Black Bear Project On Fort Drum Military Installation Oct 2004 – Apr 2007

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2011

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Background Information

Black bears (*Ursus americanus*) are the most widely distributed members of the Ursidae family in North America. Formerly ranging from northern Mexico to Alaska and across the contiguous United States, black bear populations are now fragmented from historical over-harvest and habitat loss. However, many bear populations including those in New York State (NYS) are increasing in size and reoccupying more of their historical range (NYSDEC 2007).
In NYS, black bears are considered a big game animal and managed by the New York State Department of Environmental Conservation (NYSDEC).

Historically, NYS has had three distinct populations of black bears in northern, western, and southeastern New York centered in the Adirondack Range, Alleghany Range, and Catskill Range, respectively (McCaffery et al. 1974, 1976 as cited in NYSDEC 2007). Due to the expansion of bear populations in southern New York over the last 30 years, the Allegany and Catskill Ranges have merged and are now considered the Southern Black Bear Range; likewise, the bear population in the Adirondack Range has expanded slightly and is now referred to as the Northern Black Bear Range (Figure 1; NYSDEC 2007). The Northern Black Bear Range covers approximately 33,200 km^2 (12,800 mi^2) and includes the 24,700 km^2 (9,400 mi^2/6.1 million ac) Adirondack Park (NYSDEC 2007). Most of Adirondack Park is public land consisting of State Forest Preserve which cannot be developed or logged.

The western edge of the Northern Black Bear Range includes Fort Drum Military Installation (Fort Drum). Fort Drum is designated as Wildlife Management Unit 6H and is part of the northern zone where bear hunting is allowed. In 2002 and 2003, Fort Drum's Fish & Wildlife Management Program observed an increase in the number of negative human-black bear interactions and expressed a need to investigate methods for reducing these conflicts while also describing black bear demographics on the installation. The following objectives were developed: (1) test a newly developed technique for aversive conditioning of nuisance black bears; (2) estimate the black bear population on Fort Drum; and (3) determine home range size, movements, and den site use. A fourth objective to quantify mast production as an indicator of food abundance was dropped due to time and resource constraints. However, a fifth objective was added later by researchers to determine habitat preferences of black bears.

This project was initiated by Fort Drum's Fish & Wildlife Management Program with the majority of funding provided by Fort Drum. The project was carried out by the New York Cooperative Fish and Wildlife Research Unit at Cornell University under the guidance and support of Milo Richmond. Guidance and support was also provided by Louis Berchelli, New York State Department of Environmental Conservation. Jaime Marhevsky provided geographic information system (GIS) support for the home range analysis. Project grants were also provided by the Northeast Wildlife Damage Management Cooperative and Doris Duke Foundation. Other project cooperators were Fort Drum's Range Branch, Cornell's College of Veterinary Medicine, and Fort Drum's Commissary.

Figure 1. Black bear populations in NYS in relation to Fort Drum Military Installation.

Study Area

Fort Drum is a 43,408 ha (107,265 ac) U.S. Army installation located in northwestern New York (Figure 1). The study area was 16,334 ha (40,361 ac) of contiguous habitat in the Training Area where year-round military training occurs (Figure 2). This area was selected due to the high incidence of nuisance black bear complaints in 2002 and 2003 and its proximity to the Cantonment Area to reduce travel time. The majority of the northern edge of the study area is bordered by the Indian River. The Main Impact Area (6,184 ha / 15,281 ac) is located across the Indian River and is inaccessible to personnel due to unexploded ordnance. The southern edge of the study area is generally the installation boundary and includes a short stretch of the Black River. The western and eastern edges of the study area are the installation boundaries and U.S. Hwy. 11 and NYS Rte. 3, respectively. Fort Drum has an extensive network of roads and trails and is generally accessible to vehicles. There is no permanent human habitation within the study area, but soldiers routinely establish temporary bivouac areas while training.

There are 5 ecoregions on Fort Drum; however, the majority of the study took place in the Eastern Ontario Plains Ecoregion which is approximately the southern third of the installation. The Eastern Ontario Plains has an average elevation of 208 m (682 ft) with a range of 150 - 263 m (492 - 862 ft); the average slope is 3.5%. The Eastern Ontario Plains ecoregion is characterized by hillocks formed from recessional moraines and drumlins, and small plains dominated by sandy soils including some areas with sand over 30 m (100 ft) deep. Wetlands are relatively common throughout the installation. There are various vegetative communities represented within the study area (Fort Drum 2011).

A portion of the study area are sandplain grasslands and oak savannah. The sandplain grasslands are characterized by low growing sedges and grasses, fewer than 30 cm (12 in) tall with widely scattered trees. White oak (*Quercus alba*) and northern red oak (*Q. rubra*) dominate the savannah areas. White pine (*Pinus strobus*), lowbush blueberry (*Vaccinium angustifolia*), blackberry (*Rubus fruricosis*), raspberry (*Rubus idaeus*), bush honeysuckle (*Diervilla lonicera*), and whorled loosestrife (*Lysimachia quadrifolia*) are associated with the oak savannahs. Other forest habitats include northern mixed forests of sugar maple (*Acer saccharum*), hemlock (*Tsuga canadensis*), and quaking (*Populus tremuloides*) and bigtooth aspen (*Populus grandidentata*); as well as deciduous lowland forests which are predominantly sugar maple, oak (*Quercus spp*.) and American beech (*Fagus grandifolia*). Because much of the southern half of Fort Drum was agricultural land until 1940, much of the forest is still in the early stages of natural succession (Fort Drum 2011). The general land cover types and acreages of the study area are included in Table 1.

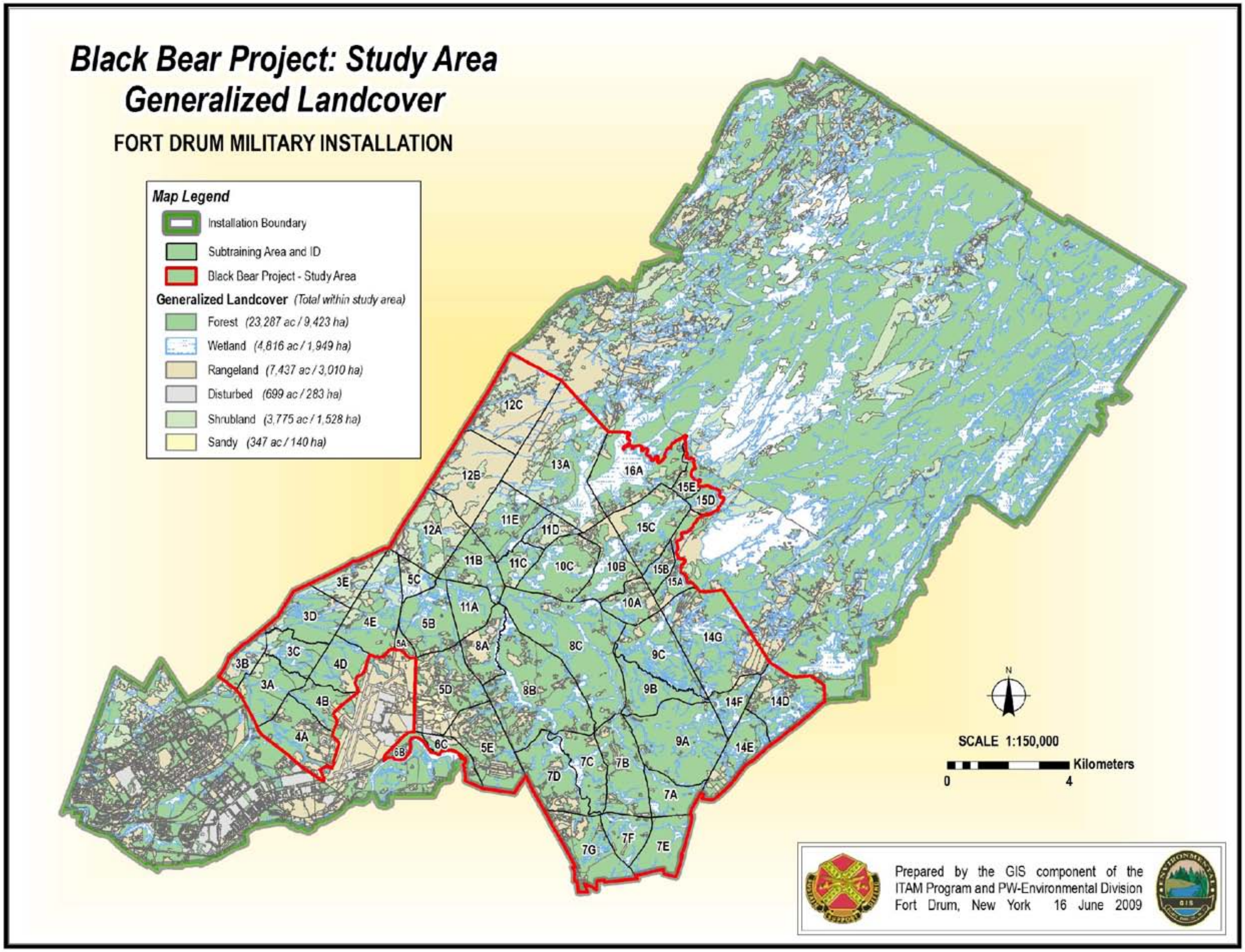

Figure 2. Study area and general land covers types on Fort Drum Military Installation. Note: Alphanumeric symbols denote installation subtraining area names.

Table 1. Land use/land cover area in the study area and on the entire Fort Drum Military Installation.

	STUDY AREA		FORT DRUM TOTAL AREA	
Types	**Acres**	**Hectacres**	**Acres**	**Hectacres**
Forest Upland	23,287	9,424	66,237	26,805
Forest Wetland	1,580	640	8,278	3,350
Shrub Upland	3,775	1,528	2,549	1,031
Shrub Wetland	1,728	699	4,738	1,917
Graminoid Community Upland	6,177	2,500	6,561	2,655
Graminoid Community Wetland	391	158	2,189	886
Forb Community Upland	935	378	5,058	2,047
Forb Community Wetland	69	28	279	113
NonVascular Upland	0	0	13	5
NonVascular Wetland	0	0	15	6
Surface Water Lake	49	20	803	325
Surface Water Stream	113	46	2,205	892
Surface Water Drainage	743	301	1,669	675
Developed Hardscape	699	283	5,259	2,128
Developed Landscaped	320	129	2,645	1,070
Other Bedrock	0	0	184	75
Other Sand	347	140	327	133
Other	148	60	15	6
Fort Drum (Total)	40,361	16,334	109,024*	44,119

* Although Fort Drum is officially recognized as 107,265 ac in size, based on GIS coverages, the total land area is 109,024 ac.

CHAPTER 2
Capturing, Marking & Tracking Black Bears on Fort Drum

Capturing & Handling Methodology

Black bears on Fort Drum were captured either with leg snares or culvert traps between September – November 2004, April - September 2005, and May - August 2006. Snares were spring-activated Fulton leg snares (The Snare Shop, Carroll, Iowa, USA; Figures 3-5).

Figure 3. Setting a Fulton leg snare. Note the cable attached to a tree to keep the bear from leaving the area.

Figure 4. The final arrangement of a snare set with trees used to lead the bear towards the bait and the snare. Note the snare is sprung and the cable visible in this photo.

Figure 5. Bear 026 captured in a snare.

Culvert traps were built especially for use on Fort Drum based on the best attributes of two different culvert traps used by NYSDEC. This “Fort Drum hybrid” version was designed to be handled by two people when empty and be transported in the back of a full-size pick-up (Figures 6-8).

Traps were located throughout the study area in likely areas with known or suspected bear activity. Traps were baited with ham, bacon, sardines, and/or road-killed white-tailed deer (*Odecoileus virginianus*).

Figure 6. Side view of "Fort Drum hybrid" culvert trap.

Figure 7. Inside of the "Fort Drum hybrid" culvert trap.

All captured bears were anesthetized with a 2:1 mixture of ketamine and xylazine hydrochloride (Clark et al. 2005). The immobilizing drug was administered at a rate of 7.4 mg/kg ketamine and 3.7 mg/kg of xylazine hydrochloride and delivered via jabstick, dart gun, or blowgun in an intramuscular injection (Figure 8). If necessary, yohimbine was administered as an antagonist intravenously to the sublingual vein after processing (Clark et al. 2005). Temperature, pulse, and respiration were all monitored while bears were under anesthesia. All capture and handling procedures followed the Animal Care and Use Protocol No. 04-52 approved by the Cornell Center for Animal Research and Education.

Figure 8. Bear 037 being anesthetized with a jab stick in the culvert trap.

Bears in dens were captured by simply anesthetizing the bear using a dart gun or blowgun, depending on the situation.

Biological Measurements, Marking Methodology & Radio Telemetry

All captured bears were weighed to the nearest lbs and measurements were taken based on Figure 9 including: contour length (A-1), girth (B), neck circumference (D), head length (E), head width (F), and head circumference (F-1) to the nearest cm; and foot measurements (G-N) to the nearest mm. See Table 22 and 23 for results.

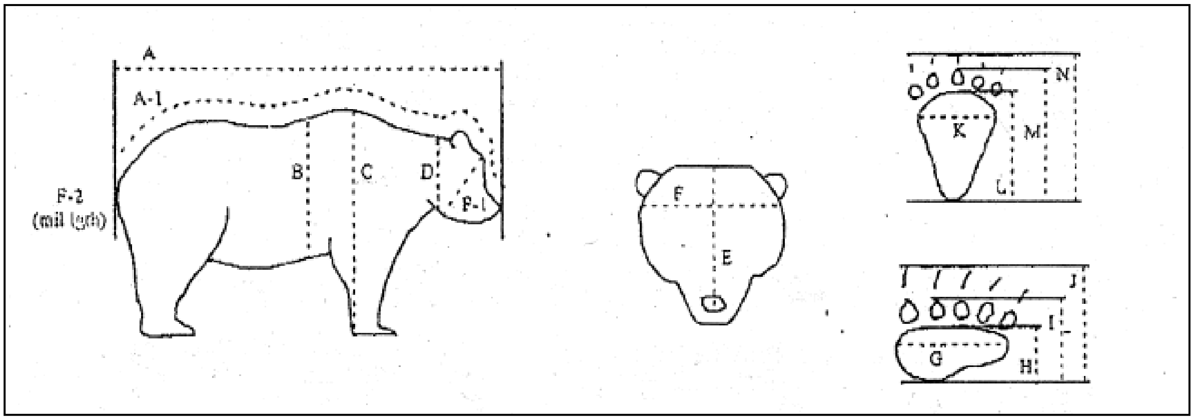

Figure 9. Measurements taken of bears on Fort Drum Military Installation recording contour length (A-1), girth (B), neck circumference (D), head length (E), head width (F), and head circumference (F-1); and foot measurements (G-N).

One first upper premolar was removed from each bear for aging by cemetum annuli analysis (Willey 1974). Teeth were submitted to NYSDEC and tooth sectioning, staining and age assignment were conducted by Matson Laboratories (Milltown, Montana, USA; http://www.matsonslab.com/index.htm).

Cubs found with females in the den were weighed, and their ear length and the length of hair behind the sagittal crest were measured to estimate the date of birth (Bridges et al. 2002).

Figure 10. Taking measurements on Bear

Figure 11. Tattoo under the upper lip on Bear 036.

Each bear received a unique number tattoo (Figure 11) on the inside of one of the upper lips (Clark et al. 2005). Monel ear tags (size: 1 x 4 cm) with a unique number (e.g., FD026) was attached to one ear. Two fabric ear streamers approximate 2 x 14 cm were attached in both ears with a unique color combination in order to identify individual bears from a distance (Figure 12).

Each bear that was large enough (≥100 lbs / 45 kg) was fitted with a radio-collar. In 2004 and 2005 locally made radio-collars by a NYSDEC employee were retrofitted for use from an earlier deer project. These radio collars were 5.5-cm wide and 0.2-cm thick, and operated in the VHF frequency between 150 and 152 MHz. The antennas were internal within the leather neckband. Double-battery collars were designed to last 4 years. A canvas break-away spacer was installed to allow the collar to naturally fall off over time if the bear could not be captured in the future. Unfortunately, these collars were readily removed by bears at the point of the canvas spacer (Figure 13) and loss of the collars was a significant problem during the first field season. It is assumed that the collars—because they were oval-shaped to fit the neck of deer from a previous project—rubbed the sides of the bears' necks and acted as an irritant causing the bears to scratch at them and subsequently tear the collars off. Additionally, the radio signal emitted by these collars was not as strong as radio collars used in 2006.

Figure 12. Ear streamers, ear tag, and radio collar attached to Bear 026.

Beginning March 2006, new radio collars specifically built for the project (MOD-500 VHF radio-collar by Telonics, Inc., Mesa, AZ) were deployed on all newly captured bears. Earlier collars were replaced opportunistically as bears were recaptured. The new radio collars were naturally round in shape when fastened and the spacer was made of leather rather than canvas. None of the new collars were removed by bears.

Figure 13. Attaching an older model radio collar to Bear 026. Note the canvas spacer near the hands of the researcher.

Personnel attempted to collect radio-telemetry locations on all collared bears 2-3 times per week. A Communications Specialists, Inc., R-1000 receiver (Orange, California, USA) with a 3-element yagi antenna (Figure 14) was used in conjunction with a compass to take readings of the radio-collared bear. Three azimuths between 45 and 135 degrees of each other were taken within 20 min for each location (Clark et al. 2005). Additional azimuths (up to 8) were used if they fell into the 20 min timetable of the three required azimuths. If the animal was accessible by road, radio-telemetry from the ground was used to collect triangulated locations. Due to erratic and sometimes long distance movements by study animals, radio-telemetry was performed from fixed-wing aircrafts as needed. The radio signal was located from the air and a general location was recorded as a UTM (Universal Transverse Mercator) reading.

All radio-telemetry data were collected June - September 2005 and May - October 2006. The minimum number of radio locations desired was 5 locations at dawn, 5 locations at dusk, 10 locations at night and 10 locations during the day. Dawn was considered 1.5 hrs before sunrise until 1.5 hrs after sunrise. Dusk was considered

1.5 hrs before sunset until 1.5 hrs after sunset. Night was considered 1.5 hrs after sunset until 1.5 hrs before sunrise. Day was considered 1.5 hrs after sunrise until 1.5 hrs before sunset. (The purpose of this protocol was to account for all activity patterns of the study animals.) Consecutive locations on a study animal were separated by at least 24 hrs to ensure independence (Clark et al. 2005). Occasionally, bears were visually sighted during attempts to collect radio-telemetry locations. If these sightings met the independence requirement, the UTM coordinates where the bear was located was recorded.

Figure 14. Taking radio telemetry locations with a 3-element yagi antenna.

All investigators were required to perform error testing. Radio-collars were placed in locations unknown to the investigator. An azimuth was recorded by the investigator and compared to the actual azimuth from the investigator's position. The collar locations were spaced between 50 and 1000 m (164 and 3281 ft) from the investigator. Each investigator was required to record at least 30 error testing azimuths, with at least 2 in each of the 6 general habitat types.

Table 2. Capture and marking information for each study animal on Fort Drum from 2004-2006.

Sex	Age	Date of Capture	Method of Capture	Town of Capture	Monel Ear Tags	Streamer Ear Tags
F	1.5	10/6/2004	Snare	Wilna	FD026	Orange/Orange
F	1.75	3/9/2005	Den	Wilna	FD027	Yellow/Black
M	6.25	4/16/2005	Culvert	Wilna	FD028	Blue/Blue
F	5.25	5/24/2005	Snare	LeRay	FD029	Red/Red
M	11.25	5/28/2005	Culvert	LeRay	FD031	Green/Yellow
M	3.25	6/20/2005	Culvert	LeRay	FD032	Red/Green
F	9.5	6/25/2005	Snare	Wilna	FD033	Green/Green
F	14.5	6/25/2005	Snare	Wilna	FD034	Red/Black
M	0.5	6/25/2005	Snare	Philadelphia	FD035	Not tagged
F	13.5	6/30/2005	Culvert	Wilna	FD036	Red/Yellow
F	4.5	7/6/2005	Culvert	Wilna	FD037	Yellow/Yellow
F	7.5	5/28/2006	Snare	Philadelphia	FD038	Orange/Green
M	3.5	6/5/2006	Culvert	LeRay	FD039	Red/White
F	1.5	6/21/2006	Snare	Wilna	FD040	Yellow/White
F	5.5	6/22/2006	Snare	Wilna	FD042	Orange/White
M	10	7/10/2006	Culvert	Wilna	FD043	Blue/White
M	3.5	7/12/2006	Snare	Wilna	FD044	Yellow/Yellow
F	10	7/25/2006	Culvert	Wilna	FD045	Yellow/Blue

CHAPTER 3

Spatial information on black bears on Fort Drum

Introduction

Management of black bear populations requires an understanding of spatial requirements. Individual black bears may utilize large areas to acquire all resources necessary to fulfill energy, shelter, and cover requirements (Grogan 1997). Because of this, black bears have been described as "landscape" species (Samson and Huot 1998), implying that management should focus on a large spatial scale.

Methods

Spatial information was collected from a variety of sources. Radio-telemetry data was collected on all individuals (as explained in Chapter 2). Other investigations in this project provided additional spatial information including capture and den locations, encounters with hair traps (determined through DNA analysis of hair samples), and encounters with aversive conditioning bait stations (determined through DNA analysis of hair samples and/or photos). (Methods for hair traps and aversive conditioning bait stations are explained in Chapters 6 and 7, respectively.)

Black bear spatial data were incorporated into a GIS and utilized to delineate estimates of home range size and extent. Using Hawth's Analysis Tools for ESRI's ArcGIS (Beyer 2004), home ranges were calculated using two distinct techniques: minimum convex polygons (MCP; Mohr 1947) and kernel density estimator (Worton 1989). Both methods are commonly cited in the literature for delineating the home ranges of black bears (Horner and Powell 1990, Oli et al. 2002, Lee and Vaughn 2004, Endurat et al. 2005).

Simplistic in construction, the minimum convex polygon method computes the minimum possible area that contains all points within a given dataset. Sensitive to sample size and outliers, this methodology provides a conservative home range estimate and describes only the extent of an animal's range (Giesen and Braun 1992). In this study, minimum convex polygons home ranges were calculated for only those bears who met the minimum protocol for a formal spatial analysis.

A non-parametric statistical method, the kernel density estimator has no shape assumptions and produces the probability density function of a random variable. Moreover, unlike minimum convex polygons, the kernel density estimator is not sensitive to the effects of sample size and addresses intensity of use in an animal's home range (Seaman and Powell 1996). For comparative purposes, fixed kernel density home range estimates were calculated for all bears in this study using the quartic approximation of a true Gaussian kernel function (Beyer 2004). In addition, 95% by volume contours were produced representing the boundary of the area that contains 95% of the volume of the probability density distribution.

Results

Not enough individuals were captured in each age and/or sex cohort to generate enough data for comparison between cohorts. Males were much more difficult to locate via radio-telemetry than females, resulting in incomplete home range calculations. Radio-telemetry efforts in 2004 and 2005 were hampered by an unexpectedly high rate of the loss of radio-collars (see Chapter 2). These factors combined to make statistical inferences between and within some cohorts impossible.

Only 5 individuals—all adult females (036, 037, 038, 042, 045)—met the minimum protocol for a formal spatial analysis using 95% minimum convex polygons and 95% fixed kernel estimators. Data for these 5 bears included 169 radio-telemetry points and 7 visual sightings. Capture locations (n = 5) and hair trap captures in which the individual was identified via genetic analysis (n = 16) were used for home range estimation. The mean 95% fixed kernel summer/fall home range estimate was 15.09 km^2 (SD=4.89 km^2; Figures 22a, 23a, 24a, 26a, and 29a). The mean MCP home range estimate for the same data set was 12.17 km^2 (SD=3.94 km_2; Figures 22b, 23b, 24b, 26b, and 29b). The mean home range overlap for the 95% fixed kernel home range estimate was 53.35% (SD=20.66%; Figure 30). The mean error in radio-telemetry readings was 5.6° with no significant difference between individuals (p=0.210).

Table 3. Home range information for Bears 036, 037, 038, 042, and 045 in 2006 on Fort Drum Military Installation.

Bear	Sex	Age (Years)	Home Range Estimate			
			KDE - 95% Volume Contour (Acres)	KDE - 95% Volume Contour (Hectares)	Minimum Convex Polygon (Acres)	Minimum Convex Polygon (Hectares)
036	Female	13.5	8,723.73	3,530.37	4,380.14	1,772.58
037	Female	4.5	5,775.65	2,337.32	2,169.56	877.99
038	Female	7.5	5,521.60	2,234.51	1,988.31	804.64
042	Female	5.5	6,891.23	2,788.78	3,181.09	1,287.34
045	Female	10	7,074.53	2,862.96	3,328.20	1,346.87

Available spatial information for other bears is presented in a qualitative framework which may allow for some insights to black bear use of space on Fort Drum. Spatial information for these 10 bears included 100 radio-telemetry locations, visual encounters, and documented encounters to aversive conditioning bait stations and hair traps. As insufficient data were gathered to generate home ranges for these bears, all forms of spatial data were pooled for each individual to create an "area of known use" (Figures 15-21, 25, 27, and 28). The areas of known use were calculated as 95% kernel home ranges, although they do not actually represent true home ranges. Long range movements were observed for three bears and are documented in Figure 31.

Table 4. Areas of known use for bears on Fort Drum Military Installation with inadequate information in 2005 and 2006 to determine complete home ranges.

Bear	Sex	Age (Years)	Home Range Estimate KDE - 95% Volume Contour (Acres)	Home Range Estimate KDE - 95% Volume Contour (Hectares)
026	Female	1.5	9,962.08	4,031.51
027	Female	1.5	4,146.74	1,678.13
028	Male	6.25	10,288.89	4,163.77
029	Female	5.25	4,733.03	1,915.39
031	Male	11.25	6,762.70	2,736.77
032	Male	3.25	9,584.89	3,878.87
034	Female	14.5	7,394.50	2,992.45
039	Male	3.5	20,822.40	8,426.53
043	Male	10	15,643.80	6,330.82
044	Male	3.5	20,740.84	8,393.52

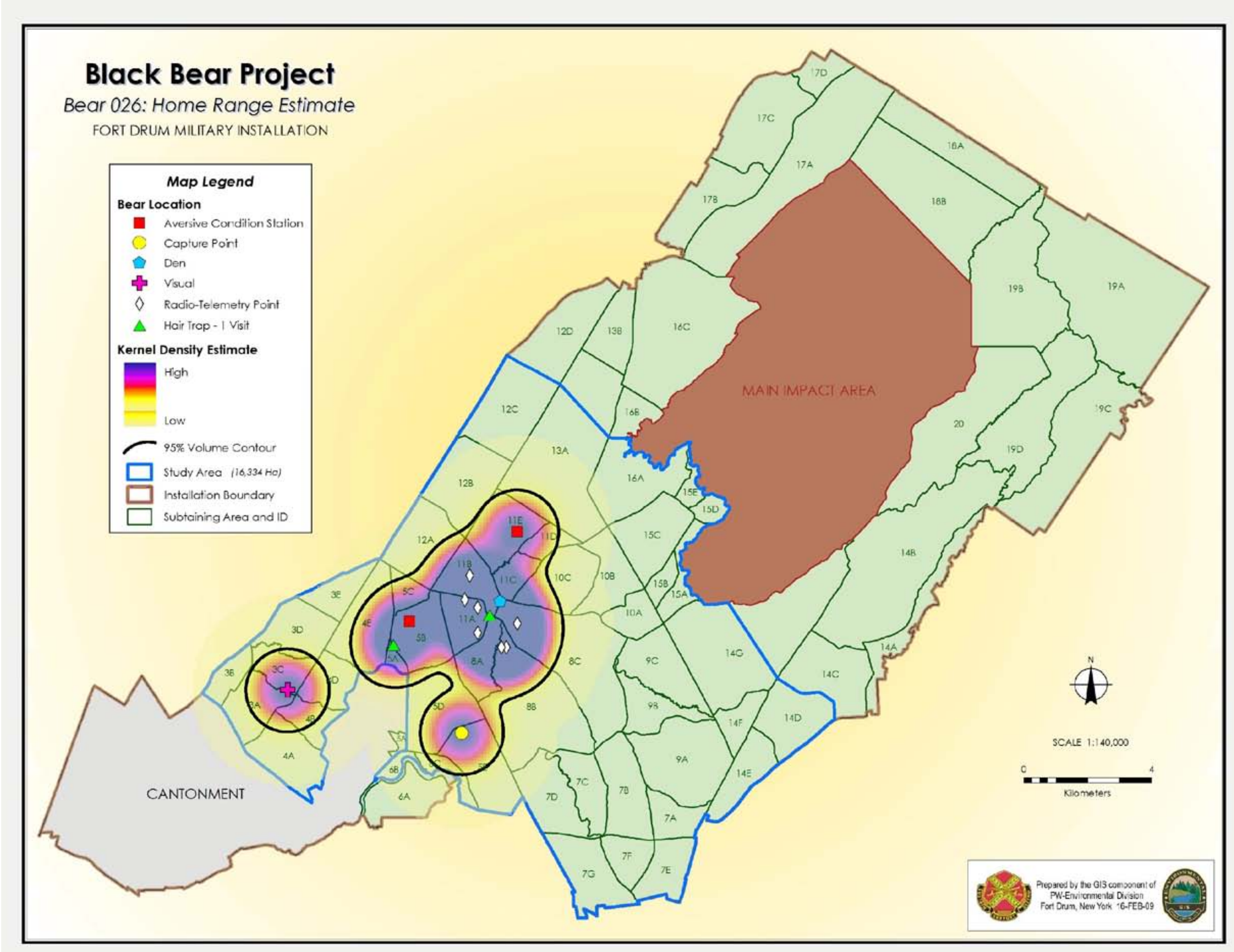

Figure 15. Area of known use for Bear 026 on Fort Drum Military Installation in 2005 and 2006 based on 95% kernel density estimates.

