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ENVIRONMENTAL IMPACT RESEARCH PROGRAM DEER SPOTLIGHT
CENSUS SECTION 643 U. (U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS ENVIR.. W A MITCHELL
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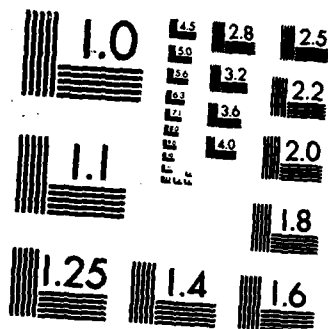
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**ENVIRONMENTAL IMPACT
RESEARCH PROGRAM**

TECHNICAL REPORT EL-86-53

DEER SPOTLIGHT CENSUS

Section 6.4.3, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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OCT 17 1986



July 1986
Final Report

Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000
Under EIRP Work Unit 31631

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AD-A173136

REPORT DOCUMENTATION PAGE				Form Approved OMB No 0704-0188 Exp Date Jun 30, 1986	
1a. REPORT SECURITY CLASSIFICATION <u>Unclassified</u>			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE			Approved for public release; distribution unlimited.		
4. PERFORMING ORGANIZATION REPORT NUMBER(S) <u>Technical Report EI-86-53</u>			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION <u>USAEWES</u> <u>Environmental Laboratory</u>		6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION		
6c. ADDRESS (City, State, and ZIP Code) <u>PO Box 631</u> <u>Vicksburg MS 39180-0631</u>			7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION <u>US Army Corps of Engineers</u>		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code) <u>Washington, DC 20314-1000</u>			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
					WORK UNIT ACCESSION NO <u>EIRP 31631</u>
11. TITLE (Include Security Classification) <u>Deer Spotlight Census: Section 6.4.3, US Army Corps of Engineers Wildlife Resources Management Manual</u>					
12. PERSONAL AUTHOR(S) <u>Mitchell, Wilma A.</u>					
13a. TYPE OF REPORT <u>Final report</u>		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Year, Month, Day) <u>July 1986</u>	
15. PAGE COUNT <u>25</u>					
16. SUPPLEMENTARY NOTATION <u>Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.</u>					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Deer census techniques <u>Odocoileus virginianus</u>		
			Spotlight counts <u>Odocoileus hemionus</u>		
			Population density		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
> The spotlight technique for censusing deer (<i>Odocoileus</i> spp.) is provided as Section 6.4.3 of the US Army Corps of Engineers Wildlife Resources Management Manual. This is one of several methods that the Corps District or project biologist may employ to estimate deer populations on project lands. Aspects of the census discussed in this report include regional application, timing, sampling design, counting procedure, and data analysis and interpretation. The spotlight census is used to inventory both white-tailed deer (<i>O. virginianus</i>) and mule deer (<i>O. hemionus</i>) in open or semiopen habitats. It is routinely conducted in Texas and Oregon to ascertain annual population trends, estimate population densities, and determine herd composition. In this report regional application and optimum seasonal timing of surveys are discussed, and transect specifications and equipment needs are (Continued)					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION <u>Unclassified</u>		
22a. NAME OF RESPONSIBLE INDIVIDUAL			22b. TELEPHONE (Include Area Code)		22c. OFFICE SYMBOL

19. ABSTRACT (Continued).

defined. Detailed instructions are given for establishing transect lines, taking visibility readings for acreage determination, and counting spotlighted deer. Formulas for calculating acreage surveyed, population density, sex ratios, and fawn success are accompanied by numerical examples that illustrate each of the computations. Reproducible forms used for collecting spotlight survey data are provided in the Appendix.

Keywords: Spotlight Counts.

PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. David Mathis, Water Resources Support Center.

