PENNSYLVANIA GAME COMMISSION
BUREAU OF WILDLIFE MANAGEMENT
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PROJECT ANNUAL JOB REPORT

PROJECT CODE NO.: 06210

TITLE: White-tailed Deer Research/Management

PROJECT JOB NO.: 21010

TITLE: Survival and Response to Hunting Activity of Female White-tailed Deer

PERIOD COVERED: 1 July 2005 through 30 June 2006

COOPERATING AGENCIES: Pennsylvania Cooperative Fish and Wildlife Research Unit, The Pennsylvania State University, Department of Conservation and Natural Resources

WORK LOCATION(S): Wildlife Management Units (WMUs) 2G and 4B

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Abstract: In 2006, we captured and attached radio transmitters to 102 female white-tailed deer (*Odocoileus virginianus*) to monitor their survival, dispersal, and movements in response to hunting activity. Since the start of this study in 2005, 36 mortalities have been recorded and hunting was the most common cause of mortality. In 2005, annual survival for does was 86% and 66% in WMUs 2G and 4B, respectively. Preliminary estimates of hunter behavior during the 2005 firearms season varied by study area. In WMU 2G, hunter locations were closer to the roads and in areas with less slope than randomly located points. In WMU 4B, hunter locations were not related to distance from the road or slope of the land. Radio-collared deer distributions also varied between study areas. In WMU 2G, radio-collared deer densities were not influenced by distance from the nearest road, but generally increased as slope of the land increased. In WMU 4B, radio-collared deer density generally increased as distance from the road and slope of the land increased. Telemetry data continue to be collected.

OBJECTIVES

1) Estimate female survival and mortality causes.

2) Quantify effect of variables on survival.

3) Estimate female dispersal.

4) Estimate density and distribution of hunters on 2 study areas.

5) Monitor home ranges and movements of antlerless deer on these study areas to determine the response of deer to hunting-related activities.

6) Determine if specific environmental factors are related to whether an antlerless deer is harvested by a hunter (e.g., proximity to area closed to hunting, distance from road, etc.).

METHODS

Northern and southern study areas were located in (WMUs) 2G and 4B. These WMUs represented 2 of 5 physiographic units within the WMU system and thus provide broad coverage of Pennsylvania. Based on deer, habitat, and human-related characteristics, the study area WMUs were selected to represent larger groups of WMUs across Pennsylvania.

In 2005, Study activities began on the Sproul and Tuscarora State Forests. Over the course of the study, the study area expanded out from state forests. In the first year of deer capture, most deer capture activities occurred in state forests to ensure adequate numbers of marked deer for hunting-related objectives (4-6). In following years, capture activities have expanded out into other areas to increase variability of survival covariates, thus improving biological inference of the relationship between survival and covariates (Steury et al. 2002).

We used drop nets (Conner et al. 1987), rocket nets, and modified Clover traps (Clover 1954, McCullough 1975) baited with corn to capture deer. Deer captured using drop-nets and rocket nets were sedated with a light, intramuscular (IM) dose of xylazine hydrochloride (XYL), and face-masked. XYL was delivered via hand syringe at about 0.6 mg/kg body weight, or about 20 mg for a fawn, 30 mg for a yearling, and 40 mg for an adult. These dosages were well below the dosage recommended by Bubenik (1982) for immobilization of white-tailed deer using xylazine alone; complete sedation was not required to facilitate handling deer tangled in the nets. Deer captured with Clover traps were manually restrained and face-masked.

When captured, all deer were fitted with an ear tag in each ear. All suitable female deer were fitted with standard VHF radiocollars that use microchip technology to indicate time of mortality (if it occurs), and released at the capture site. A subset of deer were fitted with GPS radiocollars that will obtain detailed movement (e.g., bi-hourly locations) information during the hunting season. Handling protocols were approved by the Pennsylvania State University (PSU) Institutional Animal Care and Use Committee.

