

# **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 captured 119 (82 female, 37 male) white-tailed deer (*Odocoileus virginianus*) this quarter in Clover traps including 54 adults, 16 yearlings, and 49 fawns. Forty-eight females were radio-collared, of which 46 pregnant females received vaginal implant transmitters. We collected 227 adult female and 23 female yearling radiolocations. We immobilized 10 adult black bear (*Ursus americanus*; 2 male, 8 female) and 1 female yearling in their dens and we observed 11 cubs (9 male, 2 female) from 4 females. We captured 3 coyotes (*Canis latrans*) with cable neck restraints and fitted two of these individuals with GPS collars. On 10 occasions we ran bobcats (*Lynx rufus*) with dogs and captured 2. We conducted 23 wolf track surveys this quarter and identified a minimum of 6 packs with home ranges occurring at least partly within the study area. To estimate bobcat abundance, we deployed hair snares and remote cameras at 64 sites throughout the study area and obtained 160 hair samples and 508,617 images. We gave presentations and hosted volunteers to provide information on ongoing research. We updated the project website and project Facebook page with information and results obtained this quarter. We began interviewing applicants for 16 technician positions to begin work 1 May 2013.
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## Summary

- We captured 119 (82 female, 37 male) individual white-tailed deer (*Odocoileus virginianus*), including 54 adults, 16 yearlings, and 49 fawns.
- We radio-collared forty-eight females, of which 46 pregnant females were also VIT tagged.
- We detected pregnancy with ultrasound in 100% of adult ( $n = 42$ ) and 89% of yearling ( $n = 9$ ) females.
- We obtained radiolocations on 227 adult and 23 yearling deer.
- We immobilized 10 adult black bear (*Ursus americanus*; 2 male, 8 female) and 1 female yearling in their dens and we observed 11 cubs (9 male, 2 female) from 4 females.
- We set 24 cable neck restraints at 4 baited sites to capture coyotes (*Canis latrans*). We captured 3 coyotes and fitted 2 with a GPS collar.
- On 10 occasions we ran bobcats (*Lynx rufus*) with dogs, and captured 2 bobcats. Both captured bobcats were too small to collar.
- We conducted 23 wolf track surveys and identified a minimum of six packs with territories occurring at least partly within the study area: Deer Lake (minimum 4 individuals); Michigan (minimum 7 individuals); Drummond Lake (minimum 2 individuals); Shank Lake (minimum 9 individuals); Michigamme (minimum 4 individuals); and Republic (minimum 4 individuals).
- We deployed hair snares and remote cameras at 64 sites throughout the study area to estimate bobcat abundance. We obtained 160 hair samples and 508,617 images.
- We hosted volunteers/observers representing the Michigan Department of Natural Resources (MDNR), Northern Michigan University, Safari Club International, Michigan Technological University, MI Hound Hunters, and friends and relatives of current project staff. We also hosted Dave Kenyon, MDNR photographer, who took photographs and video footage of project staff performing field duties.
- We attended the Iron-Dickinson Sportsman Coalition meeting hosted by the MDNR to discuss the project with representatives from several local stakeholder groups.
- We updated our Facebook page ([www.Facebook.com/MIpredprey](http://www.Facebook.com/MIpredprey)) to provide the public with project results.

## 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 demonstrated 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 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* spp.).
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**

The second phase of this study spans about 1,000 km<sup>2</sup> (386 mi<sup>2</sup>) within Deer Management Unit 036 in Iron County (Figure 1). The general study area boundaries follow State Highway M-95 on the east, US Highway 41/28 on the north, US Highway 141 on the west, and State Highway M-69 on the south. The core study area, where most capture efforts and population surveys will occur, is north of the Michigamme Reservoir and includes state forest, commercial forest association, and private lands. The final study area will comprise a minimum convex polygon that will include the composite locations of all telemetered animals. We selected this study area because it occurs within the mid-snowfall range, receiving about 180 cm of snowfall annually (about 53 cm more snowfall annually than the phase 1 study area near Escanaba). Deer in this area migrate longer distances and exhibit yarding behavior during most winters as compared to Escanaba where deer migrate only short distances or are non-migratory (Beyer et al. 2010) and yard less frequently.