This report was prepared by Dr. Wilma A. Mitchell, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES). Mr. Chester O. Martin, Team Leader, Wildlife Resources Team, WTHG, was principal investigator for the work unit. The following individuals contributed information to the report: Dr. Gene W. Wood, Baruch Forest Institute of Clemson University, Georgetown, S. C.; Mr. Horace G. Gore, Texas Parks and Wildlife Department (TPWD), Austin; Mr. Samuel L. Brownlee, TPWD, Alpine; Mr. Gary E. Spencer, TPWD, Jasper; Mr. David R. Synatzske, TPWD, Artesia Wells; and Mr. Robert N. Jubber, Oregon Department of Fish and Wildlife, Portland. Review and comments were provided by Mr. Martin and Mr. James W. Teaforde, WTHG.

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COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

This report should be cited as follows:

Mitchell, Wilma A. 1986. "Deer Spotlight Census: Section 6.4.3, US Army Corps of Engineers Wildlife Resources Management Manual," Technical Report EL-86-53, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.



Distribution /	
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NOTE TO READER

This report is designated as Section 6.4.3 in Chapter 6 -- CENSUS AND SAMPLING TECHNIQUES, PART 6.4 -- MAMMAL SURVEY/CENSUS TECHNIQUES, of the US ARMY CORPS OF ENGINEERS RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 6.

DEER SPOTLIGHT CENSUS

Section 6.4.3, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

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The spotlight census is a convenient and relatively inexpensive method used to inventory both white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*) populations in open to semiopen habitats. Census data may be used to ascertain annual population trends or to estimate densities; herd composition can be determined and used in lieu of harvest data.

The spotlight technique has several advantages over other census methods. It requires minimum equipment and fewer man-days per unit area than other ground techniques (Litton 1972, Harwell et al. 1979, Brownlee 1981) and produces little disturbance of deer (Dealy 1966). A much larger sample can be obtained by spotlighting than by walking strip transects such as the Hahn cruise (Darr 1971). Studies conducted in Texas in areas of low to moderate population densities showed that spotlight counts produce more consistent results than daylight mobile counts, the Hahn cruise, or track counts (Harwell et al. 1979).

REGIONAL APPLICATION

Because visibility is the key factor in obtaining reliable data, spotlight counts are applied chiefly in regions with large proportions of open

country. The most suitable habitats are agricultural fields, cultivated or rangeland meadows, prairie, grassland savannah, and semioopen brushland (Progulske and Duerre 1964, Harwell et al. 1979); however, counts conducted in moderately open southeastern pine forests have also produced reliable results (G. W. Wood, Baruch Forest Science Institute of Clemson University, pers. commun., 1982).^{*} Dense woody vegetation or any other factor that severely limits visibility renders the spotlight census infeasible. This technique is used routinely for surveying white-tailed deer statewide in Texas (Harwell and Gore 1981), black-tailed deer (*O. h. columbianus*) in western Oregon (R. N. Jubber, Oregon Department of Fish and Wildlife, pers. commun., 1981), and desert mule deer (*O. h. crooki*) in the Trans-Pecos region of Texas (S. L. Brownlee, Texas Parks and Wildlife Department, pers. commun., 1982). Spotlight counts are also being used in white-tailed deer research on the coastal plain of South Carolina (Wood, pers. commun., 1982).

PRECAUTIONS

Every effort must be made to prevent public misunderstanding that could result from confusion of spotlight counts with illegal nightlighting. Before initiation of spotlight activity, the project objectives and operational procedures should be discussed with appropriate agencies and individuals. These include the state wildlife conservation agency, district wildlife biologists of other agencies such as the USDA Forest Service and the USDA Soil Conservation Service, county and local law enforcement personnel, highway patrolmen on duty within the management area vicinity, local wildlife officers, and landowners whose properties adjoin Corps units to be surveyed. Law enforcement officers and landowners should also be notified before each spotlight survey. Adherence to this procedure is essential for maintaining effective public relations and cooperation of law officers throughout the census period.

Because it is vital to a successful survey, notification policy warrants special consideration and has, therefore, been discussed as a separate topic. Additional precautions are incorporated into this account where needed for emphasis.

^{*} After first mention, each personal communication will be cited as follows: (surname, pers. commun., date).