Deer manually restrained by personnel were immediately released after individual markers were applied. Chemical immobilizations were antagonized with IM injections of tolazoline hydrochloride (TOL; 4.0 mg/kg) because it provides a more consistent antagonism of xylazine than yohimbine hydrochloride (Kreeger 1996).

Survival and locations of radio-collared deer were monitored at varying intervals throughout the year. During capture periods, deer survival was monitored at least once per week. Following capture periods, we collected at least 2 locations per deer per week. Telemetry effort depended on availability of personnel.

Mortalities were investigated within a day or 2 of detection. Field examinations to determine cause of death were performed when possible; however, if cause of death was uncertain and the carcass was in suitable condition, animals were taken to the Animal Diagnostics Laboratory at Penn State University for a complete necropsy. Annual survival was estimated using Kaplan-Meier staggered entry design (Pollock et al. 1989).

Non-hunting survival of white-tailed deer may be influenced by numerous covariates, such as winter severity, condition of deer, age of deer, predation, and human-related factors such as road density. To assess effect of these covariates on non-hunting survival of female white-tailed deer, measurements of these variables for home ranges of individual deer will be modeled in relation to the deer's survival using logistic regression (Hosmer and Lemeshow 1989). Home ranges will be estimated using Kernal methods. Recommended sample sizes of locations of at least 30 locations per animal (Seaman et al. 1999) may not be logistically possible with personnel funding available. As a result, a subset of radio-collared deer may be located at least twice a week throughout the non-capture period. For radio-collared deer without sufficient home range sample sizes, including deer that die prior to accumulation of at least 30 locations, we will create circular buffers within which habitat characteristics will be assessed. These buffers may be based on the median home range sizes of the subset of radio-collared deer for each study area (Vreeland et al. 2004). To quantify the relationship between covariates and deer survival, a series of candidate models containing likely combination of covariates will be developed with the best model(s)chosen using AIC methods (Burnham and Anderson 1998).

Dispersal will be estimated for deer captured as fawns (<1 year of age). Home range locations established prior to 1 year of age will serve as the natal range from which dispersal will be measured. This definition of natal ranges is reasonable because dispersal rarely occurs in white-tailed deer prior to 1 year of age. Dispersal will be estimated similarly to survival using Kaplan-Meier staggered entry design (Pollock et al. 1989) with dispersal analogous to death.

Aerial surveys were conducted during the regular rifle season to determine the density and distribution of hunters (Stedman et al. 2004, Diefenbach et al., in review). Fixed-wing aircraft flew transects across each study area, pending acceptable weather conditions, and observers marked the locations of hunters on a tablet PC with a digital pen. All data were geo-referenced and analyzed in a Geographic Information System. Hunter densities were estimated using distance sampling methods (Buckland et al. 2001) and hunter distribution was modeled with the Resource Selection Function approach developed by Manly et al. (2002).

Statistical models will be developed to estimate hunter density and distribution as described above, and the telemetry data will provide information on deer movements and home ranges. Models of hunter distribution from the aerial surveys and estimates of deer home ranges from telemetry data will be used to determine if deer with home ranges farther from roads (on public lands), or near areas closed to hunting (private lands) have lower harvest rates. In addition, the telemetry data from GPS radiocollars will be used to investigate deer movements in response to hunting pressure.

RESULTS

From January to April 2006, 190 white-tailed deer were captured (Table 1). Clover traps captured 45% of the deer followed by drop nets (36%), and rocket nets (18%).

In WMU 2G, 99 deer were captured on the Sproul State Forest, State Game Lands 100, and surrounding private lands. Fifty collared females were added to the 46 collared females surviving from 2005.

In WMU 4B, 91 deer were captured on the Tuscarora State Forest, State Game Lands 170 and surrounding private lands. Fifty-two collared females were added to the 23 collared females surviving from 2005.

