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

Progress Report: 16 March 2015–15 June 2015

Date Issued:
25 June 2015

Submitted to:
Michigan Department of Natural Resources
Safari Club International Foundation
Safari Club International – Michigan Involvement Committee

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**Abstract** We captured and radiocollared 27 neonate white-tailed deer (*Odocoileus virginianus*) fawns (16 male, 11 female). Nine of 15 (60%) vaginal implant transmitter searches resulted in the location of 11 live fawns. Eleven adult female, 4 juvenile deer, and 4 neonate fawn mortalities occurred this quarter. We collected 2067 adult female and neonate fawn GPS and radiolocations. We completed vegetation surveys at 150 random locations stratified within 6 land covers to estimate horizontal cover and deer forage. We captured 3 male black bears (*Ursus americanus*), 6 coyotes (*Canis latrans*; 2 male, 4 female), and 4 wolves (*C.* spp. 1 male, 3 female) with foothold traps. We conducted investigations at 228 carnivore cluster sites to identify carnivore prey sources. We opportunistically collected 382 scat samples from black bear, bobcat, coyote, and wolf. We conducted 5 ruffed grouse (*Bonasa umbellus*) drumming surveys to estimate abundance and on average detected grouse on 50% of survey points. We completed snowshoe hare (*Lepus americanus*) pellet surveys at 448 random locations stratified within 6 land covers to estimate hare density. We deployed hair snares at 64 sites to estimate black bear abundance. We gave 32 presentations, conducted a trapping demonstration for undergraduates, and hosted 31 undergraduate students to provide a field techniques seminar on the study. We updated the project website and project Facebook page with information and results obtained this quarter. We hired 13 technicians to assist with ongoing field activities.

## Summary


- We observed 11 dead radiocollared adult female white-tailed deer (*Odocoileus virginianus*). We attributed 3 to wolf predation, 1 to coyote predation, 2 to unidentied canid predations, 2 to illegal harvest, 2 to unknown causes, and 1 to capture related injuries.

- We captured and radiocollared 27 neonate fawns, including 16 males and 11 females

- 9 of 15 (60%) vaginal implant transmitter searches resulted in the location of 11 live fawns.

- We obtained 2067 adult female and neonate fawn GPS and radiolocations.

- We observed 4 dead neonate fawns attributed to 3 bobcat predations and 1 unidentified predation.

- We completed vegetation surveys at 150 random locations stratified within 6 different land cover types to estimate horizontal cover and deer forage with respect to available land cover.

- We captured 3 male black bear (*Ursus americanus*), 6 coyotes (2 male, 4 female), and 4 wolves (1 male, 3 female) and fitted each with a GPS collar.

- We conducted investigations at 228 carnivore cluster sites to identify carnivore prey sources.

- We opportunistically collected 382 scats from black bear, bobcat, coyote, and wolf.

- We conducted 5 ruffed grouse (*Bonasa umbellus*) drumming surveys to estimated grouse abundance. We detected grouse on 50% of sampling points.

- We completed snowshoe hare (*Lepus americanus*) pellet count surveys at 448 random locations stratified within 6 different land cover types to estimate hare densities with respect to available land cover.

- We deployed hair snares at 64 sites throughout the study area to estimate black bear abundance.

- We hosted 31 undergraduate students from Purdue University to demonstrate detection dog work, carnivore capture and immobilization, radio-telemetry, and fawn capture.

- We gave presentations to local school science classes, the Midwest Wolf Stewards, the Michigan Deer Forum, the Upper Peninsula Sportsman's Alliance, and other local groups.

- We updated our Facebook page (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.

Our overall goal 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 Upper 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 have now completed field work within a low snow depth study site and are currently collecting data within a second study site with moderate snow depth. The following objectives are specific to the Upper Michigan study areas but are also 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 $km^2$ (386 $mi^2$) 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**

<u>Fawn Capture</u>

Beginning mid-May, we captured, radiocollared, and obtained radio-locations for white-tailed deer fawns.  Twenty-seven neonate fawns were captured and fitted with expandable radiocollars (model 4210, Advanced Telemetry Systems, Inc., Isanti, MN) during May and June, consisting of 16 males and 11 females.  We attached 2 individually numbered plastic ear tags to fawns and attempted to collect fawn morphometrics (Table 1), blood, hair, vitals, and identify sex.  We also recorded bed site and surrounding habitat, flush distance, presence of dam, additional deer sighted, and handling time as available. Parturition began on 24 May and is continuing as of 15 June (Figure 2). Average birth mass of fawns born in 2015 (4.2± 1.8 kg) has been similar to average birth mass of fawns born in 2014 (3.7 ± 1.3 kg), and significantly greater than average estimated birth mass of fawns born in 2013 (3.1 ± 1.1 kg, Figure 3).

As of 15 June, we conducted vaginal implant transmitter (VIT) searches in the effort to find fawns of 15 implanted pregnant adult females.  Six adult females have not expelled the VIT as of 15 June.  Nine of fifteen (60%) VIT searches resulted in the location of ≥1 live or dead fawn (11 live fawns and 0 stillbirths). 16 fawns were captured through opportunistic encounters within the study area. Fawn capture is ongoing as of 15 June.

Deer Mortality

We recorded 11 adult female mortalities; six were attributed to predation (3 wolf, 1 coyote, and 3 unidentified canid predations). Unidentified canid predations showed signs of predation by coyotes or wolves (e.g. puncture wounds, hemorrhaging, signs of struggle), but lacked species-specific sign (e.g. canine spacing, tracks, scat) or showed sign of multiple predator species at mortality site. One mortality was attributed to capture myopathy because the deer showed signs of neck injury upon release when captured in February. Two mortalities were attributed to illegal harvest, because the collars showed signs of human removal and no carcass was present. We were unable to determine the cause of mortality for 2 does.

