QUANTIFYING THE EFFECTS OF HABITAT DISTURBANCE ON THE TIMBER RATTLESNAKE, *Crotalus horridus,* IN NORTHEASTERN PENNSYLVANIA

By

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A Thesis Submitted in Partial Fulfillment of
The Requirements for the Degree of
Master of Science in Biology
To the Office of Graduate and Extended Studies of
East Stroudsburg University of Pennsylvania

May 10, 2019

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ABSTRACT

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Biology to the Office of Graduate and Extended Studies of East Stroudsburg University of Pennsylvania

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Title: Quantifying the Effects of Habitat Disturbance on the Timber Rattlesnake, *Crotalus horridus*, in Northeastern Pennsylvania

Date of Graduation: May 10, 2019

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Abstract:

This project examined the relationship between anthropogenic habitat disturbance and population levels in *Crotalus horridus* (Timber Rattlesnake). This study relied on population and habitat information collected by the Pennsylvania Fish and Boat Commission (PFBC) during a previous study known as the Timber Rattlesnake Assessment Project (TRAP). Geographic Information Science (GIS) was utilized to measure landscape features such as canopy coverage, trails, and road density through habitat utilized by Timber Rattlesnakes. Using the information from TRAP, in conjunction with GIS technology, quantitative results were produced and analyzed to construct a clear picture of how human habitat alterations affect Timber Rattlesnake populations. The results were primarily derived from two main models, (1) a linear regression with a normalize distribution and (2) a generalized linear model with a binomial distribution. An inverse relationship was found between rattlesnake populations and proximity and density of buildings at the large spatial scale. These findings suggest that anthropogenic disturbance impacts Timber Rattlesnakes negatively in the commonwealth. The weak relationships between the variables assessed may be, in part, attributable to the use of TRAP reports which were mostly based on one or two site visits and not intended to provide population estimates. Further work will be necessary to refine our models, including improved population estimates and expansion of our work to the entire commonwealth.

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CHAPTER 1: INTRODUCTION

The timber rattlesnake, *Crotalus horridus*, has long been a species of interest and concern to herpetologists and conservationists in the northeastern United States. Over the years, *C. horridus* has seen severe declines in its northeastern range due to overharvesting, persecution, and habitat loss (Galligan and Dunson, 1979; Stechert, 1982; Reinert, 1990; Clark et al., 2010; Levin, 2016). As the conservation movement has gained momentum, many studies have been conducted on the long-term effects of these factors and changes in *C. horridus* populations (Martin, 1993; Andrews and Gibbons, 2005; Clark et al., 2010, 2011; Urban, 2012). Since *C. horridus* has been delisted as a candidate species in Pennsylvania, due to the relatively high numbers of snakes discovered by the Pennsylvania Fish and Boat Commission (PFBC) during the Timber Rattlesnake Assessment Project (TRAP), a monitoring program is needed to maintain confirmation of population integrity. East Stroudsburg University, under Dr. Thomas C. LaDuke, is creating the Timber Rattlesnake Monitoring Project (TRMP) through a series of integrated studies including: (1) mark and recapture study using passive integrated transponders (PIT) tags to assess population sizes; (2) assessing how anthropogenic habitat features affect population sizes; (3) measuring microhabitat use by gravid

females; and (4) measuring population recruitment by tracking neonate individuals returning to sites year after year. This specific project, number two under TRMP, will measure habitat features and relate changes in these features to snake populations as a means of assessing the relationship between specific habitat factors and timber rattlesnake population size. This will be critical to the monitoring process as the end goal is the ability to quantitatively assess population changes through disturbances in *C. horridus* habitat.

Life History of the Timber Rattlesnake

Crotalus horridus is a medium to large, venomous, heavy bodied snake in the family Crotalidae that can grow to four feet in length (Hulse et al., 2001). Males are longer in length with a larger girth than females, they can reach lengths of 180cm. This size difference can be attributed to the males' combative nature (Sutherland, 1958; Gibbons, 1972). Males also have greater than 21 subcaudal scales, representing clear sexual dimorphism from females who generally have less than 21 sub caudal scales. This species has dark, chevron shaped markings on the dorsum with a yellow to black background, representing two distinct color morphs based on the color of the head (Figure 1, Figure 2, Figure 3). It was formerly believed that color was loosely linked to the sex of an individual, with more males being black and more females being yellow (Klauber, 1956). Subsequent studies in Pennsylvania disproved this hypothesis, color is independent of age or sex (Schaefer, 1969). Dark color morphs are commonly found in mountainous regions of the East coast, and it was thought that black coloration was not a result of genetics, but instead a result of ontogenetic changes in individuals (Gloyd, 1940). This, however, was also disproved by Schaefer (1969), as they found that light and

dark color phases could be distinguished at birth and the color only deepened into adulthood. Juveniles commonly present with an orange, median stripe on the dorsum while neonates are commonly light grey to beige in color with distinct crossbands (pers. obs.). The ventrum of *C. horridus* is typically cream colored with dense black speckling (Rubio, 2014). The scales of *C. horridus* are large and triangular with a distinct medial keel.

The signature trait of the rattlesnake is the rattle found on the end of their tail. This structure is typically used to warn would be predators or large fauna of the rattlesnake's presence by rapidly shaking the tail and allowing each bead to clack against the others (Rubio, 2014).The rattle is composed of keratinized beads that form at the tip of the tail after each molt (Hulse et al., 2001)(Figure 3). Neonates are born with only a single keratinous button at the tip of the tail, but should add 2 to 5 more segments by the end of their first year (Rubio, 2014). Some claim *C. horridus* can be somewhat accurately aged by dividing the number of rattle segments by the average number of sheds per year, but this only works on snakes with intact rattles still including the button (Furman, 2007). Compared to other vipers, *C. horridus* appears to have a relatively mild temperament, preferring to flee when humans are present (Gibbons, 2017).

Until recently, this species, *Crotalus horridus*, was separated into two distinct subspecies, *Crotalus horridus* (Timber Rattlesnake) and *Crotalus horridus atricaudatus* (Canebrake Rattlesnake). The subspecies *C. h. atricaudatus* was recognized due to differences in dorsal scale row counts, a larger average adult size (30-60 inches in *C. h. horridus* and 42-65 inches in *C. h. atricaudatus*), and an orange dorsal stripe that bisected

the chevron pattern medially (Gloyd, 1935; Rubio, 2014). Additionally, the southern subspecies, *C. h. atricaudatus* has a stripe along the face extending from the eye to the rear of the mouth (Gloyd, 1935). However, variation in scale counts is now thought to be attributed to sexual dimorphism and not subspeciation, as the variation in morphological traits is equal between *C. h. horridus* and *C. h. atricaudatus* (Pisani et al., 1973). Additional genetic research has shown that there are distinct east-west populations of *C. horridus* but not along north-south gradients (Clark et al., 2003).

Figure 1. Several yellow phase *C. horridus* basking between boulders on a powerline right of way.

Figure 2. A large, female black phase *C. horridus* where the keeled scales, forked tongue, and pit organs can be easily viewed.

C. horridus ranges from New Hampshire to Florida on the east coast of the United States and extends westward to Texas and southeastern Minnesota (Conant and Collins, 1998). In the northern parts of its range, this species hibernates in the winter months at communal den sites in crevices on south facing slopes (Galligan and Dunson, 1979; Ernst, 1992; Gibbons, 2017). Of northern den sites examined, 70% faced south while the other 30% faced southwest and southeast (Galligan and Dunson, 1979). Likewise, members of the "canebrake" population in the south may hibernate in tree stumps or tree root systems for short periods of extreme cold (Gibbons, 2017). This species has differing habitat preferences across its range. In the northeast it prefers wooded areas for foraging with nearby rocky edges for basking, gestation, and denning. In the southeastern portion of the range it prefers lowland thickets, canebrakes, and swampy edges. Lastly, in the western portion of the range the species prefers dry, brushy flatlands and beech-maple-birch woodlands (Campbell and Lamar, 2004).

In addition to having a rattle, *C. horridus* contains a trait common to all other pit vipers, the facial pit. This pit is found on the head between the eyes and nostrils and allows the snake to sense heat emanating from potential prey. The posterior portion of the pit contains a membrane stretched across it which is in contact with thermal receptors attached to the trigeminal nerve. Stimulation of these heat receptors travels along the trigeminal nerve to the optic tectum where it can be represented as visual stimuli (Goris, 2011).

Figure 3. A black phase *C. horridus* in defensive posturing with the rattle raised at one of the northeastern field sites.

This species has a solenoglyphous dentition and therefore has two large venom glands at the posterior portion of the skull that lead to retractable fangs on the maxilla bone (Reinert et al., 1984). The maxillary teeth found in other tetrapods have been reduced to just these fangs. The venom of *C. horridus* varies geographically in its composition as well as its potency and can be divided into four variations including: A, B, A + B, and C. Type A venom is found in the southern portion of the range and contains the neurotoxin canebrake toxin. The type B venom is the most common throughout the range and consists of hemotoxins and polypeptides that cause hemorrhagic damage to potential prey and predators. The third venom type, A+B, is found in intergrade zones between A and B and has been noted in eastern South Carolina, southeastern Georgia, southwestern Arkansas, and northern Louisiana. The last venom,

Type C, had one of the lowest LD50's the paper's author had ever observed among snake taxa and lacks both the canebrake toxin of Type A as well as the peptides of Type B. Type C venom is found in Georgia, Florida, and South Carolina and seems to be, at least partially, sympatric with Type A (Glenn et al., 1994) (Figure 4).

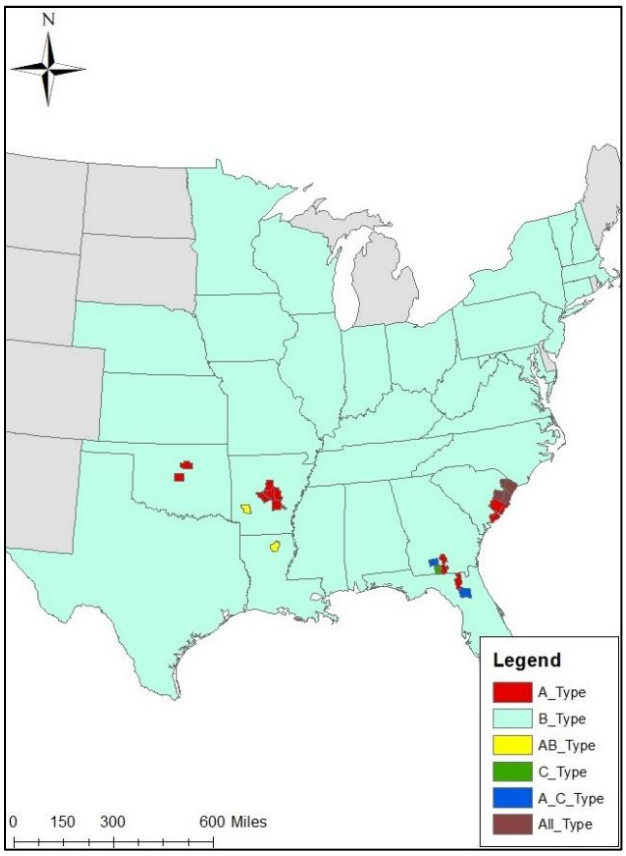

Figure 4. Map of the regional variations in *C. horridus* venom as described by Glenn et al., 1994. Notice that there is overlap between A and C in Georgia and Florida as well as overlap between all four types in South Carolina.

C. horridus is an ambush predator that often relies on fallen trees to find prey items (Reinert et al., 1984). It has been shown that individuals will curl up next to fallen trees with a portion of the body and the lower jaw coming in contact with the fallen trees to feel for vibrations of incoming mammals, usually rodents, that compose a majority of their prey (Reinert et al., 1984; Hulse et al., 2001). However, other prey items make up at

least a portion of the diet including members of “Lacertilia”, Serpentes, Anura, Piciformes, Galliformes, Passeriformes, Chiroptera, and Eulipotyphla (Clark, 2002). Using the Jacobson’s organ the snake can sense if incoming individuals are prey (Rubio, 2014). Rattlesnakes are generalists, thus, the proportion of prey consumed appears to match the prey’s proportion in the environment with a majority of prey caught at night (Reinert et al., 1984).

While *C. horridus* is often thought of as being near the top of the food chain, there are several predators that prey on them when the chance arises. In the northern parts of the range, *Coluber constrictor* is commonly found near den sites and is known to take young *C. horridus* (Klemens, 1993). Anecdotally, when *C. constrictor* is present *C. horridus* populations appear to be in flux. Additionally, hawks may prey even on adult individuals (Klauber, 1956; Ernst and Ernst, 2003). In the southern portion of the range, *Drymarchon sp.* and *Lampropeltis sp.* will commonly prey on large and small individuals of *C. horridus*, being immune to their venom (Gibbons, 2017).

During the warmer months males, post-partum females, and non-breeding females disperse from den sites into surrounding forest for feeding opportunities. In addition to hunting, males will seek out receptive females to breed with throughout the late summer. There is at least some evidence that males will guard basking females or a highly suitable basking site for possible mating opportunities (Howey, 2017). Females start ovulation in late spring and reproduction occurs in mid to late summer (Martin, 1993). Females of *C. horridus* seem to aggregate in family groups of related females. This provides several benefits including group defense against predators as well as increasing the ability to

thermoregulate. It is theorized that not only does group basking deter predators, but females may be more likely to defend a site if they know that related members will indirectly benefit. Likewise, if adults are grouped together it increases the likelihood that neonates may scent trail an adult to den sites, increasing survivability of offspring (Clark et al., 2012). *C. horridus* is strongly K-selected; females do not mature until roughly six or seven years of age, they only breed once every 2-6 years depending on abiotic conditions, and they have relatively small litters of 3-16 young (Gibbons, 1972; Galligan and Dunson, 1979; Martin, 1993; Gibbons, 2017). This species is viviparous giving birth to live young with at least some transfer of nutrients from mother to offspring (Blackburn, 2000; Hulse et al., 2001). Mothers will stay with the young for up to two weeks, roughly timing their parting with the first molt of the neonates (Gibbons, 2017). During this time, mothers will typically become bolder and actively defend the young against would-be predators. Surprisingly, neonate individuals tend to act in an opposite way, being incredibly curious to the happenings around them and not readily avoiding danger as they should (pers. obs.).

Decline of Timber Rattlesnake

There are many biotic and abiotic factors that contribute to a population's decline including habitat destruction, overharvesting, pollution, and disease (Wilcove et al., 1998). The factors described by Wilcove et al. (1998) all contribute to population changes in *C. horridus*. Habitat destruction is a pervasive problem that many species in the modern age are facing, imperiled or otherwise. Roads have become commonplace through many habitat types and have been shown to restrict gene flow and genetic diversity among populations (Forman 2000; Shine et al., 2004; Andrews and Gibbons,

2005; Coffin, 2007; Row et al., 2007; Eigenbrod et al., 2008; Fahrig and Rytwinski, 2009; Clark et al., 2010; Beebee, 2013). *C. horridus,* specifically, has been shown to be exceptionally susceptible to the impacts of roadways bisecting habitat because of their unwillingness to traverse open habitat (Andrews and Gibbons, 2005). Studies have also shown that *C. horridus* is already experiencing a decrease in genetic diversity in the south due to population fragmentation by roadways (Clark et al., 2010). Overharvesting occurred, until recently, in the form of rattlesnake roundups. In the modern era, these events are strictly educational and all snakes that are not being tagged with a hunting license are returned to the site that they were collected from. These events awarded prizes to participants in various categories such as largest snake and longest rattle (Reinert, 1990). Many individual snakes observed at hunts appeared to be injured, with several showing signs of damaged cervical vertebrae (Reinert, 1990). Of the snakes collected at hunts, a large number appeared to be gravid females, thought to have been collected in such numbers due to their preference for open areas with high amounts of sunlight (Reinert, 1990). While hunters were supposed to return captured snakes to the same area they were captured, several hunters explained they had no intention of doing so. It has been shown that *C. horridus* who have been relocated experience high mortality in the range of 50% (Reinert and Rupert, 1999). The relocation of snakes coupled with severe injury and handling of gravid individuals could potentially carry many unintended consequences.

There are anecdotal accounts that repeated handling or excess stress may cause infections of Snake Fungal Disease (SFD) to become more severe. There are reports of *O. ophiodiicola* in Pennsylvania in Luzerne (LaDuke pers. comm., pers. obs.) and Lycoming

(Dunning pers. comm.) counties (Figure 5). With enough warmth and several molts it would seem that many individuals can overcome infections (Lorch et al., 2016). Fungal diseases have impacted many other reptile and amphibian taxa as well including *Batrachochytrium dendrobatidis* in Anura (Retallick et al., 2001), *B. salamandrivorans* in Caudata (Martel et al., 2013), *Pseudogymnoascus destructans* in Chiroptera (Blehert et al., 2009), and *Ophidiomyces ophiodiicola* in Serpentes (Allender et al., 2015; McBride et al., 2015; Guthrie et al., 2016).The full impacts of Snake Fungal Disease are unknown but are one more reason that a species with a cryptic lifestyle and low fecundity should be monitored. In addition to these factors, hiking trails have become more abundant throughout the commonwealth. One study revealed a negative correlation between species abundance and trail area in wood turtles (Garber and Burger, 1995). The average person is largely biased against rattlesnakes, owed to the sensationalized view that rattlesnakes are an aggressive species, and hiking trails through habitat increase the likelihood of human interaction with the species, leading to eventual mortality.

Figure 5. A large fungal lesion found on a juvenile black phase.

Timber Rattlesnake Assessment Project

Our understanding of the status of the timber rattlesnake in Pennsylvania has been improving gradually over the years. Until 2016 it was listed as a Candidate Species in Pennsylvania (Stauffer, 2016). The Pennsylvania Fish and Boat Commission conducted a study from 2003-2014 known as the Timber Rattlesnake Assessment Project (TRAP) whose purpose was confirming historical site occupancy and generally checking potential habitat for the presence of *C. horridus* (Urban, 2012). This study found *C. horridus* at more than 1000 sites in Pennsylvania, showing they are more numerous than previously thought. With the conclusion of this study, the species' conservation status was reduced (Stauffer, 2016). However, the species' hunting limits will remain in place and environmental impact studies will still be conducted on and near *C. horridus* habitat.

Geographic Information Science

Geographic Information Systems (GIS) reference geospatial data in the real world by overlaying various landscapes/ habitat features on a base map, thus providing a view of the spatial orientation of mapped features and the ability manipulate and analyze such data (Maguire, 1991). There are seemingly innumerable GIS applications but we are using it to track wildlife populations (Peterson, 2001) as well as monitor habitat loss and fragmentation (Vogelmann, 1995; Heilman et al., 2002).

Studies involving herpetofauna and GIS have typically been limited to habitat suitability modeling for a given species or group (Raxworthy et al., 2003; Santos et al., 2006, 2009). Other projects, such as the Pennsylvania Amphibian and Reptile Survey, have used citizen science jointly with GIS technology to map out population ranges. There are also projects that have attempted to work out passages between territories over

roadways (Clevenger et al., 2002). This project will attempt a novel use, regarding timber rattlesnakes in Pennsylvania, of GIS technology in assessing population integrity of given sites in relationship to habitat features at different spatial scales.

Objectives

Due to the low fecundity of individual females, the risk of spreading pathogens, and the ever-increasing habitat destruction from human development, this project aims to accomplish two goals using GIS technology:

1. Use GIS technology to evaluate the relationship between anthropogenic habitat alterations and population status where data are available.
2. Use the relationships revealed in 1, above, to produce formulae that can estimate the impact of future changes of similar type on populations.

CHAPTER 2: METHODS AND MATERIALS

This project used geographic information science (GIS) technology to quantify habitat features surrounding Timber Rattlesnake habitat within Pennsylvania. Data was collected from several major sources including the Pennsylvania Fish and Boat Commission (PFBC), Pennsylvania Spatial Data Access (PASDA), and local county GIS coordinators. This data was processed in ESRI's GIS program ArcMap®. Data for certain counties was removed from consideration due to anomalies in structure. The data that was processed in ArcMap® was then transferred to R where the analyses were conducted. A set of six generalized linear models were produced to assess the relationships between environmental factors and snake populations.

Study Area

The study area consisted of the northeastern Pennsylvania counties including Monroe, Pike, Carbon, Luzerne, Lackawanna, Wayne, Wyoming, and Susquehanna (Figure 6). This portion of the state was chosen due to ease of access for regular visits during which additional population data could be collected. This area of the state has a high rate of development and diverse habitat types, many of which are unsuitable to the

life history of *Crotalus horridus*. As such, while several of the sites hold substantial colonies, many of the populations in this area have low population numbers. This wide range of population sizes likely leads to a more realistic model, as there is no bias towards large or small populations. However, there is bias in the overall methodology of how data was collected from sites. The goal of the Timber Rattlesnake Assessment Project (TRAP) was to confirm rattlesnake sites, not rattlesnake numbers. Due to these methods low site numbers are a result of low effort while absences may represent pseudo-absences. All sites used for the project were verified by the TRAP and historically held timber rattlesnake populations, or were new sites discovered by TRAP that contained a population of rattlesnakes. All the sites reported by TRAP within the northeast counties were used. The data from TRAP was imported into Microsoft Excel in the comma-separated values (CSV) format, as this is the only format that ArcMap® supports. Using the latitude and longitude from the TRAP surveys, the sites were imported into ArcMap®, creating the points for each rattlesnake site. Rattlesnake sites were clipped to the extent of the focal counties, using the Clip tool in ArcMap®, to remove any additional rattlesnake sites that were not included in the scope of this study. Each site was then isolated using the Select function and then made into its own layer to individually create buffers around each point for analysis. Buffers of interest (radii 50m, 400m, and 5,000m), were then added to each site using the buffer tool in ArcMap®. These buffer zones align with various life history components of *C. horridus*. The innermost buffer zone, 50m, represents immediate habitat at a site that has been identified as critical to individuals in a population, primarily basking and gestation habitat. The intermediate buffer zone (400m) would likely contain the den site as well as alternate gestating and basking habitat that is

vital to biological maintenance of the population, especially gravid females. The last buffer zone, 5000m, likely includes all other important habitat such as foraging habitat based on farthest traveling distances of males seeking mating opportunities.

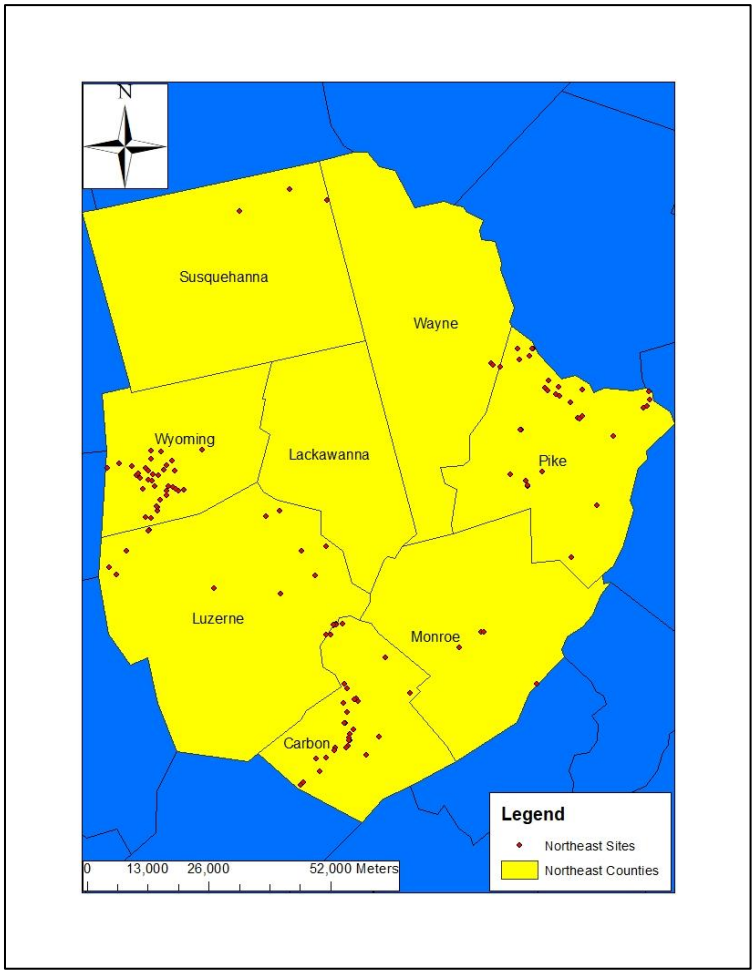

Figure 6. Regional map of the northeastern counties including the sites found within this area.

Data Collection

Rattlesnake population information was collected by TRAP teams that visited sites around the state. Population numbers at these sites varied widely, as many of the sites were only visited once, and the number of snakes seen was recorded as the population. There are a few exceptions to this, including PIT-tagging sites such as the

Hell Creek site that has a large population and has been visited numerous times over several years. Snakes at several such sites across the state have been marked with passive integrated transponder (PIT) tags. These tags are subdermal and can be checked with a handheld receiver. Additionally, Dr. LaDuke and his students have visited many sites around the northeast to mark snakes. This has helped to improve population estimates at several different sites, mostly in Luzerne and Monroe counties. If snakes have been marked at a site, the total number of marked snakes has been used as the population estimate as opposed to the number provided by the TRAP. If snakes are not being marked with PIT tags at a site, then the highest number observed at the site during a given visit is used as the population estimate. This was modified if obvious characteristics give away individuals as unique members, such as a yellow phase juvenile who hadn't previously been recorded. Neonate snakes were not added to population estimates due to the wide mortality fluctuation in these individuals as well as the uncertainty that they would remain within the same natal subpopulation.

Roadway data was collected from the Pennsylvania Spatial Data Access (PASDA). Three roadway layers were collected: state, local, and unpaved. These three layers were combined using the merge tool in ArcMap® to form one layer that could be easily manipulated. This joint layer was then projected into the North America Equidistant Conic projection, as were all the layers that were used. From here, a new column was created in the road attribute table and given the name Shape_Length. Using the calculate geometry tool within the attribute table the total length, in meters, of each line segment was found. The roads were clipped, using the Clip tool in ArcMap®, to each buffer zone and summed using the statistics tool within the attribute table. A density of

roads was then calculated for each site by taking the total distance of roads within the buffer zone and dividing by the total area of the buffer zone, 7,853.98m^2 for the 50m, 502,654.82m^2 for the 400m, and 78,539,816.34m^2 for the 5,000m. This density (m/m^2) relativized the measurements from each buffer zone. Additionally, the Near tool was used to calculate the distance from each site to the nearest road. Trail data was collected from PASDA and were processed using the same procedure described above. Recreational waterways were excluded from the trail data.

Building data was collected for each county from its respective GIS county coordinator. Since there was no standard method regarding the form geographic data was in, each county represented buildings in different ways. Pike count only has data for land parcels, instead of buildings, and represents this with polygon data. Monroe and Wayne counties maintain building data as polygons. The remaining counties all use point data for buildings. Due to Pike County only having land parcel data, the description field of the attribute table was manually reviewed to identify all records that mentioned a building on the property. Of the 61,000 attributes in the Pike County land parcel data, 36,000 were identified as containing buildings. However, many of the land parcels with buildings contained more than one building. Additionally, the polygons were converted to points to represent the geographic location of the buildings in a more useful representation. This works well for small land parcels but not for parcels as they become larger. Thus, the buildings in Pike County may not be represented accurately for this model. The Near tool was used to calculate distance from each site to the nearest building. Using the Clip tool in ArcMap®, buildings were clipped to each buffer zone and a total count of buildings within the buffer zone was conducted for each site. A handful of the counties included

highway markers with the building data. These points were subsequently removed from the layer.

Canopy data was collected from PASDA in the raster format. This file spans the entirety of Pennsylvania and has a resolution of $1x1m^2$. Due to its high resolution, this data layer was ideal for the project and was chosen over other more highly recommended data types such as a normalized difference vegetation index (NDVI), as the smallest usable resolution that could be located was $250x250m^2$. However, this raster file only contained values that held canopy cover (as a value of 1) and did not assign values to open canopy. Using the Raster Calculator tool, within the Map Algebra toolbox, null values were assigned a value of 0 within the raster layer. With the Raster Clip tool, within Raster Processing tools, the canopy raster layer was clipped to each buffer zone. These clipped raster files returned values of open and closed canopy within each buffer zone. The amount of closed canopy grids was divided by the total amount of canopy grids to find the percent canopy coverage for each buffer zone.

Correlation Factors

Correlation coefficients were examined to determine collinearity between predictor variables in Model 1 at each spatial scale to establish if autocorrelation was playing a role in each of the models. Moderate and high degrees of correlation were noted between variables. Ideally, if factors are shown to be strongly autocorrelated the overall factors used in the model can be reduced by eliminating one of the correlated factors.

At the fifty-meter buffer zone a moderate positive correlation was observed between Nearest Trail and Nearest Road (r= 0.474, Table 1) and between Nearest Building and Nearest Road (r= 0.547, Table 1).

Table 1. Correlation coefficients between each factor at 50m for Model 1. Moderate correlations are bolded.

	Nearest Road	Road Density	Nearest Trail	Trail. Density	Nearest Building	Total Buildings
Road Density	-0.169					
Nearest Trail	**0.474**	-0.059				
Trail Density	-0.090	-0.019	-0.157			
Nearest Building	**0.547**	-0.005	0.339	-0.166		
Total Buildings	-	-	-	-	-	
Canopy Cover	0.086	-0.070	0.152	-0.278	0.049	-

At the four-hundred-meter buffer zone for Model 1 there was a moderate positive correlation between Nearest Trail and Nearest Road (r= 0.474, Table 2), Nearest Building and Nearest Road (r= 0.547, Table 2), and Road Density and Total Buildings (r= 0.461, Table 2). A moderate negative correlation was observed between Nearest Road and Road Density (r= -0.572, Table 2), Nearest Trail and Trail Density (-0.453, Table 2) and Nearest Building and Total Buildings (-0.450, Table 2).

Table 2. Correlation coefficients between each factor at 400m for Model 1. Moderate correlations are bolded.

	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Total Buildings
Road Density	**-0.572**					
Nearest Trail	**0.474**	-0.149				
Trail Density	-0.200	-0.033	**-0.453**			
Nearest Building	**0.547**	-0.198	0.339	-0.339		
Total Buildings	-0.332	**0.461**	-0.192	0.173	**-0.450**	
Canopy Cover	0.369	-0.372	0.291	-0.153	0.347	-0.394

At the five-thousand-meter buffer zone there were moderate positive correlations between Nearest Road and Nearest Trail (r= 0.506, Table 3) and Nearest Road and Nearest Building (r=0.535, Table 3). There was a strong positive correlation between Road Density and Total Buildings (r= 0.873, Table 3). At this spatial scale there was a moderate negative correlation between Road Density and Nearest Building (r= -0.415, Table 3), Nearest Trail and Trail Density (r= -0.655, Table 3), and Road Density and Nearest Trail (-0.520, Table 3). There was a strong negative correlation between Total Buildings and Canopy Cover (r= -0.734, Table 3) as well as between canopy cover and road density.

Table 3. Correlation coefficients of all factors within the 5000m buffer zone. Moderate correlations are bolded while strong correlations are italicized.

	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Total Buildings
Road Density	-0.377					
Nearest Trail	**0.506**	**-0.520**				
Trail Density	-0.260	0.116	**-0.655**			
Nearest Building	**0.535**	**-0.415**	0.345	-0.349		
Total Buildings	-0.272	*0.873*	-0.343	0.037	-0.344	
Canopy Cover	0.324	*-0.758*	0.329	0.038	0.379	*-0.734*

The correlations that were observed between factors at different spatial scales were ultimately deemed to be insignificant relative to our purposes. There were few correlations observed, most of which were relatively low in magnitude. The few factors that did show a higher degree of correlation were only found at the large spatial scale, 0.873 (total buildings and road density), -0.758 (Canopy Cover and Road Density) and -0.734 (total buildings and canopy cover) and were deemed to not have a strong influence on the results of our models. Due to these low correlation values and the fact that correlations were not replicated across spatial scales it was decided that all factors should be retained in the models.

Analysis

All analyses were conducted using the statistical programming language R. A table was made for each of the three buffer zones in a CSV format to be imported into R. Snake population size was modeled as a function of the following fixed factors: Nearest

Road, Road Density, Nearest Trail, Trail Density, Nearest Building, Total Buildings, and Canopy Cover (Model 1). These factors were chosen as they increase the likelihood of detrimental effects on rattlesnake populations, usually in the form of mortality. This model was treated as the base model against which others are compared, similarly to Vos and Chardon (1998).

Two other models were used to separately address variation in snake population size within occupied sites (Model 2) and to focus on drivers of presence-absence rather than abundance of snakes (Model 3). Model 2 avoids possible issues of zero-inflation in Model 1, while Model 3 removes noise from variation in abundance to focus just on factors affecting presence. Model 2 used a normal linear regression model, while a generalized linear model (GLM) assuming a binomial error distribution was used for Model 3.

These three core models were also run with a subset of the data that excluded Pike County, due to differences in GIS data resolution from Pike as compared to the other Pennsylvania counties and certain effects of its positioning on the state border. The spread of Pike County's building data was irregular when compared to the other counties and did not align with actual building location. Additionally, many of Pike County's rattlesnake sites occurred along the Delaware River near the New York border. Because of this, buffer zones around these sites included land in New York State, for which no GIS information was collected. Therefore, the models were re-evaluated after excluding the sites from this county. These models (Model 4, 5, and 6) were otherwise identical to

Models 1, 2, and 3, respectively. These models (Model 1-6) were then repeated for each spatial scale.

Additionally, a linear model was run on each factor individually for each buffer zone to validate statistical significance in the aggregate models. The Bonferroni correction was used to adjust critical values for multiple comparisons. A Bonferroni-adjusted critical value of 0.00833 was used for comparisons when 6 factors were used (Fifty-meter buffer zones) and a value of 0.0071 was used for the other two spatial scales. Most models were conducted using unscaled predictor variables. Model 1 was additionally tested with centered data (i.e., representing each predictor variable value as a deviation from that variable's mean) to assess the effect of centering on the model outcome.

Presence/pseudo-absence comparisons

Finally, we wanted to account for the inherent sampling bias of the TRAP project. As mentioned previously, teams were sent out to verify historic sites for rattlesnake populations, but also looked for rattlesnake populations in suitable habitat. It is likely that TRAP participants used their knowledge of what constitutes good rattlesnake habitat in choosing where to search, thus biasing the location of sites. In addition to this factor, TRAP surveyors searching for new sites probably avoided many tracts of private property where permission to search could not be easily obtained. Therefore, we also compared the rattlesnake sites to "pseudo-absences" generated by sampling random background points in the northeast region of Pennsylvania using the Create Random Points Tool in ArcMap®. One-hundred random points were generated within the study area with the three spatial scale buffer zones added to each point. Canopy cover for pseudo-absences

was taken directly at the point, as opposed to the entire buffer zone. These values of 1's (Closed canopy) and 0's (Open canopy) were used for comparisons. In addition to this, nearest roads and nearest trails as well as road and trail densities were measured at each spatial scale around the pseudo-absences. Using this data, an analysis of variance (ANOVA) was conducted on each factor between the rattlesnake sites and random point data. If the random data is significantly different from that of the rattlesnake points, this demonstrates that the rattlesnake sites are not distributed randomly with respect to the locations and densities of the factors (roads, trails, buildings, etc.), indicating that they are either attracted to or repulsed by the presence of those factors. Comparing rattlesnake sites to pseudo-absences (e.g., background environmental conditions) provides an alternate method of testing whether these populations have specific habitat associations within the available environmental options in the region. Additionally, this can help account for possible bias introduced in the selection of the sites that generated the true absences (e.g., if those sites were chosen to sample because they appeared to be plausible rattlesnake habitat, rather than more broadly sampling habitat types within the region).

CHAPTER 3: RESULTS

The results are presented in model order from one to six. Within each model the results are presented starting with the small spatial scale and then are presented in size order following this. Each spatial scale is presented first with all factors included and then with population size or occupancy as a function of each individual factor. Results from the statistical tests are represented in tables when all factors are included and are included in the text when just one factor was used. The predictor variables (Nearest Road, Road Density, Nearest Trail, Trail Density, Nearest Building, Total Buildings, and Canopy Cover) are the same across all models. Models one, two, four, and five are linear regressions assuming a normal distribution of residuals, with population size (abundance) as the response. Models 3 and Model 6 are generalized linear models (GLM) assuming binomially-distributed residuals, using presence-absence data as the response.

Model 1: Abundance Model

The first linear model (Model 1) included population size as a function of all factors and included all sites. This model examined how the factors affect snake abundance, including absences, at the different spatial scales. Model 1: Fifty-Meters

Model 1: Fifty-Meters

At the fifty-meter buffer zone this model showed a significant relationship between population size and distance to nearest building ($p = 0.04$, Table 4). Another model was analyzed on this data set, for fifty meters, with the distribution of data centered. Centering the data did not change the outcome with nearest building still being the only significant factor ($p= 0.04$, Table 5).

Table 4. Results of Model 1 at the 50m buffer zone. A significant relationship was observed between population size and nearest building.

R^2= 0.0234 AIC= 806.53	Coefficient	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0023	1	41.98	41.98	0.655	0.420
Road Density	-460.58	1	11.01	11.01	0.171	0.679
Nearest Trail	-0.00014	1	50.60	50.60	0.789	0.376
Trail Density	378.78	1	164.49	164.49	2.56	0.112
Nearest Building	0.0032	1	277.12	277.12	4.32	0.0399*
Canopy Percent	-2.84	1	12.64	12.64	0.197	0.657
Residuals	5.81	107	6855.46	64.06		

Table 5. Results of Model 1 at the 50m buffer zone after factors were centered. A significant relationship was observed between population size and nearest building.

R^2= 0.0234 AIC= 806.53	Coefficient	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-1.230	1	41.98	41.98	0.655	0.420
Road Density	-0.437	1	11.01	11.01	0.171	0.679
Nearest Trail	-0.707	1	50.60	50.60	0.789	0.376
Trail Density	1.307	1	164.49	164.49	2.567	0.112
Nearest Building	2.025	1	277.12	277.12	4.325	0.0399*
Canopy Percent	-0.348	1	12.64	12.64	0.197	0.657
Residuals	3.730	107	6855.46	64.06		

Roadways varied in their distance to sites at the fifty-meter buffer from 29.9m to 2,445.7m with a mean distance of 720.8m (n=116). A linear model that was used with population size as a function of only nearest road did not yield significant results (ANOVA; df= (1, 115), F= 0.588, p= 0.444).