TIMING

The time to conduct spotlight counts will depend upon the geographical region and the objectives of the census. In South Dakota, Progulske and Duerre (1964) censused white-tailed deer throughout the summer to estimate population density and to study herd structure. To evaluate these same parameters the Texas Parks and Wildlife Department annually surveys white-tailed and desert mule deer in late summer and early fall (Harwell and Gore 1981; Brownlee, pers. commun., 1982). However, the Oregon Department of Fish and Wildlife counts black-tailed deer in spring to ascertain population trends and in late fall and early winter to determine herd composition (Jubber, pers. commun., 1982).

If only one census period is feasible for collecting both density and herd structure data, the optimum time would be from mid-July through early September. The highest average counts for white-tailed deer have been found in late July in northeast Texas (Alexander 1966) and mid-September in South Dakota (Progulske and Duerre 1964). The most reliable data for determining herd composition will be collected toward the latter part of this time interval; by late August bucks are readily discernible, and in most parts of the country the majority of the fawn crop has been added to the population. The census should be completed by mid-September on management units that contain or are surrounded by high mast production areas away from spotlight routes. Deer begin to move into hardwood forests by early fall, and spotlight counts may drop sharply, biasing the results (G. E. Spencer, Texas Parks and Wildlife Department, pers. commun., 1982). A split census could be undertaken wherein adult counts are made in July when fawn counts are low; following doe-fawn observations of the early September census, herd structure data could be adjusted for fawn production (H. G. Gore, Texas Parks and Wildlife Department, pers. commun., 1982).

SAMPLING DESIGN

Transect Specifications

One 15-mile transect, also referred to as a census line or route, is adequate to sample 5000 to 7000 acres of deer habitat. For example, the Texas Parks and Wildlife Department runs 2 routes on the 15,000-acre Chaparral Wildlife Management Area in the South Texas Plains and 1 route on the

11,000 acre Engeling Wildlife Management Area in the Post Oak Savannah of east Texas (Gore, pers. commun., 1982).

Permanent transects should be established in vegetation types representative of the area, and routes should include proportional amounts of these types. For example, if 40% of a management area is forested and 60% is open, approximately 40% of the total lines should pass through woodlands and 60% through open habitats. Major vegetation types can be determined from a vegetation map of the area or from visual estimates made before route selection. Distribution of transects based on geologic soil type may also be necessary in some sections of the country, as in the Trans-Pecos region of Texas where mule deer densities are highly correlated with soil types (Brownlee 1981).

Routes should be continuous in open habitats but may be segmented through areas containing dense cover. Freedom from vehicular disturbance is essential; therefore, transects must be located on infrequently traveled roads, well away from recreational areas used during the hours of census. Areas used only during daytime, such as picnic grounds, may be included on the spotlight routes. The exact location of each line should be marked clearly on a management area map to be retained for permanent use.

Because of transect requirements, routes cannot always be selected in a truly random manner. If the objective of the census is to estimate deer density for the entire management unit, adherence to a more random sampling design may be preferable. However, if the objective is to determine population trends by counting deer where they are in evidence, placing routes in accessible deer habitat with good visibility may be more feasible and provide more accurate information than completely random sampling.

Sample Size

Each transect should be censused as many times as possible. Ideally, routes should be run from 3 to 5 times at standard intervals during a 30- to 45-day period (Gore, pers. commun., 1982). If time and personnel are available, all transects could be surveyed 5 times during this period on areas containing deer habitat of 20,000 acres or less. Reliable density estimates require a minimum of 2 counts per line; however, 1 count may provide valuable trend information if time and personnel are limited (D. R. Synatzske, Texas Parks and Wildlife Department, pers. commun., 1982).

EQUIPMENT

The spotlight count should be made from the back of a pickup truck that has been properly serviced to eliminate excessive noise. A frame with an observation platform can be placed immediately behind the cab on a level with its top. This arrangement allows the spotters to remain seated throughout the survey and facilitates visibility by elevating their line of sight.

