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 13 (5 female, 8 male) neonate white-tailed deer fawns (*Odocoileus virginianus*) opportunistically or during VIT searches this quarter. Four of 7 VIT searches resulted in the location of ≥1 fawn; stillborn fawns were found at 2 independent VIT sites. Three adult female mortalities were attributed to wolf (*Canis lupus*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*); 76% of adult females radiocollared from 2009–2011 are alive. We obtained 754 adult females, 17 yearling, and 312 fawn (2010 and 2011) radiolocations during the quarter. We captured and fitted 6 adult (2 female, 4 male) black bears (*Ursus americanus*) with GPS radiocollars. One male black bear (BB43) was recaptured and had its radiocollar replaced. We also captured and fitted a bobcat (*Lynx rufus*; 1 male) and 9 coyotes (*Canis latrans*; 3 female, 6 male) with GPS radiocollars. One GPS collared male coyote was harvested and one female coyote was poached. Three wolves (*Canis lupus*; 3 female) were captured and fitted with GPS radiocollars. This quarter, 105 clusters (46 black bear, 14 bobcat, 35 coyote, 10 wolf) and 20 non-cluster locations (7 black bear, 2 bobcat, 8 coyote, 3 wolf) were investigated to determine potential predation locations. We collected 92 scats (36 coyote, 35 black bear, 11 wolf, 2 bobcat, and 8 unknown) this quarter. We recorded 635 alternate prey and deer observations. Project staff gave 4 presentations this quarter and hired 8 summer technicians.

Summary

- We captured and radiocollared 13 neonate fawns including 5 females and 8 males this quarter.
- We conducted 7 VIT searches and 4 resulted in the location of ≥1 fawn; stillborn fawns were found at 2 independent VIT sites.
- We observed 3 adult female mortalities which were attributed to wolf (*Canis lupus*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*); 76% of adult females radiocollared from 2009–2011 are alive.
- We obtained 754 adult females, 17 yearling, and 312 fawn (collared in 2010 and 2011) radiolocations during this quarter.
- We captured and fitted GPS radiocollars on 6 adult (2 female, 4 male) black bear, 1 bobcat (1 male), 9 coyotes (3 female, 6 male) and 3 wolves (3 female). .
- One male black bear was recaptured and had its radiocollar replaced.
- One GPS collared male coyote was harvested and one female coyote was poached.
- We collected 27,591 locations (10,738 black bear, 1,988 bobcat, 9,109 coyote, and 5,756 wolf) on carnivores this quarter.
- We investigated 105 cluster (46 black bear, 14 bobcat, 35 coyote, 10 wolf) and 20 non-cluster locations (7 black bear, 2 bobcat, 8 coyote, 3 wolf) to determine potential predation events.
- We collected 92 scats (36 coyote, 35 black bear, 11 wolf, 2 bobcat, and 8 unknown) this quarter.
- We conducted 46 random, 13 fawn, and 7 VIT vegetation surveys quantifying vegetation structure, composition, and density this quarter.
- We recorded 635 alternate prey, deer, and carnivore observations this quarter.
- Personnel hired 8 seasonal technicians and gave 4 presentations this quarter.

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 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 and 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) 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*) predation.

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 area 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. We selected this study area because of the relatively low snowfall and generally low winter severity. Deer in this area generally migrate only short distances or are non-migratory, making direct comparisons to southern Michigan (i.e., Pusateri Burroughs et al. 2006) easier.

Accomplishments:

Fawn Capture

Beginning mid-May, project staff began capturing, radiocollaring, and radiolocating white-tailed deer fawns. We captured and fitted 13 fawns with expandable radiocollars (model 4210, Advanced Telemetry Systems Inc., Isanti, MN) from 25 May–31 May 2010 (Figures 1), consisting of 5 females, 8 males. We captured 4 fawns during vaginal implant transmitter (VIT) searches. Personnel attached 2 individually numbered (#1–50) rectangular white flexible plastic ear tags to fawns (Figure 1) and attempted to collect fawn body weight and length, chest girth, and front shoulder length; saliva, blood, and hair samples; vitals; and identify sex. Bed site and surrounding habitat, flush distance, presence of dam, additional deer, dam behavior, and handling time were also recorded as available. Our mean fawn handling time was 14 min, compared to the mean of 25 min in 2009 and 24 min in 2010.