We recorded three mortalities on fawns born during 2014; two were attributed to wolf predation, and one was attributed to unknown causes because predation could not be distinguished from scavenging.

We recorded 4 neonate fawn mortalities on individuals born during 2015, including 3 bobcat predations and 1 unidentified predation.

Deer Telemetry

We used bi-weekly aerial telemetry, GPS collars, and 24-hour ground triangulation to obtain 2067 locations of radiocollared adult females and neonate fawns between 1 May and 15 June 2014.

Vegetation Survey

From 07 May to 15 June we conducted vegetation surveys at 150 random locations within 6 main land covers (deciduous, coniferous, mixed forest, woody wetland, grassland, and herbaceous wetland). At each random location we estimated horizontal cover and we established 5 plots. Within each plot we counted number of trees and shrubs, and estimated percentage of herbaceous plants selected for by white-tailed deer (McCaffery et al. 1974, Stormer and Bauer 1980). We also collected all vegetation that deer select for within each plot, which we dry and weigh. We will use vegetation data to estimate forage availability within each of our land cover types.

Carnivore Capture

During 22 May–15 June, we captured 3 male black bears, 6 coyotes (2 male, 4 female), and 4 wolves (1 male, 3 female) using foothold traps. We immobilized captured individuals and recorded gender, weight, and affixed uniquely numbered ear tags (Table 2). We recorded morphometric measurements and collected blood and hair from each immobilized carnivore. We estimated body condition scores for each carnivore and estimated body condition of black bears using bioelectrical impedance analysis. We removed a vestigial premolar for age estimation in black bears. We fitted all captured coyotes and wolves with Lotek 7000SU (Lotek Engineering, Newmarket, ON, Canada) or Vectronic 1C GPS Plus (Vectronic Aerospace GmbH, Berlin, Germany) global positioning system (GPS) radiocollars. We fitted all captured bears with a Lotek 7000MU GPS radiocollar. We euthanized a male coyote that suffered trap injuries and observed a female coyote mortality from unknown causes. We sent both individuals to the Michigan Department of Natural Resources Wildlife Disease Laboratory for further investigation.

We programmed all GPS radiocollars for coyotes and wolves to obtain a location every 35 hours until 1 May, every 15 minutes from 1 May–31 September and then every 35 hours until the scheduled collar drop-off date. We programmed all GPS radiocollars, fitted on black bear, to obtain a location every 35 hours until 1 May and then every 15 minutes until we change their collars out in their dens. We fitted all 7000SU and GPS Plus 1C GPS radiocollars with a drop-off mechanism to release collars 25–35 weeks after deployment. We fit all radiocollars on black bears with a leather breakaway device in case bears disperse and we cannot relocate them.

Carnivore Cluster Investigation

During 7 May–15 June, we used clusters of carnivore locations obtained from GPS radiocollars to identify potential kill sites and estimate the number and species of prey killed. Currently, we have investigated 228 GPS location clusters identified using ArcGIS and the statistical software program R (R Development Core Team, Vienna, Austria). We defined a cluster spatially as ≥5 locations within 50 m of each other within a 24-hour period. Of the 228 clusters, 109 were black bear, 53 bobcat, 41 coyote, and 25 wolf. Analysis of cluster data is ongoing.

Carnivore Scat Collection

We opportunistically collected 382 scats from black bear, bobcat, coyote, and wolf this quarter. We will wash, package, and then send scat samples to Mississippi State University's Carnivore Ecology Laboratory for identification of prey remains.

Ruffed Grouse Drumming Survey

We conducted ruffed grouse (*Bonasa umbellus*) drumming surveys during 23 April–1 May. We conducted surveys from one half hour before sunrise to 5 hours after sunrise. Each survey contained 3 routes with 20–25 sites in each route for a total of 65 sites (Figure 4). Observers listened for 5 minutes at each site for drumming grouse and recorded number and bearing of each drumming grouse. We will use site occupancy to estimate male grouse density. Throughout the survey drumming grouse response was 50% on average.

Snowshoe Hare Pellet Counts

We conducted snowshoe hare (*Lepus americanus*) pellet counts during 24 April–26 May. We counted number of hare pellets within a 1 $m^2$ rectangle at 485 random sites (Figure 5). We separated pellet counts into 6 main land cover types (aspen [*Populus tremuloides*]), deciduous (excluding aspen), coniferous, mixed forest, woody wetland, and open herbaceous). We will relate hare pellet densities to hare abundance using a linear regression developed by McCann et al. (2008).

Black Bear Abundance Estimation

On 15 May we began the pre-bait period for a hair snare survey to estimate black bear abundance. Hair snares ($n$ = 64; Figure 6) consist of a single strand of 4-pronged barbed wire placed around three or four trees to create an enclosure about 50 cm above ground. We baited snares by placing 0.5 L of fish oil on a pile of dead wood in the center of each enclosure and spraying anise oil on each of the trees 2 m above ground. We also placed a remote trail camera at each site to document site visitation. Project personnel check snares, add lure, and collect hair samples every ten days. We will check each snare five times; the survey will continue through 11 July. We will send hair samples to the MDNR lab for DNA extraction and subsequent individual identification.

Public Outreach

We hosted 31 undergraduate students from Purdue University on 4–5 June for demonstrations of detection dogs, carnivore immobilizations, fawn capture, vegetation surveys, and deer telemetry. We presented at a local community center in Iron River, MI on 9 May to inform members of the public about ongoing research in the area. We also gave presentations to 25 classes at local public schools, reaching over 400 students. We updated our Facebook page (www.Facebook.com/MIpredprey) to provide the public with project results.

