-recapture imperfect detection models (Lukacs et al. 2004) to estimate brood survival for the radioed hens that had broods, which includes one radioed hen from 2015 and six radioed hens from 2016 that had nests that made it to the brood stage. These models will include the additive and interactive effects of nest-site vegetation characteristics and incubation behaviors. Study area, year, nest id, and management history of the nest location will be included as random variables. I will also evaluate landscape features (e.g., distance to edge) that may influence nesting mortality (i.e. death of hen or failure of nest) based on previous research. All analyses will be conducted using R (2016).

Camera Trap Data. To evaluate the nest/hen predator community in burned and unburned areas within Forbes, we conducted trail-camera surveys during June 2016. Eighteen cameras were deployed, each for a 4-week period, 9 within recently burned/thinned areas (winter/spring 2016), and 9 at locations at least 300m from recently burned/thinned areas. Cameras were baited with fatty-acid tablets to attract mesocarnivores and other potential nest/hen predator species, and images were uploaded weekly.

Home-range analyses. We continue to work on these analyses and provide some sample information in the results section below. Just below in this section is a detailed description of our approach to the many aspects of home-range analyses. A spatial database has been created to facilitate the quality control and management of all spatially related data for this project. This database has been designed to automate many time-consuming processes, such as the association of individual turkey attributes with GPS locations and environmental data. It is also designed for time-efficient data queries, which are otherwise very cumbersome with such large data sets.

Utilization distributions. All location and habitat data will be managed in a spatial database developed in PostgreSQL (Urbano and Cagnacci 2014). To ensure quality, location data must meet two requirements: 1) locations were recorded between the release date of the transmitter and the date of death, or date of last known location of a hen; 2) locations occur in realistic locations - relative to previous and successive locations, and within the landscape (i.e., not in open water). To evaluate the seasonal and annual habitat selection by WITUs, we will use Brownian Bridge Movement Models (BBMM) using the 'adehabitatHR' package in R to calculate 95% utilization distributions (UDs) for each turkey (Calenge 2006). UDs created using BBMMs take into account the time elapsed between successive locations, location errors, and the mobility or speed of the animal to account for the fact that successive locations for some species may be correlated (Horne et al. 2007). To account for temporal and spatial errors, the parameters *sig1* and *sig2*, are included in BBMMs. *Sig1* represents the Brownian motion variance related to the speed of the individual animal, and will be calculated following Horne et al. (2007) and Calenge (2006). *Sig2* represents location error of the µGPS units; a value of 20 m will be used for all models based on manufacturer's specifications (Byrne et al. 2014). Using *sig1* and *sig2*, BBMMs predict the probability of use along a route between successive locations, and quantify UDs that are adjusted for error. UDs will be the focus of data analyses described here, but we will also calculate a 100% minimum convex polygon (MCP) to delineate habitat available to all turkey hens (Wigley et al. 1986, Byrne et al. 2014, Mäkeläinen et al. 2016). Physical barriers (e.g., reservoir) within study areas may preclude access to the entire study area by hens, therefore we will calculate MCP's by individual flocks. Where flock habitat use overlaps with other flocks, we will calculate MCP's that include each of the overlapping flocks.

Habitat and landscape characteristics. To evaluate how understory cover influences WITU habitat selection, we will survey visual obstruction twice per year, during summer (i.e., breeding) and winter (i.e., non-breeding) seasons. At least 30 locations were surveyed in each study area, and additional surveys may be added to ensure each management unit and areas used by turkeys are surveyed. Each survey location was ≥ 200 m from other survey locations in managed and non-managed units throughout each study area. At each survey location (similar to the nest-site cover surveys), we recorded visual obstruction at 15 m from the survey location using a density board, viewed from each cardinal direction (Nudds 1977). Visual obstruction was estimated at three height classes: 0-50 cm, 51 – 100 cm, and 101 – 200 cm using 6 categories: [1] < 2.5%, [2] 2.5 – 25%, [3] 26 – 50%, [4] 51 – 75%, [5] 76 – 95%, and [6] > 95% (Badyaev 1995).

To determine the proportion of land cover categories and forest type within each UD, we used data from the National Agricultural Statistics Service (NASS) and Advanced Very High Resolution Radiometer (AVHRR) data. These data will facilitate classification of yearly land cover (NASS), and identify specific forest types (AVHRR). Forest management data for areas where fire-only, fire + thinning, and thinning-only occur were provided by Illinois Department of Natural Resources.

To determine the influence of acorn abundance on turkey habitat selection during the non-breeding season, we will conduct two acorn counts: one during Sep - Oct, and another during the following January at the same locations where vegetation cover is surveyed. Visual counts prior to acorn-drop are typically used as an indication of acorn availability in wildlife studies (Koenig et al. 1994, Kozakai et al. 2011). Acorn counts on the ground conducted during the timeframe when they will be eaten by wildlife may be a more appropriate evaluation of availability for turkeys. Therefore, we will count all acorns on the ground (after acorn drop) within a 1 m^2 area located 25 m in a random direction from each vegetation cover survey point. We will conduct 5 of these counts at each survey point and will calculate the average number of acorns per point. To verify that fall and winter acorn counts on the ground adequately represent acorn availability, we will also visually count acorns in trees during Aug - Sep prior to acorn-drop. Within 30 m of the survey location, we will count acorns in the canopy of each oak tree that is > 20 cm diameter at breast height (Perry and Thill 1999, Kozakai et al. 2011). Following Koenig et al. (1994), two observers will select different aspects of the focal tree and then count acorns for 15 s. The tree species and number of acorns counted by both observers will be added together to yield the number of acorns counted per 30 s effort.

Evaluating habitat selection. To evaluate habitat selection, we will compare proportions of used habitats to proportions of habitat available to turkey hens following (Aebischer et al. 1993) by using the R package 'adehabitatHS' (Calenge 2006). This process will allow us to determine whether or not hen turkeys prefer particular habitats relative to what is available at the scale of "landscape", and also whether or not hen turkeys prefer particular habitats relative to what is available within their own specific home range. Compositional analysis will be performed in several steps. First, we will define the area "available" to all hens with a 100% minimum convex polygon (MCP) that includes all hen locations. We will use geoprocessing tools in QGIS to calculate the proportion of land cover types within the MCP. Next, we will define used habitat for individual hens within the MCP using 95% UDs. After calculating the proportion of land cover types within each UD, we will rank habitat use in each UD relative to available habitat within the MCP (Equation 1). Then we will rank habitats by comparing the proportion of hen locations per habitat relative to habitat available within the 95% UD (Equation 2). The difference between y_{UD} and y_{MCP} represents the use of a habitat type within the UD relative to all habitat available within the MCP (Equation 3). For values of $d > 0$, use of the habitat type is greater relative to compared habitat type. Compositional analyses will be conducted for each hen during the breeding season, and will be pooled by flock during the non-breeding season.

1. $y_{UD} = \ln\left(\frac{used(habitat\ A)}{used(habitat\ B)}\right) - \ln\left(\frac{available(habitat\ A)}{available(habitat\ B)}\right)$

2. $y_{MCP} = \ln\left(\frac{used(habitat\ A)}{used(habitat\ B)}\right) - \ln\left(\frac{available(habitat\ A)}{available(habitat\ B)}\right)$

3. $d = y_{UD} - y_{MCP}$

This approach can be applied/tailored to any time period of interest (e.g. breeding season, brood-rearing period for hens with poults, non-breeding period, etc.). We will conduct separate iterations of the compositional analysis to compare hen selection of managed versus non-managed areas, and to rank differently managed habitats selected by hens. To rank habitat selection by acorn availability during the non-breeding season, we will calculate the mean acorn abundance from acorn surveys located within the "available" and "used" habitat for each hen. The effect of age will be examined by conducting separate compositional analyses for adult and juvenile age classes and comparing the results. Finally, we will use a redundancy analysis to further examine relationships between habitat composition of turkey UDs with forest management, and landscape and habitat features (Ellison and Gotelli 2013).

Results and Discussion

General. The μGPS units deployed on hens in 2015 recorded from 102 - 3279 location points, and are no longer active. During late January through March 2016 we baited and trapped at multiple locations at Forbes and Lake Shelbyville. We also baited at Kibbe Biological Station this spring, however, no females were detected at the bait site, and only 3-4 males were detected occasionally so we did not deploy any transmitters there. All captured birds were processed and received a rivet band on the leg, all captured females were fitted with micro-GPS telemetry units, and all birds were released where captured.

Capture Information. We captured and banded a total of 46 turkeys during the 2016 trapping season. Of the 22 captured in Forbes, 1 adult male was banded and 21 females (12 juveniles, 9 adults) were banded and marked with µGPS units. Of the 24 captured around Lake Shelbyville (Opossum Creek and Sand Creek), 17 females (5 juvenile, 12 adults) and were banded and marked with µGPS units, and 7 males were banded (3 juveniles, 4 adults). During the 2016 hunting season, 2 males each were harvested from Lake Shelbyville (both banded in 2016) and Forbes (1 banded in 2016 and the other banded in 2015). Going into our next segment of this research, we retained 24 units for deployment next year, and will order 38 new units. One unit was defective and was returned to the company and replaced at no cost.