We conducted 7 Vaginal Implant Transmitter (VIT) searches in efforts to find fawns of implanted pregnant adult females from 18 May–31 May 2011. One additional VIT failed due mechanical failure of transmitter assembly and was recovered. We found ≥1 fawn, including a set of twins, at 4 of 7 VIT searches. Also, we found a still born fawn at 2 independent VIT sites.

Deer Mortality

This quarter, 3 radiocollared adult female mortalities occurred. One wolf predation occurred in early May along with 1 coyote and 1 bobcat predation in mid-May. No 2011 (n = 13) or 2010 (n = 18) radiocollared fawns died this quarter and all were monitored as of 31 May 2011. Also, 1 yearling captured as a 2009 fawn is still being monitored.

Deer Telemetry

Adult females– We monitored adults ≥1 time/week using aerial and ground telemetry. From 2009–2011 captures, 62 radiocollared adult females were being monitored as of 31 May 2011. We collected 754 radiolocations this quarter. Individual adult females (2009–2011) had 1–170 radiolocations depending on capture and censor dates.

Yearlings– We monitored yearlings (i.e., 2009 fawns) ≥1 time/week using aerial telemetry. Only 1 yearling was being monitored as of 31 May 2011. We collected 17 radiolocations this quarter. Individual yearlings captured in May–July 2009 had 2–87 radiolocations depending on capture and censor dates. We were unable to relocate 1 yearling this quarter, presumably due to radiocollar battery failure.

Fawns– We monitored 2010 and 2011 fawns ≥1 time/week using ground telemetry. Eighteen fawns captured in 2010 and 13 captured in 2011 were monitored as of 31 May 2011. We collected 215 and 97 radiolocations of 2010 and 2011 fawns, respectively, this quarter. Individual fawns had 1–10 radiolocations depending on capture date.

Carnivore Trapping and Monitoring

From 1 March–31 May 2011, we captured and immobilized 6 black bears (*Ursus americanus*; 2 female, 4 male), 1 bobcat (*Lynx rufus*; 1 male), 9 coyotes (*Canis latrans*; 3 females, 6 males), and 3 wolves (*C. lupus*; 3 female). We fitted 5 black bears (2 female, 3 male) with Lotek 7000MU GPS collars (Lotek Engineering, Newmarket, ON, Canada). We recaptured 1 male black bear that was previously collared and replaced its collar. One male black bear was not collared and was released. We recovered 2 GPS collars that slipped off a previously collared male and female black bear. Five GPS collared black bears (3 female, 2 male) radiocollared during den checks are being monitored resulting in 11 GPS collared black bears (5 female, 6 male) currently being monitored (Table 1). We fitted all captured bobcats and wolves with Lotek 7000SU GPS collars. We fitted 8 coyotes (3 female, 5 male) with Lotek 7000SU GPS collars. One captured coyote (1 male) sustained a broken leg, was released without a collar. One collared male coyote was harvested and 1 female coyote was poached resulting in 6 coyotes (2 female, 4 male) currently being monitored (Table 1). All collars were programmed to obtain a GPS location every 8 hours until 1 May, every 15 min from 1 May – 30 September and every 8 hr until the collars are removed. All 7000SU GPS collars include a drop-off mechanism to release collars 30 weeks after deployment. We can download all GPS location data remotely; this quarter 13 flights have occurred to download these locations.

This quarter, GPS collared black bears have worn collars from 1–91 consecutive days (mean = 41, SD = 45) resulting in 1–3196 locations per individual (mean = 883, SD = 1282). In 2011, black bears have worn collars from 2–165 consecutive days (mean = 58, SD = 62), resulting in 1–3546 locations per individual (mean = 895, SD = 1291; Table 2). All bobcats, coyotes, and wolves were captured this quarter. This quarter the bobcat has worn an active collar for 21 consecutive days resulting in 1988 locations. This quarter coyotes have worn active collars from 11–81 consecutive days (mean = 41, SD = 31) resulting in 1–2947 locations per individual (mean = 1012, SD = 1263). This quarter wolves have worn active collars from 10–18 consecutive days (mean = 15, SD = 5) resulting in 1000–2520 locations per individual (mean = 1919, SD = 808).

