2001 Annual Animal Survey Report

for the

Minnesota Army National Guard
Camp Ripley Training Site
and
Arden Hills Army Training Site

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MINNESOTA DEPARTMENT OF NATURAL RESOURCES
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EXECUTIVE SUMMARY

The Department of Defense has established survey programs at military installations across the country to monitor natural resources and examine the impact of military activities on the natural environment. The eleventh year of animal surveys has been completed at the Minnesota Army National Guard (MNARNG) Camp Ripley Training Site, and the second year at the Arden Hills Army Training Site (AHATS) by the Minnesota Department of Natural Resources (MN DNR). Animal surveys were completed on Land Condition-Trend Analysis (LCTA) wildlife core and special use plots, and elsewhere throughout the installations. Monitoring and protection of threatened, endangered, and rare species also continued in 2001.

CAMP RIPLEY

Songbird surveys documented 45 species of birds on 31 LCTA core and special use plots. As in past years, the four most common birds recorded were the red-eyed vireo, American redstart, ovenbird, and least flycatcher. A male cerulean warbler was observed this year on LCTA plot #9 in the northeastern portion of Camp Ripley. The hooded warbler nesting area was surveyed for singing males and to locate nests, yet no hooded warblers were documented this year. Bald eagles occupied four territories within Camp Ripley and fledged two eaglets per territory. The osprey nest at Sylvan Dam was occupied again and produced three young. Wild turkey numbers continue to increase on Camp Ripley. In 2001, numerous wild turkey sightings were recorded, including several broods.

Evidence suggests there may still be two wolf packs occupying Camp Ripley. Currently, there are VHF radio collars on the north pack alpha female, an older male and younger male, plus a satellite collar on a subordinate female. The two male wolves were captured this fall in the southernmost region of Camp Ripley, while the north pack alpha female and satellite female were consistently located in the northern region. An alpha male that was recaptured and collared in January died of unknown causes between June 27 and July 2. Monitoring of the radio-collared wolves continued throughout the year using ground and aerial tracking.

The third year of the White-tailed Deer/Jack Pine Study was completed. Data from 54 radio-collared deer has provided information concerning habitat use and home ranges. Graduate student Carolin Humpal further refined the study to include evaluation of the influence of nutrition and the use

of adjacent agricultural fields by deer on their use of jack pine stands for thermal cover/snow shelter. The tenth annual Disabled Veterans Deer Hunt and the annual Archery Deer Hunt were again successful with 44 and 3,729 hunters respectively, resulting in the fourth highest total harvest of 354 deer.

Black bear reproductive success, movements, and mortality were monitored throughout the year. Four females (two adults and two 2-year-olds) were tracked throughout the year with radio-telemetry. Two additional female bears carried radio-collars that were non-functioning in 2001.

Small mammals were surveyed to monitor population trends. In 2001, 12 species of small mammals (1032 individuals) were captured on 53 LCTA plots. Peromyscus species were captured the most often, followed by southern red-backed voles and meadow voles.

Surveys for Blanding's turtles were conducted in June. Nine turtles were observed, of which two were not caught, four were new captures, and three were recaptures. No nests were located before destruction by predators. Anuran surveys were conducted for the ninth year at Camp Ripley. Eight species were heard, of which the most common were the spring peeper, wood frog and western chorus frog during the first sampling period, and the gray treefrog, American toad and spring peeper during the second sampling period. The only species detected during the third sampling period were the green frog and gray treefrog. Drift fence surveys for reptiles and amphibians are conducted every five years at Camp Ripley. Five fences were placed in differing habitats, and monitored in the spring and fall. Eight species were captured in 2001, which is lower than in 1996 and 1991.

AHATS

In September, 1,245 acres of what was historically known as the Twin Cities Army Ammunition Plant (TCAAP) were transferred to MNARNG. With that transfer MNARNG renamed the facility the Arden Hills Army Training Site (AHATS). Management of the resources on this site became the responsibility of MNARNG at the time of transfer. Population studies will be an ongoing part of the installation's INRMP, which was completed in November of 2001.

Songbird surveys were completed for the first time on 14 LCTA plots established in various habitats throughout AHATS. A total of 31 avian species were recorded, with a total of 117 birds documented. House wrens, American goldfinches, savannah sparrows and American robins were the

most abundant species. Ospreys were observed on the nesting platform for the fourth year, and fledged three young.

Small mammal surveys were conducted on six LCTA plots at AHATS, three in grasslands and three in woodlands. Eight species were captured, with 49 total individual captures. The most abundant small mammals were Peromyscus species. White-tailed deer have been hunted on AHATS since 1993, but were not hunted in 2001 due to increased security measures.

INTRODUCTION

A long-term environmental monitoring program is being conducted at Camp Ripley and the Arden Hills Army Training Site (AHATS). The program's primary function is to evaluate and monitor the impact of military activities on natural resources. Land Condition-Trend Analysis (LCTA) was developed to standardize flora and fauna data collection at military installations nationwide (Tazik et. al. 1992). Since 1991, Minnesota Department of Natural Resources (MN DNR) personnel have conducted LCTA and other wildlife surveys at Camp Ripley. Animal surveys conducted in 2001 are summarized in this report. As in previous years Marty Skoglund, Camp Ripley Environmental Supervisor, and Pam Perry, DNR Regional Nongame Specialist at Brainerd, supervised the 2001 season.

CAMP RIPLEY TRAINING SITE

Camp Ripley is located in the central portion of Minnesota approximately 100 miles northwest of the Minneapolis/St. Paul metropolitan area. Camp Ripley occupies a gross area of 52,795 acres (approx. 82 sq. miles) within Morrison County and is bordered on the north by the Crow Wing River and on the east by the Mississippi River. Land ownership is 98% state land under the administration of the Minnesota Department of Military Affairs (DMA), with the remainder under lease from ALLETE Power Company.

Camp Ripley's landscape was sculpted during the last glacial period (the Late Wisconsinan). Because the glaciers receded along the northern two-thirds of the Camp, a sharp contrast is evident from north to south, both topographically and biologically. The high diversity of life forms (over 600 plant species, 202 migratory and resident bird species, 51 mammal species, and 23 reptile and amphibian species) is also a result of Camp Ripley's location along the forest transition zone in central Minnesota. Dryland forest dominates the landscape, covering 27,875 acres or 55% of the installation. The remainder is almost equally divided between wetlands, dry open grass and brush lands, and odd areas.

Camp Ripley supports the state mission for military reserve component training as a 7,800 person, year-round training facility for the National Guard, primarily consisting of units from Minnesota, North Dakota, South Dakota, Wisconsin, Iowa, and Illinois. The civilian training mission focuses primarily on law enforcement activities, natural resource education, environmental agencies,

and emergency management activities. The central mission of the natural resource management program is to ensure that the multiple demands for land use can be met without sacrificing the integrity of Camp Ripley's resources and training mission.

The Land Condition Trend Analysis (LCTA) program was initiated at Camp Ripley in 1991. LCTA is a program that provides for inventorying and monitoring biological and physical resource data as a means of quantifying the condition of the land. Under this system, permanent study plots were established to inventory the flora and fauna of Camp Ripley, and are referred to as special use and core plots. See Appendix A for Camp Ripley's animal survey schedule.

BIRDS

Songbirds

Songbirds have been surveyed on approximately 90 LCTA plots at Camp Ripley each year since 1991. Starting in 2001, surveys of 30 plots will be conducted annually on a rotational basis with a complete count of all ninety sites every fourth year (Appendix A). Conducting a sample of point counts each year allows detection of fluctuations in the number of species and individuals, but will reduce the amount of effort expended in any one year. The 2001 songbird surveys took place within 31 randomly selected LCTA core and special use plots (Fig. 1). All species and individuals seen or heard within 50 meters of the midpoint of each LCTA plot during one 10-minute point count were documented.

This year's songbird surveys documented 45 species of birds on LCTA plots. Deciduous forest plots contained the most species and the highest number of birds by habitat type. As in past years, red-eyed vireos (*Viveo olivaceus*), American redstarts (*Setophaga ruticilla*), ovenbirds (*Seiurus aurocapillus*) and least flycatchers (*Empidonax minimus*) were the most commonly documented species. Eleven species represent 72% of the total birds counted in 2001. Comparing data from the 31 plots surveyed, ten species were documented in 2001 that were not documented in 2000, and seven species were documented in 2000 that were not documented in 2001 (Table 1). For species that occurred both years, counts were generally similar (Table 2). A few individual species were noticeably different between years. Red-eyed vireo, least flycatcher, indigo bunting (*Passerina cyanea*), and veery (*Catharus fuscescens*) numbers were all down more than 20% from 2000 while species such as American redstarts, ovenbirds, yellow-throated vireos (*Vireo flavifrons*), chipping sparrows (*Spizella passerina*) and common yellowthroats (*Geothlypis trichas*) were all at least 20% more abundant than in 2000. However, there were only two species that experienced highly significant ($P<0.01$) declining trends since 1994, the brown-headed cowbird (*Molothrus ater*) and the golden-winged warbler (*Vermivora chrysoptera*). The field sparrow (*Spizella pusilla*) and sedge wren (*Cistothorus platensis*) experienced less significant declines ($P<0.05$) since 1994, while the red-eyed vireo and yellow-throated vireo increased significantly ($P<0.05$).

Figure 1. LCTA plots surveyed for songbirds in 2001 at Camp Ripley.

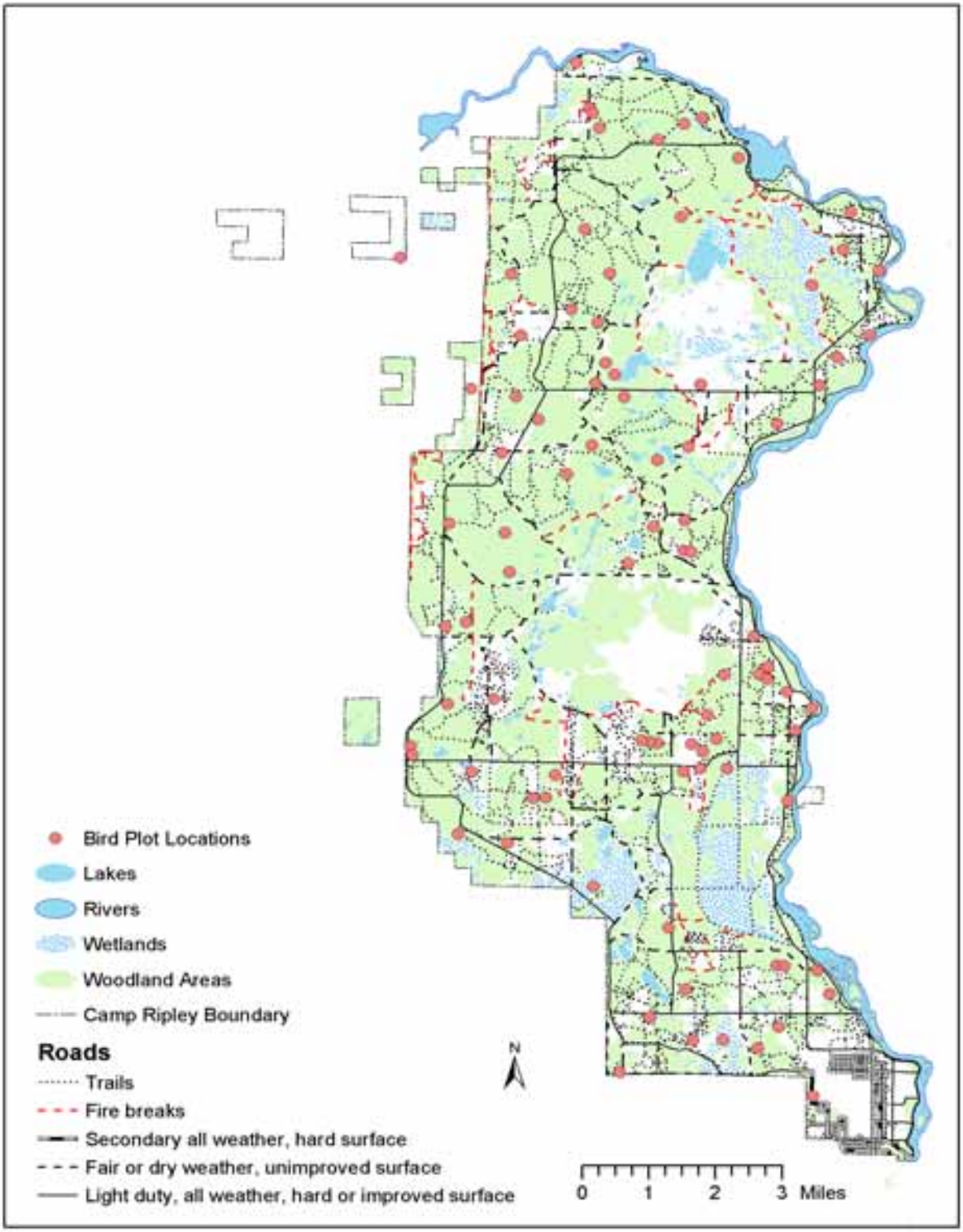


Table 1. Songbird species that occurred on at least one of 31 LCTA plots surveyed at Camp Ripley in either 2000 or 2001, but did not occur in both years.

Birds documented in 2001 but not in 2000
Red-tailed hawk
Cerulean warbler
Swamp sparrow
Sedge wren
Hermit thrush
Northern oriole
Red-breasted nuthatch
American crow
Yellow-bellied flycatcher
Common raven

Birds documented in 2000 but not in 2001
Great-crested flycatcher
Mourning dove
Ruffed grouse
Tree swallow
Downy woodpecker
House wren
Purple finch

Table 2. Summary of bird data by habitat from LCTA plots surveyed at Camp Ripley from 1994 to 2001.

	Lowland Grass/shrub	Plantation	Grassland	Deciduous Forest	Aspen Regeneration	Coniferous Deciduous	Upland Shrub	Mixed Hardwood	Pine	Total
1994										
# Plots	1	1	3	13	3	3	1	2	2	**29**
# Birds	3	6	24	152	35	44	22	18	36	**340**
# Species	2	5	13	32	16	14	14	9	18	**46**
1995										
# Plots	1	2	4	13	3	2	1	2	2	**30**
# Birds	27	29	44	113	42	29	6	25	18	**333**
# Species	8	13	19	21	16	16	6	13	11	**50**
1996										
# Plots	1	2	3	13	3	3	1	2	1	**29**
# Birds	24	22	15	176	23	49	7	22	16	**354**
# Species	3	10	10	32	10	19	7	14	12	**50**
1997										
# Plots	1	2	3	13	3	3	1	1	2	**29**
# Birds	14	30	20	156	30	42	11	13	39	**355**
# Species	5	16	12	31	14	14	9	11	17	**47**
1998										
# Plots	1	2	4	13	3	3	1	1	2	**30**
# Birds	13	8	31	193	32	57	10	27	32	**403**
# Species	8	5	20	27	11	19	7	14	18	**47**
1999										
# Plots	1	1	4	13	3	3	1	2	2	**30**
# Birds	17	34	22	189	33	62	10	12	43	**422**
# Species	7	14	13	30	11	20	8	6	19	**46**
2000										
# Plots	1	2	4	13	3	3	1	2	2	**31**
# Birds	3	19	29	151	34	31	10	25	19	**321**
# Species	4	11	17	24	11	8	8	12	13	**43**
2001										
# Plots	1	2	4	13	3	3	1	2	2	**31**
# Birds	10	24	26	129	32	35	9	25	26	**316**
# Species	5	9	14	26	9	10	5	12	13	**45**

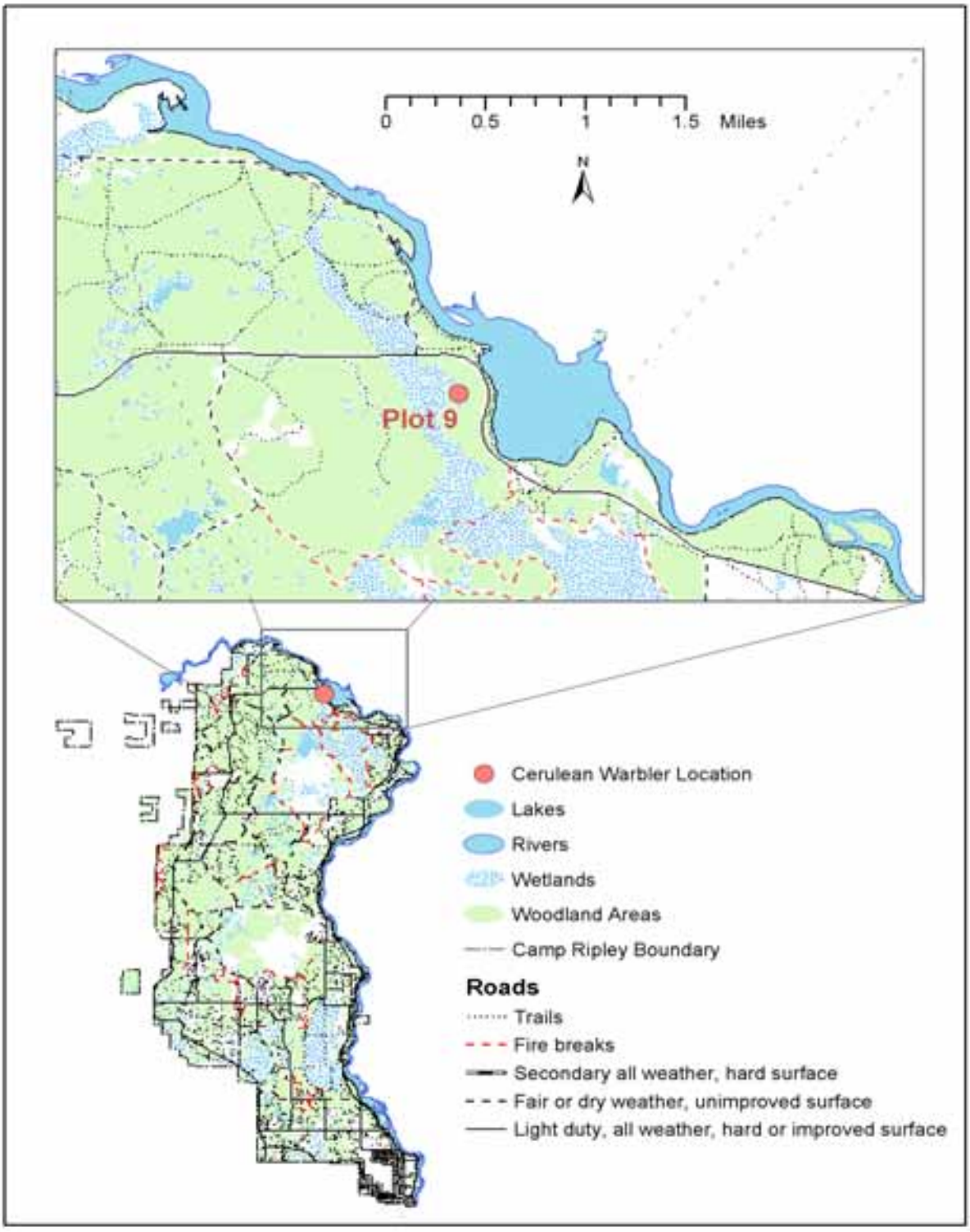
Hooded Warbler

The hooded warbler (*Wilsonia citrina*) is primarily a species of the southeast and east-central United States (Sauer et al. 2001) and is considered a species of special concern in Minnesota. This species prefers unfragmented mature deciduous forests with a dense, shrub understory. However, little of this habitat remains in Minnesota, and this species is routinely subjected to parasitization by brown-headed cowbirds (Minnesota Ornithologists Union 2001). Camp Ripley is one of two areas in Minnesota with confirmed hooded warbler nesting records. Hooded warbler territories have been documented since 1996 at Camp Ripley by using call-back tapes. In 2001, call playback surveys were used to elicit responses from territorial male hooded warblers in the traditional breeding area south of Observation Point 2; however, because of limited access due to military training, the presence of hooded warblers was not documented. Call playback surveys will continue in 2002 to document hooded warbler presence and possible nesting activity (Appendix A).

Cerulean Warbler

The cerulean warbler (*Dendroica cerulea*) is a rare southeastern Minnesota summer resident (Janssen 1987) where it is listed as a species of special concern. Typical habitat for this species is mature, mesic deciduous forest with large trees and closed or semi-closed canopy. Cerulean warblers are very sensitive to fragmentation in their breeding habitat, which may be a cause for the species' nationwide decline during the last 20 years (Bessken 2000). Their decline has been so severe that in 2000, environmental groups petitioned the federal government to add the cerulean warbler as a threatened species on the Endangered Species List (Southern Environmental Law Center 2001). Camp Ripley is on the northern edge of cerulean warbler range. In 1978 they were documented nesting northwest of Camp Ripley at Maplewood State Park in Otter Tail County (Janssen 1987). In 2001, a male cerulean warbler was documented on LCTA plot 9 in the northeastern portion of Camp Ripley (Fig. 2). The area was visited several times throughout the summer. Although two males were heard in this area only one could be confirmed. This area will be monitored in 2002, to determine presence and possible nesting activity.