To date, 36 mortalities have been recorded. Hunting caused a third of all recorded mortalities (Table 2). Annual survival estimates, including harvest mortalities, from 1 March 2005 to 1 January 2006 were 86% $\pm$ 5% for WMU 2G and 66% $\pm$ 7% for WMU 4B.

Dispersal analyses have not been completed for the 2005 field season.

Poor weather during the first 2 days of the 2005 firearms season prevented aerial surveys. Initial surveys were flown on the third day.

Preliminary estimates of hunter and radio-collared deer distributions during the firearms season varied by study area. In WMU 2G, where the focus during the 2005 firearms season was on the Sproul State Forest, hunters hunted closer to roads and in areas with less slope than randomly located points (Figures 1 and 2). In WMU 4B, where the focus was on the Tuscarora State Forest, hunter locations were not affected by distance from the nearest road or slope of the area (Figures 1 and 2).

Radio-collared deer distributions varied between study areas. On the Sproul State Forest, radio-collared deer density was not influenced by distance from a road, but generally increased as slope of the land increased (Figures 3 & 4). On the Tuscarora State Forest, radio-collared deer density generally increased as distance from a road and slope of the land increased (Figures 3 & 4). In both study areas, distance of radio-collared deer to the nearest road prior to and during the hunting season did not differ (Table 3).

Based on aerial surveys, hunter densities ranged from approximately 0.1 to 1.0 hunter per square kilometer during the second half of the first week and the last Saturday (Figure 5). Overall, hunter densities were 0.25 ± 0.07 hunters per square kilometer on the Sproul study area and 0.39 ± 0.07 on the Tuscarora study area.

RECOMMENDATIONS

1. Continue telemetry monitoring of survival and movements through at least December 2007.

2. Continue expanded capture activities on areas outside state forests for the 2007 winter trapping season.

3. Conduct analyses of hunter distributions, deer movements, dispersal, and survival and harvest vulnerability modeling activities.

4. Conduct hunter survey flights through the 2007 regular firearms season on each study area.

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Table 1. White-tailed deer captures including recaptures reported in parentheses by sex and age class from January - April 2006 in WMUs 2G and 4B, Pennsylvania. An adult is classified as an animal 1.5 years old or older. Totals do not include 3 trapping-related mortalities.

	WMU		
Sex/age class	2G	4B	Total
Male adults	14 (3)	8 (0)	22 (3)
Male fawns	31 (10)	28 (6)	59 (16)
Female adults	33 (1)	28 (1)	61 (2)
Female fawns	21 (2)	27 (1)	48 (3)
Total	99 (16)	91 (8)	190 (24)

Table 2. Mortality causes for female white-tailed deer in Pennsylvania, January 2005 to June 2006.

	WMU		
Mortality Cause	2G	4B	Total
Hunting	4	8	12
Roadkill	1	2	3
Unrecovered Hunting	2	2	4
Capture-related	5	2	7
Unknown	5	4	9
Other	0	1	1
Total	17	19	36

Table 3. Average distance of radio-collared female white-tailed deer locations to the nearest road prior to and during the regular firearms season in WMUs 2G and 4B, Pennsylvania 2005.

Study Area	Season	Distance (m)	Change (m)	*P*
WMU 2G	Pre-hunting	650		
	Hunting	585	-65	0.488
WMU 4B	Pre-hunting	565		
	Hunting	679	114	0.328