*Presentations:*

Kautz, T., T.R. Petroelje, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 13 April 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Watkins Glen High School, Watkins Glen, NY. 60 attendees.

Kautz, T., T.R. Petroelje, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 14 April 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Cornell University Student Chapter of The Wildlife Society, Ithaca, NY. 20 attendees.

Lutto, A.L., N. Fowler, T.R. Petroelje, T. Kautz, J.L. Belant, and D.E. Beyer, Jr. 27 March 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. West Iron County Public School, Iron River, MI. 15 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 30 March 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Iron Mountain Public Schools North Elementary, Iron Mountain, MI. 20 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 31 March 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Forest Park Elementary School Pre-Kindergarten, Crystal Falls, MI. 12 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 31 March 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Forest Park Elementary School Pre-Kindergarten, Crystal Falls, MI. 7 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 31 March 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Forest Park High School, Crystal Falls, MI. 48 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 1 April 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Forest Park Elementary School Second Grade, Crystal Falls, MI. 30 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 1 April 2015. Michigan Predator-Prey Project. Forest Park Elementary School Fifth Grade, Crystal Falls, MI. 22 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 1 April 2015. Michigan Predator-Prey Project. Forest Park Elementary School Third Grade, Crystal Falls, MI. 25 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 1 April 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Forest Park Elementary School First and Second Grade, Crystal Falls, MI. 16 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 2 April 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Forest Park Elementary School First Grade, Crystal Falls, MI. 26 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 2 April 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Forest Park Elementary Kindergarten, Crystal Falls, MI. 16 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 21 April 2015. Michigan Predator-Prey Project. Iron Mountain East Elementary Sixth Grade, Iron Mountain, MI. 18 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 21 April 2015. Michigan Predator-Prey Project. Iron Mountain East Elementary Sixth Grade, Iron Mountain, MI. 20 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 21 April 2015. Michigan Predator-Prey Project. Iron Mountain East Elementary Fourth Grade, Iron Mountain, MI. 16 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 21 April 2015. Michigan Predator-Prey Project. Iron Mountain East Elementary Fouth Grade, Iron Mountain, MI. 18 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 21 April 2015. Michigan Predator-Prey Project. Iron Mountain North Elementary Third Grade, Iron Mountain, MI. 40 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 21 April 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Iron Mountain High School, Iron Mountain, MI. 45 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 23 April 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Iron Mountain Middle School, Iron Mountain, MI. 48 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 23 April 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Iron Mountain Middle School, Iron Mountain, MI. 49 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 23 April 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Stambaugh Elementary School Kindergarten, Iron River, MI. 16 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 23 April 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Stambaugh Elementary School Kindergarten, Iron River, MI. 17 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 23 April 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Stambaugh Elementary School Kindergarten, Iron River, MI. 13 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 28 April 2015. Michigan Predator-Prey Project and Upper Peninsula Wildlife. Stambaugh Elementary School First Grade, Iron River, MI. 19 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 23 April 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Forest Park Middle School Seventh Grade, Crystal Falls, MI. 19 attendees.

Lutto, A.L., T.R. Petroelje, T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 23 April 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Forest Park Middle School Eighth Grade, Crystal Falls, MI. 24 attendees.

Petroelje, T.R., T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 11 April 2015. Michigan Predator-Prey Project: Deer Survival in Michigan's Upper Peninsula. Grayling, MI. 40 attendees.

Petroelje, T.R., T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 18 April 2015. Michigan Predator-Prey: Deer Survival Update 2015. Upper Peninsula Sportsman Alliance, Iron Mountain, MI. 70 attendees.

Petroelje, T.R., N. Fowler, T.M. Kautz, N.S. Svoboda, J.F. Duquette J.L. Belant, and D.E. Beyer, Jr. 23 April 2015. Michigan Predator-Prey Project: Wolf-Deer Relationships in Michigan's Upper Peninsula. Midwest Wolf Stewards Conference. Ashland, WI. 150 attendees.

Petroelje, T.R., T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 9 May 2015. Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan. Windsor Center, Iron River, MI. 70 attendees.

Petroelje, T.R., T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 8 June 2015. Update on Michigan Predator Prey Project. Sagola Sportman's Coalition Meeting, Sagola, MI. 15 attendees.

*Workshops:*

Petroelje, T.R., T. Kautz, N. Fowler, J.L. Belant, and D.E. Beyer, Jr. 24-25 May 2015. Field techniques for wildlife capture and predation investigation. Purdue Wildlife Ecology Field Class, Crystal Falls, MI. 40 attendees.

Technician Selection and Hiring

This quarter we hired 13 technicians to assist with field work from 1 May through 31 August, 2015. Additionally, we contracted work with Find It Detection Dogs for the use of 2 conservation detection dogs and 1 handler to aid in the search of predation events at carnivore cluster sites.

**Work to be completed (16 June 2015–30 September 2015)**

Carnivore Monitoring

We will continue monitoring carnivores twice weekly via aerial telemetry. We will download location data from carnivore GPS collars through 31 August for predation site investigation.

Predation Site Investigation

We will continue investigations of carnivore predation site locations (clusters) through 31 August to assess their role in predation on white-tailed deer.

Carnivore Scat Collection

We will continue collecting scat of black bear, bobcat, coyote, and wolves opportunistically through 31 August for diet analysis. We will record date, GPS location, whether tracks are present, scat diameter, and species for each collected scat.

Deer Telemetry

We will continue to monitor all radio-collared deer up to 4 times daily through 31 August to monitor survival and obtain locations. We will investigate mortalities as soon as practical after detecting a mortality signal to determine cause of death.