Carnivore Cluster Investigations

From 1 May–31 May we investigated 105 GPS location clusters identified using ArcGIS and the statistical software program R (R Development Core Team, Vienna, Austria) and 20 non-cluster locations selected opportunistically. A cluster was defined spatially as ≥8 locations within 50 m of each other within a 24–hour period. Of the 105 clusters, 46 were black bear (mean clusters/black bear = 12, SD = 5), 14 bobcat, 35 coyote (mean clusters/coyote = 9, SD = 1), and 10 wolf (mean clusters/wolf = 5, SD = 4). Of the 20 non-cluster locations, 7 were black bear (mean non-clusters/bear = 2, SD = 3), 2 bobcat, 8 coyote (mean non-clusters/coyote = 2, SD = 3) and 3 wolf (mean non-clusters/wolf = 2, SD = 2). Cluster location investigations are currently being analyzed.

Carnivore Mortality

As of 31 May, 1 collared male coyote was harvested by a hunter. One female coyote was poached and is still under investigation.

Bobcat Harvest Data

Unpublished MDNRE data for 2010–2011 harvest season were compiled and used to assess bobcat distribution and sex ratio in the study area. Distribution was assessed by plotting bobcat harvest locations by section in a GIS (Figure 2). Harvested bobcats from the study area (n = 14) included 6 females and 8 males. Two of the harvested bobcats had been previously collared on the project.

Carnivore Scat Collection

Carnivore scat samples were collected opportunistically throughout the study area; labeled by date, species, presence of tracks, and UTM coordinates; and frozen. This quarter 92 samples were collected (35 black bear, 2 bobcat, 36 coyote, 11 wolf, and 8 unknown scats).

From 2009-2011, we collected 986 scats consisting of 369 black bear, 41 bobcat, 324 coyote, 144 wolf, and 108 unknown. From 2009-2011, we have cleaned and sorted 348 samples of which 269 (94 bear, 3 bobcat, 120 coyote, 52 wolf) were analyzed. Scats are analyzed for presence of prey species (e.g., deer fawn) hair and other dietary items (e.g., berries and corn). Analysis of scats is ongoing.

Vegetation Surveys

We quantified vegetation structure, composition, and density at 46 random sites, 105 cluster sites, 20 non-cluster sites, 13 fawn capture sites, and 7 VIT sites. We chose random locations using a generalized random tessellation stratified (GRTS) design that was stratified by habitat classifications. For each location of interest (e.g., mortality site) a random site was randomly chosen from the list of GRTS sampled locations.

Alternate Prey, Carnivore, and Deer Data

This quarter, 635 alternate prey, deer, and carnivore observations were recorded (Table 3). Carnivore data included sightings and observations of tracks.

Public Outreach

Presentations:

Svoboda, N., T. Petroelje, J. Duquette, J. Belant, D. Beyer, and J. Fosdick. 8 Mar 2011. ***Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan.*** Menominee Rotary Club, Menominee, MI. 36 attendees.

Svoboda, N., T. Petroelje, J. Fosdick, J. Duquette, J. Belant, and D. Beyer. 18 April 2011. ***Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan.*** First Presbyterian Church men's group, Menominee, MI. 29 attendees.

Svoboda, N., J. Duquette, J. Belant, D. Beyer, T. Petroelje, and J. Fosdick. 16 April 2011. ***Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan.*** Safari Club International Michigan Involvement Committee Banquet, Gladstone, MI. 86 attendees.

Svoboda, N., J. Duquette, J. Belant, D. Beyer, T. Petroelje, and J. Fosdick. 18 May 2011. *Role of predators, winter weather, and habitat on white-tailed deer fawn survival in Michigan.* Wildlife Unlimited Annual Banquet, Gladstone, MI. 52 attendees.

Duquette, J. 16 May 2011. *The Wildlife Experience*. St. Charles Community High School, St. Charles, MI. 120 attendees.