### **Accomplishments**

#### Deer Trapping

From 5 January 2012–10 March 2013 we captured white-tailed deer in Clover traps to place radiocollars on pregnant females (Figure 2). We captured 119 deer (82 females, 37 males) in Clover traps, with an additional 74 recaptures. Individual captures included 46 adult females, 8 adult males, 9 yearling females, 7 yearling males, 27 female fawns, and 22 male fawns. The female:male fawn ratio was 1:0.81. We attempted to collect body condition scores (BCS) and attach ear tags (females = blue, males = yellow) to each deer. We also assessed pregnancy of yearling and adult females using ultrasonography.

Females ( $n = 75$ ) and males ( $n = 36$ ) had mean ( $\pm$  SD) BCS (scale: 1 [moribund]–5 [obese]) of  $2.8 \pm 0.5$  and  $2.8 \pm 0.4$ , respectively. Eight capture related mortalities occurred; 5 resulted from a vertebral fracture from striking the Clover trap, 1 from a broken tibia in the trap, and 2 were likely related to physiological stress from the capture event.

We immobilized 48 females and fitted them with a radiocollar (model 2610B, Advanced Telemetry Systems Inc., Isanti, MN), and also fitted 46 of the pregnant females with a vaginal implant transmitter (VIT; model 3930, Advanced Telemetry Systems Inc., Isanti, MN). We monitored

temperature, respiration, and heart rate as soon as practical after immobilization and at about 10 minute intervals thereafter until a reversal drug was administered. We estimated and recorded deer morphometrics and maximum (MAXF) and mid-rump (MIDF) fat depths (Table 1) when practical. We detected pregnancy with ultrasound in 100% of adults ( $n = 42$ ) and 89% of yearlings ( $n = 9$ ).

### Deer Mortality

Three radiocollared deer mortalities occurred. There was one wolf predation of a yearling, one yearling drowned in a lake after falling through the ice, and an adult apparently died of disease. We submitted this latter carcass to the Michigan DNR Diagnostics Laboratory for necropsy.

### Deer Telemetry

We monitored radiocollared deer  $\geq 1$  time/week using aerial telemetry and collected 227 adult and 23 yearling radiolocations.

### Black Bear Den Checks

During 23 January–23 February we immobilized 10 adult black bears (2 male, 8 female) and 1 female yearling. We weighed, recorded morphometric measurements, and drew blood from each immobilized bear. We replaced VHF collars with Global Positioning System (GPS) collars on all previously collared adult black bears. We programmed these collars to obtain a location every 35 h until 1 May and then every 15 min until we remove the collar in the den next winter. We handled 11 cubs (9 male, 2 female) from 4 adult females; mean litter size was 2.75 (SD = 0.96; Table 2).

### Coyote Cable Neck Restraints

We baited 6 locations with vehicle-killed deer carcasses to attract coyotes for capture. We set 24 relaxing-lock cable neck restraints at 4 sites and captured 3 female coyotes. One coyote escaped the cable neck restraint before we arrived to immobilize the individual. One coyote mortality occurred from thermal shock likely due to severe mange. We immobilized 2 coyotes and fit GPS collars and affixed ear tags. We drew blood, collected a hair sample, and recorded morphological measurements. We will remove all coyote cable neck restraints by 19 March.

### Bobcat Capture

We used dogs ( $n = 1-3$ ) to run bobcats on 10 occasions during 6–15 March. We successfully captured 2 female bobcats using a dart gun once the bobcats were treed or cornered on the ground. Once immobilized, we weighed, sexed, and collected morphometric measurements from bobcats. We were unable to collar either bobcat due to their low weight (5.7 and 6.0 kg).

### Wolf Track Surveys

We conducted 23 wolf track surveys between 1 January and 15 March. We also recorded wolf tracks, scat, urine, and sightings opportunistically while performing other field duties.

We used track surveys to identify the number of wolf packs in the study area and the minimum number of individuals within each pack. We also used information from two radio-collared individuals to estimate territorial boundaries for two packs in the study area; the Deer Lake and Michigan packs (Figure 3). Based on this information and data gathered in previous years, we identified a minimum of six packs with territories occurring at least partly within the study area: Deer Lake (minimum 4 individuals); Michigan (minimum 7 individuals); Drummond Lake (minimum 2 individuals); Shank Lake (minimum 9 individuals); Michigamme (minimum 4 individuals); and Republic (minimum 4 individuals).

