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WHITETAIL DEER RESEARCH

PROGRESS REPORT

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JOB PROGRESS REPORT

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SUBPROJECT NO.:	2	TITLE:	Research and Technical Services
STUDY:	BG-1	TITLE:	Deer
JOB NO.:	10	TITLE:	Population Ecology of White-tailed Deer in Northwestern Montana

Period Covered: July 1, 1992 - June 30, 1994

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Harvey Nyberg

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ABSTRACT

A study to investigate the population ecology and habitat relationships of white-tailed deer (*Odocoileus virginianus*) in the coniferous ecosystems of northwestern Montana began in January, 1988 and continued through the fiscal year ending 30 June, 1994. The study area includes portions of the Tally Lake Ranger District (Flathead National Forest), the Fortine Ranger District (Kootenai National Forest), and adjacent state and private lands. Objectives of the study are to describe habitats used by white-tailed deer, develop population census techniques, and investigate the effects of various hunting season regulations on population parameters. During the report period, a PhD graduate study investigating the ecology and summer habitat use patterns was completed. The dissertation abstract and management recommendations are included as an addendum to this report.

Whitetails were trapped on 2 core winter ranges where populations were censused using pellet surveys and remote camera mark-resight surveys. On the Bowser-Tally unit (Flathead National Forest) which occurs within Hunting District (HD) 102, the maximum and minimum population estimates (either method) were 6,540 and 1,142 deer, respectively. In the Murphy-Dickey unit (Kootenai National Forest) which occurs within HD 101, the maximum and minimum population estimates (pellet survey method) were 2,645 and 1,763 deer. Hunter check stations were also used to gather information on population age structure.

Since the inception of this project, the deer rifle hunting regulation for both HD's has been 2 weeks either sex, either deer species hunting followed by 3 weeks of antlered buck only hunting. A harvest regime increasing the number of antlerless deer harvested in HD 102 was implemented in 1991. Six to 700 "B" permits or licenses were issued through a special drawing, enabling permit holders to harvest an antlerless whitetail at any time during the rifle season.

To test hypotheses regarding the effects of increased antlerless harvest on various population parameters for deer in HD 102, HD 101 was used as a control. Annual survival of adult females did not differ over the 3 year period prior to 1991, nor were there differences between areas among other population variables. Total whitetail harvest in HD 102 increased 33% and total hunter numbers increased 22% over the years 1991, 92, and 93. The number of antlerless whitetails taken on B-permits averaged 272 over three years. B-permit hunters in HD 102 enjoyed an average of 43% success in filling their tags. In HD 101, total harvest increased 7% while hunter numbers increased 5%. The apparent survival of radio-collared females in HD 102 was not altered by the issuance of B-permits. Female survival in HD 102 prior to 1991 was 0.87 and survival in 1991 and subsequent years was 0.88. Survival in HD 101 prior to 1991 was 0.80 and survival in 1991 and subsequent years was 0.86. Numbers of antlerless whitetails harvested by hunters through B-permits are probably insignificant relative to total population size in HD 102. Male survival in HD 102 prior to 1991 was not significantly different from survival during subsequent years in which 6-700 B-permit hunters were afield.

ACKNOWLEDGMENTS

The research effort during this report period required the assistance and cooperation of numerous individuals. Between July 1992 and April 1994, the project leader/biologist position was officially vacant. However, during the vacancy, Gary Dusek (previously in the position) assisted with data collection and helped assure a smooth transition of personnel by his willingness to discuss the project and to share additional related information concerning white-tailed deer research and management in Montana. Other Department of Fish, Wildlife and Parks personnel also assisted during the vacancy and transition. During the latter part of the vacancy, John Morgan (a graduate student affiliated with the project) served as project biologist and collected much of the data which are presented in this report. His dedication and commitment to the project are gratefully acknowledged. Personnel from the U.S. Forest Service and Montana State University have assisted during field work and made valid contributions to this project. Additional funding for field work was provided by the Flathead National Forest, Tally Lake District, and the Kootenai National Forest, Murphy Lake Ranger Station. Special thanks are also extended to the volunteers who have helped with field work and especially to Leonard Howke, for his dedicated participation and continued interest. Our gratitude also is extended to private landowners who have granted access to their property.

JOB OBJECTIVES:

To develop techniques for estimating population parameters, to determine basic biological and ecological parameters for white-tailed deer in coniferous forests of northwestern Montana and to relate those parameters to characteristics of individual habitats and potentially limiting factors, including:

- a) physical and biological characteristics of individual habitats;
- b) interactions between changing environmental conditions and population characteristics; and,
- c) hunting, land use practices, and other human-related factors.

INTRODUCTION

This study was initiated during January 1988 as a 10-year project to investigate the population ecology and habitat relationships of white-tailed deer in the coniferous ecosystems of northwestern Montana, administratively known as Montana Fish, Wildlife and Parks (MFWP) Region 1. Northwest Montana is characterized by intensively managed timber resources and relatively high road densities. White-tailed deer are the most abundant and widely distributed big game species in Region 1 accounting for about 73% of the Region's total annual deer harvest (Dusek 1989). Current perception holds that whitetail numbers in northwestern Montana have steadily increased over the past 16 years. Trend in annual harvest of antlered deer (Fig. 1) supports that hypothesis. The increases have also occurred concomitant with a relatively conservative harvest regime for antlerless deer that resulted in proportionately fewer antlerless deer harvested since 1975 (Fig. 1). Additionally, total antlered white-tailed deer harvest has steadily increased while hunter days (effort) per whitetail harvested has steadily declined (Fig. 2). Although a series of mild winters and subtle habitat changes associated with past forest management practices are most commonly credited for the increases, causes have not been directly or empirically determined.

Harvest management for deer has been largely predicated on the concept of a "shootable surplus", and as most often applied, assumes that deer populations are inherently irruptive and limited by winter forage (Mackie et al. 1990). The concept also assumes that winter carrying capacity (K) is stable and that removal of a "harvestable surplus" increases per capita forage availability, thereby increasing survivability of remaining individuals over winter in a compensatory manner. While acknowledging the potential for density-dependent phenomena to occur, experimental evidence suggests that broad application of the concept may not be the most pragmatic approach to management (Mackie et al. 1990). Experimental evidence suggested hunting-related mortality was additive to natural mortality among adult female deer in some eastern Montana populations (Dusek et al. 1989, Dusek et al. 1992).

Figure 1. Northwest Montana (Region 1) white-tailed deer harvest, 1960-93. Bars represent antlered buck harvest and line represents antlerless harvest expressed as a percent of the buck harvest.

■ HUNTER DAYS/WTD HARV ■ ANTLERED HARVEST

Figure 2. Northwest Montana (Regions 1 and 2) antlered white-tailed deer harvest, 1972-1993, and total deer hunting effort per antlered white-tailed deer taken.

Determining population response to hunter harvest strategies is one primary goal of this project (Dusek 1989). Design of this research project lends itself to addressing these questions by using a portion of the area as a control in which antlerless deer are harvested to a lesser extent than in the treatment area; both areas are simultaneously subjected to the same environmental variables. Manipulative studies involving perturbations of the system with both temporal and spatial controls offer a rigorous approach to determining cause and effect relationships (White and Garrott 1990).

A harvest regime doubling the current number of antlerless deer harvested in one of 2 hunting districts was implemented in 1991 to test hypotheses regarding the effects of increased antlerless harvest on populations of white-tailed deer in northwestern Montana. Control and treatment areas include Hunting Districts (HD's) 101 and 102, respectively. Each appears to represent a discrete herd unit in the Salish Range but yet similar in climate, topography, vegetation, and land use. Harvest regulations in HD 101, the control area, remained unchanged. In hunting District 102, the doubling of antlerless harvest levels was attempted by issuing antlerless B-permits through a drawing. Harvest regulations have been the same in both units over the past 3 years. Annual survival of adult females did not differ over a 3-year period prior to the initiation of B-permit hunting, although the sample of radio-collared deer in HD 101 was rather small (Dusek 1991). However, significant differences were not observed between areas among other population variables examined.