Nesting Information. Nest locations for the 2015 and 2016 nesting seasons are given in Figures 5-9. Turkeys initiated incubation of first nests primarily during late April and early May at both study areas in 2016 (Tables 1 and 2). Of the 25 nests in 2016, 6 succeeded into the poult stage (eggs looked like they successfully hatched, poults observed with hen), 6 were classified as unknown (eggs may have hatched given condition of eggs when seen by field personnel, but poults were never observed with hens during several subsequent observations of hens), and 14 failed (hen predated, or eggs smashed/eaten. This was much better success compared to 2015 when only one nest had been successful. In the Lake Shelbyville area, three hens attempted a second nest (after a first failed), and one hen attempted a second nest in Forbes. Of those 4 second attempts, only 1 hen in the Lake Shelbyville area was observed with poults after the estimated hatch date. We will next analyze activity and nest-vegetation data to determine the influence of nest-site vegetation on incubation behavior, and how vegetation and incubation behavior may influence nesting mortality (i.e., death of the hen and/or nest). By week 16 only two hens still had poults (2/7 and 3/5? [poults alive/maximum number poults ever observed with hen]). One hen (originally seen with only 3 poults) was later observed among other adult hens and 5 poults - so who the poults belonged to was uncertain.

Table 1. Summary of first-nest initiations by Wild Turkey hens in Lake Shelbyville area during 2015 - 2016.

Nesting parameter	2015	2016
Mean first-nest initiation	22-Apr	29-Apr
Median first-nest initiation	22-Apr	28-Apr
Earliest first-nest initiation	12-Apr	15-Apr
Latest first-nest initiation	30-Apr	17-May

Table 2.Summary of first-nest initiations by Wild Turkey hens in Stephen A. Forbes State Recreation Area during 2015 - 2016.

Nesting parameter	2015	2016
Mean first-nest initiation	8-May	1-May
Median first-nest initiation	6-May	2-May
Earliest first-nest initiation	21-Apr	19-Apr
Latest first-nest initiation	8-Jun	18-May

<u>Hen Survival</u>. Among the 2016 captures, there have been 10 female fatalities, and 5 females are currently missing (presumably due to radio failure) (Table 3). One female was likely related to capture as she was found dead at Lake Shelbyville just one week after capture. All but one of the 9 other known deaths was presumed to be due to predation following the onset of incubation because the carcasses were found near nest locations. The outlier was a hen at Forbes that died in October 2016 of unknown causes. This result is now similar across 2 years and

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 of 4 time periods are provided below for Forbes and Lake Shelbyville for 2015 and 2016 (Table 3).

Table 3. Counts and cumulative proportions of micro GPS-tagged turkeys by status (alive, dead, or unknown) at the end of each date range in Stephen A. Forbes Recreation Area and Lake Shelbyville during 4 time-periods in 2015 and 2016.

	2015						2016					
Date range	Forbes			L. Shelbyville			Forbes			L. Shelbyville		
Counts	Alive	Dead	Unknown	Alive	Dead	Unknown	Alive	Dead	Unknown	Alive	Dead	Unknown
1 Jan - 15 Mar	24	0	2	6	0	0	21	0	0	16	1	0
16 Mar - 15 Jun	13	5	6	5	1	0	16	3	2	9	5	2
16 Jun - 31 Aug	10	1	2	2	2	1	16	0	0	7	0	2
1 Sep - 30 Nov	7	1	2	1	0	1	9	1	6	6	0	1
Cumulative proportion	Alive	Dead	Unknown	Alive	Dead	Unknown	Alive	Dead	Unknown	Alive	Dead	Unknown
1 Jan - 15 Mar	0.92	0.00	0.08	1.00	0.00	0.00	1.00	0.00	0.00	0.94	0.06	0.00
16 Mar - 15 Jun	0.50	0.19	0.31	0.83	0.17	0.00	0.76	0.14	0.10	0.53	0.35	0.12
16 Jun - 31 Aug	0.38	0.23	0.38	0.33	0.50	0.17	0.76	0.14	0.10	0.41	0.35	0.24
1 Sep - 30 Nov	0.27	0.27	0.46	0.17	0.50	0.33	0.43	0.19	0.38	0.35	0.35	0.29

Camera Trap Data. To evaluate the predator community in burned and unburned areas within Forbes, we conducted trail-camera surveys during June. Among the species detected, we found that raccoons were common in both habitats and that opossums, and birds of prey (including crows) were detected at a higher rate in burned areas vs. non-burned areas (Figure 10). These preliminary findings suggest that nest predators may be more abundant in areas managed with recent prescribed fire relative to non-managed areas.

Turkey GPS Locations and Home Ranges. Examples of non-breeding (Figure 11) and incubating (Figure 12) accelerometer (activity) data demonstrate that we will have the ability to compare this type of data to activity levels of hens in different types of habitats as well as comparing activity during incubation to vegetation cover metrics and nest and hen survival. Figure 13 is a simple plot of the percentage of hen locations in different habitat types for all data collected from all hens during 2015 at Forbes illustrating the predominant use of forests and some use of agricultural fields (soy beans, corn, grassland/pasture) over the course of the year. The distribution of a single hen's locations, including the cluster of locations indicating her nest, is shown in Figure 14. The 95% and 50% UDs for 4 different hens is shown in Figure 15 and overall (e.g. not limited to a particular season or period of time) 95% and 50% UDs for hens from the 2015 cohort (captured in late winter 2015) are given in Table 4. The overall 95% UDs average about 250 hectares whereas the overall 50% UDs average just 30 hectares.

Table 4. Summary statistics of Brownian bridge utilization distributions (in hectares) for wild turkey hens in south-central Illinois during 2015.

	2015	
Summary statistics	UD (50%)	UD (95%)
Min.	7.196	90.52
1st Qu.	20.724	141.28
Median	29.236	248.56
Mean	29.907	263.45
3rd Qu.	38.843	330
Max.	64.195	702.81

Hens with active GPS units will continue to be monitored every 2 weeks and we also continue to search for missing birds. Moving forward, we will calculate season-specific UDs to further investigate the turkey space use in managed habitats. We will evaluate habitat selection by hens at multiple levels: site – defined by a minimum convex polygon that includes all turkey locations, 95% UD – calculated using Brownian bridge movement models, and locations per habitat type. At each level, we will determine the proportion of use in managed vs. non-managed habitats and other landscape types (e.g., forest, grassland/fields, cropland). As results of survival, nest-site selection and habitat use analyses are completed, we will provide those results to our IDNR project managers.

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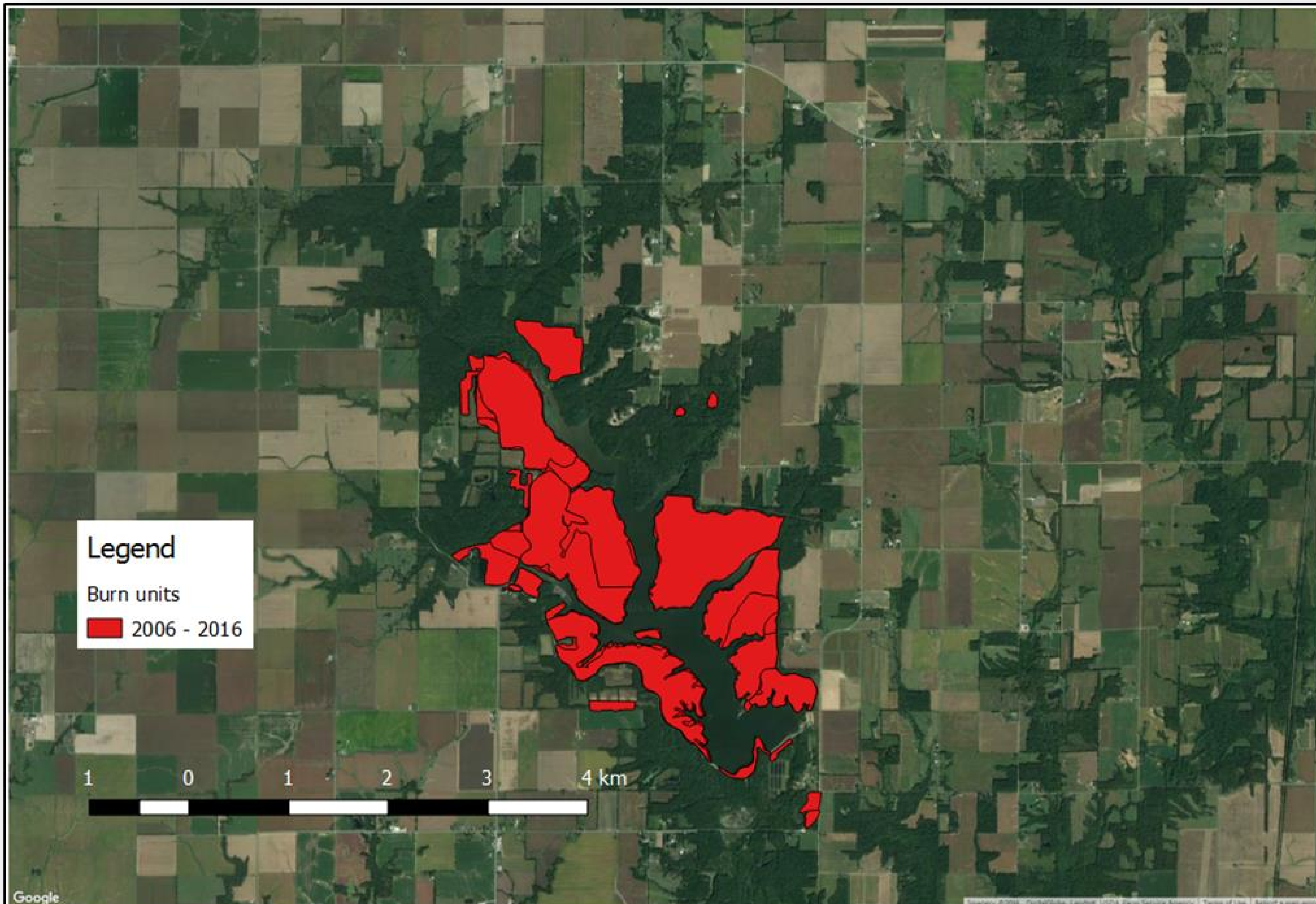