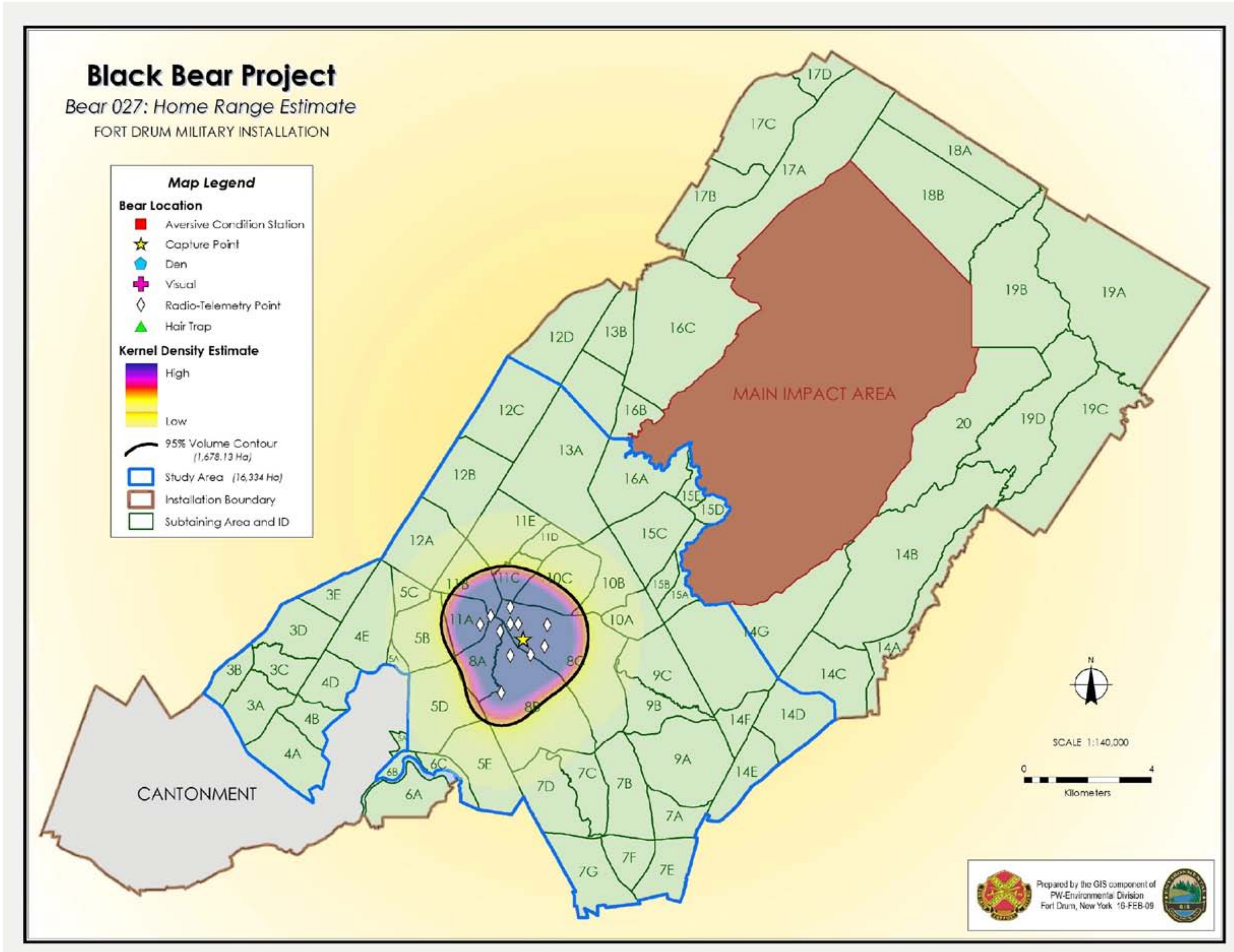

Figure 16. Area of known use for Bear 027 on Fort Drum Military Installation in 2005 based on 95% kernel density estimates.

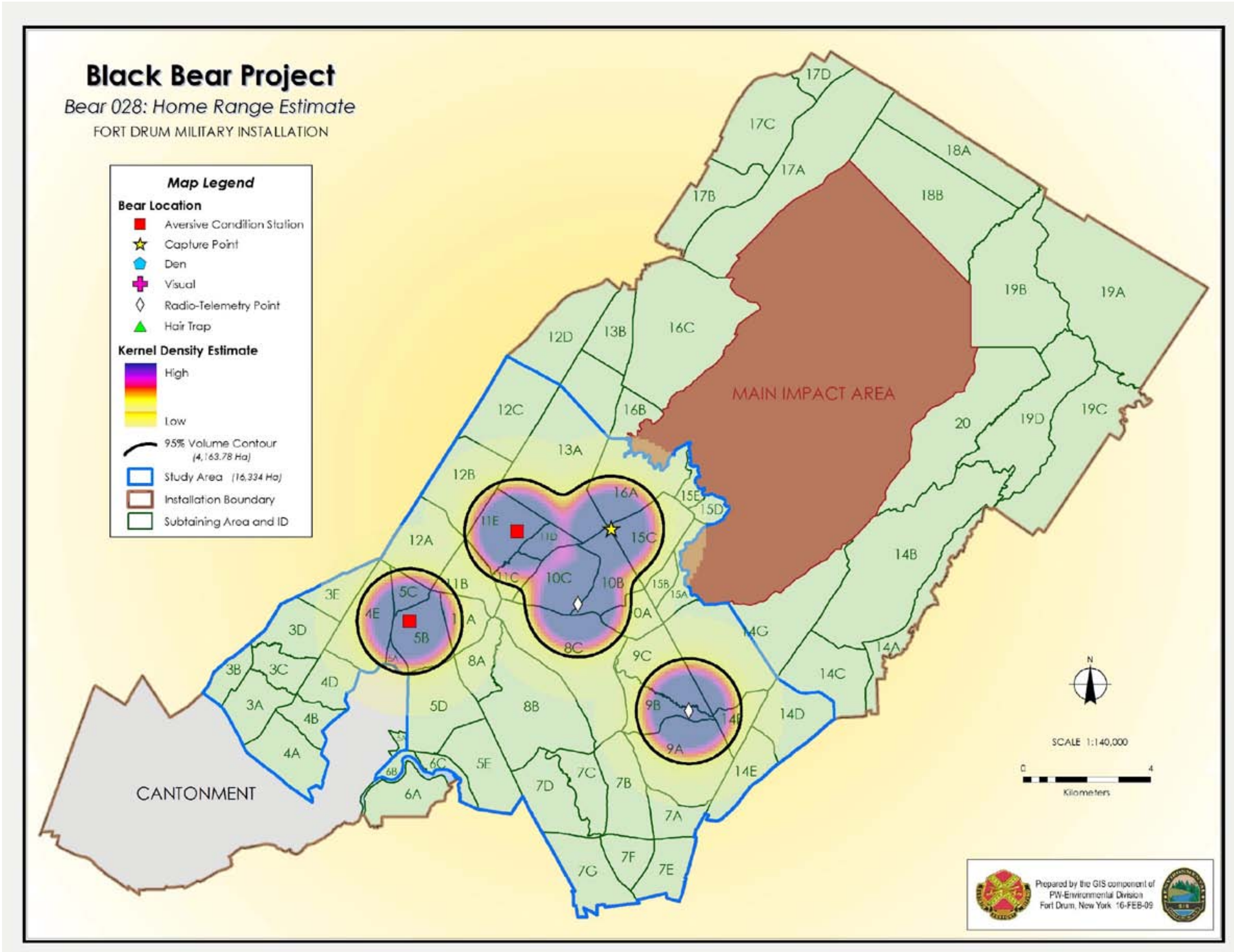

Figure 17. Area of known use for Bear 028 on Fort Drum Military Installation in 2005 and 2006 based on 95% kernel density estimates.

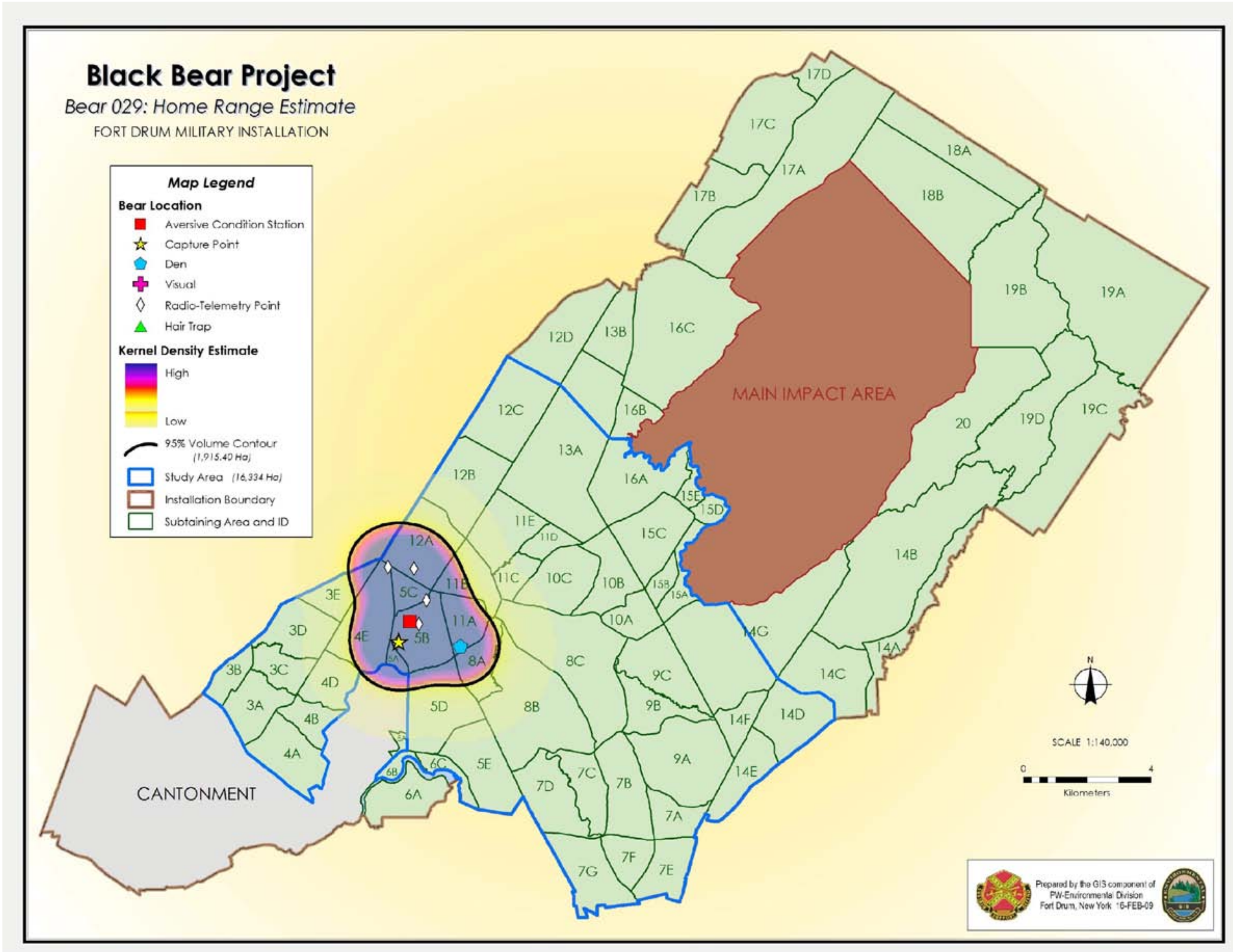

Figure 18. Area of known use for Bear 029 on Fort Drum Military Installation in 2005 and 2006 based on 95% kernel density estimates.

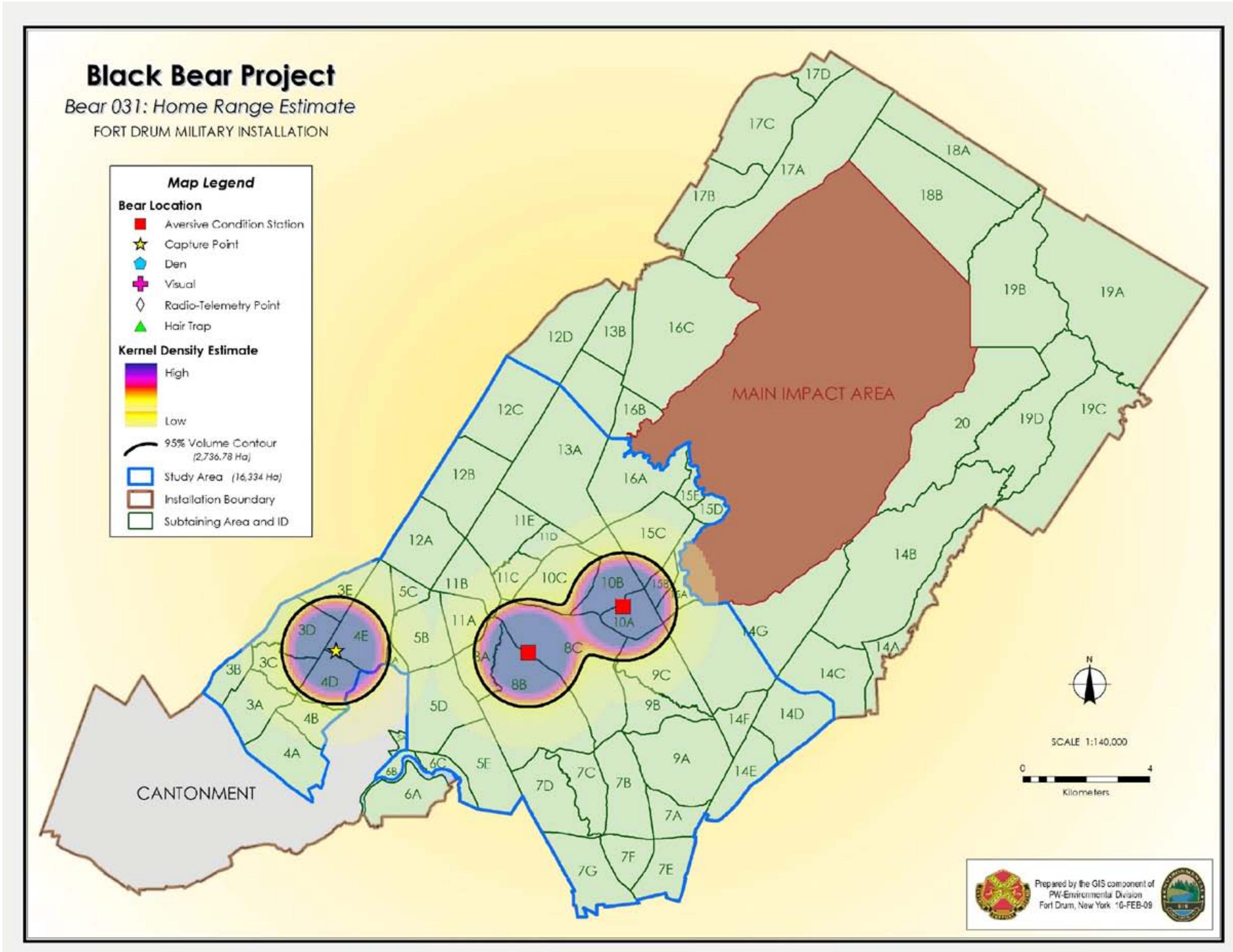

Figure 19. Area of known use for Bear 031 on Fort Drum Military Installation in 2005 based on 95% kernel density estimates.

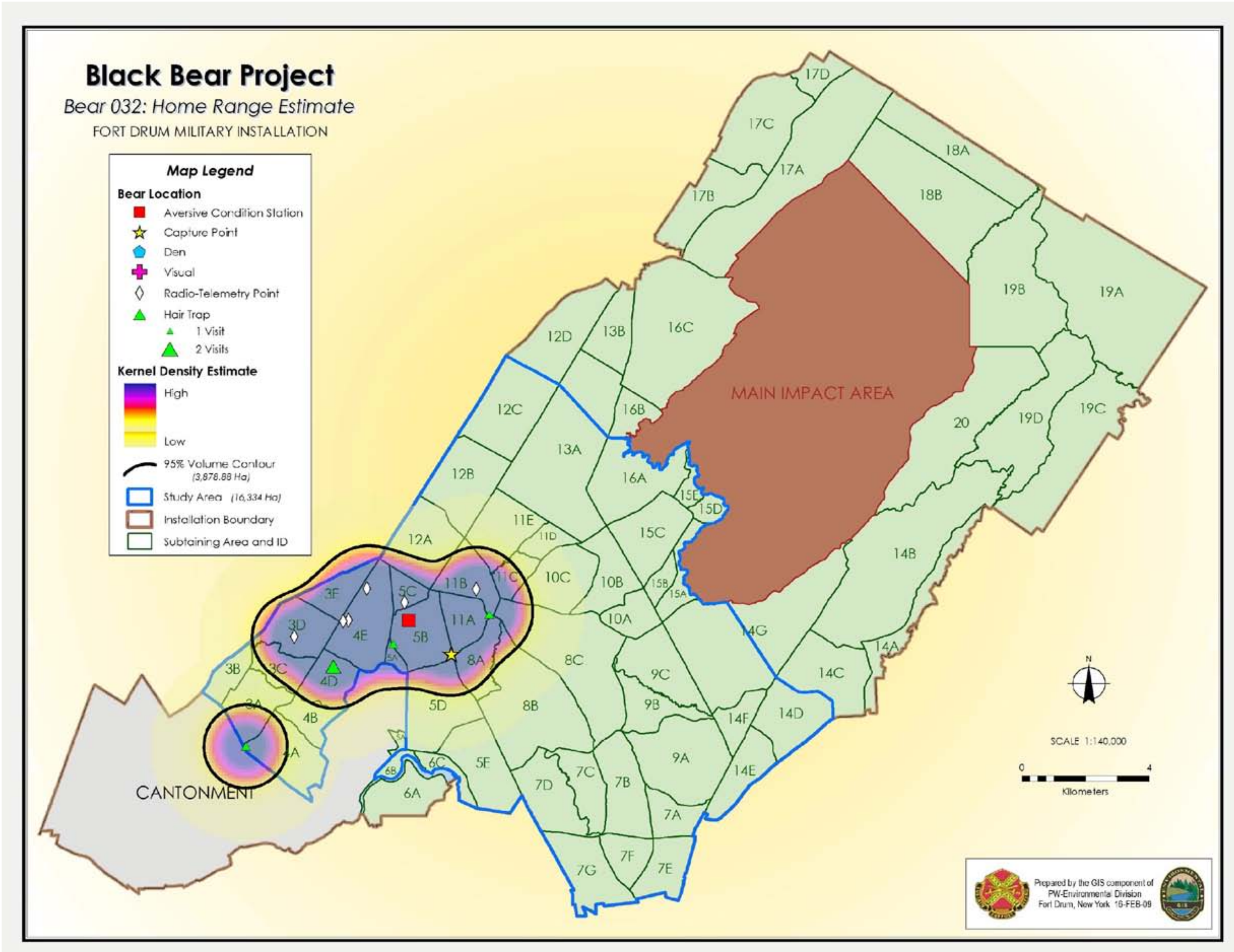

Figure 20. Area of known use for Bear 032 on Fort Drum Military Installation in 2005 and 2006 based on 95% kernel density estimates.

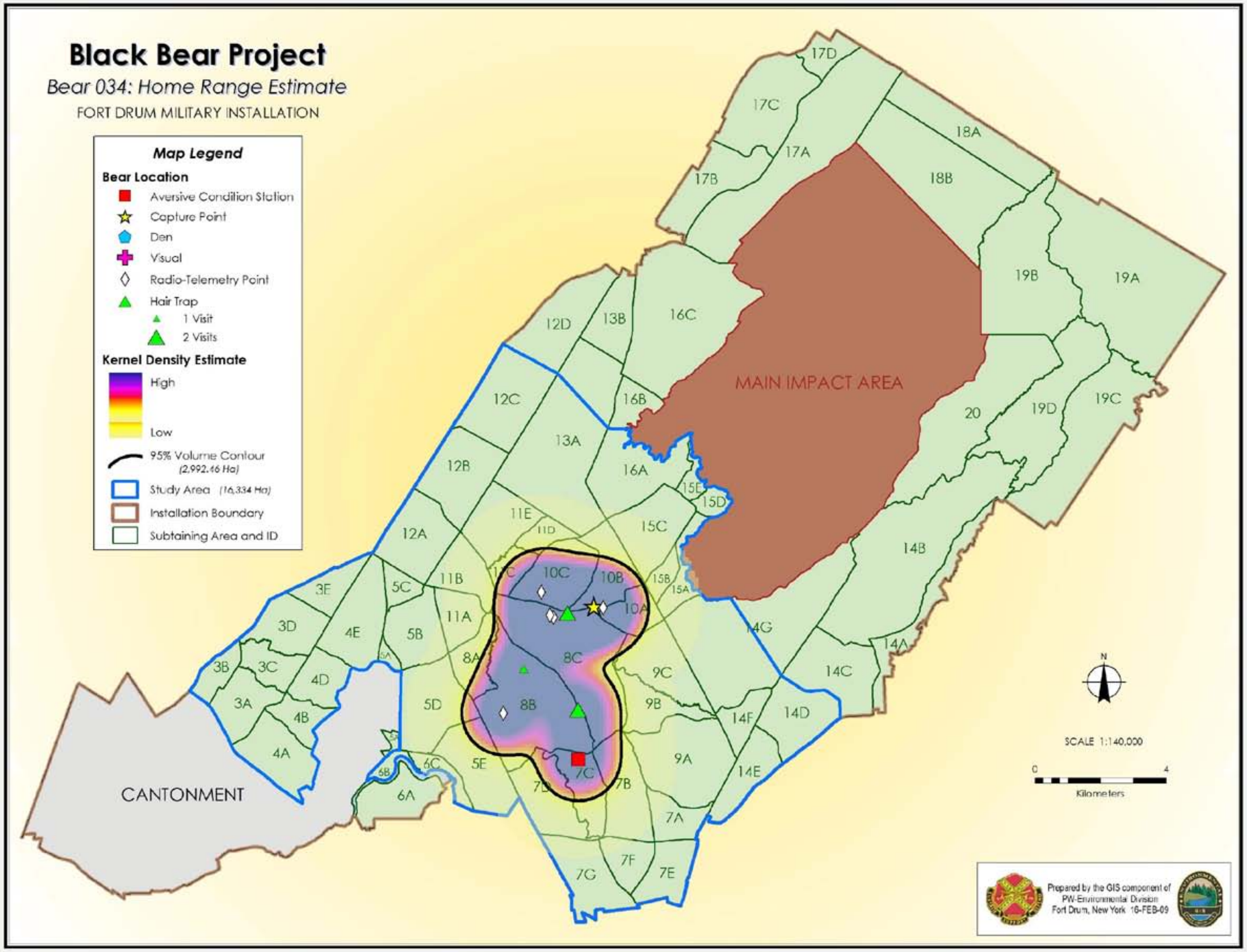

Figure 21. Area of known use for Bear 034 on Fort Drum Military Installation in 2005 and 2006 based on 95 kernel density estimates.

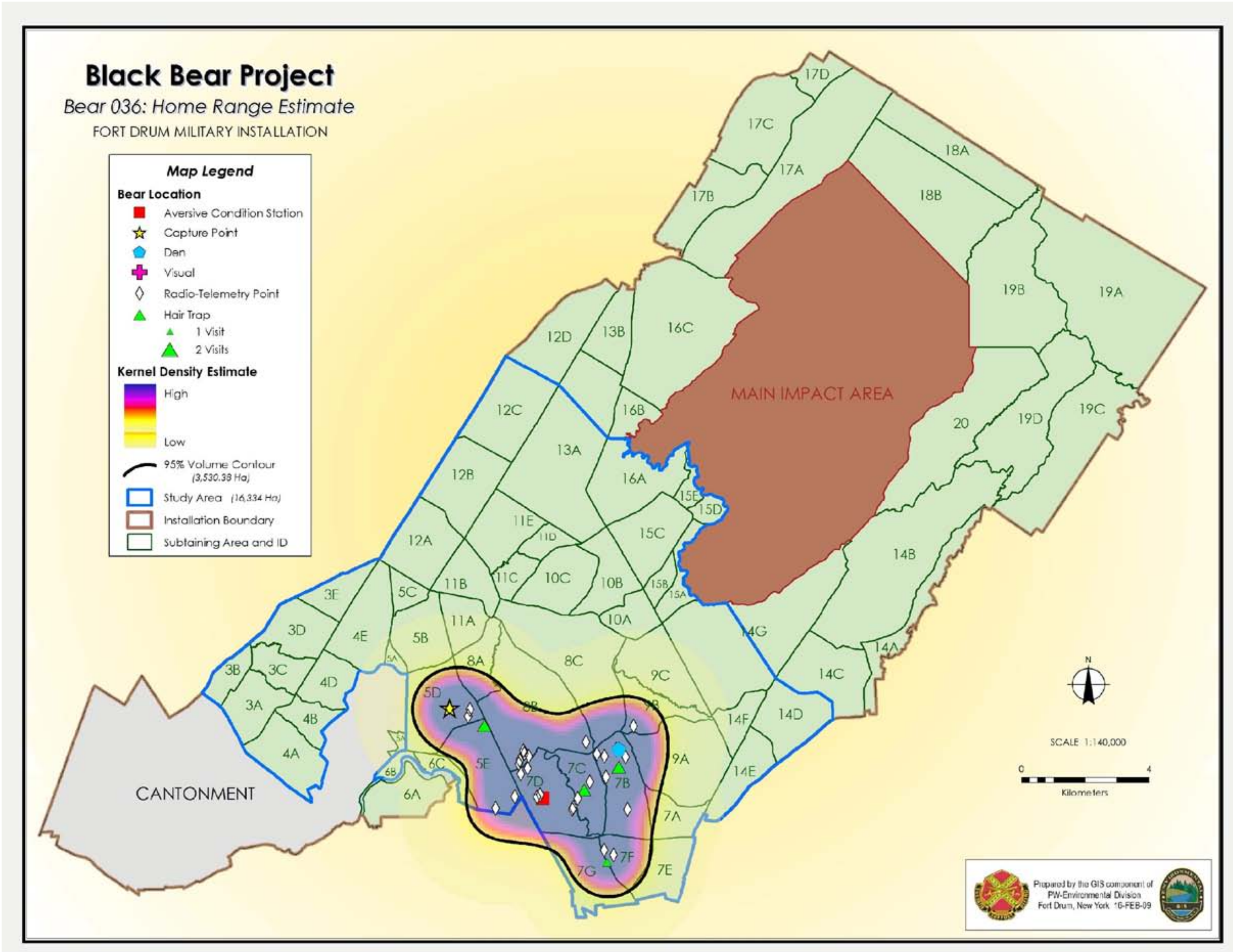

Figure 22a. Area of known use for Bear 036 on Fort Drum Military Installation in 2006 based on 95% kernel density estimates.

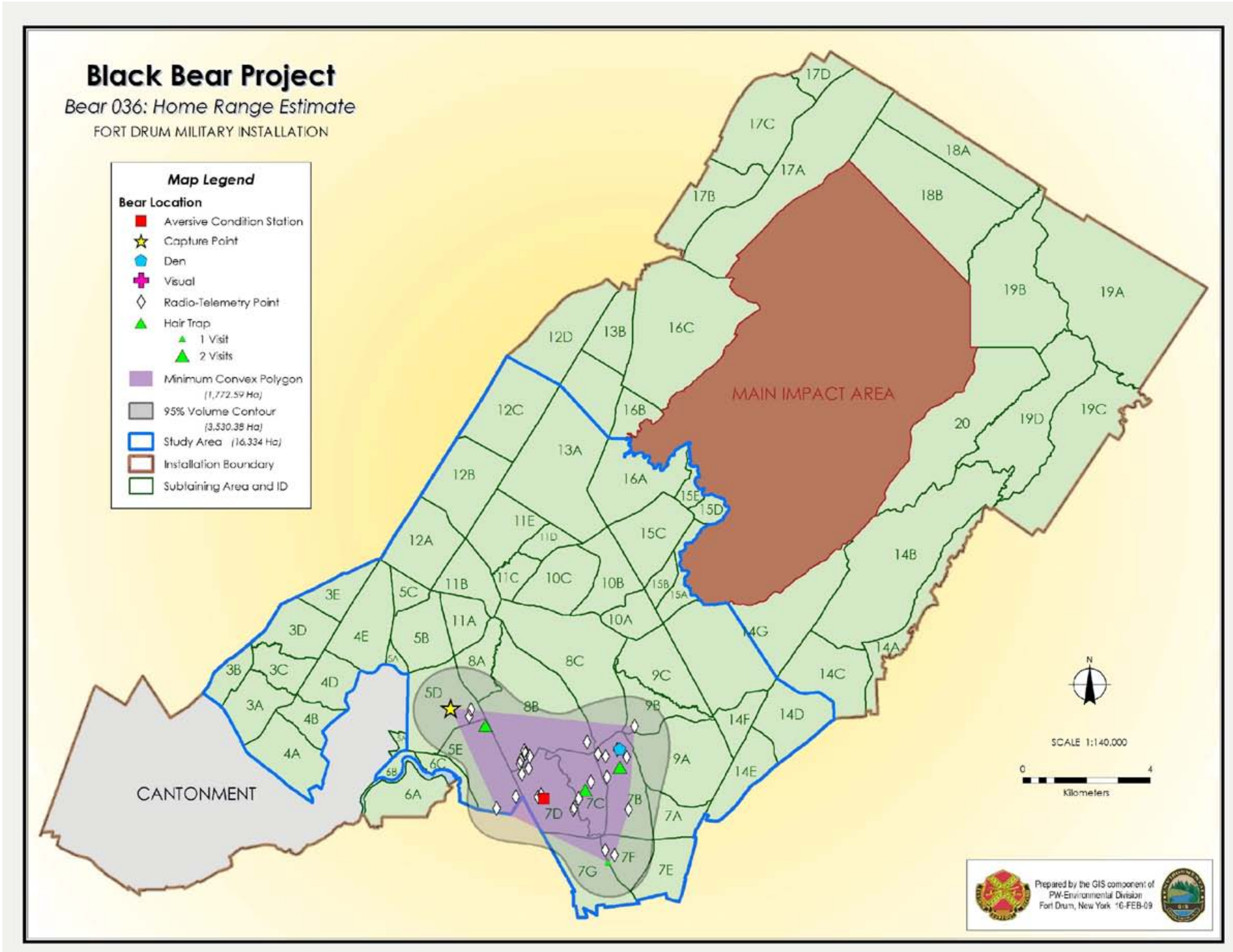

Figure 22b. Area of known use for Bear 036 on Fort Drum Military Installation in 2006 based on 95% minimum convex polygon.