The purpose of this experimental design is to develop harvest management guidelines for white-tailed deer in northwest Montana. Objectives associated with this goal are: (1) to monitor natural mortality rates and contrast them between populations with high and low harvest rates of antlerless deer; (2) to monitor the effects of harvest manipulation on population trend, structure, condition, and productivity; and, (3) to monitor mortality of antlered bucks and effects of antlerless regulations on trend in buck harvest. Another goal of this project is to describe the habitats used by white-tailed deer. To that end, a PhD graduate study was undertaken in 1989 to investigate whitetail activity patterns while deer occupied summer and transitional ranges. This study was completed during the report period and the dissertation abstract and management recommendations are included in this report (Morgan 1993).

STUDY AREA

Study areas include portions of the Tally Lake Ranger District on the Flathead National Forest (FNF), the Fortine Ranger District on the Kootenai National Forest (KNF), and the surrounding Department of State Lands (DSL) holdings and private lands in the Salish Mountains (Fig. 3). The study areas have been described previously (Dusek 1989, Dusek and Morgan 1990, Morgan 1993). Included are portions of the Salish Range drained by the Stillwater and Tobacco rivers encompassing deer HD's 101, 102, and a portion of 110. HD 102 is largely encompassed by the Tally Lake Ranger District. HD's 101 and 110 occur on the Fortine Ranger District.

Figure 3. The Salish Mountains study areas including the Bowser-Tally Lakes winter range (BTWR) and Murphy-Dickey Lakes winter range (MDWR).

Based on previous research on white-tailed deer in the Salish Mountains (Mundinger and Riley 1982) and on preliminary results of this study (Dusek and Morgan 1991), two discrete herd units were recognized. The southern herd unit occupies Kuhn's Wildlife Management Area (MFWP), Stillwater State Forest (DSL), and the eastern boundary of the Tally Lake District during the winter. Deer from this winter range typically migrate north and northwest to summer in the Star Meadows area and the Good Creek drainage. This winter range and herd segment will be referred to as the Bowser-Tally winter range (BTWR) unit. The yearlong distribution of radio-collared individuals in this herd unit is encompassed by HD 102. The northern herd unit winters in the vicinity of Murphy and Dickey lakes and summers to the west in the Fortine and Swamp creek drainages. This winter range and herd segment will be referred to as the Murphy-Dickey lakes winter range (MDWR) unit. The yearlong distribution of radio-collared individuals from this herd unit is encompassed by HD 101 primarily. Lower Sunday Creek and upper Martin Creek may be occupied in the summer by individuals from either winter range.

Timbered lands in the Tally Lake and Fortine ranger districts are predominantly second growth forest and are intensively managed for timber production. Habitat description followed Pfister et al. (1977). Winter ranges include comparatively dry sites below 1,100 m in elevation occupied by the *Pseudotsuga menziesii*/*Symphoricarpos albus* h.t. Summer ranges primarily include lower subalpine habitat types of the *Abies lasiocarpa* series with the *P.m./Calamagrostis rubescens* h.t. occupying drier, southerly exposures. Many of the upper drainages of the Salish Range are occupied by a *Pinus contorta/Xerophyllum tenax* c.t. Riparian sites include streams with yearlong surface flow and mesic sites such as seeps, sloughs, or potholes which are distributed in the uplands. Summer range habitats on the Tally Lake District were described in greater detail by Morgan (1993).

METHODS

All trapping was facilitated with Clover traps (Clover 1954). Capture and handling procedures, as described previously (Dusek 1989), included assigning an age, obtaining a blood sample, and measuring heart girth of each captured deer. Blood was not collected regularly during this report period. Maintaining samples of radio-collared deer emphasized equipping with transmitters those animals of known age rather than assigned age based on tooth eruption and wear. For example, most female deer equipped with radio collars since winter 1991 were fawns or yearlings or were older, recaptured deer which were initially marked as fawns or yearlings during previous years. Adult deer with assigned ages were typically fitted with a neck band allowing individual identification. Because capture rate of males ≥ 1 year of age tended to be lower than females, most captured bucks were fitted with transmitters. The greatest trapping efforts were expended during winters; however, during the summer of 1993, trapping also was conducted on the summer range of the BTWR herd unit.

Remote camera surveys, employing cameras with passive infrared (PIR) or motion sensors, were conducted during the report period, as previously described (Dusek and Morgan 1990). Deployment of these self-activating cameras permitted the evaluation of population parameters

and spatial distribution of white-tailed deer. This technique also permits the collection of such data throughout the diel period under all weather conditions and in an environment with poor deer observability in closed canopy forest.

Procedures for summarizing and analyzing data from camera surveys were previously described by Dusek and Morgan (1990) and Dusek and Mace (1991). Level of significance was $p \leq 0.05$. Data from late winter camera surveys were used to estimate numbers of deer on the respective winter ranges using a capture-resight technique based on a Monte Carlo simulation (Minta and Mangel 1989). A maximum likelihood estimate (MLE) and 95% likelihood interval were derived from 10,000 iterations of the Monte Carlo simulation. The sample of marked deer used to calculate the MLE included all radio-collared deer using the area, all neckbanded deer captured within the area just prior to the survey, excluding known mortalities, and neckbanded deer captured during previous years known by reobservation or recapture to have survived. The model requires identification of marked individuals and assumed equal observability among individuals. The model also requires demographic and geographic closure of the population. The minimum number of marked deer in the survey area was determined by monitoring distribution of radio-collared deer, and visual sightings of neckbanded deer from snowmobile routes and camera sessions.

During 1992, remote camera surveys were conducted on both the Bowser-Tally and Murphy-Dickey lakes winter ranges. However, the closure assumption of the model was violated because the surveys were conducted late enough in a mild winter that radio-marked deer began moving off winter range during the survey. Therefore, population estimates were not calculated. During the winter of 1993, a camera survey was conducted on BTWR only. The survey met all assumptions of the model and population estimates were calculated. During the winter of 1994, camera surveys were conducted on both BTWR and MDWR. The BTWR survey met all assumptions of the model and population estimates were calculated. However, deer began leaving the MDWR during the camera survey. A population estimate was calculated though it was considered inaccurate.

During the report period, fixed-wing aerial surveys were conducted during all months to locate radio-collared deer to determine seasonal distribution, migration routes, and timing of migration. Intensive monitoring of radio-collared deer to determine diel patterns was conducted during summers 1989, 1990, and 1991. The results were presented by Morgan (1993).

During the 1991, 1992, and 1993 general big game hunting seasons, harvested whitetails were examined at a check station to determine condition and harvest composition by sex and age. The same location (near the town of Olney) was used during the entire report period. Assignment of age was based on tooth replacement and wear for all deer (Severinghaus 1949) and with counts of cementum annuli (Gilbert 1966) from a middle incisor extracted from those assigned ages ≥ 2 years (Matson's Lab, Milltown, MT). Diastema length was measured on all deer, and antler measurements, including length and diameter of the main beam and number of points,

were taken from all males of ages ≥ 1 year. As time permitted, some deer carcasses were weighed. Results of the statewide Annual Game Harvest Survey provided additional information regarding hunter effort and the harvest of deer in HD's 101, 102, and 110.

Hunting regulations since the inception of this project have not changed. Either sex, either species of deer could be harvested on the general deer "A" license during the first 2 weeks of the 5 week general rifle season. During the remaining three weeks, only antlered bucks of either deer species could be legally harvested using the general "A" license. These regulations were the same for the 3 hunting districts which overlap the project study area.

However, beginning with the 1991 hunting season, special antlerless "B" licenses or permits were issued for HD 102 through the special licensing process. These special licenses were valid for antlerless whitetails only and could be filled at any time during the 5 week general rifle season. In 1991 and 1992, 600 permits were issued. In 1993 and 1994, 700 permits were issued.

All B license holders were mailed a letter requesting that, if successful, half of the lower jaw (with a tag indicating sex, location of kill etc...) be deposited in barrels located in the parking lot of the MFWP Kalispell Regional Office. Periodically, the barrel would be emptied and ages would be assigned according to the criteria outlined above. Alternatively, successful hunters could drop off jaws at any Regional check station.