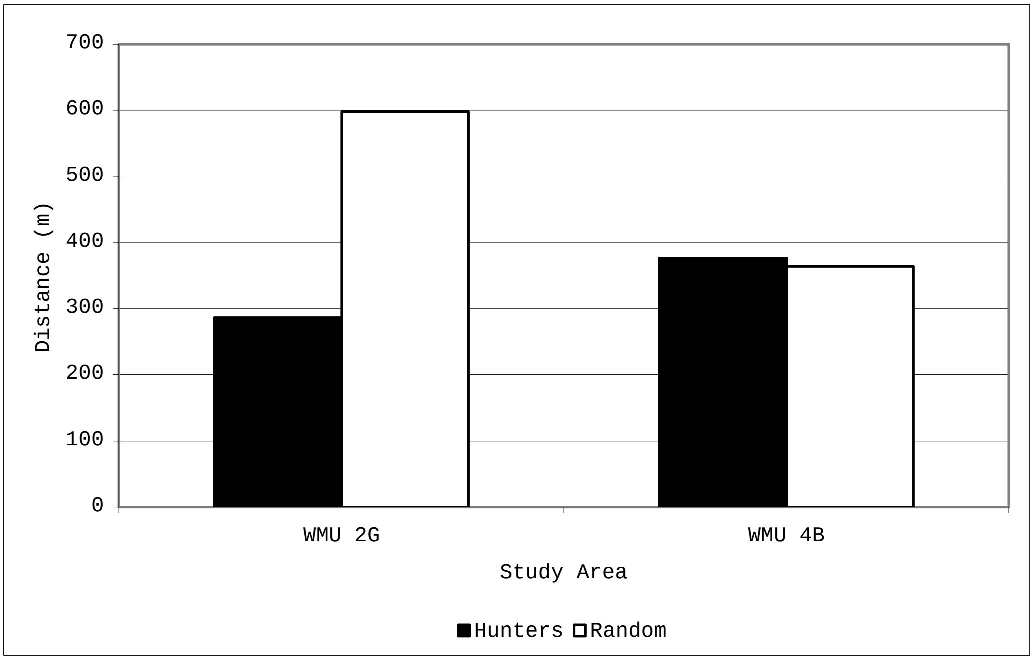

Figure 1. Median distance from nearest road for deer hunter locations during the 2005 regular firearms hunting season and for randomly located points, WMUs 2G and 4B, Pennsylvania.

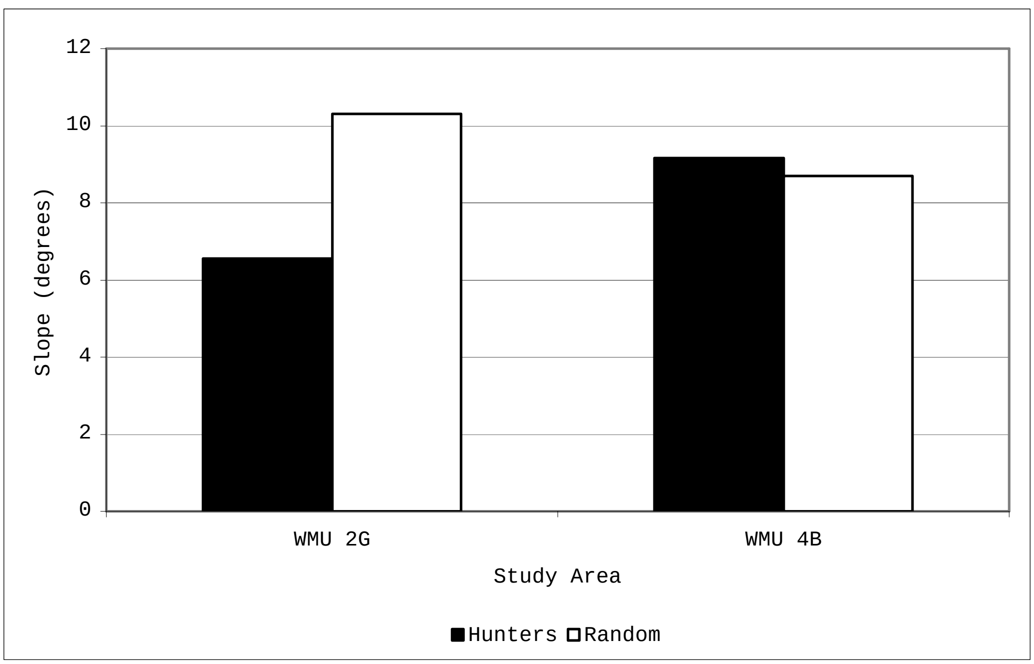

Figure 2. Median slope of land for deer hunter locations during the 2005 regular firearms hunting season and for randomly located points, WMUs 2G and 4B, Pennsylvania.

