Role of predators, winter weather, and habitat on white-tailed deer fawn survival in the south-central Upper Peninsula of Michigan

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Abstract– We collected 545 locations from radiocollared adult female deer this quarter; and 40 were alive through 15 December. We collected 34 locations from radiocollared yearling deer (2009 fawns); 2 remained alive through 15 December. We collected 250 locations from fawns collared in 2010; 24 were alive through 15 December. No radiocollared adult female or yearling mortalities occurred during the quarter, but 2 mortalities of fawns captured in 2010 occurred, 1 from wolves and 1 harvested during firearm season. Six males ear-tagged as fawns in 2009 were reported harvested during deer firearm season. Mean age for females radiocollared in 2010 (n = 27) was 6 years. We obtained 6,749 images of deer from 55 remote infrared cameras during 1 September-8 October 2010 to estimate deer abundance in the study area. This quarter, we collected 26,377 bear locations, 2,085 bobcat locations, 10,839 coyote locations, and 6,860 wolf locations. Five active beaver caches were located in 712 km of rivers and streams that were aerially searched. Howl surveys yielded a coyote response rate (RR) of 23.6% and wolf RR of 0% to the coyote group-yip howl and a 23.6% RR from coyotes and 3.6% RR from wolves to the lone wolf howl. We analyzed 43 scats (24 coyote and 19 wolf) this quarter. Forty-six alternative prey and deer observations were recorded. Project personnel provided public outreach programs and several popular articles were published. Project personnel had 3 peer-reviewed manuscripts accepted or in preparation for journal publication.

Summary

- This quarter, 545 radiocollared adult female deer locations were collected, 40 females were alive through 15 December.
- This quarter, 34 radiocollared yearling (2009 fawns) locations were collected and 5 radiocollars dropped off yearlings and were retrieved, 2 yearlings were alive through 15 December.
- This quarter, 250 locations from fawns radiocollared in 2010 were collected, 24 fawns were alive through15 December.
- This quarter, no radiocollared adult female or yearling mortalities occurred, but 2 mortalities of 2010 fawns occurred, 1 wolf and 1 harvested during firearm season.
- Six males ear-tagged as fawns in 2009 were harvested and reported during firearm season.
- Mean age for does radiocollared in 2010 (n = 27) was 6 years.
- Fifty-five remote infrared cameras captured 6,749 images of deer from 1 September-8 October 2010 to estimate deer abundance in the study area.
- Nine flights this quarter and 35 flights in 2010 occurred to download GPS locations.
- This quarter, 26,377 bear locations, 2,085 bobcat locations, 10,839 coyote locations, and 6,860 wolf locations have been collected.
- Five active beaver caches were located in 712 km of rivers and streams that were aerially searched.
- Howl surveys yielded a coyote response rate (RR) of 23.6% to the coyote group-yip howl with no responses from wolves and a 23.6% and 3.6% RR was obtained from coyotes and wolves to the lone wolf howl, respectively.
- This quarter, 43 scats were analyzed (24 coyote and 19 wolf).
- This quarter, 46 alternative prey and deer observations were recorded.
- Project personnel provided public outreach programs and several popular articles were published.
- Project personnel had several peer-reviewed journal publications of study results accepted or prepared for journal submission.

Introduction:

Management of wildlife is based on an understanding, and in some cases, manipulation of factors that limit wildlife populations. Wildlife managers sometimes manipulate the effect of a limiting factor to allow a wildlife population to increase or decrease. White-tailed deer (*Odocoileus virginianus*) are an important wildlife species in North America providing many ecological, social, and economic values. Most generally, factors that can limit deer numbers include food supply, winter cover, disease, predation, weather, and hunter harvest. Deer numbers change with changes in these limiting factors.

White-tailed deer provide food, sport, income, and viewing opportunities to millions of Americans throughout the United States and are among the most visible and ecologically–important wildlife species in North America. They occur throughout Michigan at various densities, based on geographical region and habitat type. Michigan spans about 600 km from north to south. The importance of factors that limit deer populations vary along this latitudinal gradient. For example, winter severity and winter food availability have less impact on deer numbers in Lower Michigan than in Upper Michigan.