Figure 2. Location of the cerulean warbler sighting at Camp Ripley.



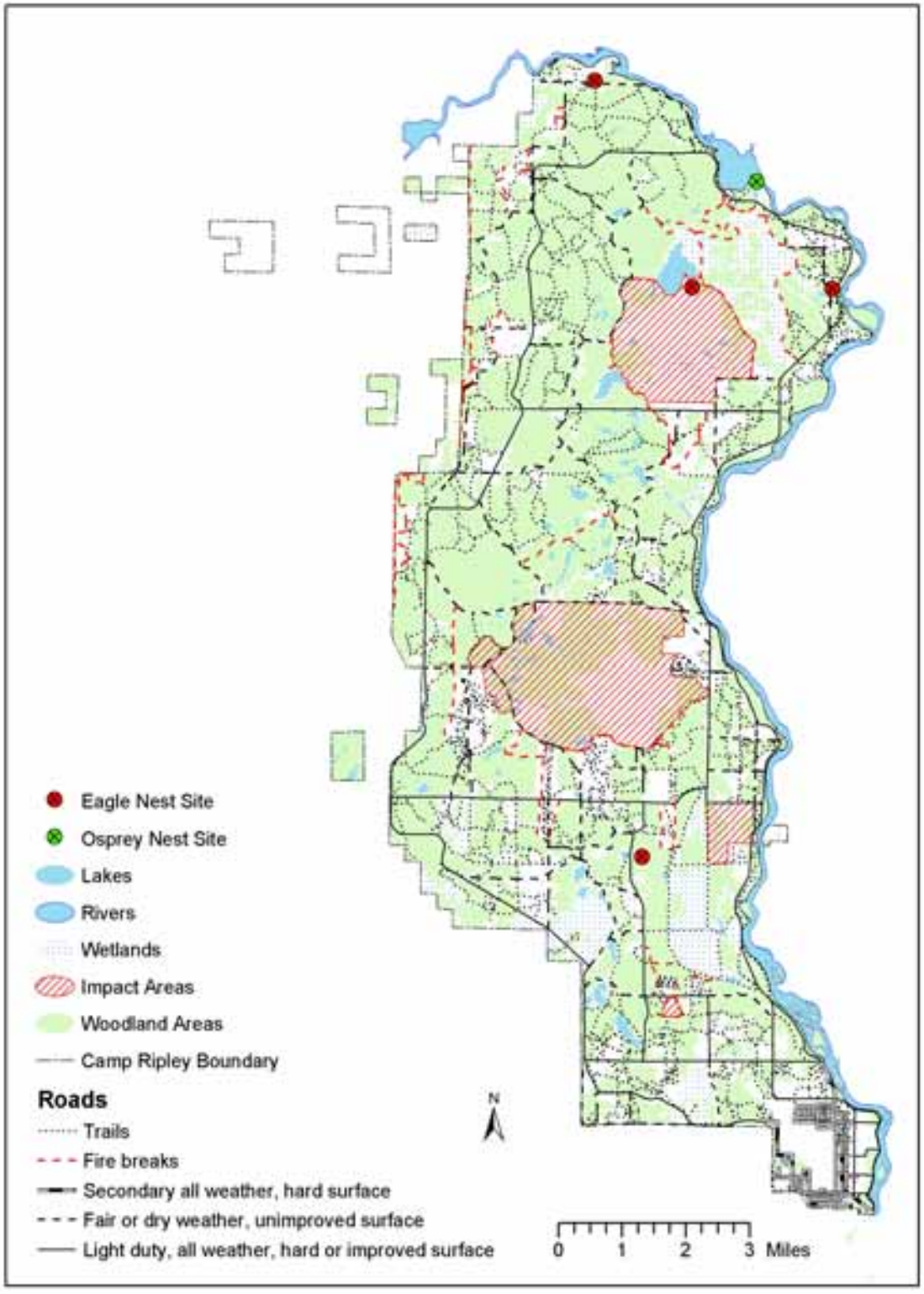
Bald Eagle

Bald eagles (*Haliaeetus leucocephalus*) are listed as a species of special concern in Minnesota. The federal status of this species was downgraded from endangered to threatened in 1994, two decades after DDT was banned and laws were passed to protect both eagles and their nesting trees. The U.S. Fish and Wildlife Service has proposed to remove the bald eagle from the federal list of endangered species, however, population monitoring for a period of at least five years after delisting is required. Four bald eagle territories were identified on Camp Ripley in 1991, and eagles have been monitored since. In 2001, four bald eagle pairs nested within Camp Ripley boundaries (Fig. 3) and fledged two eaglets per nest. One nest was located within an impact area, so was not as accessible for observation as the remaining nests. The average number of eaglets fledged from Camp Ripley since 1993 is five young/year (Table 2). Monitoring of pairs and nests will continue in 2002 (Appendix A).

Table 2. Number of active territories and eaglets produced within Camp Ripley since 1994.

Year	**1991-1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Number of active nests or territories	4	2	3	3	3	3	2	3	4	4
Number of eaglets	?	4	5	4	4	6	4	3	8	8

Figure 3. Bald eagle and osprey nest locations at Camp Ripley in 2001.



Osprey

Ospreys (*Pandion haliaetus*) are listed as a special concern species in Minnesota. Their breeding range extends north from Camp Ripley into Canada and Alaska. Over 700 nesting territories have been recorded in Minnesota and the current population is estimated to be around 400 pairs (MNDNR Natural Heritage Database 1995). However, there are only three known nests in Morrison County. Ospreys are often tolerant of humans, and will nest on a variety of artificial structures such as the platform erected at Sylvan dam (Fig. 3). The nesting platform was occupied again this year and three young ospreys were fledged. Most years the nest contains at least one fledged young, with an average of 1.75 young/year since 1994 (Table 3). Since fifty percent of young die the first year, and 10-15% of adults die each year, researchers estimate 0.8 young per year must be produced to maintain a stable population (Ewins 1994). An additional osprey platform was erected on the Mississippi river in 1993, but has never been used. New locations for this platform will be investigated in 2002. Osprey presence and nesting success will be monitored in 2002.

Table 3. Young produced by ospreys using a nesting platform at Camp Ripley since 1994.

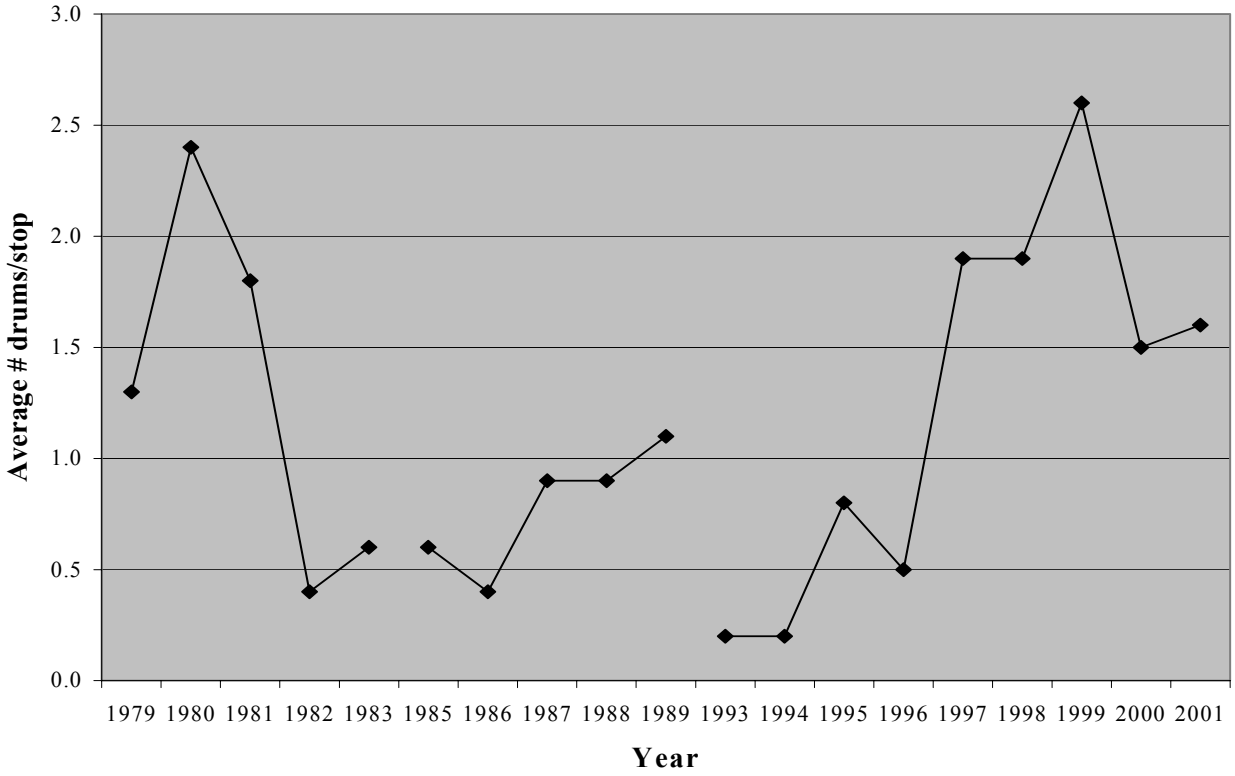
Year	1994	1995	1996	1997	1998	1999	2000	2001
Number of Young	1	0	2	2	2	1	3	3

Ruffed Grouse

Ruffed grouse (*Bonasa umbellus*) populations have been monitored in the south half of Camp Ripley (route #38) by Little Falls DNR personnel since 1979 (Fig. 4). Surveys have been conducted in the spring of each year except for 1984, 1990, 1991, and 1992. Drumming counts are conducted for four minutes at ten stops along each route. In 2001, drum counts along route #38 averaged 1.6 drums/stop. In 1998 Camp Ripley Environmental personnel started conducting an additional route (#39) in the northern portion of Camp. Drumming counts along route #39 averaged 0.2 drums/stop in 2001. Drum counts at Camp Ripley have declined since 1999, as they have throughout Minnesota, which may indicate the beginning of downward trend in their 10-year

population cycle. Grouse populations in Minnesota tend in be the highest at the start/end of a decade, as demonstrated by counts at Camp Ripley (Fig. 4).

Figure 4. Results from ruffed grouse drumming surveys on route #38 at Camp Ripley 1979-2001.



Wild Turkey

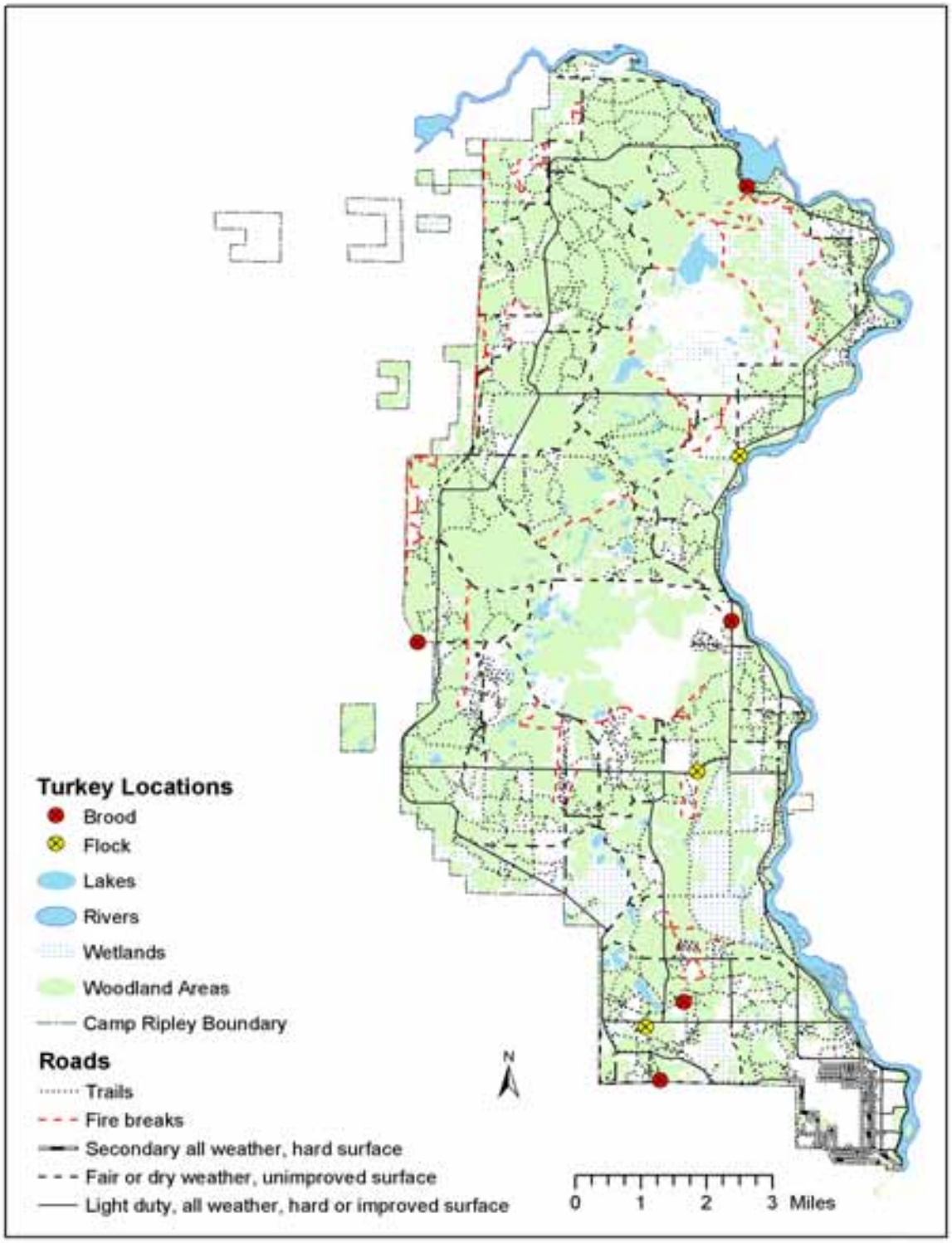
Wild turkeys (*Meleagris gallopavo*) were successfully reintroduced to Minnesota in 1973. Since then the turkey has extended it's range west and north in Minnesota by natural reproduction along with help from continued relocation efforts by the DNR and the National Wild Turkey Federation. Within 25 years the state's wild turkey population grew from a few birds to more than 30,000 (MN DNR 2001). Shortly after they were released in Morrison County in 1998, wild turkeys were recorded on Camp Ripley. Since then sightings of turkeys have been increasing each year. In 2000 and 2001 turkeys were surveyed on the 20 ruffed grouse survey points. Turkeys were heard gobbling at one site

in 2000 and three sites in 2001. Tracks, sightings and broods were recorded throughout Camp in 2001 (Fig. 4). The limiting factor for turkey range expansion in Minnesota is their ability to survive winter. After the two previous mild winters, the winter of 2000-2001 was near "normal" with average snow depths and temperatures. The increase in turkey gobbling counts and sightings in 2001 indicates that turkeys are able to survive average winter conditions at Camp Ripley. Presence and distribution of turkeys at Camp Ripley will continue to be monitored in 2002.

Yellow Rail

Yellow rails (*Coturnicops noveboracensis*) have relatively specific habitat requirements and their habitat is sparse throughout Minnesota, therefore they are listed as a species of special concern by the MN DNR. Camp Ripley and Morrison County are on the southernmost extent of the yellow rail breeding range. Yellow rails were initially documented at five locations in Camp Ripley during 1991 and 1992. Yellow rails were documented again in 1994, 1995, and 1996. In 2001, traditional breeding areas were surveyed from April through July using call-back techniques. However, there were no yellow rail responses in 2001. Efforts will be made in 2002 to elicit responses from yellow rails in order to determine presence and possible nesting activity.

Figure 4. Locations of turkey broods and flocks sighted during 2001 at Camp Ripley.



MAMMALS

Gray Wolf

The gray wolf (*Canis lupus*) is a Minnesota special concern species and a federally listed threatened species. In the mid 1990s the range of gray wolves in Minnesota expanded to include Camp Ripley. Since then, 18 wolves have been captured and collared (Table 4) to determine pack size, movements and possible effects of military training. Pack numbers in Camp Ripley have fluctuated during this time from one to two packs. Evidence in 2000-2001 suggested that there were two packs using the area. Wolf activity tends to be concentrated in the north half of Camp and wolves that use this area are referred to as the north pack. Wolf use of the south half of Camp is sporadic. Wolf sign (tracks and scat) was found on the south third of Camp in the fall of 2000, however, no evidence of wolves using this area was observed during the winter of 2000-2001. During the same time period there were reports of wolves using a forested area south of Lake Alexander (west of Camp Ripley). This and other evidence suggested intermittent use of the south third of Camp by a second pack, which is referred to as the south pack.

In 2000 both the north pack alpha male (#15) and alpha female (#14) were wearing VHF radio collars. As late as November 2000 these wolves were observed in a pack of seven wolves. During the helicopter deer and wolf capture in January 2001, only three of these wolves could be located and two were the collared wolves. Two of these wolves were captured, including the alpha male and a young female. The alpha male's collar was failing and was replaced with a VHF collar. The young female (#16) was collared with a satellite collar from Microwave Telemetry. A second attempt at capturing wolves was made two days after the deer capture. The collared wolves in the north were located and an aerial search of the south half of Camp was conducted but no other wolves were found.

The goal of the 2001 helicopter capture was to collar wolves from the south pack in order to monitor their population size, composition, and movements. However, after the unsuccessful attempt to find wolves, it was determined that a south pack wolf needed to be collared in order to locate the pack during winter helicopter captures.

Table 4. All wolves captured and collared at Camp Ripley 1996-2001.

Wolf #	Sex	Number of Captures	Age at First Capture	Date of First Capture	Fate	Comments
1	F	1	Yearling	9/10/96	dead	Trapped/shot on farm in Cass County (8/8/97)
2	F	2	Pup	9/19/96	dead	Shot
3	F	1	Yearling	9/20/96	dead	Poisoned
4	M	2	Yearling	9/23/96	dead	Hit by car
5	F	1	Yearling	2/21/97	unknown	Dropped collar for data retrieval
6	F	3	4-5 years	2/21/97	dead	Hit by a car
7	M	3	10 months	2/21/97	dead	Shot
8	F	1	10 months	2/21/97	unknown	Dropped collar for data retrieval
9	M	2	3-4 years	2/21/97	unknown	Pillsbury State Forest
10	M	1	Pup	8/29/97	dead	Starved? Weight at death 19-20 lbs (9/23/97)
11	F	4	Pup	10/31/97	dead	Shot in Hillman area? Collar found in swamp
12	M	2	Yearling	11/4/97	dead	Killed by ADC in Pine County. (7/26/99)
13	M	1	Yearling	2/3/98	unknown	Dropped collar for data retrieval
14	F	2	Yearling	9/14/98	ALIVE	2001- tracked movements - Current Alpha Female – North Pack
15	M	3	>3 years	2/2/99	dead	Unknown - found dead (7/01)
16	F	1	1-2 years	1/18/01	ALIVE	2001 - VHF part of collar failed, sporadic locates from satellite
17	M	1	1-2 years	9/26/01	ALIVE	2001 - tracked movements
18	M	1	3-4 years	11/15/01	ALIVE	2001 - tracked movements – Current Alpha Male – North Pack

During the summer and fall of 2001 evidence of wolf presence and activity were again observed throughout the southern regions of Camp including the areas south of Argonne Road. Modified experimental leg hold traps were obtained from the Grand Rapids DNR office. Wolves previously captured with these traps had experienced very few and minute injuries. In addition, the traps caught few non-target animals. Trapping took place from September 19 – 28 and November 6-16. Fourteen traps were placed in areas of Camp Ripley where wolf activity was apparent. Traps were moved or pulled to adjust for changes in military training activities. Only one non-target animal, a raccoon, was caught in one of the modified traps. On September 26, a 75 lb. yearling male wolf (#17) was caught in a trap in the southwest portion of Camp. The wolf was in good physical condition and received minor injuries to his trapped foot. He was fitted with a VHF radio-collar, measured and weighed, then released. Days later, he moved to the north end of Camp and remained there for a few weeks. During the second trapping event, a 94 lb. male wolf (#18) was caught close to the south border of Camp Ripley. From tooth wear and body measurements, the wolf was determined to be approximately three or four years old. He was also fitted with a VHF radio-collar, measured and released. The first day after capture he had moved south and it was hoped he was the south pack alpha male. However, six days later he had moved approximately 12 miles north and was located with the north pack alpha female.