### Bobcat Hair Snares

We began baiting 64 bobcat hair snare sites (Figure 4) on 18 December 2012. After a two-week pre-bait period, we set 4–5 hair snares at each site beginning on 2 January 2013. We also deployed a trail camera at each site, directed at the bait, to capture photos of all animals visiting the site.

We visited each bait site every 7 days to collect hair samples, reset snares, perform trail camera maintenance, and add bait as necessary. The eight-week survey was completed and we pulled snares during 27 February–5 March 2013.

We collected 160 hair samples (of both target and non-target species) and sent them to the MDNR Wildlife Disease Laboratory in Lansing for DNA extraction. We also obtained 508,617 camera images containing at least 31 species of birds and mammals. Data entry and analysis is ongoing.

### Public Outreach

During black bear den checks we hosted individuals from Michigan Department of Natural Resources (MDNR), Northern Michigan University, Safari Club International (SCI), Michigan Technological University, Michigan Hound Hunters Association, and friends and relatives of project staff.

On 14 January 2013, we attended the Iron-Dickinson Sportsman Coalition meeting hosted by the MDNR, where we discussed the project with representatives from several local stakeholder groups.

From 25–28 February 2013, we hosted Dave Kenyon, MDNR photographer. Kenyon captured photographs and video footage of project staff performing various field duties and will provide this media to SCI to promote the project.

We updated our Facebook page ([www.Facebook.com/MIpredprey](http://www.Facebook.com/MIpredprey)) to provide the public with project results.

### *Presentations:*

Libal, N.S., T.R. Petroelje, D. Martell, J.L. Belant, and D.E. Beyer, Jr. 13 February 2013. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Crystal Falls Methodist Men's Breakfast Group, Crystal Falls, MI. 20 attendees.

### Technician Hiring

We posted a job advertisement and have begun reviewing applicants to assist with summer field work. We plan on hiring 16 technicians to begin field work 1 May 2013.

### Publications

Duquette, J.F., J.L. Belant, D.E. Beyer, Jr., and N.J. Svoboda. 2013. Body condition and dosage effects on ketamine-xylazine immobilization of female white-tailed deer. *Wildlife Society Bulletin* 36:In press.

Petroelje, T.P., J.L. Belant, and D.E., Beyer, Jr. 2013. Factors affecting the elicitation of vocal responses from coyotes. *Wildlife Biology* 19:41–47.

Svoboda, N.J., J.L. Belant, D.E. Beyer, Jr., J.F. Duquette, and J.A. Martin. 2013. Identifying bobcat kill sites using a global positioning system. *Wildlife Biology* 19:79–86.

## **Work to be completed (16 March 2013–15 June 2013)**

### Snowshoe Hare Pellet Survey

Following snowmelt and before spring green-up, we will conduct snowshoe hare (*Lepus americanus*) pellet counts along transects within each vegetation type to assess hare density within our study area.

### Ruffed Grouse Drumming Survey

We will conduct ruffed grouse (*Bonasa umbellus*) drumming surveys beginning in mid–April to estimate occupancy of grouse at survey sites. We will use grouse occupancy to estimate male densities with respect to habitat within our study area.

### Carnivore Trapping and Radio-collaring

We will begin trapping black bear, bobcat, coyote, and wolves during late April or May. We will use #3 Victor soft-catch (Oneida Victor Inc., Cleveland, Ohio) foothold traps for bobcats and coyotes; MB 750 (Minnesota Trapline Products Inc., Pennock, Minnesota) footholds to capture wolves; and barrel traps and foot-snares to capture black bears. We will fit captured carnivores with a GPS collar, affix ear tags, record morphometric measurements, determine sex and body condition, and evaluate for injury. We will collect blood, hair, and extract a vestigial premolar to estimate age.

### Predation Site Investigation

We will begin investigations of possible carnivore predation sites (clusters) in early May to assess their relative roles in white-tailed deer mortality.

### Carnivore Scat Collection

We will begin collecting scat of black bear, bobcat, coyote, and wolves opportunistically throughout the study area 1 May for diet analysis. We will record date, GPS location, if tracks are present, scat diameter, and species for each collected scat.

### Technician Hiring

We will conduct interviews of applicants and make final hiring decisions. We will hire 16 technicians to begin work 1 May.

### Public Outreach

We will continue to update our project Facebook page (<http://www.facebook.com/MIpredprey>) and web site (<http://fwrc.msstate.edu/carnivore/predatorprey/>) with project results.