Quantifying the relative role of factors potentially limiting white-tailed deer recruitment and how the importance of these factors varies across this latitudinal gradient is critical for understanding deer demography and ensuring effective management strategies. Considerable research has been conducted demonstrating the effects of winter severity on white-tailed deer condition and survival (Ozoga and Gysel 1972, Moen 1976, DelGiudice et al. 2002). In addition, the importance of food supply and cover, particularly during winter, has been documented (Moen 1976, Taillon et al. 2006). Finally, the role of predation on white-tailed deer survival has received considerable attention (e.g., Ballard et al. 2001). However, few studies have simultaneously addressed the roles of limiting factors on white-tailed deer.

The overall goal of this project is to assess baseline reproductive parameters and the magnitude of cause-specific mortality and survival of white-tailed deer fawns, particularly mortality due to predation, in relation to other possible limiting mortality agents along a latitudinal gradient in Michigan. We will simultaneously assess effects of predation and winter severity and indirectly evaluate the influence of habitat conditions on fawn recruitment. Considering results from Lower Michigan (Pusateri Burroughs et al. 2006, Hiller 2007) as the southern extent of this gradient, we propose three additional study sites from south to north across Upper Michigan. Because of logistical and financial constraints, we propose to conduct work sequentially across these study areas. The following objectives are specific to the southern Upper Michigan study area but applicable to other study areas with varying predator suites.

Objectives:

1. Estimate survival and cause-specific mortality of white-tailed deer fawns and does.

2. Estimate proportion of fawn mortality attributable to black bear (*Ursus americanus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), and wolf (*Canis lupus*).

3. Estimate number and age of fawns killed by a bear, coyote, bobcat, or wolf during summer.

4. Provide updated information on white-tailed deer pregnancy and fecundity rates.

5. Estimate annual and seasonal resource use (e.g., habitat) and home range of white-tailed deer.

6. Estimate if familiarity of an area to each predator species affects the likelihood of fawn predation.

7. Assess if estimated composite bear, coyote, bobcat, and wolf use of an area influences fawn predation rates.

8. Describe association between fawn birth site habitat characteristics and black bear, coyote, bobcat, or wolf habitat use.

9. Estimate seasonal resource use (e.g., habitat, prey) and home range size of black bear, coyote, bobcat and wolf.

Study Area:

This study is centered on a ~900 km^2 (~350 mi^2) area within Deer Management Unit (DMU) 055 in Menominee County. The general study area is bordered on the east by the shoreline of Lake Michigan, on the north by US Highway 2, on the west by US Highway 41, and the south by the town of Stephenson. The core study area includes a mix of forested and agricultural lands and is where capture efforts occur. The overall study area consists of a minimum convex polygon that includes the composite locations of telemetered animals. This study area was selected because of the relatively low snowfall and generally low winter severity. Deer in this area are generally migrate only short distances or are non-migratory, making direct comparisons to southern Michigan (i.e., Pusateri Burroughs et al. 2006) easier.

Accomplishments:

Deer Telemetry

Locations of radiocollared adult females captured in 2009 and 2010 were monitored ≥1 time/week using aerial or ground telemetry. This quarter, we collected 545 locations from adult females. Forty adult females were being monitored as of 15 December. Overall, we collected 3,970 locations (median = 70; range = 1–149) from all radiocollared adults during 18 February 2009–1 December 2010.

Locations of fawns radiocollared in 2009 (i.e., yearlings in 2010) were also monitored ≥1 time/week using aerial telemetry. This quarter, we collected 34 radiolocations from this cohort. Overall, we collected 1,431 locations (median = 23; range = 1–81) from all deer radiocollared as fawns in 2009. Two individuals from this cohort were being monitored as of 30 November.

Locations of fawns radiocollared in 2010 were monitored ≥1 times/week using aerial or ground telemetry. This quarter, we collected 250 locations. Overall, we collected 1,412 locations (median = 36; range = 1–67) for all deer radiocollared as fawns in 2010. There were 24 fawns captured in 2010 being monitored as of 30 November and have a median of 41 locations (range = 23–67). Mortalities were investigated as soon as practical after receiving a mortality signal to estimate survival and cause-specific mortality.