Vegetation Surveys

We will continue to dry and weigh vegetation samples obtained during the last quarter. We will continue to collect vegetation data at random locations within the deciduous, evergreen, mixed forest, woody wetland, and herbaceous wetland vegetation classes. 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 species selected for by deer (McCaffery et al. 1974, Stormer and Bauer 1980), drying the samples, and comparing the resulting dry weights across vegetation classes.

Black Bear Abundance Estimation

We will check each hair snare two more times for a total of five checks; the survey will continue through 11 July. We will continue to send hair samples to the MDNR lab for DNA extraction and subsequent individual identification.

Coyote Abundance Estimation

On 12 July we will begin conducting howl surveys at 40 sites to estimate coyote abundance. We will conduct surveys every ten days and will continue through approximately 4 October for a total of eight surveys. We will estimate coyote abundance using an occupancy modeling approach (Royle and Nichols 2003).

Deer Abundance Estimation

We will begin pre-baiting 64 sites with 7.5 L of whole kernel corn on 12 August, and will re-bait each site at least every three days. Beginning 22 August we will place remote infrared cameras at each site. We will continue baiting at least every three days during the ten day survey. On 1 September we will start retrieving cameras. From camera images, we will estimate deer abundance/density for the 298.1 km$^2$ sampling area using an occupancy modeling approach (Royle and Nichols 2003).

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.

**Acknowledgements**

We thank the following for their support:
Michigan Department of Natural Resources (MDNR)
Safari Club International (SCI)
SCI Foundation
SCI, Michigan Involvement Committee
Mississippi State University; College of Forest Resources; Department of Wildlife, Fisheries, and Aquaculture; and Forest and Wildlife Research Center
Participating Upper Peninsula landowners
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Jake Boone
Jen Grauer
Kyle Smith
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Sara Harrington
Zack Farley
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Ashley Lutto
Kaitlin Haase
Jason Lombardi
Tom Lacerda
Monique Picon
Garret Price
Carrie Kyle
Erica Perez
Conner Almond
Wes Tucker
Kyle Travis
Morgan Oberly
Joe LaRose
Katie Torreano
Emily Moberg
Brett Skelly
Mollie Liskiewicz
Casey Maynard

Chuck and Jim Sartori for allowing us to establish a weather station on their property
Rick Westphal – Westphal Productions
Michigan Out-of-Doors
906 Outdoors
Greg Davidson and Find It Detection Dogs
Pat Sommers – Sommers Sausage Shop
Dan Absilon
Art Villenue
Rob and Darren Peterson
Kim and Lee Nylund
Steve Atkinson
The Bicigo family
Jerry Grailer
Dr. Dean Beyer, Jr., Co-Principle Investigator, MDNR
Erin Largent, MDNR
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Bob Doepker, MDNR
Kurt Hogue, MDNR
Jason Peterson, MDNR
Marvin Gerlach, MDNR
Jason Neimi, MDNR
Vernon Richardson, MDNR
Dusty Arsnoe, MDNR
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## Literature Cited

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**Table 1.** Mean ($\bar{x}$) and standard deviation (SD) of 27 captured female ($n$ = 11) and male ($n$ = 16) neonate fawn morphometrics, Upper Peninsula of Michigan, USA, 27 May–15 June 2015.

| | **Sex** | |
|---|---|---|
| | **Female** | **Male** |
| **Estimate** | $\bar{x}$ **± SD** | $\bar{x}$ **± SD** |
| Body Weight (kg) | 4.8 ± 2.0 | 4.6 ± 1.2 |
| Body Length (cm) | 61.5 ± 5.0 | 60.4 ± 2.9 |
| Chest Girth (cm) | 36.3 ± 3.2 | 35.0 ± 2.2 |
| Hind Foot (cm) | 26.9 ± 2.0 | 26.2 ± 1.1 |
| Shoulder Height (cm) | 52.3 ± 7.7 | 48.5 ± 3.5 |
| New Hoof Growth (mm) | 2.2 ±1.2 | 3.2 ± 1.0 |
| Birth Mass (kg)[1] | 4.5 ± 1.8 | 4.0 ± 1.0 |

[1] Birth masses of fawns with unknown parturition dates estimated by assuming an average daily mass gain of 0.2 kg since birth (Carstensen et al. 2009, Verme and Ullrey 1984).

**Table 2.** Carnivore capture data, Upper Peninsula of Michigan, USA, 16 March–15 June 2015.

| Species | ID | Capture date | Sex | Body weight (kg) | Right ear tag | Left ear tag |
|---|---|---|---|---|---|---|
| Black Bear | BB175 | 30-May | Male | 40.8 | 337 | 336 |
| Black Bear | BB176 | 5-June | Male | 67.1 | 334 | 335 |
| Black Bear | BB177 | 6-June | Male | 40.8 | 349 | 350 |
| Coyote | CO114 | 6-May | Female | 10.7 | 418 | 416 |
| Coyote | CO115 | 16-May | Male | 12.5 | 347 | 348 |
| Coyote | CO116 | 18-May | Female | 11.0 | 339 | 338 |
| Coyote | CO117 | 25-May | Female | 13.0 | NA | NA |
| Coyote | CO118 | 2-June | Male | 10.0 | 110 | 109 |
| Coyote | CO119 | 5-June | Female | 12.2 | 114 | 113 |
| Wolf | WO110 | 4-May | Female | 28.1 | 1110 | 1109 |
| Wolf | WO111 | 15-May | Female | 33.0 | 1238 | 1239 |
| Wolf | WO102 | 18-May | Male | 32.0 | 1104 | 1103 |
| Wolf | WO112 | 29-May | Female | 25.4 | 1117 | 1241 |