### Equipment Organization, Inventory, and Storage

We will inventory, organize, repair, and store all deer trapping and immobilization equipment and bobcat hair snare equipment. We will also repair and store all project snowmobiles.

### Radiotelemetry

We will continue to monitor all radio-collared deer  $\geq 1$  time weekly. Beginning mid-May through 90 days post-parturition, we will locate radio-collared deer up to 4 times daily to monitor VIT tag expulsion (as available) and obtain locations. We will investigate mortalities as soon as practical after detecting a mortality signal to determine cause of death.



### Fawn Capture and Radio-collaring

We will capture fawns opportunistically and by searching areas surrounding expelled VIT transmitters during late May and early June. We will locate radio-collared fawns up to 4 times daily through 90 days post-parturition. We will investigate mortalities as soon as practical after detecting a mortality signal to determine cause of death. In addition, we will use our observations of immobile fawns to estimate how long the fawning period lasts. To estimate the twinning rate for the population, we will record observations of multiple young/adult female and will monitor and occasionally flush collared fawns to observe whether a sibling is present.

### Vegetation Surveys

Beginning mid-May, we will collect vegetation data at random locations within the vegetation classes present in our study area. At each point, we will estimate horizontal cover following Ordiz et al. (2009). We will also estimate available forage by collecting current year's growth of preferred deer food species (McCaffery et al. 1974, Stormer and Bauer 1980), drying the samples, and comparing the resulting dry weights across vegetation classes.

### Traffic Estimates

Beginning mid-May, we will place remote cameras at random points along roadways to estimate human use of roads in our study area during the fawning season.

### Black Bear Hair Snares

During April–May, we will conduct necessary repairs on black bear hair snares ( $n = 64$ ), which were established during 2012. From late May–July we will collect black bear hair samples from snares to estimate abundance throughout the study area.

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Participating Upper Peninsula landowners

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 Kurt Hogue, MDNR  
 Jason Peterson, MDNR  
 Marvin Gerlach, MDNR  
 Jason Neimi, MDNR  
 Vernon Richardson, MDNR

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**Table 1.** Mean ( $\bar{x}$ ) and standard deviation (SD) of 51 captured adult ( $n = 42$ ) and yearling ( $n = 9$ ) female white-tailed deer morphometrics and body condition estimates, Upper Peninsula of Michigan, USA, January–March 2013.

Metric	Age Class			
	Adults		Yearlings	
	$\bar{x}$	SD	$\bar{x}$	SD
Body weight (kg)	63.4	6.0	52.5	5.1
Body length (cm)	153.8	6.3	146.3	10.0
Total length (cm)	177.8	6.7	170.1	9.0
Chest girth (cm)	95.3	5.0	89.0	4.3
Neck circumference (cm)	39.4	3.8	37.2	2.7
Shoulder length (cm)	96.8	3.5	92.9	3.1
Hind foot (cm)	48.0	1.6	47.4	1.6
Tail length (cm)	24.0	3.4	23.9	2.7
Head length (cm)	32.6	2.0	29.4	2.4
Ear length (cm)	15.6	0.8	15.2	0.4
Front teat length (mm)	15.8	4.2	8.8	2.8
Front teat width (mm)	9.1	3.0	4.8	0.9
Back teat length (mm)	16.6	4.2	9.1	3.3
Back teat width (mm)	9.3	3.5	4.6	1.6
BCS <sup>1</sup>	3.0	0.5	2.8	0.5
MIDF <sup>2</sup> (cm)	0.5	0.3	0.7	0.4
MAXF <sup>3</sup> (cm)	0.9	0.3	1.4	1.0