Currently, there is a VHF radio collar on the alpha female (#14), the yearling male (#17) and the older male (#18), plus a satellite collar on a subordinate female (#16). Monitoring of radio-collared wolves continued throughout the year using ground and aerial tracking. The alpha female was always located in the north end of Camp, but never outside Camp boundaries. The older male captured this fall has been consistently located near the alpha female in the north end of Camp (Fig. 5). The younger male eventually moved south again, and was located consistently on the far southwest corner of Camp in December (Fig. 5). The subordinate female has been more difficult to track. Accurate positions from her satellite collar have been intermittent, and the VHF transmitter within her collar failed in July. However, most locations from the satellite collar indicate this wolf is also spending the majority of her time in the north portion of Camp (Fig. 6). Additionally, she was observed during a telemetry flight running with the alpha female.

Figure 5. Locations and movements of the two newly captured male wolves at Camp Ripley in 2001.

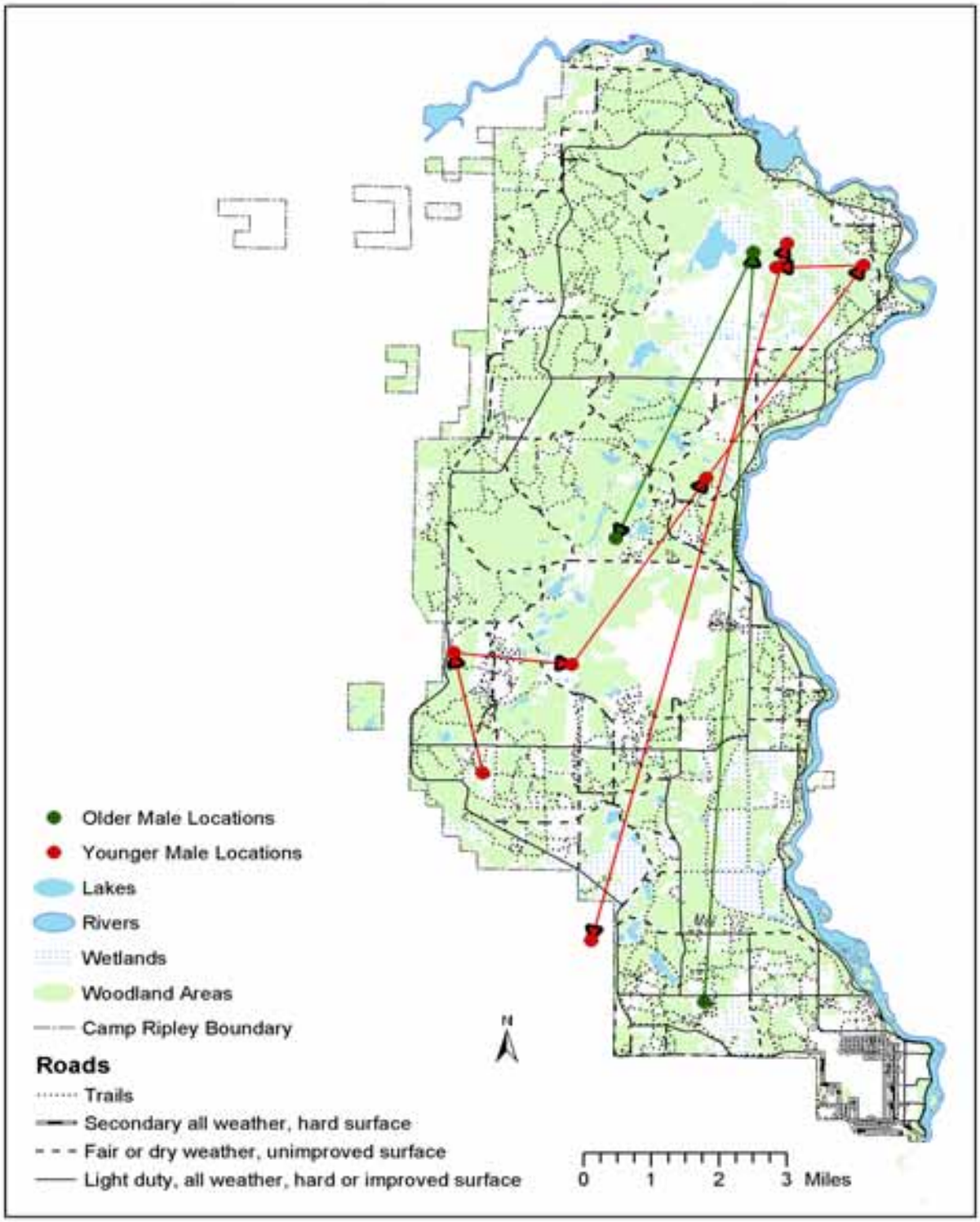
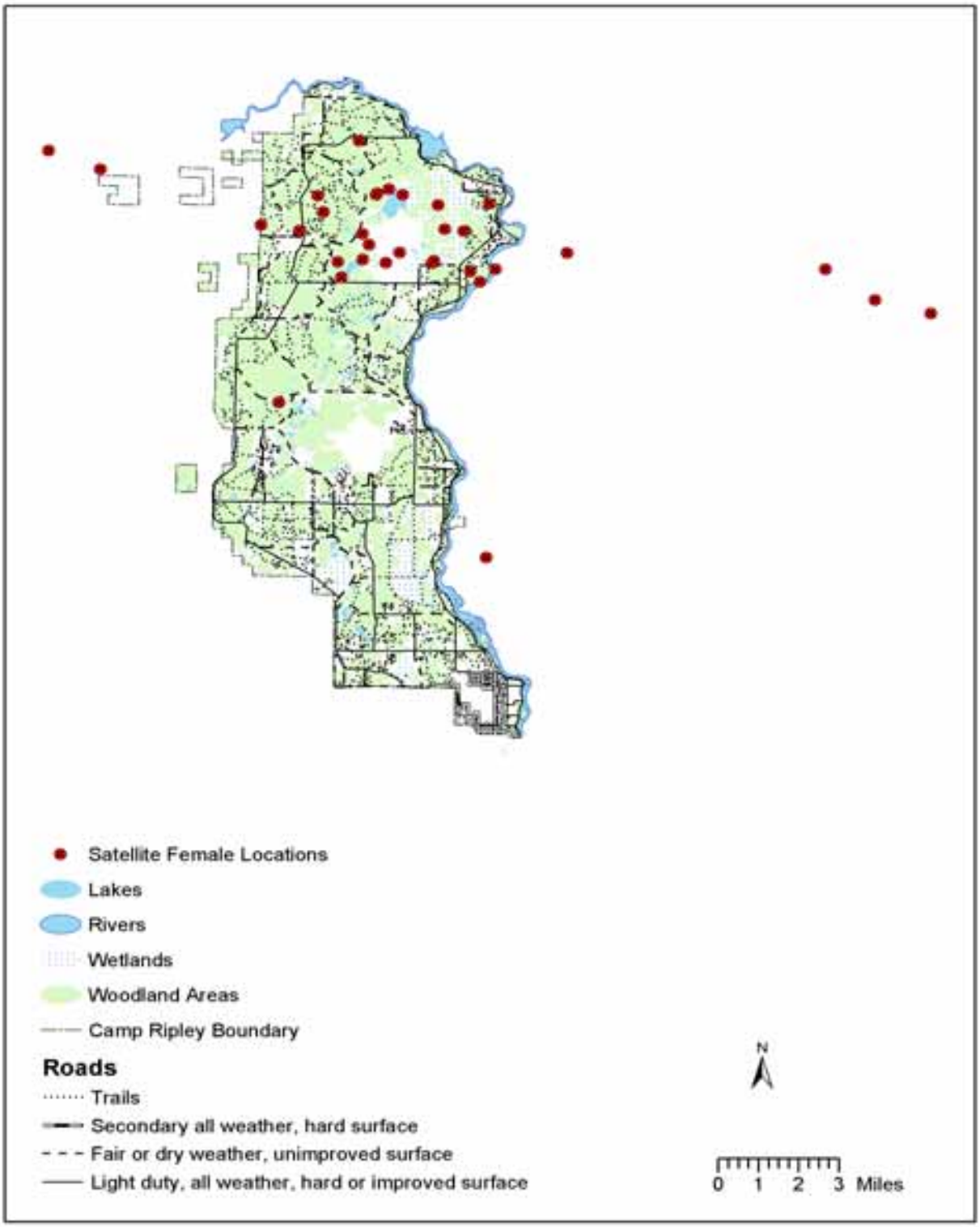


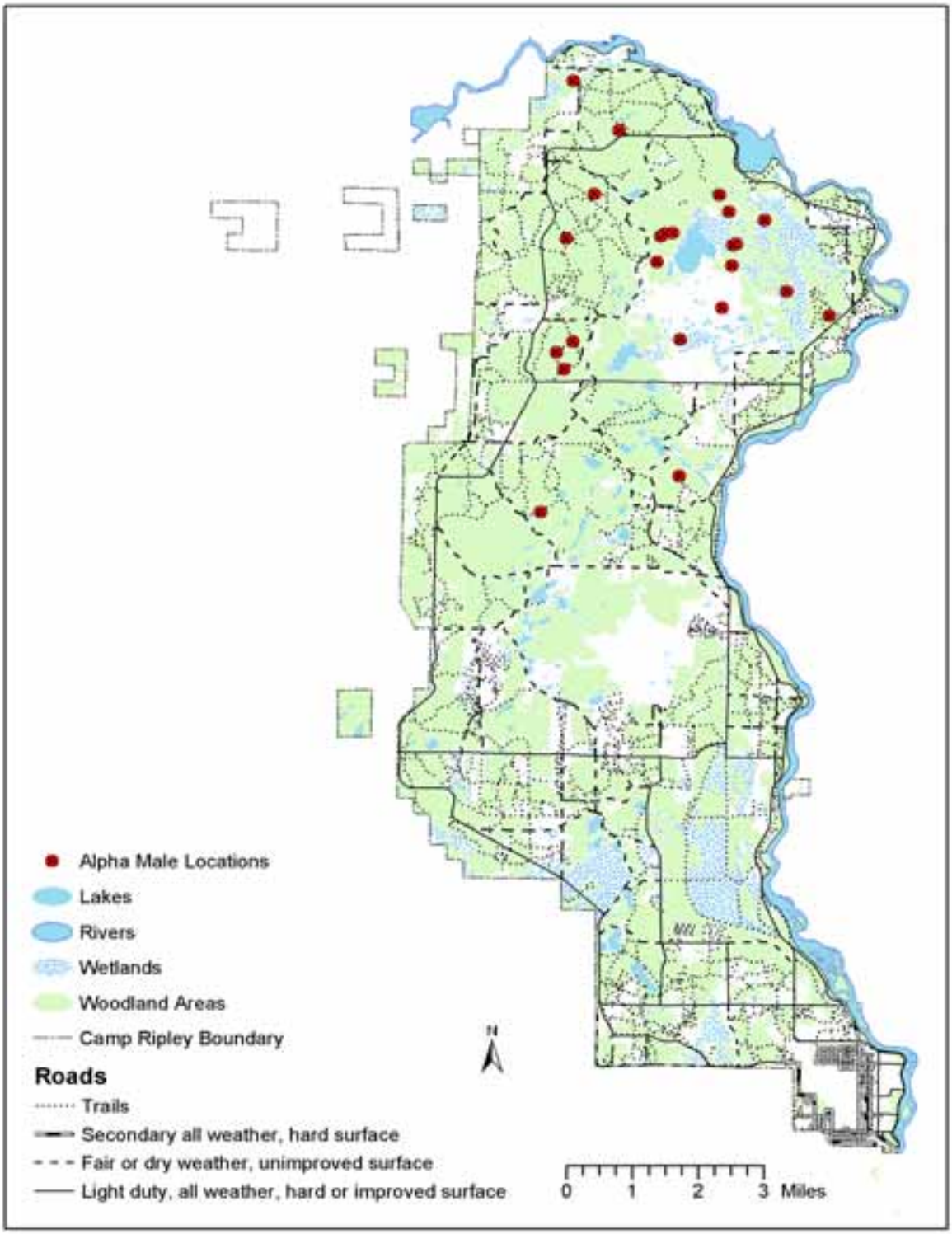
Figure 6. Locations of the satellite-collared female wolf at Camp Ripley during 2001.



Up until July of 2001 the alpha male (#15) from the north pack had been collared, but it died of unknown causes. It was originally collared with a GPS collar in February 1999. This collar failed shortly after and no usable GPS locations were obtained. In January 2000 this wolf was recaptured and collared with a VHF collar (151.780). When it was recaptured in January 2001 the VHF collar was replaced (164.480), and the wolf's movements were followed throughout the spring. This wolf had been alive on the 27th of June, but when located on July 2nd the collar produced a mortality signal. Because of military training, personnel were unable to walk in and locate the animal until July 4th, when no diagnosis could be made due to carcass decomposition. Twenty-eight radio-telemetry locations were acquired from 1999-2001 (Fig. 7). Remarkably, this wolf was always located within Camp Ripley boundaries.

An attempt will be made in January of 2002 to capture four wolves using helicopter capture, deploy three new satellite collars and replace the alpha female's three-year-old VHF collar. Prime candidates for the satellite collars are the young male captured earlier this year and the subordinate female with the failing satellite collar. Due to their age and dominance level, both these animals have the potential to disperse. Satellite collars will allow these animals to be tracked long distances. All collared wolves will be tracked throughout 2002 (Appendix A). Work will continue to determine pack movements, population size and demographics within Camp Ripley.

Figure 7. Locations for the alpha male at Camp Ripley from 1999-2001.



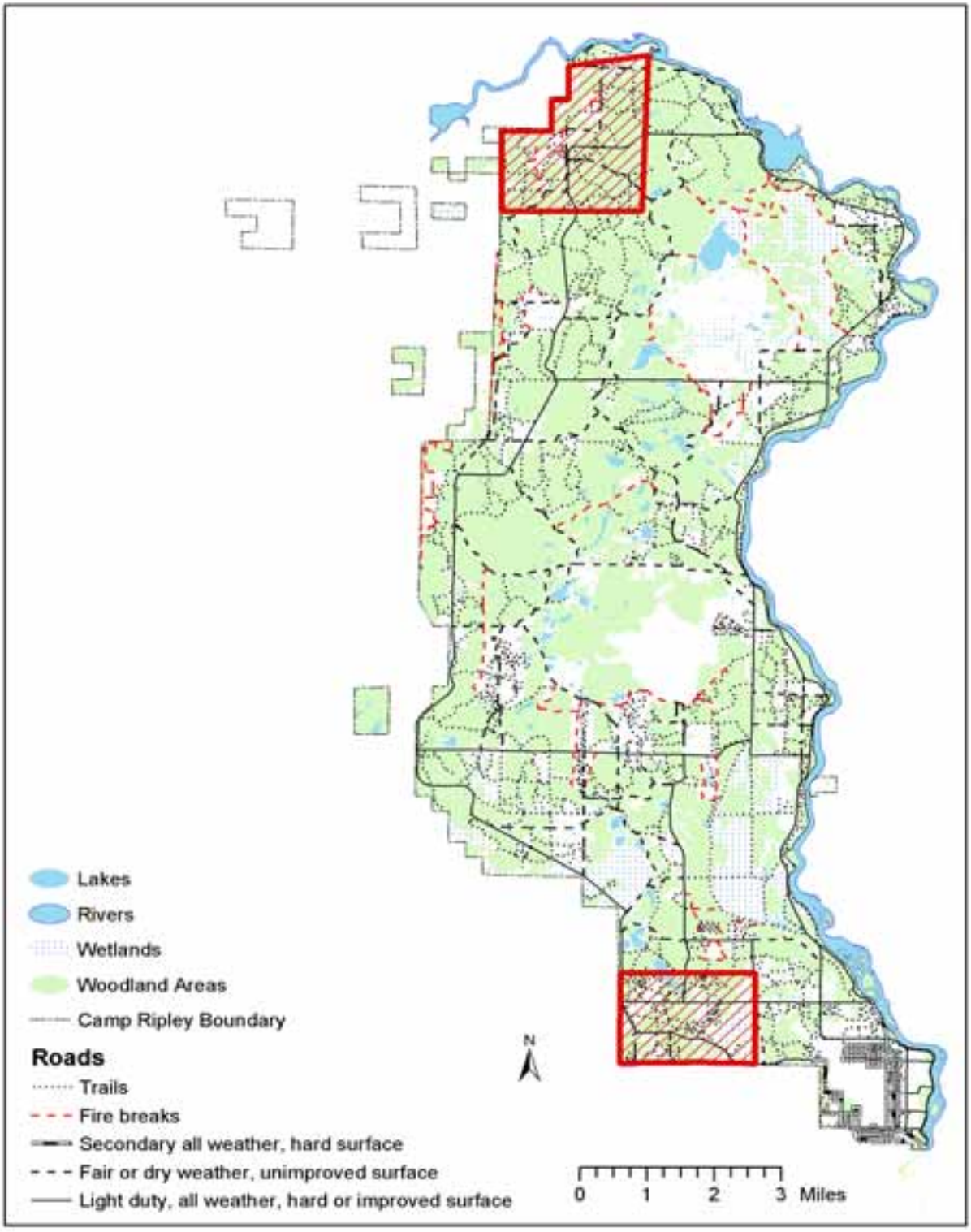
White-tailed Deer

A report from the third year of the White-tailed Deer/Jack Pine Study is included in Appendix C. The goal of this study is to examine the relative influences of winter severity and nutrition on use of the jack pine-hardwood habitat type as winter thermal cover by white-tailed deer (*Odocoileus virginianus*) in Camp Ripley. During February 1999, 40 female deer were captured from two study sites (Fig. 8) by net-guns fired from a helicopter. Capture operations were repeated in January of 2000 to replace six deer that died during the first year and eight deer from which GPS collars were released. Eight additional does were captured for a companion study of a new GPS radio collar prototype. In February 2001, 17 additional deer were captured to replace study animals that had died and to add more collared deer in case some transmitters should fail. Radio telemetry and the mortality switch in each collar were used to monitor survival of deer. Telemetry locations were used to determine winter home range. Mean home ranges did not differ between deer of the two study sites during winter of 1998–1999, 1999–2000, and 2000-2001.

Additional data analysis for both study sites is in progress. Data from a detailed habitat analysis and the large data sets of telemetry locations during winters 1998–99, 1999–2000 and 2000-2001 will be used to compare the habitat compositions of home ranges of deer with and without daily access to unnatural high quality food in adjacent agricultural fields. Habitat use will be related to winter weather conditions, nutrition, and human disturbance.

However, data collected during the first two years (1998–1999 and 1999-2000) of the study must be interpreted within the context of two historically mild winters. Both winters were mild, with snow depths that never reached the 41-cm threshold beyond which mobility becomes energetically costly for deer. In seeking to assess and better understand the importance of the mixed jack pine/hardwood cover type as winter thermal cover and snow shelter, as well as to more closely assess the interactions of the wolves and deer in Camp Ripley, the study must include typical and moderately severe to severe winter conditions. In 2000 researchers decided to continue the study for at least another two years in order to capture that breadth of environmental variability. The weather

Figure 8. Study site locations for the deer project, 1998-2001.