Popular Articles:

The Mining Journal. 7 March 2011. "U.P. predator/prey research project finds good data". Website: < http://miningjournal.net/page/content.detail/id/559655/U-P--predator--prey-research-project-finds-good-data.html>.

The Daily Press. 7 March 2011. "Walking on the Wild Side". Website: <http://www.dailypress.net/page/content.detail/id/528946/Walking-on-the-Wild-Side.html>.

Outdoor Life magazine (online). "What's killing your deer?". <http://www.outdoorlife.com/photos/gallery/hunting/2011/03/whats-killing-your-deer>. Accessed 20 March 2011.

Website

We continue to update the project website (www.fwrc.msstate.edu/carnivore/predatorprey) with images and pertinent information. The website received 356,213 visits in 2010 (equivalent to 975 visits per day or about one visit every 40 seconds). Quarterly and annual progress reports posted on the website were downloaded 13,814 times in 2010 (equivalent to 38 downloads per day).

Project Crew Selection and Hires

We posted an announcement for seasonal wildlife technicians on the Texas A&M job board on 4 March and closed the announcement on 25 March. Forty–two applications were received, evaluated, and scored. We hired 8 individuals for the summer field season:

Alec Nelson
Cody Norton
Jasmine Reppen
Kelsy Payne
Eric Maringer
Eric Ness
Marie Tosa
Stephanie Raiman

Publications

Duquette, J.F., J.L. Belant, D.E., Beyer, N.J. Svoboda, and C.A. Albright. 2011. Bald Eagle predation of a white-tailed deer fawn. Northeastern Naturalist 18:87-94.

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

Duquette, J.F., J.L. Belant, D.E. Beyer, and N.J. Svoboda. *In Prep*. Interaction of serum leptin and body condition in female white-tailed deer. Journal of Wildlife Diseases.

Svoboda, N.S., J.L. Belant, D.E., Beyer, J.F. Duquette, H.K. Stricker, and C.A. Albright. 2011. American black bear predation of an adult white-tailed deer. Ursus 22:91-94.

Work to be completed (Jun–Aug):

Gear Organization, Inventory, and Storage

We will inventory all foothold, foot snare, and barrel traps before placing them in storage until further use. We will similarly organize, inventory, and store all carnivore trapping and immobilization gear that will not be used until 2011 winter den checks.

Radiotelemetry

We will continue to monitor all radiocollared deer ≥1 weekly. We will continue to locate adult females and fawns radiocollared in 2011 daily until 30 d post-parturition to monitor VIT tag expulsion (as available) and obtain locations. After the 30 d post-parturition period we will monitor all deer ≥3 times weekly. Radiocollared fawns and adult females associated with VIT searches will be monitored simultaneously to determine spatial relationship of dams and fawns.

Fawn Capture and Radiocollaring

We will attempt to capture and radiocollar ≥50 fawns. We will also locate radiocollared fawns ≥3 times/week through August, after which they will be located ≥1 time/week. We will investigate mortalities as soon as practical after detecting a mortality signal to determine cause of death. In addition, we will record fawn observations to assist in estimating the temporal range of fawning and twinning rates. Finally, we will monitor and occasionally flush collared fawns to observe whether a sibling is present and estimate the twinning rate.

Adult Deer Nutrition

All radiocollared female blood and urine characteristics have been received and will be statistically analyzed to determine the nutritional status of females.

Cluster Investigation

We will continue to investigate carnivore cluster locations through early–September to obtain information on predations events.

Vegetation Surveys

We will collect vegetation and habitat data at cluster locations, fawn birth site locations, predation sites, carnivore cluster locations and randomly selected predator locations beginning early–May.

Carnivore Scat Collection

We will continue to collect scats of focal carnivore species opportunistically throughout the study area for diet analyses. We will record date, GPS location, and species for each scat collected.

Alternative Prey and Deer Observations

We will continue to record daily start and end times in the field, as well as locations 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.

Public Outreach

We will continue to provide project presentations to the general public, university classes, and interested clubs or organizations.

Protocols and Manuals

All protocols and manuals are in final revision.