The density of roads within the fifty-meter buffer zone (found by dividing the total length of roads by the area of the buffer zone) ranged from 0 to 0.009001m/m^2 with a mean density of 0.0001196m/m^2 (n=118). The linear model relating road density to population size did not produce a significant result (ANOVA; df= (1, 116), F= 0.0821, p= 0.775).

The distance of trails varied from 3.4m to 14,548.48 at the fifty-meter buffer in model 1 with a mean distance of 5,043.22 meters (n=117). The linear model relating population size as a function of this factor did not show a significant relationship (ANOVA; df = (1, 115), F= 1.5519, p= 0.2154). The density of trails for this model at fifty meters ranged from 0m/m^2 to 0.02849m/m^2 with a mean density of 0.000517m/m^2 (n=118). The linear model for this factor did not yield a significant result (ANOVA; df = (1,116), F= 3.0528, p= 0.08324).

The distance of nearby buildings to sites ranged from 51.5 meters to 3,311.77 meters with a mean distance of 882.32 meters (n=115). Another linear model using population size as a function of distance to nearest building did not show a significant result (ANOVA; df= (1, 113), F= 0.7657, p= 0.3834). There were no buildings within the fifty-meter buffer zone for Model 1 (n=118).

The canopy cover of sites at fifty meters ranged from 28.64% to 100% with a mean cover of 94.72% (n=117). The linear model relating canopy cover to snake population size did not show a significant result (ANOVA; df= (1, 115), F= 0.9611, p= 0.329).

Model 1: Four-Hundred-Meters

The linear model at four-hundred-meters did not yield any significant results though Nearest Building was just outside of this threshold (Table 6). In a separate run, the four-hundred-meter buffer for model 1 was also scaled to center the factors used. A linear model was run using these scaled factors. This model did not yield results different from the original model (Table 7).

Table 6. Results of Model 1 at the 400m buffer zone. There were no significant relationships observed.

R^2= -0.005034 AIC= 810.73	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0036	1	41.98	41.98	0.636	0.426
Road Density	-1507.50	1	84.61	84.61	1.283	0.259
Nearest Trail	-0.00012	1	32.76	32.76	0.496	0.482
Trail Density	156.18	1	3.59	3.59	0.054	0.815
Nearest Building	0.0032	1	253.48	253.48	3.844	0.052
Buildings Within	-0.035	1	0.19	0.19	0.002	0.956
Canopy Percent	-4.16	1	7.59	7.59	0.115	0.735
Residuals	8.72	106	6989.11	65.93		

Table 7. Results of Model 1 at the 400m buffer zone with factors centered. There were no significant relationships observed.

R^2= -0.005034 AIC= 810.73	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-1.936	1	41.98	41.98	0.636	0.426
Road Density	-1.230	1	84.61	84.61	1.283	0.259
Nearest Trail	-0.624	1	32.76	32.76	0.496	0.482
Trail Density	0.228	1	3.59	3.59	0.054	0.815
Nearest Building	2.037	1	253.48	253.48	3.844	0.052
Buildings Within	-0.106	1	0.19	0.19	0.002	0.956
Canopy Percent	-0.299	1	7.59	7.59	0.115	0.735
Residuals	3.749	106	6989.11	65.93		

The four-hundred-meter buffer zone did not vary from the fifty-meter buffer zone regarding measurements of nearest road, nearest trail, or nearest building (Appendix XIX, Appendix XX).

A linear model with nearest road alone at four-hundred-meters did not yield a significant result (ANOVA; df= (1, 114), F= 0.5884, p= 0.4446). The density of roads within the four-hundred-meter buffer zone for Model 1 ranged from 0 m/m^2 to 0.003602 m/m^2 with a mean density of 0.0004563 m/m^2 (n=118). The linear model relating road density to population size did not show a significant result (ANOVA; df= (1, 116), F= 0.3702, p= 0.5441).

The linear model with population size as a function of nearest trail did not show a significant result (ANOVA; df= (1, 115), F= 1.5519, p=0.2154). The density of trails in Model 1 at four-hundred-meters ranged from 0 m/m^2 to 0.005346 m/m^2 with a mean density of 0.0006586 m/m^2 (n=118). The linear model did not show a significant

relationship between trail density and population size at four-hundred-meters (ANOVA; df= (1, 116), F= 0.1353, p= 0.7137).

No significant relationship was observed between population size and nearest building (ANOVA; df= (1,113), F= 0.7657, p= 0.3834). The quantity of buildings within the four-hundred-meter buffer zone in Model 1 ranged from zero to sixteen with a mean quantity of 1.14 (n= 115). No significant relationship was discovered between quantity of buildings and population size (ANOVA; df= (1, 115), F= 0.7274, p= 0.3955).

Canopy cover at four-hundred-meters in Model 1 ranged from 63.8% to 100% with a mean cover of 94.736% (n= 117). The linear model with population size as a function of canopy cover did not show a significant result (ANOVA; df= (1, 115), F= 0.001, p= 0.9744).

Model 1: Five-Thousand-Meters

The last buffer zone within Model 1, five-thousand-meters, showed a significant relationship between population size and nearest building (p= 0.02, Table 8), as well as a significant relationship between population size and quantity of buildings (p= 0.04, Table 8).

Another model was run with the factors scaled to adjust for the distribution of the data, however, results did not change with this model. There was a significant relationship between nearest building (p= 0.02, Table 9) and population size as well as quantity of buildings and population size (p= 0.04, Table 9).

Table 8. Results of Model 1 at the 5000m buffer zone. A significant relationship was observed between nearest building and population size as well as between quantity of buildings and population size.

R^2= 0.0879 AIC= 677.67	Coefficient	Df	Sum Sq	Mean Sq	F value	Pr (>F)
Nearest Road	-0.0028	1	69.73	69.73	0.976	0.325
Road Density	8623.13	1	167.42	167.42	2.343	0.129
Nearest Trail	0.00025	1	6.75	6.75	0.094	0.759
Trail Density	2897.49	1	0.33	0.33	0.004	0.945
Nearest Building	0.0043	1	425.08	425.08	5.94	0.016*
Buildings Within	-0.0012	1	308.23	308.23	4.314	0.040*
Canopy Percent	28.46	1	163.52	163.52	2.288	0.133
Residuals	-34.71	86	6144.23	71.44		

Table 9. Results of Model 1 at the 5000m buffer zone with factors centered. A significant relationship was observed between nearest building and population size as well as between quantity of buildings and population size.

R^2= 0.0879 AIC= 677.67	Coefficient	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-1.53	1	69.73	69.73	0.976	0.325
Road Density	7.04	1	167.42	167.42	2.343	0.129
Nearest Trail	1.32	1	6.75	6.75	0.094	0.759
Trail Density	1.02	1	0.33	0.33	0.004	0.945
Nearest Building	2.77	1	425.08	425.08	5.949	0.016*
Buildings Within	-3.23	1	308.23	308.23	4.314	0.040*
Canopy Percent	2.14	1	163.52	163.52	2.288	0.133
Residuals	3.99	86	6144.23	71.44		

The minimum and maximum distance from sites to nearest road did not change for the five-thousand-meter buffer zone, ranging from 29.9m to 2445.7m, however the mean, 764.4 (n=101), is slightly altered due to the lower sample size of this buffer zone. The linear model with population size as a function of nearest road alone did not yield a significant result (ANOVA; df= (1, 99), F= 0.775, p= 0.3808). The density of roads within the five-thousand-meter buffer for Model 1 ranged from 0.0003487m/m^2 to

0.004001m/m^2 with a mean density of 0.001383m/m^2 (n=102). This linear model did not show a significant result between road density and population size (ANOVA; df= (1, 100), F= 3.0216, p= 0.08524).

The distance of trails to sites in this buffer zone ranged from 3.4m to 14,548.48m with a mean of 5,177.062 (n=102). The linear model for this factor did not show a significant relationship (ANOVA; df= (1, 100), F= 1.4362, p=0.2336). The density of trails within this buffer zone ranged from 0m/m^2 to 0.001597m/m^2 with a mean density of 0.0002557m/m^2 (n=102). The linear model for trail density at five-thousand-meters for Model 1 did not show a significant relationship between trail density and population size (ANOVA; df= (1, 100), F= 0.3271, p= 0.5687).

Buildings had a mean distance of 936.45m (n= 96) with a minimum distance of 78.1m and a maximum distance of 15,706m. There was no significant relationship between nearest building and population size at 5 five-thousand-meters in Model 1 (ANOVA; df= (1, 94), F= 0.6195, p= 0.4332). The quantity of buildings within the five-thousand-meter buffer zone ranged from forty-two to fifteen-thousand-seven-hundred-and-six with a mean quantity of buildings of 1,871.03 (n=95). The linear model did not show a significant relationship between number of buildings within the five-thousand-meter buffer zone and population size (ANOVA; df= (1, 93), F= 0.2731, p= 0.6025).

Lastly, the amount of canopy cover in Model 1 for five-thousand-meters ranged from 58.44% to 97.76% with a mean cover of 88.56% (n= 101). There was no significant relationship between canopy cover and population size at five-thousand-meters for Model 1 (ANOVA; df= (1, 99), F= 0.0266, p= 0.8708).

Model 2: Non-Zero Abundance Model

The second linear model (Model 2) included population size as a function of all factors but removed all sites that did not have snake populations. This was done to remove the bias associated with zero inflation. Model 2 assesses the relationship between the predictor variables and snake abundance at sites where at least some snakes are present.

Model 2: Fifty-Meters

The model that was run for the fifty-meter buffer zone showed a significant relationship between population size and nearest building (p= 0.04, Table 10).

Table 10. Results of Model 2 at the 50m buffer zone with all factors included. There were no building measures at 50m. A significant relationship was observed between population size and nearest building.

R^2= 0.0302 AIC= 562.81	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr (>F)
Nearest Road	-0.0045	1	93.21	93.21	1.084	0.301
Road Density	-901.69	1	50.20	50.20	0.584	0.447
Nearest Trail	-0.00025	1	120.20	120.20	1.398	0.241
Trail Density	331.24	1	65.38	65.38	0.760	0.386
Nearest Building	0.0050	1	385.89	385.89	4.489	0.037*
Canopy Percent	1.37	1	1.90	1.90	0.022	0.882
Residuals	4.37	69	5930.19	85.94		

At the fifty-meter buffer distances of roadways to sites ranged from 29.9m to 2,061.8m with a mean distance of 737.5m (n=77). The linear model between nearest road and population size did not yield a significant result at fifty-meters (ANOVA; df= (1, 75), F= 1.0863, p= 0.3006). The density of roads within the fifty-meter buffer zone ranged from 0m/m^2 to 0.009m/m^2 with a mean density of 0.00017m/m^2 (n=79). A linear model

was used to assess the relationship between road density and snake populations but did not reveal a significant result (ANOVA; df= (1, 77), F= 0.2722, p= 0.6033).

The distance of trails at the fifty-meter buffer zone for Model 2 ranged from 3.4m to 14,517.335m with a mean distance of 5,182.67 (n=78). There was no significant relationship found between nearest trail and population size at this spatial scale (ANOVA; df= (1, 76), F= 2.2363, p= 0.1389). The density of trails at the fifty-meter buffer zone ranged from $0m/m^2$ to $0.0284m/m^2$ with a mean density of $0.0007724m/m^2$ (n=79). The linear model did not show a significant relationship between population size and road density (ANOVA; df= (1, 77), F= 1.3973, p= 0.2408).

Distances of buildings ranged from 51.5m to 3,311.77m at the fifty-meter buffer zone with a mean distance of 913.12m (n= 77). The linear model did not show a significant relationship between nearest building and population size (ANOVA; df= (1, 75), F= 0.4582, p= 0.5006). There were zero buildings measured within the fifty-meter buffer zone for all sites (n= 79).

Canopy cover within the fifty-meter buffer zone ranged from 41.67% to 100% with a mean cover of 93.4% (n=78). The linear model that was used to compare the relationship between canopy cover and population size did not show a significant result (ANOVA; df= (1, 76), F= 0.2181, p= 0.6419).

Model 2: Four-Hundred-Meters

The linear model for the four-hundred-meter buffer zone yielded a significant result between population size and nearest building (p= 0.02, Table 11).

Table 11. Results of Model 2 at the 400m buffer zone with all factors included. A significant relationship was observed between population size and nearest building.

R^2= 0.0348 AIC= 563.34	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0077	1	93.21	93.21	1.089	0.300
Road Density	-3178.28	1	142.95	142.95	1.671	0.200
Nearest Trail	-0.00014	1	90.83	90.83	1.061	0.306
Trail Density	557.45	1	0.63	0.63	0.007	0.931
Nearest Building	0.0063	1	465.36	465.36	5.440	0.022*
Buildings Within	0.29	1	15.85	15.85	0.185	0.668
Canopy Percent	-9.11	1	21.66	21.66	0.253	0.616
Residuals	15.99	68	5816.47	85.53		

The distances between the fifty-meter and four-hundred-meter buffer zones did not change regarding nearest road, nearest trail, and nearest building (Appendix XXII, Appendix XXIII).

The linear model for nearest road at four-hundred-meters did not show a significant result (ANOVA; df= (1, 75), F= 1.0863, p= 0.3006). The density of roads ranged from 0m/m^2 to 0.003107m/m^2 with a mean density of 0.000427m/m^2. The linear model that evaluated population size and road density did not yield a significant result (ANOVA; df= (1, 77), F= 0.207, p= 0.6504).

There was no significant relationship between nearest trail and population size within the four-hundred-meter buffer zone (ANOVA; df= (1, 76), F= 2.2363, p= 0.1389). The density of trails within the four-hundred-meter buffer zone ranged from 0m/m^2 to 0.00534m/m^2 with a mean density of 0.000558m/m^2 (n= 79). The linear model did not show a significant relationship between population size and trail density (ANOVA; df= (1, 77), F= 0.6022, p= 0.4401).

The linear model did not produce a significant result between nearest building and population size (ANOVA; df= (1, 75), F= 0.4582, p= 0.5006). The quantity of buildings within the four-hundred-meter buffer zone ranged from zero to twelve with a mean quantity of .66 (n= 78). There was no significant relationship between population size and total buildings shown by the linear model (ANOVA; df= (1, 76), F= 0.0069, p= 0.9339).

Canopy cover at the four-hundred-meter buffer zone for Model 2 ranged from 67.7% to 100% with a mean cover value of 95.4% (n=78). The linear model did not show a significant result between canopy cover and population size at the four-hundred-meter buffer (ANOVA; df= (1, 76), F= 0.2982, p= 0.5866).

Model 2: Five-Thousand-Meters

A linear model was used at five-thousand-meters to assess the relationship between the measured factors and population size, however, only nearest building was significant (p= 0.03, Table 12).

Table 12. Results of Model 2 at the 5000m buffer zone with all factors included. A significant relationship was observed between population size and nearest building.

R^2= 0.1097 AIC= 468.03	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0053	1	165.08	165.08	1.729	0.194
Road Density	11848.70	1	269.61	269.61	2.823	0.098
Nearest Trail	0.00035	1	7.151	7.15	0.074	0.785
Trail Density	7101.51	1	46.22	46.22	0.484	0.489
Nearest Building	0.0061	1	495.25	495.25	5.187	0.026*
Buildings Within	-0.0025	1	189.02	189.02	1.979	0.165
Canopy Percent	44.66	1	213.75	213.75	2.238	0.140
Residuals	-51.09	54	5155.62	95.47		

The distance of sites from roadways within the five-thousand-meter buffer zone ranged from 29.9m to 2,061.8m with a mean distance of 796.123m (n=64). A linear model did not show a significant result between population size and nearest road (ANOVA; df= (1, 62), F= 1.7025, p= 0.1968). The density of roads within this buffer zone ranged from 0.000419m/m^2 to 0.00359m/m^2 with a mean density of 0.00137m/m^2 (n=65). The relationship between road density and population size was not significant (ANOVA; df= (1, 63), F= 3.6841, p= 0.05947).

For the five-thousand-meter buffer zone the distance from sites to trails ranged from 3.4m to 14,517.33m with a mean distance of 5,390.93. The linear model used to assess the relationship between nearest trail and population size did not show a significant result (ANOVA; df= (1, 63), F= 2.1766, p= 0.1451). Trail density within this buffer zone ranged from 0m/m^2 to 0.00133m/m^2 with a mean density of 0.000223m/m^2 (n=65). No relationship was found between trail density and population size seen for this buffer zone (ANOVA; df= (1, 63), F= 1.3572, p= 0.2484)

The building distances recorded at the five-thousand-meter buffer zone for Model 2 ranged from 78.16m to 3,311.77m with a mean distance of 985.9m (n=64). There was no significant relationship between distance to buildings and population size within this buffer zone (ANOVA; df= (1, 62), F= 0.2266, p= 0.6357). The quantity of buildings within this buffer zone ranged from forty-two to seven-thousand-five-hundred-ninety-one with a mean quantity of 1,675.58 (n=63). The linear model did not yield a significant result when run with quantity of buildings and population size (ANOVA; df= (1, 61), F= 1.4683, p= 0.2303).

Canopy cover within this buffer zone ranged from 70.1% to 97.69% with a mean cover of 89.1% (n=64). There was no significant relationship discovered between canopy cover and population size (ANOVA; df=(1, 62), F= 0.0578, p= 0.8108).

Model 3: Presence-Absence Model

The third model that was explored used a generalized linear model with a binomial distribution to relate occupancy data as a function of the factors previously mentioned. All factors were included in this model. If the site had a population size of zero, it was assigned a value of zero, for absent, while any sites with a population size greater than or equal to one had a value of one assigned to them, for present, indicating that the site was occupied at the time it was visited. The goal of Model 3 was to assess which factors determine whether snakes will be present or absent.

Model 3: Fifty-Meters

This model did not show a significant relationship between factors and site occupancy at fifty-meters (Table 13).

Table 13. Results of the GLM for Model 3 within the 50m buffer zone. There were no buildings measured within this buffer zone. There was no significant relationship observed at this spatial scale.

AIC= 128.75	Coefficient	Df	Z- Value	Pr (>|z|)
Nearest Road	-0.0000091	1	-0.018	0.986
Road Density	2949.74	1	0.007	0.994
Nearest Trail	0.000045	1	0.965	0.334
Trail Density	1504.12	1	0.012	0.991
Nearest Building	0.00014	1	0.339	0.734
Canopy Percent	-2.97	1	-1.257	0.209
Residuals	3.12	107	1.360	0.174

The distance of sites to nearest roadways varied from 29.9m to 2,061.8m with a mean distance of 737.5m (n=77) for occupied sites while distances at unoccupied sites varied from 88.5m to 2,445.7m with a mean distance of 687.69 (n=39). There was no significant relationship seen between nearest road and site occupancy for this spatial scale in Model 3 (GLM; df= (1, 114), Z= 0.484 p= 0.628). The density of roadways in occupied sites ranged from 0m.m^2 to 0.009m/m^2 with a mean density of 0.000178m/m^2 (n=79) while no roadways were recorded within the fifty-meter buffer zone for unoccupied sites. The model did not show a significant relationship between road density and occupancy at fifty-meters for Model 3 (GLM; df=(1, 106), Z= 0.011, p= 0.990).

Within this buffer zone (50m) the distances of trails to sites varied from 3.4m to 14,517.34 with a mean distance of 5,182.67 (n=78) for occupied sites while unoccupied sites ranged from 87.3 to 14,548.48m with a mean distance of 4,764.34m (n=39). The GLM did not show a significant relationship between population and trail density for this spatial scale (GLM; df= (1, 115), Z= 0. .435, p= 0. 663). The density of trails at this spatial scale ranged from 0m/m^2 to 0.2849m/m^2 for occupied sites while unoccupied sites did not have any trails within the buffer zone for Model 3. There was no significant relationship observed between trail density and occupancy at this spatial scale for Model 3 (GLM; df= (1, 116), Z= 0.012, p= 0.990).

The distances from sites to buildings ranged from 51.5m to 3,311.77m with a mean distance of 913.12m (n=77) for occupied sites while nearest building ranged from 98.7m to 2,253.4m for unoccupied sites with a mean distance of 822.94m (n=33). The GLM did not show a significant relationship between site occupancy and nearest building

(GLM; df= (1, 113), Z= 0.733, p=0.263). There were no buildings present within the fifty-meter buffer zone for Model 3.

Canopy cover ranged from 41.67% to 100% for occupied sites with a mean cover of 93.43% (n=78) while the canopy cover at unoccupied sites ranged from 28.6 to 100% with a mean cover of 97.29% (n= 39). There was no significant relationship between occupancy and canopy cover for Model 3 at fifty-meters (GLM; df= (1, 115), Z= -1.512, p= 0.1306).

Model 3: Four-Hundred-Meters

The GLM at the four-hundred-meter buffer zone showed a significant relationship between quantity of buildings and population (p=0.03, Table 14). There was no difference between measurements regarding nearest road, nearest trail, and nearest building between the fifty-meter and four-hundred-meter buffer zones (Appendix XXV, Appendix XXVI).

The density of roadways within the four-hundred-meter buffer zone for occupied sites ranged from $0m/m^2$ to $0.0031m/m^2$ with a mean density of $0.000428m/m^2$ (n=79) while the density of roadways at the unoccupied sites ranged from $0m/m^2$ to $0.0036m/m^2$ with a mean density of $0.000514m/m^2$ (n=39). The GLM did not show a significant relationship between road density and site occupancy at this spatial scale in Model 3 (GLM; df= (1, 116), Z= -0.539, p= 0.589).

Table 14. Results of the GLM for Model 3 at the 400m buffer zone. A significant relationship was observed between quantity of buildings and occupancy.

AIC= 152.33	Coefficient	Df	Z- Value	Pr (>|z|)
Nearest Road	0.00013	1	0.210	0.833
Road Density	388.76	1	0.959	0.337
Nearest Trail	0.0000034	1	0.062	0.950
Trail Density	-99.55	1	-0.633	0.526
Nearest Building	-0.00053	1	-1.083	0.278
Buildings Within	-0.21	1	-2.137	0.032
Canopy Percent	3.07	1	0.937	0.580
Residuals	-1.69	106	-0.552	.5306

At the four-hundred-meter buffer zone in Model 3 trail densities ranged from 0m/m^2 to 0.00534m/m^2 with a mean density of 0.000558m/m^2 (n=79) for occupied sites while trail density in unoccupied sites ranged from 0m/m^2 to 0.00528m/m^2 with a mean density of 0.000862m/m^2 (n=39). No significant relationship was observed between trail density and occupancy for this spatial scale in Model 3 (GLM; df= (1, 116), Z= -1.052, p= 0.2928).

The quantity of buildings for occupied sites at four-hundred-meters ranged from zero to twelve with a mean quantity of 0.667 (n=78). For unoccupied sites the quantity of buildings ranged from zero to sixteen with a mean quantity of 2.102 (n=39). The GLM did not show a significant relationship between quantity of buildings and occupancy at the four-hundred-meter buffer zone for Model 3 after the Bonferroni correction accounting for multiple comparisons (GLM; df= (1, 115), Z= -2.203, p= 0.0276).

Canopy cover at the four-hundred-meter buffer zone ranged from 67.7% to 100% with a mean cover of 95.43% at occupied sites while cover ranged from 63.8% to 100% with a mean cover of 93.33% (n= 39) at unoccupied sites. There was no significant

relationship observed between canopy cover and population for this spatial scale (GLM; df= (1, 115), Z= 1.461, p= 0.144).

Model 3: Five-Thousand-Meters

The GLM at the five-thousand-meter buffer zone in Model 3 did not show a significant relationship between the factors and site occupancy (Table 15).

Table 15. Results of the GLM for the 5000m buffer zone in Model 3. There was no significant result observed between the factors and the response variable.

AIC= 128.75	Coefficient	Df	Z- Value	Pr (>|z|)
Nearest Road	0.000098	1	0.175	0.861
Road Density	1438.44	1	1.706	0.087
Nearest Trail	-0.000024	1	-0.296	0.767
Trail Density	-1240.32	1	-1.281	0.200
Nearest Building	0.000071	1	0.138	0.889
Buildings Within	-0.00038	1	-1.682	0.092
Canopy Percent	5.58	1	1.108	0.267
Residuals	-5.20	86	-1.053	0.292

The distance of nearest roadways to occupied sites ranged from 29.9m to 2,061.8m with a mean distance of 796.12m (n=64) while the distance from unoccupied sites to nearest road ranged from 88.5m to 2,445.7m with a mean distance of 709.54m (n=37). The GLM did not show a significant relationship between site occupancy and nearest roadway (GLM; df= (1, 99), Z= 0.785, p= 0.433). The density of roadways at this spatial scale for occupied sites in Model 3 ranged from 0.000419m/m^2 to 0.003599m/m^2 with a mean density of 0.00137m/m^2 (n=65) while unoccupied sites had a density range of 0.0003m/m^2 to 0.004m/m^2 with a mean density of 0.00139m/m^2 (n= 37). The GLM did not show a significant relationship between site occupancy and road density within the five-thousand-meter buffer zone for Model 3 (GLM; df= (1, 100), Z= -0.0109, p=

0.913) The distance from trails to sites at five-thousand-meters ranged from 3.4m to 14,517.34m with a mean distance of 5,309.93 (n=65) for occupied sites while unoccupied sites ranged from 87.3m to 14, 548.48m with a mean distance of 4,801.33m (n=37). There was no significant relationship observed between distance to nearest trail and site occupancy for this spatial scale in Model 3 (GLM; df= (1, 100), Z= 0.556, p= 0.578). The density of trails within the five-thousand-meter buffer zone ranged from $0m/m^2$ to $0.00133m/m^2$ for occupied sites with a mean density of $0.00022m/m^2$ (n=65) while unoccupied sites ranged from $0m/m^2$ to $0.00159m/m^2$ with a mean density of $0.000312m/m^2$ (n=37). The GLM did not show a significant relationship between trail density and population size at this spatial scale for Model 3 (GLM; df= (1, 100), Z= -1.217, p= 0.2234).

For this spatial scale, in Model 3, the distance to nearest building for occupied sites ranged from 78.16m to 3,311.77m with a mean distance of 985. 93m (n= 64) while the distance of nearest buildings to unoccupied sites ranged from 146.76m to 2,253.4m with a mean distance of 837.5m (n= 32). There was no significant relationship observed between nearest building and population at this spatial scale for Model 3 (GLM; df= (1, 94), Z= 1.074, p= 0.283). The quantity of buildings within the five-thousand-meter buffer zone for occupied sites ranged from forty-two to seven-thousand-five-hundred-ninety-one with a mean quantity of 1,675.58 (n= 63). For the unoccupied sites the quantity of buildings ranged from eighty-four to fifteen-thousand-seven-hundred-six with a mean quantity of 2,255.81 (n= 32). The GLM did not show a significant relationship between quantity of buildings and site occupancy at this spatial scale for model 3 (GLM; df= (1, 93), Z= -1.033, p= 0.3014).

The amount of canopy cover for occupied sites at the five-thousand-meter buffer zone in Model 3 ranged from 70.1% to 97.69% with a mean cover of 89.15% (n= 64) while unoccupied sites had 58.44% to 97.76% cover with a mean of 87.54% (n=37). The linear model did not show a significant relationship between canopy cover and site occupancy at the five-thousand-meter buffer zone for Model 3 (GLM; df= (1, 99), Z= 1.027, p= 0.304).

Model 4: Abundance Model Without Pike County

The fourth model (Model 4) was identical to Model 1, however, the data from Pike county is removed. This model included population size as a function of all measured factors.

Model 4: Fifty-Meters

At the fifty-meter buffer zone there was a significant relationship between trail density and population size (p= 0.01, Table 16).

Table 16. Results of Model 4 at 50m showing a significant relationship between trail density and population size. There were no buildings measured at this spatial scale.

R^2= 0.0557 AIC= 648.38	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0030	1	56.58	56.58	0.721	0.398
Road Density	-630.29	1	13.75	13.75	0.175	0.676
Nearest Trail	-0.00010	1	24.46	24.46	0.311	0.578
Trail Density	1031.66	1	520.43	520.43	6.635	0.011*
Nearest Building	0.0037	1	252.31	252.31	3.216	0.076
Canopy Percent	0.91	1	0.92	0.92	0.011	0.913
Residuals	1.98	80	6274.92	78.43		

As with previous models, each factor was put into a linear model individually to assess the relationship between each factor and population size at each site. Distances

from roadways to sites varied from 29.9m to 2,445.7m with a mean distance of 767.91 (n=89). The model relating population size to nearest roadway at fifty-meters did not yield a significant result (ANOVA; df= (1, 87), F= 0.6256, p=0.4311). The density of roads within this buffer zone ranged from 0m/m^2 to 0.009m/m^2 with a mean density of 0.0001m/m^2 (n= 90). The linear model for road density at fifty-meters did not reveal a significant result (ANOVA; df= (1, 87), F= 0.0799, p= 0.7782).

The distance of trails to sites at fifty-meters varied from 21.6m to 14,548.48m with a mean distance of 5,676.42m (n= 90). There was no significant relationship observed between population size and distance to nearest trail for this spatial scale (ANOVA; df= (1, 88), F= 0.963, p= 0.3291). The density of trails at fifty-meters for Model 4 ranged from 0m/m^2 to 0.0227m/m^2 with a mean density of 0.000361m/m^2 (n= 90). However, the linear model for this spatial scale showed a significant relationship between trail density and population size after correcting for multiple comparisons (Bonferroni, critical value= 0.0083) (ANOVA; df= (1, 88), F= 7.5827, p= 0.00716).

The distance from buildings to sites at the fifty-meter buffer zone ranged from 78.16m to 3,311.77m with a mean distance of 913.342m (n=88). The linear model used at this spatial scale for nearest building and snake numbers did not show a significant relationship (ANOVA; df= (1, 86), F= 0.2152, p= 0.6439). There were no buildings measured within the fifty-meter buffer zone for Model 4.

The canopy cover for Model 4 at fifty-meters ranged from 28.64% to 100% with a mean cover of 96.28% (n=89). The linear model did not show a significant relationship between canopy cover and population size (ANOVA; df= (1, 87), F= 0.5957, p= 0.4423).

Model 4: Four-Hundred-Meters

Within the four-hundred-meter buffer zone for Model 4 there was no significant relationship discovered between the factors and population size (Table 17).

The values of nearest factor did not differ between the fifty-meter and four-hundred-meter buffer zones for Model 4 (Appendix XXVIII, Appendix XXIX). The linear model for four-hundred-meters in Model 4 between nearest road and population size did not show a significant result (ANOVA; df= (1, 87), F= 0.625, p= 0.4311). The density of roads for this spatial scale in Model 4 ranged from $0m/m^2$ to $0.0031m/m^2$ with a mean density of $0.0004177m/m^2$ (n=90). There was no significant relationship found between road density and population size (ANOVA; df= (1, 88), F= 0.096, p= 0.7574).

Table 17. Results of Model 4 at the 400m buffer zone. There was no significant relationship observed between the factors and population size.

R^2= -0.0337 AIC= 643.89	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0040	1	56.58	56.58	0.659	0.419
Road Density	-1587.84	1	66.41	66.41	0.773	0.381
Nearest Trail	-0.00010	1	16.35	16.35	0.190	0.663
Trail Density	253.59	1	2.017	2.01	0.023	0.878
Nearest Building	0.0033	1	203.70	203.70	2.37	0.127
Buildings Within	-0.14	1	8.06	8.06	0.093	0.760
Canopy Percent	-4.56	1	6.85	6.85	0.079	0.778
Residuals	9.17	79	6783.40	85.86		

The linear model relating nearest trail and population size did not show a significant result (ANOVA; df= (1, 88), F= 0.963, p= 0.3291). The densities of trails within the four-hundred-meter buffer zone ranged from $0m/m^2$ to $0.00534m/m^2$ with a mean density of $0.000789m/m^2$ (n=90). The linear model did not show a significant

relationship at this spatial scale between trail density and population size (ANOVA; df= (1, 88), F= 0.2414, p= 0.6244).

Within this buffer zone for Model 4 there was no relationship found between nearest building and population size (ANOVA; df= (1,86), F= 0.2152, p= 0.6439). The quantity of buildings within this buffer zone ranged from zero to sixteen with a mean quantity of 0.9438 (n=89). There was no significant relationship seen between total buildings within the buffer zone and population size for Model 4 at four-hundred-meters (ANOVA; df= (1, 87), F= 0.3617, p=0.5492).

Canopy cover within the four-hundred-meter buffer zone ranged from 67.7% to 100% with a mean cover of 94.44% (n=89). There was no significant relationship seen between canopy cover and population size at this buffer zone for Model 4 (ANOVA; df= (1, 87), F= 0.116, p= 0.7342).

The last buffer zone for Model 4, five-thousand-meters, showed a significant relationship between quantity of buildings and population size (p=0.02, Table 18) as well as canopy cover and population size (p=0.048, Table 18).

Table 18. Results of Model 4 at the 5000m buffer zone. A significant relationship was observed between quantity of buildings and population size as well as canopy cover and population size.

R^2= 0.122 **AIC= 592.01**	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0017	1	65.18	65.18	0.839	0.362
Road Density	11645.94	1	269.36	269.36	3.467	0.066
Nearest Trail	0.00016	1	0.26	0.26	0.003	0.953
Trail Density	-491.08	1	0.69	0.69	0.008	0.924
Nearest Building	0.0028	1	307.84	307.84	3.96	0.050
Buildings Within	-0.0018	1	459.84	459.84	5.918	0.017*
Canopy Percent	43.21	1	311.71	311.71	4.012	0.048*
Residuals	-48.70	73	5671.62	77.69		

The distance between roadways and sites within this buffer zone for Model 4 varied from 29.9m to 2,445.7m with a mean distance of 770.84m (n=88). The linear model that tested population size as a function of distance to nearest roadways did not show a significant result (ANOVA; df= (1, 86), F= 0.6335, p= 0.4283). The density of roadways within this buffer zone in Model 4 ranged from 0.000348m/m^2 to 0.004001m/m^2 with a mean density of 0.0011354m/m^2 (n=89). The linear model relating population size as a function of road density for this spatial scale did not show a significant result (ANOVA; df= (1 87), F= 3.9419, p= 0.05025).

Model 4: Five-Thousand-Meters

Within the five-thousand-meter buffer zone for Model 4 the distances from sites to nearest trail ranged from 21.6m to 12,548.48m with a mean distance of 530.453m (n=89). The linear model for nearest trail distance and population size did not show a significant result (ANOVA; df= (1, 87), F= 0.9948, p= 0.3213). Densities of trails within the five-thousand-meter buffer zone ranged from 0m/m^2 to 0.00160m/m^2 with a mean

density of 0.000249m/m^2 (n= 89). There was no significant relationship seen between trail density and population size at five-thousand-meters for Model 4 (ANOVA; df= (1, 87), F= 0.0964, p= 0.7569).

The distance of nearest building ranged from 78.16m to 3,311.77m with a mean distance of 914.548m (n=83). The linear model that tested population size as a function of distance to nearest building did not show a significant result (ANOVA; df = (1, 81), F= 0.2176, p= 0.6421). At this spatial scale, for Model 4, the quantity of buildings within the buffer zone ranged from forty-two to fifteen-thousand-seven-hundred-six with a mean quantity of 1,904.304 (n= 82). The linear model did not show a significant relationship between population size and quantity of buildings for this spatial scale (ANOVA; df= (1, 80), F= 0.4506, p= 0.504).

Canopy cover within this buffer zone for Model 4 ranged from 58.44% to 97.7% with a mean cover of 88.44% (n=88). The linear model did not show a significant relationship between canopy cover and population size at this spatial scale (ANOVA; df= (1, 86), F= 0.0034, p= 0.9536).

Model 5: Non-Zero Abundance Model Without Pike County

The fifth model, Model 5, was identical to Model 2- that is, all sites that had a value of zero recorded for their population size were removed. Additionally, for this model Pike county was removed.

Model 5: Fifty-Meters

The linear model for the fifty-meter buffer zone showed a significant relationship between population size and nearest building (p=0.03, Table 19).

Table 19. Results of Model 5 at the 50m buffer zone. A significant relationship was observed between population size and nearest building. There were no buildings measured at this spatial scale.

R^2= 0.100 AIC= 394.96	Coefficients	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0081	1	180.47	180.47	1.576	0.215
Road Density	-1594.83	1	66.73	66.73	0.583	0.449
Nearest Trail	-0.00032	1	150.96	150.96	1.318	0.257
Trail Density	1002.14	1	281.53	281.53	2.459	0.123
Nearest Building	0.0087	1	604.67	604.67	5.282	0.026*
Canopy Percent	8.44	1	42.43	42.43	0.370	0.545
Residuals	-1.55	44	5036.86	114.47		

Nearest distance of roadways to sites varied within the fifty-meter buffer zone for Model 5 from 29.9m to 2,061.8m with a mean distance of 809.45m (n=52). The linear model did not find a significant result relating nearest distance of roadways to site (ANOVA; df= (1, 50), F= 1.4744, p= 0.2304). The density of roadways at this spatial scale for fifty-meters ranged from 0m/m^2 to 0.009m/m^2 with a mean density of 0.0001m/m^2 (n=53). A linear model was run relating population size as a function of road density and did not find a significant result (ANOVA; df= (1, 51), F= 0.2047, p= 0.6529).

The distance of trails ranged from 21.6m to 14,517.33m with a mean distance of 6,287.33m (n=53). There was no significant result discovered between nearest trail and population size for this spatial scale in Model 5 (ANOVA; df= (1, 51), F= 2.3026, p= 0.1353). The density of trails for Model 5 ranged from 0m/m^2 to 0.227m/m^2 with a mean density of 0.000613m/m^2 (n=53). The linear model relating population size as a function of trail density did not show a significant relationship for this spatial scale in Model 5 (ANOVA; df= (1, 51), F= 3.6766, p= 0.06079).

The distance of nearest building to sites ranged from 78.16m to 3,311.77m with a mean distance of 953.65m (n=52). The linear model relating nearest building to population size did not show a significant relationship (ANOVA; df= (1, 50), F= 0.0574, p= 0.8117). There were no buildings measured within the fifty-meter buffer zone in Model 5.

The total amount of canopy cover in Model 5 at this spatial scale ranged from 41.67% to 100% with a mean cover of 95.39% (n=52). There was no significant relationship reported between canopy cover and population size at fifty-meters (ANOVA; df= (1, 50), F= 0.2676, p= 0.6072).

Model 5: Four-Hundred-Meters

Within the four-hundred-meter buffer zone for Model 5 there was a significant relationship seen between nearest building and population size (p=0.04, Table 20).