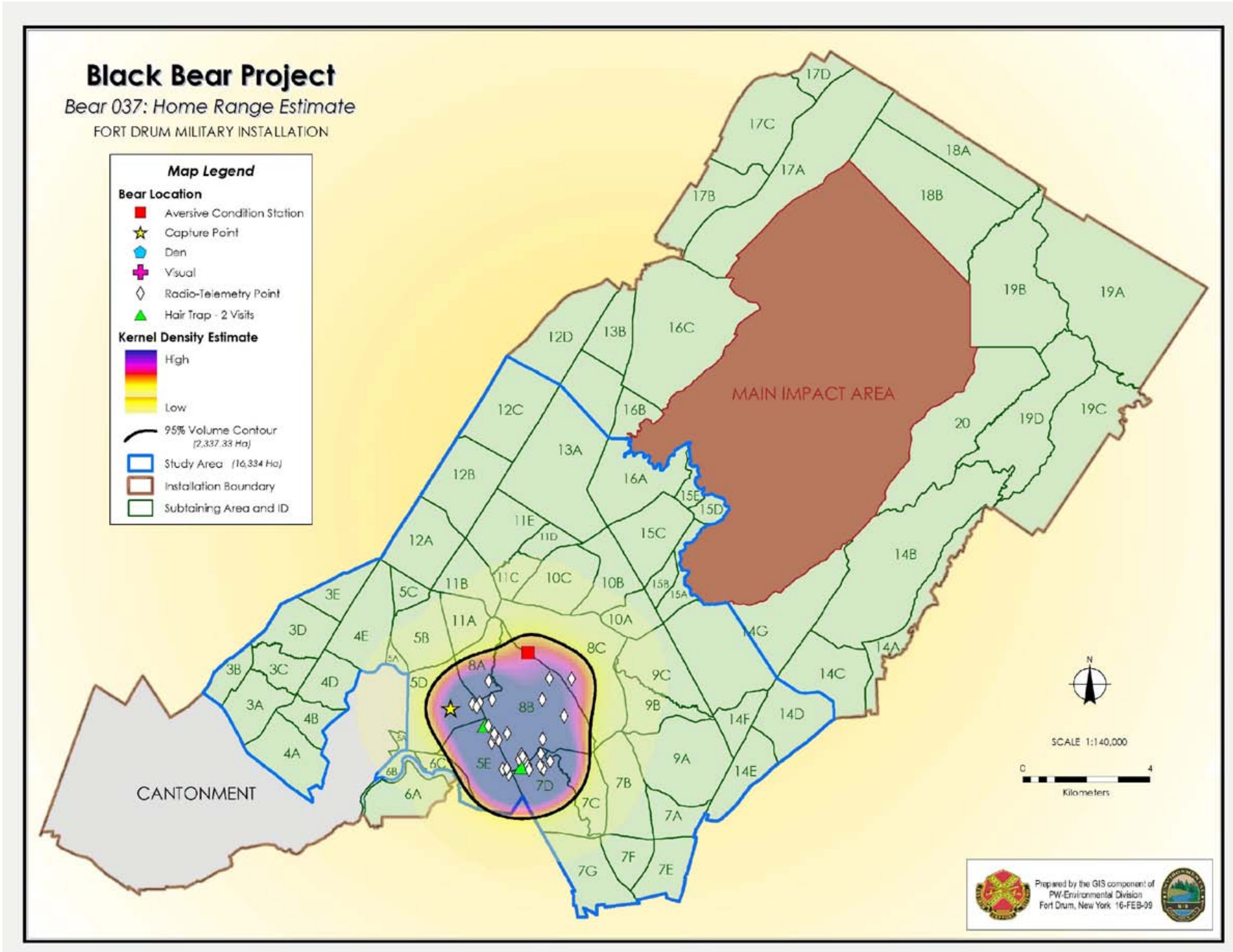

Figure 23a. Area of known use for Bear 037 on Fort Drum Military Installation in 2006 based on 95% kernel density estimates.

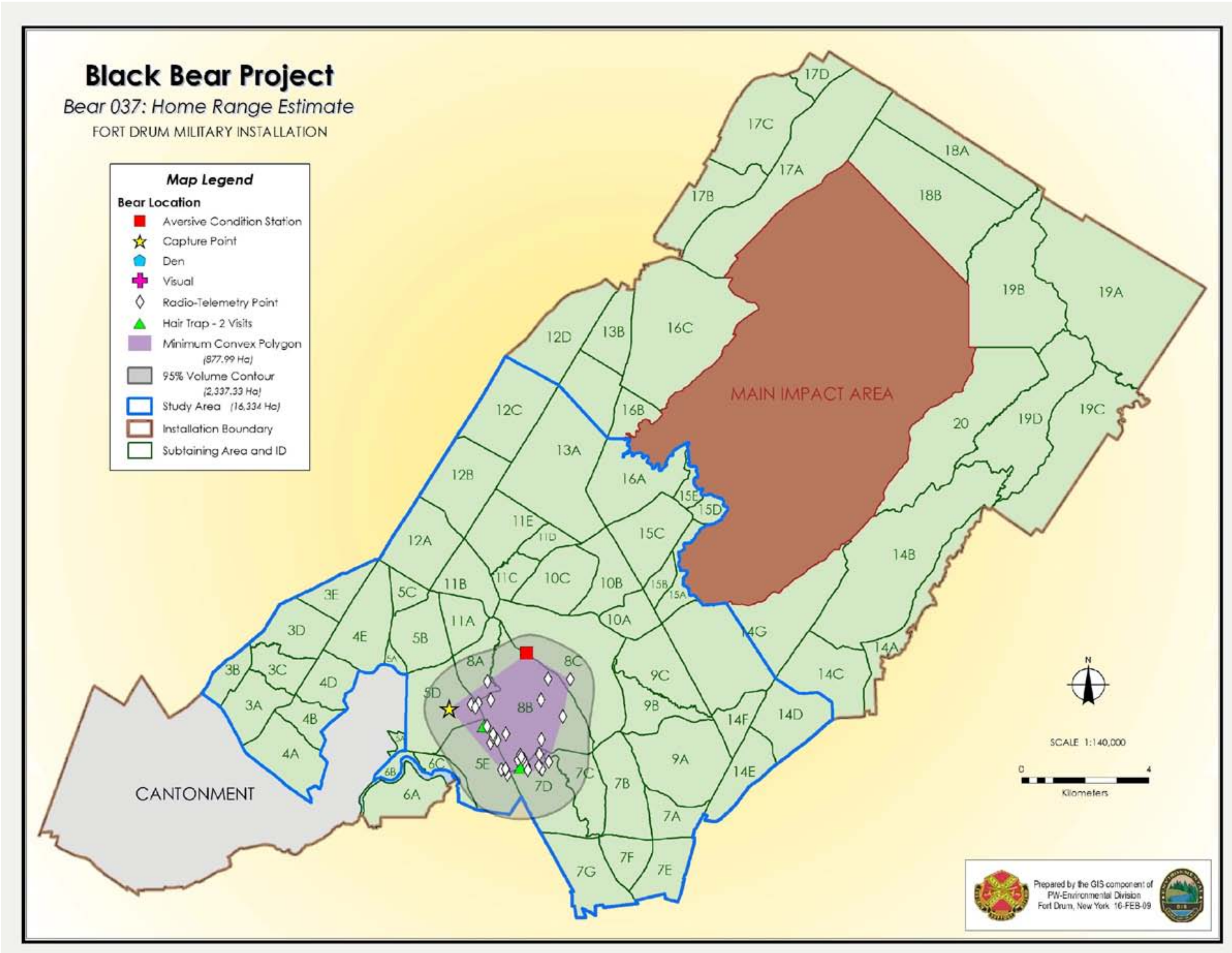

Figure 23b. Area of known use for Bear 037 on Fort Drum Military Installation in 2006 based on 95% minimum convex polygon.

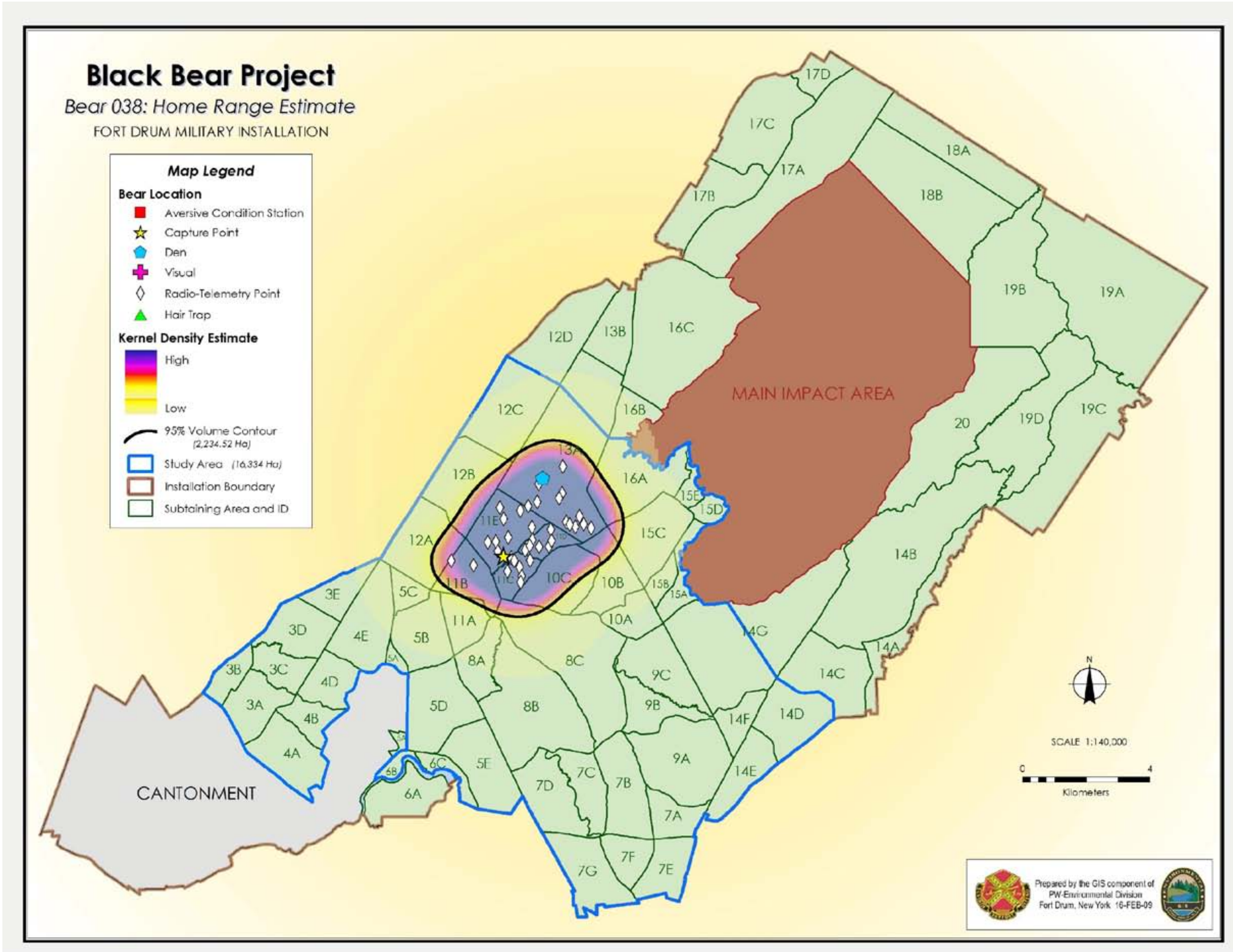

Figure 24a. Area of known use for Bear 038 on Fort Drum Military Installation in 2006 based on 95% kernel density estimates.

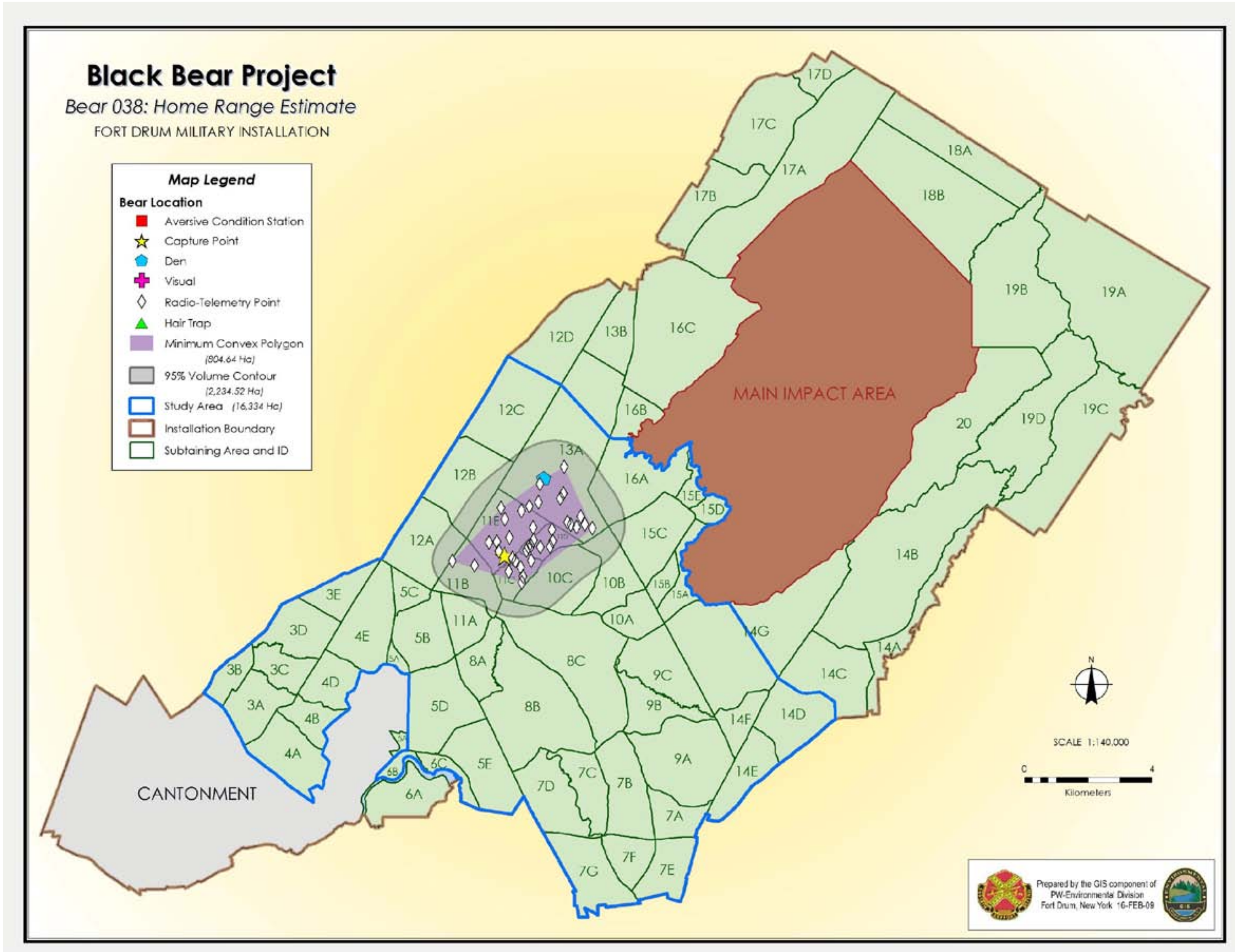

Figure 24b. Area of known use for Bear 038 on Fort Drum Military Installation in 2006 based on 95% minimum convex polygon.

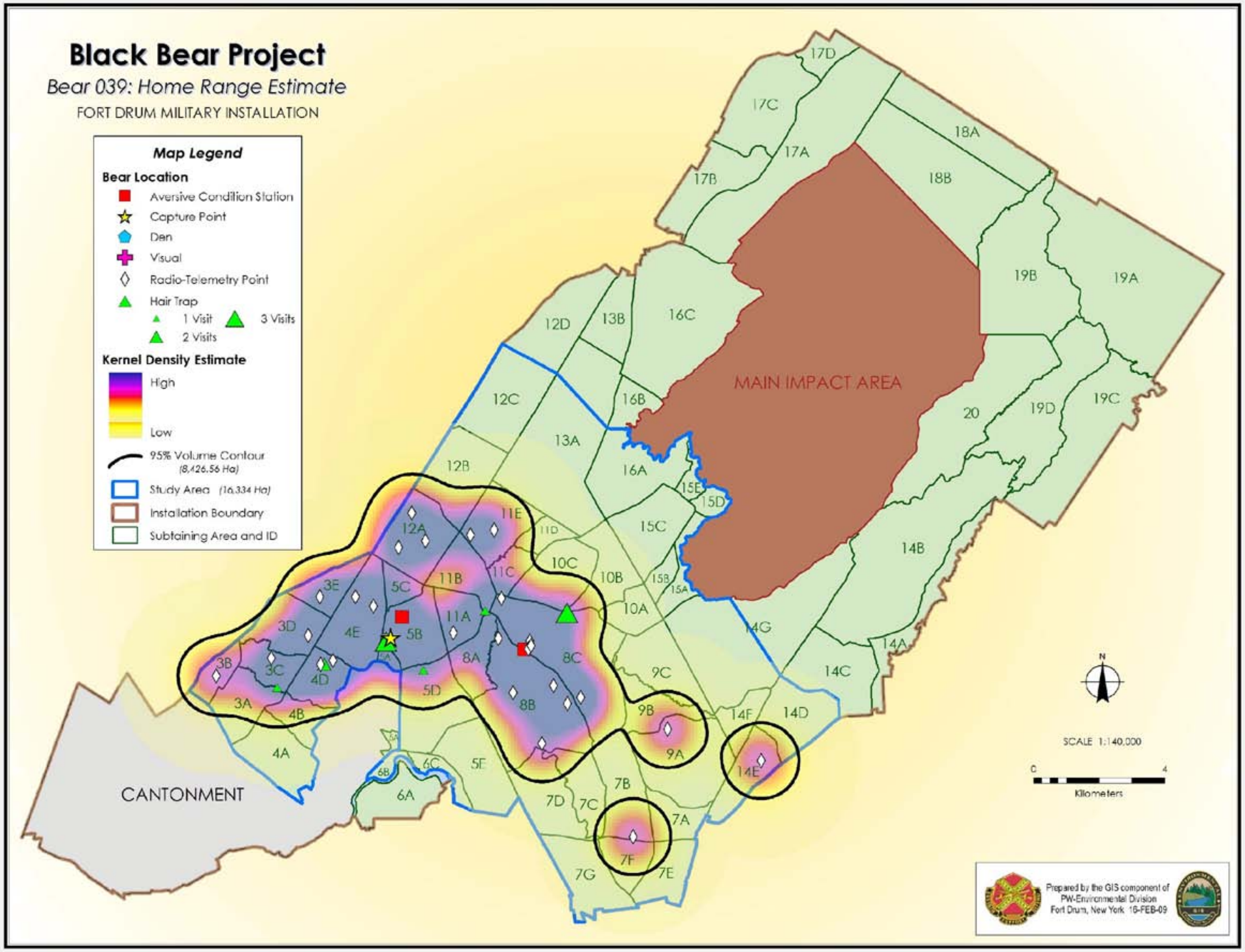

Figure 25. Area of known use for Bear 039 on Fort Drum Military Installation in 2006 based on 95% kernel density estimates.

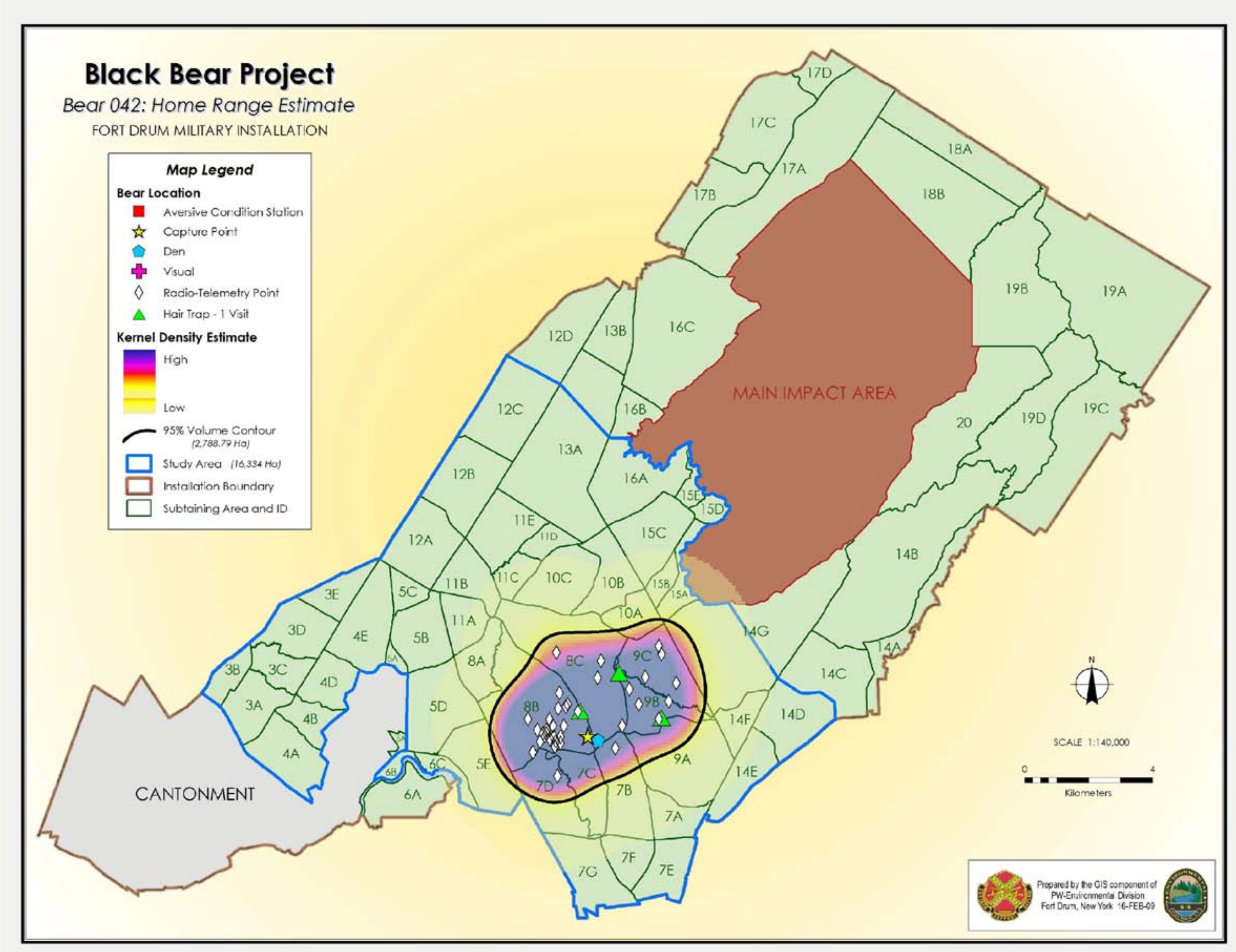

Figure 26a. Area of known use for Bear 042 on Fort Drum Military Installation in 2006 based on 95% kernel density estimates.

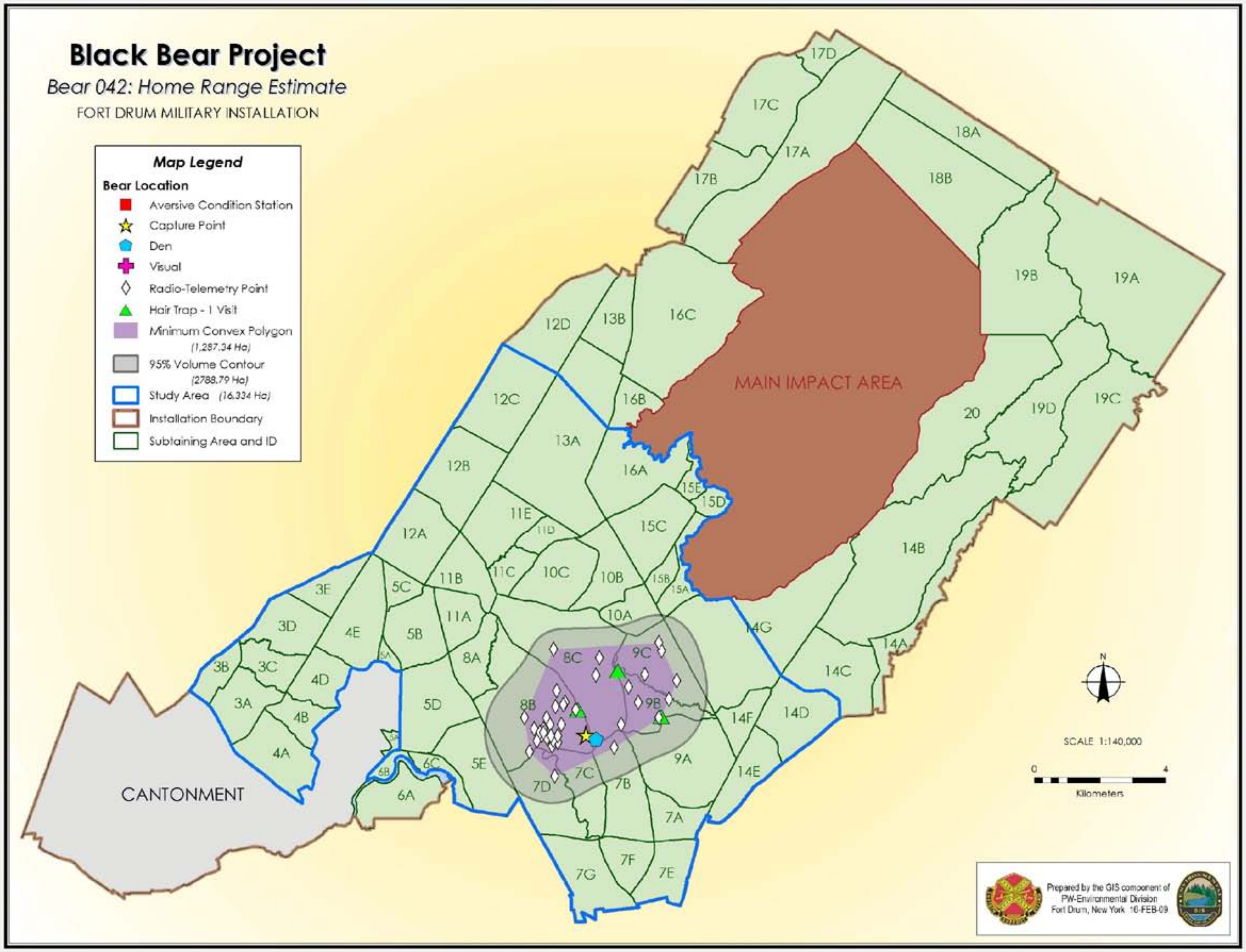

Figure 26b. Area of known use for Bear 042 on Fort Drum Military Installation in 2006 based on 95% minimum convex polygon.

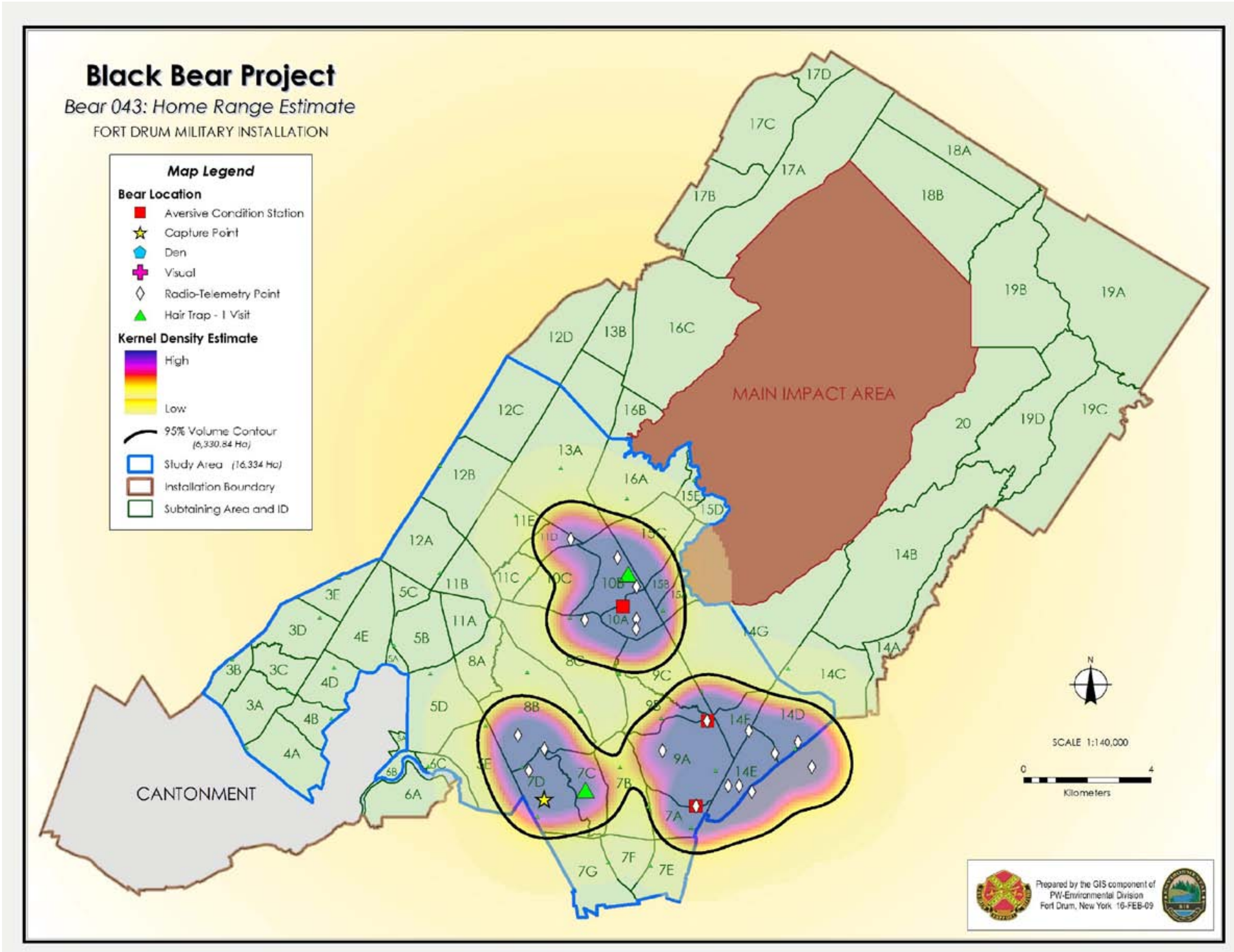

Figure 27. Area of known use for Bear 043 on Fort Drum Military Installation in 2006 based on 95% kernel density estimates.