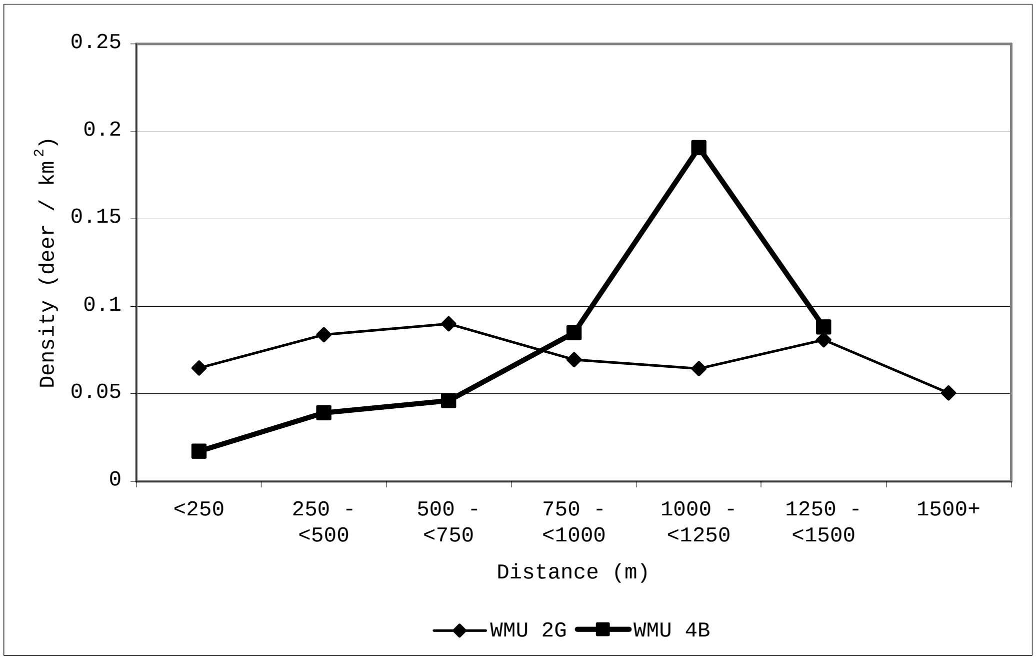

Figure 3. Density of radio-collared deer compared to distance from the nearest road during the 2005 firearms season, WMUs 2G and 4B, Pennsylvania.