Spring pellet group transects were conducted on the core winter ranges (BTWR and MDWR) as previously described (Dusek 1989, Dusek and Morgan 1990) using the rationale of Longhurst and Connolly (1982) and the analytical procedures of Davis (1982). Sampling intensity was maintained at 50 1-milliacre circular plots per transect for a desired level of precision (Dusek and Morgan 1990). Individual transects were placed within 14 randomly selected 1-km² quadrats for a total of 700 sampled plots. Pellet transects were conducted as soon as radio-marked deer had left the winter ranges and snow melt was complete. During the springs of 1992, 1993, and 1994, transects were conducted on both BTWR and MDWR.

Estimates of the probability of survival among radio-collared females of ages ≥ 1 year and males ≥ 2 years followed Heisey and Fuller (1985) using the software MICROMORT. Eleven intervals, as previously described (Dusek and Morgan 1990), were used during which the probability of daily survival was assumed constant throughout each period. A χ^2 statistic was used to test survivorship for homogeneity among classes of deer and between study areas (Sauer and Williams 1989) based on sex, age and study area. Additionally, survivorship of antlerless (≥ 1 year old does) before and after the issuance of B-tags in HD 102 was compared. Multiple comparisons using a Chi-square statistic and individual comparisons using a Z-test (Heisey and Fuller 1985, Nelson and Mech 1986, Sauer and Williams 1989) were employed when the Chi-square test for homogeneity resulted in a significant difference.

MICROMORT also determines probabilities of death attributable to various mortality sources as defined by the user. Categories used in this study are defined below. Natural mortalities are those attributable to predation, accidents such as drowning, malnutrition etc... Road/train mortalities are those attributable to deer collisions with vehicle traffic on roads or trains on railroad tracks. Harvest mortalities are those attributable to legal harvest, illegal harvest, or crippling loss. Unknown mortalities are those mortalities for which death was confirmed although the circumstances or field evidence prevented a confident attribution to a particular source.

RESULTS AND DISCUSSION

Trapping

In 1992, 119 white-tailed deer were caught on BTWR, of which 75 were marked with either a radio transmitter or a neck band. On MDWR, 70 whitetails were caught and 56 were marked. No trapping mortalities were recorded for either winter range. Blood samples were collected from most deer. However, screening results were not available at the time this report was prepared. Heart girth measurements were recorded for all deer. Figure 4 presents the age composition, pooled by hunting district, for all captured whitetails between 1989 and 1994.

In 1993, 101 whitetails were caught on BTWR and 66 were marked. Additionally, 14 whitetails were trapped on summer range used by the BTWR herd unit. Nine mortalities were recorded during the winter trapping season. Domestic dogs were thought responsible in all cases, as they were observed in the area numerous times and were also photographed numerous times during the camera surveys. Although coyotes have also been observed in this study area, they have not been known previously to harass trapped deer during this study. On MDWR, 70 deer were trapped and 59 were marked. There were no mortalities while trapping MDWR in 1993. No blood samples were collected; however, heart girth measurements were taken. The nine mortalities on the BTWR represented 4.8% of all captures in 1993, including those deer trapped on summer range.

In 1994, 92 deer were trapped on BTWR and 63 were marked. There were no mortalities. Fifty three deer were trapped on MDWR and 44 were marked. One mortality was recorded on MDWR, resulting from trap related injuries. As in 1993, no blood samples were collected, but heart girth measurements were recorded.

Since the initiation of the project, a total of 924 deer have been marked on the two study areas, 47 of which were trapped on summer ranges. Tables 1 and 2 summarize to date the timing and results of project trapping efforts on the two core winter ranges. The results of summer trapping efforts were omitted from the tables because of intermittent effort and dispersed trap sites. The difference between the total number of deer captured and total deer marked results from previously marked deer which were subsequently recaptured.

Figure 4. Age composition of captured whitetails pooled by sex in Hunting Districts 101 and 102, 1988-94. Hunting District 102 encompasses the Bowser-Tally herd unit and Hunting District 101 encompasses the Murphy-Dickey herd unit.

Table 1. Efficiency of Clover traps for capturing white-tailed deer on Bowser-Tally Lake winter range, 1988-1994.

Month	Year	Total trap nights	Total captures	Total deer marked	Total captures/trap night
December	1988	100	41	30	0.41
January	1988	---	---	11	---
	1989	152	53	41	0.35
	1990	215	71	55	0.33
	1991	105	51	43	0.49
	1992	114	69	46	0.61
	1993	144	75	45	0.52
	1994	161	53	39	0.33
February	1988	---	---	22	---
	1989	129	65	49	0.50
	1990	125	49	42	0.39
	1991	154	70	47	0.45
	1992	109	50	29	0.46
	1993	52	26	21	0.50
	1994	67	39	24	0.58
March	1988	---	---	3	---
	1989	42	19	13	0.45
Total all years ² :		1669	731	524	0.44

¹ Value unknown.

² Totals do not include values from 1988 for which total trap nights was unknown.

During the winters of 1992, 1993, and 1994, a total of 312 white-tailed deer were trapped on BTWR and 193 deer were trapped on MDWR (Tables 1 and 2). In general, the goal has been to maintain a sample of radio-collared deer in the BTWR unit of 55-70 and a sample of 30-35 collared deer in the MDWR unit. Overall trapping efficiency for all years on BTWR was not significantly different from efficiency on MDWR ($p = 0.13$), although there was variation from month to month and from year to year. This variation could result from varying winter snow conditions from month to month and from varying winter severity from year to year. Additionally, as some individual sites have been trapped in sequential years, white-tailed deer may be responding behaviorally, thus avoiding trapping sites.

Table 2. Efficiency of Clover traps for capturing white-tailed deer on Murphy-Dickey lakes winter range, 1988-94.

Month	Year	Total trap nights	Total captures	Total deer marked	Total captures/trap night
January	1989	70	27	23	0.39
	1990	45	20	17	0.44
	1991	72	60	49	0.83
	1992	104	57	46	0.55
	1994	119	35	29	0.29
February	1988	---	---	17	---
	1989	42	22	19	0.52
	1990	44	32	28	0.73
	1992	32	13	10	0.41
	1993	87	70	59	0.80
	1994	45	18	14	0.40
March	1988	---	---	5	---
Total all years ² :		660	354	295	0.54

¹ Value unknown.

² Totals do not include values from 1988 for which total trap nights are unknown.

Camera Surveys

The 1993 camera survey at BTWR yielded 619 exposures of white-tailed deer. Additionally, domestic dogs, mule deer (*O. hemionus*), mountain lion (*Felis concolor*), and coyote (*Canis latrans*) were photographed. A total of 567 individual deer-visits was estimated (Table 3). Though total deer-visits do not necessarily equal total individuals photographed during an individual survey, a low frequency of re-visitation by individually marked deer suggested most deer were photographed only once during a survey. During this 21-day survey, 2 individually marked deer were photographed twice, whereas 36 marked individuals were photographed only once and 81 marked individuals thought to be in the survey area were not detected by the remote camera system. Approximately 7% (n=40) of the photographed deer were individually marked. The Monte Carlo simulation yielded a MLE of 1,703 deer (95% C.I. 1,577 - 1,812) (Fig. 5).

Table 3. Summary of remote camera survey results for white-tailed deer (WTD) occupying the Bowser and Murphy-Dickey Lakes winter ranges during winters 1993 and 1994.

	SURVEY		
	Bowser-Tally 1993	Bowser-Tally 1994	Murphy-Dickey 1994
Dates operated	2-17 to 3-9	2-11 to 2-25	3-1 to 3-17
No. stations (functional)	20	19	10
No. camera days	339	261	149
No. frames with WTD	619	478	63
No. frames with other wildlife	4	2	5
No. frames with humans or pets	3	4	0
No. WTD ¹	664	555	72
No. individual WTD	567	486	68
No. classified	547	432	66
Fawn : adult ratio	208:339 (61%)	127:305 (42%)	13:53 (25%)
No. WTD marked	40 (7.1%)	48 (9.9%)	7 (10.2%)
Mean no. WTD visits per camera per day	1.67	1.90	0.46
No. deer visits in daylight	430 (67%)	277 (57%)	47 (69%)
No. deer visits in darkness	196 (33%)	207 (43%)	21 (31%)

¹ All frames with deer including duplicate frames of some individual(s).

