PENNSYLVANIA GAME COMMISSION
BUREAU OF WILDLIFE MANAGEMENT
RESEARCH DIVISION
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 2006 through 30 June 2007

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 monitored survival, dispersal, and movements in response to hunting activity of female white-tailed deer (*Odocoileus virginianus*) on expanded study areas in Wildlife Management Units 2G and 4B. As a result of expanded study areas, results from 2005 and 2006 are not directly comparable. Annual survival estimates for females were 83% and 74% in WMUs 2G and 4B, respectively. Hunting accounted for 53% of all recorded mortalities (*n* = 34). To better understand hunter behavior and its influence on female harvest rates, we conducted a survey of Deer Management Assistance Program permit recipients on the Sproul and Tuscarora State Forests. Survey results indicated hunters may be less likely to harvest an antlerless deer wearing a radio collar. As a result, observed harvest rates of radio-collared females may not accurately reflect antlerless harvest rates in the WMU and should be viewed as relative harvest rates among radio-collared females. Based on preliminary analysis, hunter behavior during the 2006 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 tended to be further from the road and in areas with greater slope of the land. Telemetry monitoring of GPS collared females and aerial surveys of hunters in WMU 4B will occur in 2007 with a final report expected by June 2008. Other radio-collared female deer are part of new Project Job 21013.

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. 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 2006 and 2007, 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. We fitted a subset of deer with GPS radiocollars to obtain detailed movement (e.g., bi-hourly locations) information during the hunting season. The Pennsylvania State University (PSU) Institutional Animal Care and Use Committee approved deer handling protocols.

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 XYL 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).

Numerous covariates, such as winter severity, condition of deer, age of deer, predation, and human-related factors such as road density may influence non-hunting survival of white-tailed deer. 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.

We completed a hunter survey to understand hunter willingness to harvest radio-collared female deer on the Sproul and Tuscarora State Forests (Appendix 1). We surveyed all hunters who purchased DMAP permits for DMAP units in the Sproul and Tuscarora State Forests during the 2005-06 hunting seasons. We conducted this survey using standard mail survey protocols (Dillman 1978).

This survey was conducted to gather information from hunters who hunted antlerless deer on our study areas. Surveying DMAP permit holders was the most efficient method to ensure hunters could have hunted and possessed the proper permit to harvest antlerless deer on our study areas. Outside of the DMAP program, that is specific to a local area such as a state forest, antlerless deer are harvested under an antlerless allocation system based on Wildlife Management Units (WMUs). We did not attempt to survey holders of WMU antlerless licenses because a small percentage of them may have actually hunted on our study areas and records of WMU antlerless license purchasers are maintained on paper only. DMAP permit holders provided area specific antlerless deer hunters and records were available electronically. As a result of our sampling, results may not apply to all hunters, but at a minimum would represent attitudes of hunters on our study areas who were willing to purchase additional permits to harvest antlerless deer.

We sent surveys to a total of 614 individual hunters. Our mailing resulted in 5 non-deliverable surveys (i.e., moved with no forwarding address, death, etc.) and 426 usable responses for a response rate of 70%. Due to the response rate after one mailing and a post card reminder, we did not conduct a second mailing. We present results as an estimate (e.g., 55%). These estimates have an associated 95% confidence interval of approximately ± 3%. For example, if 55% of the respondents agreed with a statement, statistically, the interval from 52% (55-3) to 58% (55+3) would include the actual percent of hunters who agreed with the statement 95% of the time.

RESULTS

Annual survival estimates, including harvest mortalities, from 1 January 2006 to 31 December 2006 were 83% ± 8% for WMU 2G and 74% ± 10% for WMU 4B. Hunting accounted for the majority of recorded mortalities (Table 1).

Dispersal analyses have not been completed for the 2005 or 2006 field season.

Preliminary estimates of hunter distributions during the firearms season varied by study area. In WMU 2G, hunters hunted closer to roads and in areas with less slope than randomly located points (Figures 1 and 2). In WMU 4B, hunters tended to hunt areas further from the nearest road and in areas with more slope (Figures 1 and 2).