The spotlight must be capable of illuminating deer at distances of 200 to 300 yards; sealed beam, 12-volt lamps of 200,000 to 300,000 candlepower meet this requirement. Lightweight, handheld lamps are inexpensive and readily available from sporting goods retailers. Although aircraft landing lights and marine searchlights are good sources of illumination, these may require special mounts for convenient handling. Bulbs from spotlights of 300,000 candlepower may be replaced by 4-in. bulbs (GE#4509) from aircraft landing lights; these can be purchased from auto parts stores. Although this lamp will produce only 110,000 candlepower, it is adequate for covering distances of 200 to 250 yards.

The spotlights can be hooked directly to the battery, or a weatherproof socket with a 3-prong plug can be mounted on the vehicle and connected to the battery. If only one lamp is used, it may be plugged into the cigarette lighter. Battery drain will be minimal if RPM's are maintained; however, an extra battery should be available for a truck with an automatic transmission.

Each spotter needs a set of binoculars of not less than 6 power to aid in the accurate identification of deer sex and age classes. For personal comfort, binoculars should be lightweight and attached to a wide strap (e.g., camera strap) that fits around the spotter's neck.

THE COUNTING PROCEDURE

Spotlight counts must be conducted on clear nights because fog and rain limit visibility and render the results unreliable. In most areas the count is begun from 1 to 2 hours after official sunset; however, on the Welder Wildlife Refuge in south Texas best results have been obtained after 33% of the nocturnal time period has elapsed (Fafarman and DeYoung 1986). Once the count has started, it should be continued without undue interruption until the transect has been completed. Three hours may be required to survey a 15-mile line; to prevent spotter fatigue, which contributes to sampling error, only

1 route of this length should be run per census night. Replicate surveys of a transect always proceed in the same direction as the original survey.

A crew ideally consists of 3 members--1 person to drive and record data and 2 people to spotlight and count deer. The vehicle is driven with dim lights at 5 to 10 mph, the driver stopping briefly only when necessary for the spotters to determine sex and age or count large groups of deer.

The spotters may stand behind the cab or be seated on an observation platform at cabtop level; each spotter is responsible for the habitat on one side of the road. Spotlights are kept moving to thoroughly cover the visible area, but they must be turned off upon approaching another vehicle or a recreational area in use.

Bucks, does, fawns, and unclassified deer (those whose sex or age cannot be identified) are called out to the recorder at the end of each 1-mile segment and totaled for the entire route. Sex and age are recorded for individuals of a group only if these characteristics can be determined for all animals in the group. Herd composition results would be biased by including a few deer that are easily categorized with many for which age and sex cannot be determined. Deer are not recorded if estimated to be beyond the limits of maximum visibility (refer to Visibility Readings section). Recording deer at greater distances would bias results because those deer would be outside the area covered by the census.

Also recorded are time limits of the survey, official sunset, and weather data for the beginning and end of the survey. A data sheet recommended for recording spotlight counts is given in the Appendix (Form 1).^{*} Separate forms or additional columns on this form should be used for recording more than 1 species of deer. For convenience the driver may prefer using a tape recorder with microphone during the survey and later transferring the information to data sheets.

VISIBILITY READINGS

Determination of the acreage surveyed is essential for converting spotlight count data to population density estimates. The acreage covered by a transect is calculated from visibility readings taken at permanent stations along the survey route. The visibility reading is an estimate of the distance

^{*} Examples of all suggested forms are shown in the Appendix.

in yards that a deer can be observed along a line perpendicular to the transect. Visibility is a function of vegetation density, and maximum visibilities may range from 300 yd in open habitat to less than 100 yd in areas of moderately dense vegetation. The Texas Parks and Wildlife Department considers 250 yd to be maximum for statewide surveys (Harwell and Gore 1981). Maximum visibility for the area is best determined before the census, as deer are not included in the count if spotted beyond that limit. (Refer to Data Analysis and Interpretation section for an explanation of the computation and use of visibility data.)