The 1994 camera survey at BTWR resulted in 478 exposures of white-tailed deer. Other species identified included domestic dogs and coyotes. A total of 486 individual deer visits was estimated. During this 14-day survey, one marked deer was photographed three times, 7 deer were photographed twice, and 29 deer were photographed once. One hundred eight other marked deer believed to be on the winter range were not photographed during this survey. Marked deer accounted for approximately 10% (n=48) of all deer photographed. The Monte Carlo simulation yielded a MLE of 1,142 (95% C.I. 1,040 - 1,237) deer (Fig. 5).

Figure 5. Maximum likelihood estimates (MLE) for the Bowser-Tally Lakes winter range with 95% likelihood intervals, 1990 - 1994.

The 1994 camera survey at MDWR resulted in 63 exposures containing white-tailed deer. Other species photographed included mule deer, mountain lion, and bobcat. Sixty eight individual deer visits were estimated during the 15-day survey. One marked deer was photographed twice, 5 were photographed once, and 53 marked deer were not detected by the remote cameras. Marked deer accounted for approximately 10% ($n=7$) of all deer photographed during this survey. The Monte Carlo simulation yielded a MLE of 532 (95% C.I. 412 - 669) deer. As assumptions of the model were not met during this survey, the MLE of 532 likely underestimates the true population number since so few deer were photographed.

System check exposures and those from unknown causes accounted for a certain percentage of all exposures. The precise number was unavailable at the time this report was prepared because only those negative frames containing animals were actually printed to identify the subject. I have not gone back to examine the negatives. Most exposures caused by unknown variables presumably resulted from animals moving out of the field of view during the time lapse between detection by the sensor and shutter release. Some may have been triggered by environmental conditions including precipitation, wind, and a rapid change in direct sunlight (Mace et al. 1990), although effects of these conditions appeared minimal during winter.

Efficiency of the system for photographing deer on winter ranges during this report period was similar to that reported for previous years for BTWR (Dusek and Morgan 1990, 1991). No significant differences were found in the mean number of deer visits/day between the years 1990, 1991, 1993, and 1994 ($p = 0.24$). However, significant differences were found for the 1990, 1991, and 1994 surveys on MDWR ($p = 0.0001$). This could be accounted for by the smaller sample size of photographed deer during the 1994 survey (1994 $n = 68$; 1991 $n = 192$; 1990 $n = 183$). Due to the mildness of the winter, only 71% of radio-marked individuals moved to winter range while the remaining deer stayed on summer or transitional range. It was plausible that unmarked deer were similarly influenced by the mild winter conditions. Thus fewer deer may have been on the winter range and within the camera survey area. The mean number of deer visits for the 1990 MDWR survey was similar to the 1991 MDWR survey, whereas the mean number of deer visits during the 1994 survey was lower.

The number of deer visiting camera sites per day over the duration of the survey decreased with time from the beginning of a session (Fig. 6). During all surveys in 1993 and 1994, the number of deer visits was negatively correlated with the number of days since the beginning of the surveys (BTWR 1993 $r = -0.68$; BTWR 1994 $r = -0.76$; MDWR 1994 $r = -0.66$). Chi-square analysis confirmed the decline, resulting in significant differences for all camera surveys in 1993 and 1994 (BTWR 1993 $p = 0.005$; BTWR 1994 $p < 0.00$; MDWR 1994 $p = 0.001$).

Figure 6. Trend in deer-visits per day during late winter camera surveys on Bowser-Tally Lakes winter range, 1990-1994.

This trend was similar to that observed in previous years (Dusek and Morgan 1991). The decline was most pronounced during the first 1-3 days after camera deployment. Thereafter, the decline was not as sharp. Deer may have responded behaviorally to camera noise, flash, etc... by using alternate trails during subsequent daily travel through the camera site. This hypothesis was substantiated by the fact that few individually marked deer were photographed more than once and that baiting camera stations with anise oil (an aromatic attractant) did not alter the downward trend (Dusek and Morgan 1991).

The downward trend could be influenced by whether deer had begun their migration to summer range prior to the conclusion of the survey. The radio-marked deer were present throughout the camera surveys. However, if some unmarked deer left the winter range prior to the radio-marked deer, fewer deer may have been present and detected by remote cameras.

This trend may also be influenced by the elapsed time between when all film was exposed in a particular camera and when the camera was checked and film re-loaded by research personnel. Days when a camera was not functioning properly and recording wildlife visits were not included in the calculations of visits/day. Fewer operative cameras may have led to a decreased rate of visitation at camera stations, particularly if cameras in which all film was exposed prior to a visit by research personnel malfunctioned (exposing all film immediately) or if the camera was placed along a heavily used deer trail. If the elapsed time between 100% film exposure and inspection by research personnel was a factor in this trend, the converse would also be expected: the number of visits/day would increase just after the cameras were checked by research personnel and film was changed. This phenomenon was only observed intermittently. During the 1993 BTWR survey, deer visits/day did increase after the camera stations were inspected by research personnel; however, the increase lagged behind two days and the increase was not substantial. During the 1994 BTWR survey, deer visits/day increased after the first inspection; however, the next two inspections were not followed by an increase as deer visits/day continued to decline. During the 1994 MDWR survey, the change in the number of deer visits/day was erratic, apparently without being strongly influenced by the timing of camera inspection by research personnel.

During previous years, a camera survey was conducted on BTWR in mid- to late December to examine buck:doe ratios and to assist in the determination of the arrival date of deer onto the winter range. A decreased proportion of deer photographed at night during the mid-December survey compared to February or March surveys was noted during the 1989-90 surveys, suggesting a transition from daily activity rhythms balanced between diurnal and nocturnal periods in early winter to a strongly diurnal rhythm by late winter. Although no surveys were conducted during the month of December for the 1992-93 or 1993-94 winters, respectively, the surveys conducted during January, February, and March did indicate a similarly strong diurnal activity pattern. Similar to previous years, the greatest proportion of photo exposures of white-tailed deer during the 1993 and 1994 (February and March) surveys were obtained during daylight hours.

During the 1993 BTWR survey, 67% of whitetail photographs were taken during daylight (Table 3). Mean number of deer visits/camera/day during daylight was compared to mean number of deer visits/camera/day during darkness over the duration of the survey using a paired *t*-test. Mean number of visits during daylight was significantly greater than mean number of visits during darkness ($p < 0.00$). During the 1994 BTWR survey, 57% of the whitetail photographs were taken during daylight (Table 3). As above, mean number of deer visits/camera/day during daylight was compared to mean number of deer visits/camera/day during darkness over the duration of the survey. The mean number of visits during daylight was again significantly greater than mean number of visits during darkness ($p = 0.01$). During the 1994 MDWR survey, 69% of the whitetail photographs were taken during daylight (Table 3). A similar paired *t*-test indicated that the means were not significantly different. As discussed above, few deer were photographed during this survey relative to previous years.

Distribution and Movements

The yearlong distribution and movement patterns of the radio-collared sample of white-tailed deer during the report period were similar to previous years, as described by (Mundinger and Riley 1982, 1983; Dusek and Morgan 1991; and Morgan 1993). For deer associated with BTWR, major areas of concentration during late spring through autumn included both Good Creek and Star Meadows in the Tally Lake District. However, each year a few radio-collared individuals have either remained in the vicinity of the winter range year-long or moved north along the Stillwater River during non-winter periods.

As during previous years, most deer associated with MDWR occupied the Fortine Creek drainage including second and third order drainages during April-November. The meadow area at the confluence of Swamp and Lake Creeks was a major concentration area during late May. These movement and distribution patterns suggest 2 discrete herd units associated with the respective winter ranges (Fig. 7). Martin Creek was used by a few individuals from each winter range and Sunday Creek was used by a few radio-collared deer from MDWR.

Dates of arrival on and departure from winter ranges have been estimated using the radio-collared sample of animals. Whitetails in the BTWR unit spent an average of 105 days (range 92 - 125) on the winter range during the years 1990 - 1994. Whitetails in the MDWR unit spent an average of 99 days (range 80 - 120) on the winter range during the years 1991 - 1994. Deer using the MDWR winter range have tended to arrive on winter range a little later and leave a little earlier than deer occupying BTWR, although much variation exists among individuals. As duration of stay on winter range is likely a function of winter severity and duration, those years during which deer remained the longest on BTWR were also the years during which deer remained the longest on MDWR.