Table 20. The results of Model 5 at the 400m buffer zone A significant relationship was found between nearest building and population size.

R^2= 0.03858 AIC= 399.18	Coefficient	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.011	1	180.47	180.47	1.474	0.231
Road Density	-4191.94	1	169.81	169.81	1.387	0.245
Nearest Trail	-0.00034	1	119.84	119.84	0.979	0.327
Trail Density	-52.31	1	14.24	14.24	0.116	0.734
Nearest Building	0.0092	1	564.17	564.17	4.610	0.037*
Buildings Within	1.51	1	53.40	53.40	0.436	0.512
Canopy Percent	0.77	1	0.11	0.11	0.000929	0.975
Residuals	9.54	43	5261.61	122.36		

The values of nearest roadway, trail, and building did not differ between the fifty-meter and four-hundred-meter buffer zones(Appendix XXXI, Appendix XXXII). The

linear model relating population size as a function of nearest road for the four-hundred-meter buffer did not show a significant result (ANOVA; df= (1, 50), F= 1.4744), p=0.2304). The density of roads at this spatial scale ranged from 0m/m^2 to 0.003107m/m^2 with a mean density of 0.000399m/m^2 (n=53). There was not a significant relationship measured between road density and population size for Model 5 at this spatial scale (ANOVA; df= (1, 51), F= 0.0446, p= 0.8336).

There was no significant relationship seen between nearest trail and population size at four-hundred-meters in Model 5 (ANOVA; df= (1, 51), F= 2.3026, p= 0.1353). The density of trails within this buffer zone for Model 5 ranged from 0m/m^2 to 0.00534m/m^2 with a mean density of 0.000706m/m^2 (n= 53). The linear model did not show a significant relationship between trail density and population size (ANOVA; df= (1, 51), F= 0.508, p= 0.4792).

The linear model relating population size as a function of nearest building at four-hundred-meters for Model 5 did not show a significant relationship (ANOVA; df= (1, 50), F= 0.0574, p=0.08117). The quantity of buildings within this buffer zone ranged from zero to six with a mean quantity of 0.3269 (n=52). The linear model did not show a significant relationship between quantity of buildings and population size (ANOVA; df= (1, 50), F= 0.4601, p= 0.5007).

The amount of canopy cover within the four-hundred-meter buffer zone ranged from 67.7% to 100% with a mean cover of 94.78% (n= 52). The linear model did not show a significant relationship between canopy cover and population size for this buffer zone in Model 5 (ANOVA; df= (1, 50), F= 0.2912, p= 0.5918).

Model 5: Five-Thousand-Meters

For the last buffer zone, five-thousand-meters, within Model 5 there was a significant relationship observed between road density and population size (p= 0.03, Table 21), quantity of buildings and population size (p= 0.03, Table 21), and canopy percent and population size (p= 0.03, Table 21). Additionally, the relationship between distance to nearest building and population size was nearly significant (p= 0.05, Table 21).

Distances of nearest road to each site varied from 29.9m to 2,061.8m with a mean distance of 815.31m (n= 51). The linear model that related population size as a function of distance to nearest road did not show a significant result (ANOVA; df= (1, 49), F= 1.533, p= 0.2215). The density of roadways within the five-thousand-meter buffer zone for Model 5 ranged from 0.000419m/m^2 to 0.003599m/m^2 with a mean density of 0.00132m/m^2 (n=52). The linear model relating population size as a function of road density did not show a significant result after Bonferroni corrections (ANOVA; df= (1, 50), F= 5.1955, p= 0.02695).

Table 21. Results of Model 5 at the 5000m buffer zone. A significant relationship was observed between population size and road density, population size and quantity of buildings, and population size and canopy cover.

R^2= 0.221 AIC= 375.3433	Coefficient	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Nearest Road	-0.0030	1	180.96	180.96	1.759	0.191
Road Density	21705.37	1	501.09	501.09	4.872	0.032*
Nearest Trail	-0.00024	1	1.76	1.76	0.017	0.896
Trail Density	-227.35	1	1.80	1.809	0.017	0.895
Nearest Building	0.0050	1	411.80	411.80	4.004	0.052
Buildings Within	-0.0061	1	510.68	510.68	4.966	0.031*
Canopy Percent	78.25	1	512.32	512.32	4.982	0.031*
Residuals	-82.51	41	4216.09	102.83		

The distance of trails to sites for Model 5 within the five-thousand-meter buffer zone ranged from 21.6m to 14,517.33m with a mean distance of 6,391.553m (n= 52). The linear model relating nearest trail to population size did not show a significant relationship (ANOVA; df= (1, 50), F= 2.4856, p= 0.1212). The density of roadways within this buffer zone ranged from 0m/m^2 to 0.00133m/m^2 with a mean density of 0.000204m/m^2 (n=52). There was no significant relationship observed between trail density and population size within this buffer zone for Model 5 (ANOVA; df= (1, 50), F= 0.8757, p= 0.3539).

The distance of buildings to sites within the five-thousand-meter buffer zone ranged from 78.16m to 3,311.77m with a mean distance of 962.886m (n= 51). There was no significant relation seen between nearest building and population size for this spatial scale in Model 5 (ANOVA; df= (1, 49), F= 0.0405, p= 0.8414). The total amount of buildings within this buffer zone for Model 5 varied from forty-two to seven-thousand-

five-hundred-ninety-one with a mean quantity of 1,679.34 (n= 50). The linear model that related population size as a function of total buildings did not show a significant relationship (ANOVA; df= (1, 48), F= 1.8941, p= 0.1751).

The amount canopy cover within this buffer zone for Model 5 ranged from 70.13% to 97.69% with a mean cover of 89.09% (n= 51). There was no significant relationship observed between canopy cover and population size within this buffer zone (ANOVA; df= (1, 49), F= 0.0972, p= 0.7566).

Model 6: Presence-Absence Model Without Pike County

The last model, Model 6, was derived from Model 3 and followed a similar structure to the previous two models with Pike County removed.

Model 6: Fifty-Meters

The first buffer zone, fifty-meters, did not show a significant relationship between the predictor and response variables (Table 22).

The distance from nearest road to sites ranged from 29.9m to 2,061.8m with a mean distance of 809.45m (n=52) for occupied sites while the distances ranged from 88.5m to 2,445.7m for unoccupied sites with a mean distance of 709.54m (n=37). The GLM did not show a significant relationship between nearest roadway and population for this spatial scale in Model 6 (GLM; df= 1, 87), Z= 0.844, p= 0.399). The density of roadways for occupied sites ranged from $0m/m^2$ to $0.009m/m^2$ with a mean density of $0.000169m/m^2$ (n= 53). There were no roadways measured within the fifty-meter buffer zone for Model 6. The GLM did not show a significant relationship between population and road density (GLM; df= (1, 88), Z= 0.010, p= 0.992).

Table 22. Results of the GLM at the 50m buffer zone for Model 6. There was no significant relationship observed between the factors and the response variable. There were no buildings measured at this spatial scale.

AIC= 124.15	Coefficient	Df	Z- Value	Pr (>|z|)
Nearest Road	-0.000019	1	-0.036	0.972
Road Density	1958.22	1	0.004	0.996
Nearest Trail	0.000096	1	1.806	0.071
Trail Density	1643.22	1	0.009	0.993
Nearest Building	-0.00015	1	-0.316	0.752
Canopy Percent	-1.44	1	-0.689	0.491
Residuals	1.28	80	0.620	0.535

The distance of nearest trail to occupied sites ranged from 21.6m to 14,517.34m with a mean distance of 6,287.33m (n=53) while distance of unoccupied sites to nearest trails ranged from 87.3m to 14,538.48m with a mean distance of 4,801.33m. There was no significant relationship observed between trail density and site occupation at this spatial scale for Model 6 (GLM; df= (1, 88), Z= 1.312, p=, 0.190). The density of trails within this buffer zone ranged from 0m/m^2 to 0.0227m/m^2 for occupied sites with a mean density of 0.000613m/m^2 (n=53). There were no trails measured within the fifty-meter buffer zone for Model 6. The GLM did not show a significant relationship between trail density and population at this spatial scale (GLM; df= (1, 88), Z= 0.014, p= 0.989).

At this spatial scale, fifty-meters, distance from occupied sites to nearest building ranged from 78.16m to 3,311.77m with a mean distance of 953.65m (n=53) while the distance of unoccupied sites to nearest sites ranged from 146.76m to 2,253.4m with a mean distance of 855.11m (n=37). There was no significant relationship observed between nearest building and site occupancy at this spatial scale for Model 6 (GLM; df=

(1, 86), Z= 0.720, p= 0.472). There were no buildings measured within the fifty-meter buffer zone.

Canopy cover for the fifty-meter buffer zone ranged from 41.6% to 100% for occupied sites with a mean cover of 95.39% (n= 52) while canopy cover ranged from 28.6% to 100% for unoccupied sites with a mean cover of 97.52% (n=37). The GLM did not show a significant relationship between canopy cover and site occupancy at this spatial scale for Model 6 (GLM; df= (1, 87), Z= -0.820, p= 0.412).

Model 6: Four-Hundred-Meters

At the four-hundred-meter buffer zone there was no significant relationship observed between the predictors and population, though total buildings were nearly significant (p=0.06, Table 23). There was no difference between the fifty-meter buffer zone and four-hundred-meter buffer zone regarding nearest road, nearest trail, and nearest building (Appendix XXXIV, Appendix XXXV).

Table 23. Results of the GLM at the 400m buffer zone for Model 6. There was no significant relationship observed between the factors and the response variable.

AIC= 121.16	Coefficient	Df	Z- Value	Pr (>|z|)
Nearest Road	0.00027	1	0.408	0.683
Road Density	556.60	1	1.209	0.227
Nearest Trail	0.00010	1	1.575	0.115
Trail Density	194.76	1	0.898	0.369
Nearest Building	-0.00061	1	-1.085	0.278
Buildings Within	-0.49	1	-1.919	0.055
Canopy Percent	-2.47	1	-0.620	0.535
Residuals	2.44	79	0.680	0.496

The density of roads within the four-hundred-meter buffer zone for occupied sites ranged from 0m/m^2 to 0.0031m/m^2 with a mean density of 0.000399m/m^2 (n= 53) while the density of unoccupied sites ranged from 0m/m^2 to 0.00224m/m^2 with a mean density of 0.000444m/m^2 (n=37). The GLM did not show a significant relationship between population and road density at this spatial scale (GLM; df= (1, 88), Z= -0.278, p= 0.781).

The density of trails for occupied sites within the four-hundred-meter buffer zone ranged from 0m/m^2 to 0.00534m/m^2 with a mean density of 0.000706m/m^2 (n= 53) while the density of trails at unoccupied sites ranged from 0m/m^2 to 0.00528m/m^2 with a mean density of 0.000908m/m^2 (n= 37). There was no significant relationship observed between trail density and occupancy at this spatial scale for Model 6 (GLM; df= (1, 88), Z= -0.593, p= 0.5530).

The quantity of buildings within the four-hundred-meter buffer zone ranged from zero to six for occupied sites with a mean quantity of 0.3269 (n= 52) while the quantity at unoccupied sites ranged from zero to sixteen with a mean quantity of 1.81 (n=37). There was no significant relationship observed between number of buildings within the buffer zone and population for Model 6 at this spatial scale after using the Bonferroni correction to account for multiple comparisons (GLM; df= (1, 87), Z= -1.981, p= 0.0476).

The amount of canopy cover for occupied sites ranged from 67.7% to 100% with a mean cover of 94.78% (n= 52) while canopy cover at unoccupied sites ranged from 74.8% to 100% with a mean cover of 93.96% (n= 37). There was no significant relationship observed between canopy cover and population at this spatial scale (GLM; df= (1, 87), Z= 0.531, p= 0.595).

Model 6: Five-Thousand-Meters

There were no significant relationships observed between the predictor variables and occupancy at the five-thousand-meter buffer zone (Table 24).

The distance of nearest roadway to occupied sites varied from 29.9m to 2,061.8m with a mean distance of 815.31m (n=51) while the distance from nearest road to unoccupied sites ranged from 88.5m to 2,445.7m with a mean distance of 709.54m (n= 37). There was no significant relationship observed between nearest road and occupancy at this spatial scale for Model 6 (GLM; df= (1, 86), Z= 0.886, p= 0.376). The density of roadways at occupied sites ranged from 0.000419m/m^2 to 0.00359m/m^2 with a mean density of 0.00132m/m^2 (n= 52) while the density of roadways at unoccupied sites ranged from 0.000348m/m^2 to 0.004m/m^2 with a mean density of 0.00139m/m^2 (n=37). There was no significant relationship observed between road density and occupancy at this spatial scale for Model (GLM; df= (1, 87), Z= -0.381, p= 0.704).

Table 24. Results from the GLM at the 5000m buffer zone for Model 6. There were no significant relationships observed between the factors and population.

AIC= 118.15	Coefficient	Df	Z- Value	Pr (>|z|)
Nearest Road	0.00015	1	0.270	0.787
Road Density	1408.76	1	1.620	0.105
Nearest Trail	0.000028	1	0.323	0.747
Trail Density	-1249.63	1	-1.084	0.278
Nearest Building	-0.00036	1	-0.612	0.541
Buildings Within	-0.00034	1	-1.507	0.132
Canopy Percent	5.68	1	1.059	0.290
Residuals	-5.47	73	-1.073	0.283

The distance of occupied sites to nearest trail ranged from 21.6m to 14,517.34m with a mean distance of 6,391.55m (n=52) while the distance from nearest trail to unoccupied sites ranged from 87.3m to 14,548.48m with a mean distance of 4,801.339m (n= 37). There was no significant relationship observed between nearest trail and occupancy at this spatial scale for Model 6 (GLM; df= (1, 87), Z= 1.396, p= 0.163). The density of trails within the five-thousand-meter buffer zone for occupied sites ranged from $0m/m^2$ to $0.00133m/m^2$ with a mean density of $0.000204m/m^2$ (n=52) while the density at unoccupied sites ranged from $0m/m^2$ to $0.00159m/m^2$ with a mean density of $0.000312m/m^2$ (n=37). There was no significant relationship observed between trail density and population at the five-thousand-meter buffer zone for Model 6 (GLM; df= (1, 87), Z= -1.374, p= 0.1695).

The distance of nearest building to occupied sites ranged from 78.16m to 3,311.77m with a mean distance of 962.88m (n=51) while the distance from nearest building to unoccupied sites ranged from 146.76m to 2,253.4m with a mean distance of 837.5m (n= 32). There was no significant relationship observed between nearest building and population size at this spatial scale for Model 6. (GLM; df= (1, 81), Z= 0.864, p= 0.387). The quantity of buildings within the five-thousand-meter buffer zone for occupied sites ranged from forty-two to seven-thousand-five-hundred-ninety-one with a mean quantity of 1,679.34m (n=50). The amount of buildings within the five-thousand-meter buffer zone for unoccupied sites ranged from eighty-four to fifteen-thousand-seven-hundred-six with a mean quantity of 2,255.81 (n=32). There was no significant relationship observed between quantity of buildings and population at this spatial scale for Model 6 (GLM; df= (1, 80), Z= -0.935, p= 0.350).

Canopy cover within the five-thousand-meter buffer zone for Model 6 ranged from 70.13% to 97.69% for occupied sites with a mean cover of 89.09% (n=51) while the canopy cover of unoccupied sites ranged from 58.44% to 97.76% with a mean cover of 87.54% (n=37). There was no significant relationship observed between occupancy and canopy cover for this spatial scale in Model 6 (GLM; df= (1, 86), Z= 0.892, p= 0.373).

Presence/Pseudo-Absence Analyses

There were one-hundred total points added to the Northeast region in ArcMap®. Two points were removed from Nearest Trail as the distance from the site to the nearest trail was greater than the distance from the site to the state border. Due to the nature of how canopy was measured for the random points, the values of canopy did not change between buffer zones for random points. (Appendix XL).

The distance of random points to nearest road varied from 0.8484m to 1,266.63m with a mean distance of 269.03m (n=100). A significant difference was found between nearest roads to rattlesnake sites and nearest roads to random points (ANOVA; df= (1, 214), F= 59.33, p< 0.0001). The distance of nearest trail to the random points ranged from 6.779m to 13,125.97m with a mean distance of 3,917.05m (n=98). There was not a significant difference observed between nearest trail to rattlesnake sites and nearest trail to random points (ANOVA; df= (1, 213), F= 3.874, p= 0.0503).

Within the fifty-meter buffer zone the density of roadways ranged from $0m/m^2$ to $0.026m/m^2$ with a mean density of $0.0029m/m^2$ (n=100). There was a significant difference between the density of roadways within fifty-meters of a rattlesnake site and the density of roads within fifty-meters of the random points (ANOVA; df= (1, 216), F=

22.23, $p< 0.0001$). The density of trails at this spatial scale for random points ranged from $0m/m^2$ to $0.0125m/m^2$ with a mean density of $0.000341m/m^2$ (n=100). There was not a significant difference observed between the trail density within fifty-meters of a rattlesnake site and the trail density within fifty-meters of a random point (ANOVA; df= (1, 216), F= 0.204, p= 0.652). The amount of canopy cover for the fifty-meter buffer zone ranged from 0% to 100% with a mean cover of 64% (n= 100). There was a significant difference between the canopy cover of rattlesnake sites at fifty-meters and the canopy cover of random points (ANOVA; df= (1, 215), F= 44.15, $p< 0.0001$).

The density of roadways within the four-hundred-meter buffer zone for random points ranged from $0m/m^2$ to $0.0213m/m^2$ with a mean density of $0.00285m/m^2$ (n=100). There was a significant difference observed between road density around rattlesnake sites at four-hundred meters and road density around the random points at four-hundred-meters (ANOVA; df= (1, 216), F= 58.33, $p< 0.0001$). The density of trails at this spatial scale ranged from $0m/m^2$ to $0.00347m/m^2$ with a mean density of $0.00009468m/m^2$ (n=100). There was a significant difference observed between trail density around rattlesnake sites and trail density around the random points (ANOVA; df= (1, 216), F= 13.74, $p< 0.001$). There was a significant difference observed between the canopy cover around rattlesnake sites at four-hundred-meters and canopy cover at the random points (ANOVA; df= (1, 215), F= 46.32, $p< 0.0001$).

The density of roadways within the five-thousand-meter buffer zone for random points ranged from $0.000398m/m^2$ to $0.0142m/m^2$ with a mean density of $0.00441m/m^2$ (n=100). There was a significant difference observed between the road density around

rattlesnake sites at five-thousand-meters and the road density around random points at five-thousand meters (ANOVA; df= (1, 200), F= 129.2, p<0.0001). The density of trails at this spatial scale ranged from 0m/m^2 to 0.00173m/m^2 with a mean density of 0.000253m/m^2 (n=100). The was no significant difference observed between trail density around rattlesnake sites at five-thousand-meters and trail density around random points at five-thousand-meters (ANOVA; df= (1, 200), F= 0.003, p= 0.954). There was a significant difference observed between canopy cover around rattlesnake sites at five-thousand-meters and canopy cover of random points (ANOVA; df= (1, 199), F= 25.56, p< 0.0001).

CHAPTER 4: DISCUSSION

Another recently published work relating habitat to *C. horridus* populations was limited to using habitat suitability models to predict where populations of this species should be (Kolba, 2016). Our work on this project represents a novel method of measuring the effects of disturbance on this species at various spatial scales. Likewise, whereas the previous work explored presence data as well as habitat features, both natural and abiotic, to predict where timber rattlesnakes should be, our approach explores where members of this species have been observed and relates anthropogenic impacts to these real-world observations to assess how population estimates are impacted. This project can have real-world implications in the management of this species at large spatial scales. The following section will describe in detail the significance of the results produced by the project. The layout of the discussion will follow the same order as the results, covering each model in detail before moving on to overall conclusions and future directions.

Model 1: Abundance Model

This model, which examined snake populations as a function of all factors in a linear model with all counties, showed a significant positive relationship between population size and distance to nearest building at the small and large spatial scales (50mand 5000m, respectively), with an additional significant negative relationship to total buildings at the large spatial scale. This relationship suggests snake populations do better at greater distances from buildings. As with all the models, R-Squared values are much higher at the large spatial scale while Akaike Information Criterion (AIC) values are lowest, suggesting that our data explains more of the variation in population size at this spatial scale. There are low quantities of trails and roads found within fifty-meters of a handful of sites with all sites in close proximity to these features containing a non-zero population of snakes (Appendix XIX). While canopy cover was not shown to be significant at any spatial scale, the pattern of the data fits the biology of the rattlesnake with canopy cover at small spatial scales having lower values than at the intermediate and large spatial scale, though the average amount of cover between the small and intermediate spatial scale did not differ very much. This suggests that snakes utilize small amounts of open habitat within this buffer zone that they would use primarily for maintenance behaviors including gestation, digestion, and ecdysis. The higher values of canopy cover at the large spatial scale suggest that forested habitat is required, likely for foraging and mate seeking behavior. There were no buildings measured at the small spatial scale, making their effect impossible to interpret. However, a negative relationship was observed between quantity of buildings and snake populations at the large spatial

scale, suggesting that developing land with associated structures may have a detrimental effect on populations.

Model 2: Non-Zero Abundance Model

Model 2 included snake abundance only within presence-sites. Within this model, all spatial scales showed a significant positive relationship between population size and distance to nearest building, again suggesting that as buildings encroach on snake habitats, snake populations become smaller. This model showed a similar pattern of higher R-squared values and lower AIC values at the large spatial scale, similarly suggesting that the observations better explain variation in snake populations at the large spatial scale. Removing the variance applied to sites with population numbers of zero does not seem to greatly change model results, with significant relationships and coefficients not differing by much. This model shows that small spatial scales have a wider range of canopy cover values with some sites having very low values at this spatial scale. Additionally, the large spatial scale seems to have much higher overall canopy cover with a smaller range of values. This reinforces the idea that forest cover seems to be more important at large spatial scales while the small spatial scale is reliant on patches of open canopy for maintenance habitat. Additionally, this model again shows that roads and trails are present close to rattlesnake populations. There was a negative relationship observed between buildings and populations at the large spatial scale, further suggesting that buildings are detrimental to snake populations at the landscape level.

Model 3: Presence-Absence Model

The third model used a generalized linear model with a binomial distribution and converted population size to occupancy data as a function of all factors. This model

showed a significant negative relationship between quantity of buildings and occupancy at the intermediate spatial scale. This model represented an interesting result in that it is the only model showing a significant relationship between these factors at this spatial scale, though it does reinforce the idea that buildings have a negative impact at larger spatial scales relative to the snake site. However, the small and large spatial scales within this model did not reveal a significant relationship and both had lower AIC values than the intermediate spatial scale, suggesting that this model better fits the data at these scales. This model also reveals that the factors are in line with what would be expected relative to presence-absence data; that is, sites where snakes are absent show higher densities of roads and trails, and have roads, trails, and buildings closer to them than sites where rattlesnakes are present (Appendix XXV, Appendix XXVI, Appendix XXVII, Appendix XXXIV, Appendix XXXV, Appendix XXXVI). This is further evidence that as human development encroaches on rattlesnake habitat, sites may become extirpated.

Model 4: Abundance Model Without Pike County

As mentioned previously, the next three models are mirrors of Model 1, Model 2, and Model 3 with Pike County removed. Model 4 showed a significant positive relationship between trail density and population size at the small spatial scale, which was corroborated when trail density was run individually in relation to population size. This was the only model to show a relationship with trail density and was the only model to show a significant relationship between an individual factor and population size after the critical value was corrected using the Bonferonni correction. This represents an unusual outcome in the otherwise consistent results. It may represent a Type I error in the results, incorrectly rejecting the null hypothesis. However, given the small p-value that

was observed here, it seems unlikely that this is true. Additionally, a significant negative relationship was observed between quantity of buildings and population size as well as a significant positive relationship between canopy cover and population size. This species, *C. horridus*, utilizes larger spatial scales for mate-seeking and foraging behaviors, and thus it would make sense that increased canopy and reduced quantity of buildings are favored by timber rattlesnakes. The R-squared values again suggest that the factors at the large spatial scale better explain the variation in population size.

Model 5: Non-Zero Abundance Model Without Pike County

This model, a repeat of Model 2 except that Pike County data was removed, showed a significant positive relationship between distance to nearest building and population size at the small and intermediate spatial scales. Additionally, the large spatial scale showed a significant positive relationship between canopy cover and population size as well as road density and population size as well as a significant negative relationship between total buildings and population size. The findings from this model corroborate observations from other models in that snake populations have an inverse relationship with distance to nearest building as well as building density around sites. Likewise, the canopy data reinforces the idea that this species needs forest habitat to disperse into. The road data here represents an interesting result in that it suggests that snake populations are higher when road density is higher. This is likely another type I error, as no other model showed a significant relationship between this factor and population size, nor is high road density congruent with the life history of timber rattlesnakes (Andrews and Gibbons, 2005). Once again, the R-squared values were much

higher at the large spatial scale while AIC values were lowest suggesting that more of the variation in population size can be explained by the predictors at this spatial scale.

Model 6: Presence-Absence Model Without Pike County

The last model was a mirror of Model 3 with Pike County removed. This model did not show any significant relationships between predictors and population size at any spatial scale, whether in one model or separate models for individual factors. Despite this absence of statistically significant relationships, some trends were present in the data. The roadway and trail data agreed with what would be expected for this species, with trails and roads being in lower densities around occupied sites and distances to these factors being higher around occupied sites. Building data for this model was in line with the other models in that occupied sites had less buildings within the buffer zones and distance to nearest building was farther for occupied sites, suggesting that building presence influences *C. horridus* populations. Lastly, canopy cover was higher around occupied sites at larger spatial scales while being lower at small spatial scales. This is in line with the known life history of *C. horridus* where habitats needed for maintenance and gestating represent small openings within largely forested regions and would be mostly visible at smaller spatial scales while at large spatial scales the habitat needed for dispersing, either for mating or feeding behavior, would dominate. Additionally, this model repeats what was shown in Model 3: roadways and trails are denser at unoccupied sites with more buildings within buffer zones, and lower overall canopy cover at unoccupied sites.

Presence/Pseudo-Absence Comparisons

The random points were added to the map to explore whether the sites represented truly random points where snakes were observed or if there was a bias associated with locating the rattlesnake sites. Whereas the six models examined previously compare designated rattlesnake sites to one another, the present comparison asks whether they have a preference for a specific habitat type compared to random samples of habitat within the region. The random background points differed significantly from the known rattlesnake locations in terms of their factors at nearly every spatial scale except for trail density at small and large spatial scales as well as distance to nearest trail. These results suggest sampling bias associated with the rattlesnake sites which is in line with the habitat requirements of this species, specifically at the small spatial scale where open canopy is necessary for maintenance behaviors associated with basking. Individuals of this species can be easily located in springtime after exiting a den site or in the fall just before ingress for hibernation. Additionally, these results show us that *C. horridus* has specific habitat requirements and these sites that were explored likely represent the realized niche of the species. Due to this preference for habitat during various parts of the year this species can be more readily located if the habitat requirements are understood. Our results show that this is likely the case with our sites, at least for sites that were newly discovered during the TRAP. The bias in our data likely contributes to the low R-squared values in our models as well as the low degree of significance that was observed.

Conclusion

These results present an interesting look into the forces that affect rattlesnake populations through various degrees of disturbance. The main conclusions are that,

among the factors examined, building density and canopy cover seem to be the main forces affecting population size at the large spatial scale. This information is reflective of the biology of the timber rattlesnake (Reinert, 1984a, 1984b) as well as the idea that buildings create disturbance zones that affect wildlife populations (Theobald et al., 1997). In nearly all models examined, buildings had a significant effect, although with a low effect size, whether it was distance to the nearest building or total quantity of buildings within the buffer zone. This information suggests that encroaching development may be detrimental to timber rattlesnake populations at the large scale level and may affect foraging habitat quality in some way, possibly by reducing the number of prey items, either through habitat loss or through the increase of meso-predators that are commensal with human settlements (Theobald et al., 1997). Additionally, anthropogenic impacts may isolate populations and reduce genetic diversity (Clark et al., 2010) while also increasing human-snake interactions, causing mortality (sensu Garber and Burger, 1995). The reduced canopy cover caused by development at the large spatial scale also likely reduces the quantity of prey items for individuals.

It's strange that few significant effects were observed between roads and population size in any model. Studies have shown that roadways have a major effect on individual snakes with high rates of mortality (Shine et al., 2004; Andrews and Gibbons, 2005; Frazer, 2005; Row et al., 2007; Clark et al., 2010). However, this could be related to one of the flaws represented in this work in that road area and road use were not accounted for. There is at least some difference in the effect of a large highway relative to that of a country dirt road. Additionally, some work has shown that hiking trails should have a measurable effect on herpetofauna populations by increasing the interactions of

humans and wildlife. This can result in direct mortality or collection for the pet trade, a problem which seems pervasive throughout all herpetofauna taxa (Garber and Burger, 1995; pers. obs.). As mentioned previously, timber rattlesnakes in particular are susceptible to the hazards of roadways due to their habit of relying on cryptic coloration (Andrews and Gibbons, 2005). However, the lack of significant results arising from these two predictor categories likely stems from the initial selection of survey sites, as illustrated by the comparison with pseudo-absence or background points. Specifically, rattlesnakes seem to have a preference for specific habitat types and surveyors have likely become attuned to this habitat specificity. Roadways and trails are commonly used to scout for rattlesnake habitat and this could be affecting the results of the model, since most sites will theoretically have trails or roads associated with them. Even though roads and trails did not show up as significant factors, it's assuring to see that measurements of these features fall in line with what would be expected: roadways and trails are less dense at occupied sites, there is higher canopy cover at occupied sites, there are fewer buildings at occupied sites, and lastly buildings, trails, and roads were farther away from occupied.

One explanation of the results seen here is that roadways and trails may represent a transient threat to individuals while buildings represent a more persistent threat. While interactions with vehicles undoubtedly cause mortality to wildlife crossing them, there are a number of factors that must combine to cause this mortality: snakes must encounter a road and make a conscious decision to cross, a vehicle must be traveling down the same roadway, the driver may or may not see the snake crossing the road, and finally there is a chance that drivers may decide to safely stop and allow a snake to cross a roadway if they observe one in the road. This logic follows for trailways where a snake must make the

decision to cross, a person must be coming down the trail at the same time, and the person must be aware of the snake's presence on the trail which may or may not occur depending on how cryptic a snake is and the degree to which a person is searching. Alternatively, buildings, and all things they include, represent a permanent human presence in a given area. The building presence comes with a more regular human presence, along with pets that may or may not interact with wildlife, increased vehicle presence, increased impermeable surfaces, increased habitat loss, destruction, and alteration. Based on my results, these factors seem to combine to be a larger threat to snake populations, overall.

Finally, due to the higher R-squared values and low AIC values seen at the large spatial scale versus the small and intermediate scales, it can be suggested that anthropogenic habitat features better explain the variation in population size at the large spatial scale. One of the drawbacks of this project was that it did not include natural abiotic factors. Due to the low R-squared values shown at the small spatial scale it seems likely that other factors are having the greatest influence on population size such as slope and slope aspect, cover objects, elevation, or temperature. Additionally, the four-hundred-meter buffer relationships do not usually agree with many of the results of the other two spatial scales. This buffer zone consistently had lower R-squared values that were reinforced by higher AIC values than either of the other spatial scales. There were several cases where the R-squared values for this spatial scale were adjusted below zero. It is likely that this spatial scale is too close in size to the small spatial scale and not large enough to capture intermediate differences where the effects of natural habitat factors drop off and the effects of anthropogenic factors pick up.

Running the models without Pike County seems to have improved them. In addition to high R-squared values in the last three models, AIC values also seem to be lower suggesting that the predictor variables better explain the range of response variables seen. Overall, these two indicators of how well a model fits followed a consistent pattern among models. In both model series (1-3 and 4-6) the fifty-meter buffer zone had higher AIC values and lower R-squared values while the five-thousand-meter buffer zone had lower AIC values and higher R-squared values, showing that the variance in population size and occupancy is better explained by our variables at the large spatial scales. Overall, all three models tell us different things. However, the R-squared values are highest for Model 5 while the AIC values were lowest for Model 6. This suggests that these two models explain more of the variation in population size and occupancy. However, Model 4 may be more informative when a model that accounts for zero-inflation is used.

Future Goals

There are several factors that should be considered in terms of future work with this project. First, anyone undertaking a follow-up study should consider adding in natural factors, such as slope, slope aspect, rock cover, elevation, etc., to see how their interactions are impacted by anthropogenic factors. Likewise, these features may contribute more to the models and may be more strongly predictive of the rattlesnake abundance. Additionally, the project should be expanded to more of the state to bolster the sample size and amplify any factors that are significant.

One of the major flaws in this study is that population estimates were low at nearly every site that did not have long term monitoring, primarily due to the nature of

TRAP where the goal was to locate populations and not to assess their size. With better populations estimates the models shown here would have better predictive ability and would give better insight into the effect our factors are having on the population. The other TRAMP efforts, most notably mark and recapture, can likely improve population estimates and help refine our models.

Additionally, it may be worth adding other buffer zones to assess just where the overlap between anthropogenic and natural factors lies. Both categories clearly influence rattlesnake populations, though our model lacks the ability to assess just where one ends and one picks up. It may be worth adding several buffers of differing size such as 750m, 1500m, and 2250m. These smaller changes in spatial scale could likely give a better picture of what is happening at the intermediate spatial scale and what may be the driving force behind population size at this level.

Lastly, it may be worth modifying how the road data is used in the model. One possible change would be to use road area within a buffer zone to assess how roads relate to population size at given spatial scales. This would require road layers to include width of the roadway in addition to length. Additionally, road substrate and road use could be included as random factors in a generalized linear model. Road substrate, whether asphalt, dirt, or gravel, may affect the role that the roadways play. The amount of time that a road is used on a given day would also affect the overall impact of a roadway. A road that is traversed once or twice a day will have a strongly different impact than a road that sees constant traffic throughout the day.

In conclusion, our project is a stepping stone into the study of how habitat affects populations of the timber rattlesnake at the landscape level. Anthropogenic factors have a larger impact at the large spatial scale with buildings being the main driving force. Likewise, natural factors are likely the driving force behind population size at the small spatial scale. There are many ways that our work can be improved upon to narrow down how habitat features specifically affect population levels, but this project gives a glimpse into the nature of how anthropogenic features are changing rattlesnake populations.