Figure 1. Locations of Burn Units at Forbes State Park that have experienced prescribed fire at least one time since 2006. Many have been burned >3 times.

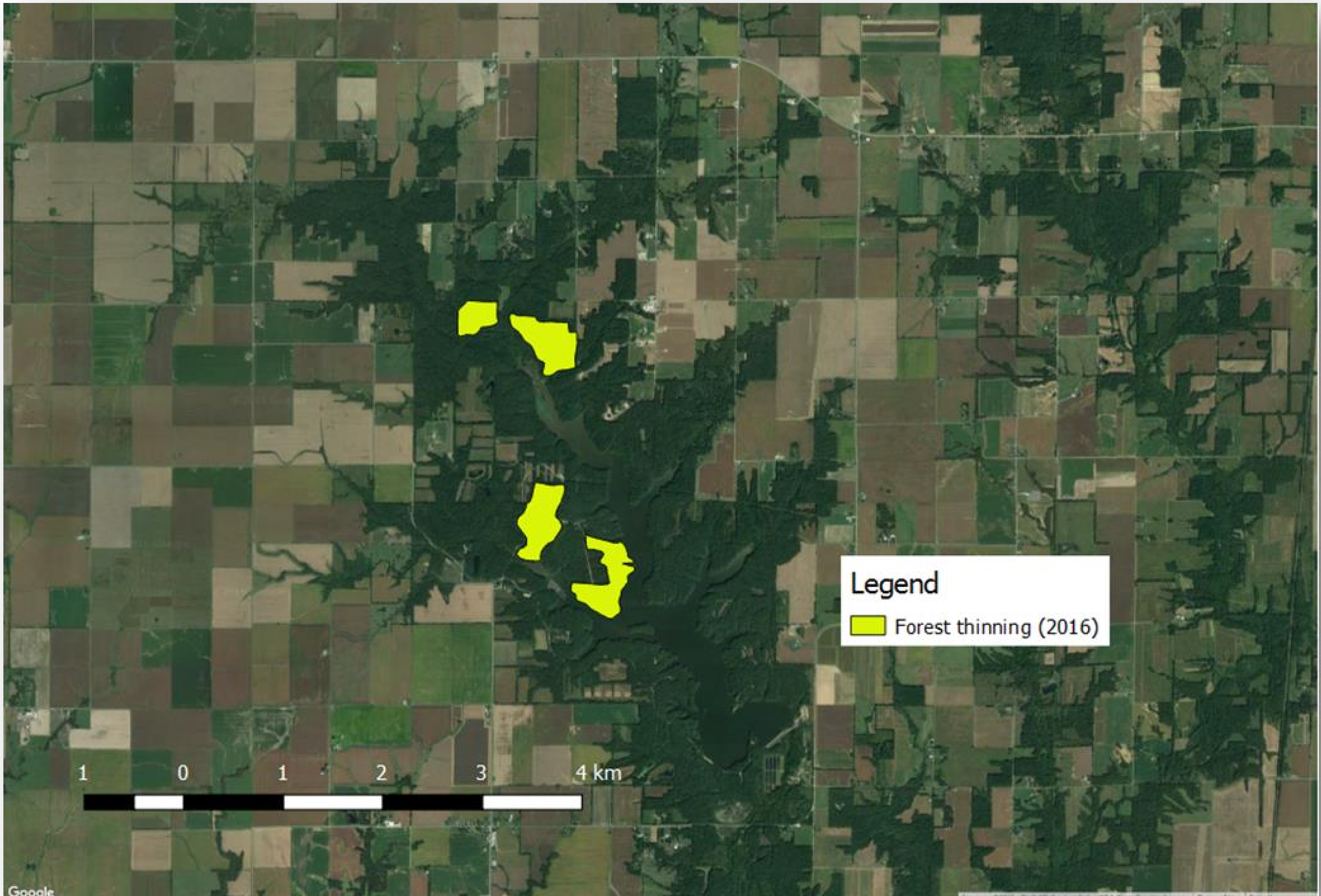


Figure 2. Locations of tree thinning units at Forbes State Park where thinning operations began during the winter of 2016 (NWTF is assisting with thinning).

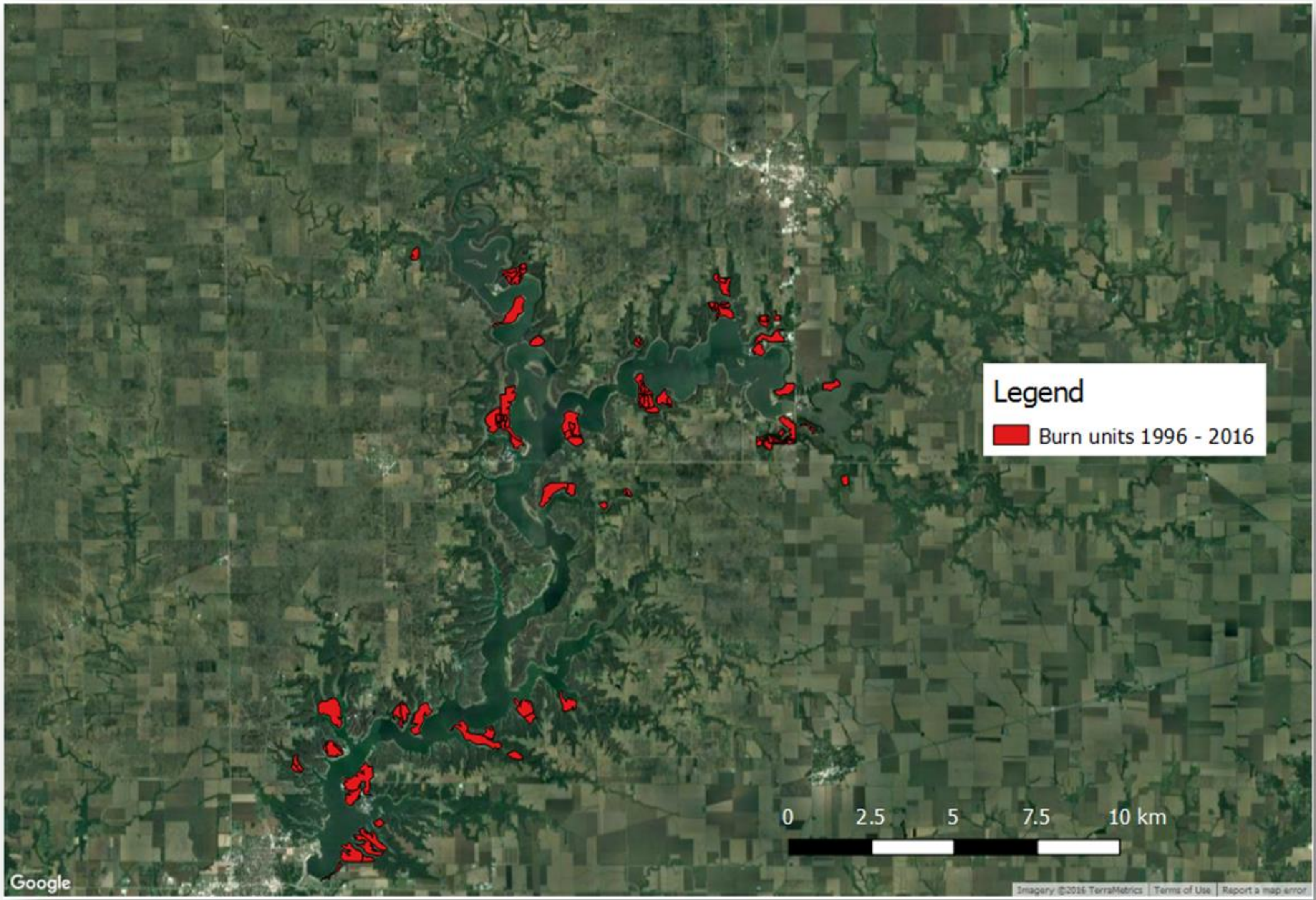


Figure 3. Locations of burn units at Lake Shelbyville. Many of these units have experience prescribed fire several times during the past 20 years.