Based on aerial surveys, hunter densities on public lands in WMU 2G dropped off after Wednesday morning of the first week and remained below 1 hunter per square kilometer for remainder of the firearms season (Figure 3). Hunter densities on private lands in WMU 2G had a similar pattern to public lands (Figure 4). Hunter densities on public lands in WMU 4B increased from opening day morning to Tuesday morning of the first week and then dropped off to approximately 0.5 hunters per square kilometer for the remainder of the season (Figure 3). The exception was the morning of the first Saturday when hunter densities increased to 1.50 hunters per square kilometer. On private lands in WMU 4B, hunter densities declined after opening morning and remained below 0.5 hunters per square kilometer for most of the season (Figure 4). Overall, hunter densities were 0.77 ± 0.04 hunters per square kilometer on WMU 2G study area and 0.59 ± 0.05 on WMU 4B study area.

Based on a hunter survey, hunters were generally undecided when asked if a radio collar would make them more willing (54% undecided) or less willing (47% undecided) to harvest an antlerless deer. Few hunters (9%) agreed that a radio collar would make them more likely to harvest an antlerless deer, but 25% agreed that a radio collar would make them less likely to harvest an antlerless deer. Harvesting an antlerless deer during the 2005-06 hunting seasons did not affect whether a hunter was more willing ($\chi^2 = 2.73$, d.f. = 2, $P = 0.26$) or less willing ($\chi^2 = 2.75$, d.f. = 2, $P = 0.25$) to harvest an antlerless deer with a radio collar.

When presented with a scenario of 2 antlerless deer where one of the deer was wearing a radio collar, few hunters (13%) would harvest the deer with the radio collar. Most were undecided (49%), but 38% would not harvest the antlerless deer with the collar.

For hunters who were more willing to harvest an antlerless deer with a radio collar, 49% were undecided or disagreed that they would harvest an antlerless deer with a radio collar if they saw 2 antlerless deer. Of those who were less likely to harvest an antlerless deer with a radio collar, 70% would not harvest an antlerless deer with a collar if they saw 2 antlerless deer.

Hunters from both study areas were generally similar in their attitudes towards harvesting deer with radio collars, but hunters on the Sproul State Forest were less willing to harvest a deer wearing a radio collar (29% agree vs. 18% agree) than hunters on the Tuscarora State Forest. Another slight difference (P = 0.07) included hunters on the Sproul State Forest being less likely (41% vs. 32%) to harvest an antlerless deer with a radio collar if they saw 2 antlerless deer.

RECOMMENDATIONS

1. Continue telemetry monitoring of survival and movements of GPS equipped female deer through December 2007 in WMU 4B.

2. Complete analyses of hunter distributions, deer movements, dispersal, and survival and harvest vulnerability modeling.

3. Conduct hunter survey flights during the 2007 regular firearms season in WMU 4B.

4. Prepare final report by June 2008.

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Table 1. Mortality causes for female white-tailed deer in Pennsylvania, January - December 2006.

	WMU		
Mortality Cause	2G	4B	Total
Hunting	3	15	18
Hunting-Related[1]	4	0	4
Unrecovered Hunting	0	3	3
Roadkill	3	0	3
Poaching	1	0	1
Predation	2	0	2
Unknown	2	0	2
Total	15	18	33