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APPENDICES

Appendix A: Raw Data of Models

Appendix I. Raw data for Model 1 at the 50m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.000	2124.90	0.000	451.1	0	0.584
Christman 1	Carbon	0	279.10	0.000	197.70	0.000	222.6	0	0.990
Christman 10	Carbon	0	151.90	0.000	1062.20	0.000	146.8	0	1.000
Christman 11	Carbon	29	397.10	0.000	21.60	0.023	78.2	0	0.662
Christman 12	Carbon	10	408.70	0.000	58.00	0.000	195.0	0	1.000
Christman 1N	Carbon	2	165.70	0.000	569.10	0.000	614.9	0	1.000
Christman 2	Carbon	4	186.80	0.000	227.90	0.000	414.2	0	1.000
Christman 3	Carbon	0	854.40	0.000	88.20	0.000	158.5	0	0.931
Christman 4	Carbon	0	316.90	0.000	252.60	0.000	315.3	0	1.000
Christman 5	Carbon	0	1224.10	0.000	595.70	0.000	624.2	0	1.000
Christman 6	Carbon	1	1126.70	0.000	411.50	0.000	423.0	0	1.000
Christman 7	Carbon	0	436.60	0.000	302.80	0.000	458.6	0	1.000
Christman 8	Carbon	0	401.50	0.000	192.05	0.000	350.9	0	1.000
Christman 9	Carbon	0	588.30	0.000	393.40	0.000	489.8	0	1.000
Hell Creek	Carbon	73	145.00	0.000	3037.30	0.000	1582.9	0	1.000
Hickory Run 4	Carbon	11	1544.20	0.000	552.50	0.000	2021.8	0	1.000
Hickory Run 5	Carbon	16	1101.90	0.000	86.40	0.000	89.2	0	1.000
Lehighton 1N	Carbon	2	475.30	0.000	240.90	0.000	244.5	0	0.932
Nesquehoning 1	Carbon	0	297.40	0.000	2154.20	0.000	319.8	0	0.956
Tamaqua 1	Carbon	0	247.57	0.000	3289.00	0.000	978.9	0	1.000
Tamaqua 1N	Carbon	0	415.50	0.000	2830.20	0.000	600.6	0	1.000

Weatherly 1	Carbon	0	1437.60	0.000	854.90	0.000	884.3	0	1.000
Weatherly 1N-Ribello	Carbon	2	348.80	0.000	2379.90	0.000	1126.1	0	0.973
Weatherly 1N-Stan	Carbon	1	219.30	0.000	162.60	0.000	322.7	0	1.000
Weatherly 2	Carbon	0	398.30	0.000	229.10	0.000	387.5	0	1.000
Weatherly 3	Carbon	1	544.20	0.000	316.30	0.000	440.4	0	1.000
Weatherly 4	Carbon	1	29.90	0.009	2393.90	0.000	1101.3	0	0.980
Weatherly 5	Carbon	0	217.40	0.000	162.80	0.000	320.7	0	1.000
Weatherly 6	Carbon	1	732.90	0.000	3411.40	0.000	660.9	0	0.998
Weatherly 7	Carbon	2	1466.50	0.000	4823.60	0.000	2034.3	0	1.000
Avoca 7	Luzerne	6	265.90	0.000	4099.60	0.000	463.7	0	1.000
Dutch Mountain 6	Luzerne	0	320.70	0.000	6494.40	0.000	2013.9	0	1.000
Hickory Run 1-Koval	Luzerne	0	238.80	0.000	1199.50	0.000	606.1	0	1.000
Hickory Run 2- Koval	Luzerne	31	966.60	0.000	1260.40	0.000	1114.2	0	1.000
Hickory Run 3- Koval	Luzerne	2	583.00	0.000	944.50	0.000	525.8	0	0.912
Nanticoke 1N	Luzerne	4	1110.80	0.000	2009.10	0.000	1253.6	0	1.000
Pittston 1	Luzerne	0	363.80	0.000	4098.00	0.000	151.6	0	1.000
Pittston 2	Luzerne	0	258.00	0.000	3557.40	0.000	158.4	0	1.000
Pittston 3	Luzerne	0	632.70	0.000	5916.00	0.000	858.0	0	0.960
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.000	3289.90	0.000	1312.7	0	0.286
Red Rock 2	Luzerne	0	1116.90	0.000	194.80	0.000	1637.0	0	1.000
Red Rock 3	Luzerne	0	766.10	0.000	89.30	0.000	767.4	0	0.985
Sweet Valley 1	Luzerne	0	430.60	0.000	6257.30	0.000	2253.4	0	1.000
Sweet Valley 2	Luzerne	0	88.50	0.000	87.30	0.000	1945.0	0	1.000
Wilkes Barre East 1	Luzerne	0	811.20	0.000	5878.10	0.000	733.1	0	1.000
Mount Pocono 1N	Monroe	1	620.80	0.000	64.80	0.000	694.1	0	1.000
Mount Pocono 2N	Monroe	4	827.40	0.000	25.00	0.010	700.7	0	0.880

Pocono Pines 1N	Monroe	3	907.56	0.000	3311.77	0.000	3311.8	0	
Stroudsburg 2N	Monroe	5		0.000	51.20	0.000		0	1.000
Lake Maskenozha 1N	Pike	3	504.80	0.000	2424.60	0.000	472.5	0	0.912
Milford 1N	Pike	3	377.60	0.000	377.60	0.000	491.5	0	1.000
Narrowsburg 1N	Pike	21		0.000		0.000		0	1.000
Narrowsburg 2	Pike	3	390.80	0.000	6085.00	0.000	269.9	0	0.925
Narrowsburg 2N	Pike	5	367.30	0.000	8573.00	0.000	1115.1	0	1.000
Narrowsburg 3	Pike	1	59.10	0.000	6611.90	0.000	1522.1	0	0.864
Pecks Pond 1N	Pike	2	286.10	0.000	3.40	0.028	195.0	0	0.715
Pond Eddy 1N	Pike	8	764.00	0.000	5170.00	0.000	703.8	0	0.961
Pond Eddy 2N	Pike	2	174.50	0.000	5259.00	0.000	179.7	0	0.898
Pond Eddy 3N	Pike	3	554.20	0.000	5595.00	0.000	369.5	0	0.898
Port Jervis North 1	Pike	2	507.00	0.000	6698.00	0.000	421.1	0	1.000
Promised Land 1	Pike	9	108.20	0.000	109.10	0.000	2184.0	0	1.000
Promised Land 2N	Pike	16	546.60	0.000	547.90	0.000	1350.9	0	0.513
Promised Land 3N	Pike	5	1275.80	0.000	691.70	0.000	1973.0	0	1.000
Rowland 1	Pike	4	122.60	0.000	257.40	0.000	95.2	0	1.000
Rowland 1N	Pike	5	959.07	0.000	959.07	0.000	876.2	0	0.815
Rowland 2N	Pike	3	1181.50	0.000	1600.20	0.000	745.2	0	0.838
Rowland 3N	Pike	6	928.30	0.000	1657.50	0.000	1367.7	0	0.916
Rowland 4N	Pike	6	1078.90	0.000	1759.40	0.000	1319.4	0	1.000
Shohola 1N	Pike	5	212.60	0.000	2718.50	0.000	51.5	0	0.945
Shohola 2	Pike	0	409.60	0.000	1788.40	0.000	389.0	0	1.000
Shohola 2N	Pike	4	32.60	0.005	3442.60	0.000	379.2	0	0.700
Shohola 3	Pike	0	157.60	0.000	6371.50	0.000	98.7	0	0.860
Shohola 4	Pike	3	1319.30	0.000	1319.30	0.000	1019.5	0	1.000

Shohola 4N	Pike	3	589.60	0.000	2076.00	0.000	1166.5	0	0.869
Shohola 5	Pike	3	1244.30	0.000	1246.50	0.000	1322.7	0	1.000
Shohola 3N	Pike	2	604.20	0.000	4604.30	0.000	623.9	0	0.883
Twelvemile Pond 1N	Pike	2	507.30	0.000	1232.70	0.000	505.9	0	0.621
Great Bend 1	Susquehanna	0	640.70	0.000	2560.10	0.000	800.1	0	1.000
Starrucca 1	Susquehanna	0	251.40	0.000	251.40	0.000	273.1	0	1.000
Susquehanna 1N	Susquehanna	2	510.90	0.000	867.80	0.000	482.5	0	0.999
White Mills 1	Wayne	3	252.20	0.000	4747.60	0.000	889.6	0	1.000
White Mills 1N	Wayne	3	106.70	0.000	4904.10	0.000	1117.4	0	0.417
White Mills 2	Wayne	3	573.20	0.000	6118.60	0.000	607.3	0	1.000
Dutch Mountain 1	Wyoming	3	534.50	0.000	12447.34	0.000	561.0	0	1.000
Dutch Mountain 1N	Wyoming	1	1508.54	0.000	14033.38	0.000	1430.0	0	0.997
Dutch Mountain 2	Wyoming	0	1231.58	0.000	14548.48	0.000	1018.2	0	1.000
Dutch Mountain 2N	Wyoming	7	618.80	0.000	14517.34	0.000	557.8	0	1.000
Dutch Mountain 3	Wyoming	0	163.60	0.000	12580.00	0.000	353.6	0	1.000
Dutch Mountain 3N	Wyoming	3	1119.80	0.000	13554.38	0.000	1157.6	0	1.000
Dutch Mountain 4	Wyoming	3	444.90	0.000	7862.37	0.000	1932.7	0	1.000
Dutch Mountain 5	Wyoming	0	385.50	0.000	8452.92	0.000	946.9	0	1.000
Jenningsville 1	Wyoming	0	259.10	0.000	13997.25	0.000		0	1.000
Jenningsville 1N	Wyoming	1	2061.80	0.000	12393.23	0.000	2026.7	0	0.878
Jenningsville 2N	Wyoming	3	1502.40	0.000	12400.73	0.000	1335.3	0	0.741
Meshoppen 1	Wyoming	0	414.20	0.000	8617.82	0.000	426.6	0	1.000
Meshoppen 1N	Wyoming	2	831.80	0.000	8763.22	0.000	414.5	0	1.000
Meshoppen 2N	Wyoming	6	202.60	0.000	10486.80	0.000	261.4	0	1.000
Noxen	Wyoming	0	2203.10	0.000	13030.57	0.000	2108.5	0	0.976
Noxen 1	Wyoming	4	1328.50	0.000	9656.14	0.000	1428.6	0	1.000

Noxen 10	Wyoming	6	1025.90	0.000	10649.31	0.000	911.2	0	1.000
Noxen 10N	Wyoming	4	1702.40	0.000	11205.63	0.000	1716.0	0	1.000
Noxen 1N	Wyoming	3	1273.90	0.000	12692.77	0.000	1318.2	0	1.000
Noxen 2	Wyoming	4	911.60	0.000	13087.59	0.000	558.0	0	1.000
Noxen 2N	Wyoming	3	1317.10	0.000	12992.57	0.000	1312.3	0	1.000
Noxen 3	Wyoming	0	1320.80	0.000	13011.71	0.000	1328.3	0	1.000
Noxen 3N	Wyoming	2	1335.40	0.000	12391.78	0.000	1343.5	0	1.000
Noxen 4	Wyoming	2	711.20	0.000	9559.28	0.000	593.5	0	1.000
Noxen 4N	Wyoming	1	1882.00	0.000	14165.07	0.000	1704.5	0	1.000
Noxen 5	Wyoming	0	2445.70	0.000	14364.49	0.000	1497.4	0	1.000
Noxen 5N	Wyoming	4	955.30	0.000	12570.92	0.000	925.9	0	1.000
Noxen 6N	Wyoming	2	934.80	0.000	10707.81	0.000	521.0	0	1.000
Noxen 7	Wyoming	0	1649.60	0.000	12814.95	0.000	1535.8	0	1.000
Noxen 7N	Wyoming	3	1625.90	0.000	11145.25	0.000	1575.3	0	1.000
Noxen 8	Wyoming	8	1280.70	0.000	12783.07	0.000	1249.5	0	0.934
Noxen 8N	Wyoming	4	299.40	0.000	8074.57	0.000	1071.0	0	1.000
Noxen 9	Wyoming	0	1746.90	0.000	13753.02	0.000	1800.8	0	1.000
Noxen 9N	Wyoming	2	296.00	0.000	12346.09	0.000	358.8	0	1.000
Tunkannock 1N	Wyoming	2	244.80	0.000	3519.70	0.000	364.5	0	0.721

Appendix II. Raw data for Model 1 at the 400m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0000	2124.90	0.0000	451.14	0	0.929
Christman 1	Carbon	0	279.10	0.0006	197.70	0.0047	222.55	2	0.819
Christman 10	Carbon	0	151.90	0.0019	1062.20	0.0000	146.76	10	0.975
Christman 11	Carbon	29	397.10	0.0001	21.60	0.0048	78.16	3	0.902
Christman 12	Carbon	10	408.70	0.0000	58.00	0.0047	194.96	2	0.915
Christman 1N	Carbon	2	165.70	0.0028	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	4	186.80	0.0015	227.90	0.0011	414.20	0	0.932
Christman 3	Carbon	0	854.40	0.0000	88.20	0.0045	158.52	2	0.925
Christman 4	Carbon	0	316.90	0.0003	252.60	0.0028	315.33	2	0.929
Christman 5	Carbon	0	1224.10	0.0000	595.70	0.0000	624.19	0	0.994
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Christman 7	Carbon	0	436.60	0.0000	302.80	0.0023	458.56	0	0.951
Christman 8	Carbon	0	401.50	0.0000	192.05	0.0035	350.89	2	0.896
Christman 9	Carbon	0	588.30	0.0000	393.40	0.0006	489.78	0	0.929
Hell Creek	Carbon	73	145.00	0.0006	3037.30	0.0000	1582.90	0	0.991
Hickory Run 4	Carbon	11	1544.20	0.0000	552.50	0.0000	2021.82	0	0.951
Hickory Run 5	Carbon	16	1101.90	0.0000	86.40	0.0052	89.18	2	0.908
Lehighton 1N	Carbon	2	475.30	0.0000	240.90	0.0039	244.48	1	0.932
Nesquehoning 1	Carbon	0	297.40	0.0016	2154.20	0.0000	319.82	13	0.799
Tamaqua 1	Carbon	0	247.57	0.0003	3289.00	0.0000	978.90	0	0.930
Tamaqua 1N	Carbon	0	415.50	0.0000	2830.20	0.0000	600.60	0	0.741
Weatherly 1	Carbon	0	1437.60	0.0000	854.90	0.0000	884.28	0	0.996
Weatherly 1N-Ribello	Carbon	2	348.80	0.0006	2379.90	0.0000	1126.11	0	0.997
Weatherly 1N-Stan	Carbon	1	219.30	0.0013	162.60	0.0053	322.65	6	0.869

Weatherly 2	Carbon	0	398.30	0.0000	229.10	0.0031	387.50	1	0.898
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0019	440.40	0	0.926
Weatherly 4	Carbon	1	29.90	0.0018	2393.90	0.0000	1101.32	0	0.988
Weatherly 5	Carbon	0	217.40	0.0013	162.80	0.0053	320.73	6	0.868
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.999
Weatherly 7	Carbon	2	1466.50	0.0000	4823.60	0.0000	2034.26	0	0.999
Avoca 7	Luzerne	6	265.90	0.0014	4099.60	0.0000	463.70	0	0.883
Dutch Mountain 6	Luzerne	0	320.70	0.0009	6494.40	0.0000	2013.90	0	0.997
Hickory Run 1-Koval	Luzerne	0	238.80	0.0013	1199.50	0.0000	606.10	0	0.889
Hickory Run 2- Koval	Luzerne	31	966.60	0.0000	1260.40	0.0000	1114.20	0	0.796
Hickory Run 3- Koval	Luzerne	2	583.00	0.0000	944.50	0.0000	525.80	0	0.677
Nanticoke 1N	Luzerne	4	1110.80	0.0000	2009.10	0.0000	1253.60	0	0.888
Pittston 1	Luzerne	0	363.80	0.0007	4098.00	0.0000	151.60	16	0.927
Pittston 2	Luzerne	0	258.00	0.0016	3557.40	0.0000	158.40	9	0.791
Pittston 3	Luzerne	0	632.70	0.0000	5916.00	0.0000	858.00	0	0.829
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0000	3289.90	0.0000	1312.70	0	0.902
Red Rock 2	Luzerne	0	1116.90	0.0000	194.80	0.0024	1637.00	0	1.000
Red Rock 3	Luzerne	0	766.10	0.0000	89.30	0.0018	767.40	0	1.000
Sweet Valley 1	Luzerne	0	430.60	0.0000	6257.30	0.0000	2253.40	0	1.000
Sweet Valley 2	Luzerne	0	88.50	0.0022	87.30	0.0016	1945.00	0	0.994
Wilkes Barre East 1	Luzerne	0	811.20	0.0000	5878.10	0.0000	733.10	0	0.938
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0053	694.10	0	0.998
Mount Pocono 2N	Monroe	4	827.40	0.0000	25.00	0.0035	700.70	0	0.995
Pocono Pines 1N	Monroe	3	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	5		0.0000	51.20	0.0017			0.984
Lake Maskenozha 1N	Pike	3	504.80	0.0000	2424.60	0.0000	472.50	0	0.990

Milford 1N	Pike	3	377.60	0.0003	377.60	0.0003	491.50	0	0.990
Narrowsburg 1N	Pike	21		0.0000		0.0000		0	1.000
Narrowsburg 2	Pike	3	390.80	0.0002	6085.00	0.0000	269.90	1	0.961
Narrowsburg 2N	Pike	5	367.30	0.0009	8573.00	0.0000	1115.10	0	0.971
Narrowsburg 3	Pike	1	59.10	0.0026	6611.90	0.0000	1522.10	0	0.825
Pecks Pond 1N	Pike	2	286.10	0.0006	3.40	0.0042	195.00	8	0.940
Pond Eddy 1N	Pike	8	764.00	0.0000	5170.00	0.0000	703.80	0	0.998
Pond Eddy 2N	Pike	2	174.50	0.0012	5259.00	0.0000	179.70	5	0.937
Pond Eddy 3N	Pike	3	554.20	0.0000	5595.00	0.0000	369.50	1	0.991
Port Jervis North 1	Pike	2	507.00	0.0000	6698.00	0.0000	421.10	0	1.000
Promised Land 1	Pike	9	108.20	0.0012	109.10	0.0013	2184.00	0	0.956
Promised Land 2N	Pike	16	546.60	0.0000	547.90	0.0000	1350.90	0	0.927
Promised Land 3N	Pike	5	1275.80	0.0000	691.70	0.0000	1973.00	0	0.999
Rowland 1	Pike	4	122.60	0.0024	257.40	0.0008	95.20	6	0.937
Rowland 1N	Pike	5	959.07	0.0000	959.07	0.0000	876.20	0	0.978
Rowland 2N	Pike	3	1181.50	0.0000	1600.20	0.0000	745.20	0	0.976
Rowland 3N	Pike	6	928.30	0.0000	1657.50	0.0000	1367.70	0	0.997
Rowland 4N	Pike	6	1078.90	0.0000	1759.40	0.0000	1319.40	0	0.998
Shohola 1N	Pike	5	212.60	0.0019	2718.50	0.0000	51.50	12	0.928
Shohola 2	Pike	0	409.60	0.0000	1788.40	0.0000	389.00	1	0.995
Shohola 2N	Pike	4	32.60	0.0011	3442.60	0.0000	379.20	2	0.953
Shohola 3	Pike	0	157.60	0.0036	6371.50	0.0000	98.70	14	0.638
Shohola 4	Pike	3	1319.30	0.0000	1319.30	0.0000	1019.50	0	0.984
Shohola 4N	Pike	3	589.60	0.0000	2076.00	0.0000	1166.50	0	0.995
Shohola 5	Pike	3	1244.30	0.0000	1246.50	0.0000	1322.70	0	0.998
Shohola 3N	Pike	2	604.20	0.0000	4604.30	0.0000	623.90	0	0.981

Twelvemile Pond 1N	Pike	2	507.30	0.0000	1232.70	0.0000	505.90	0	0.938
Great Bend 1	Susquehanna	0	640.70	0.0000	2560.10	0.0000	800.10	0	1.000
Starrucca 1	Susquehanna	0	251.40	0.0010	251.40	0.0010	273.10	3	0.900
Susquehanna 1N	Susquehanna	2	510.90	0.0000	867.80	0.0000	482.50	0	0.735
White Mills 1	Wayne	3	252.20	0.0027	4747.60	0.0000	889.60	0	0.923
White Mills 1N	Wayne	3	106.70	0.0031	4904.10	0.0000	1117.40	0	0.772
White Mills 2	Wayne	3	573.20	0.0000	6118.60	0.0000	607.30	0	0.993
Dutch Mountain 1	Wyoming	3	534.50	0.0000	12447.34	0.0000	561.00	0	0.964
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.976
Dutch Mountain 2	Wyoming	0	1231.58	0.0000	14548.48	0.0000	1018.17	0	1.000
Dutch Mountain 2N	Wyoming	7	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3	Wyoming	0	163.60	0.0014	12580.00	0.0000	353.60	1	0.981
Dutch Mountain 3N	Wyoming	3	1119.80	0.0000	13554.38	0.0000	1157.60	0	0.992
Dutch Mountain 4	Wyoming	3	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Dutch Mountain 5	Wyoming	0	385.50	0.0004	8452.92	0.0000	946.90	0	1.000
Jenningsville 1	Wyoming	0	259.10	0.0010	13997.25	0.0000		0	0.995
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.983
Jenningsville 2N	Wyoming	3	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.987
Meshoppen 1	Wyoming	0	414.20	0.0000	8617.82	0.0000	426.60	0	0.989
Meshoppen 1N	Wyoming	2	831.80	0.0000	8763.22	0.0000	414.50	0	0.968
Meshoppen 2N	Wyoming	6	202.60	0.0027	10486.80	0.0000	261.40	1	0.988
Noxen	Wyoming	0	2203.10	0.0000	13030.57	0.0000	2108.50	0	0.992
Noxen 1	Wyoming	4	1328.50	0.0000	9656.14	0.0000	1428.60	0	0.990
Noxen 10	Wyoming	6	1025.90	0.0000	10649.31	0.0000	911.20	0	0.998
Noxen 10N	Wyoming	4	1702.40	0.0000	11205.63	0.0000	1716.00	0	0.999
Noxen 1N	Wyoming	3	1273.90	0.0000	12692.77	0.0000	1318.20	0	0.988

Noxen 2	Wyoming	4	911.60	0.0000	13087.59	0.0000	558.00	0	0.998
Noxen 2N	Wyoming	3	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3	Wyoming	0	1320.80	0.0000	13011.71	0.0000	1328.30	0	1.000
Noxen 3N	Wyoming	2	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	2	711.20	0.0000	9559.28	0.0000	593.50	0	0.996
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	0.998
Noxen 5	Wyoming	0	2445.70	0.0000	14364.49	0.0000	1497.40	0	1.000
Noxen 5N	Wyoming	4	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	2	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7	Wyoming	0	1649.60	0.0000	12814.95	0.0000	1535.80	0	1.000
Noxen 7N	Wyoming	3	1625.90	0.0000	11145.25	0.0000	1575.30	0	0.984
Noxen 8	Wyoming	8	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.911
Noxen 8N	Wyoming	4	299.40	0.0011	8074.57	0.0000	1071.00	0	0.901
Noxen 9	Wyoming	0	1746.90	0.0000	13753.02	0.0000	1800.80	0	0.996
Noxen 9N	Wyoming	2	296.00	0.0002	12346.09	0.0000	358.80	1	0.907
Tunkannock 1N	Wyoming	2	244.80	0.0011	3519.70	0.0000	364.50	1	0.878

Appendix III. Raw data for Model 1 at the 5000m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0026	2124.90	0.0005	451.14	4034	0.872
Christman 1	Carbon	0	279.10	0.0013	197.70	0.0014	222.50	512	0.882
Christman 10	Carbon	0	151.90	0.0022	1062.20	0.0002	146.76	2601	0.833
Christman 11	Carbon	29	397.10	0.0018	21.60	0.0007	78.16	3167	0.921
Christman 12	Carbon	10	408.70	0.0011	58.00	0.0008	194.96	581	0.890
Christman 1N	Carbon	2	165.70	0.0009	569.10	0.0009	614.90	787	0.893
Christman 2	Carbon	4	186.80	0.0013	227.90	0.0006	414.20	726	0.887
Christman 3	Carbon	0	854.40	0.0010	88.20	0.0009	158.50	471	0.862
Christman 4	Carbon	0	316.90	0.0016	252.60	0.0008	315.33	1238	0.884
Christman 5	Carbon	0	1224.10	0.0009	595.70	0.0008	624.19	606	0.930
Christman 6	Carbon	1	1126.70	0.0016	411.50	0.0007	423.00	2195	0.918
Christman 7	Carbon	0	436.60	0.0016	302.80	0.0006	458.56	2298	0.928
Christman 8	Carbon	0	401.50	0.0016	192.05	0.0016	350.89	2683	0.933
Christman 9	Carbon	0	588.30	0.0016	393.40	0.0007	489.78	2738	0.929
Hell Creek	Carbon	73	145.00	0.0036	3037.30	0.0001	1582.90	5239	0.850
Hickory Run 4	Carbon	11	1544.20	0.0007	552.50	0.0003	2021.80	554	0.901
Hickory Run 5	Carbon	16	1101.90	0.0013	86.40	0.0013	89.10	424	0.884
Lehighton 1N	Carbon	2	475.30	0.0032	240.90	0.0008	244.48	7373	0.741
Nesquehoning 1	Carbon	0	297.40	0.0021	2154.20	0.0001	319.82	5193	0.818
Tamaqua 1	Carbon	0	247.57	0.0021	3289.00	0.0000			0.802
Tamaqua 1N	Carbon	0	415.50	0.0021	2830.20	0.0000			0.808
Weatherly 1	Carbon	0	1437.60	0.0009	854.90	0.0007	884.28	518	0.927
Weatherly 1N-Ribello	Carbon	2	348.80	0.0016	2379.90	0.0005	1126.11	2764	0.922
Weatherly 1N-Stan	Carbon	1	219.30	0.0020	162.60	0.0007	322.65	3921	0.908

Weatherly 2	Carbon	0	398.30	0.0016	229.10	0.0006	387.50	2682	0.933
Weatherly 3	Carbon	1	544.20	0.0016	316.30	0.0007	440.40	2723	0.930
Weatherly 4	Carbon	1	29.90	0.0017	2393.90	0.0005	1101.32	2734	0.909
Weatherly 5	Carbon	0	217.40	0.0020	162.80	0.0007	320.73	3917	0.908
Weatherly 6	Carbon	1	732.90	0.0015	3411.40	0.0002	660.86	1585	0.893
Weatherly 7	Carbon	2	1466.50	0.0014	4823.60	0.0000	2034.26	1701	0.853
Avoca 7	Luzerne	6	265.90	0.0006	4099.60	0.0001	463.70	483	0.905
Dutch Mountain 6	Luzerne	0	320.70	0.0006	6494.40	0.0000	2013.90	121	0.963
Hickory Run 1-Koval	Luzerne	0	238.80	0.0013	1199.50	0.0004	606.10	1021	0.875
Hickory Run 2- Koval	Luzerne	31	966.60	0.0008	1260.40	0.0002	1114.20	812	0.909
Hickory Run 3- Koval	Luzerne	2	583.00	0.0008	944.50	0.0002	525.80	574	0.908
Nanticoke 1N	Luzerne	4	1110.80	0.0023	2009.10	0.0001	1253.60	5986	0.726
Pittston 1	Luzerne	0	363.80	0.0040	4098.00	0.0000	151.60	15706	0.584
Pittston 2	Luzerne	0	258.00	0.0030	3557.40	0.0001	158.40	9643	0.621
Pittston 3	Luzerne	0	632.70	0.0025	5916.00	0.0000	858.00	3735	0.704
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0014	3289.90	0.0001	1312.70	934	0.902
Red Rock 2	Luzerne	0	1116.90	0.0008	194.80	0.0005			0.920
Red Rock 3	Luzerne	0	766.10	0.0011	89.30	0.0004			0.905
Sweet Valley 1	Luzerne	0	430.60	0.0006	6257.30	0.0000	2253.40	118	0.964
Sweet Valley 2	Luzerne	0	88.50	0.0006	87.30	0.0004	1945.00	84	0.944
Wilkes Barre East 1	Luzerne	0	811.20	0.0030	5878.10	0.0000	733.10	9805	0.711
Mount Pocono 1N	Monroe	1	620.80	0.0034	64.80	0.0001	694.10	7057	0.820
Mount Pocono 2N	Monroe	4	827.40	0.0035	25.00	0.0001	700.70	7591	0.818
Pocono Pines 1N	Monroe	3	907.56	0.0027	3311.77	0.0000	3311.77	4727	
Stroudsburg 2N	Monroe	5		0.0018	51.20	0.0003			0.795
Lake Maskenozha 1N	Pike	3	504.80	0.0027	2424.60	0.0001	472.50	3967	0.874

Milford 1N	Pike	3	377.60	0.0023	377.60	0.0001	491.50	2105	0.879
Pecks Pond 1N	Pike	2	286.10	0.0021	3.40	0.0005	195.00	3395	0.870
Promised Land 1	Pike	9	108.20	0.0007	109.10	0.0006	2184.00	397	0.921
Promised Land 2N	Pike	16	546.60	0.0007	547.90	0.0007	1350.90	427	0.919
Promised Land 3N	Pike	5	1275.80	0.0010	691.70	0.0011	1973.00	561	0.886
Rowland 3N	Pike	6	928.30	0.0011	1657.50	0.0001	1367.70	683	0.903
Rowland 4N	Pike	6	1078.90	0.0011	1759.40	0.0001	1319.40	675	0.902
Shohola 4	Pike	3	1319.30	0.0018	1319.30	0.0001	1019.50	1314	0.879
Shohola 4N	Pike	3	589.60	0.0018	2076.00	0.0001	1166.50	1309	0.892
Shohola 5	Pike	3	1244.30	0.0018	1246.50	0.0001	1322.70	1378	0.878
Shohola 3N	Pike	2	604.20	0.0016	4604.30	0.0000	623.90	1217	0.917
Twelvemile Pond 1N	Pike	2	507.30	0.0018	1232.70	0.0002	505.90	4167	0.898
Great Bend 1	Susquehanna	0	640.70	0.0021	2560.10	0.0001	800.10	1850	0.807
Starrucca 1	Susquehanna	0	251.40	0.0014	251.40	0.0003	273.10	588	0.770
White Mills 1	Wayne	3	252.20	0.0016	4747.60	0.0000	889.60	1654	0.798
White Mills 1N	Wayne	3	106.70	0.0016	4904.10	0.0000	1117.40	1554	0.814
White Mills 2	Wayne	3	573.20	0.0015	6118.60	0.0000	607.30	1469	0.849
Dutch Mountain 1	Wyoming	3	534.50	0.0006	12447.34	0.0000	561.00	271	0.934
Dutch Mountain 1N	Wyoming	1	1508.54	0.0004	14033.38	0.0000	1430.01	142	0.968
Dutch Mountain 2	Wyoming	0	1231.58	0.0004	14548.48	0.0000	1018.17	151	0.976
Dutch Mountain 2N	Wyoming	7	618.80	0.0004	14517.34	0.0000	557.80	156	0.973
Dutch Mountain 3	Wyoming	0	163.60	0.0003	12580.00	0.0000	353.60	94	0.978
Dutch Mountain 3N	Wyoming	3	1119.80	0.0005	13554.38	0.0000	1157.60	218	0.956
Dutch Mountain 4	Wyoming	3	444.90	0.0005	7862.37	0.0000	1932.70	42	0.964
Dutch Mountain 5	Wyoming	0	385.50	0.0006	8452.92	0.0000	946.90	88	0.965
Jenningsville 1	Wyoming	0	259.10	0.0007	13997.25	0.0000			0.904

Jenningsville 1N	Wyoming	1	2061.80	0.0007	12393.23	0.0000	2026.70	318	0.925
Jenningsville 2N	Wyoming	3	1502.40	0.0006	12400.73	0.0000	1335.30		0.913
Meshoppen 1	Wyoming	0	414.20	0.0013	8617.82	0.0000	426.60	402	0.798
Meshoppen 1N	Wyoming	2	831.80	0.0013	8763.22	0.0000	414.50	455	0.778
Meshoppen 2N	Wyoming	6	202.60	0.0009	10486.80	0.0000	261.40	334	0.870
Noxen	Wyoming	0	2203.10	0.0007	13030.57	0.0000	2108.50	655	0.937
Noxen 1	Wyoming	4	1328.50	0.0007	9656.14	0.0000	1428.60	247	0.925
Noxen 10	Wyoming	6	1025.90	0.0008	10649.31	0.0000	911.20	268	0.958
Noxen 10N	Wyoming	4	1702.40	0.0008	11205.63	0.0000	1716.00	344	0.961
Noxen 1N	Wyoming	3	1273.90	0.0008	12692.77	0.0000	1318.20	439	0.955
Noxen 2	Wyoming	4	911.60	0.0005	13087.59	0.0000	558.00	243	0.949
Noxen 2N	Wyoming	3	1317.10	0.0008	12992.57	0.0000	1312.30	624	0.929
Noxen 3	Wyoming	0	1320.80	0.0005	13011.71	0.0000	1328.30	216	0.961
Noxen 3N	Wyoming	2	1335.40	0.0005	12391.78	0.0000	1343.50	208	0.968
Noxen 4	Wyoming	2	711.20	0.0008	9559.28	0.0000	593.50	477	0.914
Noxen 4N	Wyoming	1	1882.00	0.0004	14165.07	0.0000	1704.50	154	0.977
Noxen 5	Wyoming	0	2445.70	0.0004	14364.49	0.0000	1497.40	183	0.976
Noxen 5N	Wyoming	4	955.30	0.0012	12570.92	0.0000	925.90	912	0.881
Noxen 6N	Wyoming	2	934.80	0.0005	10707.81	0.0000	521.00	224	0.947
Noxen 7	Wyoming	0	1649.60	0.0008	12814.95	0.0000	1535.80	738	0.914
Noxen 7N	Wyoming	3	1625.90	0.0008	11145.25	0.0000	1575.30	363	0.959
Noxen 8	Wyoming	8	1280.70	0.0010	12783.07	0.0000	1249.50	865	0.897
Noxen 8N	Wyoming	4	299.40	0.0010	8074.57	0.0000	1071.00	427	0.894
Noxen 9	Wyoming	0	1746.90	0.0007	13753.02	0.0000	1800.80	597	0.936
Noxen 9N	Wyoming	2	296.00	0.0014	12346.09	0.0000	358.80	1152	0.832
Tunkannock 1N	Wyoming	2	244.80	0.0024	3519.70	0.0001	364.50	2669	0.701

Appendix IV. Raw data for Model 2 at the 50m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0000	2124.90	0.0000	451.14	0	0.584
Christman 11	Carbon	29	397.10	0.0000	21.60	0.0228	78.16	0	0.662
Christman 12	Carbon	10	408.70	0.0000	58.00	0.0000	194.96	0	1.000
Christman 1N	Carbon	2	165.70	0.0000	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	4	186.80	0.0000	227.90	0.0000	414.20	0	1.000
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Hell Creek	Carbon	73	145.00	0.0000	3037.30	0.0000	1582.90	0	1.000
Hickory Run 4	Carbon	11	1544.20	0.0000	552.50	0.0000	2021.82	0	1.000
Hickory Run 5	Carbon	16	1101.90	0.0000	86.40	0.0000	89.18	0	1.000
Lehighton 1N	Carbon	2	475.30	0.0000	240.90	0.0000	244.48	0	0.932
Weatherly 1N-Ribello	Carbon	2	348.80	0.0000	2379.90	0.0000	1126.11	0	0.973
Weatherly 1N-Stan	Carbon	1	219.30	0.0000	162.60	0.0000	322.65	0	1.000
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0000	440.40	0	1.000
Weatherly 4	Carbon	1	29.90	0.0090	2393.90	0.0000	1101.32	0	0.980
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.998
Weatherly 7	Carbon	2	1466.50	0.0000	4823.60	0.0000	2034.26	0	1.000
Avoca 7	Luzerne	6	265.90	0.0000	4099.60	0.0000	463.70	0	1.000
Hickory Run 2- Koval	Luzerne	31	966.60	0.0000	1260.40	0.0000	1114.20	0	1.000
Hickory Run 3- Koval	Luzerne	2	583.00	0.0000	944.50	0.0000	525.80	0	0.912
Nanticoke 1N	Luzerne	4	1110.80	0.0000	2009.10	0.0000	1253.60	0	1.000
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0000	694.10	0	1.000
Mount Pocono 2N	Monroe	4	827.40	0.0000	25.00	0.0097	700.70	0	0.880
Pocono Pines 1N	Monroe	3	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	5		0.0000	51.20	0.0000		0	1.000

Lake Maskenozha 1N	Pike	3	504.80	0.0000	2424.60	0.0000	472.50	0	0.912
Milford 1N	Pike	3	377.60	0.0000	377.60	0.0000	491.50	0	1.000
Narrowsburg 1N	Pike	21		0.0000		0.0000		0	1.000
Narrowsburg 2	Pike	3	390.80	0.0000	6085.00	0.0000	269.90	0	0.925
Narrowsburg 2N	Pike	5	367.30	0.0000	8573.00	0.0000	1115.10	0	1.000
Narrowsburg 3	Pike	1	59.10	0.0000	6611.90	0.0000	1522.10	0	0.864
Pecks Pond 1N	Pike	2	286.10	0.0000	3.40	0.0285	195.00	0	0.715
Pond Eddy 1N	Pike	8	764.00	0.0000	5170.00	0.0000	703.80	0	0.961
Pond Eddy 2N	Pike	2	174.50	0.0000	5259.00	0.0000	179.70	0	0.898
Pond Eddy 3N	Pike	3	554.20	0.0000	5595.00	0.0000	369.50	0	0.898
Port Jervis North 1	Pike	2	507.00	0.0000	6698.00	0.0000	421.10	0	1.000
Promised Land 1	Pike	9	108.20	0.0000	109.10	0.0000	2184.00	0	1.000
Promised Land 2N	Pike	16	546.60	0.0000	547.90	0.0000	1350.90	0	0.513
Promised Land 3N	Pike	5	1275.80	0.0000	691.70	0.0000	1973.00	0	1.000
Rowland 1	Pike	4	122.60	0.0000	257.40	0.0000	95.20	0	1.000
Rowland 1N	Pike	5	959.07	0.0000	959.07	0.0000	876.20	0	0.815
Rowland 2N	Pike	3	1181.50	0.0000	1600.20	0.0000	745.20	0	0.838
Rowland 3N	Pike	6	928.30	0.0000	1657.50	0.0000	1367.70	0	0.916
Rowland 4N	Pike	6	1078.90	0.0000	1759.40	0.0000	1319.40	0	1.000
Shohola 1N	Pike	5	212.60	0.0000	2718.50	0.0000	51.50	0	0.945
Shohola 2N	Pike	4	32.60	0.0051	3442.60	0.0000	379.20	0	0.700
Shohola 4	Pike	3	1319.30	0.0000	1319.30	0.0000	1019.50	0	1.000
Shohola 4N	Pike	3	589.60	0.0000	2076.00	0.0000	1166.50	0	0.869
Shohola 5	Pike	3	1244.30	0.0000	1246.50	0.0000	1322.70	0	1.000
Shohola 3N	Pike	2	604.20	0.0000	4604.30	0.0000	623.90	0	0.883
Twelvemile Pond 1N	Pike	2	507.30	0.0000	1232.70	0.0000	505.90	0	0.621

Susquehanna 1N	Susquehanna	2	510.90	0.0000	867.80	0.0000	482.50	0	0.999
White Mills 1	Wayne	3	252.20	0.0000	4747.60	0.0000	889.60	0	1.000
White Mills 1N	Wayne	3	106.70	0.0000	4904.10	0.0000	1117.40	0	0.417
White Mills 2	Wayne	3	573.20	0.0000	6118.60	0.0000	607.30	0	1.000
Dutch Mountain 1	Wyoming	3	534.50	0.0000	12447.34	0.0000	561.00	0	1.000
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.997
Dutch Mountain 2N	Wyoming	7	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3N	Wyoming	3	1119.80	0.0000	13554.38	0.0000	1157.60	0	1.000
Dutch Mountain 4	Wyoming	3	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.878
Jenningsville 2N	Wyoming	3	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.741
Meshoppen 1N	Wyoming	2	831.80	0.0000	8763.22	0.0000	414.50	0	1.000
Meshoppen 2N	Wyoming	6	202.60	0.0000	10486.80	0.0000	261.40	0	1.000
Noxen 1	Wyoming	4	1328.50	0.0000	9656.14	0.0000	1428.60	0	1.000
Noxen 10	Wyoming	6	1025.90	0.0000	10649.31	0.0000	911.20	0	1.000
Noxen 10N	Wyoming	4	1702.40	0.0000	11205.63	0.0000	1716.00	0	1.000
Noxen 1N	Wyoming	3	1273.90	0.0000	12692.77	0.0000	1318.20	0	1.000
Noxen 2	Wyoming	4	911.60	0.0000	13087.59	0.0000	558.00	0	1.000
Noxen 2N	Wyoming	3	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3N	Wyoming	2	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	2	711.20	0.0000	9559.28	0.0000	593.50	0	1.000
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	1.000
Noxen 5N	Wyoming	4	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	2	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7N	Wyoming	3	1625.90	0.0000	11145.25	0.0000	1575.30	0	1.000
Noxen 8	Wyoming	8	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.934

Noxen 8N	Wyoming	4	299.40	0.0000	8074.57	0.0000	1071.00	0	1.000
Noxen 9N	Wyoming	2	296.00	0.0000	12346.09	0.0000	358.80	0	1.000
Tunkannock 1N	Wyoming	2	244.80	0.0000	3519.70	0.0000	364.50	0	0.721