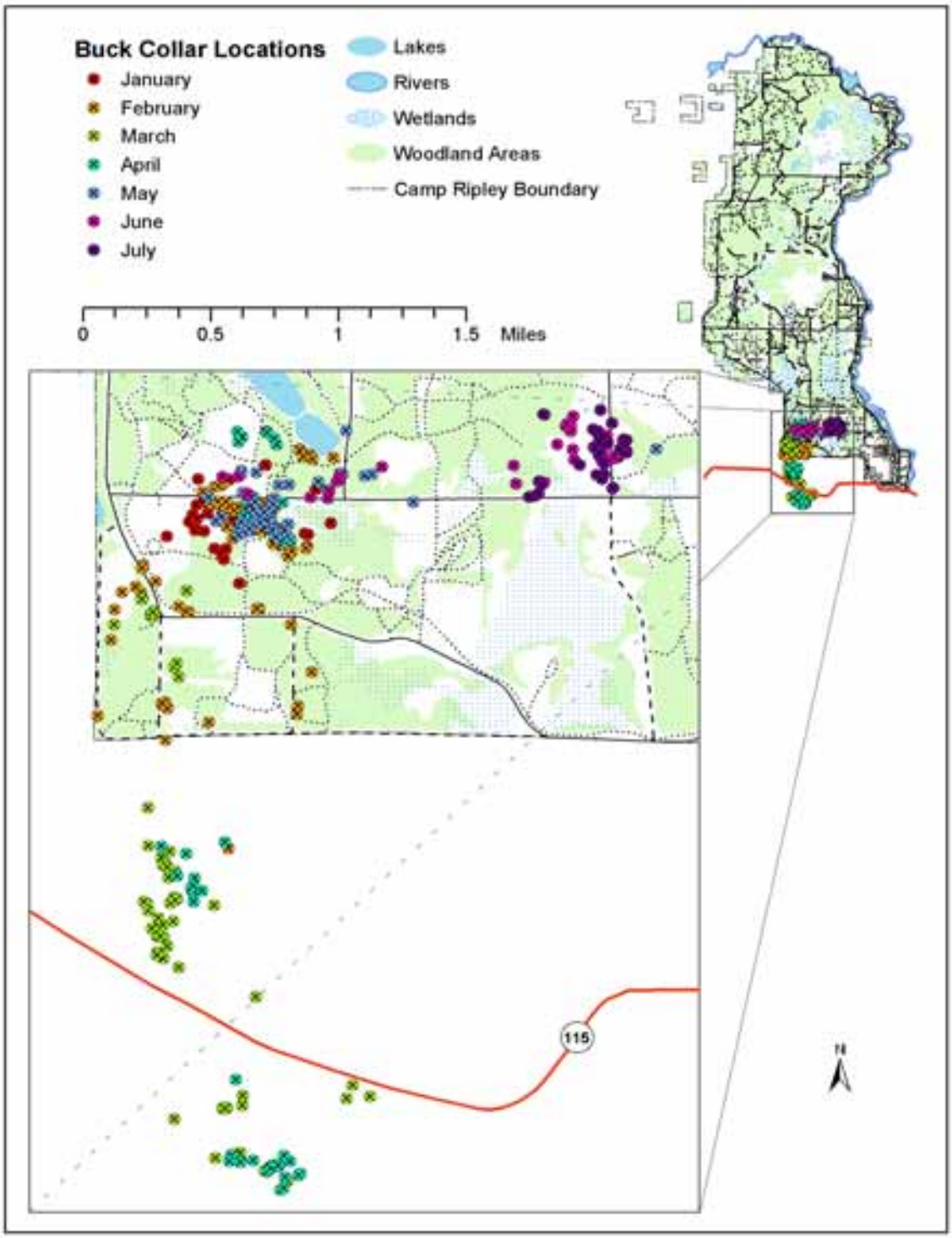


conditions of winter 2000-2001 were “normal”, with mean snow depths approximating and exceeding the 41-cm threshold until 21 March 2001.

With what was accomplished and learned in the first two years about deer distribution, movement patterns, and feeding behavior, graduate student Carolin Humpal refined the study in 2001 to include evaluation of the influence of nutrition and the use of adjacent agricultural fields by deer on their use of jack pine stands for thermal cover/snow shelter. Carolin Humpal will continue the deer research in 2002, beginning with helicopter net gunning in January. Extensive radio telemetry will be conducted through winter, and air photo interpretation, data analysis, and report writing will occur through the year.

A young male deer was also captured during the helicopter net-gunning in January and fitted with an experimental GPS collar. Funding to purchase the GPS collar was provided by the Minnesota Deer Hunters Association (Brainerd Chapter). This collar contained a segment of expandable fabric between the traditional leather sections. Hopes were that the collar would expand to fit the growing neck of the buck, and that the deer could be tracked throughout the fall. However, the expandable fabric ripped in July, and the collar dropped off the animal. The collar was located and the data downloaded. This deer changed its habitat use throughout the winter, spring and summer. In March and April this deer spent the majority of his time feeding in two harvested cornfields south of Camp Ripley (Fig. 9). The GPS collar was refurbished, and will be placed on another buck during the deer capture in 2002.

Figure 9. Locations taken by a GPS-radio collar worn by a buck deer at Camp Ripley from January-July 2001.



Archery and Disabled American Veteran Deer Hunts

An annual archery hunt has been held on Camp Ripley since 1954. The hunt is one of the largest archery deer hunts in the United States. It draws nation wide attention due to the healthy deer population and the opportunity to pursue one of Ripley's notoriously large bucks. As in recent years, hunters were allowed to apply for one of two seasons, October 18-19, or October 27-28. This year, 3,729 out of the 4,500 hunters issued permits participated in the two-day hunts (Table 5). A total of 350 deer were shot, 180 during the first hunt and 170 during the second. This is the fourth largest harvest recorded at Camp Ripley, but is down from last year (375).

The tenth annual Disabled Veteran Hunt was held on October 10-11, 2001. Four hunters out of 44 were successful (Table 6). A four-point buck, two does, and a button-buck were harvested. This is the lowest success rate and the fewest number of deer harvested since 1995 when six deer were taken. Rain and cold weather the first day of the hunt greatly affected hunter success.

Table 5. Deer harvested during Camp Ripley archery deer hunts from 1980-2001.

Year	# Deer Harvested	Adult Males	%	Adult Females	%	Fawns	%	Permits Issued	No. of Hunters	Percent Success	1st season	2nd season	Largest Deer (lbs)
1980	Closed	--	--	--	--	--	--	--	--	--	--	--	--
1981	153	48	31	45	29	60	39	2,587	1,972	7.8	10/10-10/25	3 weekends	272
1982	200	67	34	86	43	47	23	3,000	2,274	8.8	10/23-10/24	10/30-10/31	236
1983	237	89	38	94	40	54	22	3,500	2,831	8.4	10/08-10/09	10/15-10/16	253
1984	387	162	42	151	39	74	19	4,500	3,815	10.1	10/06-10/07	10/27-10/28	238
1985	278	118	42	113	41	47	17	5,000	3,996	7.0	10/12-10/13	10/27-10/28	257
1986	257	106	41	83	32	68	26	5,000	3,940	6.5	10/11-10/12	10/25-10/26	243
1987	284	122	43	91	32	71	25	5,000	4,112	6.9	10/10-10/11	10/24-10/25	250
1988	241	91	38	101	42	49	20	5,000	4,090	5.9	10/08-10/09	10/22-10/23	262
1989	215	95	44	75	35	45	21	4,000	3,136	6.9	10/17-10/18	10/28-10/29	226
1990	301	137	46	115	38	49	16	3,500	2,585	11.6	10/27-10/28	11/17-11/18	225
1991	219	87	40	90	41	42	19	4,000	2,217	9.9	10/19-10/20	11/30-12/01	232
1992	406	228	56	140	35	38	9	4,500	3,156	12.9	10/31-11/01	11/21-11/22	224
1993	287	147	51	82	29	58	20	5,000	4,127	7.0	10/21-10/22	10/30-10/31	237
1994	267	136	51	95	36	36	13	4,000	3,158	8.5	10/20-10/21	10/29-10/30	237
1995	247	102	41	100	41	45	18	4,500	3,564	6.9	10/19-10/20	10/28-10/29	256
1996	160	78	49	55	34	27	17	4,000	3,154	5.1	10/17-10/18	10/26-10/27	248
1997	142	67	47	57	40	18	13	3,000	2,316	6.1	10/16-10/17	10/25-10/26	243
1998	189	116	61	50	26	23	12	3,000	2,291	8.2	10/15-10/16	10/31-11/01	249
1999	203	100	49	83	41	20	10	3,000	2,335	8.7	10/21-10/22	10/30-10/31	251
2000	375	228	61	109	29	38	10	4,000	3,128	12.0	10/19-10/20	10/28-10/29	247
2001	350	192	55	126	36	32	9	4,500	3,729	9.4	10/18-10/19	10/27-10/28	272
Average	257	120	46	92	36	45	18	4,028	3,139	8.0			246

Table 6. Disabled Veterans Deer Hunt participation and harvest at Camp Ripley from 1992-2001.

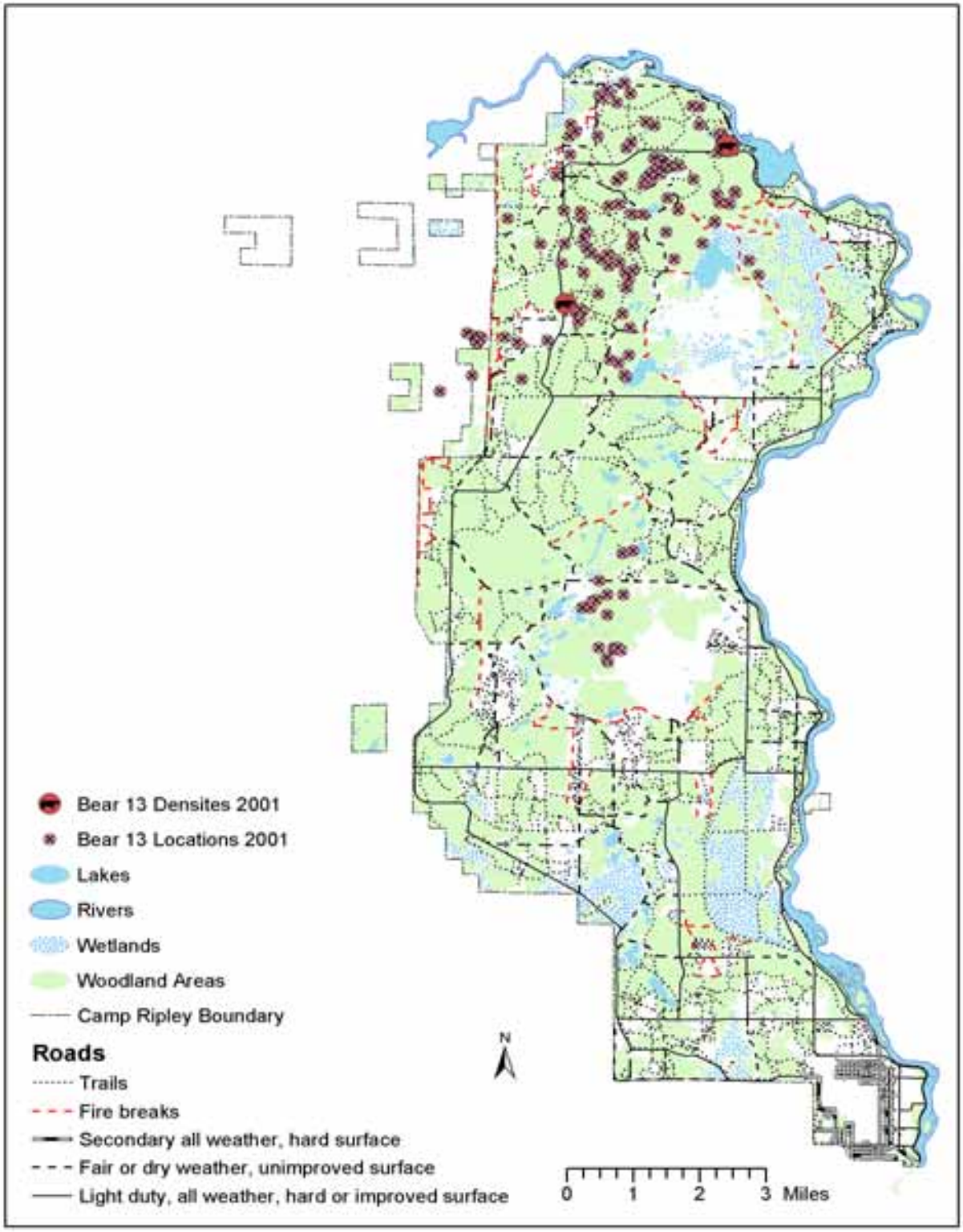
Year	Deer Harvested	Adult Males	Adult Females	Fawns	Permit Issued	No. of Hunters	Percent Success	Season Dates	Largest Deer (lbs)
1992	7	4	2	1	19	19	37	Oct. 14-15	152
1993	11	5	4	2	31	31	35	Oct. 13-14	132
1994	14	3	3	8	42	40	35	Oct. 12-13	185
1995	6	1	5	0	40	39	15	Oct. 11-12	142
1996	9	3	4	2	40	39	23	Oct. 9-10	132
1997	9	2	2	5	40	38	23	Oct. 8-9	152
1998	11	2	5	4	39	37	30	Oct. 7-8	129
1999	8	4	3	1	38	35	23	Oct. 6-7	137
2000	14	5	5	4	40	38	37	Oct. 4-5	181
2001	4	2	2	0	44	38	10.5	Oct. 10-11	124
Average	9.3								

Black Bear

A black bear (*Ursus americanus*) study is being conducted in cooperation with the MN Department of Natural Resources Bear Research Project in Grand Rapids. The study is designed to monitor the reproductive success, movements, and mortality of bears on Camp Ripley. The first Camp Ripley bears were radio collared in 1991. Since then thirty-one have been fitted with radio collars and/or ear tags (Table 7). Currently six bears are wearing radio-collars; four traditional VHF collars and two GPS collars. One VHF collar and one GPS collar have been silent since November of 2000 and June of 2001, respectively. However, both bears were observed within Camp Ripley boundaries during 2001.

Bear #2013 has been studied almost continuously since she was captured as a yearling in 1992. During this time, she has produced 11 cubs, an average of 2.2 cubs per breeding season, and has worn three GPS and six VHF collars. Her den has been visited 12 times, she has been caught in a trap four times, and she was darted once at a bait site. Her highest documented weight occurred in March 2001 during a den visit. She weighed 250 lbs, and was caring for three new cubs at the time. At that time, she was fitted with a GPS collar, which gathered her location data and stored it until the collar could be removed by researchers. Her collar also contained a traditional VHF transmitter, which allowed for additional locations throughout the year (Fig. 10). Her den was again located in the fall of 2001 (Fig. 10), and was visited on December 20th. She had two yearlings with her (#2058 and #2060), each weighing approximately 85 lbs. One yearling (#2059) was missing, and is presumed dead. Bear #2013's GPS collar was removed, the data downloaded, and the collar refurbished. Another den visit is planned for February/March 2002 to replace her refurbished GPS collar. Researchers from the University of Minnesota were present at the December den visit, and are including bear #2013 in a new research project. They will return for the February/March den visit to monitor physiological changes in bear #2013 during the winter.

Figure 10. Locations and den sites for bear #2013 during 2001.



Bear #2020 has also been followed since 1992, when she was captured as a cub in the den with her mother. She was not seen again for seven years, when in 1999 her den was found by accident. Her identity was unknown due to missing ear tags, but she was fitted with a GPS radio-collar. Evidence of having been ear tagged and her age identified her as bear #2020. During her den visit in February 2001, she received a refurbished GPS collar, which later went silent in July. Bill Brown (Camp Ripley Natural/Cultural Resource Specialist) saw bear #2020 with two cubs in Hole in Day Marsh in May of 2001. Her two yearlings, bears #2053 and #2054 were also fitted with expandable radio-collars during the February den visit. Past attempts to use collars made to expand as the bear grows have failed. This year both bears retained their collars, their movements were tracked throughout the year, and their dens were located in the fall/winter of 2001 (Fig. 11). Den visits are scheduled for February/March of 2002.

Bear #2049 was caught once in a trap in June 1999. She was fitted with a traditional VHF radio-collar and tracked throughout 1999 and 2000. Because of the unusually warm weather in the spring of 2000, bear #2049 left her den earlier than expected and her collar could not be replaced. Several times in November of 2000 she was observed when all other collared bears were denned. Subsequently her collar went silent and ground and aerial searches failed to locate her den. However, she was sighted with two cubs during the October 2001 archery hunt.

Bear #2041 was first captured in the den with three cubs in March 1999. She was radio-collared and visited in the den again in March of 2000. She was tracked throughout the year and her den was again located this fall (2001). A den visit is planned for February/March 2002.

Collared bears are providing information concerning reproductive rates and movements of female bears on Camp Ripley. Collared female bears continue to have high reproductive rates of two or three cubs every other year. Female bears have demonstrated that they stay on Camp for most of the year. However, male bears travel further than females and additional information concerning their use of Camp and the surrounding landscape should be investigated. The success of the two expandable collars on the yearlings provided information on the movements of these two females throughout the year. Black bears will continue to be studied in 2002, in order to monitor the reproductive success, movements, and mortality of bears on Camp Ripley (Appendix A).

Figure 11. Locations and den sites for bears #2053 and #2054 at Camp Ripley during 2001.

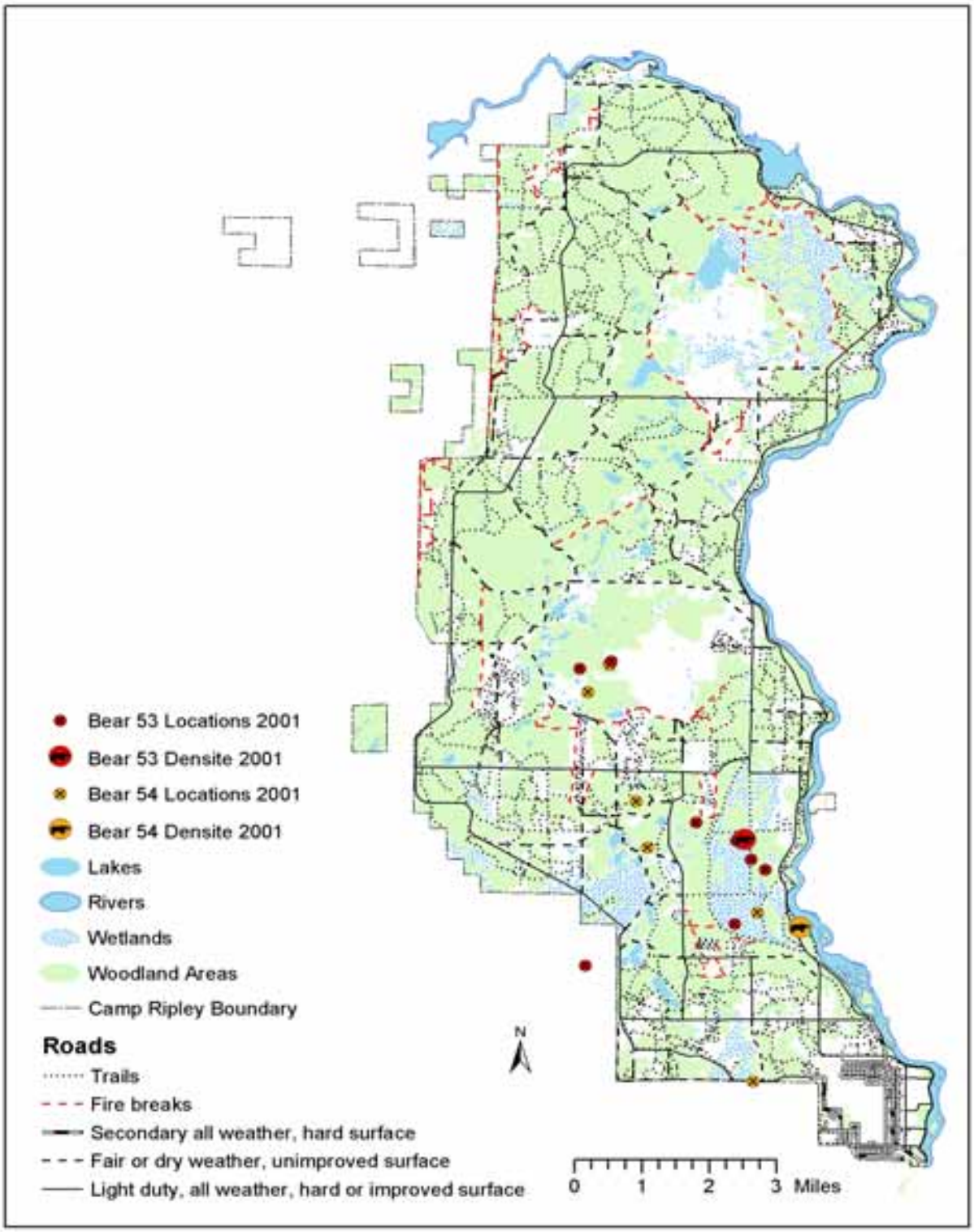


Table 7. Summary of black bears captured since 1997 at Camp Ripley.