Deer Mortality

This quarter, only 2 fawns radiocollared in 2010 died; 17 have died since 11 June 2010. One (female) in mid-September was attributed to wolf predation and the other (female) was harvested during firearm season. Additionally, 2 radiocollars of 2010 fawns likely failed this quarter and could not be located on 4 subsequent aerial telemetry flights (fawn collar battery life expectancy is 12 months). Six males ear-tagged as fawns (7-8 months old) in 2009 were harvested and reported during firearm season.

Deer Characteristics

Ages of females captured in 2010 (mean = 6 yrs; range = 1–15; $n = 27$) were similar to those captured in 2009 (mean = 6 yrs; range = 1 –13; $n = 38$). Additionally, 3 female deer collected from vehicle collisions in January-February 2010 were aged at 1 ($n = 2$) and 3 ($n = 1$) years.

Blood ($n = 56$) and urine ($n = 49$) characteristics (Table 1) were received from the Michigan State University, Diagnostic Center for Population and Animal Health. Characteristic results will be compared to previously published characteristic levels to assess nutritional status of yearling and adult females captured in 2009 and 2010.

Deer Abundance Camera Survey

We obtained 6,749 images of deer from 55 remote infrared cameras from 1 September–8 October 2010 to estimate deer abundance in the study area. Deer abundance and density/km^2 will be estimated for the 256.2 km^2 sampling area using 2 methods (Jacobson et al. 1997, Demarais et al. 2000) based on male antler characteristics and deer demography. An additional

2010 deer density estimate will be derived from radiocollared doe photo occurrence and rate of movement during the survey.

Carnivore Monitoring

Bobcat, coyote, and wolf collars were programmed to obtain a GPS location every 35 hours until 1 May, every 15 minutes from 1 May–30 September and then every 35 hours until the collars are removed. Black bear GPS collars were programmed to obtain a location every 15 minutes from the time of deployment until the collars are removed. Nine flights this quarter and 35 flights in 2010 have occurred to download GPS locations (Table 2). One GPS collar (C18) malfunctioned and did not collect data. Five black bear GPS collars (BB12, BB18, BB29, BB36, BB37) dropped off shortly after being deployed.

This quarter, we collected an average of 2,196 (SD = 1,828) locations from GPS collared black bears, 695(SD = 1,104) locations from bobcats, 1,806 (SD = 1,124) locations from coyotes, and 2,287 (SD = 389) locations from wolves (Table 2). Throughout 2010, we collected an average of 9,307 (SD = 13,615) locations from GPS collared black bears, 9,156 (SD = 4,319) locations from bobcats, 11,219 (SD = 892) locations from coyotes, and 12,153 (SD = 376) locations from wolves.

Beaver Survey

To index beaver abundance, we conducted aerial flights on 8-9 November throughout the study area to detect fresh beaver caches. Flights were conducted at an altitude of about 150–300 m. We searched 712 km of rivers and streams and located 5 active beaver caches.

Coyote and Wolf Howl Surveys

September surveys yielded a coyote response rate (RR) of 23.6% to the coyote group-yip howl with no responses from wolves. From the lone wolf howl we obtained a 23.6% and 3.6% RR from coyotes and wolves, respectively. The aurally estimated number of coyotes responding during September coyote and wolf surveys was 49 and 54, respectively. Analysis of howl survey data is continuing.

Elicitation of collared individuals during this quarter yielded a 6% and 0% RR from coyotes and wolves, respectively, when using a coyote group-yip call. When using a wolf call, we obtained a RR for collared coyotes and wolves of 11% and 0%, respectively.

Carnivore Scat Collection

We collected carnivore scat samples opportunistically throughout the study area that were labeled by date, species, and UTM coordinates; and frozen. Scats were analyzed for presence of prey species (e.g., deer fawn) hair and other dietary items (e.g., berries and corn). This quarter we analyzed 43 scats (24 coyote and 19 wolf) collected during the summer of 2009. Proportion of coyote scat with adult and fawn white-tailed deer hair was 48% and 15%, respectively. Proportion of wolf scat with adult and fawn white-tailed deer hair was 30% and 30%, respectively.