Figure 7. General migration routes and spring (SA) and fall (FA) accessory areas of white-tailed deer moving to and from the Bowser Lake winter range (labels removed for clarity, see Fig. 1). Taken from Morgan (1993).

The extent and timing of movement by radio-collared deer off both winter ranges (BTWR and MDWR) during this report period followed the pattern described previously by Dusek and Morgan (1990) and Munding and Riley (1982 and 1983). In late March or early April, deer left winter range, moving to transitional and summer ranges. Distance between geographical activity centers for winter and summer home ranges varied from 22 to 31 km (Dusek 1989 and Morgan 1993). Deer movement back to winter range was more variable, with summer range departure dates spread out during September, October, and November (Morgan 1993).

Morgan (1993) reported that summer home ranges of whitetails in the BTWR unit varied with age and sex. The largest home ranges were established by subadult males (268.2 ha), followed by adult males (235.3 ha). Subadult females established the third largest home ranges (90.8 ha), followed by adult females with the smallest (61.6 ha). The reader is referred to Morgan (1993) for additional discussion of movement patterns and distribution of whitetails in the BTWR unit. Home ranges of whitetails in the MDWR unit have not been calculated for this report, but will be addressed in subsequent reports.

Check Stations

Data obtained from white-tailed deer examined at the check station near Olney during the 1991, 1992, and 1993 general big game hunting seasons were used to evaluate several parameters, including: age and sex distribution, antler measurements, and carcass weight. Age and sex composition of harvested whitetails from 1988-1993 appears in Figure 8. Addition of data collected during the 1991, 1992, and 1993 seasons to the pre-1991 harvest data set did not noticeably alter the distributions. That is to say that although sample sizes have increased, approximately the same proportions of each age and sex class have been harvested with the addition of subsequent years' data. Similarly, the average carcass weights of white-tailed deer checked at the Olney station have remained approximately the same over the period (Table 4).

Previous analysis of antler characteristics among males ≥ 1 year of age indicated that mean basal diameter, mean length of the main antler beam, and maximum spread all increased with age (Dusek 1989). Similar trends were apparent with the addition of subsequent years' data. Average main beam length appeared somewhat variable between years and areas for all age classes of males (Fig. 9). However, the average main beam length was more a function of age than area as indicated by ANOVA. There were no differences between mean main beam lengths between areas ($p = 0.21$), but there were differences between ages ($p < 0.00$).

Because yearling males comprise the largest percentage of males in the harvested sample examined at the Olney check station, additional comparisons were made for just the yearling male segment. No real differences were apparent in main beam diameter, diastema length, or carcass weight for yearling males between hunting districts or years (Table 5). This would be expected since yearlings had experienced only 1 winter, thus minimizing cumulative effects of environmental conditions on growth and condition over several years (Swenson and Stewart 1982).

Figure 8. Age composition of the harvested white-tailed deer pooled by sex in Hunting Districts 101 and 102, 1988-1993. Hunting District 102 encompasses the Bowser-Tally herd unit and Hunting District 101 encompasses the Murphy-Dickey herd unit.

Table 4. Mean field-dressed weights (kg) of 235 white-tailed deer examined at check stations from Hunting Districts 101, 102, and 110, 1989-1993.

Age	Female		Male	
	Number	Mean	Number	Mean
0	14	24.5	14	26.8
1	29	39.9	47	47.2
2	13	44.0	23	57.6
3	23	46.3	23	62.6
4	10	43.1	11	73.0
5	3	44.5	5	80.7
6	5	46.7	1	72.6
7	1	45.4	5	79.8
≥8	5	49.0	3	78.9

Pellet Group Transects

During the springs of 1992, 1993 and 1994, pellet transects were conducted on the core Bowser-Tally and Murphy-Dickey winter ranges. The 1992 BTWR pellet survey yielded an estimate of 4,389 deer using the core wintering area (Fig. 10). The 1993 survey yielded an estimate of 5,594 deer, while the 1994 survey resulted in an estimate of 6,545 deer. These figures continue a trend of increasing deer abundance in the BTWR herd unit since the initiation of pellet surveys on this winter range in 1989. The 1992 MDWR pellet survey yielded an estimate of 2,310 deer in the core wintering area (Fig. 10). The 1993 survey yielded an estimate of 1,763 deer, while the 1994 survey resulted in an estimate of 5,729 deer. Excluding the 1994 estimate (see below), the 1992 and 1993 estimates continue a pattern of fluctuating deer abundance around a 4-year mean of 2,172 white-tailed deer using the Murphy-Dickey Lakes winter range. These results will be explored in greater detail in a subsequent section of this report.

Figure 9. Mean antler beam length by area and age class from white-tailed bucks examined at hunter check stations from Hunting Districts 102, 101, and 110, 1989-1993.

Table 5. Number (n), mean ($\bar{x}$), and standard error (SE) of the antler beam diameter (cm), diastemal length (mm), and dressed carcass weight (kg) of yearling male white-tailed deer examined at check stations from Hunting Districts (HD) 101 and 102, 1988-93.

Year	HD	Beam diameter			Diastema			Weight		
		n	$\bar{x}$	SE	n	$\bar{x}$	SE	n	$\bar{x}$	SE
1988	101	10	1.8	0.1	14	72.4	0.9			
	102	14	2.0	0.1	14	72.4	0.6			
1989	101	17	1.7	0.1	18	69.6	0.9	6	49.2	1.0
	102	10	1.8	0.1	9	68.9	1.2	4	48.8	2.0
1990	101	46	1.8	0.0	45	70.6	0.6	7	49.6	1.6
	102	19	1.7	0.1	19	70.0	0.9	9	46.7	1.6
1991	101	43	1.7	0.4	43	69.4	0.6	6	44.5	1.8
	102	11	1.7	0.1	10	69.1	0.6	5	46.3	2.3
1992	101	42	1.9	0.1	44	69.9	0.5	3	46.7	4.3
	102	10	1.6	0.1	11	69.8	0.1	0		
1993	101	34	1.5	1.5	34	69.5	0.1	2	53.5	7.5
	102	16	1.8	1.8	16	69.5	0.1	1	46.7	

Two variables must be estimated with reasonable accuracy for pellet group counts to reflect actual numbers of deer. First, the number of days that deer occupy the winter range must be estimated. This was determined from average dates of entry onto and departure from the winter ranges by radio-collared deer, i.e. average number of days that autumn migrants occupied the winter range. The second and perhaps most critical variable which must be estimated is the daily defecation rate. The commonly used rate of 12.7 groups/day/individual (Davis 1982), and the one used here, was less than rates reported for free-ranging deer (Rodgers 1987, Sawyer et al. 1990). Because of the likelihood of substantial regional variation in defecation rates and no comparative data for white-tailed deer in the northern Rocky Mountain region, pellet group counts provide only an index of animal abundance on the winter range. It was assumed that the rate, although probably not accurate, was relatively constant from year to year.

Other factors influence the accuracy of such indices. Winter severity, in part, determines how many deer return to the core area of the winter range. In mild winters with light snowfall, not all deer return to the core winter range. Some deer may occupy areas peripheral to the core or even transitional range somewhere between their summer and winter ranges. This pattern has

Figure 10. Estimated number of white-tailed deer using the Bowser-Tally Lakes winter range, 1989-94 (top) and white-tailed deer using the Murphy-Dickey Lakes winter range 1990-94 (bottom) from pellet group counts with 95% confidence intervals.

been demonstrated by radio-marked deer during this study, particularly by individuals in the MDWR herd unit. Pellet surveys have been conducted on the same core areas each year, regardless of winter severity, due to private property and other logistical constraints. Winter severity also dictates the number of days which deer occupy the winter range.

Observer bias also influences the accuracy and consistency of an index of animal abundance based on pellet surveys. The number of observers searching for pellet groups may influence the number of groups actually counted. In addition, observer experience influences the efficiency of the search as well as the determination of whether or not a particular group was deposited during the immediately preceding winter. During the report period, personnel changes occurred. The BTWR surveys have been conducted by two individuals, one of which was present during each year since 1992. The second observer in 1994 was different from the second observer during the 1992 and 1993 surveys. The MDWR surveys have typically been conducted by one observer. The 1994 MDWR pellet transects were conducted by a different individual than the 1992 and 1993 surveys.