Appendix V. Raw data for Model 2 at the 400m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0000	2124.90	0.0000	451.14	0	0.929
Christman 11	Carbon	29	397.10	0.0001	21.60	0.0048	78.16	3	0.902
Christman 12	Carbon	10	408.70	0.0000	58.00	0.0047	194.96	2	0.915
Christman 1N	Carbon	2	165.70	0.0028	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	4	186.80	0.0015	227.90	0.0011	414.20	0	0.932
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Hell Creek	Carbon	73	145.00	0.0006	3037.30	0.0000	1582.90	0	0.991
Hickory Run 4	Carbon	11	1544.20	0.0000	552.50	0.0000	2021.82	0	0.951
Hickory Run 5	Carbon	16	1101.90	0.0000	86.40	0.0052	89.18	2	0.908
Lehighton 1N	Carbon	2	475.30	0.0000	240.90	0.0039	244.48	1	0.932
Weatherly 1N-Ribello	Carbon	2	348.80	0.0006	2379.90	0.0000	1126.11	0	0.997
Weatherly 1N-Stan	Carbon	1	219.30	0.0013	162.60	0.0053	322.65	6	0.869
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0019	440.40	0	0.926
Weatherly 4	Carbon	1	29.90	0.0018	2393.90	0.0000	1101.32	0	0.988
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.999
Weatherly 7	Carbon	2	1466.50	0.0000	4823.60	0.0000	2034.26	0	0.999
Avoca 7	Luzerne	6	265.90	0.0014	4099.60	0.0000	463.70	0	0.883
Hickory Run 2- Koval	Luzerne	31	966.60	0.0000	1260.40	0.0000	1114.20	0	0.796
Hickory Run 3- Koval	Luzerne	2	583.00	0.0000	944.50	0.0000	525.80	0	0.677
Nanticoke 1N	Luzerne	4	1110.80	0.0000	2009.10	0.0000	1253.60	0	0.888
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0053	694.10	0	0.998
Mount Pocono 2N	Monroe	4	827.40	0.0000	25.00	0.0035	700.70	0	0.995
Pocono Pines 1N	Monroe	3	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	5		0.0000	51.20	0.0017			0.984

Lake Maskenozha 1N	Pike	3	504.80	0.0000	2424.60	0.0000	472.50	0	0.990
Milford 1N	Pike	3	377.60	0.0003	377.60	0.0003	491.50	0	0.990
Narrowsburg 1N	Pike	21		0.0000		0.0000		0	1.000
Narrowsburg 2	Pike	3	390.80	0.0002	6085.00	0.0000	269.90	1	0.961
Narrowsburg 2N	Pike	5	367.30	0.0009	8573.00	0.0000	1115.10	0	0.971
Narrowsburg 3	Pike	1	59.10	0.0026	6611.90	0.0000	1522.10	0	0.825
Pecks Pond 1N	Pike	2	286.10	0.0006	3.40	0.0042	195.00	8	0.940
Pond Eddy 1N	Pike	8	764.00	0.0000	5170.00	0.0000	703.80	0	0.998
Pond Eddy 2N	Pike	2	174.50	0.0012	5259.00	0.0000	179.70	5	0.937
Pond Eddy 3N	Pike	3	554.20	0.0000	5595.00	0.0000	369.50	1	0.991
Port Jervis North 1	Pike	2	507.00	0.0000	6698.00	0.0000	421.10	0	1.000
Promised Land 1	Pike	9	108.20	0.0012	109.10	0.0013	2184.00	0	0.956
Promised Land 2N	Pike	16	546.60	0.0000	547.90	0.0000	1350.90	0	0.927
Promised Land 3N	Pike	5	1275.80	0.0000	691.70	0.0000	1973.00	0	0.999
Rowland 1	Pike	4	122.60	0.0024	257.40	0.0008	95.20	6	0.937
Rowland 1N	Pike	5	959.07	0.0000	959.07	0.0000	876.20	0	0.978
Rowland 2N	Pike	3	1181.50	0.0000	1600.20	0.0000	745.20	0	0.976
Rowland 3N	Pike	6	928.30	0.0000	1657.50	0.0000	1367.70	0	0.997
Rowland 4N	Pike	6	1078.90	0.0000	1759.40	0.0000	1319.40	0	0.998
Shohola 1N	Pike	5	212.60	0.0019	2718.50	0.0000	51.50	12	0.928
Shohola 2N	Pike	4	32.60	0.0011	3442.60	0.0000	379.20	2	0.953
Shohola 4	Pike	3	1319.30	0.0000	1319.30	0.0000	1019.50	0	0.984
Shohola 4N	Pike	3	589.60	0.0000	2076.00	0.0000	1166.50	0	0.995
Shohola 5	Pike	3	1244.30	0.0000	1246.50	0.0000	1322.70	0	0.998
Shohola 3N	Pike	2	604.20	0.0000	4604.30	0.0000	623.90	0	0.981
Twelvemile Pond 1N	Pike	2	507.30	0.0000	1232.70	0.0000	505.90	0	0.938

Susquehanna 1N	Susquehanna	2	510.90	0.0000	867.80	0.0000	482.50	0	0.735
White Mills 1	Wayne	3	252.20	0.0027	4747.60	0.0000	889.60	0	0.923
White Mills 1N	Wayne	3	106.70	0.0031	4904.10	0.0000	1117.40	0	0.772
White Mills 2	Wayne	3	573.20	0.0000	6118.60	0.0000	607.30	0	0.993
Dutch Mountain 1	Wyoming	3	534.50	0.0000	12447.34	0.0000	561.00	0	0.964
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.976
Dutch Mountain 2N	Wyoming	7	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3N	Wyoming	3	1119.80	0.0000	13554.38	0.0000	1157.60	0	0.992
Dutch Mountain 4	Wyoming	3	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.983
Jenningsville 2N	Wyoming	3	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.987
Meshoppen 1N	Wyoming	2	831.80	0.0000	8763.22	0.0000	414.50	0	0.968
Meshoppen 2N	Wyoming	6	202.60	0.0027	10486.80	0.0000	261.40	1	0.988
Noxen 1	Wyoming	4	1328.50	0.0000	9656.14	0.0000	1428.60	0	0.990
Noxen 10	Wyoming	6	1025.90	0.0000	10649.31	0.0000	911.20	0	0.998
Noxen 10N	Wyoming	4	1702.40	0.0000	11205.63	0.0000	1716.00	0	0.999
Noxen 1N	Wyoming	3	1273.90	0.0000	12692.77	0.0000	1318.20	0	0.988
Noxen 2	Wyoming	4	911.60	0.0000	13087.59	0.0000	558.00	0	0.998
Noxen 2N	Wyoming	3	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3N	Wyoming	2	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	2	711.20	0.0000	9559.28	0.0000	593.50	0	0.996
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	0.998
Noxen 5N	Wyoming	4	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	2	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7N	Wyoming	3	1625.90	0.0000	11145.25	0.0000	1575.30	0	0.984
Noxen 8	Wyoming	8	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.911

Noxen 8N	Wyoming	4	299.40	0.0011	8074.57	0.0000	1071.00	0	0.901
Noxen 9N	Wyoming	2	296.00	0.0002	12346.09	0.0000	358.80	1	0.907
Tunkannock 1N	Wyoming	2	244.80	0.0011	3519.70	0.0000	364.50	1	0.878

Appendix VI. Raw data for Model 2 at the 5000m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0026	2124.90	0.0005	451.14	4034	0.872
Christman 11	Carbon	29	397.10	0.0018	21.60	0.0007	78.16	3167	0.921
Christman 12	Carbon	10	408.70	0.0011	58.00	0.0008	194.96	581	0.890
Christman 1N	Carbon	2	165.70	0.0009	569.10	0.0009	614.90	787	0.893
Christman 2	Carbon	4	186.80	0.0013	227.90	0.0006	414.20	726	0.887
Christman 6	Carbon	1	1126.70	0.0016	411.50	0.0007	423.00	2195	0.918
Hell Creek	Carbon	73	145.00	0.0036	3037.30	0.0001	1582.90	5239	0.850
Hickory Run 4	Carbon	11	1544.20	0.0007	552.50	0.0003	2021.80	554	0.901
Hickory Run 5	Carbon	16	1101.90	0.0013	86.40	0.0013	89.10	424	0.884
Lehighton 1N	Carbon	2	475.30	0.0032	240.90	0.0008	244.48	7373	0.741
Weatherly 1N-Ribello	Carbon	2	348.80	0.0016	2379.90	0.0005	1126.11	2764	0.922
Weatherly 1N-Stan	Carbon	1	219.30	0.0020	162.60	0.0007	322.65	3921	0.908
Weatherly 3	Carbon	1	544.20	0.0016	316.30	0.0007	440.40	2723	0.930
Weatherly 4	Carbon	1	29.90	0.0017	2393.90	0.0005	1101.32	2734	0.909
Weatherly 6	Carbon	1	732.90	0.0015	3411.40	0.0002	660.86	1585	0.893
Weatherly 7	Carbon	2	1466.50	0.0014	4823.60	0.0000	2034.26	1701	0.853
Avoca 7	Luzerne	6	265.90	0.0006	4099.60	0.0001	463.70	483	0.905
Hickory Run 2- Koval	Luzerne	31	966.60	0.0008	1260.40	0.0002	1114.20	812	0.909
Hickory Run 3- Koval	Luzerne	2	583.00	0.0008	944.50	0.0002	525.80	574	0.908
Nanticoke 1N	Luzerne	4	1110.80	0.0023	2009.10	0.0001	1253.60	5986	0.726
Mount Pocono 1N	Monroe	1	620.80	0.0034	64.80	0.0001	694.10	7057	0.820
Mount Pocono 2N	Monroe	4	827.40	0.0035	25.00	0.0001	700.70	7591	0.818
Pocono Pines 1N	Monroe	3	907.56	0.0027	3311.77	0.0000	3311.77	4727	
Stroudsburg 2N	Monroe	5		0.0018	51.20	0.0003			0.795

Lake Maskenozha 1N	Pike	3	504.80	0.0027	2424.60	0.0001	472.50	3967	0.874
Milford 1N	Pike	3	377.60	0.0023	377.60	0.0001	491.50	2105	0.879
Pecks Pond 1N	Pike	2	286.10	0.0021	3.40	0.0005	195.00	3395	0.870
Promised Land 1	Pike	9	108.20	0.0007	109.10	0.0006	2184.00	397	0.921
Promised Land 2N	Pike	16	546.60	0.0007	547.90	0.0007	1350.90	427	0.919
Promised Land 3N	Pike	5	1275.80	0.0010	691.70	0.0011	1973.00	561	0.886
Rowland 3N	Pike	6	928.30	0.0011	1657.50	0.0001	1367.70	683	0.903
Rowland 4N	Pike	6	1078.90	0.0011	1759.40	0.0001	1319.40	675	0.902
Shohola 4	Pike	3	1319.30	0.0018	1319.30	0.0001	1019.50	1314	0.879
Shohola 4N	Pike	3	589.60	0.0018	2076.00	0.0001	1166.50	1309	0.892
Shohola 5	Pike	3	1244.30	0.0018	1246.50	0.0001	1322.70	1378	0.878
Shohola 3N	Pike	2	604.20	0.0016	4604.30	0.0000	623.90	1217	0.917
Twelvemile Pond 1N	Pike	2	507.30	0.0018	1232.70	0.0002	505.90	4167	0.898
White Mills 1	Wayne	3	252.20	0.0016	4747.60	0.0000	889.60	1654	0.798
White Mills 1N	Wayne	3	106.70	0.0016	4904.10	0.0000	1117.40	1554	0.814
White Mills 2	Wayne	3	573.20	0.0015	6118.60	0.0000	607.30	1469	0.849
Dutch Mountain 1	Wyoming	3	534.50	0.0006	12447.34	0.0000	561.00	271	0.934
Dutch Mountain 1N	Wyoming	1	1508.54	0.0004	14033.38	0.0000	1430.01	142	0.968
Dutch Mountain 2N	Wyoming	7	618.80	0.0004	14517.34	0.0000	557.80	156	0.973
Dutch Mountain 3N	Wyoming	3	1119.80	0.0005	13554.38	0.0000	1157.60	218	0.956
Dutch Mountain 4	Wyoming	3	444.90	0.0005	7862.37	0.0000	1932.70	42	0.964
Jenningsville 1N	Wyoming	1	2061.80	0.0007	12393.23	0.0000	2026.70	318	0.925
Jenningsville 2N	Wyoming	3	1502.40	0.0006	12400.73	0.0000	1335.30		0.913
Meshoppen 1N	Wyoming	2	831.80	0.0013	8763.22	0.0000	414.50	455	0.778
Meshoppen 2N	Wyoming	6	202.60	0.0009	10486.80	0.0000	261.40	334	0.870
Noxen 1	Wyoming	4	1328.50	0.0007	9656.14	0.0000	1428.60	247	0.925

Noxen 10	Wyoming	6	1025.90	0.0008	10649.31	0.0000	911.20	268	0.958
Noxen 10N	Wyoming	4	1702.40	0.0008	11205.63	0.0000	1716.00	344	0.961
Noxen 1N	Wyoming	3	1273.90	0.0008	12692.77	0.0000	1318.20	439	0.955
Noxen 2	Wyoming	4	911.60	0.0005	13087.59	0.0000	558.00	243	0.949
Noxen 2N	Wyoming	3	1317.10	0.0008	12992.57	0.0000	1312.30	624	0.929
Noxen 3N	Wyoming	2	1335.40	0.0005	12391.78	0.0000	1343.50	208	0.968
Noxen 4	Wyoming	2	711.20	0.0008	9559.28	0.0000	593.50	477	0.914
Noxen 4N	Wyoming	1	1882.00	0.0004	14165.07	0.0000	1704.50	154	0.977
Noxen 5N	Wyoming	4	955.30	0.0012	12570.92	0.0000	925.90	912	0.881
Noxen 6N	Wyoming	2	934.80	0.0005	10707.81	0.0000	521.00	224	0.947
Noxen 7N	Wyoming	3	1625.90	0.0008	11145.25	0.0000	1575.30	363	0.959
Noxen 8	Wyoming	8	1280.70	0.0010	12783.07	0.0000	1249.50	865	0.897
Noxen 8N	Wyoming	4	299.40	0.0010	8074.57	0.0000	1071.00	427	0.894
Noxen 9N	Wyoming	2	296.00	0.0014	12346.09	0.0000	358.80	1152	0.832
Tunkannock 1N	Wyoming	2	244.80	0.0024	3519.70	0.0001	364.50	2669	0.701

Appendix VII. Raw data for Model 3 at the 50m buffer zone where Number of Snakes (Population) has been changed to presence (1) - absence(0) data.

Site	County	Population	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	1	523.70	0.0000	2124.90	0.0000	451.14	0	0.584
Christman 1	Carbon	0	279.10	0.0000	197.70	0.0000	222.55	0	0.990
Christman 10	Carbon	0	151.90	0.0000	1062.20	0.0000	146.76	0	1.000
Christman 11	Carbon	1	397.10	0.0000	21.60	0.0228	78.16	0	0.662
Christman 12	Carbon	1	408.70	0.0000	58.00	0.0000	194.96	0	1.000
Christman 1N	Carbon	1	165.70	0.0000	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	1	186.80	0.0000	227.90	0.0000	414.20	0	1.000
Christman 3	Carbon	0	854.40	0.0000	88.20	0.0000	158.52	0	0.931
Christman 4	Carbon	0	316.90	0.0000	252.60	0.0000	315.33	0	1.000
Christman 5	Carbon	0	1224.10	0.0000	595.70	0.0000	624.19	0	1.000
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Christman 7	Carbon	0	436.60	0.0000	302.80	0.0000	458.56	0	1.000
Christman 8	Carbon	0	401.50	0.0000	192.05	0.0000	350.89	0	1.000
Christman 9	Carbon	0	588.30	0.0000	393.40	0.0000	489.78	0	1.000
Hell Creek	Carbon	1	145.00	0.0000	3037.30	0.0000	1582.90	0	1.000
Hickory Run 4	Carbon	1	1544.20	0.0000	552.50	0.0000	2021.82	0	1.000
Hickory Run 5	Carbon	1	1101.90	0.0000	86.40	0.0000	89.18	0	1.000
Lehighton 1N	Carbon	1	475.30	0.0000	240.90	0.0000	244.48	0	0.932
Nesquehoning 1	Carbon	0	297.40	0.0000	2154.20	0.0000	319.82	0	0.956
Tamaqua 1	Carbon	0	247.57	0.0000	3289.00	0.0000	978.90	0	1.000
Tamaqua 1N	Carbon	0	415.50	0.0000	2830.20	0.0000	600.60	0	1.000
Weatherly 1	Carbon	0	1437.60	0.0000	854.90	0.0000	884.28	0	1.000
Weatherly 1N-Ribello	Carbon	1	348.80	0.0000	2379.90	0.0000	1126.11	0	0.973

Weatherly 1N-Stan	Carbon	1	219.30	0.0000	162.60	0.0000	322.65	0	1.000
Weatherly 2	Carbon	0	398.30	0.0000	229.10	0.0000	387.50	0	1.000
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0000	440.40	0	1.000
Weatherly 4	Carbon	1	29.90	0.0090	2393.90	0.0000	1101.32	0	0.980
Weatherly 5	Carbon	0	217.40	0.0000	162.80	0.0000	320.73	0	1.000
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.998
Weatherly 7	Carbon	1	1466.50	0.0000	4823.60	0.0000	2034.26	0	1.000
Avoca 7	Luzerne	1	265.90	0.0000	4099.60	0.0000	463.70	0	1.000
Dutch Mountain 6	Luzerne	0	320.70	0.0000	6494.40	0.0000	2013.90	0	1.000
Hickory Run 1-Koval	Luzerne	0	238.80	0.0000	1199.50	0.0000	606.10	0	1.000
Hickory Run 2- Koval	Luzerne	1	966.60	0.0000	1260.40	0.0000	1114.20	0	1.000
Hickory Run 3- Koval	Luzerne	1	583.00	0.0000	944.50	0.0000	525.80	0	0.912
Nanticoke 1N	Luzerne	1	1110.80	0.0000	2009.10	0.0000	1253.60	0	1.000
Pittston 1	Luzerne	0	363.80	0.0000	4098.00	0.0000	151.60	0	1.000
Pittston 2	Luzerne	0	258.00	0.0000	3557.40	0.0000	158.40	0	1.000
Pittston 3	Luzerne	0	632.70	0.0000	5916.00	0.0000	858.00	0	0.960
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0000	3289.90	0.0000	1312.70	0	0.286
Red Rock 2	Luzerne	0	1116.90	0.0000	194.80	0.0000	1637.00	0	1.000
Red Rock 3	Luzerne	0	766.10	0.0000	89.30	0.0000	767.40	0	0.985
Sweet Valley 1	Luzerne	0	430.60	0.0000	6257.30	0.0000	2253.40	0	1.000
Sweet Valley 2	Luzerne	0	88.50	0.0000	87.30	0.0000	1945.00	0	1.000
Wilkes Barre East 1	Luzerne	0	811.20	0.0000	5878.10	0.0000	733.10	0	1.000
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0000	694.10	0	1.000
Mount Pocono 2N	Monroe	1	827.40	0.0000	25.00	0.0097	700.70	0	0.880
Pocono Pines 1N	Monroe	1	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	1		0.0000	51.20	0.0000		0	1.000

Lake Maskenozha 1N	Pike	1	504.80	0.0000	2424.60	0.0000	472.50	0	0.912
Milford 1N	Pike	1	377.60	0.0000	377.60	0.0000	491.50	0	1.000
Narrowsburg 1N	Pike	1		0.0000		0.0000		0	1.000
Narrowsburg 2	Pike	1	390.80	0.0000	6085.00	0.0000	269.90	0	0.925
Narrowsburg 2N	Pike	1	367.30	0.0000	8573.00	0.0000	1115.10	0	1.000
Narrowsburg 3	Pike	1	59.10	0.0000	6611.90	0.0000	1522.10	0	0.864
Pecks Pond 1N	Pike	1	286.10	0.0000	3.40	0.0285	195.00	0	0.715
Pond Eddy 1N	Pike	1	764.00	0.0000	5170.00	0.0000	703.80	0	0.961
Pond Eddy 2N	Pike	1	174.50	0.0000	5259.00	0.0000	179.70	0	0.898
Pond Eddy 3N	Pike	1	554.20	0.0000	5595.00	0.0000	369.50	0	0.898
Port Jervis North 1	Pike	1	507.00	0.0000	6698.00	0.0000	421.10	0	1.000
Promised Land 1	Pike	1	108.20	0.0000	109.10	0.0000	2184.00	0	1.000
Promised Land 2N	Pike	1	546.60	0.0000	547.90	0.0000	1350.90	0	0.513
Promised Land 3N	Pike	1	1275.80	0.0000	691.70	0.0000	1973.00	0	1.000
Rowland 1	Pike	1	122.60	0.0000	257.40	0.0000	95.20	0	1.000
Rowland 1N	Pike	1	959.07	0.0000	959.07	0.0000	876.20	0	0.815
Rowland 2N	Pike	1	1181.50	0.0000	1600.20	0.0000	745.20	0	0.838
Rowland 3N	Pike	1	928.30	0.0000	1657.50	0.0000	1367.70	0	0.916
Rowland 4N	Pike	1	1078.90	0.0000	1759.40	0.0000	1319.40	0	1.000
Shohola 1N	Pike	1	212.60	0.0000	2718.50	0.0000	51.50	0	0.945
Shohola 2	Pike	0	409.60	0.0000	1788.40	0.0000	389.00	0	1.000
Shohola 2N	Pike	1	32.60	0.0051	3442.60	0.0000	379.20	0	0.700
Shohola 3	Pike	0	157.60	0.0000	6371.50	0.0000	98.70	0	0.860
Shohola 4	Pike	1	1319.30	0.0000	1319.30	0.0000	1019.50	0	1.000
Shohola 4N	Pike	1	589.60	0.0000	2076.00	0.0000	1166.50	0	0.869
Shohola 5	Pike	1	1244.30	0.0000	1246.50	0.0000	1322.70	0	1.000

Shohola 3N	Pike	1	604.20	0.0000	4604.30	0.0000	623.90	0	0.883
Twelvemile Pond 1N	Pike	1	507.30	0.0000	1232.70	0.0000	505.90	0	0.621
Great Bend 1	Susquehanna	0	640.70	0.0000	2560.10	0.0000	800.10	0	1.000
Starrucca 1	Susquehanna	0	251.40	0.0000	251.40	0.0000	273.10	0	1.000
Susquehanna 1N	Susquehanna	1	510.90	0.0000	867.80	0.0000	482.50	0	0.999
White Mills 1	Wayne	1	252.20	0.0000	4747.60	0.0000	889.60	0	1.000
White Mills 1N	Wayne	1	106.70	0.0000	4904.10	0.0000	1117.40	0	0.417
White Mills 2	Wayne	1	573.20	0.0000	6118.60	0.0000	607.30	0	1.000
Dutch Mountain 1	Wyoming	1	534.50	0.0000	12447.34	0.0000	561.00	0	1.000
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.997
Dutch Mountain 2	Wyoming	0	1231.58	0.0000	14548.48	0.0000	1018.17	0	1.000
Dutch Mountain 2N	Wyoming	1	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3	Wyoming	0	163.60	0.0000	12580.00	0.0000	353.60	0	1.000
Dutch Mountain 3N	Wyoming	1	1119.80	0.0000	13554.38	0.0000	1157.60	0	1.000
Dutch Mountain 4	Wyoming	1	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Dutch Mountain 5	Wyoming	0	385.50	0.0000	8452.92	0.0000	946.90	0	1.000
Jenningsville 1	Wyoming	0	259.10	0.0000	13997.25	0.0000		0	1.000
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.878
Jenningsville 2N	Wyoming	1	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.741
Meshoppen 1	Wyoming	0	414.20	0.0000	8617.82	0.0000	426.60	0	1.000
Meshoppen 1N	Wyoming	1	831.80	0.0000	8763.22	0.0000	414.50	0	1.000
Meshoppen 2N	Wyoming	1	202.60	0.0000	10486.80	0.0000	261.40	0	1.000
Noxen	Wyoming	0	2203.10	0.0000	13030.57	0.0000	2108.50	0	0.976
Noxen 1	Wyoming	1	1328.50	0.0000	9656.14	0.0000	1428.60	0	1.000
Noxen 10	Wyoming	1	1025.90	0.0000	10649.31	0.0000	911.20	0	1.000
Noxen 10N	Wyoming	1	1702.40	0.0000	11205.63	0.0000	1716.00	0	1.000

Noxen 1N	Wyoming	1	1273.90	0.0000	12692.77	0.0000	1318.20	0	1.000
Noxen 2	Wyoming	1	911.60	0.0000	13087.59	0.0000	558.00	0	1.000
Noxen 2N	Wyoming	1	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3	Wyoming	0	1320.80	0.0000	13011.71	0.0000	1328.30	0	1.000
Noxen 3N	Wyoming	1	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	1	711.20	0.0000	9559.28	0.0000	593.50	0	1.000
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	1.000
Noxen 5	Wyoming	0	2445.70	0.0000	14364.49	0.0000	1497.40	0	1.000
Noxen 5N	Wyoming	1	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	1	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7	Wyoming	0	1649.60	0.0000	12814.95	0.0000	1535.80	0	1.000
Noxen 7N	Wyoming	1	1625.90	0.0000	11145.25	0.0000	1575.30	0	1.000
Noxen 8	Wyoming	1	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.934
Noxen 8N	Wyoming	1	299.40	0.0000	8074.57	0.0000	1071.00	0	1.000
Noxen 9	Wyoming	0	1746.90	0.0000	13753.02	0.0000	1800.80	0	1.000
Noxen 9N	Wyoming	1	296.00	0.0000	12346.09	0.0000	358.80	0	1.000
Tunkannock 1N	Wyoming	1	244.80	0.0000	3519.70	0.0000	364.50	0	0.721

Appendix VIII. Raw data for Model 3 at the 400m buffer zone where Number of Snakes (Population) has been changed to presence (1) - absence(0) data.

Site	County	Population	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	1	523.70	0.0000	2124.90	0.0000	451.14	0	0.929
Christman 1	Carbon	0	279.10	0.0006	197.70	0.0047	222.55	2	0.819
Christman 10	Carbon	0	151.90	0.0019	1062.20	0.0000	146.76	10	0.975
Christman 11	Carbon	1	397.10	0.0001	21.60	0.0048	78.16	3	0.902
Christman 12	Carbon	1	408.70	0.0000	58.00	0.0047	194.96	2	0.915
Christman 1N	Carbon	1	165.70	0.0028	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	1	186.80	0.0015	227.90	0.0011	414.20	0	0.932
Christman 3	Carbon	0	854.40	0.0000	88.20	0.0045	158.52	2	0.925
Christman 4	Carbon	0	316.90	0.0003	252.60	0.0028	315.33	2	0.929
Christman 5	Carbon	0	1224.10	0.0000	595.70	0.0000	624.19	0	0.994
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Christman 7	Carbon	0	436.60	0.0000	302.80	0.0023	458.56	0	0.951
Christman 8	Carbon	0	401.50	0.0000	192.05	0.0035	350.89	2	0.896
Christman 9	Carbon	0	588.30	0.0000	393.40	0.0006	489.78	0	0.929
Hell Creek	Carbon	1	145.00	0.0006	3037.30	0.0000	1582.90	0	0.991
Hickory Run 4	Carbon	1	1544.20	0.0000	552.50	0.0000	2021.82	0	0.951
Hickory Run 5	Carbon	1	1101.90	0.0000	86.40	0.0052	89.18	2	0.908
Lehighton 1N	Carbon	1	475.30	0.0000	240.90	0.0039	244.48	1	0.932
Nesquehoning 1	Carbon	0	297.40	0.0016	2154.20	0.0000	319.82	13	0.799
Tamaqua 1	Carbon	0	247.57	0.0003	3289.00	0.0000	978.90	0	0.930
Tamaqua 1N	Carbon	0	415.50	0.0000	2830.20	0.0000	600.60	0	0.741
Weatherly 1	Carbon	0	1437.60	0.0000	854.90	0.0000	884.28	0	0.996
Weatherly 1N-Ribello	Carbon	1	348.80	0.0006	2379.90	0.0000	1126.11	0	0.997

Weatherly 1N-Stan	Carbon	1	219.30	0.0013	162.60	0.0053	322.65	6	0.869
Weatherly 2	Carbon	0	398.30	0.0000	229.10	0.0031	387.50	1	0.898
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0019	440.40	0	0.926
Weatherly 4	Carbon	1	29.90	0.0018	2393.90	0.0000	1101.32	0	0.988
Weatherly 5	Carbon	0	217.40	0.0013	162.80	0.0053	320.73	6	0.868
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.999
Weatherly 7	Carbon	1	1466.50	0.0000	4823.60	0.0000	2034.26	0	0.999
Avoca 7	Luzerne	1	265.90	0.0014	4099.60	0.0000	463.70	0	0.883
Dutch Mountain 6	Luzerne	0	320.70	0.0009	6494.40	0.0000	2013.90	0	0.997
Hickory Run 1-Koval	Luzerne	0	238.80	0.0013	1199.50	0.0000	606.10	0	0.889
Hickory Run 2- Koval	Luzerne	1	966.60	0.0000	1260.40	0.0000	1114.20	0	0.796
Hickory Run 3- Koval	Luzerne	1	583.00	0.0000	944.50	0.0000	525.80	0	0.677
Nanticoke 1N	Luzerne	1	1110.80	0.0000	2009.10	0.0000	1253.60	0	0.888
Pittston 1	Luzerne	0	363.80	0.0007	4098.00	0.0000	151.60	16	0.927
Pittston 2	Luzerne	0	258.00	0.0016	3557.40	0.0000	158.40	9	0.791
Pittston 3	Luzerne	0	632.70	0.0000	5916.00	0.0000	858.00	0	0.829
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0000	3289.90	0.0000	1312.70	0	0.902
Red Rock 2	Luzerne	0	1116.90	0.0000	194.80	0.0024	1637.00	0	1.000
Red Rock 3	Luzerne	0	766.10	0.0000	89.30	0.0018	767.40	0	1.000
Sweet Valley 1	Luzerne	0	430.60	0.0000	6257.30	0.0000	2253.40	0	1.000
Sweet Valley 2	Luzerne	0	88.50	0.0022	87.30	0.0016	1945.00	0	0.994
Wilkes Barre East 1	Luzerne	0	811.20	0.0000	5878.10	0.0000	733.10	0	0.938
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0053	694.10	0	0.998
Mount Pocono 2N	Monroe	1	827.40	0.0000	25.00	0.0035	700.70	0	0.995
Pocono Pines 1N	Monroe	1	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	1		0.0000	51.20	0.0017			0.984

Lake Maskenozha 1N	Pike	1	504.80	0.0000	2424.60	0.0000	472.50	0	0.990
Milford 1N	Pike	1	377.60	0.0003	377.60	0.0003	491.50	0	0.990
Narrowsburg 1N	Pike	1		0.0000		0.0000		0	1.000
Narrowsburg 2	Pike	1	390.80	0.0002	6085.00	0.0000	269.90	1	0.961
Narrowsburg 2N	Pike	1	367.30	0.0009	8573.00	0.0000	1115.10	0	0.971
Narrowsburg 3	Pike	1	59.10	0.0026	6611.90	0.0000	1522.10	0	0.825
Pecks Pond 1N	Pike	1	286.10	0.0006	3.40	0.0042	195.00	8	0.940
Pond Eddy 1N	Pike	1	764.00	0.0000	5170.00	0.0000	703.80	0	0.998
Pond Eddy 2N	Pike	1	174.50	0.0012	5259.00	0.0000	179.70	5	0.937
Pond Eddy 3N	Pike	1	554.20	0.0000	5595.00	0.0000	369.50	1	0.991
Port Jervis North 1	Pike	1	507.00	0.0000	6698.00	0.0000	421.10	0	1.000
Promised Land 1	Pike	1	108.20	0.0012	109.10	0.0013	2184.00	0	0.956
Promised Land 2N	Pike	1	546.60	0.0000	547.90	0.0000	1350.90	0	0.927
Promised Land 3N	Pike	1	1275.80	0.0000	691.70	0.0000	1973.00	0	0.999
Rowland 1	Pike	1	122.60	0.0024	257.40	0.0008	95.20	6	0.937
Rowland 1N	Pike	1	959.07	0.0000	959.07	0.0000	876.20	0	0.978
Rowland 2N	Pike	1	1181.50	0.0000	1600.20	0.0000	745.20	0	0.976
Rowland 3N	Pike	1	928.30	0.0000	1657.50	0.0000	1367.70	0	0.997
Rowland 4N	Pike	1	1078.90	0.0000	1759.40	0.0000	1319.40	0	0.998
Shohola 1N	Pike	1	212.60	0.0019	2718.50	0.0000	51.50	12	0.928
Shohola 2	Pike	0	409.60	0.0000	1788.40	0.0000	389.00	1	0.995
Shohola 2N	Pike	1	32.60	0.0011	3442.60	0.0000	379.20	2	0.953
Shohola 3	Pike	0	157.60	0.0036	6371.50	0.0000	98.70	14	0.638
Shohola 4	Pike	1	1319.30	0.0000	1319.30	0.0000	1019.50	0	0.984
Shohola 4N	Pike	1	589.60	0.0000	2076.00	0.0000	1166.50	0	0.995
Shohola 5	Pike	1	1244.30	0.0000	1246.50	0.0000	1322.70	0	0.998

Shohola 3N	Pike	1	604.20	0.0000	4604.30	0.0000	623.90	0	0.981
Twelvemile Pond 1N	Pike	1	507.30	0.0000	1232.70	0.0000	505.90	0	0.938
Great Bend 1	Susquehanna	0	640.70	0.0000	2560.10	0.0000	800.10	0	1.000
Starrucca 1	Susquehanna	0	251.40	0.0010	251.40	0.0010	273.10	3	0.900
Susquehanna 1N	Susquehanna	1	510.90	0.0000	867.80	0.0000	482.50	0	0.735
White Mills 1	Wayne	1	252.20	0.0027	4747.60	0.0000	889.60	0	0.923
White Mills 1N	Wayne	1	106.70	0.0031	4904.10	0.0000	1117.40	0	0.772
White Mills 2	Wayne	1	573.20	0.0000	6118.60	0.0000	607.30	0	0.993
Dutch Mountain 1	Wyoming	1	534.50	0.0000	12447.34	0.0000	561.00	0	0.964
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.976
Dutch Mountain 2	Wyoming	0	1231.58	0.0000	14548.48	0.0000	1018.17	0	1.000
Dutch Mountain 2N	Wyoming	1	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3	Wyoming	0	163.60	0.0014	12580.00	0.0000	353.60	1	0.981
Dutch Mountain 3N	Wyoming	1	1119.80	0.0000	13554.38	0.0000	1157.60	0	0.992
Dutch Mountain 4	Wyoming	1	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Dutch Mountain 5	Wyoming	0	385.50	0.0004	8452.92	0.0000	946.90	0	1.000
Jenningsville 1	Wyoming	0	259.10	0.0010	13997.25	0.0000		0	0.995
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.983
Jenningsville 2N	Wyoming	1	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.987
Meshoppen 1	Wyoming	0	414.20	0.0000	8617.82	0.0000	426.60	0	0.989
Meshoppen 1N	Wyoming	1	831.80	0.0000	8763.22	0.0000	414.50	0	0.968
Meshoppen 2N	Wyoming	1	202.60	0.0027	10486.80	0.0000	261.40	1	0.988
Noxen	Wyoming	0	2203.10	0.0000	13030.57	0.0000	2108.50	0	0.992
Noxen 1	Wyoming	1	1328.50	0.0000	9656.14	0.0000	1428.60	0	0.990
Noxen 10	Wyoming	1	1025.90	0.0000	10649.31	0.0000	911.20	0	0.998
Noxen 10N	Wyoming	1	1702.40	0.0000	11205.63	0.0000	1716.00	0	0.999

Noxen 1N	Wyoming	1	1273.90	0.0000	12692.77	0.0000	1318.20	0	0.988
Noxen 2	Wyoming	1	911.60	0.0000	13087.59	0.0000	558.00	0	0.998
Noxen 2N	Wyoming	1	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3	Wyoming	0	1320.80	0.0000	13011.71	0.0000	1328.30	0	1.000
Noxen 3N	Wyoming	1	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	1	711.20	0.0000	9559.28	0.0000	593.50	0	0.996
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	0.998
Noxen 5	Wyoming	0	2445.70	0.0000	14364.49	0.0000	1497.40	0	1.000
Noxen 5N	Wyoming	1	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	1	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7	Wyoming	0	1649.60	0.0000	12814.95	0.0000	1535.80	0	1.000
Noxen 7N	Wyoming	1	1625.90	0.0000	11145.25	0.0000	1575.30	0	0.984
Noxen 8	Wyoming	1	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.911
Noxen 8N	Wyoming	1	299.40	0.0011	8074.57	0.0000	1071.00	0	0.901
Noxen 9	Wyoming	0	1746.90	0.0000	13753.02	0.0000	1800.80	0	0.996
Noxen 9N	Wyoming	1	296.00	0.0002	12346.09	0.0000	358.80	1	0.907
Tunkannock 1N	Wyoming	1	244.80	0.0011	3519.70	0.0000	364.50	1	0.878

Appendix IX. Raw data for Model 3 at the 5000m buffer zone where Number of Snakes (Population) has been changed to presence (1) - absence(0) data.