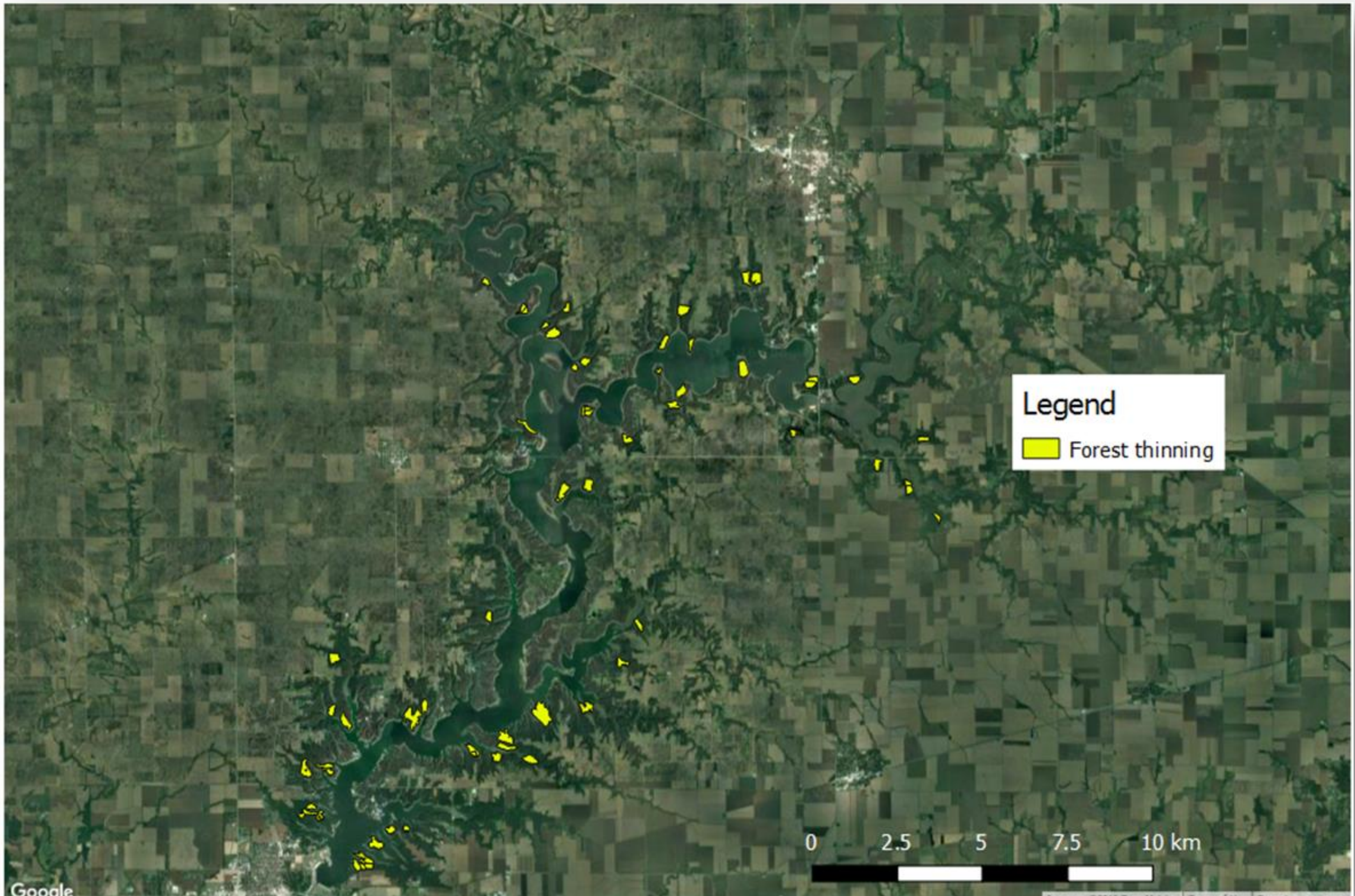


Figure 4. Locations of tree thinning units at Lake Shelbyville. Tree thinning has occurred mostly during the past 8 years.

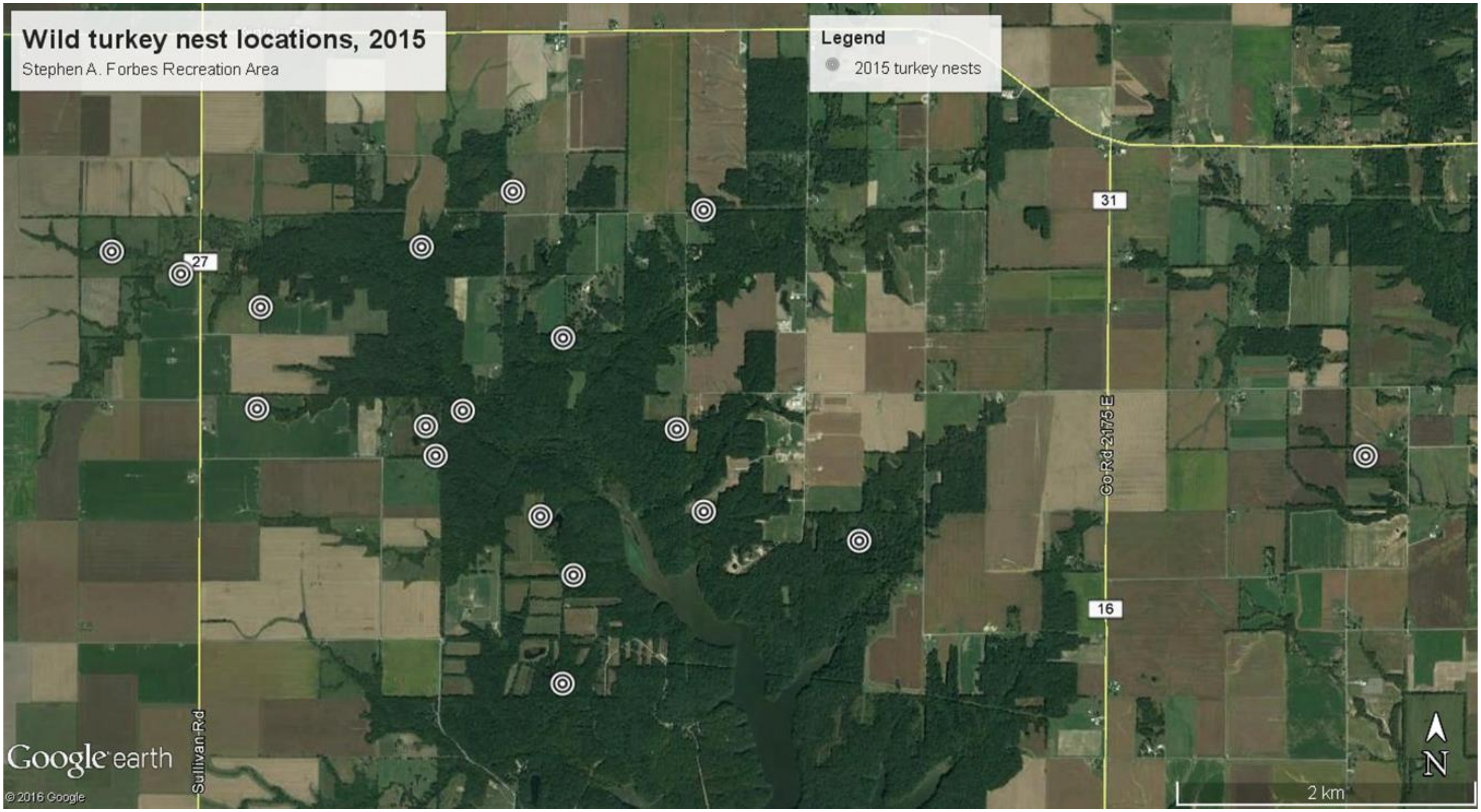


Figure 5. Locations of turkey nests at Forbes in 2015.