Population Parameters

Population Size and Trend: Population size and trend were estimated by pellet group surveys and remote camera surveys. The number of deer using BTWR as determined from pellet group counts was substantially higher than those from mark-resight techniques and probably overestimated numbers of deer on the survey areas in all years. Conversely, mark-resight techniques likely underestimated deer numbers. The true population number probably lies somewhere between the estimates derived by each method. The discrepancy between estimates was especially evident for the surveys conducted on BTWR in 1993 and 1994. Pellet surveys indicated an increasing trend while camera surveys indicated a stable to declining number of deer in the survey area. However, in the years 1990 and 1991, estimates from both techniques appeared to reflect a similar trend in abundance of deer (Figs. 5 and 10).

The differing trends from the two techniques could reflect, in part, the shortcomings of each method and the differing patterns of winter severity and deer movements from year to year. The span of time over which surveys are conducted may influence the results of each method. Mark-resight surveys are conducted over 14-21 days while pellet surveys are based on the 80-125 days which deer occupy winter range. Therefore, pellet surveys may be influenced by confounding factors over a longer time span which could influence the results to a greater degree than for mark-resight surveys. These vagaries may account for noted changes in population number rather than reflecting any true changes in population size. For example, some radio-collared deer marked on BTWR in 1988-89 did not use the winter range in 1989-90 but did in 1990-91. Additionally, fall migration was staggered through late January 1990, whereas all radio-collared deer were on the winter range by late December 1990. In recent years, mild winters have likely influenced deer movements such that some deer did not use the core winter range. For example, in 1994, only 88% of radio-marked deer occupied the winter range at Bowser-Tally Lakes and only 71% of radio-marked deer occupied the winter range at Murphy-Dickey Lakes. As in

previous years, migration to and departure from winter range was staggered in 1993 and 1994. The 1994 mark-resight estimate at MDWR was invalid because radio-marked deer began leaving the winter range prior to the completion of the camera survey.

It is possible that we are unable to conduct pellet and mark-resight surveys with great enough precision to detect true population changes. Additional data will be necessary to more fully explore and compare population estimates derived using different techniques and to detect true changes in population size from year to year. Examination of other parameters such as age distributions over time will likely be necessary to discern subtle changes in population size.

Herd Composition: Composition of the population on the BTWR during winter camera surveys and in the Tally Lake District during early spring appears in Table 6. The proportion of fawns in the late winter-early spring populations during 1989, 1990, 1991, 1993, 1994 was 42%, 40%, 39%, 38%, and 30%, respectively. Dusek (1991) reported that there were no significant differences in the proportion of fawns for the years 1989-91. Similarly, no significant differences were detected between the proportions of fawns in the late winter - early spring populations for the years 1989-91 and for the years 1993 and 1994 ($p = 0.25$). The proportion of fawns in the trapped sample of whitetails on the BTWR from 1988 - 1994 was 40%. There was no significant difference between the proportion of fawns in the photographed sample and the trapped sample over all years ($p = 0.61$). Further, the proportion of fawns in the trapped sample of white-tailed deer on BTWR during the years 1989-91 (45%, 42%, and 42% respectively) did not differ from the combined years 1992-94 (40%) ($p = 0.20$).

It was assumed that male and female fawns on the BTWR were equally represented. Male fawns in this herd unit (HD 102) slightly outnumbered females among all fawns examined at hunter check stations (52%, $n=27$) for the years 1989-94. Among fawns trapped during winter on the BTWR, male fawns again slightly outnumbered female fawns (51%, $n=124$). However, sex ratios in both cases did not depart from an expected ratio of 1:1 ($p = 0.88$).

The composition of the population at MDWR during winter camera surveys was determined sporadically. Valid results were only available for the years 1990 and 1991. During the late winters of 1990 and 1991, 173 and 170 white-tailed deer were classified from camera surveys. Of these, 32% and 41% were fawns during the respective years. There were no spatial or temporal differences in the proportion of fawns within or between years on BTWR and MDWR winter ranges ($p = 0.76$). The proportion of fawns in the trapped sample of whitetails on the MDWR from 1989 - 1994 was 35%. There were no significant differences between the proportion of fawns in the photographed sample during the years 1990 and 1991 and the trapped sample over all years combined (32% and 41% photographed and 35% trapped, respectively). Further, the proportion of fawns in the trapped sample of white-tailed deer on MDWR during the combined years 1989-91 was not significantly different from the combined years 1992-94 (36% and 33%, respectively).

Table 6. Seasonal herd composition of white-tailed deer on the Tally Lake District and/or the Bowser-Tally winter range from vehicle surveys, helicopter census, and remote camera surveys, 1988-94.

Period and survey type	Number classified	Herd Composition (%)				Sex and age ratios			
		Adults ≥ 1 yr	Fawns	Female = 1 yr	Male = 1 yr	Male ≥ 2 yrs	FF:100 fem	FF:100 adults	Bucks:100 does
Jan/Feb 1989:									
Vehicle	63	65	35					54	
Photography	110	59	41					69	
March 1989:									
Helicopter	284	58	42					71	
Photography	80	56	44					78	
Dec/Jan 1989-90:									
Photography	113	64	36	55	4	5	66	57	16
Feb/Mar 1990:									
Vehicle	166	61	39					64	
Photography	230	60	40					67	
May 1990:									
Photography	203	71	29	56		15 ¹	51	40	26
Dec/Jan 1990-91:									
Photography	231	65	35	54	4	7	65	54	20
Feb/Mar 1991:									
Vehicle	244	66	34					52	
Photography	242	61	39					63	
Jan/Feb 1993:									
Photography	547	62	38					61	
Jan/Feb 1994:									
Photography	439	70	30					42	

¹ Includes all males ≥ 1 year of age.

It was assumed that male and female fawns on the MDWR were equally represented. Female fawns in this herd unit (HD 101) slightly outnumbered males among all fawns examined at hunter check stations (52%, $n=37$) for the years 1989-94. Among fawns trapped during winter on the MDWR, female fawns again slightly outnumbered male fawns (52%, $n=58$). However, sex ratios in both cases did not depart from an expected ratio of 1:1 ($p = 0.98$). Furthermore, fawn sex ratios did not differ significantly between winter ranges or between the trapped sample and the checked sample of fawns ($p = 0.92$).

Survival and Mortality: Annually, the highest mortality occurred during the general firearms hunting season (16 Oct - 30 Nov, Fig. 11). Seventy five deaths of radio-collared deer were documented during the years 1989-94. Of all deaths, 33 (44%) were directly attributable to hunting. Among other documented causes, natural mortality accounted for 13 (18%) and vehicle/train collisions accounted for 4 (5%). Cause of death could not be confidently discerned for the remaining ($n=25$). However, temporal circumstances indicated that 11 deaths of unknown causes occurred during the archery and general rifle intervals. The others occurred throughout the year, although there was a peak of six deaths in December.

Yearling and older females from the BTWR and MDWR study areas combined exhibited higher survivability than adult males ≥ 2 years old ($p < 0.00$). A Chi-square test indicated significant differences between yearling females, 2-7 year-old females, ≥ 8 year-old females, and ≥ 2 year-old males ($p < 0.00$). However, there were no significant differences in survival between female age classes ($p = 0.07$). Because the highest mortality occurred during the general firearms hunting season, mortality attributable to harvest was examined. Again, there were significant differences noted between yearling females (0.05), 2-7 year-old females (0.06), ≥ 8 year-old females (0.02), and ≤ 2 year-old males (0.34) ($p = 0.00$). As above, no significant differences were detected between different age classes of females ($p = 0.44$).

Annual survival for the years 1989-94 did not differ between the BTWR and MDWR study areas for all age and sex classes combined ($p = 0.10$). When examined individually, neither male or female survival in the BTWR study area differed significantly from survival in the MDWR study area over all years ($p = 0.38$ and $p = 0.23$, respectively). However, within the respective study areas, there were differences in survival between age and sex classes (Fig. 12).