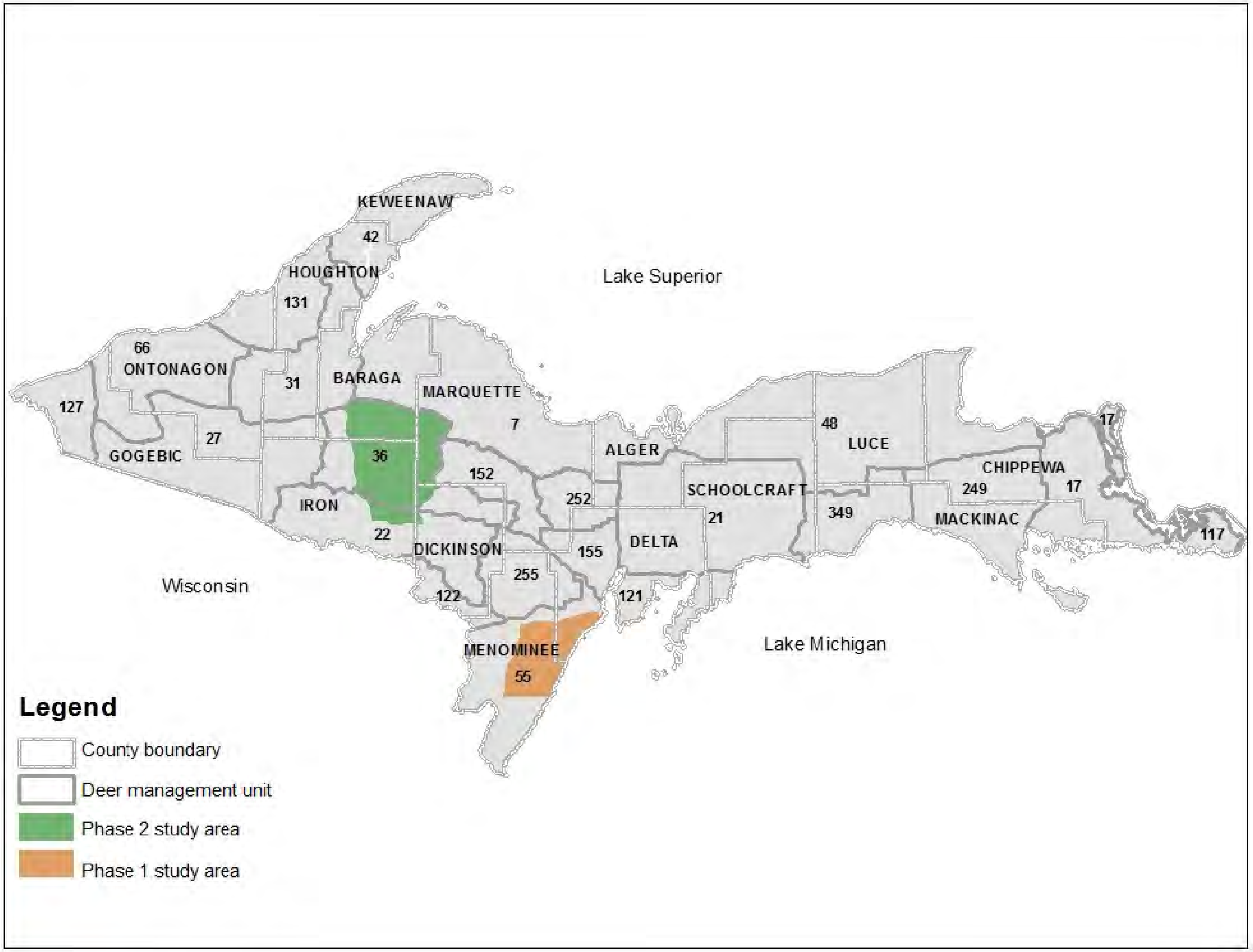


**Figure 1.** Location of phase 1 and 2 study areas and Michigan Department of Natural Resources Deer Management Units, Upper Peninsula of Michigan, USA, 2008–2015.