Bear #	Birth Year	Last Capture or Location	Sex	Mother's Number	Collared now? (Yes/No)	Fate
2013	1991	2001	F	2005	YES	Alive, multiple collars since 1992
2020	1992	2001	F	2003	YES	Alive, lost signal/collar silent (6/01)
2029	1995	1997	M	2013	NO	Unknown, sighted at bird feeder near Staples (5/1/97)
2031	1997	2001	M	2013	NO	Observed repeatedly near garbage dumpsters by Emerald Lake (10/01)
2032	*1997*	*1997*	*M*	*2013*	*NO*	*Killed by another animal (8/98)*
2033	1997	1997	M	2013	NO	Unknown
2034	1996	1998	M	---	NO	Unknown
2035	1996	1998	M	---	NO	Unknown
2036	*1995*	*1999*	*M*	*---*	*NO*	*Died of drug reaction (2/18/99)*
2037	1995	1999	M	---	NO	Unknown; broke bolts on collar (6/13/99)
2038	*1995*	*1998*	*M*	*---*	*NO*	*Shot by a hunter (10/9/98)*
2039	1994	1998	M	---	NO	Unknown; last signal heard (10/30/98)
2040	*1995*	*1998*	*M*	*---*	*NO*	*Died of unknown causes (7-8/99)*
2041	1994	1999	F	---	YES	Alive, tracked movements -2001
2042	*1999*	*2001*	*M*	*2041*	*NO*	*Shot by a hunter (8/01)*
2043	*1999*	*2001*	*M*	*2041*	*NO*	*Shot by a hunter (8/01)*
2044	1999	2000	F	2041	NO	Dropped expandable collar
2045	*1999*	*2001*	*M*	*2013*	*NO*	*Shot by a hunter (8/01)*
2046	1999	1999	F	2013	NO	Unknown
2047	*1996*	*1999*	*M*	*----*	*NO*	*Hit by a car, ran off, collar fell off (10/99)*
2048	*1997*	*1999*	*M*	*----*	*NO*	*Shot by a hunter (9/19/99)*
2049	1996	2000	F	----	YES	Sighted by hunter with 2 cubs (10/01), collar silent (11/00)
2050	*1997*	*1999*	*M*	*----*	*NO*	*Shot by a hunter (9/5/99)*
2051	*1991*	*1999*	*M*	*----*	*NO*	*Hit (killed) by a car (8/27/99)*
2053	2000	2001	F	2020	YES	Alive, tracked movements - 2001
2054	2000	2001	F	2020	YES	Alive, tracked movements - 2001
2055	*?*	*2000*	*M*	*----*	*NO*	*Hit by a car (10/11/00)*
2056	1997	2000	M	----	NO	Unknown; collar broke off (7/2/00)
2057	1997	2000	M	----	NO	Unknown
2058	2001	2001	F	2013	NO	In den with mother (12/20/01)
2059	*2001*	*2001*	*F*	*2013*	*NO*	*Not in den with mother and siblings (12/20/01)*
2060	2001	2001	F	2013	NO	In den with mother (12/20/01)

The symbol (----) in the graph signifies that mother is unknown. These bears were captured in traps, not in dens with their mothers.

The (?) symbol in the graph signifies that the age for this bear is unknown. Aging is done by removing a tooth and performing analysis on its cementum annuli. However, this tooth was misplaced before aging could be performed.

Small Mammals

Since 1991, small mammals have been surveyed every 3-5 years at Camp Ripley to monitor population trends. In 2001, small mammal surveys were conducted from mid - July through the first week of September, when population levels tend to be higher due to recent reproductive activities. Small mammals were surveyed on 53 LCTA plots (Fig. 12) according to LCTA methods in Tazik et al. (1992). The traps were set during morning to early afternoon of the first day, checked and reset the morning of the next day, and then checked and removed the third day, resulting in a total of 100 trap-nights per plot. Depending on the accessibility of the core plots, 6-10 plots were completed per two-person team each week.

Due to time constraints and difficulties in distinguishing between the different subspecies of deer mice (*Peromyscus maniculatus gapperi and P.m.gracilis*) and white-footed mice (*Peromyscus leucopus*), they are grouped together for statistical analysis. The most commonly caught small mammals were Peromyscus species, southern red-backed voles (*Clethrionomys gapperi*) and meadow voles (*Microtus pennsylvanicus*). Twelve species were captured this year, with a total of 1015 captures (Table 8). Small mammals will be surveyed on LCTA plots again in 2006 (Appendix A).

Prairie Vole

Prairie voles are listed as a species of special concern in Minnesota. One prairie vole (*Microtus ochrogaster*) was captured this year in a grassland plot (Fig. 12) on the edge of an impact area, where 11 prairie voles were captured in 1991 (Table 8). No prairie voles were captured during surveys in 1996. Populations of prairie voles fluctuate irregularly, due to rainfall amounts and consequently, the availability of succulent plant foods. The prairie vole is typically found in grassy and treeless locations (Martin 1956) from the southern Prairie Provinces southeastward to Arkansas. In the Upper Midwest, this species is restricted to grasslands that are relatively dry and undisturbed (Hazard 1982). Areas maintained as pastures and hay meadows more commonly contain the larger and more prolific meadow vole, which often displaces the prairie vole. Prairie voles will be surveyed again in 2006, during the next small mammal trapping effort (Appendix A).

Figure 12. LCTA plots surveyed for small mammals at Camp Ripley in 2001.

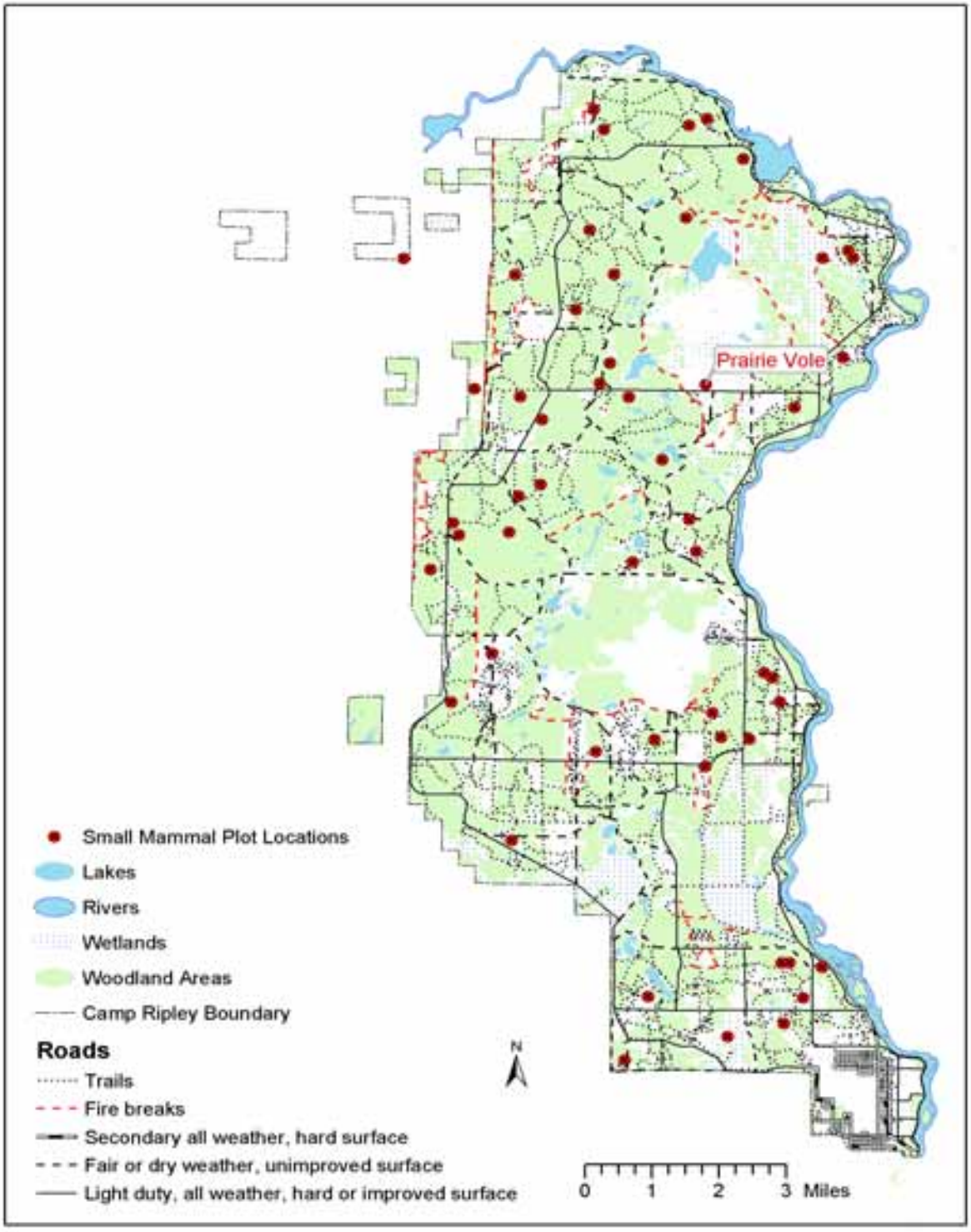


Table 8. Results from small mammal trapping on LCTA plots at Camp Ripley in 1991, 1996 and 2001.

	Occurrence on Plots			Total Number Captured		
	1991	1996	2001	1991	1996	2001
Species	N=60	N=60	N=53			
Peromyscus spp.	**?**	14	47	902	28	508
Southern red-backed vole	42	23	41	260	45	277
Eastern chipmunk	30	18	12	80	37	17
Meadow jumping mouse	23	27	12	68	100	33
Masked shrew	211	21	4	32	19	5
Meadow vole	18	16	15	73	83	109
Short-tailed shrew	11	15	18	11	42	42
Thirteen-lined ground squirrel	9	10	6	28	33	16
Snowshoe hare	5	1	1	6	1	2
Prairie vole	3	0	1	11	0	1
Northern flying squirrel	2	0	0	2	0	0
Southern flying squirrel	0	0	2	0	0	2
Arctic shrew	1	3	0	1	14	0
Pygmy shrew	0	0	3	0	0	3
Short-tailed weasel	1	0	0	1	0	0
Least chipmunk	1	0	0	1	0	0
Total				1476	402	1015

Cougar

The cougar (*Felis concolor*), the largest cat species in the northern United States, may be an occasional visitor to Camp Ripley. Although cougars are found from Alaska to the southern tip of South America, they live mostly in the mountainous region of the western US. There are resident cougars in the Black Hills of South Dakota, but that is the eastern edge of their contemporary range (Logan and Sweanor 2000). Males have a tendency to disperse farther than females, and the longest known dispersal distance is 483 km or 300 miles (Logan and Sweanor 2000). In recent years there have been unconfirmed cougar sightings in the vicinity of Camp Ripley and a cougar sighting was reported on Camp during the 2000 disabled veterans' deer hunt. In February 2001 a radio-collared deer was killed in the northwest corner of Camp Ripley; evidence from the kill site and a necropsy indicated depredation by a cougar. These accounts are not implausible, since cougars have been spotted recently in other areas of Minnesota. A male

cougar was captured in 1991 by the DNR in southwestern Minnesota. More recently, a female cougar was shot and killed approximately 80 miles northeast of Camp, near Big Sandy Lake in August of 2001. It was later discovered that she was accompanied by kittens, which indicates a possible breeding population. Before that, a cougar had not been killed in Minnesota since 1897 (Berg 2001). Cougars are a protected species in Minnesota, and cannot be hunted. Efforts to verify cougar sightings on Camp Ripley will continue in 2002.

REPTILES AND AMPHIBIANS

Blanding's Turtle

Annual surveys of Blanding's turtles (*Emydoidea blandingii*) have been conducted on Camp Ripley since 1991 and many key nesting areas have been identified. In September 2000 a small area on the east side of Goose Lake was burned to remove vegetation and make the area more attractive to turtles. Although Blanding's turtles have been seen in this area in the past, no turtles were found in the burned area in 2001.

In 2001, intensive surveys of known breeding areas were conducted to locate adults and protect as many nests as possible. Surveys were conducted according to Sajwaj et al. (1998); however, efforts were concentrated in areas with the highest quality nesting habitat (Dirks 2001). Because western painted turtles (*Chrysemys picta bellii*) on Camp Ripley move to nesting sites earlier in the year than Blanding's turtles (S.A. Piepgras, personal communication), painted turtle nesting activity was used to signal the beginning of Blanding's activity. After preliminary surveys indicated that western painted turtles had started moving to nesting sites, the first survey for Blanding's turtles was conducted on June 6, 2001. Researchers and volunteers logged a total of 79 vehicle hours conducting Blanding's turtle surveys. Because of military training, the roads in Hole in Day Marsh were not accessible and all surveys had to be terminated by 2100 hours.

The first Blanding's turtle was found on June 15 and the last was found on June 27. Nine Blanding's turtles were observed. Three turtles (one female and two males) were recaptures from previous years and four females were new captures. Two more Blanding's turtles were observed in the bog on the north side of Goose Lake and were not captured. After turtles were located, they were observed for as long as possible in an attempt to locate nests. The turtles were then

marked, measured and checked for eggs. Unfortunately, only depredated nests were located. No adult turtle mortalities were recorded during the survey period.

Although fewer turtles and nests were located in 2001 than in previous years, new unmarked turtles were located in the northeastern part of Camp. Blanding's turtles will continue to be monitored in 2002.

Anuran Surveys

Anuran surveys have been conducted annually at Camp Ripley since 1993. Frog and toad abundance estimates are documented by the index level of their chorus, following Minnesota Herpetological Society guidelines (Moriarty, unpub.). If individual songs can be counted and there is no overlap of calls, the species gets an index value of 1. If there is overlap in songs the index value is 2, and a full chorus is designated a 3. Anuran surveys are performed at ten stops along two separate routes. The routes are conducted three times from April to July.

One route was surveyed completely this year, while the other was only surveyed two of the three times due to training activities. As in past years, the most commonly heard species during the first sampling period were spring peepers (*Pseudacris crucifer*), wood frogs (*Rana sylvatica*) and western chorus frogs (*Pseudacris triserata*) (Table 9). In the second sampling period, the most common species were gray treefrogs (*Hyla versicolor*), American toads (*Bufo americana*), and spring peepers. Only green frogs (*Rana clamitans melanota*) and gray treefrogs were heard during the third sampling period. The number of wood frogs and western chorus frogs heard this year were the highest they have been since 1995. Green frogs were only detected two other years, 1996 and 1997. The Canadian toad was only heard one year (1996) during one sampling period. Data was sent to the DNR Natural Heritage Program in St. Paul where it will be used in ongoing anuran population monitoring efforts. Anuran surveys will be conducted again in the spring/summer of 2002 (Appendix A).

Table 9. Anuran survey indices calculated for both routes by survey period for each year.

Survey Period 1	2001	2000	1999	1998	1997	1996	1995	1994	1993
Wood Frog	1.8	1.0	0.5	0.4	0.3	1.1	2.3	1.1	*
Western Chorus Frog	1.3	0.9	0.6	0.6	0.4	0.6	1.6	1.2	*
Spring Peeper	2.0	2.3	1.7	1.6	2.5	1.5	2.2	2.8	*
Northern Leopard Frog	0	0.2	0.4	0.5	0.4	0.1	0	0	*
American Toad	0	0	0	0	0	0	0	0	*
Gray Treefrog	0	0	0	0	0	0	0	0	*
Cope's Gray Treefrog	0	0	0	0	0	0	0	0	*
Mink Frog	0	0	0	0	0	0	0	0	*
Green Frog	0	0	0	0	0	0	0	0	*
Survey Period 2	2001	2000	1999	1998	1997	1996	1995	1994	1993
Wood Frog	0	0	0	0	0	0	0	0.1	2.4
Western Chorus Frog	0.2	0.2	0.1	0	0	0	0.2	0.1	0.4
Spring Peeper	0.6	0.9	0.8	0.9	0	0.2	2.3	2.2	1.9
Northern Leopard Frog	0.1	0.3	0.1	0.1	0	0	0	0	0
American Toad	1.0	0.5	1.2	0.1	0.3	0.2	0.8	0.1	0.2
Gray Treefrog	2.1	1.0	2.3	0.8	1.0	1.4	1.7	1.7	0
Cope's Gray Treefrog	0.3	0.3	0.4	0.2	0.5	0.5	0.4	1.6	0
Mink Frog	0	0	0	0.1	0.1	0.2	0	0	0
Green Frog	0	0	0	0	0.1	0.1	0	0	0
Survey Period 3	2001	2000	1999	1998	1997	1996	1995	1994	1993
Wood Frog	0	*	*	*	*	0	0	*	*
Western Chorus Frog	0	*	*	*	*	0	0.1	*	*
Spring Peeper	0	*	*	*	*	0	0	*	*
Northern Leopard Frog	0	*	*	*	*	0	0	*	*
American Toad	0	*	*	*	*	0	0	*	*
Gray Treefrog	0.2	*	*	*	*	0	0.2	*	*
Cope's Gray Treefrog	0	*	*	*	*	0	0	*	*
Mink Frog	0	*	*	*	*	0.4	0.3	*	*
Green Frog	0.3	*	*	*	*	0.3	0	*	*

(*) Indicates no surveys were performed during this period due to military training activities.

Drift Fence Surveys

Drift fence surveys are conducted once every five years at Camp Ripley according to LCTA methods outlined in Tazik et al. (1992). This method of sampling herpetofauna began in 1991. However, precise locations of the drift fences were not documented at that time. In 1996 drift fences were placed in the same general locations, and the precise locations were recorded so that data could be statistically analyzed through quantitative comparisons. Drift fences were placed in five locations representing the different habitats of Camp Ripley; grassland, forest, grassland/forest edge and aquatic edge. One other habitat, floodplain forest, was sampled in 1991 and 1996, but was unavailable for sampling in 2001 due to high water levels. However, an additional forest site was added in 2001. The fences were checked every other day for 12 days in the spring, then were closed during the summer months when there is typically less amphibian and reptile movement. They were opened again September 5, and checked every other day until September 28.

Eight species were captured during drift fence surveys in 2001, which is lower than in 1996 (11 species) and in 1991 (12 species) (Table 10). The total number of individuals captured (116) was also down from 1996 (223) and 1991 (388). The number of sampling days for 1991 is unavailable, however all drift fences in 2001 were left open for 25 days compared to a range of 8-17 days for 1996 drift fences. The sampling results may be affected by sampling dates, which were typically earlier in both May and August of 1996 than in 2001.

The largest numbers of individuals were captured in the forest habitat, as occurred in past years. Wood frogs and American toads were the most captured species. Drift fence surveys will be conducted next in the year 2004 (Appendix A).

Table 10. Results from drift fence surveys conducted at Camp Ripley in 1991, 1996 and 2001.

	Drift Fence Habitat and Year Sampled											
	Aquatic Edge			Grassland			Forest			Forest/grassland edge		
	1991	1996	2001	1991	1996	2001	1991	1996	2001	1991	1996	2001
Species												
American Toad	6	14	2	2	0	8	66	22	16	9	1	1
Mink Frog	0	0	0	0	0	0	19	0	2	0	0	0
Wood Frog	1	21	3	4	4	0	84	28	44	1	2	15
Chorus Frog	0	0	0	0	1	0	0	1	1	0	14	1
Spring Peeper	0	12	0	0	0	0	7	27	3	0	1	1
Central Newt	0	0	0	0	0	0	1	6	4	0	0	0
Tiger Salamander	0	0	2	0	0	0	0	1	3	1	0	3
Blue-spotted Salamander	0	0	0	0	0	0	7	24	3	0	0	1
Leopard Frog	5	4	0	146	0	0	2	1	0	3	0	0
Green Frog	0	0	0	1	0	0	2	0	0	0	0	0
Eastern Garter Snake	1	1	0	3	0	0	1	1	0	0	1	0
Northern Prairie Skink	10	0	0	4	8	0	0	0	0	1	0	0
Snapping Turtle	0	0	0	0	0	0	1	0	0	0	0	0
Eastern Gray Treefrog	0	0	0	0	0	0	0	28	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	1	0	0	2
Total	23	52	7	160	13	8	190	139	77	15	19	24
Species Richness	5	5	3	6	3	1	10	10	9	5	5	7

ARDEN HILLS ARMY TRAINING SITE (AHATS)

The Twin Cities Army Ammunition Plant (TCAAP) was one of six Government Owned-Contractor Operated (GOCO) plants built to produce small arms ammunition during World War II. The Minnesota Army National Guard (MNARNG) began leasing its current facility in 1972 and the Organizational Maintenance Shop (OMS) vehicle maintenance buildings were constructed in 1973. In September 2000, MNARNG acquired accountability for 1,245 acres of the 2,347-acre installation. It is this portion of TCAAP that is now known as the Arden Hills Army Training Site (AHATS).

Arden Hills Army Training Site lies in the northern portion of Arden Hills, Minnesota, approximately eight miles north of St. Paul city limits and six miles northeast of Minneapolis city limits. Surrounding municipalities include Arden Hills, New Brighton, Mounds View, and Shoreview.