Site	County	Population	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	1	523.70	0.0026	2124.90	0.0005	451.14	4034	0.872
Christman 1	Carbon	0	279.10	0.0013	197.70	0.0014	222.50	512	0.882
Christman 10	Carbon	0	151.90	0.0022	1062.20	0.0002	146.76	2601	0.833
Christman 11	Carbon	1	397.10	0.0018	21.60	0.0007	78.16	3167	0.921
Christman 12	Carbon	1	408.70	0.0011	58.00	0.0008	194.96	581	0.890
Christman 1N	Carbon	1	165.70	0.0009	569.10	0.0009	614.90	787	0.893
Christman 2	Carbon	1	186.80	0.0013	227.90	0.0006	414.20	726	0.887
Christman 3	Carbon	0	854.40	0.0010	88.20	0.0009	158.50	471	0.862
Christman 4	Carbon	0	316.90	0.0016	252.60	0.0008	315.33	1238	0.884
Christman 5	Carbon	0	1224.10	0.0009	595.70	0.0008	624.19	606	0.930
Christman 6	Carbon	1	1126.70	0.0016	411.50	0.0007	423.00	2195	0.918
Christman 7	Carbon	0	436.60	0.0016	302.80	0.0006	458.56	2298	0.928
Christman 8	Carbon	0	401.50	0.0016	192.05	0.0016	350.89	2683	0.933
Christman 9	Carbon	0	588.30	0.0016	393.40	0.0007	489.78	2738	0.929
Hell Creek	Carbon	1	145.00	0.0036	3037.30	0.0001	1582.90	5239	0.850
Hickory Run 4	Carbon	1	1544.20	0.0007	552.50	0.0003	2021.80	554	0.901
Hickory Run 5	Carbon	1	1101.90	0.0013	86.40	0.0013	89.10	424	0.884
Lehighton 1N	Carbon	1	475.30	0.0032	240.90	0.0008	244.48	7373	0.741
Nesquehoning 1	Carbon	0	297.40	0.0021	2154.20	0.0001	319.82	5193	0.818
Tamaqua 1	Carbon	0	247.57	0.0021	3289.00	0.0000			0.802
Tamaqua 1N	Carbon	0	415.50	0.0021	2830.20	0.0000			0.808
Weatherly 1	Carbon	0	1437.60	0.0009	854.90	0.0007	884.28	518	0.927
Weatherly 1N-Ribello	Carbon	1	348.80	0.0016	2379.90	0.0005	1126.11	2764	0.922

Weatherly 1N-Stan	Carbon	1	219.30	0.0020	162.60	0.0007	322.65	3921	0.908
Weatherly 2	Carbon	0	398.30	0.0016	229.10	0.0006	387.50	2682	0.933
Weatherly 3	Carbon	1	544.20	0.0016	316.30	0.0007	440.40	2723	0.930
Weatherly 4	Carbon	1	29.90	0.0017	2393.90	0.0005	1101.32	2734	0.909
Weatherly 5	Carbon	0	217.40	0.0020	162.80	0.0007	320.73	3917	0.908
Weatherly 6	Carbon	1	732.90	0.0015	3411.40	0.0002	660.86	1585	0.893
Weatherly 7	Carbon	1	1466.50	0.0014	4823.60	0.0000	2034.26	1701	0.853
Avoca 7	Luzerne	1	265.90	0.0006	4099.60	0.0001	463.70	483	0.905
Dutch Mountain 6	Luzerne	0	320.70	0.0006	6494.40	0.0000	2013.90	121	0.963
Hickory Run 1-Koval	Luzerne	0	238.80	0.0013	1199.50	0.0004	606.10	1021	0.875
Hickory Run 2- Koval	Luzerne	1	966.60	0.0008	1260.40	0.0002	1114.20	812	0.909
Hickory Run 3- Koval	Luzerne	1	583.00	0.0008	944.50	0.0002	525.80	574	0.908
Nanticoke 1N	Luzerne	1	1110.80	0.0023	2009.10	0.0001	1253.60	5986	0.726
Pittston 1	Luzerne	0	363.80	0.0040	4098.00	0.0000	151.60	15706	0.584
Pittston 2	Luzerne	0	258.00	0.0030	3557.40	0.0001	158.40	9643	0.621
Pittston 3	Luzerne	0	632.70	0.0025	5916.00	0.0000	858.00	3735	0.704
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0014	3289.90	0.0001	1312.70	934	0.902
Red Rock 2	Luzerne	0	1116.90	0.0008	194.80	0.0005			0.920
Red Rock 3	Luzerne	0	766.10	0.0011	89.30	0.0004			0.905
Sweet Valley 1	Luzerne	0	430.60	0.0006	6257.30	0.0000	2253.40	118	0.964
Sweet Valley 2	Luzerne	0	88.50	0.0006	87.30	0.0004	1945.00	84	0.944
Wilkes Barre East 1	Luzerne	0	811.20	0.0030	5878.10	0.0000	733.10	9805	0.711
Mount Pocono 1N	Monroe	1	620.80	0.0034	64.80	0.0001	694.10	7057	0.820
Mount Pocono 2N	Monroe	1	827.40	0.0035	25.00	0.0001	700.70	7591	0.818
Pocono Pines 1N	Monroe	1	907.56	0.0027	3311.77	0.0000	3311.77	4727	
Stroudsburg 2N	Monroe	1		0.0018	51.20	0.0003			0.795

Lake Maskenozha 1N	Pike	1	504.80	0.0027	2424.60	0.0001	472.50	3967	0.874
Milford 1N	Pike	1	377.60	0.0023	377.60	0.0001	491.50	2105	0.879
Pecks Pond 1N	Pike	1	286.10	0.0021	3.40	0.0005	195.00	3395	0.870
Promised Land 1	Pike	1	108.20	0.0007	109.10	0.0006	2184.00	397	0.921
Promised Land 2N	Pike	1	546.60	0.0007	547.90	0.0007	1350.90	427	0.919
Promised Land 3N	Pike	1	1275.80	0.0010	691.70	0.0011	1973.00	561	0.886
Rowland 3N	Pike	1	928.30	0.0011	1657.50	0.0001	1367.70	683	0.903
Rowland 4N	Pike	1	1078.90	0.0011	1759.40	0.0001	1319.40	675	0.902
Shohola 4	Pike	1	1319.30	0.0018	1319.30	0.0001	1019.50	1314	0.879
Shohola 4N	Pike	1	589.60	0.0018	2076.00	0.0001	1166.50	1309	0.892
Shohola 5	Pike	1	1244.30	0.0018	1246.50	0.0001	1322.70	1378	0.878
Shohola 3N	Pike	1	604.20	0.0016	4604.30	0.0000	623.90	1217	0.917
Twelvemile Pond 1N	Pike	1	507.30	0.0018	1232.70	0.0002	505.90	4167	0.898
Great Bend 1	Susquehanna	0	640.70	0.0021	2560.10	0.0001	800.10	1850	0.807
Starrucca 1	Susquehanna	0	251.40	0.0014	251.40	0.0003	273.10	588	0.770
White Mills 1	Wayne	1	252.20	0.0016	4747.60	0.0000	889.60	1654	0.798
White Mills 1N	Wayne	1	106.70	0.0016	4904.10	0.0000	1117.40	1554	0.814
White Mills 2	Wayne	1	573.20	0.0015	6118.60	0.0000	607.30	1469	0.849
Dutch Mountain 1	Wyoming	1	534.50	0.0006	12447.34	0.0000	561.00	271	0.934
Dutch Mountain 1N	Wyoming	1	1508.54	0.0004	14033.38	0.0000	1430.01	142	0.968
Dutch Mountain 2	Wyoming	0	1231.58	0.0004	14548.48	0.0000	1018.17	151	0.976
Dutch Mountain 2N	Wyoming	1	618.80	0.0004	14517.34	0.0000	557.80	156	0.973
Dutch Mountain 3	Wyoming	0	163.60	0.0003	12580.00	0.0000	353.60	94	0.978
Dutch Mountain 3N	Wyoming	1	1119.80	0.0005	13554.38	0.0000	1157.60	218	0.956
Dutch Mountain 4	Wyoming	1	444.90	0.0005	7862.37	0.0000	1932.70	42	0.964
Dutch Mountain 5	Wyoming	0	385.50	0.0006	8452.92	0.0000	946.90	88	0.965

Jenningsville 1	Wyoming	0	259.10	0.0007	13997.25	0.0000			0.904
Jenningsville 1N	Wyoming	1	2061.80	0.0007	12393.23	0.0000	2026.70	318	0.925
Jenningsville 2N	Wyoming	1	1502.40	0.0006	12400.73	0.0000	1335.30		0.913
Meshoppen 1	Wyoming	0	414.20	0.0013	8617.82	0.0000	426.60	402	0.798
Meshoppen 1N	Wyoming	1	831.80	0.0013	8763.22	0.0000	414.50	455	0.778
Meshoppen 2N	Wyoming	1	202.60	0.0009	10486.80	0.0000	261.40	334	0.870
Noxen	Wyoming	0	2203.10	0.0007	13030.57	0.0000	2108.50	655	0.937
Noxen 1	Wyoming	1	1328.50	0.0007	9656.14	0.0000	1428.60	247	0.925
Noxen 10	Wyoming	1	1025.90	0.0008	10649.31	0.0000	911.20	268	0.958
Noxen 10N	Wyoming	1	1702.40	0.0008	11205.63	0.0000	1716.00	344	0.961
Noxen 1N	Wyoming	1	1273.90	0.0008	12692.77	0.0000	1318.20	439	0.955
Noxen 2	Wyoming	1	911.60	0.0005	13087.59	0.0000	558.00	243	0.949
Noxen 2N	Wyoming	1	1317.10	0.0008	12992.57	0.0000	1312.30	624	0.929
Noxen 3	Wyoming	0	1320.80	0.0005	13011.71	0.0000	1328.30	216	0.961
Noxen 3N	Wyoming	1	1335.40	0.0005	12391.78	0.0000	1343.50	208	0.968
Noxen 4	Wyoming	1	711.20	0.0008	9559.28	0.0000	593.50	477	0.914
Noxen 4N	Wyoming	1	1882.00	0.0004	14165.07	0.0000	1704.50	154	0.977
Noxen 5	Wyoming	0	2445.70	0.0004	14364.49	0.0000	1497.40	183	0.976
Noxen 5N	Wyoming	1	955.30	0.0012	12570.92	0.0000	925.90	912	0.881
Noxen 6N	Wyoming	1	934.80	0.0005	10707.81	0.0000	521.00	224	0.947
Noxen 7	Wyoming	0	1649.60	0.0008	12814.95	0.0000	1535.80	738	0.914
Noxen 7N	Wyoming	1	1625.90	0.0008	11145.25	0.0000	1575.30	363	0.959
Noxen 8	Wyoming	1	1280.70	0.0010	12783.07	0.0000	1249.50	865	0.897
Noxen 8N	Wyoming	1	299.40	0.0010	8074.57	0.0000	1071.00	427	0.894
Noxen 9	Wyoming	0	1746.90	0.0007	13753.02	0.0000	1800.80	597	0.936
Noxen 9N	Wyoming	1	296.00	0.0014	12346.09	0.0000	358.80	1152	0.832

Tunkannock 1N	Wyoming	1	244.80	0.0024	3519.70	0.0001	364.50	2669	0.701

Appendix X. Raw data for Model 4 at the 50m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0000	2124.90	0.0000	451.14	0	0.584
Christman 1	Carbon	0	279.10	0.0000	197.70	0.0000	222.55	0	0.990
Christman 10	Carbon	0	151.90	0.0000	1062.20	0.0000	146.76	0	1.000
Christman 11	Carbon	29	397.10	0.0000	21.60	0.0228	78.16	0	0.662
Christman 12	Carbon	10	408.70	0.0000	58.00	0.0000	194.96	0	1.000
Christman 1N	Carbon	2	165.70	0.0000	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	4	186.80	0.0000	227.90	0.0000	414.20	0	1.000
Christman 3	Carbon	0	854.40	0.0000	88.20	0.0000	158.52	0	0.931
Christman 4	Carbon	0	316.90	0.0000	252.60	0.0000	315.33	0	1.000
Christman 5	Carbon	0	1224.10	0.0000	595.70	0.0000	624.19	0	1.000
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Christman 7	Carbon	0	436.60	0.0000	302.80	0.0000	458.56	0	1.000
Christman 8	Carbon	0	401.50	0.0000	192.05	0.0000	350.89	0	1.000
Christman 9	Carbon	0	588.30	0.0000	393.40	0.0000	489.78	0	1.000
Hell Creek	Carbon	73	145.00	0.0000	3037.30	0.0000	1582.90	0	1.000
Hickory Run 4	Carbon	11	1544.20	0.0000	552.50	0.0000	2021.82	0	1.000
Hickory Run 5	Carbon	16	1101.90	0.0000	86.40	0.0000	89.18	0	1.000
Lehighton 1N	Carbon	2	475.30	0.0000	240.90	0.0000	244.48	0	0.932
Nesquehoning 1	Carbon	0	297.40	0.0000	2154.20	0.0000	319.82	0	0.956
Tamaqua 1	Carbon	0	247.57	0.0000	3289.00	0.0000	978.90	0	1.000
Tamaqua 1N	Carbon	0	415.50	0.0000	2830.20	0.0000	600.60	0	1.000
Weatherly 1	Carbon	0	1437.60	0.0000	854.90	0.0000	884.28	0	1.000
Weatherly 1N-Ribello	Carbon	2	348.80	0.0000	2379.90	0.0000	1126.11	0	0.973
Weatherly 1N-Stan	Carbon	1	219.30	0.0000	162.60	0.0000	322.65	0	1.000

Weatherly 2	Carbon	0	398.30	0.0000	229.10	0.0000	387.50	0	1.000
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0000	440.40	0	1.000
Weatherly 4	Carbon	1	29.90	0.0090	2393.90	0.0000	1101.32	0	0.980
Weatherly 5	Carbon	0	217.40	0.0000	162.80	0.0000	320.73	0	1.000
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.998
Weatherly 7	Carbon	2	1466.50	0.0000	4823.60	0.0000	2034.26	0	1.000
Avoca 7	Luzerne	6	265.90	0.0000	4099.60	0.0000	463.70	0	1.000
Dutch Mountain 6	Luzerne	0	320.70	0.0000	6494.40	0.0000	2013.90	0	1.000
Hickory Run 1-Koval	Luzerne	0	238.80	0.0000	1199.50	0.0000	606.10	0	1.000
Hickory Run 2- Koval	Luzerne	31	966.60	0.0000	1260.40	0.0000	1114.20	0	1.000
Hickory Run 3- Koval	Luzerne	2	583.00	0.0000	944.50	0.0000	525.80	0	0.912
Nanticoke 1N	Luzerne	4	1110.80	0.0000	2009.10	0.0000	1253.60	0	1.000
Pittston 1	Luzerne	0	363.80	0.0000	4098.00	0.0000	151.60	0	1.000
Pittston 2	Luzerne	0	258.00	0.0000	3557.40	0.0000	158.40	0	1.000
Pittston 3	Luzerne	0	632.70	0.0000	5916.00	0.0000	858.00	0	0.960
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0000	3289.90	0.0000	1312.70	0	0.286
Red Rock 2	Luzerne	0	1116.90	0.0000	194.80	0.0000	1637.00	0	1.000
Red Rock 3	Luzerne	0	766.10	0.0000	89.30	0.0000	767.40	0	0.985
Sweet Valley 1	Luzerne	0	430.60	0.0000	6257.30	0.0000	2253.40	0	1.000
Sweet Valley 2	Luzerne	0	88.50	0.0000	87.30	0.0000	1945.00	0	1.000
Wilkes Barre East 1	Luzerne	0	811.20	0.0000	5878.10	0.0000	733.10	0	1.000
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0000	694.10	0	1.000
Mount Pocono 2N	Monroe	4	827.40	0.0000	25.00	0.0097	700.70	0	0.880
Pocono Pines 1N	Monroe	3	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	5		0.0000	51.20	0.0000		0	1.000
Great Bend 1	Susquehanna	0	640.70	0.0000	2560.10	0.0000	800.10	0	1.000

Starrucca 1	Susquehanna	0	251.40	0.0000	251.40	0.0000	273.10	0	1.000
Susquehanna 1N	Susquehanna	2	510.90	0.0000	867.80	0.0000	482.50	0	0.999
White Mills 1	Wayne	3	252.20	0.0000	4747.60	0.0000	889.60	0	1.000
White Mills 1N	Wayne	3	106.70	0.0000	4904.10	0.0000	1117.40	0	0.417
White Mills 2	Wayne	3	573.20	0.0000	6118.60	0.0000	607.30	0	1.000
Dutch Mountain 1	Wyoming	3	534.50	0.0000	12447.34	0.0000	561.00	0	1.000
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.997
Dutch Mountain 2	Wyoming	0	1231.58	0.0000	14548.48	0.0000	1018.17	0	1.000
Dutch Mountain 2N	Wyoming	7	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3	Wyoming	0	163.60	0.0000	12580.00	0.0000	353.60	0	1.000
Dutch Mountain 3N	Wyoming	3	1119.80	0.0000	13554.38	0.0000	1157.60	0	1.000
Dutch Mountain 4	Wyoming	3	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Dutch Mountain 5	Wyoming	0	385.50	0.0000	8452.92	0.0000	946.90	0	1.000
Jenningsville 1	Wyoming	0	259.10	0.0000	13997.25	0.0000		0	1.000
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.878
Jenningsville 2N	Wyoming	3	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.741
Meshoppen 1	Wyoming	0	414.20	0.0000	8617.82	0.0000	426.60	0	1.000
Meshoppen 1N	Wyoming	2	831.80	0.0000	8763.22	0.0000	414.50	0	1.000
Meshoppen 2N	Wyoming	6	202.60	0.0000	10486.80	0.0000	261.40	0	1.000
Noxen	Wyoming	0	2203.10	0.0000	13030.57	0.0000	2108.50	0	0.976
Noxen 1	Wyoming	4	1328.50	0.0000	9656.14	0.0000	1428.60	0	1.000
Noxen 10	Wyoming	6	1025.90	0.0000	10649.31	0.0000	911.20	0	1.000
Noxen 10N	Wyoming	4	1702.40	0.0000	11205.63	0.0000	1716.00	0	1.000
Noxen 1N	Wyoming	3	1273.90	0.0000	12692.77	0.0000	1318.20	0	1.000
Noxen 2	Wyoming	4	911.60	0.0000	13087.59	0.0000	558.00	0	1.000
Noxen 2N	Wyoming	3	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000

Noxen 3	Wyoming	0	1320.80	0.0000	13011.71	0.0000	1328.30	0	1.000
Noxen 3N	Wyoming	2	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	2	711.20	0.0000	9559.28	0.0000	593.50	0	1.000
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	1.000
Noxen 5	Wyoming	0	2445.70	0.0000	14364.49	0.0000	1497.40	0	1.000
Noxen 5N	Wyoming	4	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	2	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7	Wyoming	0	1649.60	0.0000	12814.95	0.0000	1535.80	0	1.000
Noxen 7N	Wyoming	3	1625.90	0.0000	11145.25	0.0000	1575.30	0	1.000
Noxen 8	Wyoming	8	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.934
Noxen 8N	Wyoming	4	299.40	0.0000	8074.57	0.0000	1071.00	0	1.000
Noxen 9	Wyoming	0	1746.90	0.0000	13753.02	0.0000	1800.80	0	1.000
Noxen 9N	Wyoming	2	296.00	0.0000	12346.09	0.0000	358.80	0	1.000
Tunkannock 1N	Wyoming	2	244.80	0.0000	3519.70	0.0000	364.50	0	0.721

Appendix XI. Raw data for Model 4 at the 400m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0000	2124.90	0.0000	451.14	0	0.929
Christman 1	Carbon	0	279.10	0.0006	197.70	0.0047	222.55	2	0.819
Christman 10	Carbon	0	151.90	0.0019	1062.20	0.0000	146.76	10	0.975
Christman 11	Carbon	29	397.10	0.0001	21.60	0.0048	78.16	3	0.902
Christman 12	Carbon	10	408.70	0.0000	58.00	0.0047	194.96	2	0.915
Christman 1N	Carbon	2	165.70	0.0028	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	4	186.80	0.0015	227.90	0.0011	414.20	0	0.932
Christman 3	Carbon	0	854.40	0.0000	88.20	0.0045	158.52	2	0.925
Christman 4	Carbon	0	316.90	0.0003	252.60	0.0028	315.33	2	0.929
Christman 5	Carbon	0	1224.10	0.0000	595.70	0.0000	624.19	0	0.994
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Christman 7	Carbon	0	436.60	0.0000	302.80	0.0023	458.56	0	0.951
Christman 8	Carbon	0	401.50	0.0000	192.05	0.0035	350.89	2	0.896
Christman 9	Carbon	0	588.30	0.0000	393.40	0.0006	489.78	0	0.929
Hell Creek	Carbon	73	145.00	0.0006	3037.30	0.0000	1582.90	0	0.991
Hickory Run 4	Carbon	11	1544.20	0.0000	552.50	0.0000	2021.82	0	0.951
Hickory Run 5	Carbon	16	1101.90	0.0000	86.40	0.0052	89.18	2	0.908
Lehighton 1N	Carbon	2	475.30	0.0000	240.90	0.0039	244.48	1	0.932
Nesquehoning 1	Carbon	0	297.40	0.0016	2154.20	0.0000	319.82	13	0.799
Tamaqua 1	Carbon	0	247.57	0.0003	3289.00	0.0000	978.90	0	0.930
Tamaqua 1N	Carbon	0	415.50	0.0000	2830.20	0.0000	600.60	0	0.741
Weatherly 1	Carbon	0	1437.60	0.0000	854.90	0.0000	884.28	0	0.996
Weatherly 1N-Ribello	Carbon	2	348.80	0.0006	2379.90	0.0000	1126.11	0	0.997
Weatherly 1N-Stan	Carbon	1	219.30	0.0013	162.60	0.0053	322.65	6	0.869

Weatherly 2	Carbon	0	398.30	0.0000	229.10	0.0031	387.50	1	0.898
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0019	440.40	0	0.926
Weatherly 4	Carbon	1	29.90	0.0018	2393.90	0.0000	1101.32	0	0.988
Weatherly 5	Carbon	0	217.40	0.0013	162.80	0.0053	320.73	6	0.868
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.999
Weatherly 7	Carbon	2	1466.50	0.0000	4823.60	0.0000	2034.26	0	0.999
Avoca 7	Luzerne	6	265.90	0.0014	4099.60	0.0000	463.70	0	0.883
Dutch Mountain 6	Luzerne	0	320.70	0.0009	6494.40	0.0000	2013.90	0	0.997
Hickory Run 1-Koval	Luzerne	0	238.80	0.0013	1199.50	0.0000	606.10	0	0.889
Hickory Run 2- Koval	Luzerne	31	966.60	0.0000	1260.40	0.0000	1114.20	0	0.796
Hickory Run 3- Koval	Luzerne	2	583.00	0.0000	944.50	0.0000	525.80	0	0.677
Nanticoke 1N	Luzerne	4	1110.80	0.0000	2009.10	0.0000	1253.60	0	0.888
Pittston 1	Luzerne	0	363.80	0.0007	4098.00	0.0000	151.60	16	0.927
Pittston 2	Luzerne	0	258.00	0.0016	3557.40	0.0000	158.40	9	0.791
Pittston 3	Luzerne	0	632.70	0.0000	5916.00	0.0000	858.00	0	0.829
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0000	3289.90	0.0000	1312.70	0	0.902
Red Rock 2	Luzerne	0	1116.90	0.0000	194.80	0.0024	1637.00	0	1.000
Red Rock 3	Luzerne	0	766.10	0.0000	89.30	0.0018	767.40	0	1.000
Sweet Valley 1	Luzerne	0	430.60	0.0000	6257.30	0.0000	2253.40	0	1.000
Sweet Valley 2	Luzerne	0	88.50	0.0022	87.30	0.0016	1945.00	0	0.994
Wilkes Barre East 1	Luzerne	0	811.20	0.0000	5878.10	0.0000	733.10	0	0.938
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0053	694.10	0	0.998
Mount Pocono 2N	Monroe	4	827.40	0.0000	25.00	0.0035	700.70	0	0.995
Pocono Pines 1N	Monroe	3	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	5		0.0000	51.20	0.0017			0.984
Great Bend 1	Susquehanna	0	640.70	0.0000	2560.10	0.0000	800.10	0	1.000

Starrucca 1	Susquehanna	0	251.40	0.0010	251.40	0.0010	273.10	3	0.900
Susquehanna 1N	Susquehanna	2	510.90	0.0000	867.80	0.0000	482.50	0	0.735
White Mills 1	Wayne	3	252.20	0.0027	4747.60	0.0000	889.60	0	0.923
White Mills 1N	Wayne	3	106.70	0.0031	4904.10	0.0000	1117.40	0	0.772
White Mills 2	Wayne	3	573.20	0.0000	6118.60	0.0000	607.30	0	0.993
Dutch Mountain 1	Wyoming	3	534.50	0.0000	12447.34	0.0000	561.00	0	0.964
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.976
Dutch Mountain 2	Wyoming	0	1231.58	0.0000	14548.48	0.0000	1018.17	0	1.000
Dutch Mountain 2N	Wyoming	7	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3	Wyoming	0	163.60	0.0014	12580.00	0.0000	353.60	1	0.981
Dutch Mountain 3N	Wyoming	3	1119.80	0.0000	13554.38	0.0000	1157.60	0	0.992
Dutch Mountain 4	Wyoming	3	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Dutch Mountain 5	Wyoming	0	385.50	0.0004	8452.92	0.0000	946.90	0	1.000
Jenningsville 1	Wyoming	0	259.10	0.0010	13997.25	0.0000		0	0.995
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.983
Jenningsville 2N	Wyoming	3	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.987
Meshoppen 1	Wyoming	0	414.20	0.0000	8617.82	0.0000	426.60	0	0.989
Meshoppen 1N	Wyoming	2	831.80	0.0000	8763.22	0.0000	414.50	0	0.968
Meshoppen 2N	Wyoming	6	202.60	0.0027	10486.80	0.0000	261.40	1	0.988
Noxen	Wyoming	0	2203.10	0.0000	13030.57	0.0000	2108.50	0	0.992
Noxen 1	Wyoming	4	1328.50	0.0000	9656.14	0.0000	1428.60	0	0.990
Noxen 10	Wyoming	6	1025.90	0.0000	10649.31	0.0000	911.20	0	0.998
Noxen 10N	Wyoming	4	1702.40	0.0000	11205.63	0.0000	1716.00	0	0.999
Noxen 1N	Wyoming	3	1273.90	0.0000	12692.77	0.0000	1318.20	0	0.988
Noxen 2	Wyoming	4	911.60	0.0000	13087.59	0.0000	558.00	0	0.998
Noxen 2N	Wyoming	3	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000

Noxen 3	Wyoming	0	1320.80	0.0000	13011.71	0.0000	1328.30	0	1.000
Noxen 3N	Wyoming	2	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	2	711.20	0.0000	9559.28	0.0000	593.50	0	0.996
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	0.998
Noxen 5	Wyoming	0	2445.70	0.0000	14364.49	0.0000	1497.40	0	1.000
Noxen 5N	Wyoming	4	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	2	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7	Wyoming	0	1649.60	0.0000	12814.95	0.0000	1535.80	0	1.000
Noxen 7N	Wyoming	3	1625.90	0.0000	11145.25	0.0000	1575.30	0	0.984
Noxen 8	Wyoming	8	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.911
Noxen 8N	Wyoming	4	299.40	0.0011	8074.57	0.0000	1071.00	0	0.901
Noxen 9	Wyoming	0	1746.90	0.0000	13753.02	0.0000	1800.80	0	0.996
Noxen 9N	Wyoming	2	296.00	0.0002	12346.09	0.0000	358.80	1	0.907
Tunkannock 1N	Wyoming	2	244.80	0.0011	3519.70	0.0000	364.50	1	0.878

Appendix XII. Raw data for Model 4 at the 5000m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0026	2124.90	0.0005	451.14	4034	0.872
Christman 1	Carbon	0	279.10	0.0013	197.70	0.0014	222.50	512	0.882
Christman 10	Carbon	0	151.90	0.0022	1062.20	0.0002	146.76	2601	0.833
Christman 11	Carbon	29	397.10	0.0018	21.60	0.0007	78.16	3167	0.921
Christman 12	Carbon	10	408.70	0.0011	58.00	0.0008	194.96	581	0.890
Christman 1N	Carbon	2	165.70	0.0009	569.10	0.0009	614.90	787	0.893
Christman 2	Carbon	4	186.80	0.0013	227.90	0.0006	414.20	726	0.887
Christman 3	Carbon	0	854.40	0.0010	88.20	0.0009	158.50	471	0.862
Christman 4	Carbon	0	316.90	0.0016	252.60	0.0008	315.33	1238	0.884
Christman 5	Carbon	0	1224.10	0.0009	595.70	0.0008	624.19	606	0.930
Christman 6	Carbon	1	1126.70	0.0016	411.50	0.0007	423.00	2195	0.918
Christman 7	Carbon	0	436.60	0.0016	302.80	0.0006	458.56	2298	0.928
Christman 8	Carbon	0	401.50	0.0016	192.05	0.0016	350.89	2683	0.933
Christman 9	Carbon	0	588.30	0.0016	393.40	0.0007	489.78	2738	0.929
Hell Creek	Carbon	73	145.00	0.0036	3037.30	0.0001	1582.90	5239	0.850
Hickory Run 4	Carbon	11	1544.20	0.0007	552.50	0.0003	2021.80	554	0.901
Hickory Run 5	Carbon	16	1101.90	0.0013	86.40	0.0013	89.10	424	0.884
Lehighton 1N	Carbon	2	475.30	0.0032	240.90	0.0008	244.48	7373	0.741
Nesquehoning 1	Carbon	0	297.40	0.0021	2154.20	0.0001	319.82	5193	0.818
Tamaqua 1	Carbon	0	247.57	0.0021	3289.00	0.0000			0.802
Tamaqua 1N	Carbon	0	415.50	0.0021	2830.20	0.0000			0.808
Weatherly 1	Carbon	0	1437.60	0.0009	854.90	0.0007	884.28	518	0.927
Weatherly 1N-Ribello	Carbon	2	348.80	0.0016	2379.90	0.0005	1126.11	2764	0.922
Weatherly 1N-Stan	Carbon	1	219.30	0.0020	162.60	0.0007	322.65	3921	0.908

Weatherly 2	Carbon	0	398.30	0.0016	229.10	0.0006	387.50	2682	0.933
Weatherly 3	Carbon	1	544.20	0.0016	316.30	0.0007	440.40	2723	0.930
Weatherly 4	Carbon	1	29.90	0.0017	2393.90	0.0005	1101.32	2734	0.909
Weatherly 5	Carbon	0	217.40	0.0020	162.80	0.0007	320.73	3917	0.908
Weatherly 6	Carbon	1	732.90	0.0015	3411.40	0.0002	660.86	1585	0.893
Weatherly 7	Carbon	2	1466.50	0.0014	4823.60	0.0000	2034.26	1701	0.853
Avoca 7	Luzerne	6	265.90	0.0006	4099.60	0.0001	463.70	483	0.905
Dutch Mountain 6	Luzerne	0	320.70	0.0006	6494.40	0.0000	2013.90	121	0.963
Hickory Run 1-Koval	Luzerne	0	238.80	0.0013	1199.50	0.0004	606.10	1021	0.875
Hickory Run 2- Koval	Luzerne	31	966.60	0.0008	1260.40	0.0002	1114.20	812	0.909
Hickory Run 3- Koval	Luzerne	2	583.00	0.0008	944.50	0.0002	525.80	574	0.908
Nanticoke 1N	Luzerne	4	1110.80	0.0023	2009.10	0.0001	1253.60	5986	0.726
Pittston 1	Luzerne	0	363.80	0.0040	4098.00	0.0000	151.60	15706	0.584
Pittston 2	Luzerne	0	258.00	0.0030	3557.40	0.0001	158.40	9643	0.621
Pittston 3	Luzerne	0	632.70	0.0025	5916.00	0.0000	858.00	3735	0.704
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0014	3289.90	0.0001	1312.70	934	0.902
Red Rock 2	Luzerne	0	1116.90	0.0008	194.80	0.0005			0.920
Red Rock 3	Luzerne	0	766.10	0.0011	89.30	0.0004			0.905
Sweet Valley 1	Luzerne	0	430.60	0.0006	6257.30	0.0000	2253.40	118	0.964
Sweet Valley 2	Luzerne	0	88.50	0.0006	87.30	0.0004	1945.00	84	0.944
Wilkes Barre East 1	Luzerne	0	811.20	0.0030	5878.10	0.0000	733.10	9805	0.711
Mount Pocono 1N	Monroe	1	620.80	0.0034	64.80	0.0001	694.10	7057	0.820
Mount Pocono 2N	Monroe	4	827.40	0.0035	25.00	0.0001	700.70	7591	0.818
Pocono Pines 1N	Monroe	3	907.56	0.0027	3311.77	0.0000	3311.77	4727	
Stroudsburg 2N	Monroe	5		0.0018	51.20	0.0003			0.795
Great Bend 1	Susquehanna	0	640.70	0.0021	2560.10	0.0001	800.10	1850	0.807

Starrucca 1	Susquehanna	0	251.40	0.0014	251.40	0.0003	273.10	588	0.770
White Mills 1	Wayne	3	252.20	0.0016	4747.60	0.0000	889.60	1654	0.798
White Mills 1N	Wayne	3	106.70	0.0016	4904.10	0.0000	1117.40	1554	0.814
White Mills 2	Wayne	3	573.20	0.0015	6118.60	0.0000	607.30	1469	0.849
Dutch Mountain 1	Wyoming	3	534.50	0.0006	12447.34	0.0000	561.00	271	0.934
Dutch Mountain 1N	Wyoming	1	1508.54	0.0004	14033.38	0.0000	1430.01	142	0.968
Dutch Mountain 2	Wyoming	0	1231.58	0.0004	14548.48	0.0000	1018.17	151	0.976
Dutch Mountain 2N	Wyoming	7	618.80	0.0004	14517.34	0.0000	557.80	156	0.973
Dutch Mountain 3	Wyoming	0	163.60	0.0003	12580.00	0.0000	353.60	94	0.978
Dutch Mountain 3N	Wyoming	3	1119.80	0.0005	13554.38	0.0000	1157.60	218	0.956
Dutch Mountain 4	Wyoming	3	444.90	0.0005	7862.37	0.0000	1932.70	42	0.964
Dutch Mountain 5	Wyoming	0	385.50	0.0006	8452.92	0.0000	946.90	88	0.965
Jenningsville 1	Wyoming	0	259.10	0.0007	13997.25	0.0000			0.904
Jenningsville 1N	Wyoming	1	2061.80	0.0007	12393.23	0.0000	2026.70	318	0.925
Jenningsville 2N	Wyoming	3	1502.40	0.0006	12400.73	0.0000	1335.30		0.913
Meshoppen 1	Wyoming	0	414.20	0.0013	8617.82	0.0000	426.60	402	0.798
Meshoppen 1N	Wyoming	2	831.80	0.0013	8763.22	0.0000	414.50	455	0.778
Meshoppen 2N	Wyoming	6	202.60	0.0009	10486.80	0.0000	261.40	334	0.870
Noxen	Wyoming	0	2203.10	0.0007	13030.57	0.0000	2108.50	655	0.937
Noxen 1	Wyoming	4	1328.50	0.0007	9656.14	0.0000	1428.60	247	0.925
Noxen 10	Wyoming	6	1025.90	0.0008	10649.31	0.0000	911.20	268	0.958
Noxen 10N	Wyoming	4	1702.40	0.0008	11205.63	0.0000	1716.00	344	0.961
Noxen 1N	Wyoming	3	1273.90	0.0008	12692.77	0.0000	1318.20	439	0.955
Noxen 2	Wyoming	4	911.60	0.0005	13087.59	0.0000	558.00	243	0.949
Noxen 2N	Wyoming	3	1317.10	0.0008	12992.57	0.0000	1312.30	624	0.929
Noxen 3	Wyoming	0	1320.80	0.0005	13011.71	0.0000	1328.30	216	0.961

Noxen 3N	Wyoming	2	1335.40	0.0005	12391.78	0.0000	1343.50	208	0.968
Noxen 4	Wyoming	2	711.20	0.0008	9559.28	0.0000	593.50	477	0.914
Noxen 4N	Wyoming	1	1882.00	0.0004	14165.07	0.0000	1704.50	154	0.977
Noxen 5	Wyoming	0	2445.70	0.0004	14364.49	0.0000	1497.40	183	0.976
Noxen 5N	Wyoming	4	955.30	0.0012	12570.92	0.0000	925.90	912	0.881
Noxen 6N	Wyoming	2	934.80	0.0005	10707.81	0.0000	521.00	224	0.947
Noxen 7	Wyoming	0	1649.60	0.0008	12814.95	0.0000	1535.80	738	0.914
Noxen 7N	Wyoming	3	1625.90	0.0008	11145.25	0.0000	1575.30	363	0.959
Noxen 8	Wyoming	8	1280.70	0.0010	12783.07	0.0000	1249.50	865	0.897
Noxen 8N	Wyoming	4	299.40	0.0010	8074.57	0.0000	1071.00	427	0.894
Noxen 9	Wyoming	0	1746.90	0.0007	13753.02	0.0000	1800.80	597	0.936
Noxen 9N	Wyoming	2	296.00	0.0014	12346.09	0.0000	358.80	1152	0.832
Tunkannock 1N	Wyoming	2	244.80	0.0024	3519.70	0.0001	364.50	2669	0.701

Appendix XIII. Raw data for Model 5 at the 50m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0000	2124.90	0.0000	451.14	0	0.584
Christman 11	Carbon	29	397.10	0.0000	21.60	0.0228	78.16	0	0.662
Christman 12	Carbon	10	408.70	0.0000	58.00	0.0000	194.96	0	1.000
Christman 1N	Carbon	2	165.70	0.0000	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	4	186.80	0.0000	227.90	0.0000	414.20	0	1.000
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Hell Creek	Carbon	73	145.00	0.0000	3037.30	0.0000	1582.90	0	1.000
Hickory Run 4	Carbon	11	1544.20	0.0000	552.50	0.0000	2021.82	0	1.000
Hickory Run 5	Carbon	16	1101.90	0.0000	86.40	0.0000	89.18	0	1.000
Lehighton 1N	Carbon	2	475.30	0.0000	240.90	0.0000	244.48	0	0.932
Weatherly 1N-Ribello	Carbon	2	348.80	0.0000	2379.90	0.0000	1126.11	0	0.973
Weatherly 1N-Stan	Carbon	1	219.30	0.0000	162.60	0.0000	322.65	0	1.000
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0000	440.40	0	1.000
Weatherly 4	Carbon	1	29.90	0.0090	2393.90	0.0000	1101.32	0	0.980
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.998
Weatherly 7	Carbon	2	1466.50	0.0000	4823.60	0.0000	2034.26	0	1.000
Avoca 7	Luzerne	6	265.90	0.0000	4099.60	0.0000	463.70	0	1.000
Hickory Run 2- Koval	Luzerne	31	966.60	0.0000	1260.40	0.0000	1114.20	0	1.000
Hickory Run 3- Koval	Luzerne	2	583.00	0.0000	944.50	0.0000	525.80	0	0.912
Nanticoke 1N	Luzerne	4	1110.80	0.0000	2009.10	0.0000	1253.60	0	1.000
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0000	694.10	0	1.000
Mount Pocono 2N	Monroe	4	827.40	0.0000	25.00	0.0097	700.70	0	0.880
Pocono Pines 1N	Monroe	3	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	5		0.0000	51.20	0.0000		0	1.000