From 2009-2010, we have collected 894 samples consisting of 334 bear scats, 39 bobcat scats, 288 coyote scats, 133 wolf scats, and 100 unknown scats. From 2009-2010, we have cleaned and sorted 348 samples at Mississippi State University, Carnivore Ecology Laboratory

of which 228 (94 bear, 3 bobcat, 94 coyote, 37 wolf) were analyzed. Analyses identified plant seeds, fawn hooves and hair, unknown feathers and bones, ruffed grouse feathers and feet, snails, and adult deer hair in scats. Analysis of scats is ongoing.

Vegetation Surveys

This quarter, we conducted surveys quantifying vegetation structure, composition, and density at 2 deer mortality sites and 2 random locations. Vegetation data will be used to estimate if event locations (e.g., birth sites, predation sites) differ in vegetation structure. For example, fawn birth site locations may occur in areas with increased vegetation structure to provide greater cover and reduce predation risk. Conversely, fawn predation sites may occur in areas with reduced vegetation structure that increases predation risk.

Alternate Prey, Carnivore, and Deer Data

We recorded alternative prey and deer observations (i.e., species, location, and time) during field work to provide an index of relative abundance within the study area. Daily start and end times were also recorded by each crew to determine daily time afield. From 1 May 2009–30 November 2010, 4,365 observations were recorded, including 46 observations from 1 September-30 November 2010 (Table 3). The 3 most observed alternate prey species were ruffed grouse (*Bonasa umbellus*), turkey (*Meleagris gallopava*), and squirrel (*Sciurus* spp.).

Public Outreach

Outreach efforts conducted by project personnel this quarter:

1) Duquette, J.D., and J.S. Fosdick. 8–9 October. *Wildlife techniques and animal capture workshop*. Michigan Technological University, Student Chapter of the Wildlife Society, Escanaba, MI. 12 students.

Popular Articles:

1) The Daily Press. 27 November 2010. "Fawn, predator link being probed in U.P."
2) Michigan Department of Natural Resources and Environment. 2 December 2010. "DNRE Researches Fawn Predation in Upper Peninsula." Website: http://www.michigan.gov/dnr/0,1607,7-153-10366_46403-247869--,00.html.
3) The Porcupine Press. September 2010. "Predator impacts on white-tailed deer in the Upper Peninsula of Michigan".

Approximately six hundred project brochures describing research goals and activities have been distributed in 2010. The project website (http://fwrc.msstate.edu/carnivore/predatorprey/) has been updated with current photos and results.

Project Crew Selection and Hires

Four technicians were hired for winter 2010.

1) Caitlin Ott-Conn
2) Nicole Levikov
3) Megan Harrigan

4) Alec Nelson

Publications

Duquette, J.F., J.L. Belant, D.E., Beyer, N.J. Svoboda, and C.A. Albright. 2010. Bald Eagle predation of a white-tailed deer fawn. Northeastern Naturalist, *In Press*.

Duquette, J.F., J.L. Belant, D.E. Beyer, and N.J. Svoboda. 2010. Effect of body condition on ketamine-xylazine immobilization of female white-tailed deer. Journal of Wildlife Diseases, *In prep*.

Svoboda, N.S., J.L. Belant, D.E., Beyer, J.F. Duquette, H.K. Stricker, and C.A. Albright. 2010. American black bear predation of an adult white-tailed deer. Ursus, *In review*.

Work to be completed (December–February 2010)

Radiotelemetry

Radiocollared females and 2009 and 2010 fawns will continue to be located and monitored for mortality ≥1 weekly.

Deer Trapping

Deer trapping efforts will begin the second week of December 2010. Deer will be captured using Clover traps and air-powered cannon nets. Pregnant females will be radiocollared, ear tagged, and implanted with a vaginal implant transmitter; other deer will be ear tagged.