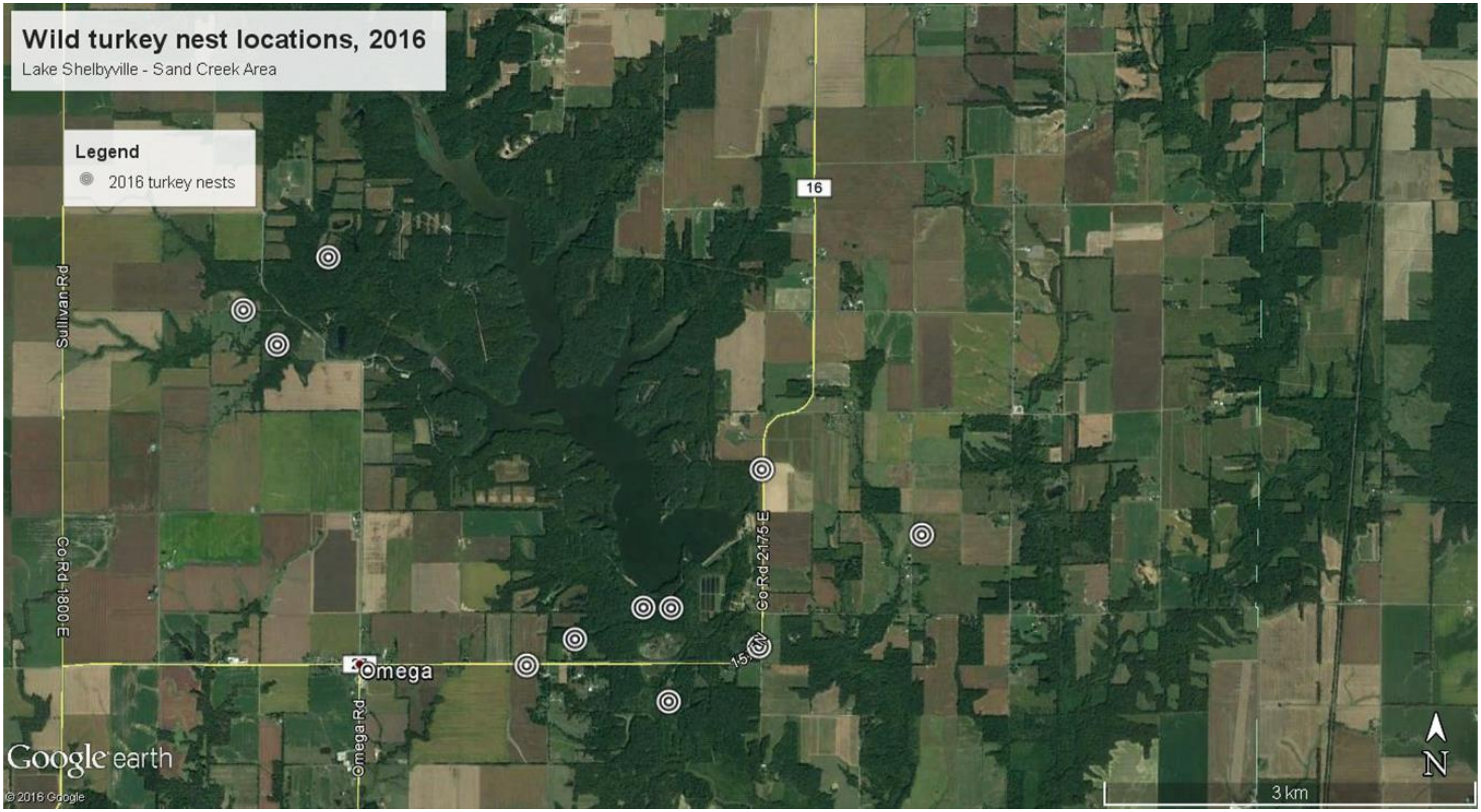


Figure 6. Locations of turkey nests at Forbes in 2016.

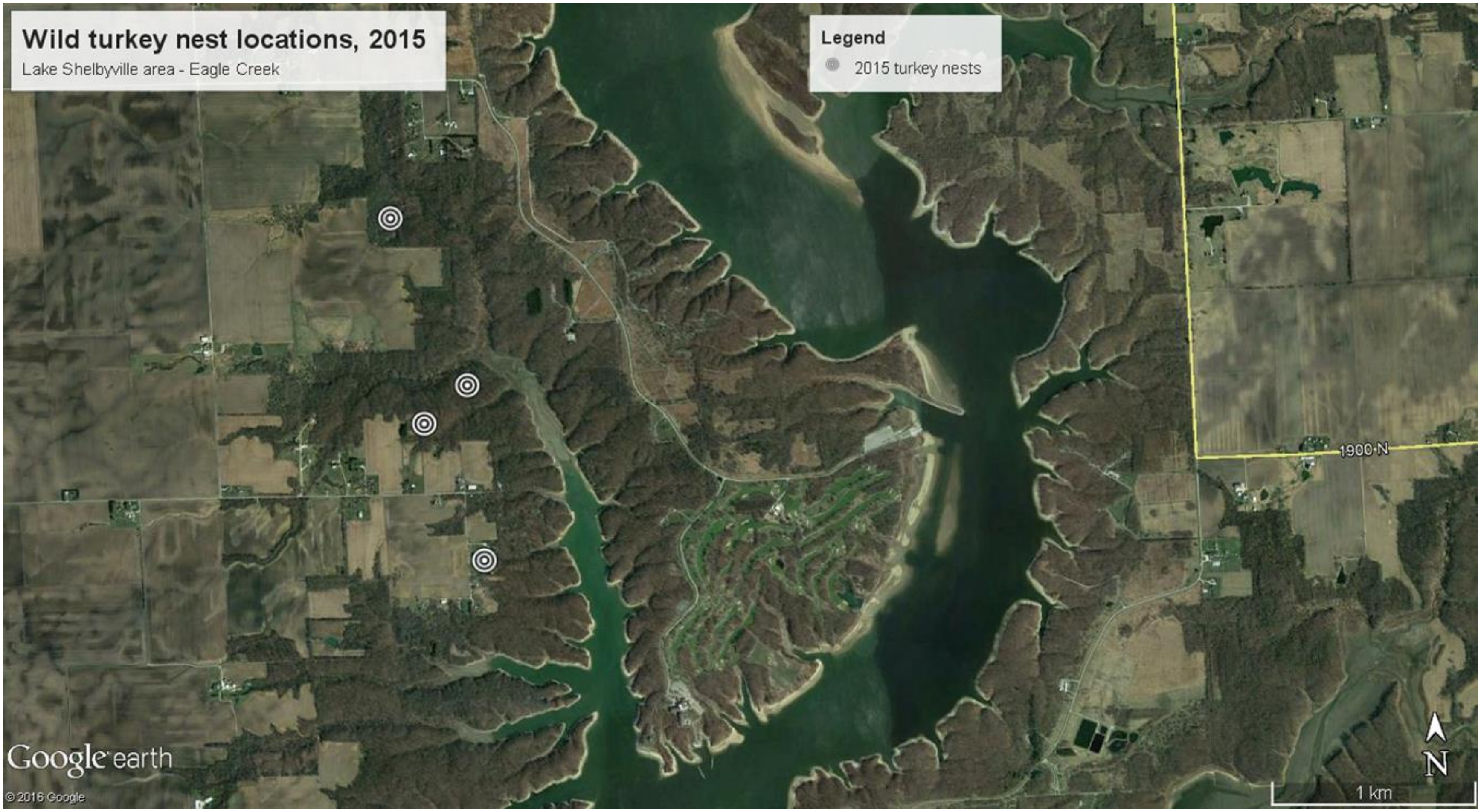


Figure 7. Locations of turkey nests at Lake Shelbyville in 2015.