Susquehanna 1N	Susquehanna	2	510.90	0.0000	867.80	0.0000	482.50	0	0.999
White Mills 1	Wayne	3	252.20	0.0000	4747.60	0.0000	889.60	0	1.000
White Mills 1N	Wayne	3	106.70	0.0000	4904.10	0.0000	1117.40	0	0.417
White Mills 2	Wayne	3	573.20	0.0000	6118.60	0.0000	607.30	0	1.000
Dutch Mountain 1	Wyoming	3	534.50	0.0000	12447.34	0.0000	561.00	0	1.000
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.997
Dutch Mountain 2N	Wyoming	7	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3N	Wyoming	3	1119.80	0.0000	13554.38	0.0000	1157.60	0	1.000
Dutch Mountain 4	Wyoming	3	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.878
Jenningsville 2N	Wyoming	3	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.741
Meshoppen 1N	Wyoming	2	831.80	0.0000	8763.22	0.0000	414.50	0	1.000
Meshoppen 2N	Wyoming	6	202.60	0.0000	10486.80	0.0000	261.40	0	1.000
Noxen 1	Wyoming	4	1328.50	0.0000	9656.14	0.0000	1428.60	0	1.000
Noxen 10	Wyoming	6	1025.90	0.0000	10649.31	0.0000	911.20	0	1.000
Noxen 10N	Wyoming	4	1702.40	0.0000	11205.63	0.0000	1716.00	0	1.000
Noxen 1N	Wyoming	3	1273.90	0.0000	12692.77	0.0000	1318.20	0	1.000
Noxen 2	Wyoming	4	911.60	0.0000	13087.59	0.0000	558.00	0	1.000
Noxen 2N	Wyoming	3	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3N	Wyoming	2	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	2	711.20	0.0000	9559.28	0.0000	593.50	0	1.000
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	1.000
Noxen 5N	Wyoming	4	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	2	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7N	Wyoming	3	1625.90	0.0000	11145.25	0.0000	1575.30	0	1.000
Noxen 8	Wyoming	8	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.934

Noxen 8N	Wyoming	4	299.40	0.0000	8074.57	0.0000	1071.00	0	1.000
Noxen 9N	Wyoming	2	296.00	0.0000	12346.09	0.0000	358.80	0	1.000
Tunkannock 1N	Wyoming	2	244.80	0.0000	3519.70	0.0000	364.50	0	0.721

Appendix XIV. Raw data for Model 5 at the 400m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0000	2124.90	0.0000	451.14	0	0.929
Christman 11	Carbon	29	397.10	0.0001	21.60	0.0048	78.16	3	0.902
Christman 12	Carbon	10	408.70	0.0000	58.00	0.0047	194.96	2	0.915
Christman 1N	Carbon	2	165.70	0.0028	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	4	186.80	0.0015	227.90	0.0011	414.20	0	0.932
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Hell Creek	Carbon	73	145.00	0.0006	3037.30	0.0000	1582.90	0	0.991
Hickory Run 4	Carbon	11	1544.20	0.0000	552.50	0.0000	2021.82	0	0.951
Hickory Run 5	Carbon	16	1101.90	0.0000	86.40	0.0052	89.18	2	0.908
Lehighton 1N	Carbon	2	475.30	0.0000	240.90	0.0039	244.48	1	0.932
Weatherly 1N-Ribello	Carbon	2	348.80	0.0006	2379.90	0.0000	1126.11	0	0.997
Weatherly 1N-Stan	Carbon	1	219.30	0.0013	162.60	0.0053	322.65	6	0.869
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0019	440.40	0	0.926
Weatherly 4	Carbon	1	29.90	0.0018	2393.90	0.0000	1101.32	0	0.988
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.999
Weatherly 7	Carbon	2	1466.50	0.0000	4823.60	0.0000	2034.26	0	0.999
Avoca 7	Luzerne	6	265.90	0.0014	4099.60	0.0000	463.70	0	0.883
Hickory Run 2- Koval	Luzerne	31	966.60	0.0000	1260.40	0.0000	1114.20	0	0.796
Hickory Run 3- Koval	Luzerne	2	583.00	0.0000	944.50	0.0000	525.80	0	0.677
Nanticoke 1N	Luzerne	4	1110.80	0.0000	2009.10	0.0000	1253.60	0	0.888
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0053	694.10	0	0.998
Mount Pocono 2N	Monroe	4	827.40	0.0000	25.00	0.0035	700.70	0	0.995
Pocono Pines 1N	Monroe	3	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	5		0.0000	51.20	0.0017			0.984

Susquehanna 1N	Susquehanna	2	510.90	0.0000	867.80	0.0000	482.50	0	0.735
White Mills 1	Wayne	3	252.20	0.0027	4747.60	0.0000	889.60	0	0.923
White Mills 1N	Wayne	3	106.70	0.0031	4904.10	0.0000	1117.40	0	0.772
White Mills 2	Wayne	3	573.20	0.0000	6118.60	0.0000	607.30	0	0.993
Dutch Mountain 1	Wyoming	3	534.50	0.0000	12447.34	0.0000	561.00	0	0.964
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.976
Dutch Mountain 2N	Wyoming	7	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3N	Wyoming	3	1119.80	0.0000	13554.38	0.0000	1157.60	0	0.992
Dutch Mountain 4	Wyoming	3	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.983
Jenningsville 2N	Wyoming	3	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.987
Meshoppen 1N	Wyoming	2	831.80	0.0000	8763.22	0.0000	414.50	0	0.968
Meshoppen 2N	Wyoming	6	202.60	0.0027	10486.80	0.0000	261.40	1	0.988
Noxen 1	Wyoming	4	1328.50	0.0000	9656.14	0.0000	1428.60	0	0.990
Noxen 10	Wyoming	6	1025.90	0.0000	10649.31	0.0000	911.20	0	0.998
Noxen 10N	Wyoming	4	1702.40	0.0000	11205.63	0.0000	1716.00	0	0.999
Noxen 1N	Wyoming	3	1273.90	0.0000	12692.77	0.0000	1318.20	0	0.988
Noxen 2	Wyoming	4	911.60	0.0000	13087.59	0.0000	558.00	0	0.998
Noxen 2N	Wyoming	3	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3N	Wyoming	2	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	2	711.20	0.0000	9559.28	0.0000	593.50	0	0.996
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	0.998
Noxen 5N	Wyoming	4	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	2	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7N	Wyoming	3	1625.90	0.0000	11145.25	0.0000	1575.30	0	0.984
Noxen 8	Wyoming	8	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.911

Noxen 8N	Wyoming	4	299.40	0.0011	8074.57	0.0000	1071.00	0	0.901
Noxen 9N	Wyoming	2	296.00	0.0002	12346.09	0.0000	358.80	1	0.907
Tunkannock 1N	Wyoming	2	244.80	0.0011	3519.70	0.0000	364.50	1	0.878

Appendix XV. Raw data for Model 5 at the 5000m buffer zone.

Site	County	Num. of Snakes	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	12	523.70	0.0026	2124.90	0.0005	451.14	4034	0.872
Christman 11	Carbon	29	397.10	0.0018	21.60	0.0007	78.16	3167	0.921
Christman 12	Carbon	10	408.70	0.0011	58.00	0.0008	194.96	581	0.890
Christman 1N	Carbon	2	165.70	0.0009	569.10	0.0009	614.90	787	0.893
Christman 2	Carbon	4	186.80	0.0013	227.90	0.0006	414.20	726	0.887
Christman 6	Carbon	1	1126.70	0.0016	411.50	0.0007	423.00	2195	0.918
Hell Creek	Carbon	73	145.00	0.0036	3037.30	0.0001	1582.90	5239	0.850
Hickory Run 4	Carbon	11	1544.20	0.0007	552.50	0.0003	2021.80	554	0.901
Hickory Run 5	Carbon	16	1101.90	0.0013	86.40	0.0013	89.10	424	0.884
Lehighton 1N	Carbon	2	475.30	0.0032	240.90	0.0008	244.48	7373	0.741
Weatherly 1N-Ribello	Carbon	2	348.80	0.0016	2379.90	0.0005	1126.11	2764	0.922
Weatherly 1N-Stan	Carbon	1	219.30	0.0020	162.60	0.0007	322.65	3921	0.908
Weatherly 3	Carbon	1	544.20	0.0016	316.30	0.0007	440.40	2723	0.930
Weatherly 4	Carbon	1	29.90	0.0017	2393.90	0.0005	1101.32	2734	0.909
Weatherly 6	Carbon	1	732.90	0.0015	3411.40	0.0002	660.86	1585	0.893
Weatherly 7	Carbon	2	1466.50	0.0014	4823.60	0.0000	2034.26	1701	0.853
Avoca 7	Luzerne	6	265.90	0.0006	4099.60	0.0001	463.70	483	0.905
Hickory Run 2- Koval	Luzerne	31	966.60	0.0008	1260.40	0.0002	1114.20	812	0.909
Hickory Run 3- Koval	Luzerne	2	583.00	0.0008	944.50	0.0002	525.80	574	0.908
Nanticoke 1N	Luzerne	4	1110.80	0.0023	2009.10	0.0001	1253.60	5986	0.726
Mount Pocono 1N	Monroe	1	620.80	0.0034	64.80	0.0001	694.10	7057	0.820
Mount Pocono 2N	Monroe	4	827.40	0.0035	25.00	0.0001	700.70	7591	0.818
Pocono Pines 1N	Monroe	3	907.56	0.0027	3311.77	0.0000	3311.77	4727	
Stroudsburg 2N	Monroe	5		0.0018	51.20	0.0003			0.795

White Mills 1	Wayne	3	252.20	0.0016	4747.60	0.0000	889.60	1654	0.798
White Mills 1N	Wayne	3	106.70	0.0016	4904.10	0.0000	1117.40	1554	0.814
White Mills 2	Wayne	3	573.20	0.0015	6118.60	0.0000	607.30	1469	0.849
Dutch Mountain 1	Wyoming	3	534.50	0.0006	12447.34	0.0000	561.00	271	0.934
Dutch Mountain 1N	Wyoming	1	1508.54	0.0004	14033.38	0.0000	1430.01	142	0.968
Dutch Mountain 2N	Wyoming	7	618.80	0.0004	14517.34	0.0000	557.80	156	0.973
Dutch Mountain 3N	Wyoming	3	1119.80	0.0005	13554.38	0.0000	1157.60	218	0.956
Dutch Mountain 4	Wyoming	3	444.90	0.0005	7862.37	0.0000	1932.70	42	0.964
Jenningsville 1N	Wyoming	1	2061.80	0.0007	12393.23	0.0000	2026.70	318	0.925
Jenningsville 2N	Wyoming	3	1502.40	0.0006	12400.73	0.0000	1335.30		0.913
Meshoppen 1N	Wyoming	2	831.80	0.0013	8763.22	0.0000	414.50	455	0.778
Meshoppen 2N	Wyoming	6	202.60	0.0009	10486.80	0.0000	261.40	334	0.870
Noxen 1	Wyoming	4	1328.50	0.0007	9656.14	0.0000	1428.60	247	0.925
Noxen 10	Wyoming	6	1025.90	0.0008	10649.31	0.0000	911.20	268	0.958
Noxen 10N	Wyoming	4	1702.40	0.0008	11205.63	0.0000	1716.00	344	0.961
Noxen 1N	Wyoming	3	1273.90	0.0008	12692.77	0.0000	1318.20	439	0.955
Noxen 2	Wyoming	4	911.60	0.0005	13087.59	0.0000	558.00	243	0.949
Noxen 2N	Wyoming	3	1317.10	0.0008	12992.57	0.0000	1312.30	624	0.929
Noxen 3N	Wyoming	2	1335.40	0.0005	12391.78	0.0000	1343.50	208	0.968
Noxen 4	Wyoming	2	711.20	0.0008	9559.28	0.0000	593.50	477	0.914
Noxen 4N	Wyoming	1	1882.00	0.0004	14165.07	0.0000	1704.50	154	0.977
Noxen 5N	Wyoming	4	955.30	0.0012	12570.92	0.0000	925.90	912	0.881
Noxen 6N	Wyoming	2	934.80	0.0005	10707.81	0.0000	521.00	224	0.947
Noxen 7N	Wyoming	3	1625.90	0.0008	11145.25	0.0000	1575.30	363	0.959
Noxen 8	Wyoming	8	1280.70	0.0010	12783.07	0.0000	1249.50	865	0.897
Noxen 8N	Wyoming	4	299.40	0.0010	8074.57	0.0000	1071.00	427	0.894

Noxen 9N	Wyoming	2	296.00	0.0014	12346.09	0.0000	358.80	1152	0.832
Tunkannock 1N	Wyoming	2	244.80	0.0024	3519.70	0.0001	364.50	2669	0.701

Appendix XVI. Raw data for Model 6 at the 50m buffer zone where Number of Snakes (Population) has been changed to presence (1) - absence(0) data.

Site	County	Population	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	1	523.70	0.0000	2124.90	0.0000	451.14	0	0.584
Christman 1	Carbon	0	279.10	0.0000	197.70	0.0000	222.55	0	0.990
Christman 10	Carbon	0	151.90	0.0000	1062.20	0.0000	146.76	0	1.000
Christman 11	Carbon	1	397.10	0.0000	21.60	0.0228	78.16	0	0.662
Christman 12	Carbon	1	408.70	0.0000	58.00	0.0000	194.96	0	1.000
Christman 1N	Carbon	1	165.70	0.0000	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	1	186.80	0.0000	227.90	0.0000	414.20	0	1.000
Christman 3	Carbon	0	854.40	0.0000	88.20	0.0000	158.52	0	0.931
Christman 4	Carbon	0	316.90	0.0000	252.60	0.0000	315.33	0	1.000
Christman 5	Carbon	0	1224.10	0.0000	595.70	0.0000	624.19	0	1.000
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Christman 7	Carbon	0	436.60	0.0000	302.80	0.0000	458.56	0	1.000
Christman 8	Carbon	0	401.50	0.0000	192.05	0.0000	350.89	0	1.000
Christman 9	Carbon	0	588.30	0.0000	393.40	0.0000	489.78	0	1.000
Hell Creek	Carbon	1	145.00	0.0000	3037.30	0.0000	1582.90	0	1.000
Hickory Run 4	Carbon	1	1544.20	0.0000	552.50	0.0000	2021.82	0	1.000
Hickory Run 5	Carbon	1	1101.90	0.0000	86.40	0.0000	89.18	0	1.000
Lehighton 1N	Carbon	1	475.30	0.0000	240.90	0.0000	244.48	0	0.932
Nesquehoning 1	Carbon	0	297.40	0.0000	2154.20	0.0000	319.82	0	0.956
Tamaqua 1	Carbon	0	247.57	0.0000	3289.00	0.0000	978.90	0	1.000
Tamaqua 1N	Carbon	0	415.50	0.0000	2830.20	0.0000	600.60	0	1.000
Weatherly 1	Carbon	0	1437.60	0.0000	854.90	0.0000	884.28	0	1.000
Weatherly 1N-Ribello	Carbon	1	348.80	0.0000	2379.90	0.0000	1126.11	0	0.973

Weatherly 1N-Stan	Carbon	1	219.30	0.0000	162.60	0.0000	322.65	0	1.000
Weatherly 2	Carbon	0	398.30	0.0000	229.10	0.0000	387.50	0	1.000
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0000	440.40	0	1.000
Weatherly 4	Carbon	1	29.90	0.0090	2393.90	0.0000	1101.32	0	0.980
Weatherly 5	Carbon	0	217.40	0.0000	162.80	0.0000	320.73	0	1.000
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.998
Weatherly 7	Carbon	1	1466.50	0.0000	4823.60	0.0000	2034.26	0	1.000
Avoca 7	Luzerne	1	265.90	0.0000	4099.60	0.0000	463.70	0	1.000
Dutch Mountain 6	Luzerne	0	320.70	0.0000	6494.40	0.0000	2013.90	0	1.000
Hickory Run 1-Koval	Luzerne	0	238.80	0.0000	1199.50	0.0000	606.10	0	1.000
Hickory Run 2- Koval	Luzerne	1	966.60	0.0000	1260.40	0.0000	1114.20	0	1.000
Hickory Run 3- Koval	Luzerne	1	583.00	0.0000	944.50	0.0000	525.80	0	0.912
Nanticoke 1N	Luzerne	1	1110.80	0.0000	2009.10	0.0000	1253.60	0	1.000
Pittston 1	Luzerne	0	363.80	0.0000	4098.00	0.0000	151.60	0	1.000
Pittston 2	Luzerne	0	258.00	0.0000	3557.40	0.0000	158.40	0	1.000
Pittston 3	Luzerne	0	632.70	0.0000	5916.00	0.0000	858.00	0	0.960
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0000	3289.90	0.0000	1312.70	0	0.286
Red Rock 2	Luzerne	0	1116.90	0.0000	194.80	0.0000	1637.00	0	1.000
Red Rock 3	Luzerne	0	766.10	0.0000	89.30	0.0000	767.40	0	0.985
Sweet Valley 1	Luzerne	0	430.60	0.0000	6257.30	0.0000	2253.40	0	1.000
Sweet Valley 2	Luzerne	0	88.50	0.0000	87.30	0.0000	1945.00	0	1.000
Wilkes Barre East 1	Luzerne	0	811.20	0.0000	5878.10	0.0000	733.10	0	1.000
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0000	694.10	0	1.000
Mount Pocono 2N	Monroe	1	827.40	0.0000	25.00	0.0097	700.70	0	0.880
Pocono Pines 1N	Monroe	1	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	1		0.0000	51.20	0.0000		0	1.000

Great Bend 1	Susquehanna	0	640.70	0.0000	2560.10	0.0000	800.10	0	1.000
Starrucca 1	Susquehanna	0	251.40	0.0000	251.40	0.0000	273.10	0	1.000
Susquehanna 1N	Susquehanna	1	510.90	0.0000	867.80	0.0000	482.50	0	0.999
White Mills 1	Wayne	1	252.20	0.0000	4747.60	0.0000	889.60	0	1.000
White Mills 1N	Wayne	1	106.70	0.0000	4904.10	0.0000	1117.40	0	0.417
White Mills 2	Wayne	1	573.20	0.0000	6118.60	0.0000	607.30	0	1.000
Dutch Mountain 1	Wyoming	1	534.50	0.0000	12447.34	0.0000	561.00	0	1.000
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.997
Dutch Mountain 2	Wyoming	0	1231.58	0.0000	14548.48	0.0000	1018.17	0	1.000
Dutch Mountain 2N	Wyoming	1	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3	Wyoming	0	163.60	0.0000	12580.00	0.0000	353.60	0	1.000
Dutch Mountain 3N	Wyoming	1	1119.80	0.0000	13554.38	0.0000	1157.60	0	1.000
Dutch Mountain 4	Wyoming	1	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Dutch Mountain 5	Wyoming	0	385.50	0.0000	8452.92	0.0000	946.90	0	1.000
Jenningsville 1	Wyoming	0	259.10	0.0000	13997.25	0.0000		0	1.000
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.878
Jenningsville 2N	Wyoming	1	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.741
Meshoppen 1	Wyoming	0	414.20	0.0000	8617.82	0.0000	426.60	0	1.000
Meshoppen 1N	Wyoming	1	831.80	0.0000	8763.22	0.0000	414.50	0	1.000
Meshoppen 2N	Wyoming	1	202.60	0.0000	10486.80	0.0000	261.40	0	1.000
Noxen	Wyoming	0	2203.10	0.0000	13030.57	0.0000	2108.50	0	0.976
Noxen 1	Wyoming	1	1328.50	0.0000	9656.14	0.0000	1428.60	0	1.000
Noxen 10	Wyoming	1	1025.90	0.0000	10649.31	0.0000	911.20	0	1.000
Noxen 10N	Wyoming	1	1702.40	0.0000	11205.63	0.0000	1716.00	0	1.000
Noxen 1N	Wyoming	1	1273.90	0.0000	12692.77	0.0000	1318.20	0	1.000
Noxen 2	Wyoming	1	911.60	0.0000	13087.59	0.0000	558.00	0	1.000

Noxen 2N	Wyoming	1	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3	Wyoming	0	1320.80	0.0000	13011.71	0.0000	1328.30	0	1.000
Noxen 3N	Wyoming	1	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	1	711.20	0.0000	9559.28	0.0000	593.50	0	1.000
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	1.000
Noxen 5	Wyoming	0	2445.70	0.0000	14364.49	0.0000	1497.40	0	1.000
Noxen 5N	Wyoming	1	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	1	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7	Wyoming	0	1649.60	0.0000	12814.95	0.0000	1535.80	0	1.000
Noxen 7N	Wyoming	1	1625.90	0.0000	11145.25	0.0000	1575.30	0	1.000
Noxen 8	Wyoming	1	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.934
Noxen 8N	Wyoming	1	299.40	0.0000	8074.57	0.0000	1071.00	0	1.000
Noxen 9	Wyoming	0	1746.90	0.0000	13753.02	0.0000	1800.80	0	1.000
Noxen 9N	Wyoming	1	296.00	0.0000	12346.09	0.0000	358.80	0	1.000
Tunkannock 1N	Wyoming	1	244.80	0.0000	3519.70	0.0000	364.50	0	0.721

Appendix XVII. Raw data for Model 6 at the 400m buffer zone where Number of Snakes (Population) has been changed to presence (1) – absence (0) data.

Site	County	Population	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	1	523.70	0.0000	2124.90	0.0000	451.14	0	0.929
Christman 1	Carbon	0	279.10	0.0006	197.70	0.0047	222.55	2	0.819
Christman 10	Carbon	0	151.90	0.0019	1062.20	0.0000	146.76	10	0.975
Christman 11	Carbon	1	397.10	0.0001	21.60	0.0048	78.16	3	0.902
Christman 12	Carbon	1	408.70	0.0000	58.00	0.0047	194.96	2	0.915
Christman 1N	Carbon	1	165.70	0.0028	569.10	0.0000	614.94	0	1.000
Christman 2	Carbon	1	186.80	0.0015	227.90	0.0011	414.20	0	0.932
Christman 3	Carbon	0	854.40	0.0000	88.20	0.0045	158.52	2	0.925
Christman 4	Carbon	0	316.90	0.0003	252.60	0.0028	315.33	2	0.929
Christman 5	Carbon	0	1224.10	0.0000	595.70	0.0000	624.19	0	0.994
Christman 6	Carbon	1	1126.70	0.0000	411.50	0.0000	423.00	0	1.000
Christman 7	Carbon	0	436.60	0.0000	302.80	0.0023	458.56	0	0.951
Christman 8	Carbon	0	401.50	0.0000	192.05	0.0035	350.89	2	0.896
Christman 9	Carbon	0	588.30	0.0000	393.40	0.0006	489.78	0	0.929
Hell Creek	Carbon	1	145.00	0.0006	3037.30	0.0000	1582.90	0	0.991
Hickory Run 4	Carbon	1	1544.20	0.0000	552.50	0.0000	2021.82	0	0.951
Hickory Run 5	Carbon	1	1101.90	0.0000	86.40	0.0052	89.18	2	0.908
Lehighton 1N	Carbon	1	475.30	0.0000	240.90	0.0039	244.48	1	0.932
Nesquehoning 1	Carbon	0	297.40	0.0016	2154.20	0.0000	319.82	13	0.799
Tamaqua 1	Carbon	0	247.57	0.0003	3289.00	0.0000	978.90	0	0.930
Tamaqua 1N	Carbon	0	415.50	0.0000	2830.20	0.0000	600.60	0	0.741
Weatherly 1	Carbon	0	1437.60	0.0000	854.90	0.0000	884.28	0	0.996
Weatherly 1N-Ribello	Carbon	1	348.80	0.0006	2379.90	0.0000	1126.11	0	0.997

Weatherly 1N-Stan	Carbon	1	219.30	0.0013	162.60	0.0053	322.65	6	0.869
Weatherly 2	Carbon	0	398.30	0.0000	229.10	0.0031	387.50	1	0.898
Weatherly 3	Carbon	1	544.20	0.0000	316.30	0.0019	440.40	0	0.926
Weatherly 4	Carbon	1	29.90	0.0018	2393.90	0.0000	1101.32	0	0.988
Weatherly 5	Carbon	0	217.40	0.0013	162.80	0.0053	320.73	6	0.868
Weatherly 6	Carbon	1	732.90	0.0000	3411.40	0.0000	660.86	0	0.999
Weatherly 7	Carbon	1	1466.50	0.0000	4823.60	0.0000	2034.26	0	0.999
Avoca 7	Luzerne	1	265.90	0.0014	4099.60	0.0000	463.70	0	0.883
Dutch Mountain 6	Luzerne	0	320.70	0.0009	6494.40	0.0000	2013.90	0	0.997
Hickory Run 1-Koval	Luzerne	0	238.80	0.0013	1199.50	0.0000	606.10	0	0.889
Hickory Run 2- Koval	Luzerne	1	966.60	0.0000	1260.40	0.0000	1114.20	0	0.796
Hickory Run 3- Koval	Luzerne	1	583.00	0.0000	944.50	0.0000	525.80	0	0.677
Nanticoke 1N	Luzerne	1	1110.80	0.0000	2009.10	0.0000	1253.60	0	0.888
Pittston 1	Luzerne	0	363.80	0.0007	4098.00	0.0000	151.60	16	0.927
Pittston 2	Luzerne	0	258.00	0.0016	3557.40	0.0000	158.40	9	0.791
Pittston 3	Luzerne	0	632.70	0.0000	5916.00	0.0000	858.00	0	0.829
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0000	3289.90	0.0000	1312.70	0	0.902
Red Rock 2	Luzerne	0	1116.90	0.0000	194.80	0.0024	1637.00	0	1.000
Red Rock 3	Luzerne	0	766.10	0.0000	89.30	0.0018	767.40	0	1.000
Sweet Valley 1	Luzerne	0	430.60	0.0000	6257.30	0.0000	2253.40	0	1.000
Sweet Valley 2	Luzerne	0	88.50	0.0022	87.30	0.0016	1945.00	0	0.994
Wilkes Barre East 1	Luzerne	0	811.20	0.0000	5878.10	0.0000	733.10	0	0.938
Mount Pocono 1N	Monroe	1	620.80	0.0000	64.80	0.0053	694.10	0	0.998
Mount Pocono 2N	Monroe	1	827.40	0.0000	25.00	0.0035	700.70	0	0.995
Pocono Pines 1N	Monroe	1	907.56	0.0000	3311.77	0.0000	3311.77	0	
Stroudsburg 2N	Monroe	1		0.0000	51.20	0.0017			0.984

Great Bend 1	Susquehanna	0	640.70	0.0000	2560.10	0.0000	800.10	0	1.000
Starrucca 1	Susquehanna	0	251.40	0.0010	251.40	0.0010	273.10	3	0.900
Susquehanna 1N	Susquehanna	1	510.90	0.0000	867.80	0.0000	482.50	0	0.735
White Mills 1	Wayne	1	252.20	0.0027	4747.60	0.0000	889.60	0	0.923
White Mills 1N	Wayne	1	106.70	0.0031	4904.10	0.0000	1117.40	0	0.772
White Mills 2	Wayne	1	573.20	0.0000	6118.60	0.0000	607.30	0	0.993
Dutch Mountain 1	Wyoming	1	534.50	0.0000	12447.34	0.0000	561.00	0	0.964
Dutch Mountain 1N	Wyoming	1	1508.54	0.0000	14033.38	0.0000	1430.01	0	0.976
Dutch Mountain 2	Wyoming	0	1231.58	0.0000	14548.48	0.0000	1018.17	0	1.000
Dutch Mountain 2N	Wyoming	1	618.80	0.0000	14517.34	0.0000	557.80	0	1.000
Dutch Mountain 3	Wyoming	0	163.60	0.0014	12580.00	0.0000	353.60	1	0.981
Dutch Mountain 3N	Wyoming	1	1119.80	0.0000	13554.38	0.0000	1157.60	0	0.992
Dutch Mountain 4	Wyoming	1	444.90	0.0000	7862.37	0.0000	1932.70	0	1.000
Dutch Mountain 5	Wyoming	0	385.50	0.0004	8452.92	0.0000	946.90	0	1.000
Jenningsville 1	Wyoming	0	259.10	0.0010	13997.25	0.0000		0	0.995
Jenningsville 1N	Wyoming	1	2061.80	0.0000	12393.23	0.0000	2026.70	0	0.983
Jenningsville 2N	Wyoming	1	1502.40	0.0000	12400.73	0.0000	1335.30	0	0.987
Meshoppen 1	Wyoming	0	414.20	0.0000	8617.82	0.0000	426.60	0	0.989
Meshoppen 1N	Wyoming	1	831.80	0.0000	8763.22	0.0000	414.50	0	0.968
Meshoppen 2N	Wyoming	1	202.60	0.0027	10486.80	0.0000	261.40	1	0.988
Noxen	Wyoming	0	2203.10	0.0000	13030.57	0.0000	2108.50	0	0.992
Noxen 1	Wyoming	1	1328.50	0.0000	9656.14	0.0000	1428.60	0	0.990
Noxen 10	Wyoming	1	1025.90	0.0000	10649.31	0.0000	911.20	0	0.998
Noxen 10N	Wyoming	1	1702.40	0.0000	11205.63	0.0000	1716.00	0	0.999
Noxen 1N	Wyoming	1	1273.90	0.0000	12692.77	0.0000	1318.20	0	0.988
Noxen 2	Wyoming	1	911.60	0.0000	13087.59	0.0000	558.00	0	0.998

Noxen 2N	Wyoming	1	1317.10	0.0000	12992.57	0.0000	1312.30	0	1.000
Noxen 3	Wyoming	0	1320.80	0.0000	13011.71	0.0000	1328.30	0	1.000
Noxen 3N	Wyoming	1	1335.40	0.0000	12391.78	0.0000	1343.50	0	1.000
Noxen 4	Wyoming	1	711.20	0.0000	9559.28	0.0000	593.50	0	0.996
Noxen 4N	Wyoming	1	1882.00	0.0000	14165.07	0.0000	1704.50	0	0.998
Noxen 5	Wyoming	0	2445.70	0.0000	14364.49	0.0000	1497.40	0	1.000
Noxen 5N	Wyoming	1	955.30	0.0000	12570.92	0.0000	925.90	0	1.000
Noxen 6N	Wyoming	1	934.80	0.0000	10707.81	0.0000	521.00	0	1.000
Noxen 7	Wyoming	0	1649.60	0.0000	12814.95	0.0000	1535.80	0	1.000
Noxen 7N	Wyoming	1	1625.90	0.0000	11145.25	0.0000	1575.30	0	0.984
Noxen 8	Wyoming	1	1280.70	0.0000	12783.07	0.0000	1249.50	0	0.911
Noxen 8N	Wyoming	1	299.40	0.0011	8074.57	0.0000	1071.00	0	0.901
Noxen 9	Wyoming	0	1746.90	0.0000	13753.02	0.0000	1800.80	0	0.996
Noxen 9N	Wyoming	1	296.00	0.0002	12346.09	0.0000	358.80	1	0.907
Tunkannock 1N	Wyoming	1	244.80	0.0011	3519.70	0.0000	364.50	1	0.878

Appendix XVIII. Raw data for Model 6 at the 5000m buffer zone where Number of Snakes (Population) has been changed to presence (1) - absence

Site	County	Population	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Blakeslee 1N	Carbon	1	523.70	0.0026	2124.90	0.0005	451.14	4034	0.872
Christman 1	Carbon	0	279.10	0.0013	197.70	0.0014	222.50	512	0.882
Christman 10	Carbon	0	151.90	0.0022	1062.20	0.0002	146.76	2601	0.833
Christman 11	Carbon	1	397.10	0.0018	21.60	0.0007	78.16	3167	0.921
Christman 12	Carbon	1	408.70	0.0011	58.00	0.0008	194.96	581	0.890
Christman 1N	Carbon	1	165.70	0.0009	569.10	0.0009	614.90	787	0.893
Christman 2	Carbon	1	186.80	0.0013	227.90	0.0006	414.20	726	0.887
Christman 3	Carbon	0	854.40	0.0010	88.20	0.0009	158.50	471	0.862
Christman 4	Carbon	0	316.90	0.0016	252.60	0.0008	315.33	1238	0.884
Christman 5	Carbon	0	1224.10	0.0009	595.70	0.0008	624.19	606	0.930
Christman 6	Carbon	1	1126.70	0.0016	411.50	0.0007	423.00	2195	0.918
Christman 7	Carbon	0	436.60	0.0016	302.80	0.0006	458.56	2298	0.928
Christman 8	Carbon	0	401.50	0.0016	192.05	0.0016	350.89	2683	0.933
Christman 9	Carbon	0	588.30	0.0016	393.40	0.0007	489.78	2738	0.929
Hell Creek	Carbon	1	145.00	0.0036	3037.30	0.0001	1582.90	5239	0.850
Hickory Run 4	Carbon	1	1544.20	0.0007	552.50	0.0003	2021.80	554	0.901
Hickory Run 5	Carbon	1	1101.90	0.0013	86.40	0.0013	89.10	424	0.884
Lehighton 1N	Carbon	1	475.30	0.0032	240.90	0.0008	244.48	7373	0.741
Nesquehoning 1	Carbon	0	297.40	0.0021	2154.20	0.0001	319.82	5193	0.818
Tamaqua 1	Carbon	0	247.57	0.0021	3289.00	0.0000			0.802
Tamaqua 1N	Carbon	0	415.50	0.0021	2830.20	0.0000			0.808
Weatherly 1	Carbon	0	1437.60	0.0009	854.90	0.0007	884.28	518	0.927
Weatherly 1N-Ribello	Carbon	1	348.80	0.0016	2379.90	0.0005	1126.11	2764	0.922

Weatherly 1N-Stan	Carbon	1	219.30	0.0020	162.60	0.0007	322.65	3921	0.908
Weatherly 2	Carbon	0	398.30	0.0016	229.10	0.0006	387.50	2682	0.933
Weatherly 3	Carbon	1	544.20	0.0016	316.30	0.0007	440.40	2723	0.930
Weatherly 4	Carbon	1	29.90	0.0017	2393.90	0.0005	1101.32	2734	0.909
Weatherly 5	Carbon	0	217.40	0.0020	162.80	0.0007	320.73	3917	0.908
Weatherly 6	Carbon	1	732.90	0.0015	3411.40	0.0002	660.86	1585	0.893
Weatherly 7	Carbon	1	1466.50	0.0014	4823.60	0.0000	2034.26	1701	0.853
Avoca 7	Luzerne	1	265.90	0.0006	4099.60	0.0001	463.70	483	0.905
Dutch Mountain 6	Luzerne	0	320.70	0.0006	6494.40	0.0000	2013.90	121	0.963
Hickory Run 1-Koval	Luzerne	0	238.80	0.0013	1199.50	0.0004	606.10	1021	0.875
Hickory Run 2- Koval	Luzerne	1	966.60	0.0008	1260.40	0.0002	1114.20	812	0.909
Hickory Run 3- Koval	Luzerne	1	583.00	0.0008	944.50	0.0002	525.80	574	0.908
Nanticoke 1N	Luzerne	1	1110.80	0.0023	2009.10	0.0001	1253.60	5986	0.726
Pittston 1	Luzerne	0	363.80	0.0040	4098.00	0.0000	151.60	15706	0.584
Pittston 2	Luzerne	0	258.00	0.0030	3557.40	0.0001	158.40	9643	0.621
Pittston 3	Luzerne	0	632.70	0.0025	5916.00	0.0000	858.00	3735	0.704
Pleasant View Summit 1- Koval	Luzerne	0	1247.00	0.0014	3289.90	0.0001	1312.70	934	0.902
Red Rock 2	Luzerne	0	1116.90	0.0008	194.80	0.0005			0.920
Red Rock 3	Luzerne	0	766.10	0.0011	89.30	0.0004			0.905
Sweet Valley 1	Luzerne	0	430.60	0.0006	6257.30	0.0000	2253.40	118	0.964
Sweet Valley 2	Luzerne	0	88.50	0.0006	87.30	0.0004	1945.00	84	0.944
Wilkes Barre East 1	Luzerne	0	811.20	0.0030	5878.10	0.0000	733.10	9805	0.711
Mount Pocono 1N	Monroe	1	620.80	0.0034	64.80	0.0001	694.10	7057	0.820
Mount Pocono 2N	Monroe	1	827.40	0.0035	25.00	0.0001	700.70	7591	0.818
Pocono Pines 1N	Monroe	1	907.56	0.0027	3311.77	0.0000	3311.77	4727	
Stroudsburg 2N	Monroe	1		0.0018	51.20	0.0003			0.795

Great Bend 1	Susquehanna	0	640.70	0.0021	2560.10	0.0001	800.10	1850	0.807
Starrucca 1	Susquehanna	0	251.40	0.0014	251.40	0.0003	273.10	588	0.770
White Mills 1	Wayne	1	252.20	0.0016	4747.60	0.0000	889.60	1654	0.798
White Mills 1N	Wayne	1	106.70	0.0016	4904.10	0.0000	1117.40	1554	0.814
White Mills 2	Wayne	1	573.20	0.0015	6118.60	0.0000	607.30	1469	0.849
Dutch Mountain 1	Wyoming	1	534.50	0.0006	12447.34	0.0000	561.00	271	0.934
Dutch Mountain 1N	Wyoming	1	1508.54	0.0004	14033.38	0.0000	1430.01	142	0.968
Dutch Mountain 2	Wyoming	0	1231.58	0.0004	14548.48	0.0000	1018.17	151	0.976
Dutch Mountain 2N	Wyoming	1	618.80	0.0004	14517.34	0.0000	557.80	156	0.973
Dutch Mountain 3	Wyoming	0	163.60	0.0003	12580.00	0.0000	353.60	94	0.978
Dutch Mountain 3N	Wyoming	1	1119.80	0.0005	13554.38	0.0000	1157.60	218	0.956
Dutch Mountain 4	Wyoming	1	444.90	0.0005	7862.37	0.0000	1932.70	42	0.964
Dutch Mountain 5	Wyoming	0	385.50	0.0006	8452.92	0.0000	946.90	88	0.965
Jenningsville 1	Wyoming	0	259.10	0.0007	13997.25	0.0000			0.904
Jenningsville 1N	Wyoming	1	2061.80	0.0007	12393.23	0.0000	2026.70	318	0.925
Jenningsville 2N	Wyoming	1	1502.40	0.0006	12400.73	0.0000	1335.30		0.913
Meshoppen 1	Wyoming	0	414.20	0.0013	8617.82	0.0000	426.60	402	0.798
Meshoppen 1N	Wyoming	1	831.80	0.0013	8763.22	0.0000	414.50	455	0.778
Meshoppen 2N	Wyoming	1	202.60	0.0009	10486.80	0.0000	261.40	334	0.870
Noxen	Wyoming	0	2203.10	0.0007	13030.57	0.0000	2108.50	655	0.937
Noxen 1	Wyoming	1	1328.50	0.0007	9656.14	0.0000	1428.60	247	0.925
Noxen 10	Wyoming	1	1025.90	0.0008	10649.31	0.0000	911.20	268	0.958
Noxen 10N	Wyoming	1	1702.40	0.0008	11205.63	0.0000	1716.00	344	0.961
Noxen 1N	Wyoming	1	1273.90	0.0008	12692.77	0.0000	1318.20	439	0.955
Noxen 2	Wyoming	1	911.60	0.0005	13087.59	0.0000	558.00	243	0.949
Noxen 2N	Wyoming	1	1317.10	0.0008	12992.57	0.0000	1312.30	624	0.929

Noxen 3	Wyoming	0	1320.80	0.0005	13011.71	0.0000	1328.30	216	0.961
Noxen 3N	Wyoming	1	1335.40	0.0005	12391.78	0.0000	1343.50	208	0.968
Noxen 4	Wyoming	1	711.20	0.0008	9559.28	0.0000	593.50	477	0.914
Noxen 4N	Wyoming	1	1882.00	0.0004	14165.07	0.0000	1704.50	154	0.977
Noxen 5	Wyoming	0	2445.70	0.0004	14364.49	0.0000	1497.40	183	0.976
Noxen 5N	Wyoming	1	955.30	0.0012	12570.92	0.0000	925.90	912	0.881
Noxen 6N	Wyoming	1	934.80	0.0005	10707.81	0.0000	521.00	224	0.947
Noxen 7	Wyoming	0	1649.60	0.0008	12814.95	0.0000	1535.80	738	0.914
Noxen 7N	Wyoming	1	1625.90	0.0008	11145.25	0.0000	1575.30	363	0.959
Noxen 8	Wyoming	1	1280.70	0.0010	12783.07	0.0000	1249.50	865	0.897
Noxen 8N	Wyoming	1	299.40	0.0010	8074.57	0.0000	1071.00	427	0.894
Noxen 9	Wyoming	0	1746.90	0.0007	13753.02	0.0000	1800.80	597	0.936
Noxen 9N	Wyoming	1	296.00	0.0014	12346.09	0.0000	358.80	1152	0.832
Tunkannock 1N	Wyoming	1	244.80	0.0024	3519.70	0.0001	364.50	2669	0.701

Appendix B: Descriptive Statistics

Appendix XIX. Descriptive statistics of factors at the 50m buffer zone for Model 1.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2445.7	720.7	116
Road Density (m/m^2)	0.000	0.0090	0.0001	118
Nearest Trail (m)	3.40	14548.48	5043.22	117
Trail Density (m/m^2)	0.0000	0.0284	0.0005	118
Nearest Building (m)	51.50	3311.77	883.32	115
Total Buildings	0	0	0	118
Canopy Cover	0.286	1	0.947	117

Appendix XX. Descriptive statistics of factors at the 400m buffer zone for Model 1.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.90	2445.70	720.76	116
Road Density (m/m^2)	0.0000	0.0036	0.0004	118
Nearest Trail (m)	3.40	14548.48	5043.22	117
Trail Density (m/m^2)	0.0000	0.0053	0.0006	118
Nearest Building (m)	51.50	3311.77	883.32	115
Total Buildings	0	16	1.14	115
Canopy Cover	0.638	1.000	0.947	117

Appendix XXI. Descriptive statistics of factors at the 5000m buffer zone for Model 1.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2445.7	764.4	101
Road Density (m/m^2)	0.0003	0.0040	0.0013	102
Nearest Trail (m)	3.40	14548.48	5177.06	102
Trail Density (m/m^2)	0.0000	0.0015	0.0002	102
Nearest Building (m)	78.10	3311.77	936.45	96
Total Buildings	42	15706	1871.03	95
Canopy Cover	0.584	0.977	0.885	101

Appendix XXII. Descriptive statistics of factors at the 50m buffer zone for Model 2.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2061.8	737.5	77
Road Density (m/m^2)	0.0000	0.0090	0.0001	79
Nearest Trail (m)	3.40	14517.33	5182.67	78
Trail Density (m/m^2)	0.0000	0.0284	0.0007	79
Nearest Building (m)	51.50	3311.77	913.12	77
Total Buildings	0	0	0	79
Canopy Cover	0.4167	1.000	0.934	78

Appendix XXIII. Descriptive statistics of factors at the 400m buffer zone for Model 2.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2061.8	737.5	77
Road Density (m/m^2)	0.0000	0.0031	0.0004	79
Nearest Trail (m)	3.40	14517.33	5182.67	78
Trail Density (m/m^2)	0.0000	0.0053	0.0005	79
Nearest Building (m)	51.50	3311.77	913.12	77
Total Buildings	0	12	0.666	78
Canopy Cover	0.677	1.000	0.954	78

Appendix XXIV. Descriptive statistics of factors at the 5000m buffer zone for Model 2.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2061.8	796.1	64
Road Density (m/m^2)	0.0004	0.0035	0.0013	65
Nearest Trail (m)	3.40	14517.33	5390.93	65
Trail Density (m/m^2)	0.0000	0.0013	0.0002	65
Nearest Building (m)	78.16	3311.77	985.90	64
Total Buildings	42	7591	1675.58	63
Canopy Cover	0.701	0.976	0.891	64

Appendix XXV. Descriptive statistics of factors at the 50m buffer zone for Model 3.