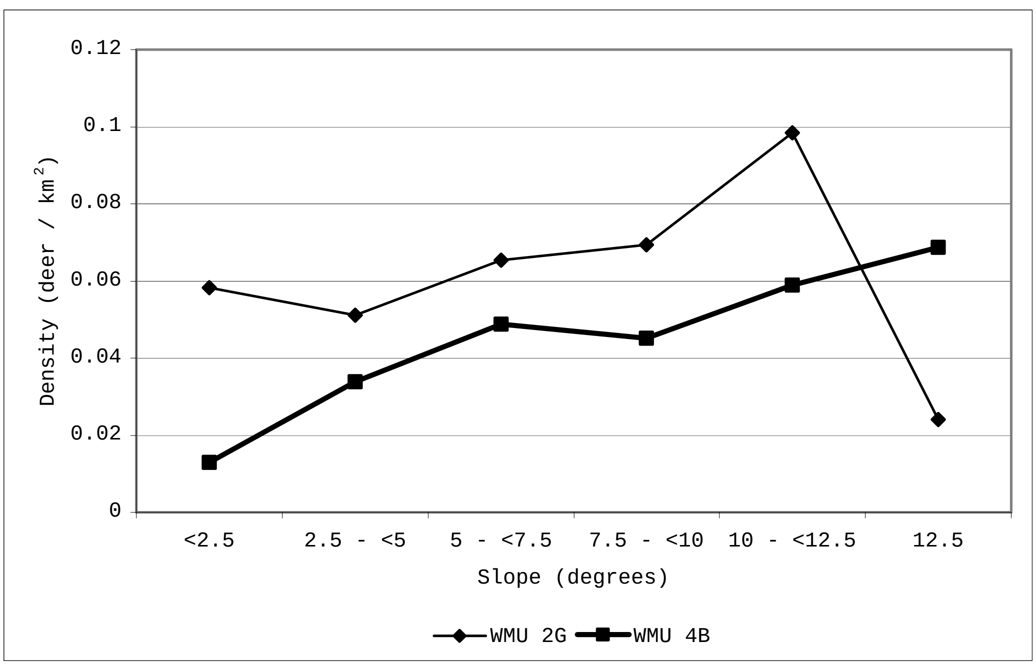

Figure 4. Density of radio-collared deer compared to slope of the land during the 2005 firearms season, WMUs 2G and 4B, Pennsylvania.

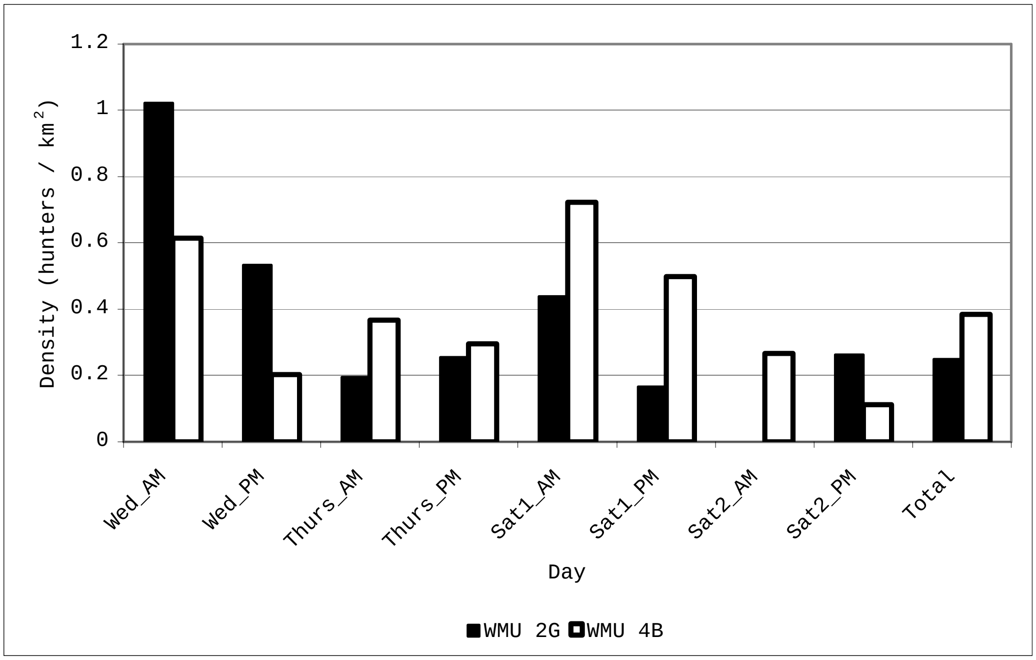

Figure 5. Density of hunters during 2005 deer firearms season by day. Morning (AM) and afternoon (PM) aerial surveys were flown on Wednesday (Wed), Thursday (Thurs), and Saturday (Sat1) of the first week, and the last Saturday (Sat2), WMUs 2G and 4B, Pennsylvania.