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Karen Brasher – Mississippi State University, Publications Editor/Web Designer
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Kelsy Payne	Eric Maringer	Eric Ness
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Table 1. Capture and monitoring data for 25 radiocollared carnivores, 15 January – 31 May 2011, Upper Peninsula of Michigan.

Species	ID	Capture date	Collar type	Sex	Weight (kg)	Rt ear tag	Lt ear tag	Days monitored	Total locs	Collar status
Black bear	[a]BB08	18-Feb-11	GPS	Female	149.7	180	NA	103	1675	Active
Black bear	BB14	11-Feb-11	GPS	Female	79.4	79	80	42	1	Inactive; Slipped
Black bear	[a]BB16	10-Feb-11	GPS	Female	NA	84	83	111	1318	Active
Black bear	[a]BB28	15-Jan-11	GPS	Male	140.6	1110	100	140	3196	Active
Black bear	[a]BB32	17-Feb-11	GPS	Female	70.3	10	6	104	1	Active
Black bear	BB33	21-Jan-11	GPS	Male	99.8	98	NA	21	1	Inactive; Slipped
Black bear	[a]BB44	17-Dec-10	GPS	Male	145.1	143	144	165	3521	Active
Black bear	BB53	25-May-11	GPS	Male	111.1	198	197	6	0	Active
Black bear	BB43	28-May-11	GPS	Male	111.1	137	212	3	318	Active
Black bear	BB54	29-May-11	GPS	Female	63.5	202	201	2	314	Active
Black bear	BB55	29-May-11	GPS	Male	88.5	42 (green)	151	2	252	Active
Black bear	BB56	29-May-11	GPS	Male	97.5	204	211	2	1	Active
Bobcat	BC08	10-May-11	GPS	Male	9.5	184	183	21	1988	Active
Coyote	[b]C21	5-Mar-11	GPS	Male	15.0	94	93	63	1	Inactive; Harvested
Coyote	[c]C22	8-Mar-11	GPS	Female	12.7	199	200	60	340	Inactive; Poached
Coyote	C23	10-Mar-11	GPS	Male	13.2	189	188	59	2802	Active
Coyote	C24	14-Mar-11	GPS	Female	13.6	140	136	55	16	Active
Coyote	C25	18-Mar-11	GPS	Male	15.4	96	194	51	2947	Active
Coyote	C26	9-May-11	GPS	Female	10.9	181	182	22	2150	Active
Coyote	C27	16-May-11	GPS	Male	12.7	192	191	15	840	Active
Coyote	[d]C28	16-May-11	GPS	Male	NA	193	192	15	1	N/A
Coyote	C29	20-May-11	GPS	Male	14.5	196	195	11	12	Active
Wolf	W08	5-May-11	GPS	Female	29.0	1118	1119	26	2520	Active
Wolf	W09	5-May-11	GPS	Female	NA	1121	1120	26	2236	Active
Wolf	W10	21-May-11	GPS	Female	27.2	1122	1123	10	1000	Active

[a] BB08, BB16, BB28, BB32, and BB44 were re-collared in den in 2011

[b] C21 was harvested

[c] C22 was poached

[d] C28 was unable to be radiocollared

Table 2. Monitoring data for 23 carnivores, Upper Peninsula of Michigan, 2011.

		1 Mar–31 May						1 Jan–31 May					
		Days Monitored			Locations			Days Monitored			Locations		
Species	n	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Black bear	12	41	45	1-91	883	1282	1-3196	58	62	2-165	895	1291	1-3546
Bobcat	1	21	0	21	1988	0	–	21	0	21	1988	0	—
Coyote	9	41	31	11-81	1012	1263	1-2947	33	21	11-59	1012	1263	1-2947
Wolf	3	15	5	10-18	1919	808	1000-2520	21	9	10-26	1919	808	1000-2520

Table 3. Alternative prey and carnivore sightings, 1 March – 31 May 2011, Upper Peninsula of Michigan

Alternative Prey	Observed	Carnivores	Observed
Deer	474	Wolf	1
Turkey	74	Skunk	2
Grouse	32	Coyote	2
Porcupine	22		
Squirrel	10		
Pheasant	6		
Rabbit	5		
Woodchuck	3		
Sm. Mammal	2		
Ant Mounds	2		

Figure 1. Ear tag (white) and expandable radiocollar (above) and neonate white-tailed deer fawn fitted with ear tags and radiocollar (below), Upper Peninsula of Michigan, 2011.