	Present				Absent			
	Min	Max	Mean	Count	Min	Max	Mean	Count
Nearest Road	29.9	2061.8	737.5	77	88.5	2445.7	687.69	39
Road Density	0.0000	0.0090	0.0001	79	0.0000	0.0000	0.0000	39
Nearest Trail	3.4	14517.34	5182.67	78	87.3	14548.48	4764.34	39
Trail Density	0.0000	0.2849	0.0007	79	0.0000	0.0000	0.0000	39
Nearest Building	51.50	3311.77	913.12	77	98.70	2253.40	822.94	38
Total Buildings	0	0	0	79	0	0	0	39
Canopy Cover	0.416	1.000	0.934	78	0.286	1.000	0.972	39

Appendix XXVI. Descriptive statistics of factors at the 400m buffer zone for Model 3.

	Present				Absent			
	Min	Max	Mean	Count	Min	Max	Mean	Count
Nearest Road	29.9	2061.8	737.5	77	88.5	2445.7	687.6	39
Road Density	0.0000	0.0031	0.0004	79	0.0000	0.0036	0.0005	39
Nearest Trail	3.40	14517.34	5182.67	78	87.30	14548.48	4764.34	39
Trail Density	0.0000	0.0053	0.0005	79	0.0000	0.0052	0.0008	39
Nearest Building	51.50	3311.77	913.12	77	98.70	2253.40	822.94	38
Total Buildings	0	12	0.667	78	0	16	2.102	39
Canopy Cover	0.677	1.000	0.954	78	0.638	1.000	0.933	39

Appendix XXVII. Descriptive statistics of factors at the 5000m buffer zone for Model 3.

	Present				Absent			
	Min	Max	Mean	Count	Min	Max	Mean	Count
Nearest Road	29.9	2061.8	796.12	64	88.5	2445.7	709.54	37
Road Density	0.0004	0.0035	0.0013	65	0.0003	0.0040	0.0013	37
Nearest Trail	3.40	14517.34	5390.93	65	87.30	14548.48	4801.33	37
Trail Density	0.0000	0.0013	0.0002	65	0.0000	0.0015	0.0003	37
Nearest Building	78.16	3311.77	985.93	64	146.76	2253.40	837.50	32
Total Buildings	42	7591	1675.58	63	84	15706	2255.81	32
Canopy Cover	0.701	0.976	0.891	64	0.584	0.977	0.875	37

Appendix XXVIII. Descriptive statistics of factors at the 50m buffer zone for Model 4.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2445.7	767.9	89
Road Density (m/m^2)	0.0000	0.0090	0.0001	90
Nearest Trail (m)	21.60	14548.47	5676.42	90
Trail Density (m/m^2)	0.0000	0.0227	0.0003	90
Nearest Building (m)	78.16	3311.77	913.34	88
Total Buildings	0	0	0	90
Canopy Cover	0.286	1.000	0.962	89

Appendix XXIX. Descriptive statistics of factors at the 400m buffer zone for Model 4.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2445.7	767.9	89
Road Density (m/m^2)	0.0000	0.0031	0.0004	90
Nearest Trail (m)	21.6	14548.4756	5676.423	90
Trail Density (m/m^2)	0.0000	0.0053	0.0007	90
Nearest Building (m)	78.16	3311.77	913.34	88
Total Buildings	0	16	0.9438	89
Canopy Cover	0.677	1.000	0.944	89

Appendix XXX. Descriptive statistics of factors at the 5000m buffer zone for Model 4.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2445.7	770.8	88
Road Density (m/m^2)	0.0003	0.0040	0.0013	89
Nearest Trail (m)	21.60	14548.47	530.45	89
Trail Density (m/m^2)	0.0000	0.0015	0.0002	89
Nearest Building (m)	78.16	3311.77	914.54	83
Total Buildings	42	15706	1904.3048	82
Canopy Cover	0.584	0.977	0.884	88

Appendix XXXI. Descriptive statistics of factors at the 50m buffer zone for Model 5.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2061.8	809.4	52
Road Density (m/m^2)	0.000	0.0090	0.0001	53
Nearest Trail (m)	21.60	14517.33	6287.33	53
Trail Density (m/m^2)	0.0000	0.0227	0.0006	53
Nearest Building (m)	78.16	3311.77	953.65	52
Total Buildings	0	0	0	53
Canopy Cover	0.416	1.000	0.953	52

Appendix XXXII. Descriptive statistics of factors at the 400m buffer zone for Model 5.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2061.8	809.4	52
Road Density (m/m^2)	0.0000	0.0031	0.0003	53
Nearest Trail (m)	21.60	14517.33	6287.33	53
Trail Density (m/m^2)	0.0000	0.0053	0.0007	53
Nearest Building (m)	78.16	3311.77	953.65	52
Total Buildings	0	6	0.3269	52
Canopy Cover	0.677	1.000	0.947	52

Appendix XXXIII. Descriptive statistics of factors at the 5000m buffer zone for Model 5.

	Min.	Max.	Mean	Count
Nearest Road (m)	29.9	2061.8	815.3	51
Road Density (m/m^2)	0.0004	0.0035	0.0013	52
Nearest Trail (m)	21.60	14517.33	6391.55	52
Trail Density (m/m^2)	0.0000	0.0013	0.0002	52
Nearest Building (m)	78.16	3311.77	962.88	51
Total Buildings	42	7591	1679.34	50
Canopy Cover	0.701	0.976	0.890	51

Appendix XXXIV. Descriptive statistics of factors at the 50m buffer zone for Model 6.

	Present				Absent			
	Min	Max	Mean	Count	Min	Max	Mean	Count
Nearest Road	29.9	2061.8	809.4	52	88.5	2445.7	709.5	37
Road Density	0.0000	0.0090	0.0001	53	0.0000	0.0000	0.0000	37
Nearest Trail	21.60	14517.34	6287.33	53	87.30	14548.48	4801.33	37
Trail Density	0.0000	0.0227	0.0006	53	0.0000	0.0000	0.0000	37
Nearest Building	78.16	3311.77	953.65	52	146.76	2253.40	855.11	36
Total Buildings	0	0	0	53	0	0	0	37
Canopy Cover	0.416	1.000	0.953	52	0.286	1.000	0.975	37

Appendix XXXV. Descriptive statistics of factors at the 400m buffer zone for Model 6.

	Present				Absent			
	Min	Max	Mean	Count	Min	Max	Mean	Count
Nearest Road	29.9	2061.8	809.4	52	88.5	2445.7	709.5	37
Road Density	0.0000	0.0031	0.0003	53	0.0000	0.0022	0.0004	37
Nearest Trail	21.60	14517.34	6287.33	53	87.30	14548.48	4801.33	37
Trail Density	0.0000	0.0053	0.0007	53	0.0000	0.0052	0.0009	37
Nearest Building	78.16	3311.77	953.65	52	146.76	2253.40	885.11	36
Total Buildings	0	6	0.3269	52	0	16	1.8108	37
Canopy Cover	0.677	1.000	0.947	52	0.740	1.000	0.939	37

Appendix XXXVI. Descriptive statistics of factors at the 5000m buffer zone for Model 6.

	Present				Absent			
	Min	Max	Mean	Count	Min	Max	Mean	Count
Nearest Road	29.9	2061.8	815.3	51	88.5	2445.7	709.5	37
Road Density	0.0004	0.0035	0.0013	52	0.0003	0.0040	0.0013	37
Nearest Trail	21.60	14517.34	6391.55	52	87.30	14548.48	4801.33	37
Trail Density	0.0000	0.0013	0.0002	52	0.0000	0.0015	0.0003	37
Nearest Building	78.16	3311.77	962.88	51	146.76	2253.40	837.50	32
Total Buildings	42	7591	1679.34	50	84	15706	2255.81	32
Canopy Cover	0.701	0.976	0.890	51	0.584	0.977	0.875	37

Appendix C: Raw Data for Random Points

Appendix XXXVII. Raw data at the 50m buffer zone for the one-hundred random points.

OID	Near Road (m)	Road Density (m/m^2)	Near Trail (m)	Trail Density (m/m^2)	Canopy
1	317.611	0.0000	7002.931	0.0000	1
2	281.638	0.0000	2318.486	0.0000	0
3	200.433	0.0000	1465.068	0.0000	0
4	208.680	0.0000	864.769	0.0000	1
5	362.259	0.0000	6441.596	0.0000	1
6	6.572	0.0260	5170.337	0.0000	0
7	609.840	0.0000	3475.755	0.0000	1
8	65.323	0.0000	688.438	0.0000	1
9	262.126	0.0000	5682.931	0.0000	1
10	191.663	0.0000	5230.337	0.0000	0
11	164.866	0.0000	1609.948	0.0000	1
12	19.987	0.0103	2119.352	0.0000	1
13	807.379	0.0000	851.974	0.0000	1
14	250.808	0.0000	4806.914	0.0000	1
15	955.744	0.0000	2162.231	0.0000	1
16	230.234	0.0000	3270.166	0.0000	1
17	231.544	0.0000	4674.978	0.0000	1
18	134.333	0.0000	7106.927	0.0000	1
19	8.777	0.0169	610.497	0.0000	0
20	224.096	0.0000	2229.744	0.0000	1
21	309.330	0.0000	2038.842	0.0000	1
22	165.948	0.0000	4816.098	0.0000	0
23	247.073	0.0000	4266.310	0.0000	0
24	611.067	0.0000	3021.257	0.0000	1
25	287.561	0.0000	8414.501	0.0000	1
26	23.488	0.0121	2923.158	0.0000	1
27	152.254	0.0000	1015.181	0.0000	1
28	192.126	0.0000	9418.221	0.0000	0
29	389.770	0.0000	8962.951	0.0000	1
30	369.355	0.0000	948.005	0.0000	0
31	77.358	0.0000	2180.727	0.0000	0
32	224.258	0.0000	6500.430	0.0000	0
33	160.333	0.0000		0.0000	0
34	1266.637	0.0000	3477.072	0.0000	1
35	376.449	0.0000	1894.005	0.0000	1
36	13.570	0.0209	977.777	0.0000	1

37	279.946	0.0000	7562.989	0.0000	1
38	183.525	0.0000	4203.417	0.0000	0
39	103.438	0.0000	2775.681	0.0000	1
40	29.224	0.0096	5991.501	0.0000	1
41	16.358	0.0118	5765.601	0.0000	1
42	1214.028	0.0000	1214.028	0.0000	1
43	573.185	0.0000	6396.252	0.0000	0
44	0.848	0.0127	4740.591	0.0000	0
45	1.449	0.0127	11844.386	0.0000	1
46	509.851	0.0000	7186.755	0.0000	1
47	521.752	0.0000	1517.770	0.0000	1
48	58.684	0.0000	1656.206	0.0000	1
49	10.742	0.0124	8.401	0.0124	1
50	111.226	0.0000	4457.615	0.0000	0
51	382.102	0.0000	3502.248	0.0000	0
52	898.659	0.0000	1803.675	0.0000	1
53	121.305	0.0000	3947.865	0.0000	0
54	1209.785	0.0000	344.456	0.0000	0
55	24.228	0.0111	746.917	0.0000	1
56	335.662	0.0000		0.0000	1
57	419.114	0.0000	4345.209	0.0000	1
58	32.037	0.0097	9483.457	0.0000	0
59	46.982	0.0044	182.839	0.0000	0
60	16.420	0.0238	1478.742	0.0000	0
61	40.983	0.0073	976.086	0.0000	1
62	642.378	0.0000	2178.282	0.0000	1
63	324.034	0.0000	2161.443	0.0000	0
64	194.685	0.0000	1936.630	0.0000	0
65	51.827	0.0000	1912.481	0.0000	0
66	5.480	0.0085	6491.087	0.0000	1
67	1021.497	0.0000	3439.948	0.0000	1
68	64.451	0.0000	2748.798	0.0000	1
69	226.200	0.0000	12526.513	0.0000	0
70	37.215	0.0056	9499.331	0.0000	1
71	67.434	0.0000	1969.470	0.0000	1
72	125.081	0.0000	478.536	0.0000	0
73	280.816	0.0000	656.508	0.0000	1
74	370.852	0.0000	3611.278	0.0000	1
75	65.894	0.0000	11529.944	0.0000	1
76	313.173	0.0000	4014.770	0.0000	0

77	382.552	0.0000	6297.893	0.0000	0
78	8.830	0.0231	2213.728	0.0000	0
79	159.744	0.0000	13125.969	0.0000	0
80	883.685	0.0000	46.622	0.0091	1
81	305.096	0.0000	3053.198	0.0000	0
82	11.684	0.0122	9710.952	0.0000	0
83	31.891	0.0170	1318.368	0.0000	1
84	357.126	0.0000	3688.058	0.0000	1
85	178.547	0.0000	4806.953	0.0000	1
86	619.812	0.0000	2527.002	0.0000	1
87	421.248	0.0000	548.340	0.0000	1
88	6.779	0.0247	6.779	0.0126	0
89	325.472	0.0000	7321.144	0.0000	1
90	54.077	0.0000	4441.603	0.0000	1
91	105.965	0.0000	6302.265	0.0000	0
92	134.047	0.0000	1814.767	0.0000	1
93	361.517	0.0000	3344.854	0.0000	1
94	264.575	0.0000	5818.811	0.0000	1
95	205.869	0.0000	935.916	0.0000	1
96	172.915	0.0000	2059.987	0.0000	0
97	56.489	0.0000	167.100	0.0000	1
98	78.242	0.0000	4876.436	0.0000	1
99	379.066	0.0000	4619.210	0.0000	1
100	65.529	0.0000	8899.716	0.0000	1

Appendix XXXVIII. Raw data at the 400m buffer zone for the one-hundred random points.

OID	Near Road (m)	Road Density (m/m^2)	Near Trail (m)	Trail Density (m/m^2)	Canopy
1	317.611	0.00193	7002.931	0.00000	1
2	281.638	0.00035	2318.486	0.00000	0
3	200.433	0.00399	1465.068	0.00000	0
4	208.680	0.00156	864.769	0.00000	1
5	362.259	0.00076	6441.596	0.00000	1
6	6.572	0.00325	5170.337	0.00000	0
7	609.840	0.00000	3475.755	0.00000	1
8	65.323	0.00779	688.438	0.00000	1
9	262.126	0.00201	5682.931	0.00000	1
10	191.663	0.00220	5230.337	0.00000	0
11	164.866	0.00452	1609.948	0.00000	1
12	19.987	0.00902	2119.352	0.00000	1
13	807.379	0.00000	851.974	0.00000	1
14	250.808	0.00230	4806.914	0.00000	1
15	955.744	0.00000	2162.231	0.00000	1
16	230.234	0.00076	3270.166	0.00000	1
17	231.544	0.00131	4674.978	0.00000	1
18	134.333	0.00306	7106.927	0.00000	1
19	8.777	0.01183	610.497	0.00000	0
20	224.096	0.00151	2229.744	0.00000	1
21	309.330	0.00100	2038.842	0.00000	1
22	165.948	0.00220	4816.098	0.00000	0
23	247.073	0.00422	4266.310	0.00000	0
24	611.067	0.00000	3021.257	0.00000	1
25	287.561	0.00084	8414.501	0.00000	1
26	23.488	0.00410	2923.158	0.00000	1
27	152.254	0.00158	1015.181	0.00000	1
28	192.126	0.00176	9418.221	0.00000	0

29	389.770	0.00037	8962.951	0.00000	1
30	369.355	0.00056	948.005	0.00000	0
31	77.358	0.00501	2180.727	0.00000	0
32	224.258	0.00243	6500.430	0.00000	0
33	160.333	0.00333		0.00000	0
34	1266.637	0.00000	3477.072	0.00000	1
35	376.449	0.00093	1894.005	0.00000	1
36	13.570	0.01188	977.777	0.00000	1
37	279.946	0.00229	7562.989	0.00000	1
38	183.525	0.00206	4203.417	0.00000	0
39	103.438	0.00195	2775.681	0.00000	1
40	29.224	0.00414	5991.501	0.00000	1
41	16.358	0.00626	5765.601	0.00000	1
42	1214.028	0.00000	1214.028	0.00000	1
43	573.185	0.00000	6396.252	0.00000	0
44	0.848	0.00259	4740.591	0.00000	0
45	1.449	0.00165	11844.386	0.00000	1
46	509.851	0.00000	7186.755	0.00000	1
47	521.752	0.00000	1517.770	0.00000	1
48	58.684	0.00387	1656.206	0.00000	1
49	10.742	0.00486	8.401	0.00171	1
50	111.226	0.00436	4457.615	0.00000	0
51	382.102	0.00047	3502.248	0.00000	0
52	898.659	0.00000	1803.675	0.00000	1
53	121.305	0.00241	3947.865	0.00000	0
54	1209.785	0.00000	344.456	0.00033	0
55	24.228	0.00496	746.917	0.00000	1
56	335.662	0.00086		0.00000	1
57	419.114	0.00000	4345.209	0.00000	1
58	32.037	0.00654	9483.457	0.00000	0
59	46.982	0.00646	182.839	0.00111	0

60	16.420	0.01007	1478.742	0.00000	0
61	40.983	0.01008	976.086	0.00000	1
62	642.378	0.00000	2178.282	0.00000	1
63	324.034	0.00121	2161.443	0.00000	0
64	194.685	0.00461	1936.630	0.00000	0
65	51.827	0.00724	1912.481	0.00000	0
66	5.480	0.00424	6491.087	0.00000	1
67	1021.497	0.00000	3439.948	0.00000	1
68	64.451	0.00732	2748.798	0.00000	1
69	226.200	0.00174	12526.513	0.00000	0
70	37.215	0.00081	9499.331	0.00000	1
71	67.434	0.00290	1969.470	0.00000	1
72	125.081	0.00145	478.536	0.00000	0
73	280.816	0.00122	656.508	0.00000	1
74	370.852	0.00041	3611.278	0.00000	1
75	65.894	0.00312	11529.944	0.00000	1
76	313.173	0.00140	4014.770	0.00000	0
77	382.552	0.00007	6297.893	0.00000	0
78	8.830	0.02131	2213.728	0.00000	0
79	159.744	0.00176	13125.969	0.00000	0
80	883.685	0.00000	46.622	0.00347	1
81	305.096	0.00199	3053.198	0.00000	0
82	11.684	0.00265	9710.952	0.00000	0
83	31.891	0.00452	1318.368	0.00000	1
84	357.126	0.00060	3688.058	0.00000	1
85	178.547	0.00260	4806.953	0.00000	1
86	619.812	0.00000	2527.002	0.00000	1
87	421.248	0.00000	548.340	0.00000	1
88	6.779	0.00507	6.779	0.00159	0
89	325.472	0.00015	7321.144	0.00000	1
90	54.077	0.00356	4441.603	0.00000	1

91	105.965	0.00211	6302.265	0.00000	0
92	134.047	0.00156	1814.767	0.00000	1
93	361.517	0.00011	3344.854	0.00000	1
94	264.575	0.00289	5818.811	0.00000	1
95	205.869	0.00547	935.916	0.00000	1
96	172.915	0.00642	2059.987	0.00000	0
97	56.489	0.00500	167.100	0.00126	1
98	78.242	0.00224	4876.436	0.00000	1
99	379.066	0.00005	4619.210	0.00000	1
100	65.529	0.00311	8899.716	0.00000	1

Appendix XXXIX. Raw data at the 5000m buffer zone for the one-hundred random points.

OID	Near Road (m)	Road Density (m/m^2)	Near Trail (m)	Trail Density (m/m^2)	Canopy
1	317.611	0.00306	7002.931	0.00000	1
2	281.638	0.00367	2318.486	0.00017	0
3	200.433	0.01199	1465.068	0.00017	0
4	208.680	0.00498	864.769	0.00048	1
5	362.259	0.00459	6441.596	0.00000	1
6	6.572	0.00390	5170.337	0.00000	0
7	609.840	0.00746	3475.755	0.00040	1
8	65.323	0.00163	688.438	0.00017	1
9	262.126	0.00745	5682.931	0.00000	1
10	191.663	0.00388	5230.337	0.00000	0
11	164.866	0.00455	1609.948	0.00014	1
12	19.987	0.00484	2119.352	0.00011	1
13	807.379	0.00256	851.974	0.00112	1
14	250.808	0.00414	4806.914	0.00004	1
15	955.744	0.00874	2162.231	0.00045	1
16	230.234	0.00220	3270.166	0.00018	1
17	231.544	0.00677	4674.978	0.00026	1
18	134.333	0.00245	7106.927	0.00000	1
19	8.777	0.00656	610.497	0.00016	0
20	224.096	0.00319	2229.744	0.00173	1
21	309.330	0.00233	2038.842	0.00010	1
22	165.948	0.00368	4816.098	0.00001	0
23	247.073	0.00341	4266.310	0.00019	0
24	611.067	0.00444	3021.257	0.00017	1
25	287.561	0.00277	8414.501	0.00000	1
26	23.488	0.00488	2923.158	0.00031	1
27	152.254	0.00117	1015.181	0.00115	1
28	192.126	0.00529	9418.221	0.00000	0
29	389.770	0.00433	8962.951	0.00000	1
30	369.355	0.00454	948.005	0.00038	0
31	77.358	0.00283	2180.727	0.00011	0
32	224.258	0.00640	6500.430	0.00000	0
33	160.333	0.00215		0.00000	0
34	1266.637	0.00103	3477.072	0.00007	1
35	376.449	0.00617	1894.005	0.00093	1
36	13.570	0.00662	977.777	0.00019	1
37	279.946	0.00282	7562.989	0.00000	1

38	183.525	0.00873	4203.417	0.00003	0
39	103.438	0.00503	2775.681	0.00030	1
40	29.224	0.00744	5991.501	0.00000	1
41	16.358	0.01018	5765.601	0.00000	1
42	1214.028	0.00172	1214.028	0.00039	1
43	573.185	0.00772	6396.252	0.00000	0
44	0.848	0.00351	4740.591	0.00007	0
45	1.449	0.00040	11844.386	0.00000	1
46	509.851	0.00225	7186.755	0.00000	1
47	521.752	0.00733	1517.770	0.00071	1
48	58.684	0.00329	1656.206	0.00034	1
49	10.742	0.00312	8.401	0.00018	1
50	111.226	0.00280	4457.615	0.00005	0
51	382.102	0.00411	3502.248	0.00012	0
52	898.659	0.00310	1803.675	0.00165	1
53	121.305	0.00426	3947.865	0.00025	0
54	1209.785	0.00474	344.456	0.00117	0
55	24.228	0.00588	746.917	0.00093	1
56	335.662	0.00292		0.00000	1
57	419.114	0.00107	4345.209	0.00007	1
58	32.037	0.00335	9483.457	0.00000	0
59	46.982	0.00613	182.839	0.00042	0
60	16.420	0.01428	1478.742	0.00017	0
61	40.983	0.00404	976.086	0.00106	1
62	642.378	0.00277	2178.282	0.00038	1
63	324.034	0.00214	2161.443	0.00024	0
64	194.685	0.01295	1936.630	0.00020	0
65	51.827	0.00662	1912.481	0.00003	0
66	5.480	0.00388	6491.087	0.00000	1
67	1021.497	0.00219	3439.948	0.00005	1
68	64.451	0.00237	2748.798	0.00017	1
69	226.200	0.00296	12526.513	0.00000	0
70	37.215	0.00177	9499.331	0.00000	1
71	67.434	0.00359	1969.470	0.00043	1
72	125.081	0.00404	478.536	0.00025	0
73	280.816	0.00689	656.508	0.00088	1
74	370.852	0.01000	3611.278	0.00012	1
75	65.894	0.00433	11529.944	0.00000	1
76	313.173	0.00445	4014.770	0.00022	0
77	382.552	0.00339	6297.893	0.00000	0

78	8.830	0.00551	2213.728	0.00050	0
79	159.744	0.00291	13125.969	0.00000	0
80	883.685	0.00336	46.622	0.00093	1
81	305.096	0.00341	3053.198	0.00048	0
82	11.684	0.00266	9710.952	0.00000	0
83	31.891	0.00564	1318.368	0.00013	1
84	357.126	0.00350	3688.058	0.00022	1
85	178.547	0.00330	4806.953	0.00001	1
86	619.812	0.00202	2527.002	0.00026	1
87	421.248	0.00134	548.340	0.00033	1
88	6.779	0.00238	6.779	0.00016	0
89	325.472	0.00225	7321.144	0.00000	1
90	54.077	0.00306	4441.603	0.00022	1
91	105.965	0.00190	6302.265	0.00000	0
92	134.047	0.00435	1814.767	0.00008	1
93	361.517	0.00945	3344.854	0.00056	1
94	264.575	0.00750	5818.811	0.00000	1
95	205.869	0.00397	935.916	0.00049	1
96	172.915	0.00547	2059.987	0.00016	0
97	56.489	0.00309	167.100	0.00046	1
98	78.242	0.00286	4876.436	0.00005	1
99	379.066	0.00283	4619.210	0.00019	1
100	65.529	0.00323	8899.716	0.00000	1

Appendix D: Descriptive Statistics for Random Points

Appendix XL. Descriptive statistics of factors at the 50m buffer zone for the random points.

	Min	Max	Mean	Count
Nearest Road	0.8484	1266.63	269.03	100
Road Density	0	0.026	0.0029	100
Nearest Trail	6.779	13125.97	3917.05	98
Trail Density	0	0.0125	0.000341	100
Canopy	0	1	0.64	100

Appendix XLI. Descriptive statistics of factors at the 400m buffer zone for the random points.

	Min	Max	Mean	Count
Nearest Road	0.8484	1266.63	269.03	100
Road Density	0	0.0213	0.00285	100
Nearest Trail	6.779	13125.97	3917.05	98
Trail Density	0	0.00347	0.00009468	100
Canopy	0	1	0.64	100

Appendix XLII. Descriptive statistics of factors at the 5000m buffer zone for the random points.

	Min	Max	Mean	Count
Nearest Road	0.8484	1266.63	269.03	100
Road Density	0.000398	0.0142	0.00441	100
Nearest Trail	6.779	13125.97	3917.05	98
Trail Density	0	0.00173	0.000253	100
Canopy	0	1	0.64	100

Appendix E: R-Squared and AIC Values

Appendix XLIII. R-Squared and AIC values for all models, sorted by model number, then by spatial scale. Note that GLMs do not give an R-squared value.

	R- Squared	AIC
Model 1 50m	0.0234	806.53
Model 1 400m	-0.0050	810.73
Model 1 5000m	0.0879	677.678
Model 2 50m	0.0302	562.81
Model 2 400m	0.0348	563.34
Model 2 5000m	0.1097	468.03
Model 3 50m	-	128.75
Model 3 400m	-	152.33
Model 3 5000m	-	128.75
Model 4 50m	0.0557	648.38
Model 4 400m	-0.0337	643.89
Model 4 5000m	0.1220	592.02
Model 5 50m	0.1000	394.96
Model 5 400m	0.0385	399.19
Model 5 5000m	0.2210	375.34
Model 6 50m	-	124.15
Model 6 400m	-	121.16
Model 6 5000m	-	118.15

Appendix XLIV. R-Squared and AIC Values for all models sorted by spatial scale followed by model number. Note that GLMs do not give an R-squared value.

	R- Squared	AIC
Model 1 50m	0.0234	806.53
Model 2 50m	0.0302	562.81
Model 3 50m	-	128.75
Model 4 50m	0.0557	648.38
Model 5 50m	0.1000	394.96
Model 6 50m	-	124.15
Model 1 400m	-0.0050	810.73
Model 2 400m	0.0348	563.34
Model 3 400m	-	152.33
Model 4 400m	-0.0337	643.89
Model 5 400m	0.0385	399.19
Model 6 400m	-	121.16
Model 1 5000m	0.0879	677.67
Model 2 5000m	0.1097	468.03
Model 3 5000m	-	128.75
Model 4 5000m	0.1220	592.02
Model 5 5000m	0.2210	375.34
Model 6 5000m	-	118.15

Appendix F: Significant Factors

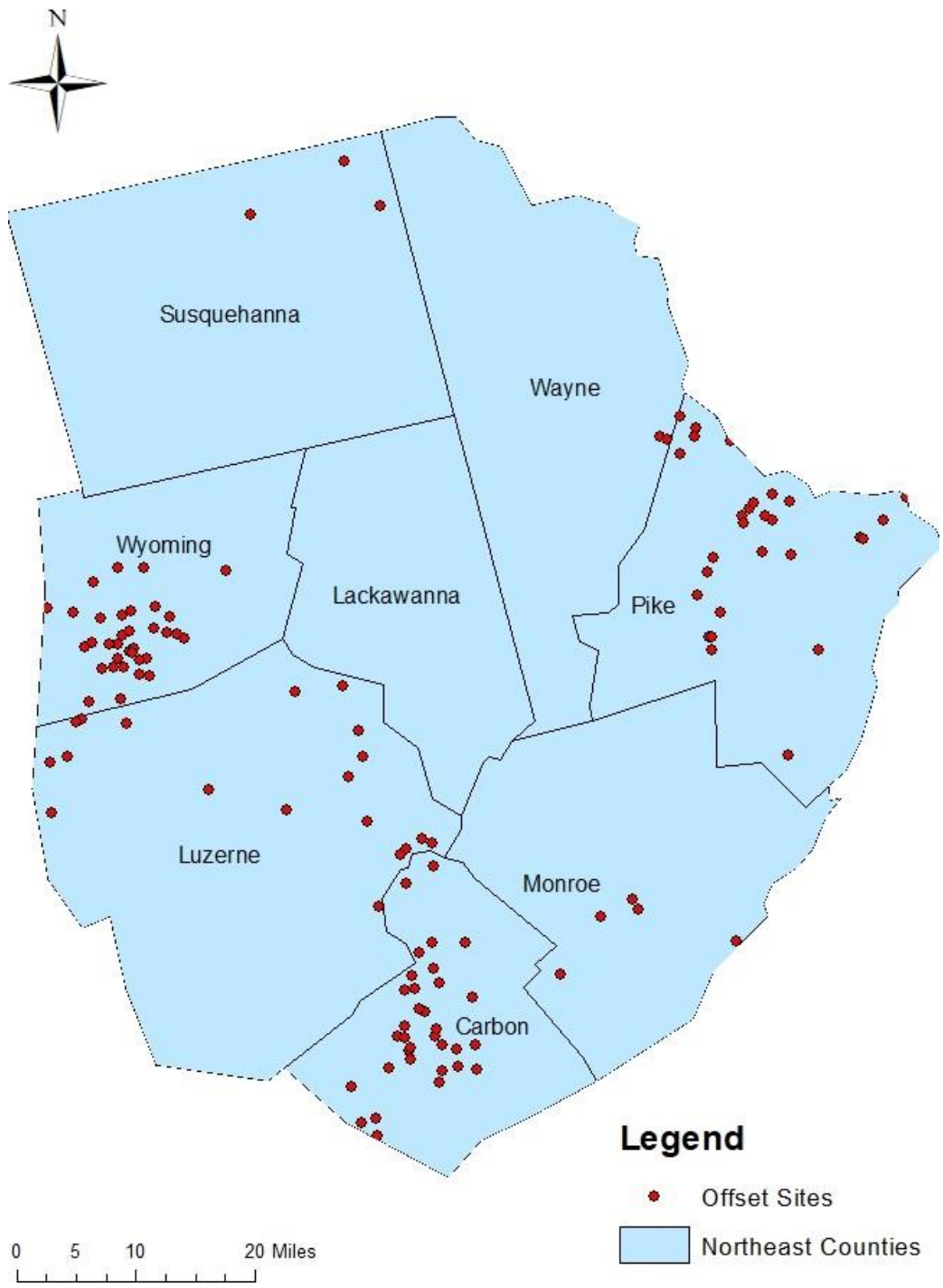
Appendix XLV. All models shown ordered by spatial scale with an 'X' indicating factors that showed a significant relationship with population size.

	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Model 1 50m					X	-	
Model 1 400m							
Model 1 5000m					X	X	
Model 2 50m					X	-	
Model 2 400m					X		
Model 2 5000m					X		
Model 3 50m						-	
Model 3 400m						X	
Model 3 5000m							
Model 4 50m				X		-	
Model 4 400m							
Model 4 5000m						X	X
Model 5 50m					X	-	
Model 5 400m					X		
Model 5 5000m		X				X	X
Model 6 50m						-	
Model 6 400m							
Model 6 5000m							

Appendix XLVI. All models shown ordered by model number with an 'X' indicating factors that showed a significant relationship with population size.

	Nearest Road	Road Density	Nearest Trail	Trail Density	Nearest Building	Buildings Within	Canopy Percent
Model 1 50m					X	-	
Model 2 50m					X	-	
Model 3 50m						-	
Model 4 50m				X		-	
Model 5 50m					X	-	
Model 6 50m						-	
Model 1 400m							
Model 2 400m					X		
Model 3 400m						X	
Model 4 400m							
Model 5 400m					X		
Model 6 400m							
Model 1 5000m					X	X	
Model 2 5000m					X		
Model 3 5000m							
Model 4 5000m						X	X
Model 5 5000m		X				X	X
Model 6 5000m							

Appendix G: TRAP Sites



Appendix XLVII. Rattlesnake sites in the Northeast produced by TRAP through the PFBC. Sites are randomly offset from actual locations by up to 5000m to minimize the potential of poaching activity from this work.