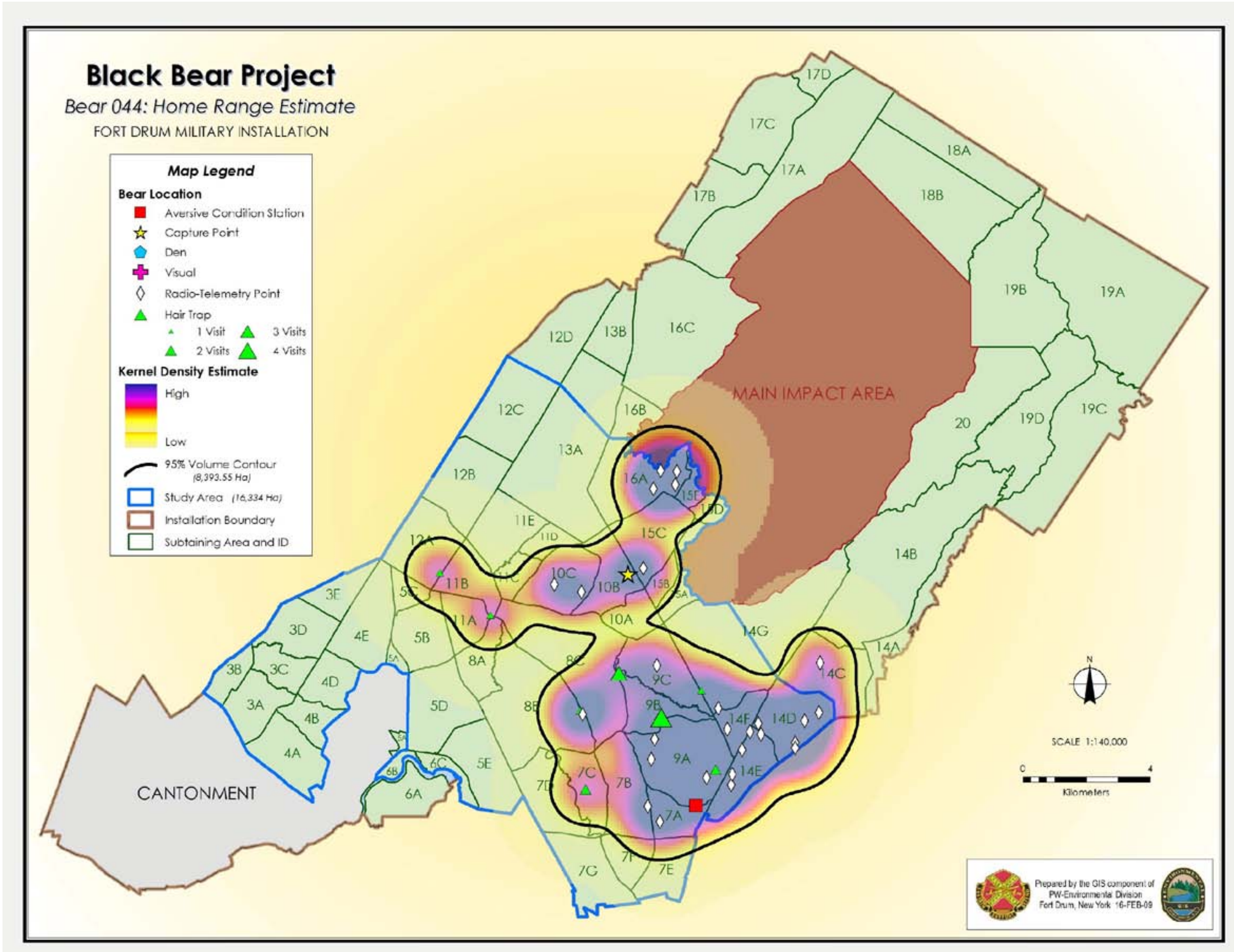

Figure 28. Area of known use for Bear 044 on Fort Drum Military Installation in 2006 based on 95% kernel density estimates.

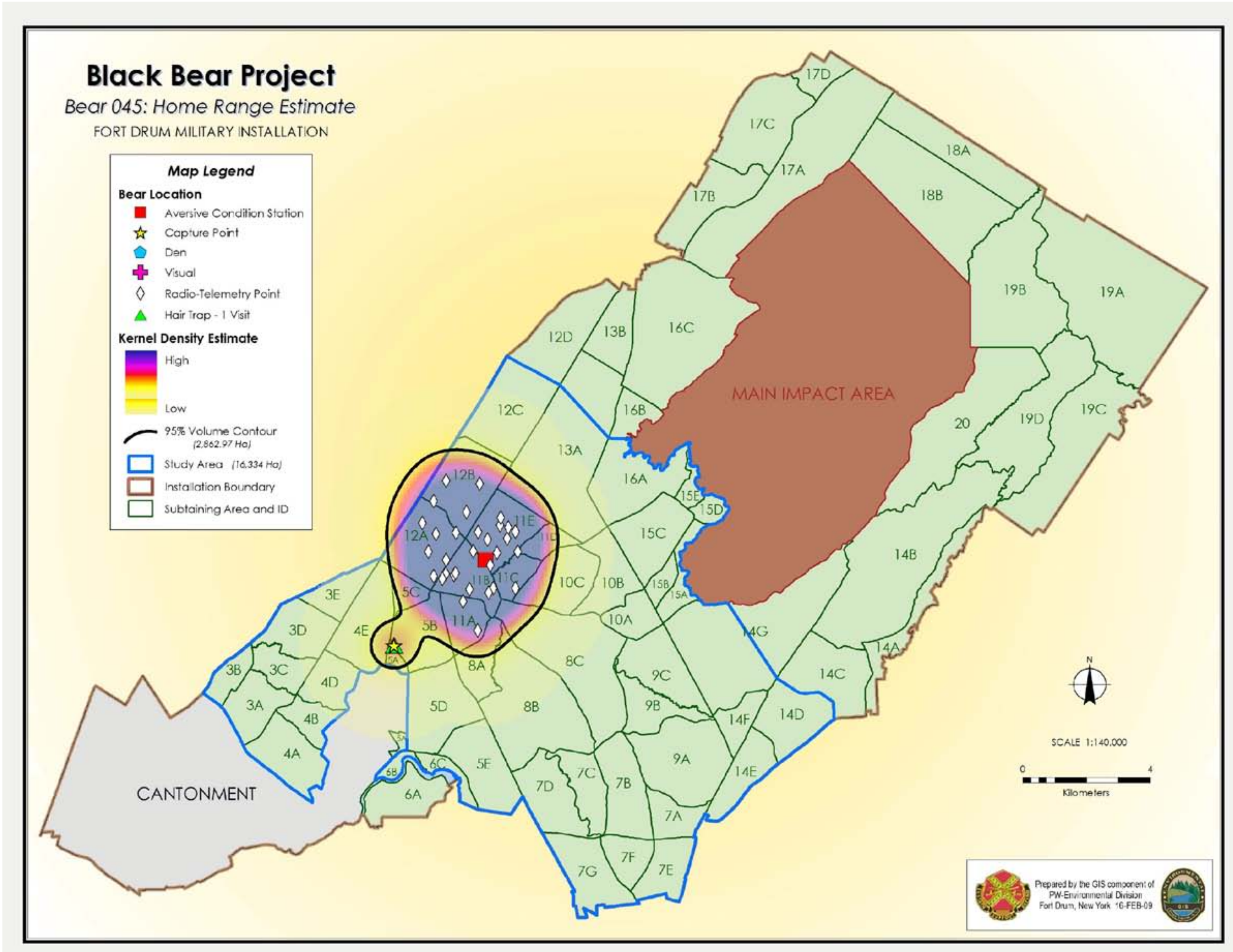

Figure 29a. Area of known use for Bear 045 on Fort Drum Military Installation in 2006 based on 95% kernel density estimates.

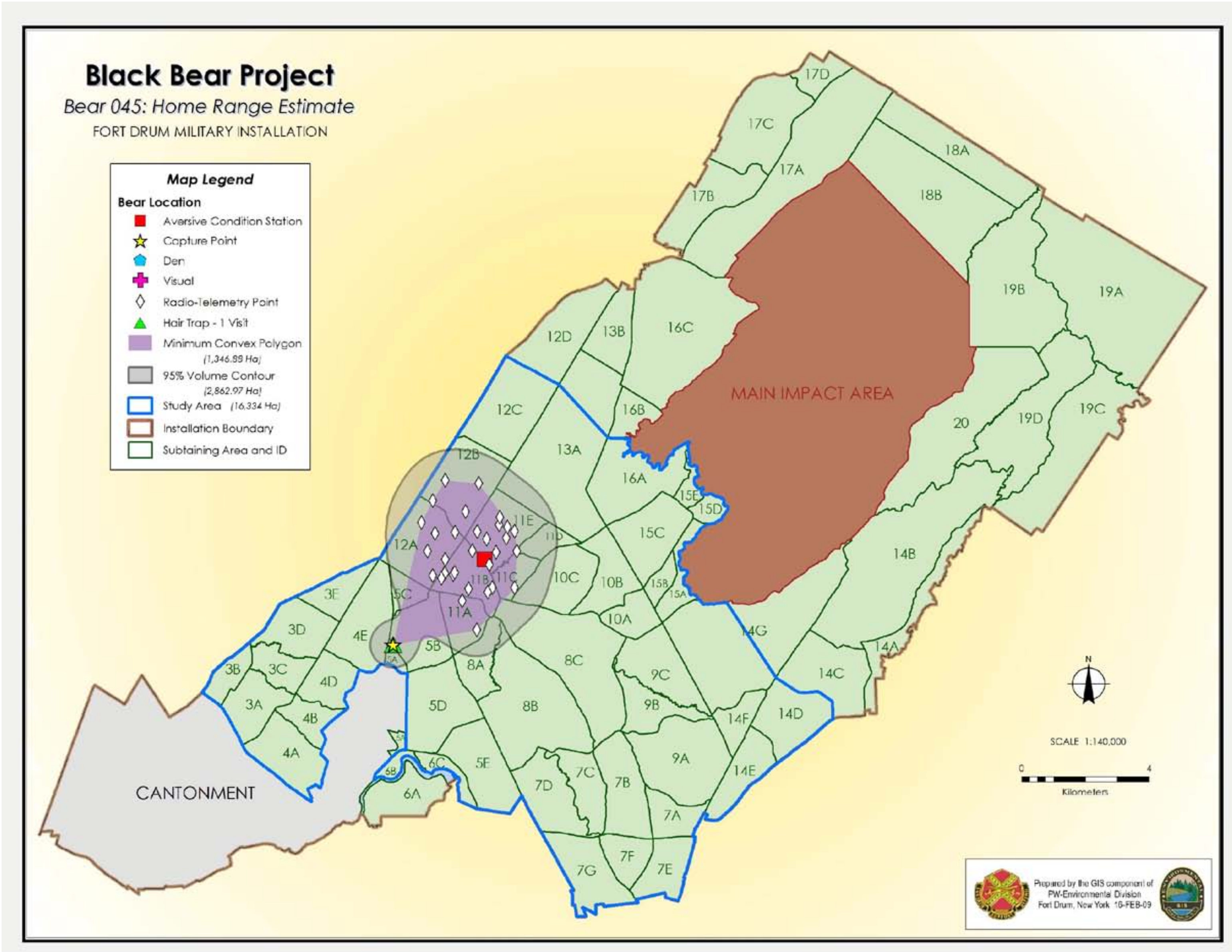

Figure 29b. Area of known use for Bear 045 on Fort Drum Military Installation in 2006 based on 95% minimum convex polygon.

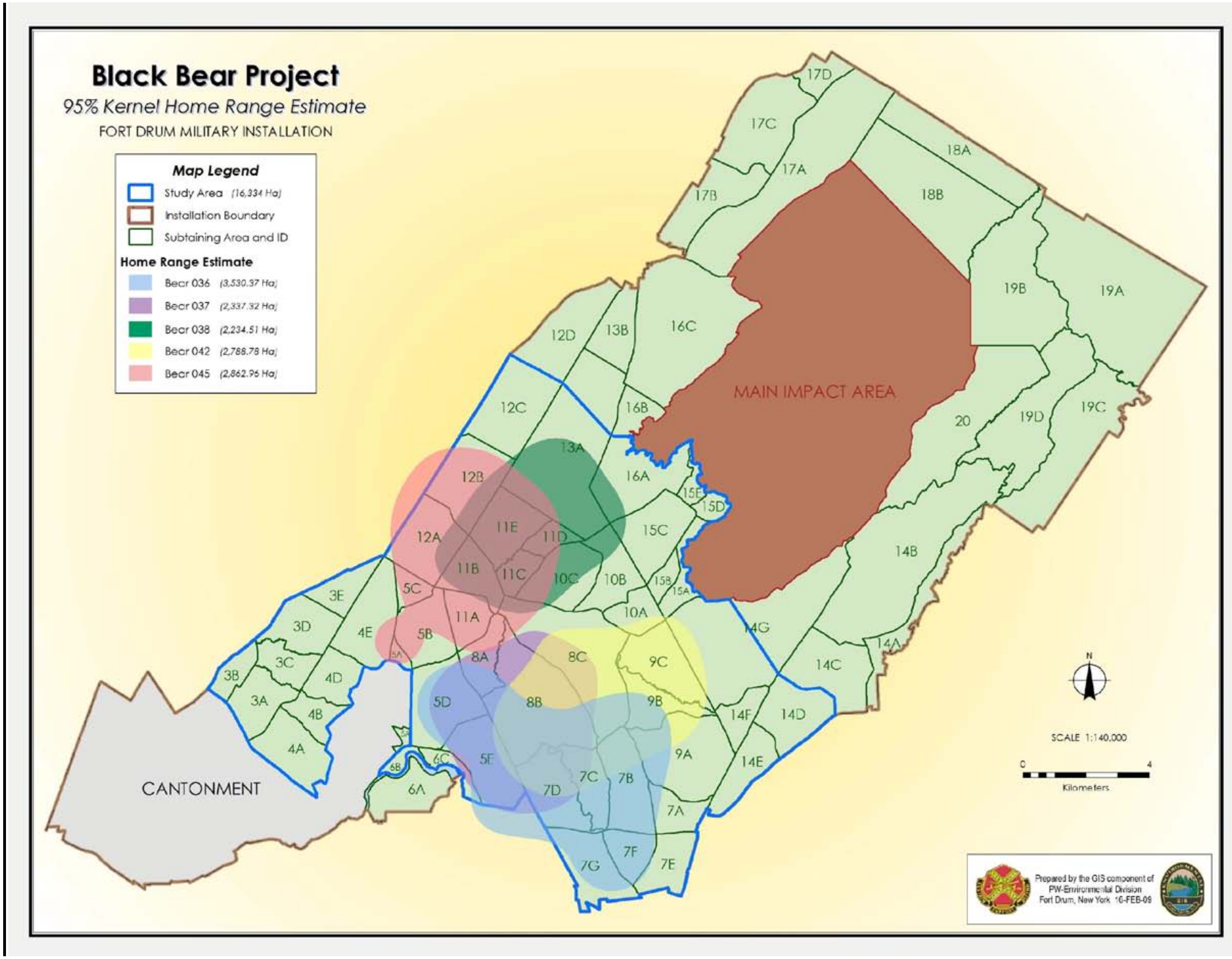

Figure 30. 95% kernel home range estimates and home range overlap of 5 female black bears on Fort Drum Military Installation in 2006.

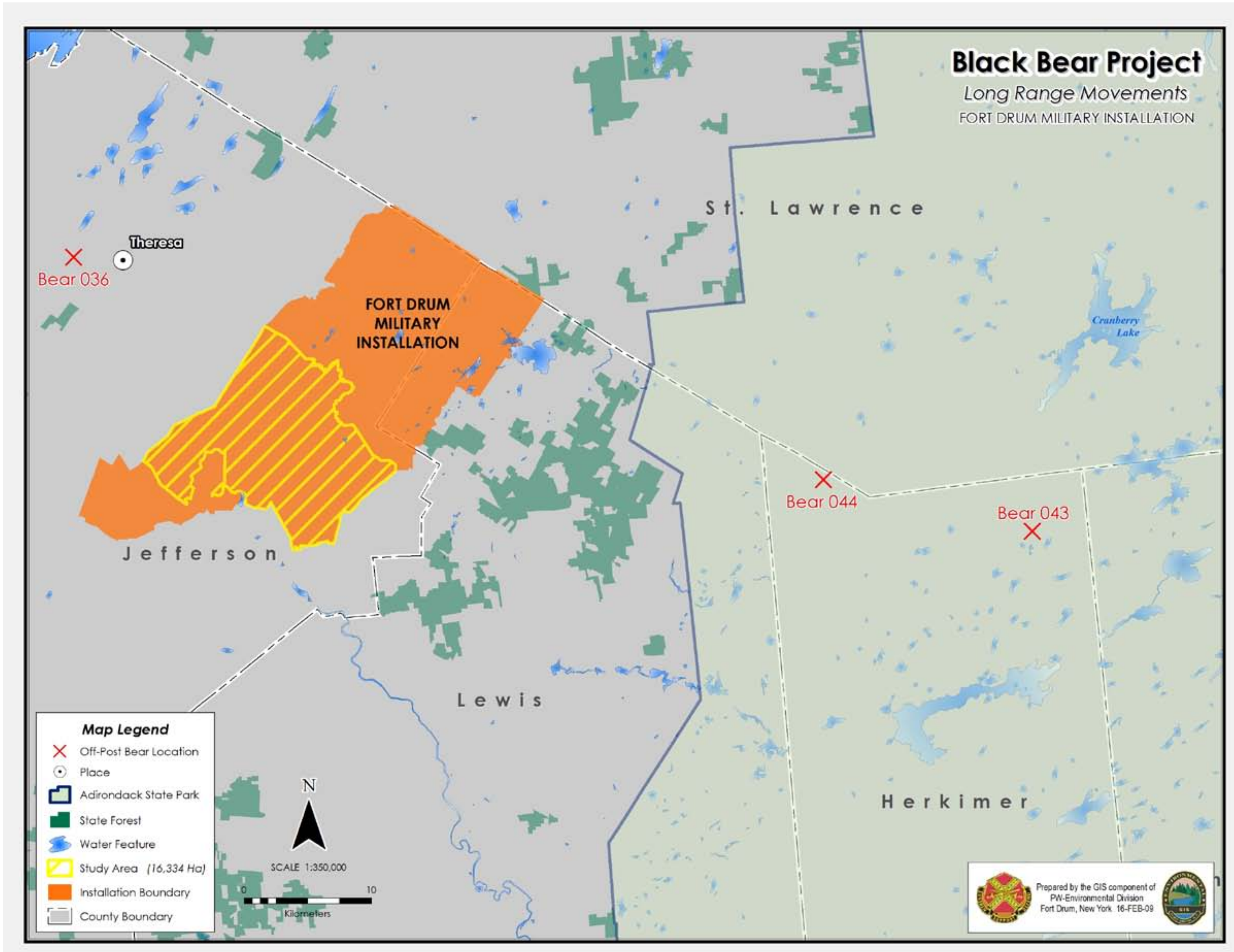

Figure 31. Long range movements of Bears 036, 044, and 043 around Fort Drum Military Installation in the fall of 2006.

Discussion

Overall, home range size is highly variable among different black bear populations. Oli et al. (2002) reported mean home range size for adult females in Arkansas's bottomland hardwood forest to be 4.90 km^2 (1210.8 ac), whereas Grogan (1997) found a mean of 137 km^2 (33,853 ac) for the adult females in the Snowy Range of Wyoming. Most mean home range estimates for other bear populations fall between these two extremes. Home range estimates for female black bears on Fort Drum was similar to estimates in southern Quebec (Samson and Huot 1998).

Sizes of home ranges are variable for different age and sex classes within a population. Mack (1988), Beecham and Rohlman (1994), and Hirsch et al. (1999) found mean home range size for adult females to be significantly smaller, sometimes equaling <25%, than that of males. Grogan (1997) further surmised that subadult males and females occupied smaller home ranges than their respective adult counterparts. On Fort Drum, females generally maintained smaller areas of known use compared to males. This cannot be statistically verified due to the incomplete nature of the data, but the visual evidence offers a moderate level of support.

Although home range estimates are widely variable for black bears across North America, a comparison may have utility in terms of understanding food availability and quality. Habitat and food quality and patchiness of food distribution all have been implicated as determinants of home range size (Jonkel and McCowan 1971; Amstrup and Beecham 1976; LeCount 1980). Bears will use the smallest home range area possible to fulfill energetic requirements (Garshelis and Pelton 1981; Schooley et al. 1994; Samson and Huot 1998). For high quality habitat with food distributed throughout, a bear would not be required to travel far to meet its nutritional requirements. However, if food is available in widely scattered patches, then it would be necessary for the bear to expand its home range in an effort to find ample sustenance. This relationship between resource availability and home range size has been investigated by several researchers with similar conclusions (Garshelis et al. 1983; Pelchat and Ruff 1986; Powell et al. 1997). The estimated home range size on Fort Drum is on the lower side of published estimates (Larivière 2001). This suggests that bears did not have to travel far to find suitable food and water resources on Fort Drum in 2005-2006. It also implies that food resources are rather continuous or patches are located in close proximity to one another.

In regions with high quality habitat, home range overlap is also more likely (Horner and Powell 1990). Oli et al. (2002) found a mean of 1.01 km^2 (249.6 ac), or 22.7%, of mean annual home range size of females (based on 95% minimum convex polygon method) to be shared with other females in Arkansas. Schenk et al. (1998) also reported "extensive home range overlap" among females in Ontario. On the other hand, bears in boreal forests where resources are relatively scarce were reported to be intrasexually territorial with little or no home range overlap (Jonkel and McCowan 1971, Young and Ruff 1982). The extent of home range overlap on Fort Drum between neighboring female bears is substantial enough to surmise that territoriality or exclusion of a neighboring bear from particular resources is marginal, if at all existent. Despite that energetic requirements for winter denning in northern New York may be high, there was no level of territoriality observed among adult female black bears on Fort Drum.

The long range movements documented through radio-telemetry were not wholly unexpected, but the nearly identical commencement of the movements between three bears was unusual. In mid-August 2006, Bears 036, 043, and 044 began these movements within a week of each other. As shown in Figure 31, each bear moved to different locations and none were of the same sex/age cohort. The only apparent factor consistent between these observations is the time of movement. The most reasonable explanation for this is that a seasonally available food source became available at these discrete locations. If this were true, the implication is that these food sources were obtainable on an annual basis at the same location and each bear had discovered them in prior years. While no more than conjecture, it is a compelling idea that black bears will retain a memory of areas removed from their summer home ranges that produce food resources at certain times of the year. Bear 036 returned to Fort Drum in the late-fall of 2006 and was harvested, but it was probable that denning activity for this individual would have taken place on the installation, as it did in the previous winter. The return of this individual may be evidence that the food source was no longer available.

CHAPTER 4
Habitat preference of adult female black bears on Fort Drum

Introduction

Black bears are typically found in large extensive forests, however, they are adaptable and will utilize open and developed areas especially where shelter or thick cover can be found nearby (NYSDEC 2007). NYS as well as Fort Drum has a relatively high percentage of forest cover, diverse food sources and an abundance of water. Because home range is primarily determined by food availability, the most utilized habitat types outside of the denning season, are generally those that have greater foraging opportunities. To manage black bear populations effectively, an understanding of habitat preferences is necessary.

Methods

Only those 5 adult females (036, 037, 038, 042, 045) that met the minimum protocol for a formal spatial analysis discussed in Chapter 3 were analyzed for habitat preference.

To analyze habitat preference of a species through radio telemetry, the most utilized analytical methodology involves classifying telemetry locations according to the habitat in which they appear to fall. These points are then used to determine if habitat use is proportional to the available habitat (Neu et al. 1974, Johnson 1980). Unfortunately, this technique is subject to telemetry error which can lead to misclassification of locations, especially when habitat patches are small. However, distance-based analysis is robust to telemetry error (Conner et al. 2003).

In distance-based analysis, Euclidean distances from radio-telemetry points to all habitat types within an animal's home range (Johnson's 3rd order selection) are calculated to generate observed distances (Johnson 1980). Expected distances are calculated from random points in the same home range. The expected distances are then compared to the observed distances to test the null hypothesis that no habitat type is selected by the sample population (Conner et al. 2003). Because this analysis does not explicitly classify telemetry points, it is not subject to the misclassification errors that may arise in the classification-based approach.

Using a very basic GIS landcover data layer of Fort Drum, a Euclidean distance analysis similar to Conner et al. (2003) was performed to investigate 3rd order habitat preference (i.e., preference within the home range) (Johnson 1980). The Fort Drum basic GIS landcover data layers were: forest, wetlands, rangeland, human disturbed areas, rocky areas, sandy areas, shrubland, and unclassified areas. Only radio-telemetry points and visual sightings that met the independence criterion were used for this analysis. The first step was to measure the Euclidean distance between all radio-telemetry points and the nearest patch of each habitat type with the associated home range. This produced a vector of observed distances to each habitat type for each bear. A Monte Carlo simulation was then performed to develop expected distances to each habitat type if the telemetry point were distributed in a truly random fashion. The simulation randomly placed the same number of points as there were telemetry points within the home range of each bear. For example, 30 radio-telemetry points were collected for Bear 036, so 30 random points were placed within the fixed kernel home range of Bear 036. The distance from each random point to the nearest patch of each habitat type within the home range was then calculated. This process was repeated 1000 times for each bear to generate expected distances to the nearest patch of each habitat type for comparison to the observed distances for the radio-telemetry points.

The mean distance to each habitat type for each bear was determined for both the radio-telemetry points (u_i; Table 5) and the random points (r_i; Table 6). The u_i was divided by the respective r_i value to generate a ratio, d_i (Table 7). If d_I = 1, meaning that $u_i = r_i$ for a particular individual and habitat type, the null hypothesis (i.e., no habitat preference) (Conner et al. 2003) could not be rejected for that study animal.

However, the investigation focused on habitat preferences for the sampled population, not the individual. Therefore, it was required to compute $\boldsymbol{\rho}$, the mean of the d_i by habitat type. SAS (Statistical Analysis Systems, SAS Institute, Cary, North Carolina, USA) was used to determine if $\boldsymbol{\rho}$ was significantly different from 1 (Conner et al. 2003). When $\boldsymbol{\rho}$ was significantly <1, use of that habitat type was greater than would be expected by random choice. The ranking of elements in the $\boldsymbol{\rho}$ vector allowed for examination of habitat selection in terms of availability (Conner and Plowman 2001).

The ranking of habitat use does not provide any insight into relative selection among habitat types (Conner et al. 2003). A pairwise t-test was performed with all possible combinations among habitat types to examine the potential of certain habitat types being selected significantly more than other habitat types.

In addition, a classification-based analysis method of the radio-telemetry data was conducted using more specific habitat types using a more detailed Fort Drum GIS landcover data layer with 43 habitat types. The average error-ellipse size associated with the radio-telemetry locations was 3.4 ha (8.4 ac). Each radio-telemetry point was buffered with a circle of this size in ArcGIS (Environmental Research Systems Institute, Redlands, CA, USA) and the presence or absence of each habitat type within each of the estimated error ellipses was recorded. From this count statistic, the percentage of error polygons in which each habitat type occurred was calculated. The radio-telemetry locations for all 5 bears were pooled into one data set for this analysis.

To compare the percentages of occurrence for each habitat type to available habitat, the 95% kernel home range estimates for each bear was combined. The percentage of area that each habitat type contributed to the conglomerate home range was calculated. These percentages were compared to the percentages of the occurrences in the error ellipses for each habitat type. Larger percentages of occurrence in error ellipses may indicate preference for that habitat type.

Table 5. The observed mean distance in meters (u_i) to the nearest patch of each habitat type within the 95% fixed kernel home range estimate for female black bears on Fort Drum, summer and fall 2006.

Bear ID	Forest	Wetland	Rangeland	Disturbed	Shrubland	Sandy
036	4.316	90.083	179.629	319.486	2617.479	546.882
037	3.961	54.905	211.385	223.744	1447.240	564.270
038	21.087	28.087	294.978	326.011	297.101	3609.728
042	2.907	63.174	424.645	331.014	2410.248	696.368
045	43.551	43.906	152.001	293.112	384.528	2931.266

Table 6. The expected distances in meters (r_i) to the nearest patch of each habitat type within the 95% fixed kernel home range for female black bears on Fort Drum, summer and fall 2006.

Bear ID	Forest	Wetland	Rangeland	Disturbed	Shrubland	Sandy
036	13.990	139.328	226.140	277.326	2465.275	567.766
037	5.911	124.831	222.734	236.021	1461.407	477.126
038	20.147	40.608	285.516	285.417	318.422	3728.111
042	5.189	80.149	397.713	333.403	2518.226	659.906
045	44.366	64.259	206.135	300.137	474.715	2852.651

Table 7. The proportion (d_i) of observed distances in meters (u_i) divided by the random distances in meters (r_i) for female black bears on Fort Drum, summer and fall 2006.

Bear ID	Forest	Wetland	Rangeland	Disturbed	Shrubland	Sandy
036	0.309	0.647	0.794	1.152	1.062	0.963
037	0.670	0.440	0.949	0.948	0.990	1.183
038	1.047	0.692	1.033	1.142	0.933	0.968
042	0.560	0.788	1.068	0.993	0.957	1.055
045	0.982	0.683	0.737	0.977	0.810	1.028

Results

The analysis based on the 8 general land cover types found that rocky areas and unclassified habitats did not occur in any of the home ranges, and were not included in the habitat analysis. The habitat preference analysis indicated that only wetlands were selected ($p = 0.004$; Table 8) with $\alpha = 0.05$. Forested habitat was close to significance ($p = 0.104$). P-values for all other habitat types were well outside of the range of significance.

The pairwise t-tests indicated that wetlands were significantly chosen over all other habitat types, except for forest ($p = 0.682$). All other pairwise comparisons were not significant ([$p>0.05$]; Table 9), implying no selection between the habitats compared.

Table 8. The comparison of 1-ρ values to 0. Significant difference of 1-ρ to 0 indicates preference for the corresponding habitat type for female black bears on Fort Drum in the summer and fall of 2006. Asterisks indicate significance, α = 0.05.

Variable	Mean	Std Error	t Value	Pr > |t |
Forest	-0.2866	0.1364	-2.10	0.1036
Wetland	- 0.3501	0.0575	-6.09	0.0037*
Rangeland	-0.0837	0.0650	-1.29	0.2674
Disturbed	0.0423	0.0434	0.98	0.3847
Shrubland	-0.0496	0.0413	-1.20	0.2957
Sandy	0.0393	0.0399	0.99	0.3791

Table 9. Pairwise t-test comparison results for all combinations of habitat types, α=0.05. A significant probability of t indicates that one habitat was chosen significantly more than the other by female black bears on Fort Drum in summer and fall 2006. Asterisks indicate significance.