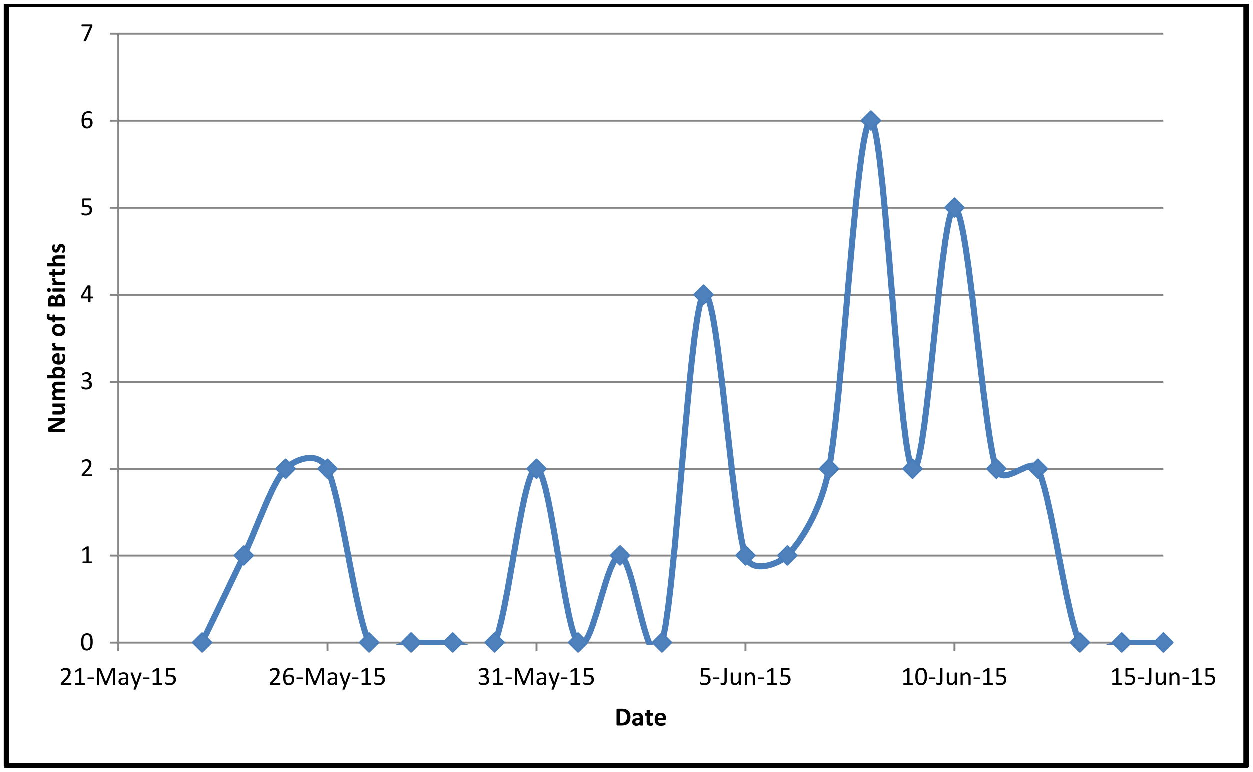


**Figure 2.** Estimated parturition dates of 27 free-ranging white-tailed deer fawns and 6 doe parturition events recorded using VITs, Upper Peninsula of Michigan, USA, 2015.

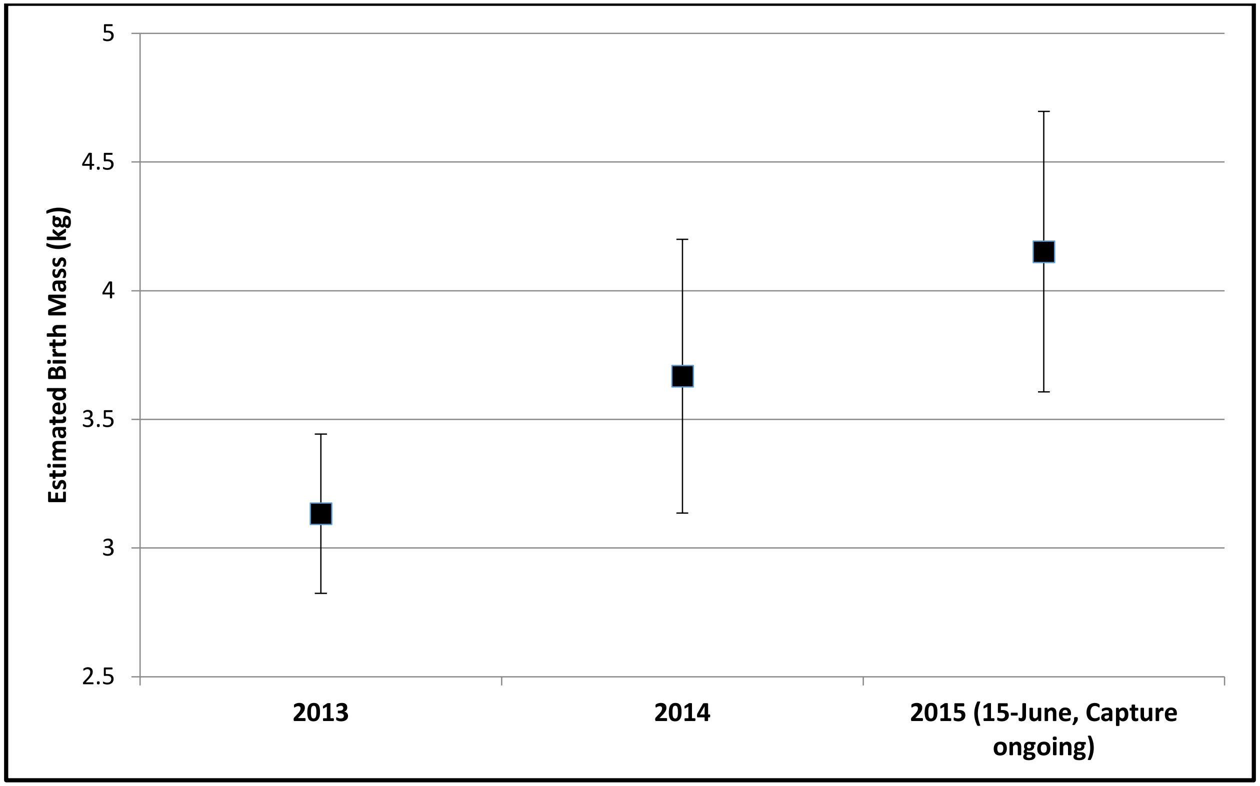


**Figure 3.** Mean estimated birth mass of captured white-tailed deer fawns for the Phase 2 study area, Upper Peninsula of Michigan, USA, 2013-2015 (2015 capture ongoing as of 15 June). Error bars reflect 95% confidence intervals.