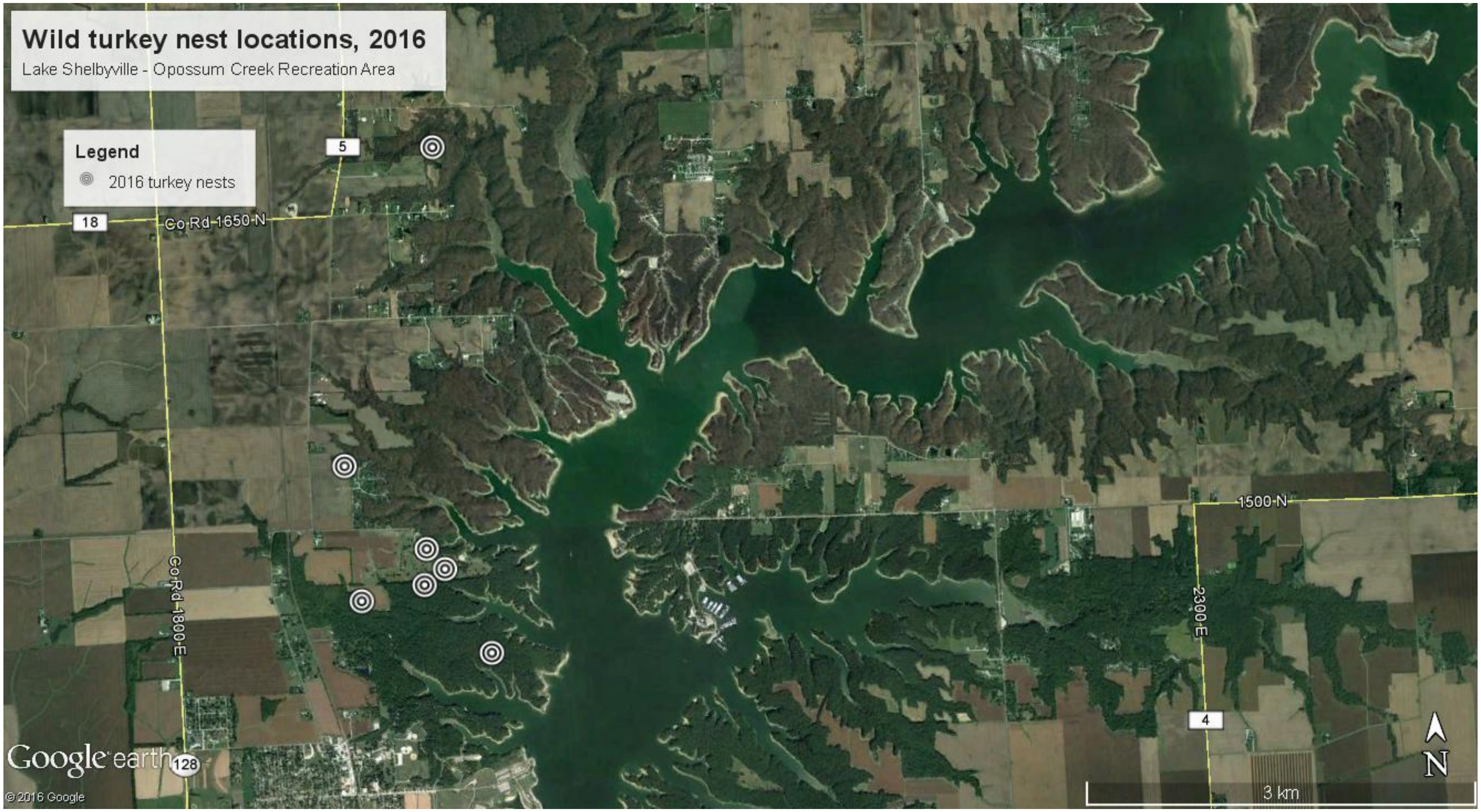


Figure 8. Locations of turkey nests in the Opossum Creek area at Lake Shelbyville in 2016.

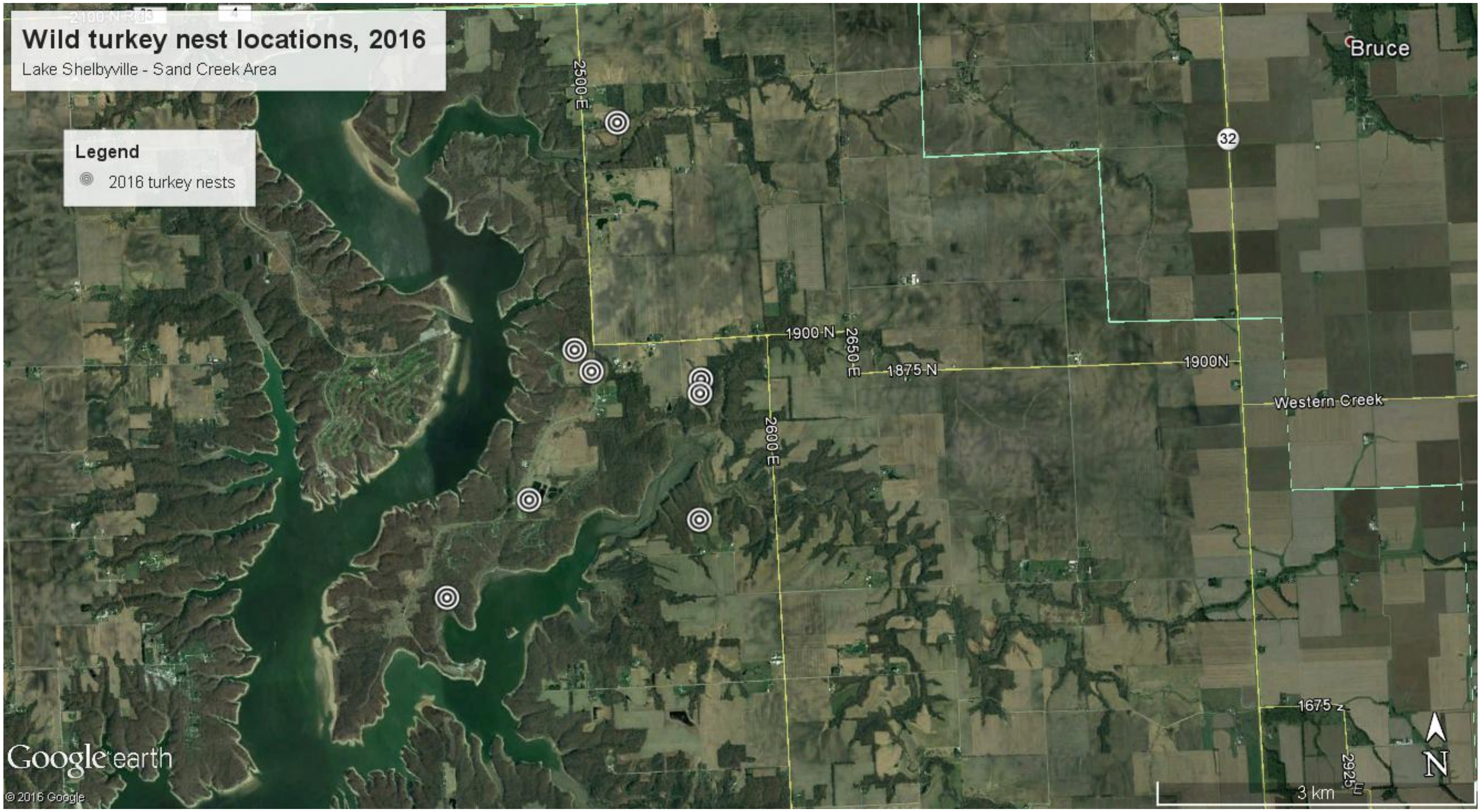


Figure 9. Locations of turkey nests in the Sand Creek area at Lake Shelbyville in 2016.

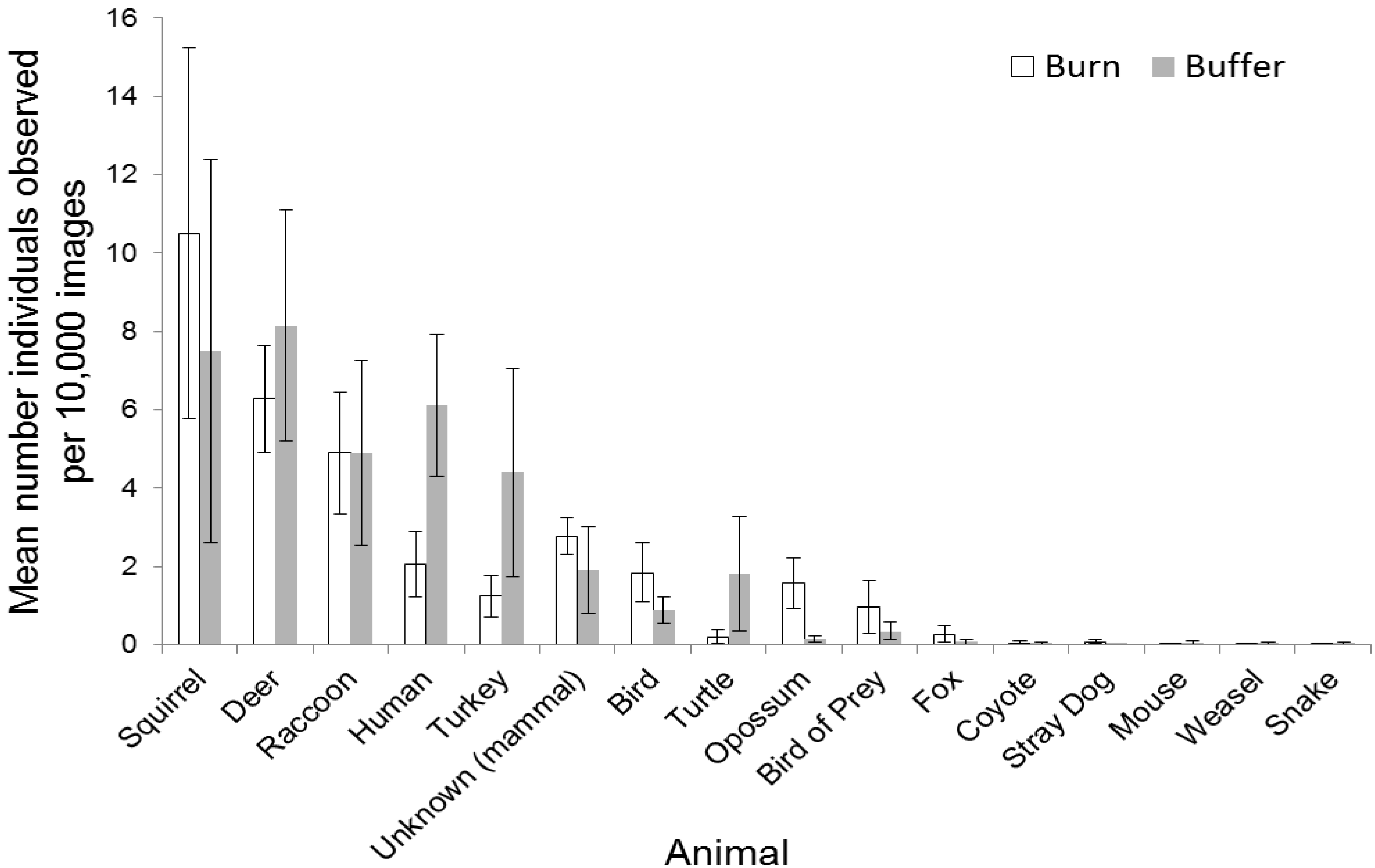


Figure 10. Mean + 1SE camera captures per camera trap of various animals that were photographed at camera traps during 2016 in forests where prescribed fire has occurred (burn) or not (buffer) at Forbes. Total numbers of images screened were 258,855 and 188,668 in the burn and buffer categories, respectively.