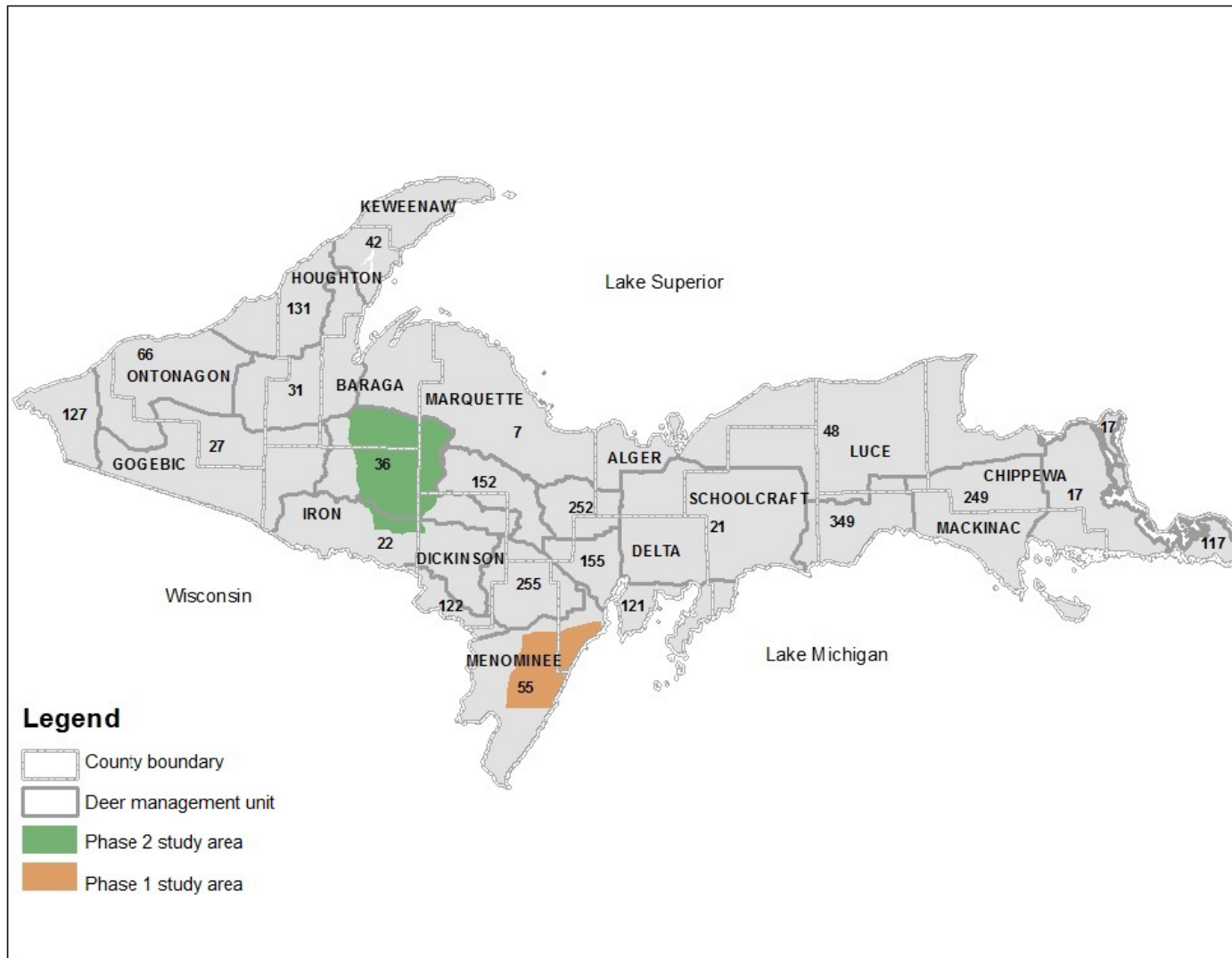
<sup>1</sup> Body Condition Score (BCS) for does derived from palpation following Cook et al. (2010).

<sup>2</sup> Middle rump fat (MIDF) estimate measured at mid-point between ilium and ischial tuberosity on right hip (Cook et al. 2007).