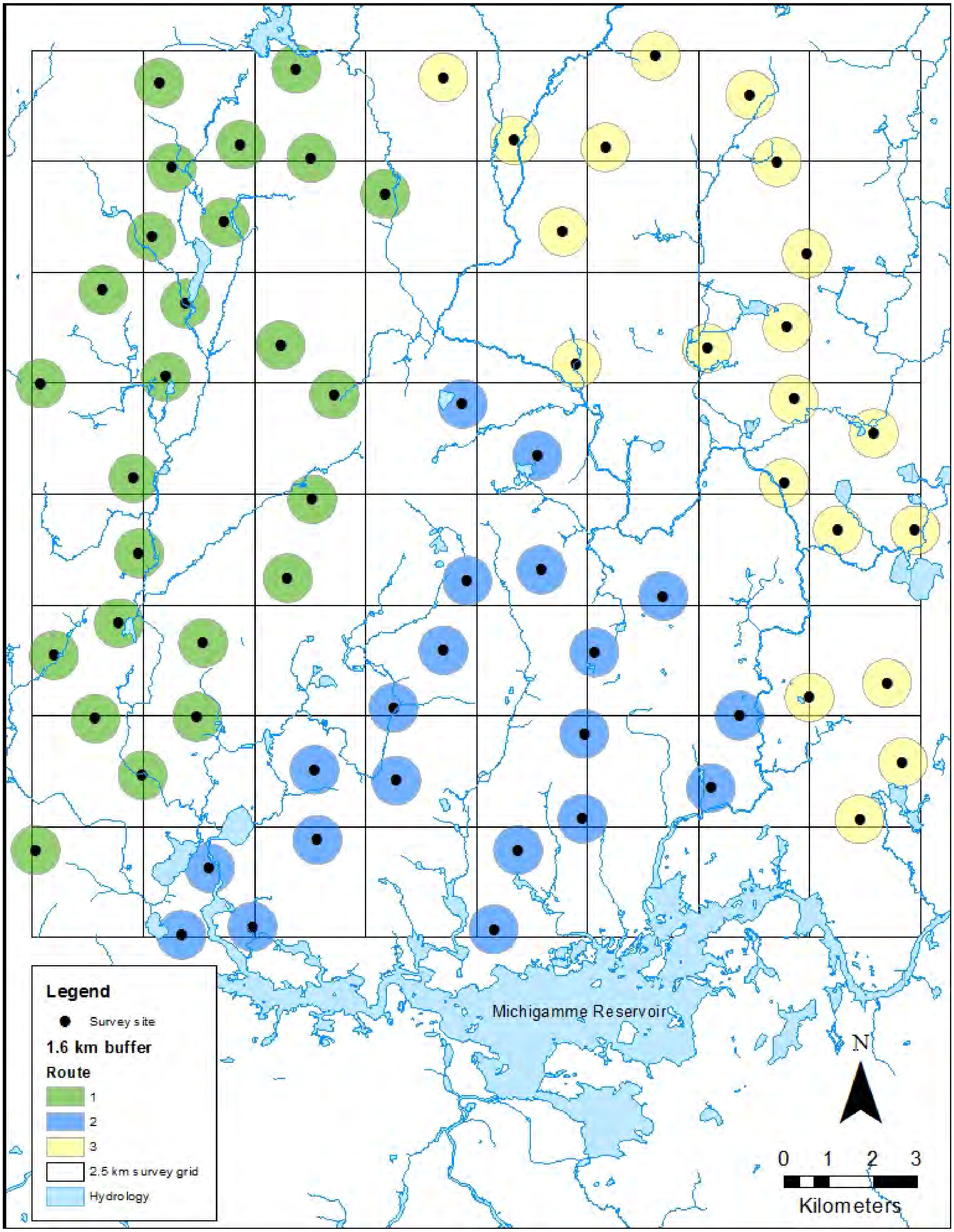


**Figure 4.** Locations of 65 grouse drumming survey sites with 3 routes shown to estimate ruffed grouse abundance, Upper Peninsula of Michigan, USA, 2015.