The annual probabilities of survival for whitetails associated with the BTWR study area among yearling females (0.87), 2-7 year-old females (0.90), ≥ 8 year-old females (0.73), and ≥ 2 year-old males (0.58) were significantly different ($p < 0.00$) (Table 7). A multiple comparison among the female age classes indicated that there was a significant difference in survival ($p = 0.03$). However, individual Z-tests indicated that the only significant difference among the female classes occurred between the 2-7 year-old females and the ≥ 8 year-old females ($p = 0.01$). Survival for yearling females was similar to ≥ 8 year-olds ($p = 0.09$) and was similar to 2-7 year-old females ($p = 0.31$). Mortality attributable to harvest was not documented among radio-collared yearling females. Despite differing survival probabilities, harvest mortality of 2-7 year-old females was not significantly different from ≥ 8 year old females ($p = 0.44$).

Likewise, natural mortality for these two classes was not different ($p = 0.12$). That survival probabilities between 2-7 year olds and ≥ 8 year olds were significantly different but natural and harvest mortality probabilities were similar may be explained by smaller sample sizes of ≥ 8 year-old females. In addition, the greatest proportion (16%) of mortalities of the females ≥ 8 years old were classified as unknown causes. Harvest mortality of both female age classes in which harvest mortality was documented was significantly less than for ≥ 2 year-old males ($p = 0.01$).

The annual probabilities of survival for whitetails associated with the MDWR study area among yearling females (0.81), 2-7 year-old females (0.84), ≥ 8 year-old females (0.81), and ≥ 2 year-old males (0.45) were significantly different ($p = 0.03$) (Table 8). A multiple comparison among the female age classes indicated that there were no significant differences in survival ($p = 0.93$). Therefore, female age classes were combined and tested against males using a Z-test. Females had a significantly higher survival probability than males ($p < 0.00$). Additionally, females had a significantly lower rate of mortality attributable to harvest than males ($p < 0.00$).

Figure 11. Daily mortality rates during monthly intervals for all deer ≥ 1 year old pooled for all sex and age cohorts. S-O includes the period of archery hunting (1 Sep - 15 Oct) and O-N includes the 5 week firearm hunt (16 Oct - 30 Nov).

Figure 12. Annual survivorship by sex and age of adult white-tailed deer associated with Bowser-Tally winter range (Hunting District 102) and Murphy-Dickey lakes winter range (Hunting District 101) for all years combined, 1988-1994.

Table 7. Annual survival and cause-specific mortality (May-April) among radio-collared white-tailed deer from the Bowser-Tally Lakes winter range, 1989-94.

	Sex and age			
	Yrlg ♀♀	2-7 yr ♀♀	≥ 8 yr ♀♀	≥ 2 yr ♂♂
No. deer (max.)	35	244	44	48
No. radio days	6,593	70,826	11,231	9,685
No. deaths	2	20	10	13
Annual Survival	0.8705	0.8977	0.7278	0.5830
95% CI	0.7182- 1.000 ¹	0.8562- 0.9411	0.5973- 0.8868	0.4346- 0.7823
Cause-specific mortality:				
Hunting	0.0000	0.0667	0.0558	0.3375
Natural	0.0000	0.0101	0.0546	0.0459
Vehicle	0.0605	0.0000	0.0000	0.0000
Unknown	0.0690	0.2552	0.1618	0.0334

¹ Upper limit was truncated at 1.000.

Table 8. Annual survival and cause-specific mortality (May-April) among radio-collared white-tailed deer from Murphy-Dickey Lakes winter range, 1989-94.

	Sex and age			
	Yrlg ♀♀	2-7 yr ♀♀	≥ 8 yr ♀♀	≥ 2 yr ♂♂
No. deer (max.)	21	98	35	24
No. radio days	2,832	28,117	8,682	4,339
No. deaths	1	13	5	9
Annual Survival	0.8078	0.8373	0.8067	0.4511
95% CI	0.5316- 1.000 ¹	0.7602- 0.9223	0.6683- 0.9739	0.2663- 0.7644
Cause-specific mortality:				
Hunting	0.1922	0.0392	0.0000	0.3404
Natural	0.0000	0.0107	0.0711	0.0328
Vehicle	0.0000	0.0237	0.0000	0.0328
Unknown	0.0000	0.0891	0.1221	0.1429

¹ Upper limit was truncated at 1.000.

Effects of Increased Antlerless Harvest

To test hypotheses regarding the effects of increasing antlerless harvest on white-tailed deer populations in northwestern Montana, we implemented a harvest regime intended to increase antlerless whitetail harvest in the BTWR herd unit which occupies HD 102. From 1989 to 91, the general deer hunting season for both HD's 101 and 102 was 2 weeks either sex, either deer species followed by 3 weeks antlered buck hunting. In 1992-94, we maintained that basic season structure, but issued 6-700 B-permits for antlerless whitetails in HD 102. HD 101 which includes the MDWR herd unit functioned as a control.

The issuing of B-permits in HD 102 over a 3-year period (1991-93) corresponded with an average increase of 33% (634 deer) in total whitetail harvest, while hunter numbers over the same period increased an average of 22% (1015 hunters) (Fig. 13). In HD 101 for comparison, the increase in total harvest was 7% (93 deer), while hunter numbers increased 5% (213 hunters) (Fig. 14). Issuing of B-tags in HD 102 corresponded with a 3% increase in overall hunter success, whereas in HD 101 over the same period, the increase was 1%. Figure 15 presents overall hunter success rates and the success rate of B-permit holders.

The 3-year average hunter success for B-permit holders was 43% (range 37-53%). Based on these success rates, the additional harvest of antlerless deer by B-permit holders averages 272 whitetails (range 240 - 318 deer). These harvest levels fall short of project goals for harvest of deer through B-permits. However, total whitetail harvest in HD 102 increased more dramatically than what could be attributed to harvest by B-permit holders alone. Harvest of the antlered segment of the population may also have increased because of increased hunter numbers. Thirty three percent of the 3-year average total harvest since 1991 was 634 deer. The discrepancy between 272 and 634 deer may also be accounted for by sampling biases inherent in the collection of harvest information through telephone surveys of randomly selected hunters and subsequent extrapolation to a particular hunting district or special hunting opportunity such as a B-permit. Nonetheless, the increases in total whitetail harvest, hunter numbers, and hunter success in HD 102 compared to HD 101 indicates that the issuance of B-permits at the current level (600 - 700 permits) has at least partially met project goals for increased antlerless deer harvest.

Figure 13. Hunter numbers and total white-tailed deer harvest in Hunting District 102 during the years 1988-93, as reported by the Hunting and Harvest Survey Reports.

Figure 14. Hunter numbers and total white-tailed deer harvest in Hunting District 101 during the years 1988-93, as reported in the Hunting and Harvest Survey Reports.

Figure 15. Overall hunter success rates (1988-1994) and the success rate of B-permit holders (1991-1993) in Hunting Districts 101, 102, and 110.

Time period of kill is another question of interest when considering hunter influences on white-tailed deer harvest. Traditionally, harvest during any given 5-week rifle season peaks during the first and last week. The first peak could be attributed to the "opening day phenomenon" and the ability to harvest an antlerless deer using an A-tag. The second peak could be attributed to increased hunter interest in the antlered segment of a deer population as bucks exhibit increasing rutting behavior as the season progresses. Harvest during the middle 3 weeks is somewhat variable due to varying hunting conditions, primarily snow cover. Similarly, snow cover and weather may affect total harvest and the overall hunter success rate both within a given season from week to week and from year to year. However, B-permit holders could harvest an antlerless deer at any time during the 5-week season, thus overall hunting pressure in HD 102 during the middle of the season could be increased over what would occur in the absence of B-permit hunting opportunities. However, issuance of B-permits in HD 102 corresponded with a slight increase (2%) in total kill by A and B permit holders during the middle 3 weeks of the general rifle season, whereas in HD 101, the increase in total kill during the middle 3 weeks increased by 0.5% (Figs. 16, 17). B-permit holders appeared somewhat more opportunistic when making kills, particularly during 1992 (Fig. 18).

Figure 16. Time period of kill for Hunting District 102 for the years 1988-93, as reported in the Hunting and Harvest Survey Reports.