Alternative Prey and Deer Data

Project personnel will continue to record daily start and end times in the field, as well as coordinates and time for each deer and alternative prey species observed. These data will provide an index of relative abundance of alternative prey and deer across the study area.

Black Bear Den Checks

Black bear den checks will be conducted on male black bears in mid-December to replace batteries on GPS radiocollars. Female den checks will be performed in February.

Carnivore Scat Collection

Project staff will continue to opportunistically collect scat samples of focal carnivore species throughout the study area. Staff will record date, GPS location, and species for each scat collected for analysis.

Bobcat Hair Snares

Design and assembly of bobcat hair snares began in October (Figure 2). Hair snares will be deployed during winter for 8 weeks at predetermined bait sites beginning in January, with hair removed at weekly intervals. Bait will consist of road-killed deer carcasses or beaver carcasses collected from private trappers. Hair samples will be sent to a genetics laboratory for analysis.

Winter Track Surveys

Winter track surveys for wolves will begin after first snowfall, likely late November-early December, and will continue throughout favorable snow conditions. Track surveys will be completed via truck, snowmobile, or ATV and will be conducted 24-48 hours after snowfall. Wolf tracks will be followed to identify the number of individuals to estimate minimum abundance.

Public Outreach

Project brochure will be updated with preliminary results, printed, and distributed.

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Taillon, J., D. G. Sauve, and S. D. Cote. 2006. The effects of decreasing winter diet quality on foraging behavior and life–history traits of white-tailed deer fawns. Journal of Wildlife Management 70:1445–1454.

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Table 1. Blood serum and urine characteristics evaluated from samples taken from female white-tailed deer captured in winter 2009 and 2010, Upper Peninsula of Michigan, USA.

Blood Serum Characteristics	Urine Characteristics
Serum Urea Nitrogen (mg/dL)	Creatinine Fl (mg/dL)
Creatinine (mg/dL)	Sodium Fl (mmol/L)
Sodium (mmol/L)	Potassium Fl (mmol/L)
Potassium (mmol/L)	Chlorine Fl (mmol/L)
Chlorine (mmol/L)	Calcium Fl (mg/dL)
Total Carbon dioxide (mmol/L)	Phosphorus Fl (mg/dL)
Anion Gap (mmol/L)	
Sodium/Potassium Ratio	
Calcium (mg/dL)	
Phosphorus (mg/dL)	
Albumin (g/dL)	
Hemolysis Chemistry	
Lipemia Chemistry	
Icterus Chemistry	
Total Thyroxine (nmol/l)	
Total Triiodothyronine (nmol/l)	
Leptin (ng/ml HE)	

Table 2. Monitoring data for 24 GPS-radiocollared carnivores, Upper Peninsula of Michigan, USA, 1 January 2010–30 November 2010.

		1 September - 9 December						2010					
		Days Monitored			Locations			Days Monitored			Locations		
Species	n	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Black bear[a]	12	68	47	2-100	2196	1828	3-6,355	197	73	1-289	9307	3615	2,774-13,663
Bobcat	3	61	53	0-100	695	1104	0-1,968	154	94	46-211	9156	4319	4,169-11,666
Coyote[b]	6	95	7	86-100	1806	1124	113-2,530	202	11	4-211	11219	892	10,138-12,508
Wolf	3	71	50	14-100	2287	389	1,839-2,538	188	48	133-221	12153	376	11,855-12,576

[a] Data does not include 7 VHF collared bears or 5 bears that slipped collars shortly after deployed (BB12, BB18, BB29, BB36, BB37).

[b] Data does not include shot coyote C12 or malfunctioning collar C18.

Table 3. Deer and alternative prey observations, Upper Peninsula of Michigan, USA, 16 September 2009–30 November 2010.