Comparison	Mean	Std Error	t Value	Pr > |t |
Forest-Wetland	0.063	0.144	0.440	0.682
Forest-Rangeland	-0.203	0.146	-1.390	0.237
Forest-Disturbed	-0.329	0.149	-2.210	0.092
Forest-Shrubland	-0.237	0.172	-1.380	0.239
Forest-Sandy	-0.326	0.144	-2.270	0.086
Wetland-Rangeland	-0.266	0.079	-3.380	0.028*
Wetland-Disturbed	-0.392	0.061	-6.420	0.003*
Wetland-Shrubland	-0.301	0.080	-3.780	0.020*
Wetland-Sandy	-0.389	0.089	-4.360	0.012*
Rangeland-Disturbed	-0.129	0.079	-1.610	0.184
Rangeland-Shrubland	-0.034	0.069	-0.500	0.646
Rangeland-Sandy	-0.123	0.069	-1.780	0.150
Disturbed-Shrubland	0.092	0.045	2.040	0.111
Disturbed-Sandy	0.003	0.080	0.040	0.972
Shrubland-Sandy	-0.089	0.057	-1.560	0.195

The classification-based analysis, performed on a finer scale of habitat resolution, produced results that are difficult to interpret. The small number of radio-telemetry and visual locations (n = 167) in comparison to the large number of habitat types (n = 43) used in this analysis make statistical analysis unreasonable. However, a qualitative analysis of the results (Figures 33 – 38) can allow for some reasonable assertions from the classification-based analysis. Palustrine wetland with open and closed canopy deciduous forest and palustrine wetland with shrub vegetation were used substantially more than available and constituted a high percentage of the habitat types within error polygons. Similarly, deciduous (e.g. maple, oak, beech, and aspen) and mixed forest (e.g. maple, hemlock, and aspen) with closed and open canopies appeared to be the most utilized forest habitat types. While many of the other habitats seem to have occurred more often than expected in the error ellipses, the percentage of error ellipses in which they actually occur is small, indicating black bear use is minimal.

Discussion

There was a displayed preference of wetlands over all habitat types other than forest and a higher usage of wetlands than would be expected based on availability. Analysis from the classification-based methodology suggests that palustrine wetlands with deciduous forests and shrubby vegetation are particularly important. Natural wetlands within the study area provide dense cover, seasonal food resources, and are likely travel corridors for black bears. The thick vegetation may also provide a thermoregulation function during hot weather (Rogers and Allen 1987).

While forests were not used significantly more than available, the finding that wetlands were not selected more than forests is important. This indicates that specific forest resources may be important to female black bears on Fort Drum. The classification-based analysis indicated that deciduous and mixed forest with closed canopies are the most utilized forest types on Fort Drum. This is most likely due to dependence upon hard (e.g. acorns and beechnuts) and soft mast food sources (e.g. raspberry, blackberry, and blueberry (Hellgren et al. 1991; Costello and Sage 1994). Areas of disturbance (e.g., logging) are often characterized as having high berry production and can be very important to black bears (Hellgren 1991; Costello and Sage 1994).

Figure 32. Black bear in Training Area 13B in June.

Although the classification-based habitat analysis provided finer scale habitat preferences for black bears on Fort Drum, caution should be exercised when applying these findings to management strategies. The number of data points was relatively small compared to the number of habitat types which may skew the findings of this analysis. However, it is useful as a baseline for high resolution habitat management for black bears which may be updated as more information becomes available.

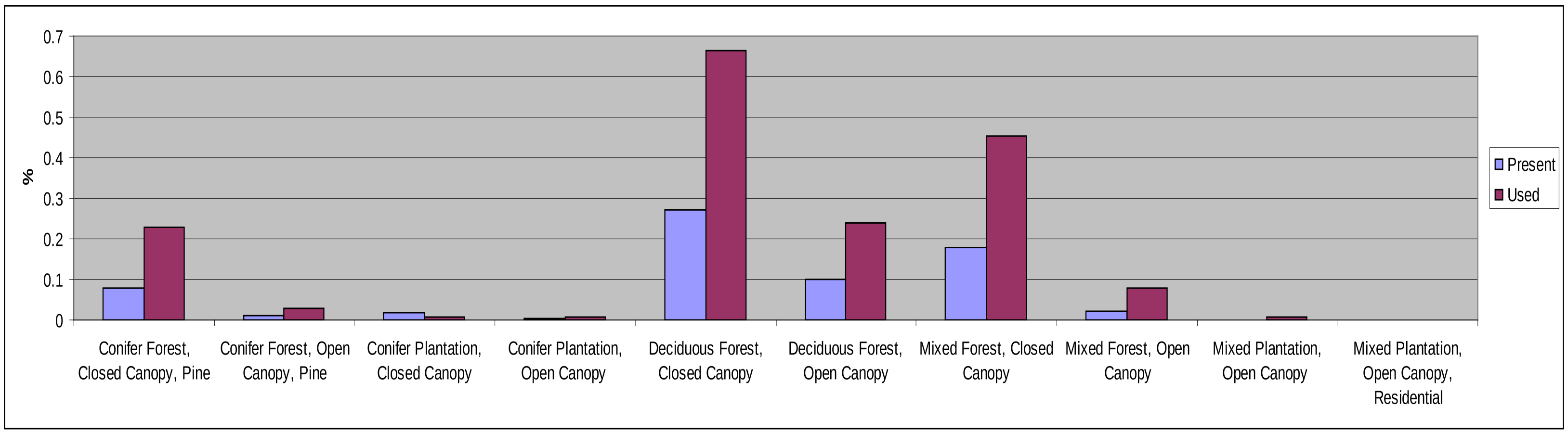

Figure 33. Results of the classification-based methodology for forest habitat types for black bears on Fort Drum Military Installation in the summer and fall of 2006. This is a comparison of the use of each habitat type to its prevalence on the study area.

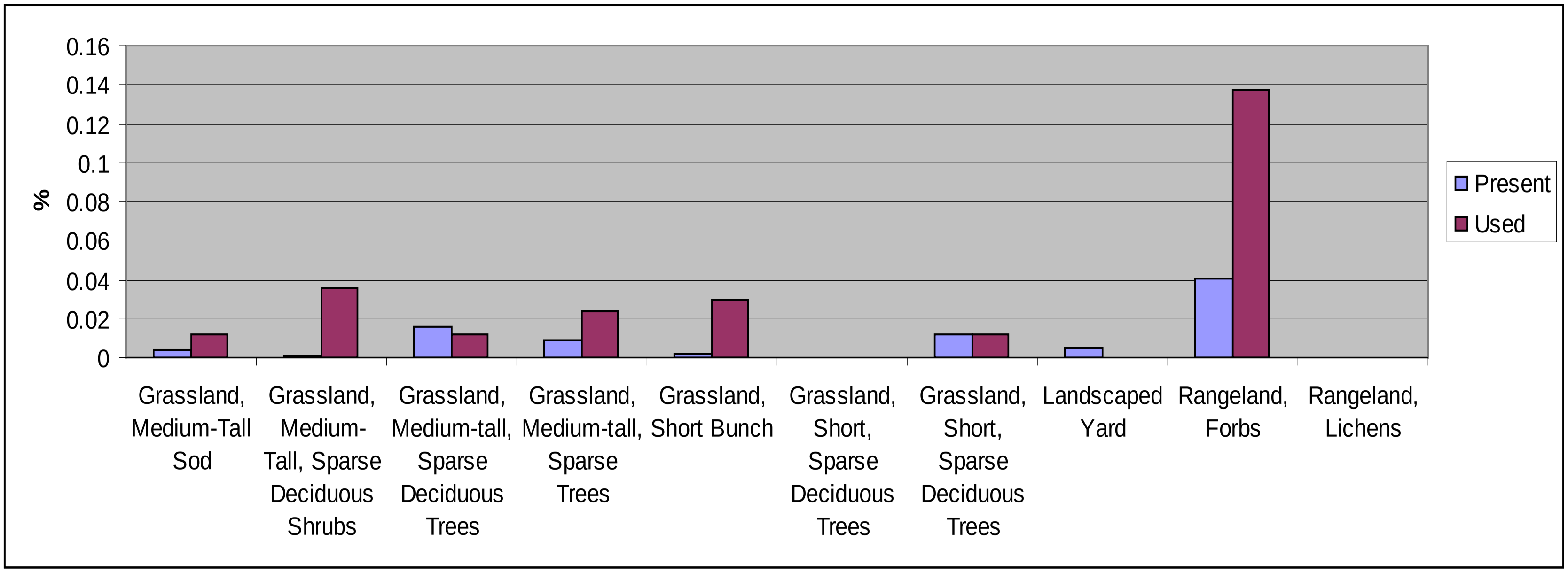

Figure 34. Results of the classification-based methodology for rangeland habitat types for black bears on Fort Drum Military Installation in the summer and fall of 2006. This is a comparison of the percent use of the habitat type to its prevalence on the study area.

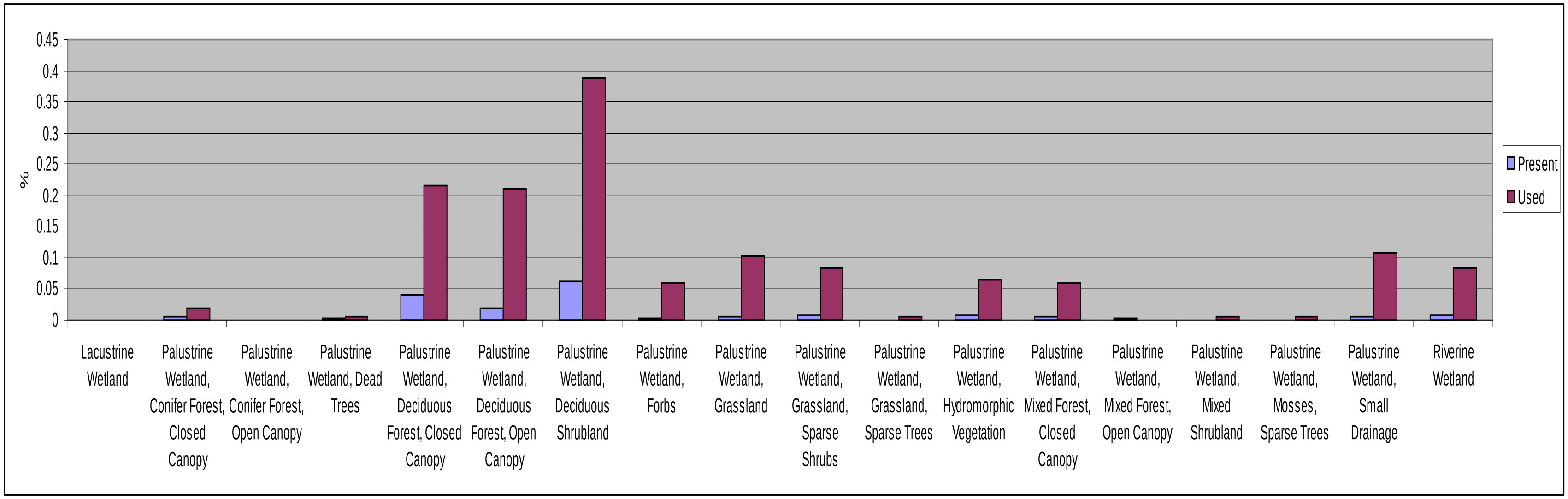

Figure 35. Results of the classification-based methodology for wetland habitat types for black bears on Fort Drum Military Installation n the summer and fall of 2006. This is a comparison of the percent use of the habitat type to its prevalence on the study area.

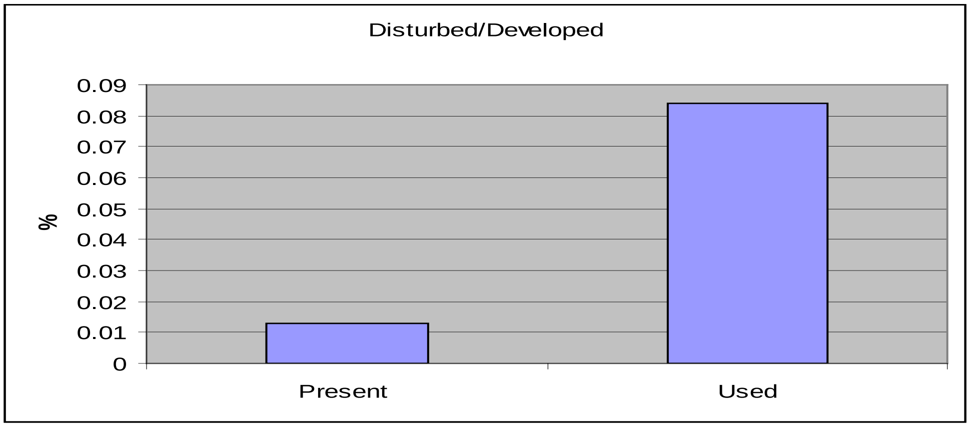

Figure 36. Results of the classification-based methodology for developed or disturbed habitat for black bears on Fort Drum Military Installation the summer and fall of 2006. This is a comparison of the use of the habitat type to its prevalence on the study area.

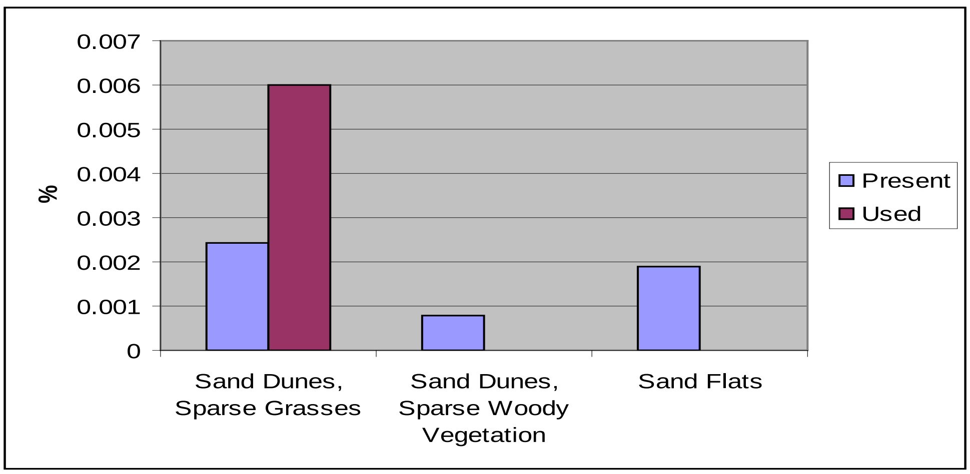

Figure 37. Results of the classification-based methodology for sandy habitat types for black bears on Fort Drum Military Installation in the summer and fall of 2006. This is a comparison of the percent use of the habitat type to its prevalence on the

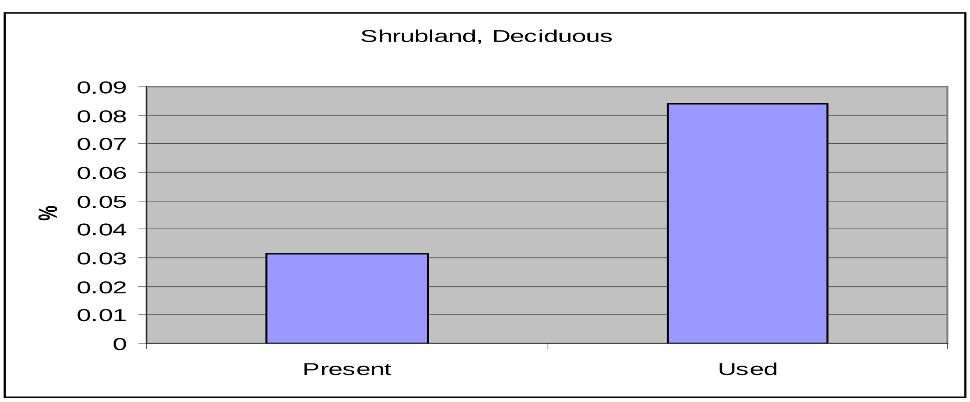

Figure 38. Results of the classification-based methodology for shrubland habitat for black bears on Fort Drum Military Installation in the summer and fall of 2006. This is a comparison of the percent use of the habitat type to its prevalence on the study

CHAPTER 5
Den Site Microhabitat Characteristics of Black bears on Fort Drum

Introduction

Black bears are not true hibernators but exhibit a dormant period during the winter. Typically, female bears enter dens during October or November, and males enter their dens in November or December (NYSDEC 2007). Except for newborn cubs, bears do not eat, drink, urinate or defecate during the denning period. Males leave their dens in March or April. Females leave their dens later than males, sometimes as late as May (NYSDEC 2007). In NYS, bear dens have been located in hollow trees, rock outcroppings, holes in the ground, brush piles, blowdowns, and even under houses (NYSDEC 2007). Generally, suitable den sites can be found within the area bear traverse while foraging (Fecske et al. 2002).

While the mating season of black bears typically occurs from mid-June to mid-July (Hirsch et al. 1999), females give birth to cubs while denning, due to delayed implantation of the embryo. Delayed implantation allows females to give intensive maternal care to their young (Hamilton and Marchington 1980) while taking advantage of the security offered by the den. This protection is also necessary to allow cubs time to develop before den emergence due to their extremely small size at birth. Energy expenditures by adult bears are also minimized (Johnson and Pelton 1981) during times of little or no food (Schooley et al. 1994). Since annual dormancy is such a critical part of black bear life history, denning site prevalence may be strongly correlated to adult and cub survival (White et al. 2001) and a limiting factor for population growth rate (Oli et al. 1997). Investigation of denning requirements based on microhabitat characteristics may provide necessary information for black bear management.

Methods

Radio-tagged black bears were followed to their den sites during the winter months. After bears emerged from their dens and before spring green-up, microhabitat characteristics for each brush pile or root wad den were measured using a subset of the methods described by Martorello and Pelton (2003). Microhabitat characteristics of fully excavated dens was not quantified as cover is inherently present in these dens in the form of soil walls and ceilings.

At each brush pile or root wad den site, a 0.04 ha (0.1 ac) circular plot (11.25 m / 36.9 ft radius) was established, with the den at the center point. Within these plots, overstory and understory characteristics were quantified. Overstory characteristics included: canopy cover (measured with a spherical densitometer and recorded by % (Strickler 1959)), diameter breast height (DBH) (measured with a DBH tape and recorded in m), tree number (number of trees ≥2.5 m (8.2 ft) within plot), and tree species. Understory (≤ 2.5 m (8.2 ft) in height) characteristics include: cover density (measured with a Nudds cover board (Nudd 1972)), shrub stem density (measured with a Daubermire frame and recorded as number/m^2 (Daubermire 1959)), and coarse woody debris (U.S. Forest Service 2002).

The cover density was recorded in a cover class scheme in which 1 = 0 - 5% coverage, 2 = 6 - 25% coverage, 3 = 26 - 50% coverage, 4 = 51 - 75% coverage, 5 = 76 - 95% coverage, and 6 = 96 - 100% coverage. The Nudds cover board was placed at the edge of the plot on the cardinal azimuths and coverage was estimated at heights of 0.5 m (1.6 ft), 1 m (3.3 ft), 1.5 m (4.9 ft), and

2 m (6.6 ft). Readings were taken from the den, or center of the plot. The estimates at each den site were averaged for each height and are compared across all den sites.

Shrub stem density was estimated by placing the Daubenmire frame at 5 equally spaced points on the cardinal azimuths and counting the number of shrub stems within the frame. The frame was equal to ¼ m^2 (2.7 ft^2) and all readings were multiplied by 4 to estimate the number of shrub stems per m^2. Shrub stems were considered any woody plant at or below 6.35 cm (2.5 in) DBH.

Results

Eight female black bear dens were recorded during the project on Fort Drum (Figure 39)—three were characterized as root wads, three were brush piles, and two were fully excavated. One of the excavated dens was located by chance when Fort Drum personnel accidentally flushed an adult female bear out of a den with cubs. In the following tables, this den site is labeled "Unclassified." The other dens were located through radio-tracking marked bears.

Microhabitat measurements were recorded at the 5 dens that were not excavated. The low sample size did not facilitate statistical analysis, but the results are presented and discussed in the context of reasonable assertions about black bear denning habitat given the data.

The overstory microhabitat characteristics are presented in Tables 10-11. Maple (*Acer* spp.) was the most prevalent tree species in the 0.04 ha plots around den sites, while pine trees (*Pinus* spp.) had the largest DBH. Mean winter canopy closure was 23.73 % (SD = 14.07). Understory microhabitat measurements are listed in Tables 12-13. Cover density means measured with the Nudds cover board were 3.45 at 0.5 m height (SD = 1.30), 2.55 at 1 m height (SD=0.69), 2.45 at 1.5 m height (SD=1.18), and 2.1 at 2 m height (SD = 0.14). As cover density was estimated in percentage classes, the means were rounded to the nearest whole number and converted to percentages. The resulting percentage estimates were: 26-50% at 0.5 m and 1 m and 5-25% at 1.5 m and 2 m. Mean shrub stem density was 9/m^2 at 2.25 m from the den (SD = 9.82), 10.2/m^2 at 4.5 m from the den (SD = 9.62), 7.8/m^2 at 6.75 m from the den (SD = 9.26), 11.8/m^2 at 9 m from the den (SD = 9.09), and 6.4/m^2 at 11.25 m from the den (SD = 3.65).

Table 10. The overstory canopy closure observed at female black bear den sites on Fort Drum.

Bear ID Number	Canopy Closure
026	32.76
027	37.44
029	7.00
036	31.33
Unclassified	10.14

Table 11. The overstory tree species observed at female black bear den sites on Fort Drum.

Tree Species	Number of Plots in Which Present	Mean Number Per Plot (SD)	Mean DBH (cm) (SD)
Acer spp.	5	5 (2)	15.90 (7.50)
Populus spp.	3	1.4 (1.67)	10.83 (3.18)
Fagus spp.	2	0.6 (0.89)	10.50 (1.73)
Fraxinus spp.	1	0.2 (0.45)	4.6 (0)
Pinus spp.	2	1.8 (3.49)	3.67 (16.43)
Prunus spp.	3	1.4 (2.07)	28.63 (3.34)
Tsuga spp.	1	0.2 (0.45)	3.9 (0)

Table 12. Cover density as measured with a Nudds cover board at female black bear den sites on Fort Drum.

Bear ID Number	0.5 m	1 m	1.5 m	2 m
026	3	2.25	2	2
027	5.5	2.75	4.5	2.25
029	2	1.5	1.5	2
036	3	3.25	2	2.25
Unclassified	3.75	3	2.25	2

Table 13. Shrub stem density (#/m^2) observed at female black bear den sites on Fort Drum.

Bear ID Number	2.25 m	4.5 m	6.75 m	9 m	11.25 m
026	8	3	3	9	5
027	1	1	3	0	12
029	10	16	7	21	2
036	1	7	2	8	6
Unclassified	25	24	24	21	7

Table 14. Coarse woody debris estimated in cubic meters per hectare as observed at den sites of female black bears on Fort Drum.

Bear ID Number	Coarse Woody Debris (m^3/ha)
026	20.54
027	183.58
029	54.59
036	37.39
Unclassified	18.76

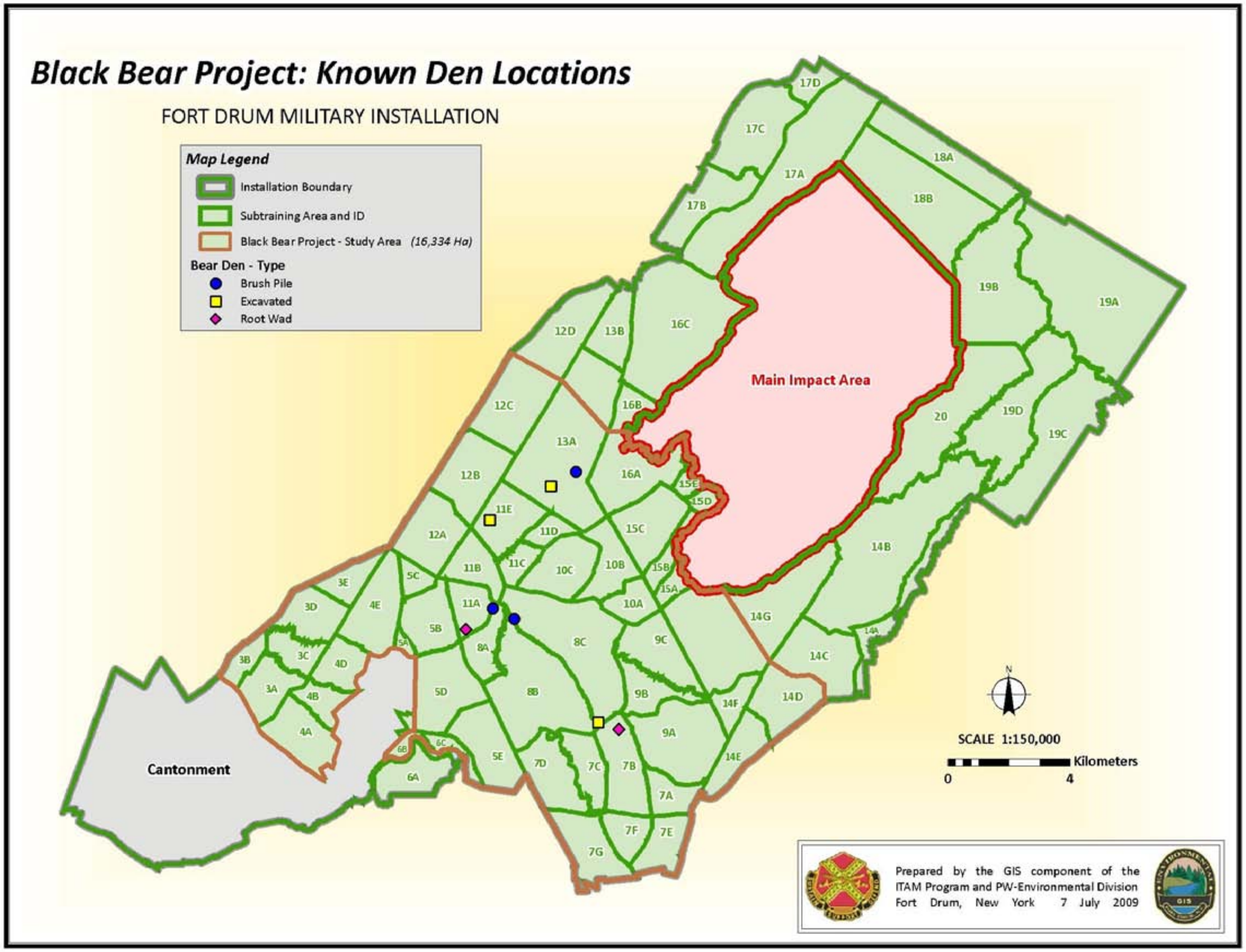

Figure 39. Known bear den sties on Fort Drum. Note: Symbols denote the types of dens (i.e. shrub pile, excavated, root wad. Examples are on Page 60).

Figure 40.   Root wad den site for Bear 029.

Figure 41. Root wad den site for Unknown Bear.

Figure 42. Brush pile den site for Bear 026 next to a road.

Figure 43. Brush pile den site for Bear 027.

Figure 44. Root wad den site for Bear 036.

Discussion

On a coarse scale based on the bear dens located, fallen trees appeared to be a very important source of den sites for bears on Fort Drum.

Maple trees (*Acer spp.*) were present in each of the 0.04 hectare plots surrounding the den sites. Aspen (*Populus spp.)* and black cherry (*Prunus serotina*) were the next most prevalent trees, found in 3 of 5 plots. The mean number of pine trees (*Pinus spp.*) per plot was greater than that of aspen and cherry trees, but was only found in two plots and was very prevalent in one of these. While these tree species are indicative of a mid-late successional stage forest, the DBH measurements were relatively small for the tree species recorded. A possible explanation for this is that a localized canopy disruption may have occurred that allowed additional sunlight to reach the forest floor, spurring new growth in the areas around the dens and creating additional cover for den safety and protection from the elements.

Further conjecture about den site microhabitat characteristics is not straightforward. Canopy closure measurement showed high variability. Shrub stem density did not appear to be any higher near the dens as compared to the outer edge of the plots. The understory cover density also offered little usable management information. Up to one meter in height, cover density is higher than from 1-2 m in height, however, this is somewhat intuitive since shrubby vegetation is inherently more dense near the ground and less so as it gets taller. The data from these measurements provide minimal management level information, but do provide managers with baseline information about black bear denning habitat.

CHAPTER 6
Black bear populations on Fort Drum: A comparison of occupancy model and mark-recapture abundance estimates

Introduction

Long-term population monitoring is crucial to the development of management plans and evaluation of management actions which may be designed to manipulate the population size of a given species. NYSDEC monitors several indices (e.g., bear harvest, non-hunting mortality, nuisance complaints) to determine population trends. Though it is difficult to determine population levels, the minimum post-harvest population estimate for black bears in NYS is between 6,000 - 7,000 animals, including 4,000-5,000 bears in the Northern Black Bear Range, about 2,000 bears in the Southern Black Bear Range, and 100-300 outside of the primary ranges (NYSDEC 2007).

Mark-recapture analysis has been one of the most frequently used population abundance estimation procedures in wildlife (Stanley and Royle 2005) including estimating black bear populations (Waits and Paetkau 2005; Garshelis and Noyce 2006). These models utilize encounter histories to estimate various demographic parameters such as population abundance, survival, detection probabilities, and recruitment and growth rates (White and Burnham 1999). As part of mark-recapture studies, marking procedures have typically involved intensive techniques such as capture of the bear and placement of a unique tag or collar. These procedures can be traumatic for the animal and are usually both time-consuming and expensive. Marks are also susceptible to being lost or misread.

Recent developments in microsatellite genotyping allow for non-invasive sampling of hair follicles, skin cells or blood (Woods et al. 1999). Since microsatellite genotypes are unique to an individual, they can be used as genetic “tags” (Woods et al. 1999) that are never lost or changed. Researchers can gather information on large numbers of individuals without having to capture and handle any animal, while also building encounter histories on specific individuals over several discrete time intervals from the genotyping results (White et al. 1982; Woods et al. 1999). Also, when samples are carefully gathered, stored, and analyzed, the error in genetic identification is low (Boersen et al. 2003). The use of this technique on free ranging ursids has occurred since the early 1990s (Shields and Kocher 1991; Taberlet and Bouvet 1992).

The methodology for non-invasive sampling has evolved from gathering hair from fecal matter and rub trees, to more effective and efficient barbed-wire enclosures. Woods et al. (1999) tested several different types of “hair traps,” reporting the barbed-wire enclosure to produce 74% of all usable samples in that study. This trap involved stringing barbed-wire around 4-5 trees at a height of 50 cm with a bear-attracting scent being placed inside the enclosure (Woods et al. 1999; Figure 46). In order to closely investigate the attractant, the bear must cross the barbed-wire, leaving hairs on the barbs as it enters the enclosure. When properly built, the hair trap enclosure does not induce “trap-shy” behavior by bears, making it especially

Figure 45. Bear hair on barbed hire. (Photo: U.S. Geological Survey)

suitable for mark-recapture population analysis. Dobey (2002), Boersen et al. (2003), and Thompson (2003) all reported "reasonable" population estimates and sex ratios based on microsatellite genotype analysis. Woods et al. (1999) also compared DNA fingerprinting to camera surveys in a mark-recapture study, reporting the hair analysis to be much more reliable for individual identification, documenting recaptures, and therefore, improved estimates.