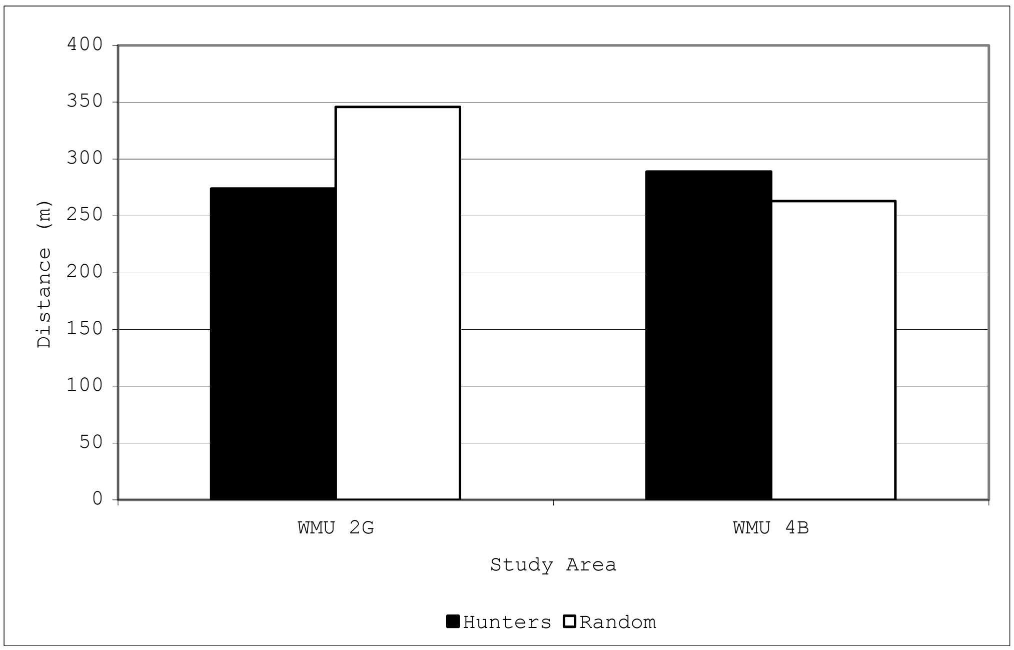

Figure 1. Median distance from nearest road for deer hunter locations during the 2006 regular firearms hunting season and for randomly located points, WMUs 2G and 4B, Pennsylvania.

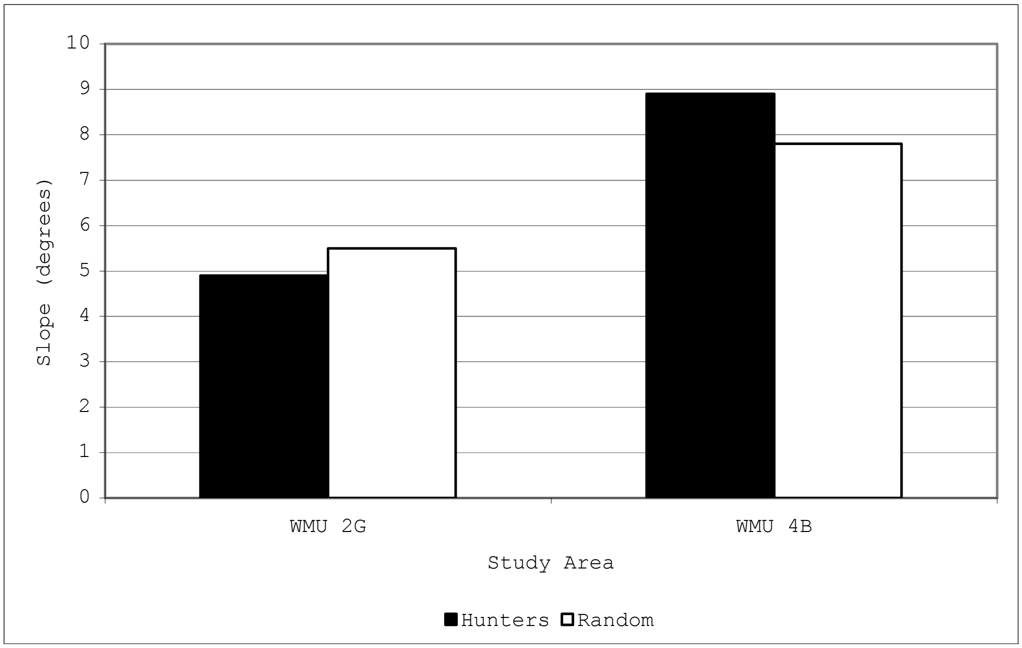

Figure 2. Median slope of land for deer hunter locations during the 2006 regular firearms hunting season and for randomly located points, WMUs 2G and 4B, Pennsylvania.