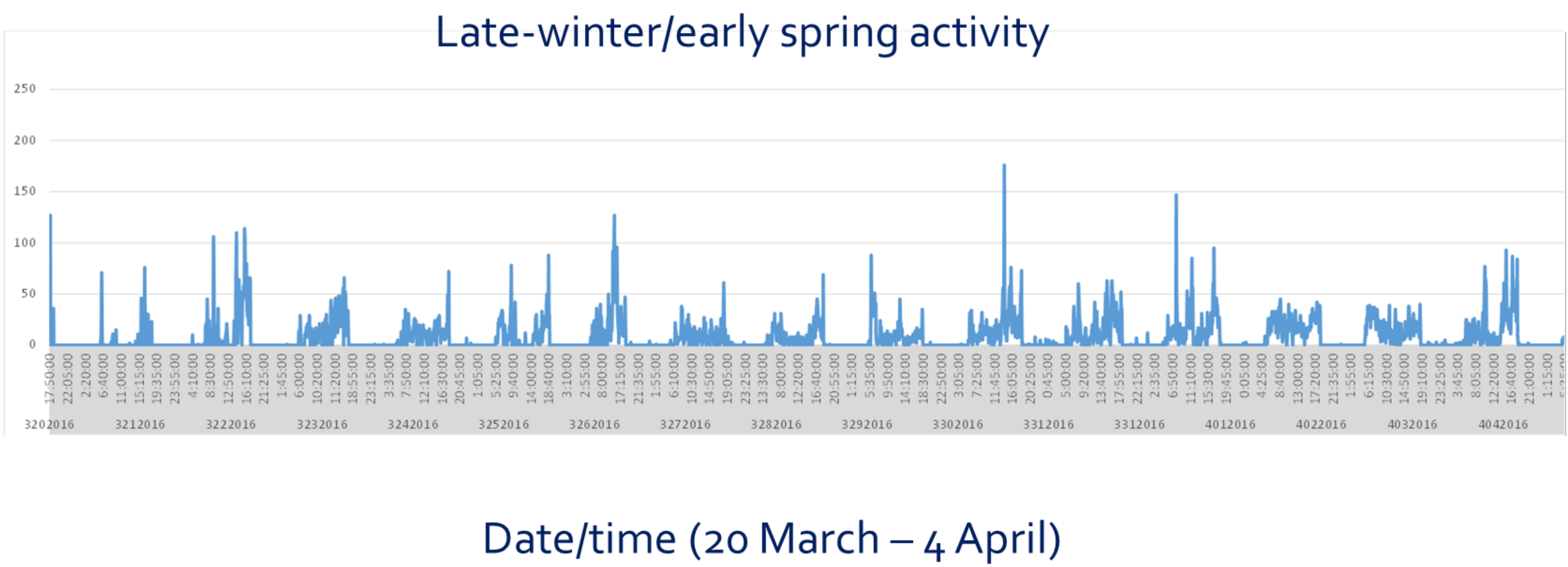
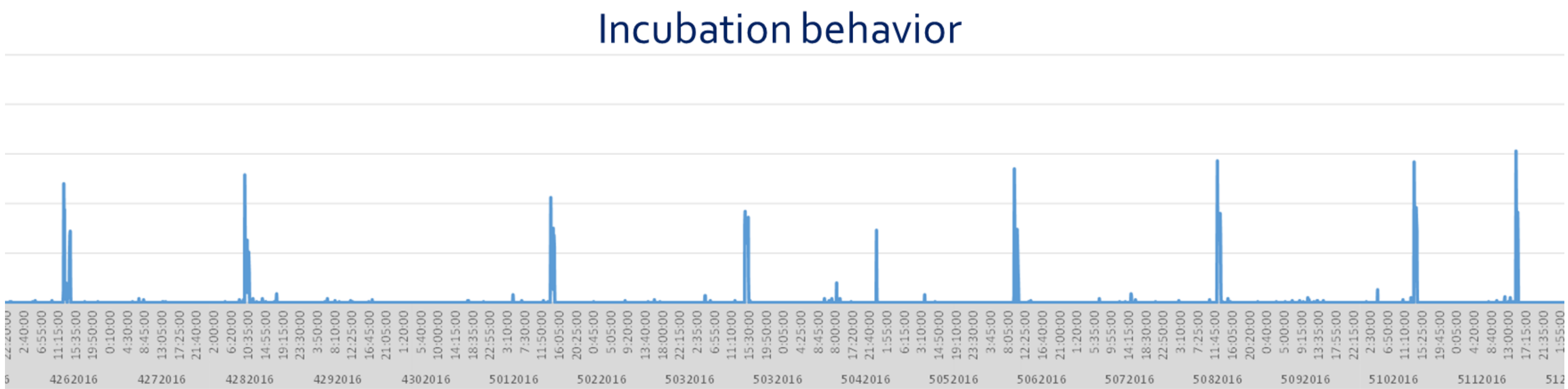


Figure 11. An example of accelerometer (activity) data for an individual hen turkey during a 2-week period prior to the breeding season in 2016.



26 April – 11 May

Figure 12. An example of accelerometer (activity) data for an individual hen turkey during a 2-week period in 2016 where she is incubating a clutch of eggs. Y-axis scale same as in Figure 11.

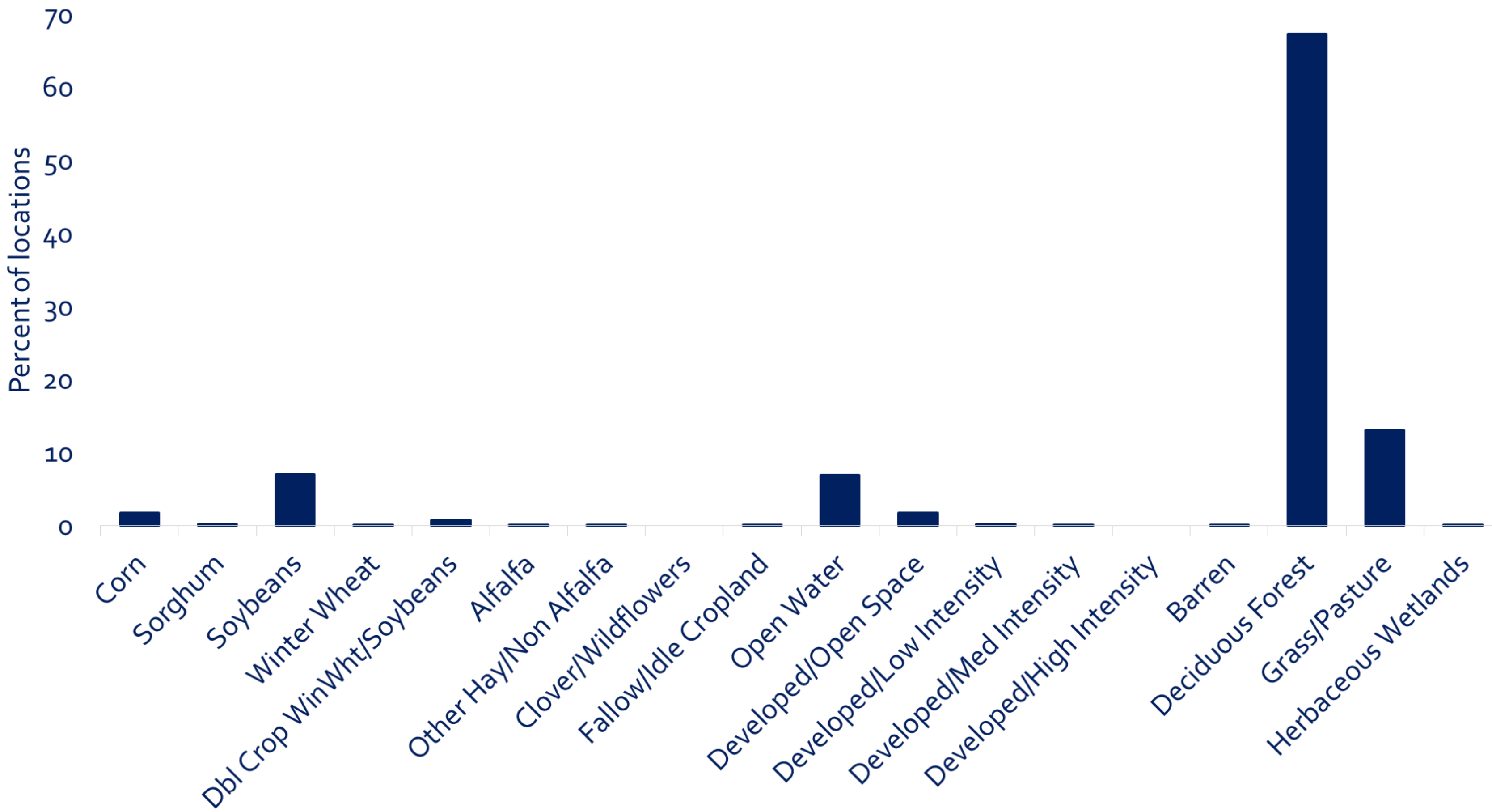


Figure 13. Example of general habitat associations of hen turkeys at Forbes during 2015 based on the proportion of locations in each landcover category. Locations over open water represent hens roosting overnight in trees that had branches overhanging the reservoir.