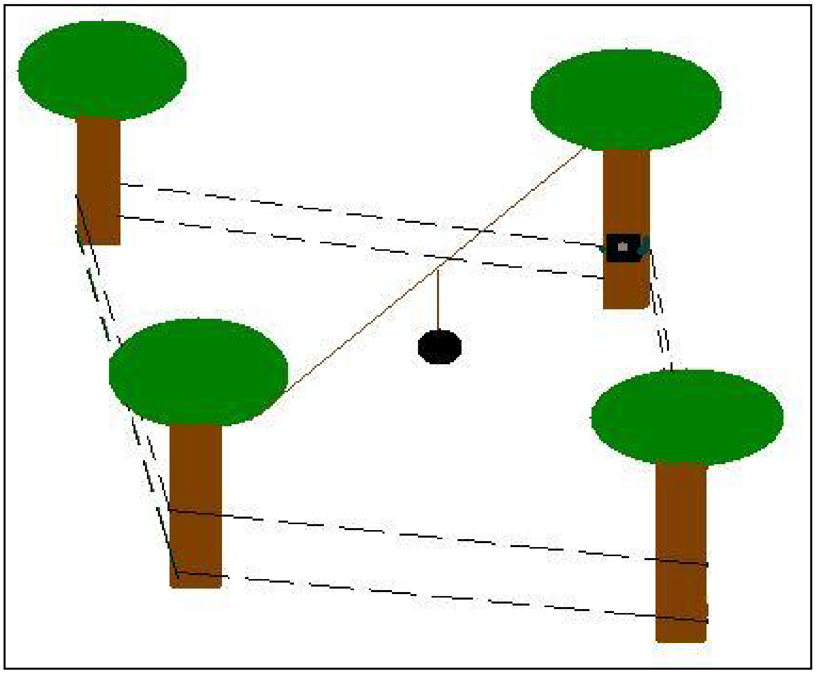

Figure 46. Schematic arrangement of a hair trap with two strands of barbed wire at a bait hanging in the middle.

Analyzing mark-recapture data consists of counts of animals observed in the field (C), which can be used in the statistical model $E[C]=pN$, where E is the expectation of counts, p is the detection probability, and N is the population size (Williams et al. 2002). Because N is to be estimated and C is observed, an accurate estimate of p is necessary to apply this model (Stanley and Royle 2005). The abundance estimate is thus generated from $\hat{N} = C / \hat{p}$. Mark-recapture models use maximum likelihood estimators (MLE) to estimate p from encounter histories of individuals from the sampled population.

New statistical techniques provide population estimates from occupancy models (Royle and Nichols 2003) using a MLE framework. The data gathered from multiple interval sampling at hair traps can be converted to a binary detection/non-detection (1 for presence, 0 for absence) form for use with these occupancy models. The occupancy model may offer an analysis tool which substantially reduces costs because only detection/non-detection data are required and not identification of individual animals. Avoiding the cost of genetic analyses of hair samples to estimate population size is understandably attractive.

Royle and Nichols (2003) originally applied the occupancy model to avian point count data. One of the objectives of this project was to apply black bear data to both the traditional mark-recapture estimator and the occupancy model and compare the estimates in terms of respective model strengths and weaknesses.

Methods

Data Collection

Bear hair was collected at barbed wire hair traps. Each hair trap consisted of 2 strands of barbed wire strung around 3-5 trees to create an enclosure (Figure 46). Strands of barbed wire were approximately 25 cm (9.8 in) and 60 cm (23.6 in) above the ground. The bait was 0.45 kg (1 lbs.) of raw bacon and 1 half-opened 170 g (6 oz.) can of sardines to attract bears into the enclosure. Baits were hung at a height of 1.5 m (4.9 ft) above ground to avoid disturbance by non-target species.

According to Otis et al. (1978), a mark-recapture study should include ≥4 traps per mean female home range. Samson and Huot (1998) reported mean black bear female home ranges as 12.45 km² (3,076 ac) in southern Quebec and this was considered to be a reasonable estimate for the study area at Fort Drum based on geographic vicinity. In order to account for possible differences in home range size, the trap spacing was based on a 3 X 3 km (1.86 mi x 1.86 mi) grid GIS laid over approximately 227 km² (56,092 ac) of Fort Drum in ArcGIS. Hair traps were placed as close to the intersections of the gridlines as possible, and one in the center of each cell.

Figure 47. A hair trap station on Fort Drum.

Twenty-eight traps were used in 2005 and sampled from 6 August to 11 September. Unfortunately, genetic analysis was possible on only 46 of 86 samples because bears were shedding (due to the time of year) without the hair follicle attached to the hair strand. Because of this low ability for analysis, it was determined to not analyze the 2005 information and change methods slightly in 2006.

In 2006, 38 traps were used (Figure 48) and sampled from 1 June to 28 July. Each week is referred to as an interval or a sampling occasion. During these checks, hair was gathered from the barbed wire once a week, packaged in envelopes, and labeled. Labeling information included time interval and hair trap number. Samples from each barb with hair attached were packaged individually. Each site was re-baited weekly regardless of whether the trap site had been visited.

Hair samples were sent to Wildlife Genetics International (Nelson, British Columbia, Canada) for microsatellite genotyping. Each hair sample that amplified at six microsatellite loci (G10L, G1D, G10P, G10M, G10J, MU59) was used for the mark-recapture analysis. The resulting genotype of each sample was then cross-referenced with all other samples to generate encounter histories for each individual identified.

Gender was determined for each individual bear based on size polymorphism in the amelogenin gene (David Paetkau, Wildlife Genetics International, personal communication). The best quality hair sample from each individual was chosen for the gender analysis, based on number of guard hair roots. Hair samples from 7 live-captured bears of known sex were also analyzed to error check the gender determination analysis. Prices for extraction of genetic material and analysis at six microsatellite markers generally range from 45 – 60 USD/sample.

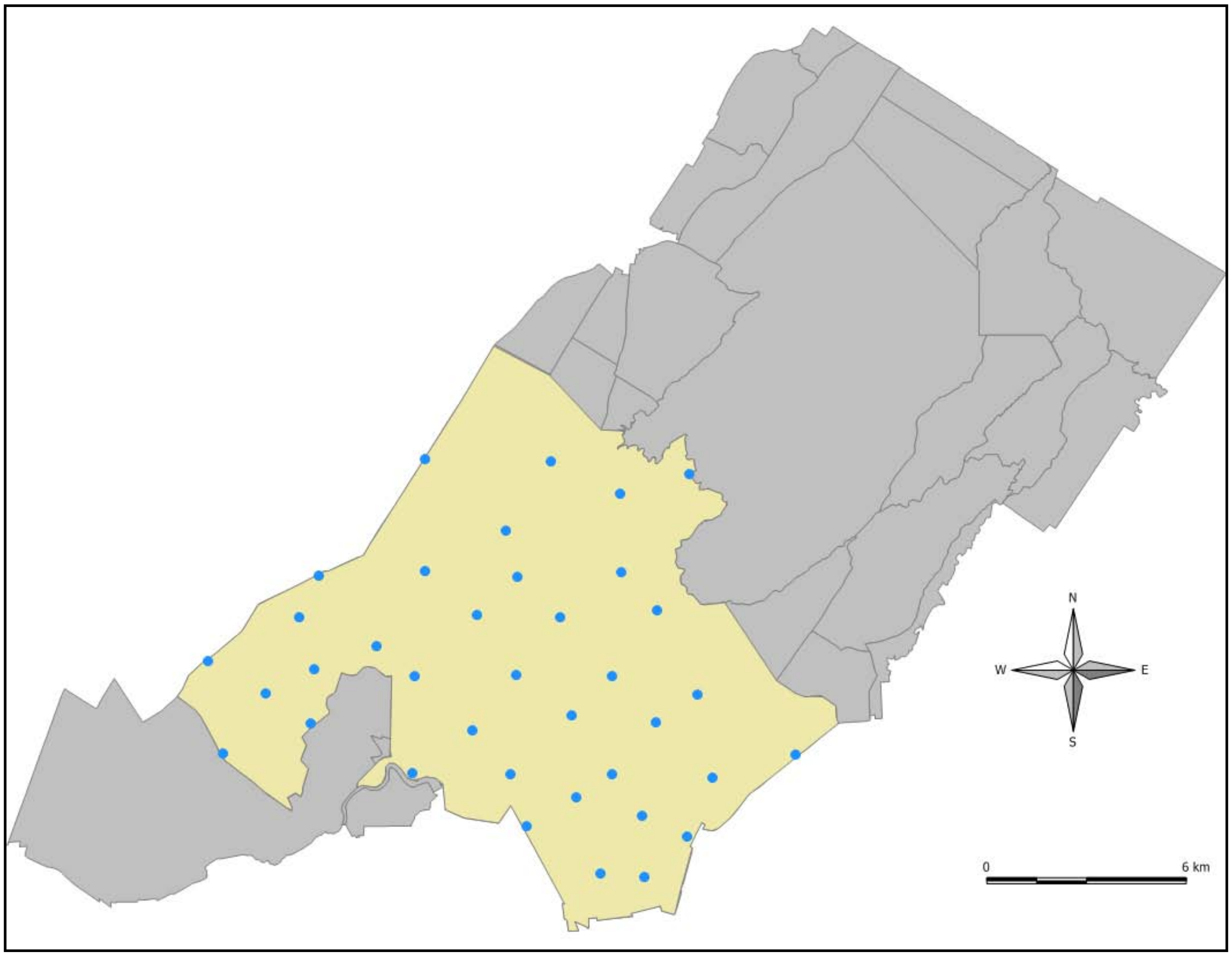

Figure 48. Arrangement of hair trap stations in the study area of Fort Drum Military Installation in 2006.

Mark-Recapture Estimation

The Closed Capture model type in Program MARK (White and Burnham 1999) was used to generate a population estimate based on the encounter histories developed from microsatellite genotyping. This model allows for the estimation of capture probability (*p*), recapture probability (*c*), and population size (*N*) (Lukacs 2006). Parameters within the models were allowed to be time dependent (*t*) or constant (.). The general model was set as *p(t)c(t)N* which allowed capture and recapture probabilities to vary with time. Additionally, because the estimates of *p* and *c* are not constrained to be equal, this model could detect a behavioral trap response in the *c* values (i.e., trap-happiness or trap-shyness) if present. All other models were reduced versions of the general model. In models where *p* was time-dependent, the model was initially fit without fixing the *p* value for the last time interval, because this is inestimable (Lukacs 2006). The mean *p* value was calculated for all but the last time interval, and refit the model using the average *p* value for the final time interval. Akaike's Information Criterion corrected for sample size (AICc) was used for model selection, with the lowest AICc value indicating the best model (Burnham and Anderson 1998). Estimates from the models for all parameters were reported as weighted averages based on the AICc weights calculated by Program MARK. Goodness of fit testing is not applicable to the Closed Capture model type (Lukacs 2006) and was not used. Population closure, (e.g., no immigration, emigration, births, or deaths during sampling), certainty in identification of individuals, and independence of visits to trap sites are basic assumptions of the model.

Occupancy Model Analysis

Population abundance was calculated based on detection/non-detection data with the occupancy model developed by Royle and Nichols (2003). Instead of using encounter histories for every individual sampled in the hair trapping effort, detection/non-detection data was used for each hair trap at each time interval. Thus, no microsatellite genotyping was necessary for this estimate to be generated.

The basis of the model was the assumption that heterogeneity in localized population size, around each trap respectively, had the greatest influence on heterogeneity in capture probabilities between sites (Royle and Nichols 2003). Therefore, estimation of abundance at each site and the summation of these estimates resulted in an estimate of abundance for the entire study area. If p_i is the detection probability at the ith hair trap and N_i is the abundance at the ith hair trap, the model describes the distribution of p_i among all sites sampled. Because variation in p_i is primarily sensitive to variation in N_i, the distribution of p_i can be used to describe the distribution of N_i. Estimates of N_i can be generated using this estimated distribution of N_i and the observed data at each site. Royle and Nichols (2003) describe the model in further detail, deriving the likelihood statement and applying the model to avian point counts and simulated data.

Because population estimates for all trap sites are compiled to create an estimate of abundance over the entire area sampled, all traps are assumed to be independent (Stanley and Royle 2005). This implies that the effective trapping area of each trap site is closed to immigration, emigration, births, and deaths. The process for measurement of effective trapping areas has yet to be determined. The occupancy model also assumes equal detectability among all individuals in the population (Royle and Nichols 2003).

Population Density Estimation

The study area size was calculated by creating a polygon with line segments joining the outermost traps in the trapping grid in Manifold 7.5 (Manifold Systems, Carson City, Nevada). The radius of the mean female home range size (15.09 km^2 / 3728.82 ac) was calculated and then the polygon was buffered by that radius (2.192 km / 1.36 mi) to estimate the effective trapping area (Bales et al. 2005). To generate estimates of population density, the population estimate derived from mark-recapture and occupancy models was divided by the effective trapping area.

Results

Hair Trapping

In 2006, 397 hair samples were collected between 1 June and 28 July at 38 hair traps over 8 week-long sampling intervals. The total number of opportunities to collect hair was 304 (i.e. 8 trapping intervals * 38 traps). A minimum of one sample was collected from a given hair trap 97 times for an average of 32%. Three hundred forty-eight (88%) hair samples were successfully genotyped and assigned to an individual. Forty-seven unique bears were identified through the process. Heterozygosity of the six markers used was 0.80. No samples or individual bears were found mismatched at less than 2 microsatellite loci. Individual bears made a conservative estimate of 151 visits to hair traps. The mean number of times a unique individual was recorded at any trap was 2.55 (SD = 1.94). Hair samples from 20 of the 47 individuals were only collected and successfully genotyped in 1 time interval. The mean number of hair traps visited was 1.95 with 23 individuals visiting at least two. The calculated effective trapping area was 255.30 km^2 (63,806 ac).

In 2006, gender analysis indicated a slight bias in the population towards females, with 19 males and 28 females identified, or a 1 m:1.47 f ratio. The gender analysis method was checked using 7 hair samples of individuals (3 male, 4 female) of known sex. Determining gender of each of the known individuals was successful using this method.

Program MARK Estimation

Six models were built in the Closed Captures model type to generate estimates of capture probability (p), recapture probability (c), and abundance (N) (Table 15). The weighted average abundance was calculated to be 57 bears with a 95% confidence interval of 49 - 96. The estimated population density from this analysis is 0.227/km^2. A response to initial capture (i.e., trap-happiness or trap-shyness) was not observed. Neither the general model, nor the model averaged values, displayed a significant difference between the capture and recapture probabilities, indicating no trap response.

Table 15. Outputs for all mark-recapture models for black bear abundance estimates on Fort Drum in 2006. (t) indicates time variation allowed for the parameter. (.) indicates that the parameter was constrained to be constant. The final p for each model with time variation in the detection probability was fixed as the mean of all other estimated p values.

Model	*AICc*	*Delta AICc*	*AICc Weight*	*Model Likelihood*	*No. of Parameters*	*Deviance*
{p(.)c(.)N}	***192.907***	***0.00***	***0.61101***	***1.0000***	***3.000***	***147.900***
{p(t/0.33)c(.)N}	***196.234***	***3.33***	***0.11579***	***0.1895***	***9.000***	***138.799***
{p=c(t)N}	***196.255***	***3.35***	***0.11458***	***0.1875***	***9.000***	***138.820***
{p(.)c(t)N}	***196.255***	***3.35***	***0.11458***	***0.1875***	***9.000***	***138.820***
{p=c(.)N}	***199.191***	***6.28***	***0.02639***	***0.0432***	***2.000***	***156.216***
{p(t/0.33)c(t)N}	***199.996***	***7.09***	***0.01765***	***0.0289***	***15.000***	***129.720***

Occupancy Model Estimation

In 2006, all 97 occasions in which bear hair was retrieved from the barbed wire sites were used. A Poisson distribution was used to describe the total number of times each trap was visited and, thus to determine the estimate of N_i (Royle and Nichols 2003). The resulting abundance estimate was 69 bears, with a 95% confidence interval of 43 -109. The population density was calculated as 0.270/km^2.

Discussion

The focus of this component of the project was to compare abundance estimates of black bears on Fort Drum with both the mark-recapture and occupancy model methodologies. As mark-recapture is generally considered the standard, the utility and reliability of the occupancy model was evaluated.

Mark-Recapture Estimation

Mark-recapture abundance estimation from hair samples required genetic analysis. This analysis is not entirely error-free (Taberlet et al. 1999). Error in genotyping can lead to two different types of misidentification: creation of an individual which was not sampled and assignment of a sample as belonging to a known individual from which it did not originate. The first type of error leads to an individual being counted more than once due to one incorrectly mismatching pair of microsatellite markers in two samples which came from that individual, resulting in overestimation. The second type of error leads to underestimation when two individuals actually differ at one or more pairs of markers, but analysis shows that the two have identical genotypes and are therefore classified as one individual. To ensure a low probability of either type of error affecting estimates, all samples mismatched at only one microsatellite locus should be retested. Because none of the 2006 samples mismatched at less than 2 microsatellite loci, this procedure was unnecessary.

The high variability of markers tested (Heterozygosity = 0.80) should result in a low probability of improperly matching two samples from individuals with differing genotypes (Paetkau 2003). No samples or individuals mismatched at less than 2 microsatellite loci were found. Four bears in the sample set were mismatched at 2 loci. According to the estimates of Paetkau (2003) the probability of this type of error can be estimated from the number of pairs of samples mismatched at 2 microsatellite loci. This particular error generally occurs one time for every 100 pairs of samples mismatched at 2 microsatellite loci. Because 4 of these sets of samples were observed, there is a 4% chance that 48 individuals were sampled instead of the reported 47. The marker power was also tested by reassigning all samples to individuals based on the three most variable markers (G10L, G1D, and G10P) in this study. The results were identical to the analysis performed with all six markers. The low probability of genotyping error and displayed power of the three markers used in the retesting procedure leads to a high level of confidence in reporting the identification of 47 unique individuals.

A lack of population closure can bias estimates (Kendall 1999). The study area on Fort Drum is part of the Northern Black Bear Range. Closure of the population is unlikely to be met during any viable sampling frame due to immigration and emigration to and from Fort Drum. Only immigration and emigration were addressed because births (which take place mid-winter) and deaths (likely low due to high food availability and closed hunting season) were expected to be minimal or non-existent during the eight week sampling period. Kendall (1999) noted, unbiased estimates of abundance can occur if the population is not closed, and one of three circumstances is met: (a) immigration and emigration probabilities are random among all individuals on the study area; (b) the entire population is present in the first sampling interval but individuals begin to leave thereafter and sampling occasions after the first are pooled into one interval; or (c) sampling begins with no individuals present in the first time interval but all individuals in the population are present by the last time interval and all intervals are pooled as one. The latter two situations are not relevant to this study because it is unreasonable to believe that at any time the "superpopulation" is condensed into the study area. It is recognized that immigration and emigration were likely, therefore, the assumption was made that the probability either occurs is random across all individuals to report a wholly unbiased estimate.

Garshelis et al. (1983) noted that adult males travel longer distances per day than do adult females. Juveniles, regardless of gender, travel more than adults (Garshelis et al. 1983). Estimates of home range have been shown to be significantly different between adult females and males (Young and Ruff 1982; Smith and Pelton 1990). If these findings are consistent with the population on Fort Drum, immigration and emigration probabilities would not be expected to be random among all bears. However, describing and correcting abundance estimates to account for this particular bias is not statistically clear.

Occupancy Model Estimation

Occupancy model estimates, in short, are summations of abundance estimates in multiple sampling areas (Royle and Nichols 2003). Independence of each sampling area is necessary to provide unbiased estimates. A lack of independence (i.e. bears visiting multiple sites) would lead to inflated p_i values, resulting in positively biased N_i values. This would lead to overestimation of abundance for the study area (Stanley and Royle 2005). Researchers constrained to detection/non-detection data for occupancy model abundance estimation cannot detect or quantify this phenomenon. The data from Fort Drum allows for the investigation of the robustness of the model to violations of site independence.

An issue associated with trap independence is lack of ability to measure the effective trapping area for sampling stations, or hair traps in this study. For unbiased estimates of abundance with occupancy models, effective trapping areas may not overlap with one another. Any overlap of these areas implies that animals on some of the study area may be captured at multiple sites. Currently there is not a defined method for determining the effective trapping area of sampling sites either before or after sampling (J. A. Royle, USGS, personal communication). As such, establishment of trapping grids with *a priori* confidence in trap independence is impossible.

The lack of independence of trap sites in this study was partially a function of study design. Mean female home range size was estimated with the intention of placing multiple traps in each individual's home range as suggested by Otis et al. (1978) for the mark-recapture estimation. Mark-recapture models require relatively large data sets to generate reasonable estimates and associated confidence intervals. More than the suggested minimum of 4 traps per mean female home range was actually placed due to the short temporal scale of this investigation. While this resulted in a reasonable abundance estimate from the mark-recapture model, it leads to difficulty in interpreting the occupancy model analysis. The occupancy estimate was not expected to be positively biased due to a lack of trap independence, however the extent of this was unknown. Variations in the input data for the occupancy model (i.e., simulation of trap independence by using the genetic analysis to inform the occupancy model input by constraining individuals to visits at only one trap site) were not investigated. The goal of this part of the project was to generate an abundance estimate with the occupancy model based on data collected in a mark-recapture framework. This allowed for investigation into the similarity of estimates from the occupancy model as compared to the mark-recapture models and the potential for the occupancy model to generate reasonable results without requiring any level of change in data collection protocol.

Comparison of Mark-Recapture and Occupancy Model Estimates

The mark-recapture and occupancy model estimates of black bear abundance on Fort Drum, 57 and 69, respectively, were not significantly different. Confidence intervals for each estimate were likewise reasonably similar. The density estimates (0.227/km^2 and 0.270/km^2) were similar to previously reported estimates of the Adirondack black bear population of 0.229 bears/km^2 (Lou Berchielli, New York State Department of Environmental Conservation, personal communication). In terms of the implications to a wildlife manager, there would be a marginal, if any, difference in decisions based upon these estimates.

For the exclusive purpose of abundance estimation, the occupancy model can produce analogous results to the traditional mark-recapture framework, at least in terms of this data set. The occupancy model performed well, even with violations of the assumption of trap independence and without measurement of effective trapping area for hair traps. These represent the major theoretical arguments against implementation of the occupancy model. However, here they did not preclude the generation of comparable estimates between the two model types.

Neither of the estimators had the capacity to model capture heterogeneity and correct abundance estimates appropriately. The phenomenon of differences in capture probabilities based on biological characteristics (e.g. sex and age) has been incorporated into models (Otis et al. 1978; Williams et al. 2002; Boulanger et al. 2004). The estimates from these models are unbiased (Boulanger et al. 2004), but may suffer from less precision than models that do not account for capture heterogeneity (Chao 1989), such as those used in this investigation.

There were several potential causes for differences in individual capture probabilities. Dissimilar travel patterns have been noted between sex and age classes (Young and Ruff 1982; Garshelis et al. 1983; Smith and Pelton 1990), and were the most likely causes of capture heterogeneity. Trap placement may have also added to this. Due to time and staffing constraints, hair traps could not be moved between trapping intervals. Traps are often moved to allow for a more even spatial distribution of traps over the course of sampling (Boulanger and McLellan 2001; Boulanger et al. 2004). This may allow for a higher probability of bears encountering hair traps at similar rates despite biological differences.

A single abundance estimate provides only a snapshot view of the population, and is not reliable for long-term management. A repeated monitoring program can produce population trends, and may help wildlife managers evaluate changes in harvest levels or other management programs. The reduced cost for implementation of the occupancy model makes it an attractive monitoring tool. The occupancy model may prove to be a dependable abundance estimator for researchers and managers with limited resources. However because this methodology is relatively new, more research is required to validate its reliability. Further research should focus on comparing the occupancy model to mark-recapture procedures, and investigating the effects of different hair trap densities for black bears and other species.

CHAPTER 7
Inducing conditioned taste aversion and site-specific avoidance in black bears on Fort Drum

Introduction

Given the opportunity, black bears will generally avoid people (NYSDEC 2007). However, bears that learn to associate people with the availability of human food and garbage often display uncharacteristically bold behavior and can learn to overcome their fear of people which creates potentially unsafe human-bear interactions (Weaver et al. 2003).

Many people believe that problematic interactions with bears will stop if wildlife managers simply "take the bear someplace else." Although translocation, or the trapping and subsequent release of an individual outside its original home range, has been a widely used technique for dealing with nuisance bears, it is not an effective way to stop problem interactions. Black bears have an excellent homing ability and they may readily return to the location from which they were removed. For example, an adult female bear in the Adirondacks, captured and marked because of nuisance behavior, returned to the same location after being relocated over 41 mi (90 km) from the original site (NYSDEC 2007). Numerous bears, including several family groups of sows and cubs, have been relocated from public sites where illegal feeding occurred in the Catskills, only to return to the exact same location in a short time and resume the nuisance behavior (NYSDEC 2007). Results of translocations in other parts of North America have been highly variable, depending on the distance an individual is moved, physiographic barriers between release and capture site, elevation gain, and age and sex cohort (McArthur 1981; Brannon 1987). Not only is translocation only sporadically successful, it is expensive and time consuming (McArthur 1981) and bears may simply repeat undesirable behavior in their new location.

Aversive conditioning is the other commonly utilized non-lethal technique for discouraging black bears (Beckmann et al. 2004). The premise behind aversive conditioning is to impose a negative association (i.e., creating pain or distress) for a particular, undesirable, action (i.e. accessing garbage cans and dumpsters). It is assumed a cognitive link may develop between the action and the negative consequences for the action, thus resulting in the animal avoiding that action if the relative gains are not sufficient to risk the consequences.

The effectiveness of several aversive conditioning techniques have been investigated. The use of rubber bullets to inflict ephemeral pain and cracker shells (pyrotechnic and noise making devices) fired from 12-gauge shotguns to scare problem bears are routinely used (Clarkson 1989; Rauer et al. 2003). Although this type of mechanical aversive conditioning is frequently used as a management tool, literature on its efficacy is sparse. Rauer et al. (2003) used rubber slugs and buckshot to aversively condition European brown bears (*Ursus arctos arctos*), but found effectiveness variable, with most attempts unsuccessful. Beckmann et al. (2004) aversively conditioned black bears trapped in urban areas with rubber buckshot and slugs, pepper spray, cracker shells, yelling, and dogs. These techniques were ineffective for reducing the likelihood that a treated bear would return to the treatment site.

On-site capture and release has also been studied as a potential tool to aversively condition bears. The negative stimuli provided by the capture and handling of the problem individual at the site of the nuisance activity reinforces the bear's natural fear of humans, resulting in avoidance of the area (Clark et al. 2002). This has been shown to be very successful in precluding problem bears from repeating nuisance behavior at the site of capture (Brady and

Maehr 1982; Wooding et al. 1988; Shull 1994; Clark et al 2002). However, these authors only discuss bear avoidance of the capture site and did not report future nuisance activity of treated bears.

Another aversive conditioning method is conditioned taste aversion (CTA) which is induced by the ingestion of a specific food that causes gastrointestinal discomfort, thus creating a desire to avoid that food. CTA has been observed in several species (Agmo 2002; Batsell and Ludvigson 1989; Steigerwald et al. 1988; Gustavson et al. 1982; Cornell and Cornley 1979) including free-ranging and captive bears. Woolridge (1980) reported CTA in both free-ranging and captive black bears and polar bears using lithium chloride (LiCl), emetine hydrochloride, and alpha-naphthyl-thiourea. Captive bears showed a greater aversion to previously treated foods, but visitation of garbage dumps by free-ranging animals did decrease after treatment, displaying the potential for site aversion to develop. Gilbert and Roy (1977) were also successful in reducing black bear depredations of commercial beehives through the use of LiCl and electric fences.

Ternent and Garshelis (1999) aversively conditioned free-ranging black bears in Minnesota using thiabendazole (TBZ). Thiabendazole is an anthelmintic drug used to treat gastrointestinal worm infestations in animals and humans (Brown et al. 1961; Standen 1963). When ingested, it causes gastrointestinal discomfort, nausea, diarrhea, and vomiting as a side-effect (Rollo 1980). These effects usually develop in less than 15 min (Mark Ternent, Pennsylvania Game Commission, personal communication). Thiabendazole is also quickly metabolized with illness subsiding after 24 hrs. Unlike LiCl, which has a strong salty flavor that may reduce its effectiveness as a conditioning agent (Burns 1980), thiabendazole is odorless and tasteless.

A component of this project on Fort Drum was to build on the results of Ternent and Garshelis (1999). The bears tested by Ternent and Garshelis (1999) were thoroughly human-habituated and treated individually by feeding thiabendazole-laced food by hand. After one treatment, all the study bears generally showed some level of aversion to the foods used in the treatment. This project attempted to further understand the feasibility of thiabendazole as an aversive conditioning agent and potential management tool for free-ranging black bears.

Methods

Ten bait stations were established to attract free-ranging black bears on Fort Drum. Bait stations were similar to hair trap stations (Figure 46) described in Chapter 6. Each bait station consisted of two strands of barbed wire strung around 3-5 trees to create an enclosure. Strands of barbed wire were approximately 25 cm (9.8 in) and 60 cm (23.6 in) above the ground. Baits were hung at a height of 1.5 m (4.9 ft) above ground to avoid disturbance by non-target species.

In 2005, bait consisted of MRE packages suspended in the middle of the station. As an additional attractant to bring bears to the bait station, a hardware cloth basket was constructed and filled with fish and suspended above the MRE. However, no MREs were consumed by bears and there were no reports of nuisance bears on the installation during the field season. Because of the lack of nuisance activity, the methodology was changed in 2006. An attempt was made to simulate circumstances in which bears often create a nuisance event by establishing bait stations with a novel food source presented in a non-natural fashion. The bait consisted of a 0.5 kg (1.1 lbs.) mixture of peanut butter and birdseed wrapped in cheesecloth and hung 1.5 m (4.9 ft) above the ground with string.

Bears visiting a bait station were photographed using digital cameras attached to trees within 3 m (10 ft) of the bait at each station. All cameras were aimed at the bait to capture images of visiting bears. In 2005, cameras were placed inside modified ammunition boxes. In 2006, Cuddeback (Park Falls, Wisconsin) infrared-triggered digital cameras were used.

Bait stations were checked daily. Bait was replaced at stations that were visited. A bait station was considered “visited” if the bait was at least 75% consumed by a bear.
The digital camera memory card was retrieved and all photographs were downloaded to a personal computer. Bears were identified in the photographs by eartags with uniquely colored vinyl streamers attached during capture; or from unique physical characteristics, such as size, coloration, and shedding pattern. If it was determined that an identifiable bear had visited the same bait station 3 times within a 10 day period, the bear was considered “habituated” to the site. This situation was assumed to be similar to what a wildlife manager might encounter in attempting to aversively condition a nuisance bear that was repeatedly visiting a site (e.g., a home or bivouac area on a military installation) due to food availability.