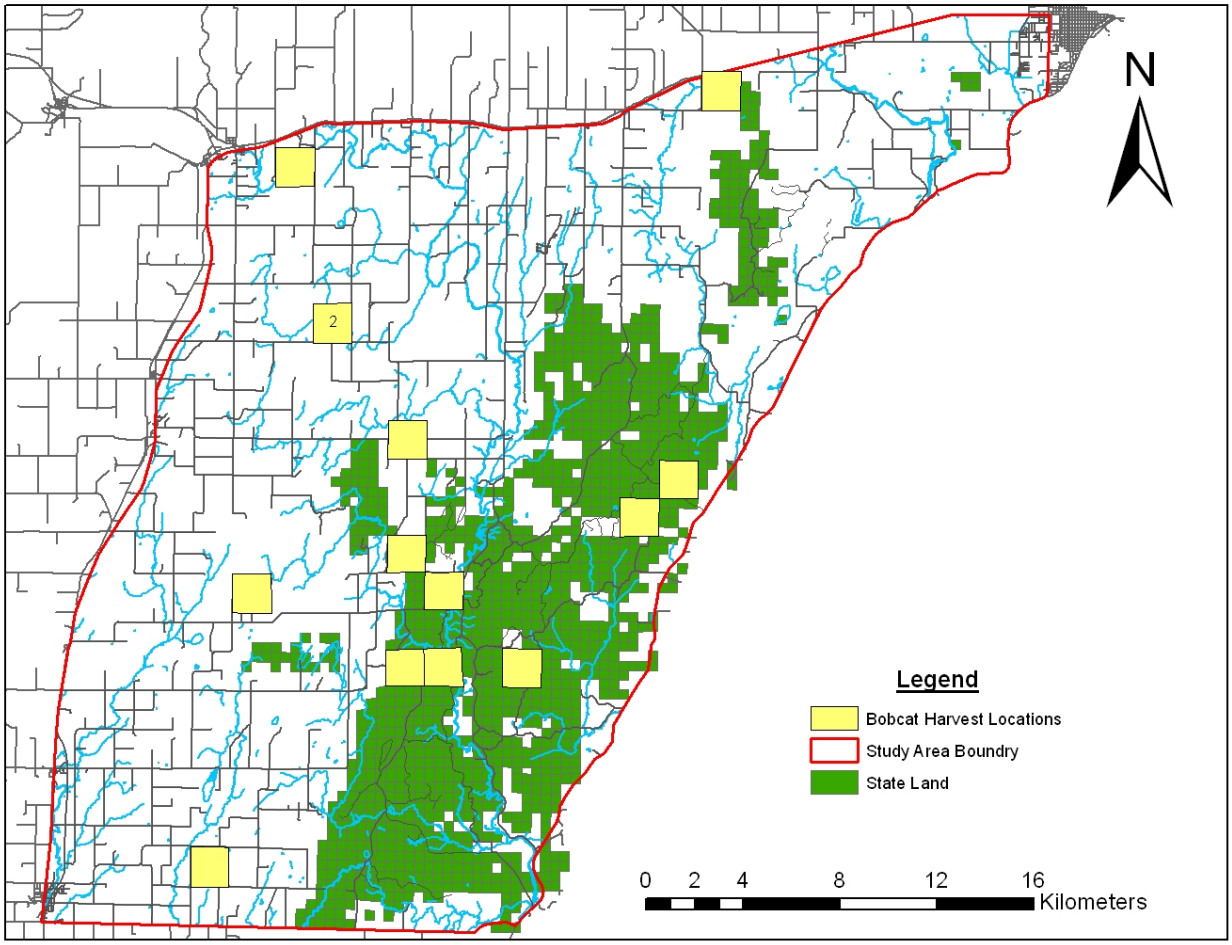

Figure 2. Location by section of bobcats harvested (n = 14) in 2010-2011 within the study area in Delta and Menominee counties, Upper Peninsula of Michigan.