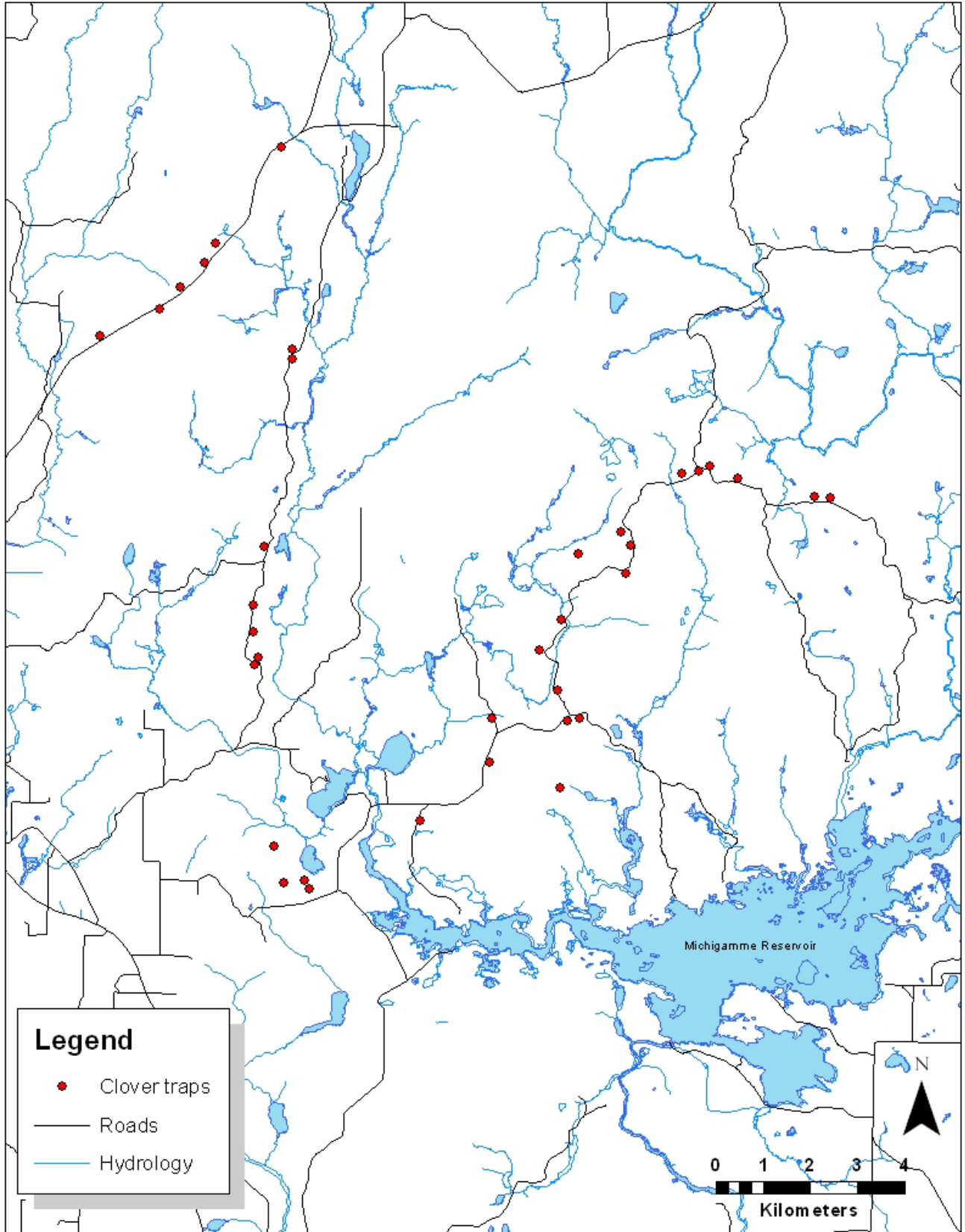
<sup>3</sup> Maximum rump fat (MAXF) estimate measured above ischial tuberosity of right hip (Cook et al. 2007).