Figure 49. A taste aversion bait station in 2005. Note the suspended MRE as bait.

Once the individual bear was determined to be eligible for treatment (i.e., it had visited a station 3 times within a 10 day period), it was randomly assigned as a treatment or control animal. Treatment animals were offered a TBZ-laced bait at their next visit to the bait station at which they met the protocol, while control animals continued to be offered unlaced baits. The replacement bait for treatment animals was laced with 10 g (0.35 oz) of thiabendazole which was equivalent to the amount used by Garshelis and Ternent (1999) to successfully create a conditioned taste aversion in some black bears. After the targeted bear accepted the treatment bait, it was replaced with an unlaced bait to determine the likelihood of that individual returning to the bait station and consuming another bait.

Figure 50. A modified ammunition box housing a remote camera used to record images of bears visiting a taste aversion bait station in 2005.

Any hair samples that were collected from the barbed wire were handled and processed as outlined in Chapter 6.

Results

In 2005, no MREs were consumed by bears or non-target organisms and there were no reports of nuisance bears on the installation. Ten bear hair samples were collected from bears presumably attracted to the fish.

With the new bait in use in 2006, black bears visited bait stations 175 times in 82 consecutive nights. From digital photographs, individual bears could be identified in 75 of these visits. Six bears met the minimum standards for treatment. Four were randomly selected as animals to be treated, while the remaining 2 were in the control group. Tables 16-19 provide the visitation histories for each bear in the treatment group and Figures 52 and 53 provide a graphical representation of the treated bear's recorded locations before and after treatment. Likewise, Tables 20 and 21 and Figure 54 provide similar information for both bears in the control group. No animals that were eligible for treatment rejected the thiabendazole-laced bait.

Figure 51. An unmarked female and her cubs visiting a bait station in 2006.

The treatment group consisted of bears 001, 026, 039, and 044. Bear 001 was a subadult of unknown sex. Bear 026 was a subadult female captured on 6 October 2004 and identified from remaining marks. Bear 039 was a subadult male captured and radio-collared on 5 June 2006. Bear 044 was a subadult male captured and radio-collared on 12 July 2006. Bears 002 and 043 comprised the control group. Bear 002 was a subadult bear of unknown sex. Bear 043 was a 10 year-old male captured in a culvert trap on 10 July 2006. All visitations and treatments of known bears were recorded after live-capture occurred.

Table 16. The visitation history for Bear 001, a subadult black bear of unknown sex, treated with thiabendazole at Bait Station 9 on Fort Drum Military Installation in the summer of 2006.

Visitation Date	Bait Station No.	Treated Bait
19 June 2006	9	No
27 June 2006	9	No
28 June 2006	9	No
29 June 2006	9	Yes
30 June 2006	9	No
1 July 2006	9	No
3 July 2006	9	No
4 July 2006	9	No

Table 17. The visitation history for Bear 026, a female subadult black bear, treated with thiabendazole at Bait Station 4 on Fort Drum Military Installation in the summer of 2006.

Visitation Date	Bait Station No.	Treated Bait
15 June 2006	2	No
15 June 2006	4	No
17 June 2006	2	No
17 June 2006	4	No
18 June 2006	4	No
21 June 2006	2	No
25 June 2006	4	Yes
28 June 2006	2	No
29 June 2006	2	No
7 July 2006	2	No
28 July 2006	2	No
5 August 2006	2	No

Table 18. The visitation history for Bear 039, a male subadult black bear, treated with thiabendazole at Bait Stations 1 and 2 on Fort Drum Military Installation in the summer of 2006. * = indicates treatment bait meant for a different individual.

Visitation Date	Bait Station No.	Treated Bait
2 July 2006	1	No
3 July 2006	1	No
6 July 2006	2	Yes*
13 July 2006	1	No
17 July 2006	1	No
18 July 2006	1	No
20 July 2006	1	Yes
26 July 2006	1	No

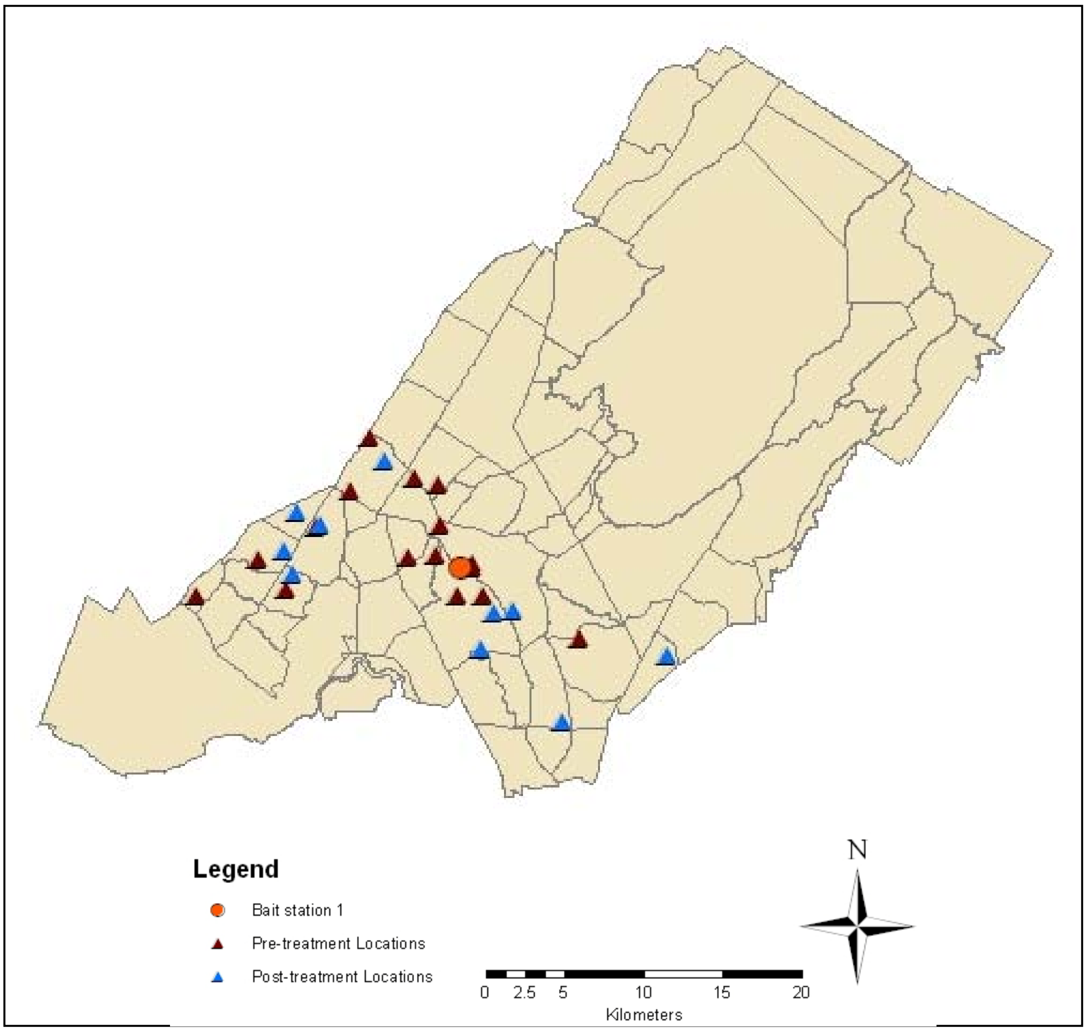

Figure 52. Pre- and post-treatment radio-telemetry locations for Bear 039, a subadult male in the treatment group, on Fort Drum Military Installation in the summer and fall of 2006. Also noted is the bait station at which bear 039 was treated.

Table 19. The visitation history for Bear 044, a male subadult black bear, treated with thiabendazole at Bait Station 8 on Fort Drum Military Installation in the summer of 2006.

Visitation Date	Bait Station No.	Treated Bait
19 July 2006	8	No
20 July 2006	8	No
21 July 2006	8	No
26 July 2006	8	Yes

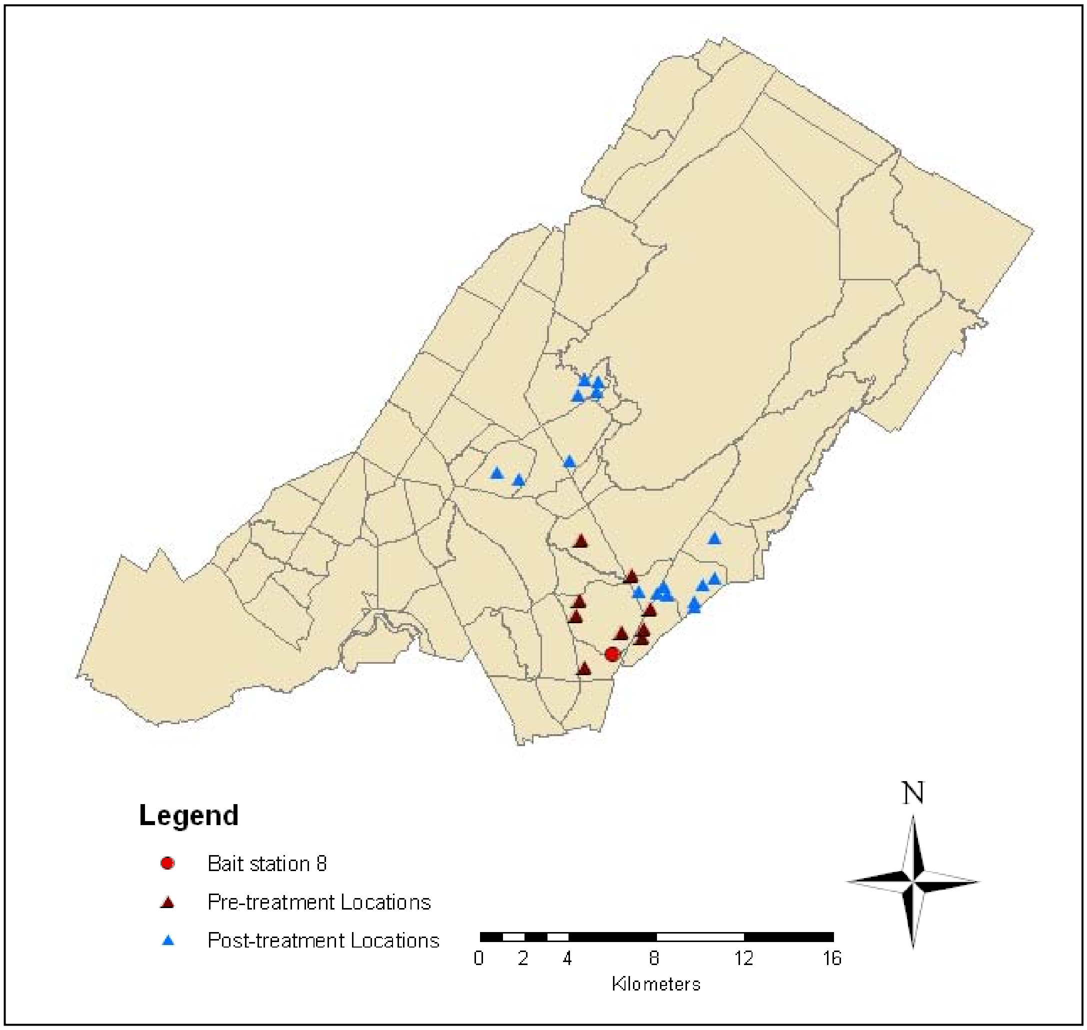

Figure 53. Pre- and post-treatment radio telemetry locations for bear 044, a subadult male in the treatment group, on Fort Drum Military Installation in the summer and fall of 2006. Also noted is the bait station at which 044 was treated.

Table 20. The visitation history for Bear 043, a male adult black bear in the control group, on Fort Drum Military Installation in the summer of 2006.

Visitation Date	Bait Station No.	Treated Bait
13 July 2006	9	No
19 July 2006	9	No
19 July 2006	8	No
22 July 2006	9	No
5 August 2006	10	No
5 August 2006	9	No
7 August 2006	8	No
7 August 2006	10	No
8 August 2006	10	No
10 August 2006	10	Yes
11 August 2006	10	No
13 August 2006	10	No
13 August 2006	9	No

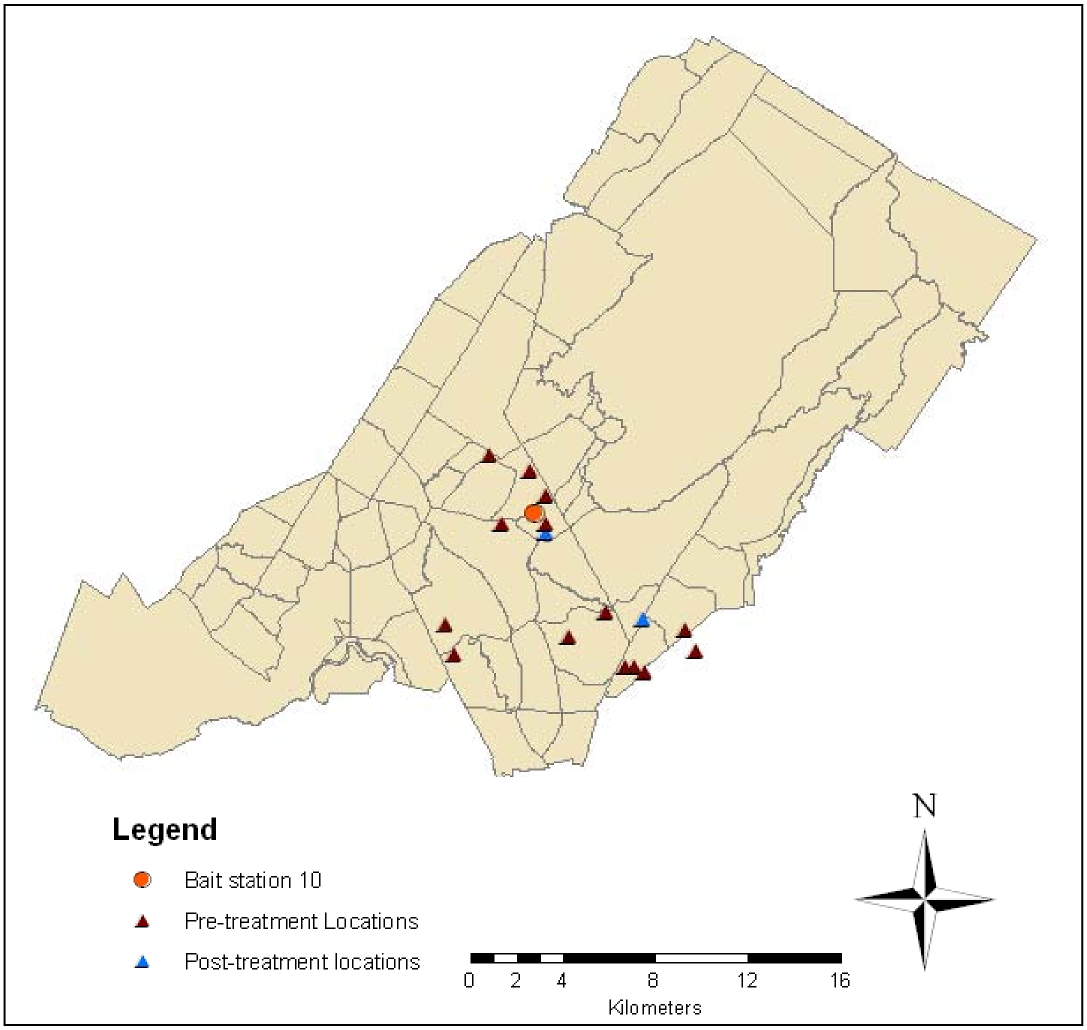

Figure 54. Pre- and post-treatment radio-telemetry locations for Bear 043, an adult male in the control group, on Fort Drum Military Installation in the summer and fall of 2006. Also noted is the bait station at which Bear 043 met the protocol for treatment had it been assigned to the treatment group.

Table 21. The visitation history for Bear 002, a subadult black bear of unknown sex in the control group, on Fort Drum Military Installation in the summer of 2006.

Visitation Date	Bait Station No.	Treated Bait
2 July 2006	10	No
3 July 2006	10	No
6 July 2006	10	No
8 July 2006	10	Yes
11 July 2006	10	No
16 July 2006	10	No
18 July 2006	10	No
19 July 2006	10	No
27 July 2006	10	No
29 July 2006	10	No
31 July 2006	10	No

Discussion

Low sample sizes and other variables prevent a meaningful quantitative analysis or strong conclusions. Most bears observed at bait stations did not meet the minimum protocol for treatment. However, a qualitative analysis of visitation and spatial data for each "habituated" bear is provided.

Treatment Group

Bear 001

From photographic evidence, Bear 001 was a subadult in relatively poor condition that displayed no site or conditioned taste aversion after treatment. It continued to visit Bait Station #9 a total of 4 times in the week after treatment (Table 16). As this bear was not radio-collared, there was no spatial data beyond visitation locations available. However, the biological information provided from the remote camera may provide insights as to the failure of thiabendazole to create a site or conditioned taste aversion. Inferred from Bear 001's size, it most likely had very recently broken the maternal bond and began to forage on its own. Bears are likely to be in poor physical condition, as Bear 001 was, immediately after leaving their mothers due to inexperience in securing high quality food resources. The baits provided at the bait stations were small, but likely provided an easily attainable food source that was very attractive for this bear and the treatment did not provide ample disincentive to cease visitation. Its failure to respond to the treatment is understandable and similar situations involving young bears and reliable food sources may continue to be challenging situations to create a lasting aversion.

Bear 026

Bear 026 was a female initially captured as a 1.75 year-old in October 2004. When treated in June 2006, she no longer was carrying a radio-collar, but was identifiable from uniquely colored eartags that persisted. No spatial data aside from visitations to bait stations was available for Bear 026 in the year of treatment. However, she did display some level of fidelity to the home range data collected in 2004 and 2005 as she visited 2 bait stations within the core of this previously calculated home range. She visited Bait Station #4 a total of 4 times within 10 days and Bait Station #2 on 8 occasions, with the bulk within a 3-week time frame. After treatment, she did not return to Bait Station #4, the location at which she accepted the thiabendazole-laced bait, but continued to visit Bait Station #2. Clearly, no conditioned taste aversion was developed as she consistently consumed identical baits at Bait Station #2 5 times after treatment. The failure to return to the site at which she was treated may mean she was effectively aversively conditioned to the site of treatment, cognitively linking the illness experienced to the location and not to the bait that created it. Or, she may have simply lost interest in the bait station due to her ability to find other high quality food resources.

Bear 039

Bear 039 was a subadult male that was treated with a thiabendazole laced bait twice in the summer of 2006 (Table 18). The initial treatment was intended for another bear that had been frequenting Bait Station #2, but Bear 039 consumed the bait before the targeted animal visited the bait station. As prior visitation to Bait Station #2 by Bear 039 was not established before treatment, the fact that no further visitations to Bait Station #2 were recorded cannot be regarded as evidence of site aversion. However, as Bear 039 continued to consume identical baits at Bait Station #1, it is evident that a conditioned taste aversion was not successfully created by the treatment at Bait Station #2.

Analysis of pre- and post-treatment spatial data showed different patterns of land use (Figure 52). Visually, it is clear that post-treatment use of areas surrounding Bait Station #2 were significantly reduced. This could lead to an assertion that Bear 039 began avoiding the area near Bait Station #2 after the thiabendazole treatment. While this seems to be a valid interpretation, it may be more likely that Bear 039 continued to use this area, but radio-telemetry locations were collected when this individual happened to be in other areas. This conclusion is based on the fact radio telemetry did not capture all fine-scale movements such as the second visit to Bait Station #2. Additionally, post-treatment locations essentially bracketed Bait Station #2 to the northwest and southeast and Bear 039 returned to Bait Station #2 at least once.

Bear 044

Bear 044 was a subadult male that received a thiabendazole treatment on 26 July 2006 (Table 19). Only 4 visitations were recorded for this individual and all occurred at aversive conditioning bait station number 8. No visits were recorded after treatment. The spatial distribution of radio-telemetry locations (Figure 53) indicates that Bear 044 reduced its use of the area surrounding Bait Station 8 after treatment. This may be misleading; however, as not all space use is recorded through radio-telemetry. Nonetheless, there are no indicators, as with Bear 039, that Bear 044 continued to use the area near Bait Station #8. While it is impossible to prove that this bear was aversively conditioned, the post-treatment data are analogous to the expected behavior of an aversively conditioned bear. As such, it is reasonable to conclude that a site aversion was created through treatment with thiabendazole. The data do not allow for a realistic finding regarding the development of a conditioned taste aversion because there is no evidence that Bear 044 actually encountered other aversive conditioning bait stations.

Control Group

The control group was established for the comparison of treatment group data. Since individuals in the control group were not treated with thiabendazole, the visitation history after the date on which treatment would have occurred (i.e., simulated treatment date) offered insight into the fidelity a bear will display to a site with readily available food resources. This provided a frame of reference for the analysis of the treatment group.

Bear 043

Bear 043 was an adult male that visited 3 bait stations on 13 occasions (Table 20). The treatment protocol was met at Bait Station #10 and this individual was selected for the control group. The number of days remaining between the simulated treatment date and the termination of the experiment was only 5 days; however, 3 additional visits were recorded in this time frame. Two of these visits were recorded at Bait Station #10, where the simulated treatment took place, and one was at Bait Station #9, at which 4 previous visits had been recorded. Neither the spatial information (Figure 54) or the visitation history of this individual indicate that any behavior change occurred after the simulated treatment.

Bear 002

Bear 002 was a subadult bear of unknown sex. It was identified in photographs at Bait Station 10 from its small size and unusual shedding pattern. As this bear was selected for the control group, the thiabendazole treatment was simulated. After the established visitation protocol had been met, the treatment was simulated on 8 July 2006 at Bait Station #10 (Table 21). Bear 002 continued to visit the same bait station 7 more times. Like Bear 001, the high number of visits can likely be attributed to its age and the potential difficulty for subadult bears to locate food resources immediately after breaking maternal bonds. From trail camera photographs it was probable that Bear 002 was 1.5 years-old, meaning that it would have been foraging on its own for approximately 1-2 months. The baits at the bait stations offered an opportunity for Bear 002 to easily exploit an attainable food source.

The results of this experiment are difficult to interpret. Within the treatment group there is little consistency in the response to thiabendazole. Bears 001 and 039 showed no clear behavior change, whereas Bears 026 and 044 appeared to be less likely to continue simulated nuisance behavior. More specifically, Bear 026 displayed signs of site aversion, while Bear 044 seemed aversively conditioned to the specific bait and the site of treatment. As expected, the individuals in the control group showed no change in behavior after the simulated treatment. Age and food availability may influence behavior, but this investigation does not allow for the prediction of a bear's response based on these factors. Individual behavioral variation appears to be a determining factor for the efficacy of thiabendazole in reducing nuisance activity. This mechanism is inherent and the exact response is impossible to forecast for any individual.

It must be acknowledged that the bears in this study were not truly “nuisance” animals. Many bears that visited bait stations did not meet the minimum treatment protocol. Despite numerous reports of nuisance bear activity in the training areas in 2002 and 2003, there was only a single report of a nuisance bear in 2005 and 2006 when natural foods were readily available. Reduced visitation to bait stations due to natural food abundance was also noted by Clark et al. (2005). Because natural foods, especially soft mast (e.g., *Vaccinium* spp. and *Rubus* spp.), were widely available on the study area, the bears on Fort Drum may have been less prone to nuisance activity during these years. It stands to reason that a true "nuisance" bear, one conditioned to human presence and seeking out associated food sources, may react to treatment with thiabendazole in a different fashion.

While the small sample size (n = 6 bears) and other confounding variables in this investigation precluded strong conclusions, the results appear to refute the findings of Ternent and Garshelis (1999), who reported a conditioned taste aversion developed in nuisance bears after just one treatment with thiabendazole. However, their study was also hampered by a limited number of bears (n = 5) available for treatment. It would be valuable to repeat components of this study with nuisance bears at Fort Drum during years with high levels of bear complaints.

Additionally, the bait, consisting of 0.5 kg (1.1 lbs.) of peanut butter and birdseed, accounts for only a small portion of a black bear's necessary caloric intake. Originally baits of this size were used to ensure that all of the thiabendazole was consumed in a treatment session. However, these baits may not have been substantial enough to entice regular visitation. A larger bait and/or larger dose of thiabendazole may be needed if this protocol were attempted again.

Thiabendazole treatment may yet prove to be a valuable management tool for wildlife managers attempting to mitigate problems with food-conditioned bears. Additional research should be conducted in a variety of situations (e.g., campgrounds, bird feeders, etc.), especially with black bears which have established patterns of nuisance behavior. The bears in this study were not causing conflicts when they were treated, and were conditioned to take novel baits at sites removed from human activity. Bears that associate food with human activity may behave differently than bears which are not conditioned (Beckmann and Berger 2003).

CHAPTER 8
Biological Information of Black Bears on Fort Drum

Biological information for all bears captured during this project are provided in Tables 22 and 23 with a short case history of each individual bear followed by a discussion of black bear biology on Fort Drum.

Bear 026

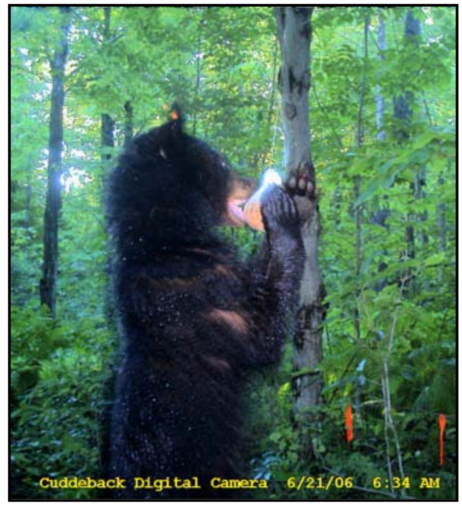

Figure 55. Bear 026 feeding on a bait at a taste aversion station.

Bear 026 was a 1.5 year-old female captured on 6 October 2004 in a leg snare in Training Area 5E. She was fitted with a VHF radio-collar.

Only 6 usable radio-telemetry locations were gathered due to equipment difficulties and failures. The radio-collar spacer failed between 2 May 2005 (when the last radio-telemetry point was determined) and 6 July 2005 (when the collar was retrieved from the field).
Additional spatial data was generated through Bear 026's visitation history to both aversive conditioning bait stations and hair traps based on photographic records and DNA genotyping, respectively. Through these means, it was determined that Bear 026 visited 2 aversive conditioning bait stations on a minimum of 14 occasions and 2 hair traps once each in the summer of 2006. (See Table 17 for her visitation history at bait stations.) Additionally, radio-tracking was used to locate a den site in the winter of 2004-05 (Figure 42). There were no cubs with her in the den. See Figure 15 for the area of known use for Bear 026 in 2005 and 2006.

Although the radio-collar fell off, this bear was known to have survived through the end of the project and in the same geographic area from 1.5 years-old to 3.5 years-old. Bear 026 was 6.75 years-old when she was legally harvested in Training Area 11A on 20 November 2009 which was still within the same geographic area she was using during the project.

Bear 027

Figure 56. Bear 027 back in her den site after being anesthetized and processed.

Bear 027 was a 1.5 year-old female when captured on 9 March 2005 in Training Area 8C. She was free-darted inside a den (Figure 43) that was discovered in the early winter of 2004-05. This was the only bear initially captured through means other than a Fulton leg snare or culvert trap. At the time of capture, she was fitted with a VHF radio-collar. There were no cubs with her in the den.

Twelve radio-telemetry locations were calculated in the field season of 2005. Bear 027 was legally harvested on Fort Drum in the fall of 2005 and the radio-collar returned by the hunter. DNA genotyping and photographic records did not identify this animal at any other sites in 2005. See Figure 16 for the area of known use for Bear 027 in 2005.

Table 22. Biological information for each study animal at the time of capture on Fort Drum Military Installation from 2004-2006. (Foot measurements are in Table 23.)

Monel Ear Tags	Weight (lbs)	Contour Length A-1 (cm)	Girth B (cm)	Neck Circumference D (cm)	Head Length E (cm)	Head Width F (cm)	Head Circumference F-1 (cm)
FD026	120	127	81	47.4	28	14	43
FD027	80	122	68.5	44.0	28.5	17	44.9
FD028	250	172	103	66.5	37	23	63.5
FD029	105	137	78	45	32	21	50.5
FD031	360	195	121	82	41	20.5	74
FD032	135	147	83	53.8	34.5	19.5	54
FD033	135	133.5	82	46.5	32	16	49.8
FD034	160	145	92	50	34	19	52.5
FD035	20	Cub – no measurements taken.					
FD036	195	145	91	56	33	18	55
FD037	135	141.5	75	49	32	17	48
FD038	110	Bear was overheating – no measurements taken.					
FD039	145	137.2	81.5	50.9	33.4	1935	53.3
FD040	75	117	62.5	39.5	27	13.5	44.1
FD042	130	138.5	83	44.6	32	16	49.4
FD043	240	178	105	66	37	26	60
FD044	140	162	81.5	51	32	17.3	51.8
FD045	190	141	95	55	35	24	53

Table 23. Foot measurements for each study animal at the time of capture on Fort Drum Military Installation from 2004-2006.

Bear ID	Front Foot H (mm)	Front Foot H (mm)	Front Foot I (mm)	Front Foot J (mm)	Rear Foot K (mm)	Rear Foot L (mm)	Rear Foot M (mm)	Rear Foot N (mm)
FD026	74	47	90	113	73	108	152	166
FD027	85	40	88	118	72	112	141	164
FD028	-	30	128	153	-	125	169	195
FD029								
FD031	145	85	150	170	115	155	180	230
FD032	85	130	187	218	85	50	102	133
FD033	85	45	92	120	75	110	155	173
FD034	95	50	98	128	84	113	160	182
FD035	Cub – no measurements taken.							
FD036	72	50	99	125	87	120	169	190
FD037	97	58	105	129	82	113	160	179
FD038	Bear was overheating – no measurements taken.							
FD039	88	45	100	124	93	129	168	186
FD040	80	50	91	114	70	110	155	175
FD042	85	45	90	118	80	113	159	177
FD043	108	59	107	136	104	147	189	210
FD044	98	45	88	121	97	136	179	194
FD045	99	56	106	135	78	122	172	193

Bear 028

Bear 028 was a 6.25 year-old male captured in a culvert trap on 16 April 2005 in Training Area 15C. Reports made by Fort Drum game wardens indicated that multiple bears were using a dumpster in Training Area 16A. Two bears were hazed with rubber buckshot and rubber slugs to deter the nuisance activity. In response to these reports, a culvert trap was placed near the dumpster and Bear 028 was captured within 24 hours.

Figure 57. Bear 028 on Fort Drum.