Visibility readings are taken only one time per season for each census line and are independent of survey activity. Estimates for a transect may be made immediately before or after the first nightly survey, but preferably in advance of initial counts. The crew should take the readings on a clear night, proceeding along a route in the same direction as the spotlight count. Visibilities are estimated at the beginning and end of each census line and at uniform intervals, designated as stations, between these points. While the vehicle is moving at 5 to 10 mph, readings are taken at each station on both sides of the road and are recorded on a data sheet similar to the one used by the Texas Parks and Wildlife Department (Form 2). The spotlights should be of the same candlepower as those used for the census.

The determination of interstation distance depends upon the amount of vegetation and diversity of habitat types along the census lines but should be standard for the entire sampling area. Tests conducted in Texas (Harwell et al. 1979) showed that readings could be taken every 0.5 mile in prairie and open rangeland and have the visibility for a transect within 20% of the mean visibility 95% of the time. However, readings taken every 0.2 mile were required to maintain this precision in the heavier cover of the Pineywoods and Post Oak Savannah areas. Lines with abrupt changes in habitat will require more visibility readings than lines within consistent habitat. Harwell et al. (1979) recommended readings of 0.1 mile to ensure adequate precision of estimates for segments within transects.

Proficiency in estimating visibility is essential and should be acquired before the seasonal readings are taken. Fafarman (1978) found that spotlight distances tended to be underestimated in areas with visibilities of 75 yd or more. Distances up to 300 yd can be marked for spotters or other personnel to identify until confidence in estimation is achieved. However, actual readings

can be taken by having a person measure the distance that a spotter can see a white flag on each side of the road at every station. The latter procedure is more time-consuming but more nearly accurate than estimating distances (Gore, pers. commun., 1982).

PERSONNEL AND COSTS

Major costs are those of manpower and vehicle operation. A team of 3 members requires from 6 to 9 man-hours to survey a 15-mile transect and from 3 to 4 man-hours to estimate visibility. Vehicle operational costs are based on mileage, cost of fuel, and maintenance. Equipment expenditures are minimal.

Manpower costs can be minimized if the census is conducted by personnel who are on night duty during summer months. One spotter may be used; however, less area can be surveyed by a 2-member team, and data are likely to be less complete than those collected by 3 people (Harwell et al. 1979).

DATA ANALYSIS AND INTERPRETATION

Acreage Determination

Deer density is related to acres or hectares of habitat and is generally stated as the number of acres or hectares per deer. The visibility readings are used to calculate the acreage surveyed on each transect. The length of the transect and the average visibility represent the length and width, respectively, of the area covered by a survey route. The area is calculated in square yards and converted to acreage by using the equivalent units

1 mile = 1760 yd
1 acre = 4840 sq yd

For each transect, the visibility readings are totaled and acreage is calculated by the following steps:

1. Length of transect in yards = miles $\times$ 1760
2. Average width in yards = $\frac{\text{total visibility in yards}}{\text{number of stations}}$

Note: The first mile will include 1 station more than other 1-mile segments because a visibility reading is taken at the beginning of the line (0 miles).

3. Square yards in transect = length of transect $\times$ average width

$$4. \text{ Acres of visibility} = \frac{\text{square yards in transect}}{4840}$$

The use of visibility readings to calculate acreage is illustrated in Example 1.

Population Density

To calculate deer density for the acreage represented by any transect, divide the acreage by the average of all replicate counts for the season:

$$D = \text{acres per deer} \\ = \frac{\text{acreage (from visibility readings)}}{\text{average number of deer (from spotlight counts)}}$$

Population density is defined as the number of animals per unit area; however, deer density is more accurately expressed as 1 deer per number of acres. To find density in metric units, use the conversion factor, 1 acre = 0.4047 ha. For example, a density of 1 deer per 25 acres is equivalent to 1 deer per 10 ha.

Population density for the management unit is calculated by totaling the acreage surveyed on all transects and dividing by the total average numbers of deer counted on all transects. The number of deer on the management unit can be estimated by dividing the management unit acreage by D (acres per deer) obtained from the census. The estimation of population density and total population is shown in Example 2.