**Table 2.** Den check data for 22 black bears, Upper Peninsula of Michigan, USA, 23 January–23 February 2013.

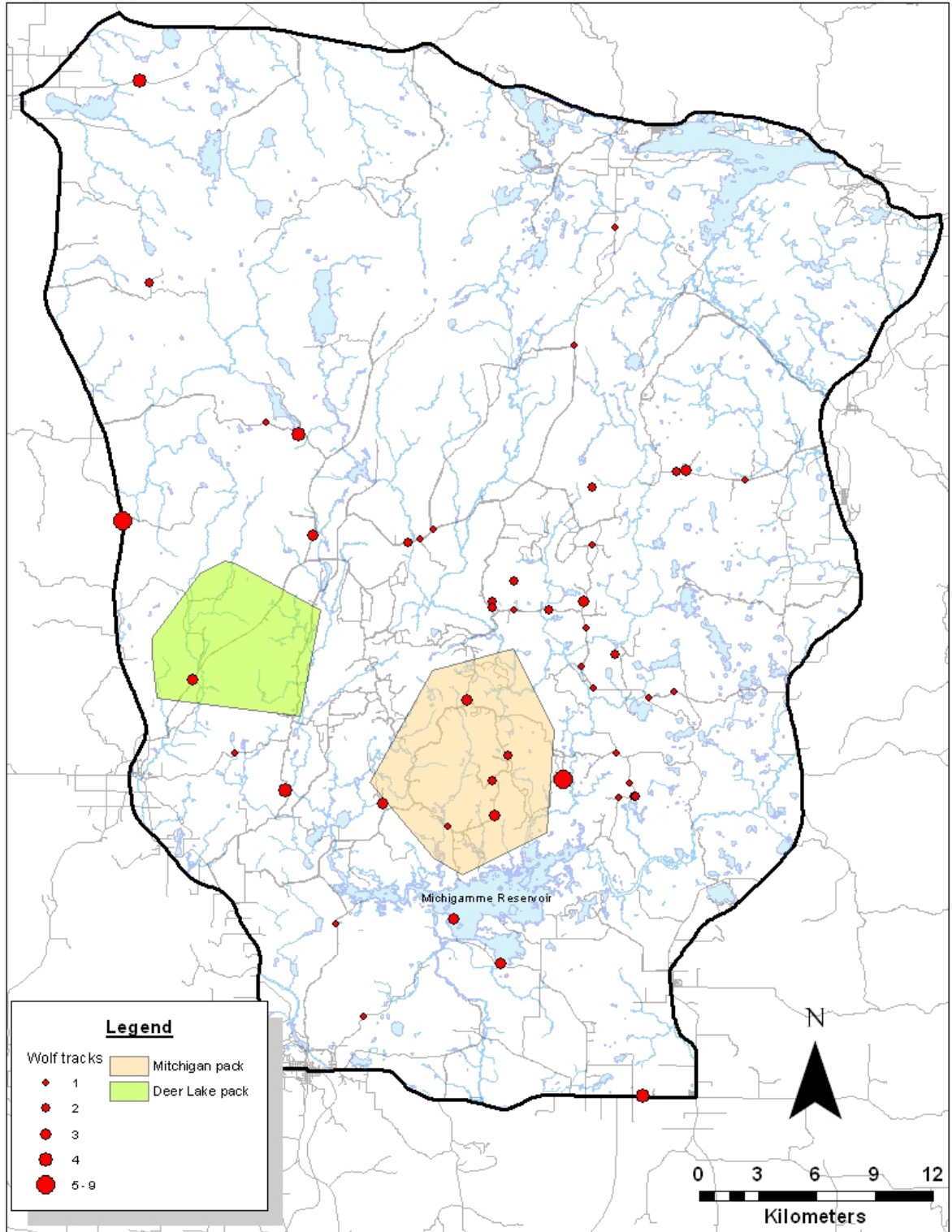
ID	Capture date	Age	Sex	Body weight (kg)	Right ear tag	Left ear tag
BB115	23 Jan	Adult	Male	60.8	235	234
BB104	5 Feb	Adult	Male	115.7	156	155
BB112	16 Feb	Adult	Female	70.3	220	219
BB123	16 Feb	Cub from BB112	Male	0.8	NA	NA
BB124	16 Feb	Cub from BB112	Male	0.9	NA	NA
BB125	16 Feb	Cub from BB112	Male	0.8	NA	NA
BB102	17 Feb	Adult	Female	50.4	154	153
BB126	18 Feb	Adult	Female	82.6	287	288
BB127	18 Feb	Cub from BB126	Female	1.6	NA	NA
BB128	18 Feb	Cub from BB126	Male	1.81	NA	NA
BB103	19 Feb	Adult	Female	54.8	213	214
BB117	20 Feb	Adult	Female	89.8	173	161
BB129	20 Feb	Cub from BB117	Male	1.3	NA	NA
BB130	20 Feb	Cub from BB117	Male	1.8	NA	NA
BB116	21 Feb	Adult	Female	53.5	239	238
BB131	21 Feb	Yearling from BB116	Female	10.8	283	284
BB120	22 Feb	Adult	Female	78.4	229	228
BB122	23 Feb	Adult	Female	73.9	170	171
BB134	23 Feb	Cub from BB122	Male	0.9	NA	NA
BB135	23 Feb	Cub from BB122	Male	1.3	NA	NA
BB136	23 Feb	Cub from BB122	Male	0.9	NA	NA
BB137	23 Feb	Cub from BB122	Female	1.1	NA	NA



**Figure 1.** Location of phase 1 and 2 study areas and Michigan Department of Natural Resources Deer Management Units, Upper Peninsula of Michigan, 2013.