Due to equipment failures and difficulties in locating a signal for this study animal, only 2 radio-telemetry locations were determined. The radio-collar spacer failed between 13 July 2005 (when the last radio-telemetry location was collected) and 2 August 2005 (when the collar was retrieved from the field). Although this individual did not visit the hair traps in 2005 or 2006, it did encounter two aversive conditioning bait stations and one live trap monitored with a remote camera in 2006. These occasions produced additional spatial data and indicated that 028 survived through the summer of 2006. See Figure 17 for the area of known use for Bear 028 in 2005 and 2006.

Bear 029

Bear 029 was a 5.25 year-old female when captured in a Fulton leg snare on 24 May 2005 in Training Area 5B. Only 3 radio-telemetry locations were determined for this individual due to equipment failures. Further spatial data is unavailable for this individual as she did not visit any hair traps or aversive conditioning bait stations in 2005 or 2006. Bear 029 was legally harvested in the fall of 2006.

During the initial den check in the winter of 2005-06, 3 cubs (2 males, 1 female) were observed (Figure 40). The estimated date of birth for the cubs was between the last week of January and the first week of February. At the time of this den visit, the old radio collar was removed because the collar was causing abrasions and a necrotic lesion. The den was visited again after one month to monitor the healing process and to reaffix the collar if appropriate. While the lesion had healed, it was determined that it hadn't healed sufficiently to replace the collar. During the second visit to the den, only two cubs (1 male, 1 female) were observed with 029.

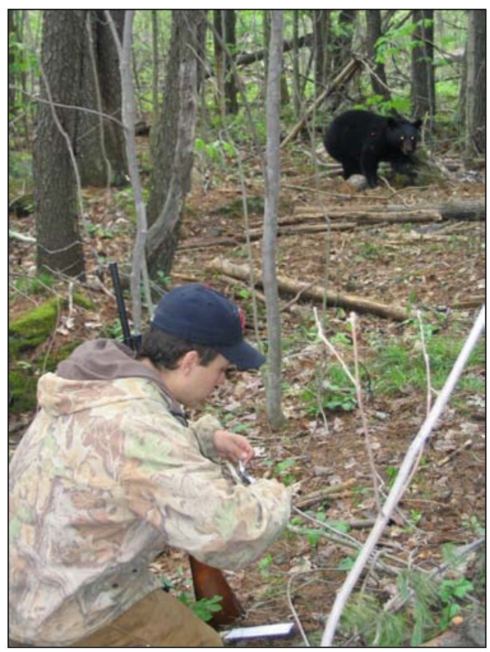

Figure 58. Bear 029 caught in a snare trap and being anesthetized with a dart gun. Note the dart (red spot) in right shoulder.

See Figure 18 for the area of known use for Bear 029 in 2005 and 2006.

Bear 031

Bear 031 was an 11.25 year-old adult male captured in a culvert trap on 28 May 2005 in Training Area 4E. No radio-telemetry locations were collected for this individual due to equipment difficulties and because the radio-collar spacer failed before 8 July 2005. This was the largest bear in the project weighing 360 lbs. at the time of capture. This individual was legally harvested in the fall of 2006. See Figure 19 for the recorded locations for Bear 031 in 2005.

Figure 59. Bear 031 on Fort Drum—the largest bear captured during the project.

Bear 032

Figure 60. Bear 032 captured in a culvert trap.

Bear 032 was a 3.25 year-old subadult male captured in a culvert trap on 20 June 2005 in Training Area 5B.

Five radio-telemetry locations were determined for this individual. The radio-collar spacer failure before 22 September 2005 and telemetry equipment difficulties precluded substantial collection of spatial data for this study animal. However, additional data were available through hair trap and aversive conditioning bait station visits. In 2006, hair was gathered at 4 hair traps on 5 separate occasions. Additionally, this individual was captured through remote photography on one occasion at an aversive conditioning bait station. These incidents not only add to the spatial information pertaining to this bear, but the information also conveys that it was still present in the population in 2006. See Figure 20 for the area of known use for Bear 032 in 2005 and 2006.

Bear 033

Bear 033 was a 9.5 year-old adult female captured in a snare trap on 25 June 2005 in Training Area 5B. This individual died within 24 hrs of initial capture. No acute cause of death was determined, but a combination of factors was suspected. The high temperature on the date of capture was approximately 90-93° F which led to a moderately elevated body temperature of 101.3° F. This bear also showed an unusual resistance to anesthesia. Three injections totaling 6.5 mL of ketamine (200 mg/mL)/xylazine (100 mg/mL) were administered. This is more than 2 times the expected amount of anesthetic for a black bear of this body size (61 kg/135 lbs). Based on the disturbance to the trapping location, Bear 033 had been relatively active while trapped which may have contributed to her resistance to anesthesia and high temperature. The bear was processed and released with no obvious ill effects, but she was found dead the next day approximately 300 m from the capture site apparently succumbing to capture myopathy.

Bear 034

Figure 61. Bear 034 feeding on a bait at a taste aversion station in 2006.

Bear 034 was a 14.5 year-old adult female captured in a snare trap on 25 June 2005 in Training Area 8C. Four radio-telemetry locations, 2 visual sightings, and visitations to 3 hair traps and 1 aversive conditioning bait station were recorded for this animal in 2005 and 2006. The radio-collar spacer deteriorated causing the collar to fall off in the early fall of 2005. It is notable that this was the oldest bear captured in this study and that it continued to be in the population in 2006 as a 15.5 year-old, evidenced by the bait station and hair trap visits. See Figure 21 for the area of known use for Bear 034 in 2005 and 2006.

Bear 035

Bear 035 was a male cub of the year captured in a snare trap on 25 June 2005 in Training Area 10C. This individual was too small to receive a radio-collar, therefore no spatial data was available. At this age, Bear 035 was dependent upon its mother for survival, but she was not present at the capture site. No visits to aversive conditioning bait stations or hair traps were recorded for this bear in 2006 and its survival status is unknown.

Bear 036

Bear 036 was a 13.5 year-old adult female captured in a culvert trap on 30 June 2005 in Training Area 5D. Thirty radio-telemetry locations, two visual sightings were collected between July 2005 and October 2006. Additional spatial data for this individual was generated from recorded visits to 4 hair traps and 2 aversive conditioning bait stations. Bear 036 met the minimum criteria to determine a home range size using both the 95% fixed kernel home range estimate (Figure 22a) and the minimum convex polygon (Figure 22b) for the summer and fall of 2006.

Figure 62. Bear 036 with a cub feeding on a bait at a taste aversion station.

In the winter of 2005-06, a den visit (Figure 44) was conducted. Three cubs (1 male and 2 females) were present. The estimated date of birth for Bear 036's cubs was the third week of January 2006. This den check was the first opportunity to exchange the original radio collar with the Telonics model.

Bear 036 and her cubs exhibited a relatively normal home range (see Chapter 3) when in the early fall of 2006, they all moved approximately 25 km (15.5 mi) to the north of her observed summer home range (Figure 31). She was legally harvested in the fall of 2006 back on Fort Drum between the observed spring/summer home range and the area she relocated north of the installation. The hunter claimed to have seen no cubs with her at the time of her death. Interestingly, in the early fall of 2005, this individual had left the installation and her destination could not be determined, but she then returned in the late fall or early winter of 2005 to den on Fort Drum. While this cannot be proven, Bear 036 may have been annually exploiting a seasonally available food resource outside of Fort Drum and returning to den and spend the spring and summer on the installation.

Bear 037

Bear 037 was a 4.5 year-old adult female captured in a culvert trap on 6 July 2005 in Training Area 5D. Spatial information for Bear 037 included 33 radio-telemetry locations, 2 visual sightings, 1 visitation to an aversive conditioning bait station, and 2 visitations to hair traps. Bear 037 met the minimum criteria to determine a home range size using both the 95% fixed kernel home range estimate (Figure 23a) and the minimum convex polygon (Figure 23b) for the summer and fall of 2006.

Figure 63. Bear 037 trapped inside a culvert trap.

A den site visit was not attempted in the winter of 2005-06 due to difficulty in locating the radio-collar signal. In early December 2005, she still had not denned, despite 8-12 in of snow on the ground. This coupled with the fact that she was a relatively young bear indicated that Bear 037 most likely did not reproduce that winter. After early December 2005, the radio-collar signal was determined to be inaudible after an exhaustive search of her normal home range and surrounding areas. As field work resumed in late May of 2006, the radio signal was once again detected and radio-telemetry locations were gathered through late September 2006. The radio-collar dropped off in late September due to failure of the canvas spacer. No additional data was available after this time.

Bear 038

Bear 038 was a 7.5 year-old adult female captured in a snare trap on 28 May 2006 in Training Area 11E. This was the first individual to be fitted with a Telonics radio-collar and a leather collar spacer at initial capture. Thirty-seven radio-telemetry locations and 1 visual sighting were recorded for this individual in the summer and fall of 2006. No visits to hair traps or aversive conditioning bait stations were recorded. Bear 038 met the minimum criteria to determine a home range size using both the 95% fixed kernel home range estimate (Figure 24a) and the minimum convex polygon (Figure 24b) for the summer and fall of 2006.

A den site visit was attempted in the winter of 2006-07, but was unsuccessful. While the den site was located prior to the attempt, Bear 038 had vacated the den before the visit was scheduled to occur in mid-March 2007. Bear 038 was radio-tracked on 19 March 2007 until visual contact was made. Unexpectedly, she had two yearlings with her at the time. Neither of these yearlings were present at the capture site in the previous May, when they would have been cubs of the year. The most likely scenario is that they had climbed a nearby tree and went unnoticed while data was being gathered on Bear 038. If the cubs had been documented at the initial capture, an earlier den visit would have been appropriate, as females with yearlings are likely to emerge from the den earlier than those with newborn cubs (O'Pezio et al. 1983; Oli et al. 1997). A secondary purpose of the den check was to remove the radio-collar, as spatial data collection was complete. This was not possible, but the leather spacer should have deteriorated in 1-3 years causing the collar to drop off.

Bear 039

Figure 64. Bear 039 peering up at a suspended bait.

Bear 039 was a 3.5 year-old subadult male captured in a culvert trap on 5 June 2006 in Training Area 5B. Spatial information for Bear 039 included 27 radio-telemetry locations, 5 visual locations, visitations to 2 hair traps visited 5 times, and visitations to 2 aversive conditioning bait stations on 8 occasions. This individual was recaptured in a snare trap on 7 July 2006, and was the only study animal to be captured more than once in a live trap. See Figure 25 for the area of known use for Bear 039 in 2006. See Table 18 and Figure 52 for his visitation history to bait stations. In October 2006, Bear 039 was legally harvested on Fort Drum.

Bear 040

Bear 040 was a 1.5 year-old female captured in a snare trap on 21 June 2006 in Training Area 15C. This bear was too small to be fitted with a radio-collar. However, she did visit 1 hair trap on 3 separate occasions in the summer of 2006.

Figure 65. Bear 040 tagged with yellow and white ear streamers.

Bear 042

Figure 66. Vital signs being taken on Bear 042 and eye ointment being applied to keep her eyes from drying out while being anesthetized.

Bear 042 was a 5.5 year-old adult female captured in a snare trap on 22 June 2006 in Training Area 8B. Spatial information for Bear 042 included 37 radio-telemetry locations, 1 visual sighting, and visitations to 3 hair trap locations at which 3 visits were recorded. Bear 042 met the minimum criteria to determine a home range size using both the 95% fixed kernel home range estimate (Figure 26a) and the minimum convex polygon (Figure 26b) for the summer and fall of 2006.

In March of 2007, a den check was conducted to record information on newborn cubs and to retrieve the radio-collar, as spatial data collection was completed. Three recently born cubs (2 males, 1 female) were observed in the den. All were in good condition and the estimated date of birth was the third week of January. The radio-collar was successfully retrieved.

Bear 043

Figure 67. Bear 043 at a taste aversion station.

Bear 043 was a 10 year-old adult male captured in a culvert trap on 10 July 2006 in Training Area 7D. Spatial information for Bear 043 included 16 radio-telemetry locations, 3 visual sightings, visitations to 3 aversive conditioning bait stations, and visitations to 2 hair traps. Collection of radio-telemetry data were inhibited by long day-to-day and seasonal movements by Bear 043. See Figure 27 for the area of known use for Bear 043 in 2006. See Table 20 and Figure 54 for his visitation history to bait stations.

During the early fall of 2006, Bear 043 moved approximately 50-60 km (31-37 mi) east of the original capture site and south of Cranberry Lake in Adirondack Park (Figure 31). It was determined through aerial radio-telemetry that Bear 043 remained in this area during the winter of 2006-07. A den check was attempted in the winter of 2006-07 through coordination with NYS Forest Rangers, but the den site location was inaccurate and could not be found. A second aerial radio-telemetry mission was made and the revised estimated den site location was prohibitively far into wilderness area, so the den visit was not done. The radio-collar was not retrieved, but the leather spacer should have deteriorated in 1 - 3 years causing the collar to drop off.

Bear 044

Bear 044 was a 3.5 year-old male captured in a snare trap on 12 July 2006 in Training Area 10B. Spatial information for Bear 044 included 25 radio-telemetry locations, visitations to 10 hair traps, visitations to 1 aversive conditioning bait station, and 2 visual sightings. See Figure 28 for the area of known use for Bear 044 in 2006. See Table 19 and Figure 53 for his visitation history to bait stations.

Bear 044 displayed a strong propensity to move long distances within the study area. The apparently unsettled nature of this bear is likely due to its subadult status. At this age, male bears are prone to frequent movements, seeking out a suitable home range that is not currently occupied by a dominant male. In fall 2006, Bear 044 moved to Adirondack Park approximately 30 km (18.6 mi) east of Fort Drum (Figure 31). It remained in this area during the winter denning season of 2006-07. The den site location was estimated from aerial telemetry and an attempt was made to access the den on the ground. The den site was located in a microburst blow-down area in which slash was stacked several feet deep. The brush pile in which Bear 044 was denned was found, but the bear could not be accessed within the tangle of downed trees. The radio-collar was not retrieved, but the leather spacer should have deteriorated in 1-3 years causing the collar to drop off.

Figure 68. Bear 044 at a bait station.

Bear 045

Bear 045 was a 10 year-old adult female captured in a culvert trap on 25 July 2006 in Training Area 5A. Spatial information for Bear 045 included 32 radio-telemetry locations, 1 visual sighting, and 1 visitation of a hair trap during a single visit. Bear 045 met the minimum criteria to determine a home range size using both the 95% fixed kernel home range estimate (Figure 29a) and the minimum convex polygon (Figure 29b) for the summer and fall of 2006.

In March 2007, a den visit was conducted to determine the presence of cubs and retrieve the radio-collar. Three recently born cubs (2 males, 1 female) were observed with Bear 045. The estimated date of birth for the cubs was the second to third week of January. The radio-collar was successfully retrieved.

Bear 045 was legally harvested in Training Area 5B on 05 October 2009. The hunter reported seeing no other bears with her at the time of harvest.

Discussion

Although the sample sizes are small, the anecdotal evidence presented here can be pooled across individuals to display tendencies in the black bear population on Fort Drum.

In NYS, the average adult male weighs approximately 135 kg (295 lbs) and the average adult female weighs approximately 73 kg (160 lbs) (NYSDEC 2007). Of 5 adult males weighed on Fort Drum, the average weight was 103 kg (227 lbs) with a range of 64-163 kg (140-360 lbs). Of 8 adult females weighed on Fort Drum, the average weight was 66 kg (145 lbs) with a range of 48-88 kg (105-195 lbs). When standing on all four feet, black bears are less than 1 m (39 in) in height at the shoulder, and are seldom more than 2 m (78 in) long from tip of nose to the tip of the tail (NYSDEC 2007).

In NYS, female black bears generally become sexually mature at 2 to 5 years of age; males become sexually mature at 4 to 6 years of age. Bears are polygamous and breeding occurs from late May until September. Female black bears may ovulate after they mate (Boone and Boone 2001 as cited in NYSDEC 2007). The fertilized egg develops into a blastocyst, but does not attach to the uterus until November or early December (Wimsatt 1963 as cited in NYSDEC 2007). This ensures that all cubs are born between January and early February while the female is still in a winter den. The earliest confirmed date for the presence of cubs in NYS, was 17 January (NYSDEC 2007). Based on measurements of ear length and length of hair behind the sagittal crest (Bridges et al. 2002), the date of birth for cubs on Fort Drum were between the third week of January and first week of February.

Figure 69. Apparatus to weigh bears in the field.

Litter size varies from 1 to 5, but 2 or 3 are most common in NYS (NYSDEC 2007). Cubs den with their mothers during their second winter and disperse as yearlings during their second spring or summer. In NYS, adult female bears regularly breed every other year. According to reproductive indicators, 1 adult female bear in NYS gave birth to cubs every other year between her 3rd and 21st year for a total of 10 litters (NYSDEC 2007). Another female was recaptured with 2 cubs 16 years after being originally captured as an adult (NYSDEC 2007).

Figure 70. Two of three cubs for Bear 029 in the den.

Recruitment on Fort Drum appears to be robust based on observed cub and yearling counts. All 5 den checks conducted for adult females resulted in finding young bears—12 cubs and 2 yearlings. One cub mortality event was recorded for Bear 029, decreasing her litter size to 2. The average litter size at approximately 2 months of age was 3, but cub survivorship was not investigated. Bear 038 had 2 yearlings with her in the winter of 2006-07, but the original litter size is unknown. Additionally, 2 females with cubs (Bear 029 with 2 cubs and Bear 036 with 3 cubs) were legally harvested. According to the hunters, the cubs were either unharmed or unseen. Without maternal guidance to aid in den selection, to provide additional body heat in the den through the winter, and to offer security after den emergence in the following spring, the odds of survival of the cubs was probably diminished. However, the fates of these cubs are unknown.

CHAPTER 9
Conclusions and Management Implications

Black Bears on Fort Drum

Field work for this project took place on Fort Drum from October 2004 – April 2007. A total of 18 black bears were captured—9 in snares, 8 in culvert traps, and 1 in its den. Fifteen bears were radio-collared, but only 5 had adequate data collected to conduct home range and habitat analyses; 2 bears were too young/small to be radio-collared; 1 bear died after collaring.

Of 5 adult males weighed on Fort Drum, the average weight was 103 kg (227 lbs) with a range of 64-163 kg (140-360 lbs). Of 8 adult females weighed on Fort Drum, the average weight was 66 kg (145 lbs) with a range of 48-88 kg (105-195 lbs).

Live capture and hair snaring records indicated that the male to female ratio was reasonable. Recruitment on Fort Drum appears to be robust based on observed cub and yearling counts. All 5 den checks conducted for adult females resulted in finding young bears—12 cubs and 2 yearlings. The average litter size at approximately 2 months of age was 3. One cub mortality event was recorded for Bear 029, decreasing her litter size to 2. The date of birth for cubs on Fort Drum were between the third week of January and first week of February. On a coarse scale based on the bear dens located, fallen trees appeared to be a very important source of den sites for bears on Fort Drum.

Figure 71. An unmarked female and a cub visiting a bait station in 2006.

The mark-recapture and occupancy model estimates of black bear abundance on Fort Drum, 57 and 69, respectively, were not significantly different. Confidence intervals for each estimate were likewise reasonably similar. In terms of the implications to a wildlife manager, there would be a marginal, if any, difference in decisions based upon these estimates. Estimated bear density for each estimate was 0.227/km^2 (1 bear/1088 ac) and 0.270/km^2 (1 bear/914 ac), respectively. This is similar to previously reported estimates by NYSDEC of the Adirondack black bear population of 0.229 bears/km^2 (1 bear/1078 ac). Extrapolating these numbers to roughly all of Fort Drum, there would be approximately 98 - 117 bears on the installation.

Only 5 individuals—all adult females (036, 037, 038, 042, 045)—met the minimum protocol for a formal spatial analysis using 95% minimum convex polygons (MCP) and 95% fixed kernel estimators. Data for these 5 bears included 169 radio-telemetry points and 7 visual sightings. Capture locations (n = 5) and hair trap captures in which the individual was identified via genetic analysis (n = 16) were also used for home range estimation. The mean 95% fixed kernel summer/fall home range estimate was 15.09 km^2 (SD = 4.89 km^2). The mean MCP home range estimate for the same data set was 12.17 km^2 (SD = 3.94 km^2). The mean home range overlap for the 95% fixed kernel home range estimate was 53.35% (SD = 20.66%). The home range size of adult female bears on Fort Drum indicated that food availability and quality were high. Additionally, the high degree of home range overlap provided evidence that there was little, if any, territoriality or exclusion of neighboring bears from food resources. Overall, it appears the habitat on Fort Drum is of excellent quality and capable of supporting high densities of black bears (at least during 2005-2006).

It was confirmed that Fort Drum bears did travel off the installation. Three bears traveled quite extensively—Bear 044 moved to Adirondack Park approximately 30 km (18.6 mi) east of Fort Drum; Bear 043 moved approximately 50-60 km (31-37 mi) east of the original capture site and south of Cranberry Lake in Adirondack Park; and Bear 036 and her cubs moved approximately 25 km (15.5 mi) to the north before returning to Fort Drum. The long range movements were not wholly unexpected, but it was interesting that all three bears of different sex/age cohorts moved within one week of one another in mid-August, but in different directions.

Besides deciduous forests (e.g., maple, oak, beech, and aspen) and mixed forest (e.g., maple, hemlock, aspen) habitats, bears were shown to strongly prefer wetland habitats, particularly palustrine wetland with open and closed canopy deciduous forest and palustrine wetland with shrub vegetation. This strong preference for wetlands can be incorporated into various management plans. It is important to minimize wetland losses, and to mitigate those impacts that cannot be avoided. Fortunately, there are extensive wetlands on Fort Drum including 6,272 ha (15,200 ac) of designated wetlands and another 367 ha (951 ac) of surface waters (Table 1). Fort Drum also has an active Wetlands Management Program whose primary purpose is to ensure impacts to wetlands are avoided, minimized and/or mitigated in accordance with Clean Water Act regulations.

Black Bear Management

Black bears are classified as a big game animal in NYS and legal harvest is the primary source of mortality for black bears in NYS. Bear hunters are legally required to report their bear take within 48 hours of harvest. Hunters that reported taking a bear in New York's Northern Zone (i.e., Adirondacks and Fort Drum) were instructed to save a tooth or the bear's jaw for age analysis and were mailed an information packet to guide the hunter in collecting and submitting the tooth sample. Additionally, to encourage harvest reporting and data

Figure 72. A male bear with a field dress weight of 320 lbs harvested on Fort Drum.

collection, all hunters who reported a bear harvest and submitted a bear tooth for age analysis were mailed a commemorative patch.

Annual legal harvest of bears in NYS has varied from 525 to 1,864 bears during the past 20 years (NYSDEC 2007). See Table 23 for the approximate number of bears harvested on Fort Drum. The average age of harvested bears from core bear ranges in New York is approximately 5 years old. However, the average age in the population is believed to be higher and tagged male and female bears have been known to live for over 20 years (NYSDEC 2007). The oldest New York bear, as determined by analysis of cementum annuli was just over 42 years old (NYSDEC 2007). Bear 034 was the oldest bear on Fort Drum recorded in this project. She was 14.5 year-old at the time of capture and was still in the population in 2006 as a 15.5 year-old.

Table 24. Approximate number of bears harvested on Fort Drum (Wildlife Management Unit 6H) from 1990-2008. Harvest numbers are based on the total number of bears reported by Town (i.e. Wilna, Diana, Antwerp, Philadelphia, LeRay) and the percentage of land area of each Town on the installation.

Year	Harvested		Year	Harvested		Year	Harvested		Year	Harvested
1990	5		1996	10		2002	6		2008	13
1991	4		1997	8		2003	12		2009	19
1992	7		1998	3		2004	13		2010	20
1993	4		1999	5		2005	6			
1994	4		2000	10		2006	6			
1995	5		2001	6		2007	17			

On Fort Drum, assuming that the likelihood of harvest is equal between previously captured and marked bears and bears that were not captured or marked, the anecdotal evidence indicated that an average of 17% of the Fort Drum black bear population is harvested on a yearly basis. The known survivorship rates for 2005 and 2006 were 72% and 75%, respectively. In 2005, one mortality was related to a capture event and Bear 035 was not observed in 2006, which does not necessarily indicate that it failed to survive, but it was not included as a known survivor. These levels of harvest and survivorship appear to be at reasonable and sustainable levels. One factor that cannot be taken into consideration is the effect of harvest of females with cubs. As cub survival may be negatively impacted by the harvest of maternal females, the population growth rate may slow or become negative should an abundance of females with cubs be harvested. At some point, cub production will become an exclusively compensatory mechanism rather than an additive should cub survival decrease due to overharvest of females. More research is needed to understand cub survival and its impacts upon the black bear population growth rate on Fort Drum, but the data presented here indicate that the current levels of harvest, survivorship, and recruitment should allow for at least a stable population level.

The impetus for this project was the interference of black bears to military training on Fort Drum. However, during the study it was observed there were excellent crops of natural foods available and very few nuisance bear complaints. Although the minimal nuisance activity during the investigation hampered efforts to test potential solutions, such as conditioned taste aversion with thiabendazole, these observations support the idea that bears on Fort Drum are driven by the presence of natural foods and are generally not habituated to human food at bivouac areas, field kitchens, dumpsters, etc.

However, nuisance activity levels are likely to change as natural food availability fluctuates over time. Most human-bear conflicts in NYS can be alleviated or resolved by addressing human behavior (NYSDEC 2007). To avoid conflicts, soldiers in the field must be vigilant about keeping a clean bivouac area, not feed wildlife, and properly dispose of garbage. These three common sense approaches will decrease human-bear conflicts substantially. A fact sheet (Appendix A) is already available during environmental awareness briefings. Military police, environmental conservation officers, and range inspectors may be able to further assist in enforcement of these policies.

CHAPTER 10
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APPENDIX A

IMNE-DRM-PWE
01 JUN 09

INFORMATION PAPER

SUBJECT: Fish and Wildlife Management Guidelines on Fort Drum.

1. PURPOSE. To provide information about fish and wildlife resources on Fort Drum.

2. INFORMATION.

a. It is illegal to pursue, shoot, hunt, kill, capture, trap or take protected fish and wildlife or engage in lesser acts that disturb or harass fish and wildlife. Protected fish and wildlife may be taken only during an open season or as permitted by law and regulation (NYS Environmental Conservation Laws, Fort Drum Regulation 420-3, Endangered Species Act, and Migratory Bird Treaty Act).

b. There is one federally endangered species on Fort Drum- the Indiana bat. All persons, including Soldiers training in the field, are responsible for ensuring no harm occurs to Indiana bats. The following are restrictions relevant to Indiana bat management and military training:

1) No vegetation shall be removed without prior coordination and approval from the Fort Drum NEPA and Fish and Wildlife Management Program. There are legal mandates regarding both federally listed wildlife protected under the Endangered Species Act and migratory birds covered under the Migratory Bird Treaty Act that govern the removal of vegetation.

2) No smoke operation will be conducted within 1,000 m of the installation boundary, public roads, Cantonment Area, ammunition supply point or WSAAF in accordance with *Fort Drum Regulation 350-4 Range Regulation* and the Fort Drum Biological Opinion on the Proposed Activities on the Fort Drum Military Installation (2009-2011) for the Federally-Endangered Indiana Bat (*Myotis sodalis*). The infrequent use of colored smoke at three mobile MOUTs within the Local Training Areas (LTAs) is allowed. Prior coordination and approval from the Fort Drum NEPA and Fish and Wildlife Program is required.

3) In the LTAs, in accordance with *Fort Drum Regulation 350-6 Assignment and Operational Use of Local Training Areas*, and the Fort Drum Biological Opinion on the Proposed Activities on the Fort Drum Military Installation (2009-2011) for the Federally-Endangered Indiana Bat (*Myotis sodalis*)- vehicular traffic is restricted to open grassy areas within easy access of the road. Vehicles are not permitted to cross streams, ditches, wetlands, or dense vegetation in order to reach grassy areas without prior NEPA review, thus minimizing impacts to natural habitats.

4) In the LTAs, in accordance with *Fort Drum Regulation 350-6 Assignment and Operational Use of Local Training Area* and the Fort Drum Biological Opinion on the Proposed Activities on the Fort Drum Military Installation (2009-2011) for the Federally-Endangered Indiana Bat (*Myotis sodalis*)- Petroleum, Oils, and Lubricants operations are prohibited which minimizes the risk of accidental water/ground contamination.

c. ALL wildlife are opportunistic feeders and will go where food is easiest to obtain. Once an animal obtains food easily at a bivouac site or other food source, they will return expecting to obtain food again and will become a nuisance and possibly aggressive. The most likely wildlife to encounter in Fort Drum training areas that may cause a conflict are black bears and raccoons. There are several ways to minimize the chances of a dangerous or damaging wildlife encounter:

1) **DO NOT FEED THE BEARS, RACCOONS, OR OTHER WILDLIFE.**

2) Keep food and cooking utensils in closed containers, preferably in sealed plastic, to prevent the scent of food from escaping. Bears and raccoons are attracted by smells. With the exception of ammonia, camphor and a few other strong chemicals, EVERYTHING smells like potential food. THIS INCLUDES MRE PACKAGING.

3) Do not cook near or have food inside tents or vehicles. When setting up at a site, the cooking area and food storage area should be at least 300 feet from sleeping quarters.

4) Do not dump fat drippings or food scraps on ground or into wastewater pits. Put food scraps in closed containers such as screw-lid jars before placing in garbage container.

5) Remove all garbage from the site at least once each day and before nightfall. Camphor disks, mothballs, or ammonia-soaked rags can be placed in garbage cans to mask food orders until the garbage is remove from the site. Police the area thoroughly and remove all garbage from the site before departing so future units do not encounter problems.

6) Do not sleep in the clothes used while cooking food. If you need to store materials that are likely to attracted bears, do so by hanging them from tree branches at least 10 feet away from the main trunk and 12 feet off the ground.

d) Raccoons and skunks are known carriers of rabies in the North Country. If you see a raccoon (or skunk or other animal) behaving abnormally, do not approach it as it may be rabid. Contact the federal police at 772-9918.

e) There are no known venomous snakes that occur on Fort Drum. If a suspected venomous snake is found, contact the Fort Drum Fish and Wildlife Management Program.

3. CONCLUSION. A comprehensive Fish and Wildlife Management Program exists on Fort Drum with a staff of two professional wildlife biologists who are civilian employees of the U.S. Army. For information about fish and wildlife management or outdoor recreation, see the Fort Drum Fish and Wildlife Management Program web site at: http://www.drum.army.mil/garrison/pw/FishAndWild.html. The point-of-contact for this program is the Fish and Wildlife Management Program Manager, (315) 772-9636, or the Fish and Wildlife Biologist (315) 772-4999.