The above calculations can be used to estimate population densities within major vegetation types on a management unit. However, vegetation data must be collected and recorded with the visibility readings (Forms 3 and 4), and the spotlight surveys must include the vegetation type in which each deer is counted. If transects have been properly distributed through major vegetation types, this procedure would be unnecessary on units with small blocks of interspersed vegetation. Its best application would be on management units that contain extensive tracts of different vegetation types. The data used in Example 1 indicate such a hypothetical situation, but it is given here to illustrate the variation that can occur among diverse habitats. Line 1 could represent open vegetation, whereas Line 3 would be more typical of forests such as longleaf pine. Estimating population density for the entire area should be sufficient to fulfill management objectives on most management units.

Example 1

Calculation of Acreage from Visibility Readings

Assume that deer spotlight surveys were conducted on three 15-mile transects of a 20,000-acre (8094-ha) wildlife management area. The stations were located at 0.1-mile intervals. Using the steps given on page 10, calculate the acreage covered by each transect if total visibilities were

Line 1	31,250 yd
Line 2	20,700 yd
Line 3	12,100 yd

The number of stations per transect is 151, and the length of each transect is 26,400 yd (15×1760).

The acreage covered by Line 1 is calculated as follows:

$$\begin{aligned}\text{Average width} &= \frac{31,250}{151} \\ &= 207 \text{ yd} \\ \text{Area} &= 26,400 \times 207 \\ &= 5,464,800 \text{ sq yd} \\ \text{Acres of visibility} &= \frac{5,464,800}{4840} \\ &= 1129 \text{ acres}\end{aligned}$$

Acreages for Lines 2 and 3 would be 747 and 436 acres, respectively.

To find the area surveyed in hectares, multiply the number of acres by the conversion factor 0.4047. The number of hectares covered by each transect would be

Line 1	457 ha
Line 2	302 ha
Line 3	176 ha

Example 2

Calculation of Population Density from Spotlight Data

Assume that the spotlight census on the management area in Example 1 produced the following average counts:

	<u>Bucks</u>	<u>Does</u>	<u>Fawns</u>	<u>Unclassified</u>	<u>Total</u>
Line 1	10	20	8	13	51
Line 2	5	8	4	8	25
Line 3	<u>2</u>	<u>5</u>	<u>3</u>	<u>2</u>	<u>12</u>
Total	17	33	15	23	88

Use data from the table above and the acreages found in Example 1 to estimate population densities on the management area.

- a) With the equation from page 11, calculate deer density for the acreage covered by each transect. Density for Line 1 would be

$$D = \frac{1129}{51}$$

= 22, expressed as 1 deer per 22 acres (9 ha)

Population densities for Lines 2 and 3 would be 1 deer per 30 acres (12 ha) and 1 deer per 36 acres (14.5 ha), respectively.

- b) Calculate the population density for the management area.

$$\text{Total area surveyed} = 1129 + 747 + 436$$

$$= 2312 \text{ acres (936 ha)}$$

$$\text{Total average numbers of deer} = 51 + 25 + 12 = 88$$

$$D = \frac{2312}{88}$$

= 26, expressed as 1 deer per 26 acres (10.5 ha)

- c) Find the total number of deer on the 20,000-acre management area area.

$$\text{Total number of deer} = \frac{\text{management area acreage}}{\text{acres per deer}}$$

$$= \frac{20,000}{26}$$

$$= 769$$

Sex Ratios and Fawn Success

Sex ratios and fawn success can be calculated from the spotlight count data. The average numbers of bucks, does, and fawns observed on all transects are totaled. The buck:doe ratio is obtained by dividing the number of bucks by the number of does; the ratio is then expressed as number of bucks per 100 does. The fawn:doe ratio is found by dividing the number of fawns by the number of does and is expressed as number of fawns per 100 does. The ratios can be combined and written as number of bucks:100 does:number of fawns.