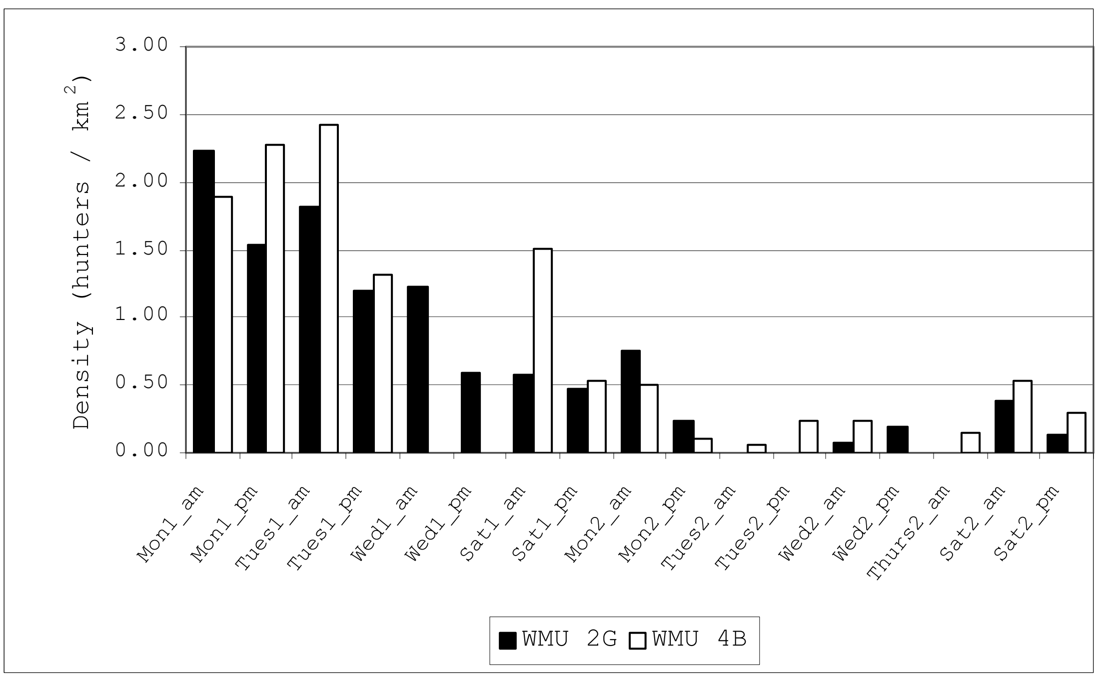

Figure 3. Density of hunters on public lands during 2006 deer firearms season by day. Morning (AM) and afternoon (PM) aerial surveys were flown during the first week (e.g., Mon1) and second week (e.g., Mon2) when weather allowed, WMUs 2G and 4B, Pennsylvania.