Figure 17. Time period of kill for Hunting District 101 for the years 1988-93, as reported in the Hunting and Harvest Survey Reports.

Figure 18. Time period of kill for B-permit holders in Hunting District 102 during the years 1991-93, as reported in the Hunting and Harvest Survey Reports.

In HD 102, the apparent survival of radio-collared female white-tailed deer was not altered by the issuance of B-permits in 1991 and in subsequent years when compared to PRE-1991 survival. PRE-1991 female survival was 0.87 in the BTWR study area and 0.79 in the MDWR study area. POST 1991 survival was 0.88 for the BTWR herd unit and 0.86 for the MDWR herd unit. No significant differences in survival were detected between study areas or PRE/POST time periods ($p = 0.49$) (Table 9). Similarly the apparent survival of radio-collared male white-tailed deer was not significantly altered by the additional B-permit hunters afield in HD 102. There were no differences between PRE-1991 and POST-1991 survival for the BTWR herd unit and the MDWR herd unit ($p = 0.38$).

Table 9. Annual survival and cause-specific mortality (May-April) among radio-collared female white-tailed deer occupying the Bowser-Tally (BT) and the Murphy-Dickey Lakes (MD) winter ranges prior to the initiation of antlerless hunting by permit (PRE) in Hunting District 102 and after the initiation of antlerless hunting by permit (POST).

	Females $\geq$ 1 Year Old			
	BT PRE ¹	BT POST ²	MD PRE ³	MD POST ⁴
No. deer (max.)	96	277	40	114
No. radio days	39,785	48,885	17,016	23,551
No. deaths	15	17	10	9
Annual Survival	0.8687	0.8755	0.7908	0.8622
95% CI	0.8086- 0.9333	0.8218- 0.9328	0.6834- 0.9152	0.7824- 0.9502
Cause-specific mortality:				
Hunting	0.0646	0.0584	0.0219	0.0495
Natural	0.0000	0.0226	0.0141	0.0295
Vehicle	0.0000	0.0076	0.0219	0.0130
Unknown	0.0667	0.0360	0.1513	0.0458

¹ Bowser-Tally winter range 1989, 1990.

² Bowser-Tally winter range 1991, 1992, 1993, and 1994.

³ Murphy-Dickey Lakes winter range 1989, 1990.

⁴ Murphy-Dickey Lakes winter range 1991, 1992, 1993, and 1994.

Preliminary Conclusions: Increasing antlerless harvest by 33% in HD 102 did not noticeably affect overall survivorship of adult female white-tailed deer according to the variables we measured and the level of precision at which we were able to measure. The number of antlerless whitetails harvested on B-permits in HD 102 is likely insignificant relative to total population size. To elucidate the effects of antlerless harvest would require a more robust experimental design and a much greater increase in the antlerless harvest. However, other results indicate that issuing of B-permits does increase the numbers of hunters afield and may lead to an increase in the harvest of the antlered segment of the population. White-tailed deer populations in most northwestern Montana hunting districts should be able to sustain an increased harvest of 200-300 antlerless whitetails over time.

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Submitted by Carolyn A. Sime

ADDENDUM

Morgan, J.T. 1993. Summer Habitat Use of White-tailed Deer on the Tally Lake Ranger District, Flathead National Forest. PhD dissertation, Montana State University, Bozeman. 103pp.

Abstract

Summer habitat relationships of white-tailed deer (*Odocoileus virginianus*) were studied on the Tally Lake Ranger District of the Flathead National Forest in northwestern Montana during 1989-1991. Macro-habitat selection patterns were analyzed using 2,009 relocations of radio-collared deer obtained through aerial surveys while deer occupied summer ranges. An additional 463 relocations provided information on migration routes and accessory areas. Micro-habitat selection was investigated in the Star Meadows and Corduroy Creek complexes through 18 diel telemetry sessions and a remote camera survey in Corduroy Creek. The geographic information system programs ERDAS and EPPL7 were used to create 8 habitat component data layers including: slope, aspect, elevation, vegetation, riparian areas, and roads (all, open, and closed).

Deer habitat selection at the macro-level appeared to be influenced by locations of second and third order streams and associated riparian meadow complexes. Deer initially selected sites close to riparian habitat, between 1,159 and 1,524 m, containing naturally occurring grass/forb and shrub/hardwood vegetation. Later in the season, deer preferences shifted to slightly higher elevations containing more open and closed pole/immature timber. In general, early seral and mature vegetation were avoided. Roads appeared to play a small role in whitetail habitat selection except for an avoidance of sites within 100 m of a road. Aspect and slope also had little impact on habitat selection. Deer habitat selection at the micro-level was less specific. Once deer selected their summer home range, use of individual habitat variables within this area apparently was less important.

Forest management on the Tally Lake District should aim to preserve riparian complexes, including mesic bottomlands and associated upland pole/immature timber within 750 m of riparian sites. Cutting units occurring above 1,646 m or below 1,159 m and/or on westerly to northerly aspects would have less impact on deer. Stands should be allowed to return to the pole/immature stage before adjacent cuts are made.

Management Implications and Recommendations

The Multiple Use-Sustained Yield Act of 1960 states, "it is the policy of congress that the national forests be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes." Additional laws have strengthened the role of fish and wildlife in the planning process on national forests, e.g. The Sikes Act Extension of 1974, The Forest and Rangeland Renewable Resources Planning Act of 1974, and The National Forest Management Act of 1976. The Tally Lake Ranger District of the Flathead National Forest is thus mandated to be managed for both timber production and white-tailed deer habitat.

Results of this study indicate that, while deer are relatively widely distributed and adaptable, there are portions of the district and habitat variables that are more important to deer than other

areas and variables. Unfortunately, without strong population data, it is difficult to determine the present status of the deer population on the district and what effect any habitat alteration may have on the population. However, based on findings from this study, some general conclusions and recommendations are possible. The most important general conclusions to forest management regarding deer habitat selection on the Tally Lake District are that early seral coniferous forest vegetation was of little benefit to deer generally, while riparian areas and adjacent uplands containing pole/immature timber were very important. These riparian complexes are core habitats or centers of spatial distribution for white-tailed deer in northwest Montana. Not all riparian areas are critical or at least were not critical at the time of this study. Many creeks on the District are used very little by deer, perhaps because the total habitat/environment complex (including hunting) with which they were associated prohibited deer from becoming established. Deer and habitat management should involve identifying and protecting those important riparian complexes which contain the preferred topographic, climatic, vegetative, and land use components discussed.

Deer showed such a strong preference for riparian areas and the vegetation types associated with them that these sites should be disturbed as little as possible. At least a 100 m buffer of vegetation, including natural grass/forb, shrub/hardwood, and mixed timber should be maintained around riparian areas. Timber harvests, except perhaps limited selective cutting, should not occur within this buffer.

As deer moved from riparian areas in late summer and fall, they often selected pole/immature uplands. While this vegetation is highly productive for timber and often cut, it can be of great benefit to deer and should be maintained, particularly when found near riparian complexes, such as Star Meadows and the Corduroy Creek areas.

While deer appeared to benefit little from early seral vegetation, they also made very little use of closed mature timber. Focusing cutting in this type would be less disturbing to deer than logging in pole/immature types which were preferred.

White-tailed deer distribution was heavily centered at elevations between 1,159 and 1,646 m and on aspects from east to southwest. These topographic features, while not inherently important to deer, provided the habitat complexes that were. However, not every location within these elevational and aspect zones need be preserved. Rather, special attention should be paid to riparian areas, pole/immature uplands, and possibly some mature timber areas as travel corridors. Locating timber sale boundaries away from zones of particular importance to deer use would be less disturbing.

In general, roads apparently did not negatively affect deer distribution and use except immediately adjacent to the road. Thus while limiting, or closing roads in the most preferred areas could be beneficial to deer in the immediate vicinity, its effect on deer over a wider area appears limited. Also closing roads could prohibit distribution of hunters and lead to heavier deer harvests in areas with greater access.

In general, sites within the study area where cutting would have minimal effect on white-tailed deer include: elevations above 1,646 m and below 1,159 m, northerly and westerly aspects, ridgetops and other sites more than 750 m from riparian habitat, areas where previous cuts have returned to the pole/immature stage, and large blocks of mature timber.

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