Prior to 1990, fish and wildlife management was directed almost entirely at white-tailed deer. The Natural Resources Program developed substantially from 1990-1994, due to creative partnerships with government agencies, universities, and non-profit organizations that provided expertise and labor. At the same time, funding was secured through the Department of Defense Legacy Program, Federal Reserve Agricultural Account, MN DNR's Conservation Partners Grant Program, and other sources.

Population studies of flora and fauna will be an ongoing part of the installation's INRMP, which was completed in November of 2001 and will be reviewed yearly. These studies (Appendix B) will be funded through the ITAM and Conservation programs, the Federal Reserve Account, MNARNG or by university or other group volunteers on an as-needed basis. The data obtained will be used to help manage the natural resources on AHATS. Of the 2,347 acres that comprise TCAAP, approximately 1,216 acres are available for wildlife management. Thirty-one mammal species, 147 bird species and 298 plant species have been identified at AHATS.

BIRDS

Songbirds

On July 12, songbird surveys were conducted for the first time on 14 LCTA plots established in various habitats throughout AHATS (Fig. 13). Habitat types were evenly sampled, i.e. seven grassland and seven woodland plots. Grassland plots ranged from moderate woodland encroachment to extension of the plot into woodlands, so observations of woodland/edge birds near the edges of the plot were common. A total of 32 avian species were observed, 24 in woodlands and 18 in or near grasslands (Table 11). The total number of birds observed was 117, of which 37 were observed in grasslands and 80 in woodlands. This is not surprising, since grasslands typically contain less avian species and individuals than woodlands. The most abundant songbirds were the house wren (*Troglodytes aedon*), American goldfinch (*Carduelis tristis*), American robin (*Turdus migratorius*), and savannah sparrow (*Passerculus sandwichensis*). Songbirds will be surveyed on LCTA plots at AHATS again in the spring of 2002, and also each subsequent year (Appendix B). Additional survey plots may be added as needed.

Osprey

A nesting platform was erected near the public wildlife viewing area on the eastern edge of AHATS in 1997, after ospreys were observed there. A pair of ospreys was observed using the nesting platform again this year, and fledged three young. This number is similar to the nesting success of previous years, with at least two young produced each year since 1998. Ospreys will continue to be monitored in 2002 to determine presence and nesting success (Appendix B).

Figure 13. LCTA plots surveyed at AHATS in 2001 for songbirds and small mammals.

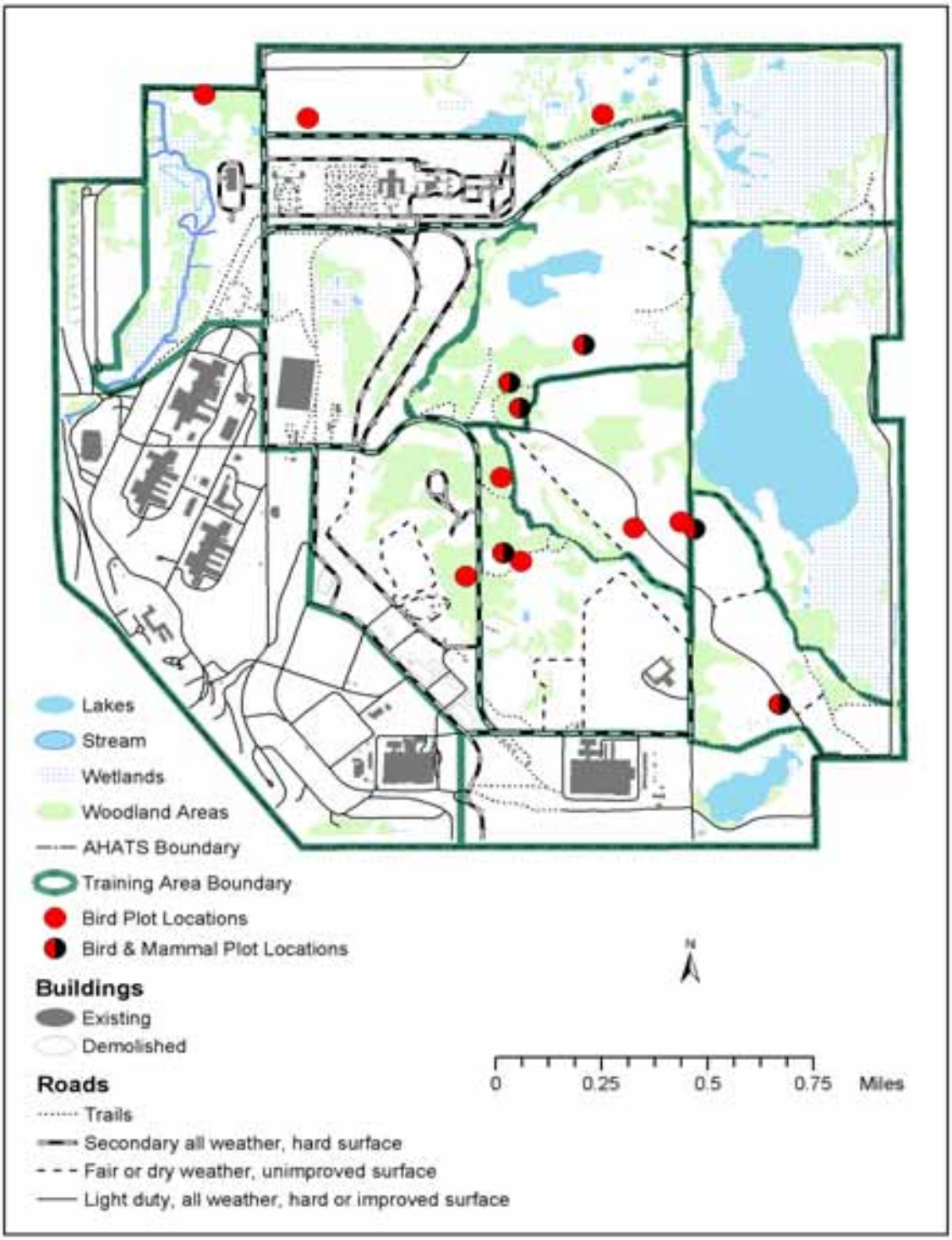


Table 11. Results from songbird surveys conducted at AHATS in 2001. Frequency of occurrence is calculated as percentage of plots of that habitat the species occurred on.

	GRASSLAND		WOODLAND	
Species	Number Documented	Frequency of Occurrence (%)	Number Documented	Frequency of Occurrence (%)
Savannah sparrow	2	14	5	4
Sedge wren	5	57	0	0
Eastern kingbird	1	14	0	0
Field sparrow	3	43	0	0
Common yellowthroat	1	14	2	2
Eastern meadowlark	2	29	0	0
House wren	3	29	11	5
American robin	1	14	6	4
Song sparrow	2	14	2	1
American goldfinch	3	43	10	5
Clay-colored sparrow	6	57	0	0
White-breasted nuthatch	0	0	3	3
Red-breasted nuthatch	0	0	2	1
Red-eyed vireo	0	0	2	1
Northern cardinal	0	0	2	2
Black-capped chickadee	1	14	4	3
Indigo bunting	2	14	0	0
Northern flicker	1	14	0	0
Brown thrasher	1	14	1	1
Cedar waxwing	1	14	1	1
Red-winged blackbird	0	0	3	1
Rose-breasted grosbeak	0	0	1	1
American crow	1	14	2	1
Mourning dove	1	1	3	3
Yellow warbler	0	0	1	1
Blue jay	0	0	3	3
Eastern wood-pewee	0	0	3	3
American redstart	0	0	1	1
Sharp-shinned hawk	0	0	1	1
Gray catbird	0	0	2	1
Downy woodpecker	0	0	3	2
Eastern towhee	0	0	6	5
Total	37		80	

MAMMALS

Small Mammals

Small mammals will be surveyed every five years at AHATS, using the same protocols as at Camp Ripley (Appendix B). Small mammals were surveyed for the first time on six LCTA plots at AHATS in 2001 (Fig. 13). Three plots were located within grasslands and three were located within woodlands. Traps were set August 20th, checked and reset August 21, then checked and removed on August 22. Catch totals per plot varied from one thirteen-lined ground squirrel in a grassland plot to 13 individuals in a woodland plot (Table 12). The total number of animals captured in grassland plots (19) was lower than the number captured in woodlands (30). Species richness did not vary substantially between grasslands and woodlands, with five and six species captured respectively. Certain species such as meadow voles were only captured in grasslands, while *Peromyscus* species (deer mice and white-footed mice) were more than six times as likely to be captured in woodlands.

Table 12. Small mammal species captured on three grassland and three woodland LCTA plots at AHATS in 2001. Frequency of occurrence is the number of plots of that habitat type the species occurred on.

	GRASSLAND		**WOODLAND**	
Species	Number Captured	Frequency of Occurrence	Number Captured	Frequency of Occurrence
Short-tailed shrew	4	2/3	2	2/3
Meadow vole	7	2/3	0	0/3
Southern red-backed vole	0	0/3	3	2/3
Peromyscus spp.	3	2/3	20	3/3
Meadow jumping mouse	0	0/3	1	1/3
Thirteen-lined ground squirrel	1	1/3	0	0/3
Masked shrew	4	2/3	3	2/3
Eastern chipmunk	0	0/3	1	1/3

White-tailed Deer

The deer population within AHATS has been a concern to managers there and to the surrounding public. High deer populations increase the incidence of deer-vehicle collisions and impact the amount of standing vegetation due to extensive winter browsing. The deer population has been estimated from aerial counts during most winters since 1997, and will continue to be surveyed in 2002 (Appendix B).

During the 1960's the herd was estimated at 400 (ca. 60/km^2 of deer habitat), so sharpshooters were brought in to reduce deer numbers. This was continued until 1995, after which the public was allowed limited access for archery hunting (Table 13). The AHATS archery hunt for 2001 was cancelled due to security concerns after the terrorist attacks of September 11, 2001.

Table 13. Deer harvested at AHATS from 1993-2001.

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Deer Harvested	34	100	35	69	49	42	37	32	0

DRAGON FLIES and MACROINVERTEBRATES

During the summers of 2000 and 2001, research was conducted to develop baseline data on dragonfly (Odonata) and aquatic macroinvertebrate communities at AHATS. Samples were collected from Sunfish Lake, Marsden Lake, the gravel pit lake, Rice Creek and other areas throughout AHATS. Nineteen adult Odonata and 58 aquatic macroinvertebrate taxa were collected during the two field seasons. Four new Odonata species were recorded for Ramsey County. The aquatic invertebrate fauna collected in the AHATS habitats were typical of small lakes and wetlands throughout this area of the state. Most of the adult dragonflies collected are fairly common in the state and none of the aquatic invertebrates collected are considered rare or uncommon. The final report on this research can be found in Appendix D.

RECOMMENDATIONS AND FUTURE RESEARCH

CAMP RIPLEY

1) Helicopter net-gunning will be conducted for wolves and white-tailed deer in January 2002. At that time, 1-3 wolves will be collared with satellite radio collars and the alpha female will be re-collared with a traditional VHF collar.
2) Continue to monitor and record all observations of threatened, endangered, and special concern species on the base. Update GIS databases and maps with new observations, and conduct spatial analyses as necessary.
3) Red-shouldered hawk nest surveys will be conducted in 2002 beginning with checking historic nest locations in February/March followed by nest checks and call playback surveys in spring/summer.
4) If training schedules permit, conduct searches for Hooded Warbler nests during June. Explore the possibility of mist-netting and banding individuals for recapture studies.
5) Search all historic cerulean warbler areas using call-playback survey methods.
6) Conduct road surveys for Blanding's turtles in June according to methods recommended by the Blanding's turtle study. Identify and protect nests and nesting areas.
7) Create or reestablish Blanding's Turtle nesting habitat by removing vegetation or burning in areas that are traditional nesting areas.
8) Continue bear telemetry. Conduct additional trapping and deploy additional conventional, GPS, and satellite radio collars as needed.
9) If training schedules permit, locate wolf den and rendezvous sites to determine productivity.
10) The second osprey platform should be moved to a more productive location.

AHATS

1) Begin animal surveys and monitoring as outlined in the AHATS Integrated Natural Resources Management Plan (Appendix B).

ACKNOWLEDGMENTS

The assistance provided by all of the people associated with Camp Ripley and in particular, the Environmental Office was greatly appreciated. We would like to acknowledge Camp Commander Colonel Terry Dorenbush for his appreciation and support of the research being conducted and his vision that Camp Ripley can continue to support environmental education and training. Marty Skoglund, Jay Brezinka, and Bill Brown were all instrumental in completing projects; this was truly a team effort. Camp Ripley's GIS specialists, Craig Erickson and Greg Blum, provided GIS related support throughout the year and created the maps for this report. We also thank the entire Range Control staff for their support and tolerance of our activities down range, especially during times of high military use. Thanks to Pam Perry, Janet Anderson and Jean Forbord for providing administrative and logistical support for all of the projects throughout the year.

The assistance and advice of many people including; Dr. David Mech, Dr. Glenn DelGiudice, Carolin Humpal, Chris Kochanny, and Bill Berg was greatly appreciated. The bear project was again successful because of the support and fieldwork of Dave Garshelis, Pam Coy, and Karen Noyce. Thanks to DNR pilots Dick Stoltman and Mike Trenholm for another year of safe and productive flight time. Welcome to Beau Liddell, Little Falls Area Manager, and thanks to him and his staff for organizing another successful archery deer hunt.

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APPENDICES

APPENDIX A. ANIMAL SURVEY SCHEDULE FOR CAMP RIPLEY

Camp Ripley	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Frequency of Surveys/Comments
Birds												
Songbirds	30	30	30	Full	30	30	30	Full	30	30	30	1/3 of total plots/year, full survey every 4 years
Owls				X					X			Call-playback survey
Hooded Warbler	X	X	X	X	X	X	X	X	X	X	X	Call-playback survey
Red-shouldered Hawk	X	+ Nest	X	X	X	X	+ Nest	X	X	X	X	Annual survey, every fifth year full nest survey
Bald Eagle	X	X	X	X	X	X	X	X	X	X	X	With other flights/radio-tracking
Osprey	X	X	X	X	X	X	X	X	X	X	X	With other flights/radio-tracking
Trumpeter Swan	X	X	X	X	X	X	X	X	X	X	X	Monitor for presence, w/flights/radio-tracking
Yellow Rail	X				X				X			
Upland Sandpiper	X	X	X	X	X	X	X	X	X	X	X	Monitor for presence
Waterfowl												To be determined
Bluebird Route	X	X	X	X	X	X	X	X	X	X	X	Check/Maintain nest boxes 3X/year
Wood Duck Box Survey	X	X	X	X	X	X	X	X	X	X	X	Checked/Maintained by DNR Little Falls
Great Blue Heron	X	X	X	X	X	X	X	X	X	X	X	Rookery on the River, check annually

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Frequency of Surveys/Comments
Mammals												
Gray Wolf	X	X	X	X	X	X	X	X	X	X	X	Monitor collars, winter track surveys, rendezvous sites
White-tailed Deer	X	X	?									DNR study extended at least 2 years (2002)
Black Bear	X	X	X	X	X	X	X	X	X	X	X	Monitor collars
Small Mammal Survey	X					X					X	
Prairie Vole	X					X					X	Same years as small mammal survey
Bats		X					X					
Porcupine												
Scent-post Survey	X	X	X	X	X	X	X	X	X	X	X	

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Frequency of Surveys/Comments
Reptiles and Amphibians												
Anuran Survey	X	X	X	X	X	X	X	X	X	X	X	
Blanding's Turtle	X	X	X	X	X	X	X	X	X	X	X	
Drift Fences	X			X			X			X		May include other techniques (e.g. coverboards)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Frequency of Surveys/Comments
Insects												
Tiger Beetles												Surveyed 1997-future surveys to be determined
Jumping Spiders												Surveyed 1998 – future surveys to be determined
Dragonflies												Two year study completed in 1999. Future surveys to be determined
Butterflies												Surveyed 1997-future surveys to be determined
Aquatic Invertebrates												To be determined

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Frequency of Surveys/Comments
Other Surveys												
Fish	X	X	X	X	X	X	X	X	X	X	X	
Mussels					X							Will determine if surveys need to be continued after 2005
Vegetation Survey LCTA			X			X			X			
Vegetation Survey T&E Species				X				X				

APPENDIX B. ANIMAL SURVEY SCHEDULE FOR AHATS

AHATS	2002	2003	2004	2005	2006	Frequency of Surveys/Comments
Birds						
Songbirds	X	X	X	X	X	Annual
Owls					X	Call-playback survey
Hawk Survey	X	X	X	X	X	Annual
Osprey	X	X	X	X	X	Annual full nest survey
Trumpeter Swan	X	X	X	X	X	Monitor for presence, record reproductive success
Yellow Rail	X				X	
Upland Sandpiper	X	X	X	X	X	Monitor for presence
Waterfowl	X	X	X	X	X	Pair and brood surveys/winter survey
Bluebird Route	X	X	X	X	X	Check/Maintain nest boxes 3X/year
Wood Duck Box Survey	X	X	X	X	X	Annual check/maintenance
Great Blue Heron	X	X	X	X	X	Monitor for presence
	2002	**2003**	**2004**	**2005**	**2006**	Frequency of Surveys/Comments
Mammals						
White-tailed Deer	X	X	X	X	X	Annual winter aerial survey
Small Mammal Survey					X	Surveyed in 2001
Plains Pocket Mouse	X		X		X	
Bats						Surveyed in 2000
Scent-post Survey	X	X	X	X	X	Annual survey
	2002	**2003**	**2004**	**2005**	**2006**	Frequency of Surveys/Comments
Reptiles and Amphibians						
Anuran Survey	X	X	X	X	X	
Blanding's Turtle	X	X	X	X	X	
Drift Fences/Cover Boards	X			X		

	2002	2003	2004	2005	2006	Frequency of Surveys/Comments
Insects						
Tiger Beetles						Surveyed in 2000
Jumping Spiders						Surveyed in 2000
Butterflies	X	X	X	X	X	Surveyed in 2000, annual Audubon survey
Aquatic Invertebrates						Second year of 2000 contract completed in 2001
Other Surveys						
Fish	X					Sunfish and Marsden Lakes
Vegetation Survey LCTA			X			
Vegetation Survey T&E Species				X		

APPENDIX C. DEER STUDY REPORT

ASSESSING THE IMPORTANCE OF NUTRITION AND WINTER SEVERITY ON THE USE OF THE JACK PINE COVER TYPE BY WHITE-TAILED DEER IN CAMP RIPLEY, MINNESOTA

Buck Mangipane, Carolin Humpal, and Glenn D. DelGiudice

BACKGROUND

Management guidelines of the Minnesota Department of Natural Resources (MNDNR) and other land management agencies integrate forest and wildlife management via practices that attempt to maximize timber productivity and yield, while enhancing wildlife habitat quantity and quality. The specific habitat needs of white-tailed deer (*Odocoileus virginianus*) are a consideration when designing timber harvests in north central Minnesota.

In Minnesota's Forest Zone, conifer thermal cover of deer typically includes dense stands of northern white cedar (*Thuja occidentalis*), spruce (*Picea spp.*), and balsam fir (*Abies balsamea*), and in some areas, jack pine (*Pinus banksiana*) and red pine (*P. resinosa*) as well. Current DNR guidelines limit the harvesting of these particular species because of their "value" as winter thermal cover and snow shelter.

Camp Ripley is located in the Transition Zone of the state. Thermal cover at the Camp is quite different than in the Forest Zone and is characterized by mixed stands of jack pine and hardwoods. Far less is known about the relationship between white-tailed deer and the type of thermal cover typically observed at Camp Ripley and elsewhere in the Transition Zone. It is apparent from observations of overbrowsing on winter ranges of deer at Camp Ripley that jack pine may have a second important value to deer--that is as a source of nutrition. Cursory observations suggest that it may be a more important dietary component there than in the Forest Zone where habitat composition can be appreciably different.

It has been suggested that "food is the basic requirement" of deer, but as sufficient food becomes less available for fulfilling energy requirements, thermal cover becomes physiologically important as a means of reducing energy lost as heat and for maintaining thermal balance. In western Minnesota, it was observed that deer did not seek cover, despite ambient temperatures < 18^{o} C (0^{o} F), when adequate food was available to maintain positive energy balance. Higher digestible energy available to deer from crop residue in agricultural fields juxtaposed to certain peripheral portions of Camp Ripley compared to that available from natural browse alone in other portions of the Camp, may have a significant influence on how and when deer use the thermal cover (i.e., jack pine stands) distributed over the Camp's landscape, as well as on aspects of their seasonal migration. In addition to the specific source of the digestible energy, the severity of winter weather conditions may strongly influence nutritional restriction.