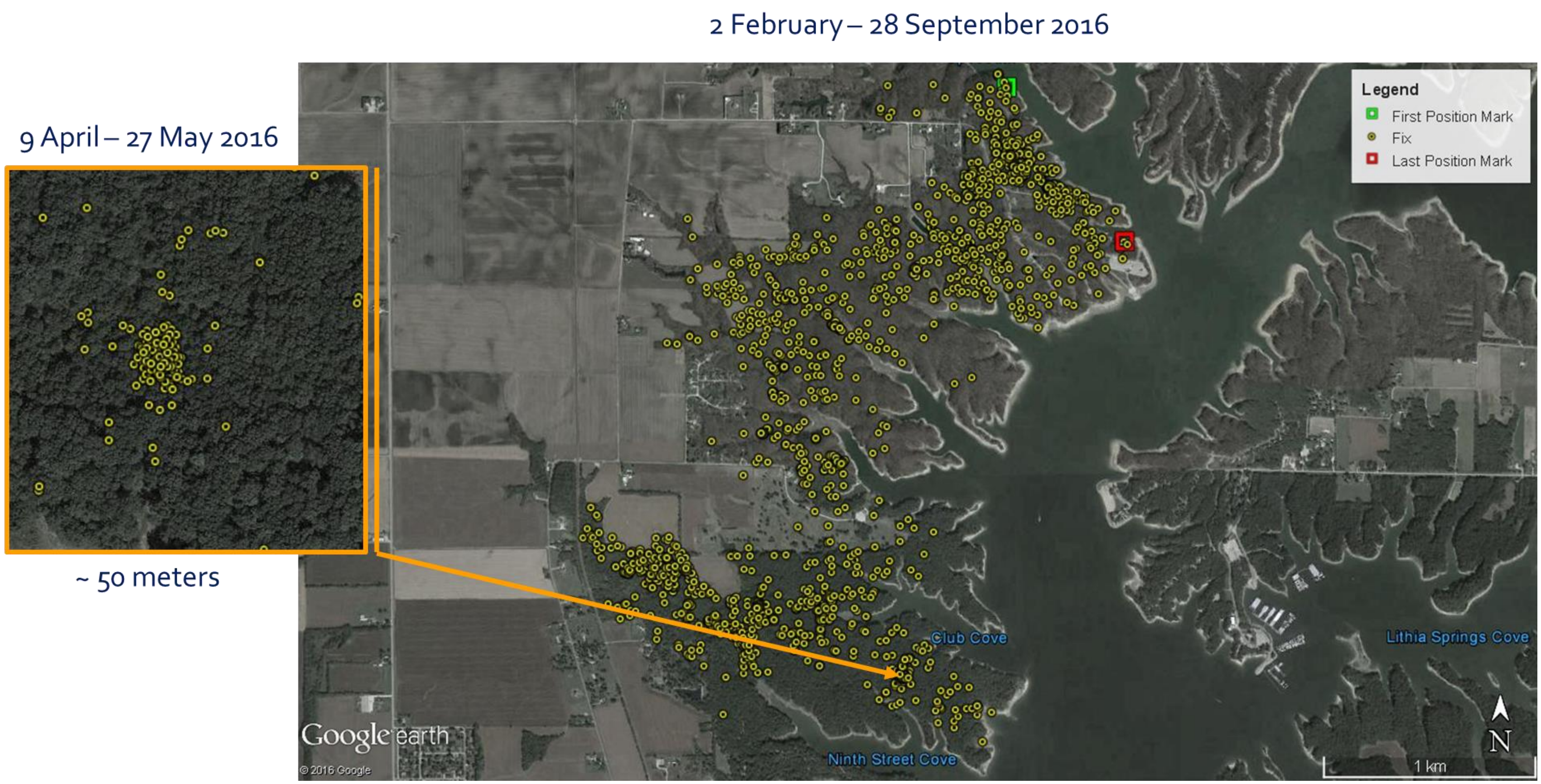


Figure 14. Example of location data (including the cluster of locations at her nest) for an individual hen turkey at Lake Shelbyville in 2016.

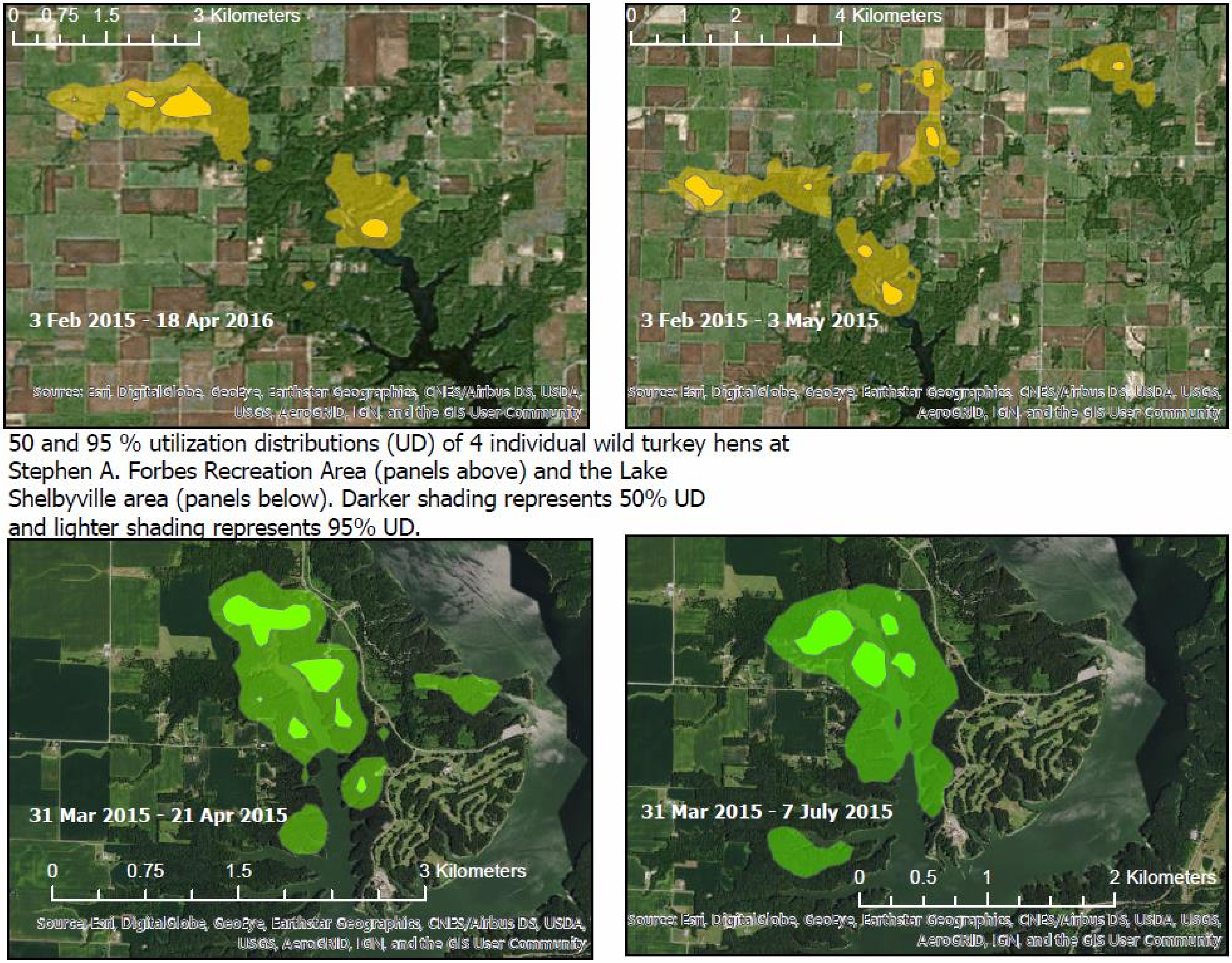


Figure 15. Examples of 95% and 50% Utilization Distributions for turkey hens (2 each) at Forbes and Lake Shelbyville.