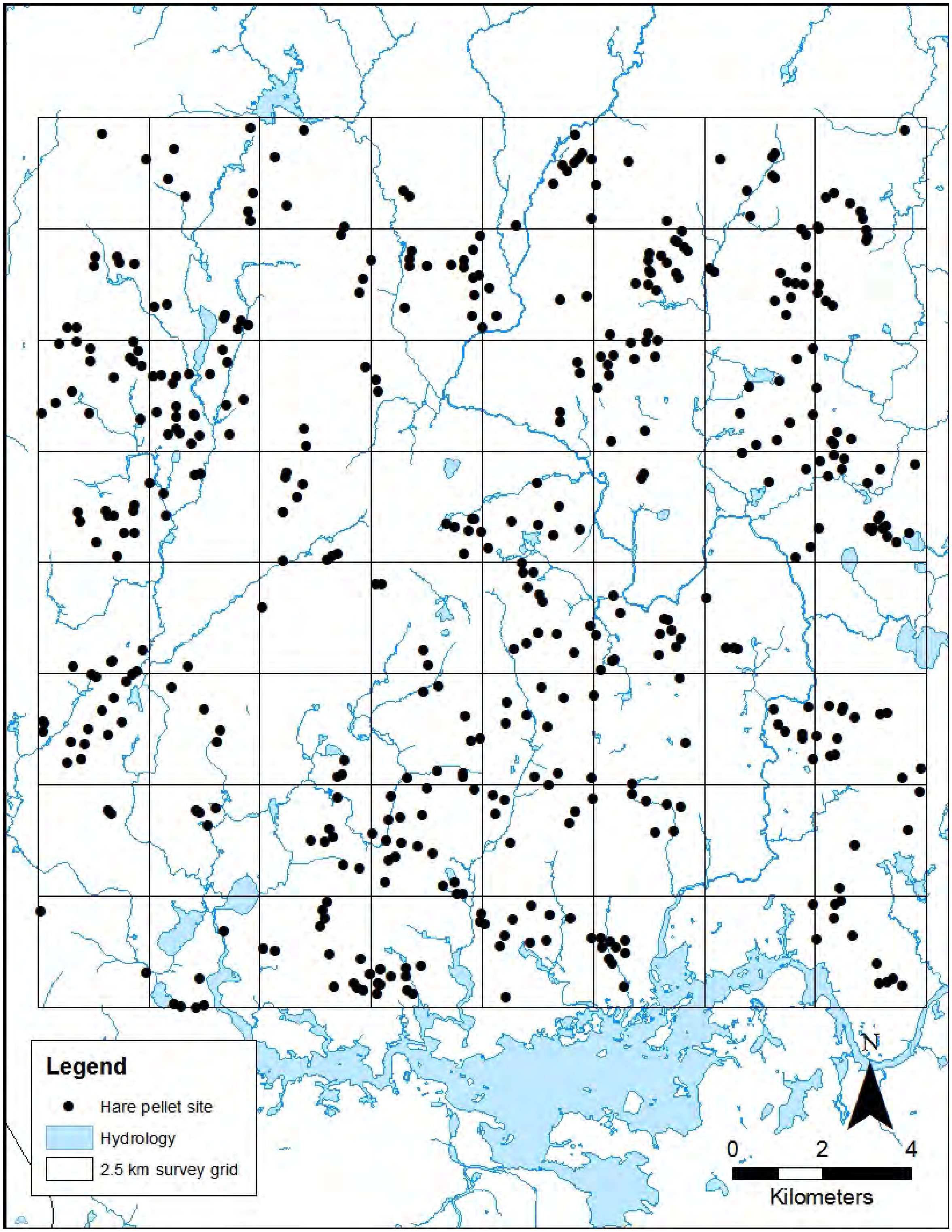


**Figure 5.** Locations of 448 completed hare pellet plot survey sites used to estimate snowshoe hare abundance, Upper Peninsula of Michigan, USA, 2015.

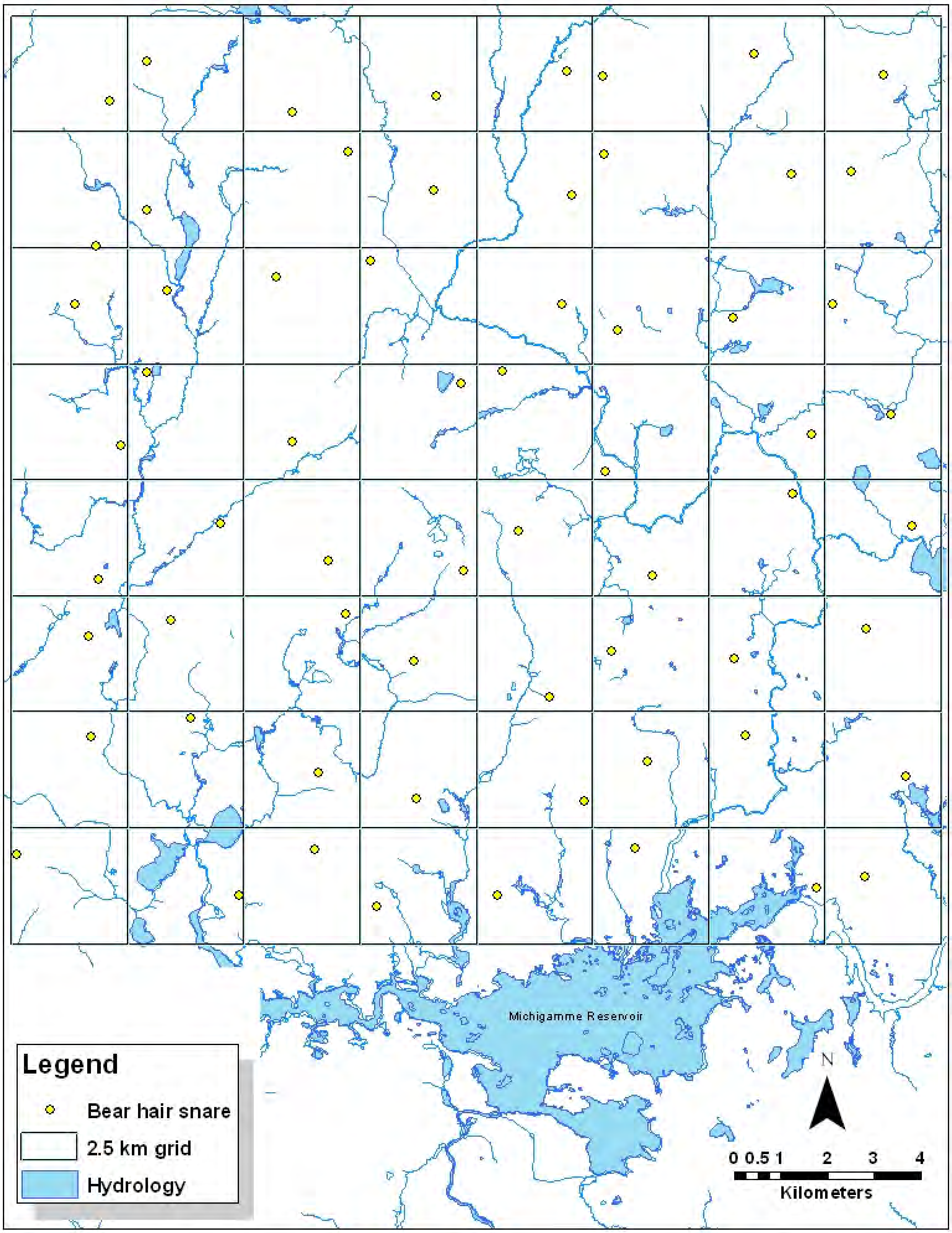


**Figure 6.** Locations of 64 black bear hair snares to estimate black bear abundance, Upper Peninsula of Michigan, USA, 2015.