The mixed conifer (i.e., jack pine)-hardwood habitat of the deer's winter range at Camp Ripley may have a third important function for deer, that is as a refuge from wolf (*Canis lupus*) predation, thus, contributing to a "balance" between the two species. Recently, timber wolves have become re-established within Camp Ripley's boundaries, and preliminary data indicate that their home range is relatively small, possibly due to the high deer densities. Further, there is an inverse relationship between winter severity and the nutritional condition of deer in Minnesota and a direct relationship between snow depth and wolf predation, which may increase the relative importance of the jack pine type to deer during severe winters.

There has been little study of Camp Ripley's deer in recent years, thus reliable information concerning deer-habitat-wolf interactions to serve as a basis for sound management decisions is sparse and sorely needed. It is clear that we must significantly increase our knowledge of the functional relationship that exists between deer and thermal cover in the Transition Zone (e.g., Camp Ripley) under varying environmental conditions to better understand the range of habitats that will fulfill the needs of deer. Important to understanding this relationship, we must become more informed about the interactive roles of nutrition and predation pressure imposed by the recently established wolves. With the increasing concern for the harvesting of jack pine stands within the Camp and the recent commencement of a wolf study, the timing for a study addressing these relationships was critical and wise with respect to the quality of information it would yield in support of the future management of deer.

The goal of this study is to examine the relative influences of winter severity and nutrition on use of the jack pine-hardwood habitat type as winter thermal cover by white-tailed deer in Camp Ripley. Our study approach involves 4-6 winter field seasons (winters 1998-99 to 2003-04) for data collection. On 2 study sites, one (SW) where deer have access to supplemental feed and crop residue, and another (NW) where they do not, specific objectives are to determine the (1) distribution and home ranges of female deer on winter range, (2) their seasonal migration patterns, (3) habitat composition of their winter home ranges and habitat use patterns relative to winter severity, and (4) survival and cause-specific mortality rates. Further, on the SW site, a final objective (5) is to determine the availability and use by deer of crop residue and supplemental feed on nearby agricultural fields as winters progress.

METHODS

The basic methodological approach includes 2 winter study sites. The SW site, 10 km^2 (6.2 mi^2), is part of a deer winter range located in the southwestern part of the Camp, where deer move out of the Camp on a daily basis during winter to consume crop residue in nearby agricultural fields. The NW site, 15 km^2 (9.3 mi^2), is part of a deer winter range located in the northwestern portion of the Camp and serves as a *control* site. Deer on this site do not move to agricultural fields for crop residue, but subsist solely on natural forage and browse.

Winter 1998-99 and 1999-2000

During 2-4 February 1999, 40 female deer were captured by net-gun dispatched from a helicopter (Helicopter Capture Services, Marysvale, UT). Nineteen (18 adults, 1 fawn) and 21 (20 adults, 1 fawn) females were captured and handled on the NW and SW sites, respectively. Male deer were released immediately. All captured females were blindfolded and injected intramuscularly by hand-held syringe with a combination of 100 mg xylazine hydrochloride and 300 mg ketamine hydrochloride. Once induced, rectal temperature of deer was monitored; deer were eartagged, blood-sampled by venipuncture of the jugular vein; and a last incisor was extracted for aging. VHF and global positioning system (GPS) radio collars were fitted on 32 and 8 deer, respectively (Advanced Telemetry Systems, Inc., Isanti, MN), and a broad-spectrum antibiotic preparation was administered intramuscularly. Mean recovery time of deer after intravenous injection of yohimbine was 13 minutes (n = 30).

Capture operations were repeated on 27-28 January 2000 to replace 6 deer that died during the first year, as well as those 8 deer from which we released the GPS collars prior to battery expiration (90-120 days post-capture). One of the deer mortalities was a GPS-collared deer. Eight additional does were captured for a companion study of a new GPS radio collar prototype being conducted by C. Kochanny (Advanced Telemetry Systems, Inc., Isanti, MN). Three adult females, 1 female fawn, and 1 male fawn (handled but released without a radio-collar) were captured and handled on the NW site, and 18 adult females were captured and handled on the SW site. All captured deer were handled as described for the first year, except serial blood specimens were collected from chemical induction (baseline) to 45 minutes post-induction at 15-minute intervals to study potential stress effects of the capture technique on the deer. Serum samples were analyzed for cortisol, creatine phosphokinase, and lactate dehydrogenase. Conventional VHF collars were fitted on 6 does, and GPS collars were fitted on 16 deer (Advanced Telemetry Systems, Inc., Isanti, MN); 8 of the GPS collars were the new prototype and are auxiliary to the current study. Mean recovery time for these deer was 4 minutes (n = 23, includes 1 male collared at the request of Camp Ripley's Environmental Office).

All deer were handled and released without injury or incident. Approximately 20-40 students (ages 12-17 years) and several teachers from Independent School District 549 (Perham, MN) observed and were permitted to participate in deer handling on one day of capture operations during each year.

Survival of all deer is monitored weekly by radio telemetry. All mortalities of deer are investigated for cause by collecting and examining carcass and site evidence. Survival analysis was conducted using the Kaplan-Meier procedure generalized to accept staggered-entry. Statistics on cause of mortality are reported.

Ten collared deer on each study site were selected randomly to radio-locate by triangulation 3-4 times per week from capture to 31 March 1999 and 2000. Further, all deer were located on their spring-summer-fall ranges during June and September to establish migration statistics and patterns. All telemetry locations (plotted by UTM

coordinates) were used to determine winter home range of deer by the minimum convex polygon method using the Animal Movement extension in Arcview.

Habitat composition of the 2 study sites was determined by air photointerpretation using color infrared air photos (1:15,840 scale), digital orthophotoquads, and confirmation by ground-truthing. Thirteen and 11 habitat types were delineated in the SW and NW sites, respectively. Habitat types were digitized and radio locations of deer imported into a geographic information system (Arc/Info or ArcView) to perform temporal and spatial analyses of habitat compositions of deer home ranges.

Habitat use for each site combining years was examined using Compositional Analysis with the program Resource Selection for Windows. Habitat use was analyzed at the second and third order, which correspond to the home range and location levels of selection. Radio telemetry error can influence the analysis of habitat use data. We used circular buffers to represent telemetry error on locations and home ranges to prevent biases that may result from overlooking this error.

Migration of deer was defined as movement between distinct summer and winter ranges. For animals that were intensely monitored, winter range was established through home range estimation. To define summer range, deer were radio-located in June or July when deer had arrived on summer range. This location was treated as the furthest point within the deer's summer range. Circular buffers with radii of 1000, 798, and 565 m (areas of 314, 200, and 100 ha, respectively), with the summer location at the outermost point and centered on a line connecting the mean winter location and the summer location, were created to represent the deer's summer home range. Using the summer location as the outermost point is a conservative approach to determining if deer are migratory. These areas represent the range of reported summer home range sizes of white-tailed deer in northern forests and agricultural areas. If the summer range did not overlap with the animals' winter range, the animal was determined to be migratory.

Deer that were not frequently located, were monitored weekly for survival. Signal strength and direction from established receiver locations were recorded. This provided information on the deer's distribution within the study area during winter. In 2000, we located these deer by triangulation to establish a reference point from which migration could be based. Migration for these deer was determined if the circular buffers on their summer location did not overlap with the study area, which was defined as the 100% MCP for all deer (1999 and 2000 combined) for that study site.

Distance of migration was determined from the mean location within a deer's home range to their summer location. For deer without winter locations, the mean location of all study area deer was used as a starting point for migration. Direction of migration was based on the line created to determine migration distance.

Winter 2000-01

Capture operations, as described for past winters, were conducted on 18-19 February 2001 to replace 8 deer that died during 2000 and to add collared animals to the study cohort should collars deployed in 1999 begin to fail. Thirteen (12 adults, 1 fawn) and 4 (4 adults) females were captured on the NW and SW sites, respectively. One buck was captured on the SW site and fitted with a GPS collar at the request of Camp Ripley's Environmental Office. All captured deer were handled following the same protocol as used in the 1999 capture. Conventional VHF collars were fitted on 10 does; GPS collars programmed to obtain 1 location per hour from winter capture through fall migration were fitted to 7 does. Mean recovery time for immobilized deer was 8 minutes (n = 18). After capture, a total of 46 deer were radio collared (25 and 21 on the NW and SW sites, respectively).

Again, all deer were handled and released without injury. Approximately 200 observers, including school groups, residents of the community, and employees of Camp Ripley, observed and/or participated in deer handling during the capture event.

We continued to locate 3-4 times per week 11 deer that were monitored intensively during winters 1998-99 and/or 1999-00. Eight additional deer were randomly selected for locating 3-4 times per week as well. The remaining 25 deer were located at least once on winter range during January-March 2001, and all deer will be located on their spring-summer-fall ranges for migration analyses.

Crop residue in the agricultural fields south of Camp is generally depleted by the middle of winter. Deer were supplementally fed to extend the higher nutritional levels throughout winter, and consequently serve as our experimental *treatment*. Orts of 3 feeders in each of 3 fields adjacent to the SW site were measured and recorded every other day, and the feeders were refilled with whole corn kernels. Landowners adjacent to Camp may also have provided supplemental feed, so orts provide an estimate of the minimum amount of corn that has been consumed.

Snow-urine specimens (75) were collected at least once per month from January to March after recent snowfalls. On the SW site, each collection included 15 specimens from each of 3 sampling areas or zones: within the crop fields or immediately adjacent to them, between the Camp boundary and 1 km into Camp, and >1 km from the boundary within the study area. In the NW site, a 1-km buffer was set up around a specific home with a deer feeder; data from 10 specimens/sampling from that area will be considered separately from the 20 specimens/sampling collected from the rest of the study area. Urea nitrogen:creatinine and potassium:creatinine ratios will be determined for these specimens to assess and compare nutritional restriction throughout each winter.

Fresh fecal samples were collected during snow-urine collections to permit dietary quality assessments on the 2 study sites. Specifically, samples will be analyzed for acid-detergent fiber (ADF), neutral-detergent fiber (NDF), and acid-detergent lignin (ADL). Amounts of ADF and NDF present in deer pellets have indicated the proportion of the

deer's diet comprised of crop residue or supplemental feed (i.e., corn). Results of fecal analyses will be examined for spatial and temporal trends. Locations of snow-urine and fecal sample collections were determined by a GPS unit and recorded. Habitat type was also recorded.

PRELIMINARY RESULTS AND PROGRESS

Snow Conditions

Weather conditions of winters 1998-99 and 1999-2000 were mild. Snow depths never reached the 41-cm threshold beyond which mobility becomes energetically costly for deer. Mean snow depths in the jack pine cover type were 27.2, 17.8, and 16. 8 cm in January, February and March 1999, respectively, and were 30.7, 18.3, and 12.1 cm in the open vegetation type for these months. During winter 1999-2000, these mean monthly snow depths were 10.3, 13.3, and 0.7 cm in dense jack pine and 11.3, 14.4, and 0.5 cm in the open. March had only 3 days with measurable snow cover.

Weather conditions were normal in winter 2000-01. By 8 February 2001, mean snow depths exceeded the 41-cm threshold and remained near or above that threshold until 21 March 2001. Mean snow depths in the jack pine cover type were 25.1, 40.3, and 42.5 cm in January, February, and March, respectively, and were 32.2, 50.5, and 48.3 cm in the open type for these months.

Number and Precision of Radio Telemetry Locations

Twenty deer collared with VHF radio transmitters, 10 on each study site, were located 424 times (20-23 locations per deer) between 9 February and 25 March 1999. Locations obtained by triangulation had an average 95% error ellipse of 3.2 hectares as calculated by the program XYLOG.

Eight GPS collars were deployed on deer between 2 and 4 February 1999 and were remotely released and retrieved during 12 May-8 June 1999. One collar failed to obtain locations, 2 obtained one location every 4 hours, and 5 obtained one location per hour, 24 hours per day. The functional GPS collars obtained 4,669 locations during the 9 February-25 March winter monitoring period.

During winter 1999-2000, surviving deer that were intensely monitored in winter 1998-99, were again monitored for home range determination. Additional deer were selected randomly to replace those that were censored from the study (GPS collars remotely released and retrieved) or that died during the previous year. During 19 January-31 March 2000, approximately 780 locations were obtained by triangulation (mean = 45 locations/deer). The average 95% error ellipse for triangulated locations was 3.0 hectares. Locations made with this level of precision allow reliable assignment of deer to jack pine-hardwood cover types, which average 8 hectares on the study sites.

Sixteen GPS collars (8 standard and 8 prototype) were deployed on 27 and 28 January 2000. The 8 standard GPS collars were programmed to obtain 1 location per hour, 24 hours per day. Deer fitted with standard GPS collars were also fitted with lightweight VHF radio collars (Advanced Telemetry Systems, Inc., Isanti, MN). The VHF collars allowed us to continue monitoring the deer after the GPS collars were remotely released. Two of the standard GPS collars malfunctioned (i.e., no longer transmitting radio signals), with one being retrieved and the other remaining on the deer. The 8 prototype GPS collars allowed programming variable sampling intervals (i.e., changing the time between locations) so that each deer could be monitored more or less intensely at different times of the year.

Twenty deer were monitored intensively during winter 2000-01; 8 of these were intensively monitored during both winters 1998-99 and 1999-00, and 3 during the winter 1999-2000. The remaining 9 deer were randomly selected from the pool of 34 remaining deer. These twenty intensively monitored deer were located 592 times between 11 January 2001 and 28 March 2001. Number of locations per animal ranged from 11 to 34, with a mean of 29.5 (SE = 6.2). The average 95% error ellipse size for triangulated locations was 2.4 ha, as calculated by the program XYLOG. An additional 41 locations were obtained for the 25 non-intensely monitored animals for use in determining migration patterns.

Ages and Pregnancy Status

Mean age at capture for 58 of the 61 female deer (3 did not have an incisor removed) handled in the winters of 1998-99 and 1999-00 was 5.0 years old. Ages ranged from 0.5 to 12.5 years old. Mean age at capture for 15 of the 17 deer (2 did not have an incisor removed) handled in late January 2001 was 6.6 years old (range = 0.5-17.5). Mean ages of SW (6.7 years old) and NW (6.5 years old) deer did not differ significantly ($P > 0.05$) in 2001.

Deer were determined to be pregnant when serum progesterone concentrations were >1.8 ng/ml. Thirty-two of 35 (91%) adult (>1 year old) females captured in 1999 were pregnant; no fawns were pregnant. Pregnancy will be determined by serum progesterone concentrations for the females captured in 2000 and 2001 as well.

Home Range Estimation

There was no difference ($P \geq 0.21$) in the mean 100% home range for deer on the NW and SW sites during winter 1998-99 (73 ± 13.1 versus 96 ± 22.6 hectares), 1999-00 (67 ± 16.6 versus 106 ± 25.5 hectares), or during winter 1999-2000 (70.5 ± 23.4 versus 57.4 ± 48.3 hectares). Further, there were no differences ($P \geq 0.05$) in home range sizes among winters for deer within the NW and SW sites; however variability was particularly large during winter 2000-01.

Habitat Use

We analyzed habitat selection at the home range level within the study site (second order) and at the individual location level within the home range (third order). Winters 1998-99 and 1999-00 were combined due to complications with the compositional analysis method, but preliminary analysis showed similar use between years, which supported the pooling of data. On the SW site, selection at both levels was not random (second order $X^2 = 71.5$, $df = 12$, $P \leq 0.0001$; third order $X^2 = 42.0$, $df = 12$, $P \leq 0.0001$). Selection on the NW site was not random at the second order ($X^2 = 54.2$, $df = 10$, $P \leq 0.0001$), but third order selection was not significantly different from random ($X^2 = 17.7$, $df = 10$, $P = 0.0599$). Rankings of SW habitats at the second order were aspen (*Populus* sp.), grassland, oak (*Quercus* sp.), jack pine, brushland, red pine, hardwood, tamarack (*Larix larichina*), development, water, white spruce (*Picea glauca*), agriculture, and marshlands. The first 4 ranked habitats were not significantly different from each other and were interchangeable (Table 1). All 4 habitats were selected significantly more than hardwood, red pine, white spruce, tamarack, agriculture, development, water, and marshlands. Third order rankings for the SW site were oak, hardwood, jack pine, white spruce, agriculture, aspen, tamarack, grassland, marsh, development, brushland, water, and red pine. Oak, hardwood, and jack pine were not significantly different from each other and were interchangeable, but all were selected over red pine and water (Table 2). The different ranking between orders indicates that selection of habitats occurred differently at large and small scales.

The NW habitat rankings for second order selection were aspen, grassland, jack pine, red pine, brushland, marsh, oak, development, water, hardwood, and agriculture. Aspen was not used significantly more than jack pine or red pine, but was used significantly more than grassland (Table 3). This appeared inconsistent with the habitat rankings derived after excluding missing values (i.e., habitats that were not used by some deer) from calculations. Grasslands were not used significantly more than either red pine or jack pine. Thus, they are interchangeable in the rankings, which helps explain the inconsistency in rankings and pairwise comparisons. Habitat use and selection by deer of the NW and SW sites will be compared between winter 2000-01 and the historically mild winters of 1998-99 and 1999-00.

Migration

During winter-spring 1999, 16 of 40 (40%) radio-collared deer migrated. Twelve of 21 deer (57%) on the SW site and 4 of 19 deer (21%) on the NW site migrated to distinctly different or non-overlapping spring-summer-fall ranges. Migration was observed in 11 of 39 deer (28%) in 2000. Eight of 22 deer (45%) and 4 of 18 deer (22%) migrated from the SW and NW sites, respectively. Two deer from each site failed to return to their winter range or the study sites following the summer of 1999. The mild weather of winter 1999-00 may have accounted for this behavior. Mean migration distance in 1999 was 7.4 km for the NW deer and 14.3 km for the SW deer. In 2000, the mean migration distances were 6.0 and 12.3 km for the NW and SW deer, respectively. After pooling data for the 2 years, migration distances for the 2 sites did not differ ($P = 0.07$). Mean migration

direction for NW and SW deer for both years combined was 61.8° and 197.5 °, respectively. Direction of migration was significantly different ($P \leq 0.0001$) between sites. Two deer made notable movements from the SW site. One moved 27.2 km, and the other migrated 52.8 km to the northwest in May 1999. The deer that moved 27.2 km returned to its winter range in January 2000, then migrated 40.1 km to the northwest in spring 2000.

Survival and Cause-Specific Mortality

Overall survival rates were not significantly different ($P = 0.3488$) between 1999 ($S = 0.78 \pm 0.08$) and 2000 ($S = 0.86 \pm 0.05$). When year and site were considered, the only combination with a significant difference ($P = 0.04$) was for NW deer ($S = 0.93 \pm 0.07$) versus SW deer ($S = 0.64 \pm 0.12$) in 1999.

Seven mortalities were recorded for radio-collared deer in 1999. Two SW deer were killed by collisions with cars, one on 21 April on Highway 115 south of Camp Ripley. The other died on 27 March on Highway 10, 6.4 km (4 mi) southwest of Camp Ripley. A third mortality occurred on 25 June on the SW site. Evidence was insufficient to permit a definitive determination of the cause of death. However, evidence indicated that wolves had fed on the carcass. Hunters harvested the 4 other deer. Three SW deer were harvested during the firearm season outside of Camp Ripley boundaries, and one NW deer was harvested during the annual bowhunt within Camp Ripley.

During 2000, 6 mortalities of radio-collared deer occurred. On 6 February, a deer was euthanized after becoming entangled in a fence. The other 5 mortalities occurred during the hunting season (3 on the SW and 2 on the NW sites), with 4 killed by hunters and 1 by an unknown cause. One of the hunter-harvested deer was taken within the SW during the annual bowhunt. Relative importance of cause-specific mortality for both years was 15.4% (2 of 13 deer) for automobile deer collisions, 61.5% (8 of 13 deer) for hunter harvest, 7.7% (1 of 13 deer) for accidental mortality, and 15.4% (2 of 13 deer) for unknown causes.

Two radio-collared deer mortalities had occurred in 2001 at the time this report was prepared. The first mortality occurred on 22 February 2001 on the NW site. Cause of death was unknown; however, evidence gathered from the site and a necropsy suggested that a vehicle collision may have wounded the deer, with predation by a cougar (*Felis concolor*) being the proximate cause of death. Predation was the cause of the second mortality, which occurred on 20 March 2001 on the SW site. Domestic dogs or coyotes (*Canis latrans*) were most likely the predators involved, but evidence at the scene was insufficient to be definitive. In addition to these mortalities, 2 deer died of unknown causes during fall 2000. The radio collar of one deer was found in the Crow Wing River, < 1.6 km west of the Camp Ripley boundary. A skeleton in a bedded position was all that remained of the other deer, which suggested death may have been due to either natural causes or wounding loss.