Alternative Prey Observations		
Species	Observations	No. Observed
Deer	36	92
Grouse	3	6
Turkey	2	12
Squirrel	2	6
Pheasant	2	2
Rabbit/Hare	1	1

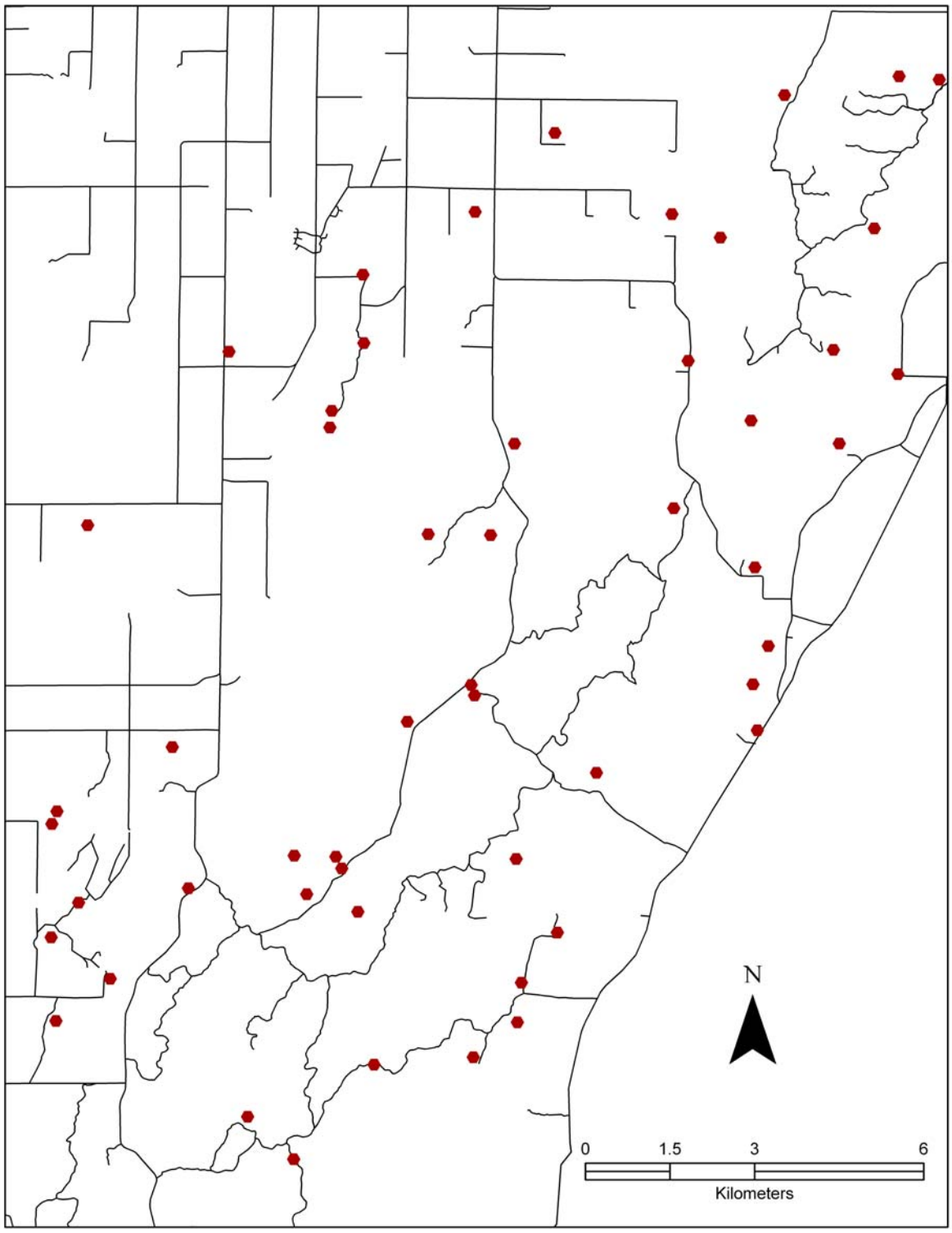

Figure 1. Locations for 55 cameras used to estimate white-tailed deer abundance, Upper Peninsula of Michigan, 1 September-8 October 2010.

Figure 2. Modified body snare (top) used at baited site (middle) to capture bobcat and coyote hair samples (bottom), Upper Peninsula of Michigan, USA.