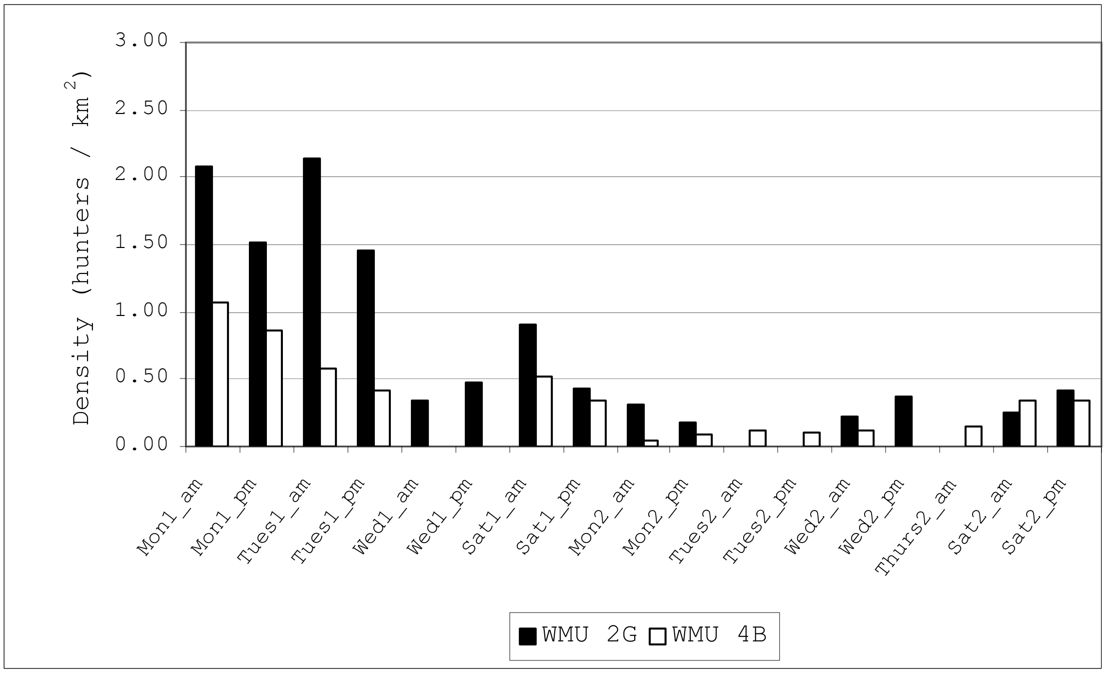

Figure 4. Density of hunters on private lands during 2006 deer firearms season by day. Morning (AM) and afternoon (PM) aerial surveys were flown during the first week (e.g., Mon1) and second week (e.g., Mon2) when weather allowed, WMUs 2G and 4B, Pennsylvania.

APPENDIX 1. Survey questions for DMAP hunters on Sproul and Tuscarora State Forests, Pennsylvania 2006.

1. What is your sex? (**Check one box**)
   1 MALE
   2 FEMALE

2. What year were you born? __________

3. For how many years have you hunted white-tailed deer? (**Check one box**)
   1 LESS THAN 3 YEARS
   2 BETWEEN 3 AND 10 YEARS
   3 MORE THAN 10 YEARS

4. Have you ever seen a deer wearing a radio collar when hunting? (**Check one box**)
   1 NO
   2 YES If YES, in which WMU did you observe this deer? __________

5. How many days did you hunt for white-tailed deer during the 2005 regular firearms season? **(If none, write in 0)** _______ days

6. How many WMU-specific antlerless deer licenses did you purchase in 2005? ________

7. How many antlerless deer did you harvest with WMU-specific antlerless licenses in 2005? _______

8. How many DMAP antlerless permits did you purchase in 2005? ________
   For how many different properties? ________

9. How many antlerless deer did you harvest with DMAP antlerless deer permits in 2005? ________

OPINION QUESTIONS

Please **circle the number** indicating your level of agreement with each statement

10. I am **MORE** willing to harvest **antlerless** deer when…

	Strongly Agree	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
a). The landowner wants more deer harvested on his or her property	**1**	**2**	**3**	**4**	**5**
b). My hunting group or I need more venison	**1**	**2**	**3**	**4**	**5**
c). A deer is wearing a radio collar	**1**	**2**	**3**	**4**	**5**
d). I have already filled my buck tag.	**1**	**2**	**3**	**4**	**5**
e). I see a lot of deer in my hunting area.	**1**	**2**	**3**	**4**	**5**

11. I am **LESS** willing to harvest **antlerless** deer when…

	Strongly Agree	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
a). I did not already harvest a buck.	**1**	**2**	**3**	**4**	**5**
b). A deer is wearing a radio collar.	**1**	**2**	**3**	**4**	**5**
c). My friends think it is more challenging to harvest a buck than a doe.	**1**	**2**	**3**	**4**	**5**
d). I do not see enough deer in my hunting area.	**1**	**2**	**3**	**4**	**5**
e). Another hunter in my family or group has already harvested a doe.	**1**	**2**	**3**	**4**	**5**

12. To what extent do you agree with the following statements about your willingness to legally harvest deer in your hunting area?

	Strongly Agree	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
a). If I saw 2 legal antlered deer, and one was wearing a radio collar, I would harvest the deer **with** the radio collar.	**1**	**2**	**3**	**4**	**5**
b). If I saw 2 legal antlerless deer, and one was wearing a radio collar, I would harvest the deer **with** the radio collar.	**1**	**2**	**3**	**4**	**5**
c). If I saw 2 legal antlered deer, and one was wearing a radio collar, I would harvest the deer **with larger antlers, regardless of whether it had a radio collar**.	**1**	**2**	**3**	**4**	**5**