In addition to the 4 collared deer, 10 additional deer carcasses were found. Two were found off the study areas, 3 were on the NW site, and the remaining 5 were on the SW site. Seven of the deer were fawns. Causes of death ranged from undernutrition to predation; however, femurs were collected from 12 of the deer and mean marrow fat content was only 57.2 $\pm$ 8.7%.

Feeders

Supplemental food was provided in 9 feeders located in 3 fields just across the Camp Ripley boundary from the SW site. Each feeder was filled with 10 kg of whole corn every other day throughout the winter field season. Between 12 January 2001 and 26 March 2001, 2,977 kg (6,550 lbs) of corn were consumed. Typically, corn was consumed within 12 hours of being placed in the feeders, and there was sign of heavy deer use (trails and beds) within and near the fields containing the feeders. Landowners also supplied supplemental feed.

Snow-Urine and Fecal Collections

Three collections of snow-urine and fecal specimens occurred during winter 2000-01: 2-5 February, 26 February–1 March, and 15-17 March 2001. Each collection consisted of 45 snow-urine and 45 fecal samples from the SW site and 30 snow-urine and fecal pellet samples from the NW site. Laboratory analyses previously discussed are presently being conducted.

Table 1. Pairwise comparisons of habitat use by female white-tailed deer at the home range level (availability at the study area level) on the Southwest study site, Camp Ripley, Minnesota, winters 1998-99 and 1999-00. Home ranges were determined by minimum convex polygon method**.** {-- means significantly less use - means less use +++ means significantly more use + means more use }

Resource	Aspen	Oak	Hardwood	R. pine	J. pine	W. spruce	Tamarack	Grassland	Brushland	Agriculture	Development	Water	Marsh
Aspen		+	+++	+++	+	+++	+++	+	+++	+++	+++	+++	+++
Oak	-		+++	+++	+	+++	+++	-	+	+++	+++	+++	+++
Hardwood	--	--		-	--	+	+	--	--	+	+	+	+
R. pine	--	--	+		-	+++	+	--	-	+++	+++	+++	+++
J. pine	-	-	+++	+		+++	+++	-	+	+++	+++	+++	+++
W. spruce	--	--	-	--	--		-	--	--	+	-	-	+
Tamarack	--	--	-	-	--	+		--	--	+	+	+	+
+Grassland	-	+	+++	+++	+	+++	+++		+++	+++	+++	+++	+++
Brushland	--	-	+++	+	-	+++	+++	--		+++	+++	+++	+++
Agriculture	--	--	-	--	--	-	-	--	--		-	-	+
Development	--	--	-	--	--	+	-	--	--	+		+	+
Water	--	--	-	--	--	+	-	--	--	+	-		+
Marsh	--	--	-	--	--	-	-	--	--	-	-	-	

Table 2. Pairwise comparisons of habitat use by female white-tailed deer at the buffered (100 m) location level (availability at the home range level) on the Southwest study site, Camp Ripley, Minnesota, winters 1998-99 and 1999-00. Home ranges were determined by minimum convex polygon method**.**

{ -- means significantly less use - means less use +++ means significantly more use + means more use}

Resource	Aspen	Oak	Hardwood	R. pine	J. pine	W. spruce	Tamarack	Grassland	Brushland	Agriculture	Development	Water	Marsh
Aspen		-	-	+++	-	-	+	+	+	-	+	+++	+
Oak	+		+	+++	+	+++	+	+++	+++	+	+++	+++	+
Hardwood	+	-		+++	+	+	+	+	+++	+	+++	+++	+
R. pine	--	--	--		--	--	--	--	-	--	-	-	--
J. pine	+	-	-	+++		+	+	+	+	+	+	+++	+
W. spruce	+	--	-	+++	-		+	+++	+	+	+++	+++	+
Tamarack	-	-	-	+++	-	-		+	+++	-	+	+	+
Grassland	-	--	-	+++	-	--	-		+	--	+	+	+
Brushland	-	--	--	+	-	-	--	-		--	-	+	-
Agriculture	+	-	-	+++	-	-	+	+++	+++		+++	+++	+
Development	-	--	--	+	-	--	-	-	+	--		+	-
Water	--	--	-	+	--	--	-	-	-	--	-		-
Marsh	-	-	-	+++	-	-	-	-	+	-	+	+	

Table 3. Pairwise comparisons of habitat use by female white-tailed deer at the home range level (availability at the study area level) on the Northwest study site, Camp Ripley, Minnesota, winters 1998-99 and 1999-00. Home ranges were determined by minimum convex polygon method**.**

{ -- means significantly less use - means less use +++ means significantly more use + means more use}

Resource	Aspen	Oak	Hardwood	R. pine	J. pine	Grassland	Brushland	Agriculture	Development	Water	Marsh
Aspen		+++	+++	+	+	+++	+++	+++	+++	+++	+++
Oak	--		+	-	--	--	-	+	+	+	-
Hardwood	--	-		--	--	--	--	+	-	-	--
R. pine	-	+	+++		-	-	+	+++	+	+++	+
J. pine	-	+++	+++	+		-	+++	+++	+++	+++	+++
Grassland	--	+++	+++	+	+		+++	+++	+++	+++	+++
Brushland	--	+	+++	-	--	--		+++	+	+++	+
Agriculture	--	-	-	--	--	--	--		--	-	--
Development	--	-	+	-	--	--	-	+++		+	-
Water	--	-	+	--	--	--	--	+	-		--
Marsh	--	+	+++	-	--	--	-	+++	+	+++	

APPENDIX D: ODONATA AND AQUATIC MACROINVERTEBRATES OF THE TWIN CITIES ARMY AMMUNITION PLANT AREA

The Odonata and Aquatic Macroinvertebrates of the Twin Cities Army Ammunition Plant Area

February 2002

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Introduction:

Aquatic macroinvertebrates, such as insects, assimilate conditions that are present in the habitats (wetlands, ponds, lakes, streams) in which they live. There has been increasing attention to this group in baseline surveys in attempts to document unique or rare fauna. For example, the Odonata (dragonflies and damselflies) are an important group of aquatic macroinvertebrates that have received increasing attention over the past several years. Some reports have suggested that the diversity of odonates in wetlands is an indication of water quality (MNPCA, personal communication).

In this study, aquatic macroinvertebrates and adult Odonates were sampled for two years from sites located within the Twin Cities Army Ammunition Plant (TCAAP) to develop baseline data on these communities. This survey originated from previous studies conducted at Camp Ripley National Guard Training facility, where adult Odonates and aquatic macroinvertebrates were sampled to establish the presence of species on the training base (Montz and Hirsch 1996, 2000).

A number of sites within TCAAP have been identified as hazardous waste sites, with much of the contamination occurring in subsurface soils and groundwater. Many of these sites are upland areas and are undergoing major cleanup efforts. In addition, efforts to decontaminate groundwater have created a unique habitat on TCAAP. Contaminated groundwater is pumped up, treated and subsequently discharged into a lake in a gravel pit area, creating an aquatic habitat significantly different than the other lakes or wetlands on the study site.

Study Area:

The Twin Cities Army Ammunition Plant (TCAAP) is located north of St. Paul, Minnesota in Ramsey County (Figure 1). In the past, this area was used for production of military munitions. Several years ago, production was greatly reduced and negotiations resulted in much of the site being transferred to ownership of the Minnesota National Guard. The western portion of the site contains numerous buildings, storage areas, road and rail tracks. The eastern two thirds of the site is much less developed, with fewer buildings and primarily dirt

roads. A large wetland complex (Marsden Lake) occupies a significant portion of the eastern edge of TCAAP. A small creek (Rice Creek) enters the site in the northwest corner and flows part of its course along the northwestern corner of the site. Two other major permanent water bodies exist on the site. A natural lake, Sunfish Lake, is located in the southeastern corner. In the central part of TCAAP is a gravel pit that contains a lake. This unnamed water body is distinctly different from any of the other aquatic habitats on TCAAP. The water is groundwater, which is pumped up and decontaminated, then discharged into this area. The water is very clear, with extensive growth of Chara sp. throughout the water basin. The other aquatic habitats are more typical of lakes and wetlands in the metropolitan area.

Methods:

Aquatic macroinvertebrates were collected in 2000 - 2001 using d-frame kick nets in various areas of TCAAP. Samples were collected from Sunfish Lake, Marsden Lake, the gravel pit lake, and Rice Creek. Material collected was preserved in the field with ethanol, labeled and transported back to the laboratory. Macroinvertebrates were sorted from debris under 10x magnification with a dissecting microscope. Organisms were identified to the lowest practical taxon, with the exception of the midges (*Chironomidae*), which were left at the family level.

Adult dragonflies were collected over the two year period with hand nets in areas throughout the TCAAP. Adults were identified in the field, recorded and released. Specimens which could not be identified were preserved for 24 hours in acetone and brought back to the laboratory where they were dried and identified. Relative abundance of dragonflies was recorded during each collection trip. Several sites were visited on a regular basis to try and establish emergence and flight patterns for the dragonflies.

Results and Discussion:

A total of fifty-eight aquatic macroinvertebrate taxa were collected in kick net samples over the two seasons (Table 1). Marsden Lake had the lowest number of taxa collected (18) while the three other sites were comparable in numbers (25 - 27 taxa). However, sampling in Marsden Lake is extremely difficult due to the soft bottom and floating cattail mats. It is very likely that there are substantially more taxa associated with this wetland complex. For example, only one genus of Odonata was collected in the aquatic samples from the lake (*Sympetrum sp*.). However, more dragonfly species are reported from similar habitats, and it is likely that there are more Odonata taxa present in this large complex.

Few taxa were restricted to only one site. An exception was the filter-feeding caddisflies (*Hydropsychidae*), which were only collected in Rice Creek samples. This group spins capture nets to filter food from current. Their absence in the lakes sampled is not surprising, as they are seldom found in small lakes. One dragonfly species, the Midland Clubtail (*Gomphurus fraternus*) was also only collected in Rice Creek. The clubtail dragonflies are generally found in flowing waters, and the Midland Clubtail is reported as living in rivers and large lakes (Walker 1958). This dragonfly was collected emerging early in the season from the stream, indicating that the taxa had completed its life cycle in these waters, instead of migrating from a different water body.

Adult dragonflies were collected at several sites in TCAAP, including upland sites near Rice Creek, Sunfish Lake, Marsden Lake and the gravel pit area. Seventeen species of dragonflies were collected and identified (Table 2). Two species identifications are uncertain: Band-Winged Meadowhawk (*Sympetrum semicinctum*) and Red Saddlebags (*Tramea onusta*). The specimen identified as the Band-Winged Meadowhawk was damaged and the identification could not be confirmed, while the Red Saddlebags were spotted and observed flying and ovipositing at the gravel pit, but could not be collected. While the field identification of this species is relatively certain, it must still be considered as tentative.

Of the nineteen Odonata taxa collected or observed on TCAAP, four have not been previously collected from Ramsey County, according to the Minnesota Dragonfly Survey project

species range maps (Rith 1999). These are: Calico Pennant (*Celithemis elisa*), Wandering Glider (*Pantala flavescens*), Band-Winged Meadowhawk and Red Saddlebags. None of the taxa identified were new records for the state, and most are found throughout large areas of Minnesota.

Only the Midland Clubtail is reported as mainly inhabiting streams. The other taxa commonly complete their life cycles in lakes, wetlands or quiet waters. Rice Creek is the only permanent flowing water on TCAAP so it was not surprising to have only a single representative from the clubtails (*Gomphidae*), which are more common in flowing waters.

Four of the taxa collected are reported in the literature as being migratory in their life cycles. Green Darner (*Anax junius*), Wandering Glider, Black Saddlebags (*Tramea lacerata*) and Red Saddlebags all have been described as moving seasonally. The Green Darner adults are among the first of the mature dragonflies to appear in spring. These adults have been suggested to emerge and mature in warmer climates and move northward early in the season. These adults lay eggs, which hatch early in the summer. These nymphs become the adults, which are seen emerging in late summer or early fall. These late emergers are thought to move south to oviposit in warmer waters. A similar life cycle is reported for the Black Saddlebags. Mature adults can be seen early in the season ovipositing in suitable habitats. Late in the season, more adults emerge from these fast-growing nymphs. These later adults have been documented in the literature to migrate south in large groups. Collections of nymphs of this genus and observations of ovipositing adults in the gravel pit lake suggest that this water body is important in the successful life cycles of these dragonflies on TCAAP.

The highest diversity of adult dragonflies was collected in the area of the gravel pit, either along the lake shoreline, on the steep banks surrounding the pit or in the open areas surrounding this lake. This habitat is also very different from the other aquatic resources on TCAAP, or even in the land surrounding TCAAP. The water in the gravel pit lake is extremely clear, and supports extensive growth of Chara sp., suggesting a hard water marl type habitat. This land around the lake has been noted as an important habitat for the plains pocket mouse (Brunet 2001), suggesting that the gravel pit area is an important ecological habitat and needs protection. Problems with access prevented extensive sampling of the aquatic habitats in the lake, but it is

likely that more aquatic invertebrate species use this habitat for the aquatic stages of their life cycle.

Relative abundance and presence of dragonflies on TCAAP (Table 3) follows suggested emergence and life cycles reported in literature for many of the taxa. Early in summer (May) the fauna is very sparse, with the Green Darners the most numerous of adults. Other taxa such as the Dot-tailed Whiteface and Four-spotted skimmer are emerging, with teneral adults being found. Mid summer (June - July) has the largest diversity of adult dragonflies, with many species present in varying degrees of abundance. Late in the summer (late July - early August) the meadowhawks become common, with the second generation of Green Darners emerging. These emergence patterns and abundances are from two seasons of collection. During the 2000 season, abnormally low water levels may have altered the numbers and timing of some species. More adults and a higher diversity were collected during the following season, with more normal water levels.

Conclusions:

The aquatic invertebrate fauna collected in the TCAAP habitats were typical of small lakes and wetlands throughout this area of the state. None of the fauna collected in kick-net samples are considered rare or uncommon. The majority of habitats sampled (Sunfish Lake, Marsden Lake, Rice Creek) are fairly typical of surrounding areas, and the absence of unique fauna is not unexpected.

Most of the adult dragonflies collected were also fairly common in the state. No new records for Minnesota were found, although four taxa not previously listed from Ramsey County were documented. However, the two taxa of Saddlebags which were ovipositing and emerging from the gravel pit lake are somewhat uncommon in the state. Additionally, both the Wandering Glider and the Calico Pennant have been reported from only a few widely scattered counties in the state.

The unique habitat presented by the gravel pit lake and the surrounding area was the location of the highest diversity of dragonflies. From both newly emerged specimens collected around the lake and the observations of ovipositing adults, it appears that this area is important in

the life cycles of the dragonflies. More extensive sampling in the lake area could reveal a greater diversity of aquatic invertebrates. This area represents the highest diversity, and presents an aquatic habitat that is very uncommon throughout the metropolitan area. This lake area and surrounding area should be protected from disturbance as well as water quality or quantity changes. Of particular concern could be changes in the amount and type of water; if the quantity of groundwater is decreased, precipitation could change the chemistry and perhaps alter the habitat. This may have unintended negative consequences to the invertebrate fauna.

Lastly, periodic surveys concentrating on the gravel pit area may be important to continue documenting presence and changes in the dragonfly fauna. Such surveys could also involve more intensive work in the lake to further the data on the aquatic invertebrates, in addition to more concentrated efforts on the adult dragonfly fauna.

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Table 1. Aquatic macroinvertebrates collected in kick net samples from TCAAP in 2000 - 2001.

Taxa	**Site**			
	Sunfish L.	Marsden L.	Gravel Pit	Rice Creek
EPHEMEROPTERA				
Caenidae				
Caenis sp.	X	X	X	X
Baetidae				
Callibaetis sp.		X	X	X
Baetis sp.				X
TRICHOPTERA				
Leptoceridae				
Oecetis sp.	X	X		
Triaenodes tarda		X		
Triaenodes sp.	X	X		X
Hydroptilidae				
Stactobiella sp.		X	X	
Polycentropodidae				
Polycentropus sp.	X			
Hydropsychidae				
Cheumatopsyche sp.				X
Hydropsyche cuanis				X
Hydropsyche (C.) bronta				X
Hydropsyche (C.) sp.				X
Leptoceridae				
Nectopsyche sp.				X
Phryganeidae				
Agrypnia sp.			X	

Table 1. (continued)

Taxa	**Site**			
	Sunfish L.	Marsden L.	Gravel Pit	Rice Creek
COLEOPTERA				
Haliplidae				
Peltodytes sp.	X	X	X	X
Haliplus sp.	X	X	X	
Hydrophilidae				
Enochrus sp.			X	
Berosus sp.	X			
Dytiscidae				
Laccophilus sp.	X			
Coptotomus sp.			X	
Agabus sp.				X
Agabetes sp.				X
Uvarus sp.				X
Neoporus sp.			X	
Scirtidae				
Scirtes sp.				X
ODONATA				
Libellulidae				
Sympetrum sp.		X	X	
Leucorrhinia sp.	X			
Libellula sp.	X			
Tramea sp.			X	
Corduliidae				
Epitheca sp.	X			
Aeshnidae				
Anax junius			X	
Coenagrionidae			X	X

Table 1. (continued)

Taxa	**Site**			
	Sunfish L.	Marsden L.	Gravel Pit	Rice Creek
ODONATA (continued)				
Enallagma sp.	X		X	
Ischnura sp.	X			X
Coenagrion sp.	X			
HETEROPTERA				
Corixidae				
Sigara sp.		X		
Cenocorixa sp.			X	
Hesperocorixa? sp.			X	
Notonectidae				
Buenoa sp.		X		
Pleidae				
Neoplea striola	X	X		X
DIPTERA				
Chironomidae	X	X	X	X
Ceratopogonidae	X		X	X
Bezzia/Palpomyia sp.	X		X	
Simulium sp.				X
Tipulidae				
Prionocera sp.				X
Stratiomyidae				
Odontomyia sp.				X

Table 1. (continued)

Taxa	**Site**			
	Sunfish L.	Marsden L.	Gravel Pit	Rice Creek
Non Insect taxa				
CRUSTACEA				
Hyalella azteca	X	X	X	X
Crangonyx sp.	X			X
Asellus sp.		X		X
MOLLUSCA				
Sphaeriidae	X	X	X	X
Gastropoda				
Physa sp.	X	X	X	X
Helisoma sp.		X	X	X
Feressia sp.	X			
Gyraulus sp	X			
Gyraulus crista?	X			
Lymnaea sp.			X	
Stagnicola sp.			X	
OLIGOCHAETA				
Hirudinea	X	X	X	

Table 2. Adult dragonflies collected on TCAAP during 2000 - 2001.

Taxa	**Common name**
Aeshnidae	
Anax junius	Green darner
Gomphidae	
Gomphurus fraternus	Midland clubtail
Libellulidae	
Celithemis elisa	Calico pennant
Celithemis eponina	Halloween pennant
Erythemis simplicicollis	Eastern pondhawk
Leucorrhinia intacta	Dot-tailed whiteface
Libellula luctuosa	Widow skimmer
Libellula pulchella	Twelve-spotted skimmer
Libellula quadrimaculata	Four-spotted skimmer
Pantala flavescens	Wandering glider
Perithemis tenera	Eastern amberwing
Plathemis lydia	Common whitetail
Sympetrum corruptum	Variegated meadowhawk
Sympetrum costiferum	Saffron-bordered meadowhawk
Sympetrum obtrusum	White-faced meadowhawk
Sympetrum vicinum	Yellow-legged meadowhawk
? Sympetrum semicinctum++	? Band-winged meadowhawk++
Tramea lacerata	Black saddlebags
? Tramea onusta**	? Red saddlebags**

? - Uncertain identification

++ - specimen in poor condition.

** - adults spotted and observed ovipositing in gravel pit, but not collected.

Table 3. Presence and relative abundance through summer for selected adult dragonflies collected on TCAAP 2000 - 2001

(x - few; + - present; * - common/abundant)

Taxa	**May**	**June**	**July**	**August**
Green Darner	xx **	xx	** ++	x
Twelve-spotted skimmer	++	**	++ xx	x
Four-spotted skimmer	xx	++ **	++	
Common Whitetail		++ **	+	
Widow Skimmer		++	** ++	xx
Eastern Pondhawk		x ++		
Halloween Pennant		++	*** +	+
Calico Pennant		+	*	
Dot-tailed Whiteface	x ++	++ **	** +	
Red Saddlebags		+	++	
Black Saddlebags			++ **	+++
White-faced Meadowhawk			+ **	++ x
Variegated Meadowhawk			++++	xx
Midland Clubtail	xx	++		

Figure 1. Twin Cities Army Ammunition Plant (TCAAP) sample sites for aquatic invertebrate and adult dragonfly collections, 2000-2001.