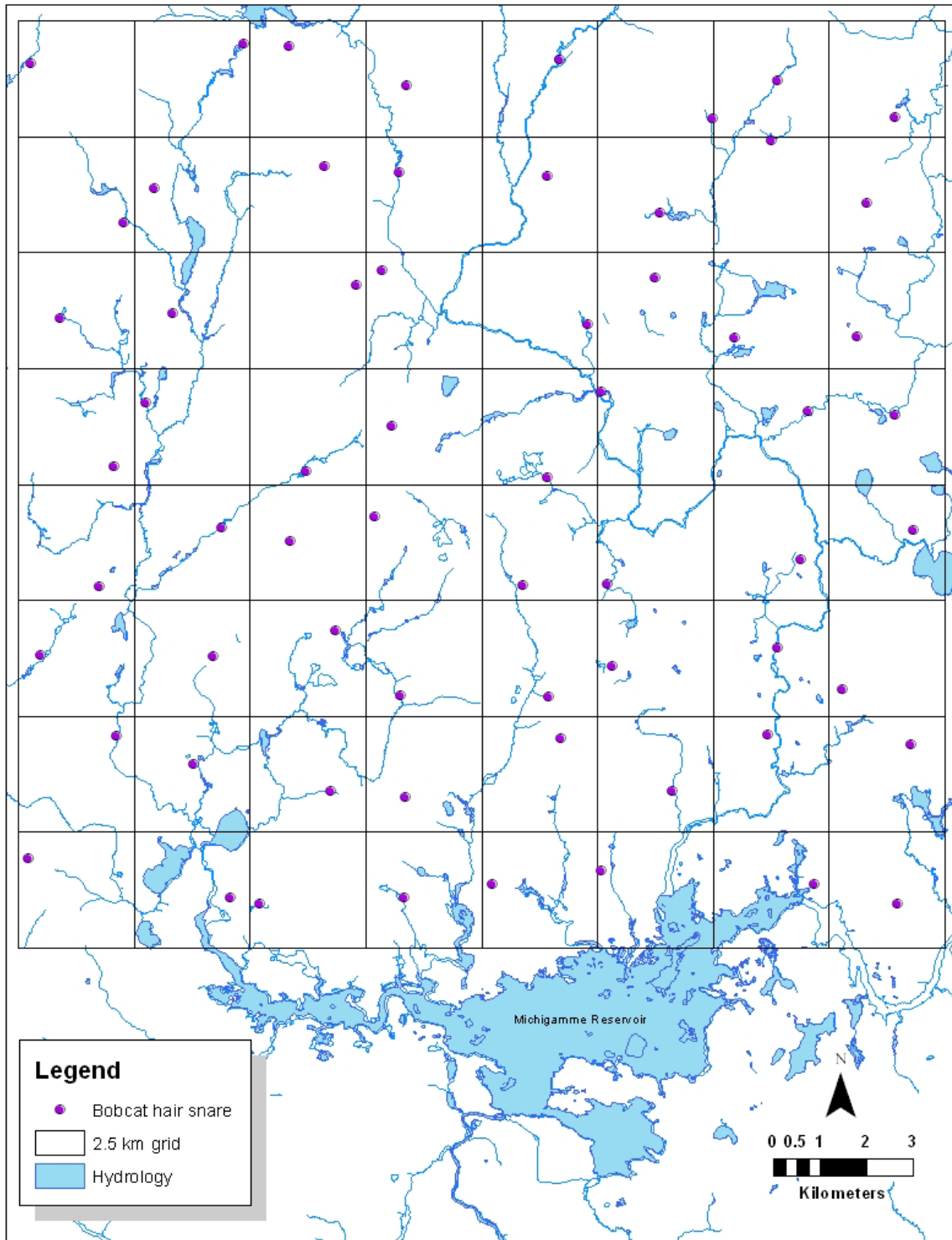


**Figure 2.** Location of 45 Clover traps, Upper Peninsula of Michigan, USA, January–March 2013.



**Figure 3.** Estimated wolf pack territories (shaded polygons) from VHF collar location data of two individuals, May 2012–February 2013. Locations and estimated number of wolves (red circles) derived from track surveys, Upper Peninsula of Michigan, USA, January–March 2013.





**Figure 4.** Location of bobcat hair snare sites ( $n = 64$ ) within a 2.5 km grid, Upper Peninsula of Michigan, USA, 2 January–5 March 2013.