To estimate the number of bucks, does, and fawns on a management area, the following formulas are used:

1. $\frac{\text{Total number deer on area}}{\text{Sum of buck:doe:fawn ratio}} = \text{units of deer on area}$
2. Deer units $\times$ number bucks per 100 does = number bucks on area
3. Deer units $\times$ 100 = number does on area
4. Deer units $\times$ number fawns per 100 does = number fawns on area

Example 3 illustrates the use of spotlight data to determine sex ratios and fawn success and to estimate the numbers of bucks, does, and fawns on a management area.

Annual Comparisons

After 2 years of spotlight counts, annual comparisons can be made to determine whether significant deer population changes have occurred on a management area. Analysis of variance can be applied to trend or density data to ascertain differences between years and among vegetation types and transect segments. Student's T test or the F test are appropriate statistical tests that may be used to detect significant differences in count data. Instructions for the computation of these tests can be found in any standard statistical methods textbook, such as Principles and Procedures of Statistics (Steel and Torrie 1960), Biostatistical Analysis (Zar 1974), and Statistical Methods (Snedecor and Cochran 1980).

Example 3

Calculation of Sex Ratios and Fawn Success from Spotlight Data

For the following computations refer to the spotlight survey data presented in the table of Example 2.

- a) Calculate the sex ratios and fawn success for the management area.

Buck:doe ratio = $\frac{17}{33} = 0.52$, expressed as 52:100
or 52 bucks per 100 does

Fawn:doe ratio = $\frac{15}{33} = 0.45$, expressed as 45:100
or 45 fawns per 100 does

Buck:doe:fawn ratio = 52:100:45

Sum of buck:doe:fawn ratio = 197

- b) Using the formulas provided on page 14, calculate the number of bucks, does, and fawns estimated for the management area. (Total number of deer = 769.)

1. $\frac{769}{197} = 3.90$ deer units
2. $3.90 \times 52 = 203$ bucks
3. $3.90 \times 100 = 390$ does
4. $3.90 \times 45 = \underline{176}$ fawns

769 deer

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APPENDIX: DEER SPOTLIGHT SURVEY FORMS

FORM 1. DEER SPOTLIGHT SURVEY

MANAGEMENT UNIT _____ LINE _____

DATE _____ SUNSET _____ P.M. TIME BEGAN _____ ENDED _____

START: TEMP. _____ CLOUD COV. _____ WIND SPEED _____ WIND DIR. _____ ODOMETER READING _____

END: TEMP. _____ CLOUD COV. _____ WIND SPEED _____ WIND DIR. _____ ODOMETER READING _____

OBSERVERS _____

MILE	NO. OF DEER				TOTAL OBSERVED
	BUCKS	DOES	FAWNS	UNCLASSIFIED	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
TOTAL					

ACRES OF VISIBILITY _____

DOES PER BUCK _____

ACRES PER DEER _____

FAWNS PER DOE _____

FORM 2. VISIBILITY FOR DEER SPOTLIGHT SURVEY TRANSECT

MANAGEMENT UNIT _____		LINE _____		DATE _____		OBSERVER _____	
VIS L + VIS R = TOTAL		VIS L + VIS R = TOTAL		VIS L + VIS R = TOTAL		VIS L + VIS R = TOTAL	
MILE*							
START		3.8		7.5		11.3	
0.1		3.9		7.6		11.4	
0.2		4.0		7.7		11.5	
0.3		SUBTOTAL		7.8		11.6	
0.4		4.1		7.9		11.7	
0.5		4.2		8.0		11.8	
0.6		4.3		SUBTOTAL		11.9	
0.7		4.4		8.1		12.0	
0.8		4.5		8.2		SUBTOTAL	
0.9		4.6		8.3		12.1	
1.0		4.7		8.4		12.2	
SUBTOTAL		4.8		8.5		12.3	
1.1		4.9		8.6		12.4	
1.2		5.0		8.7		12.5	
1.3		SUBTOTAL		8.8		12.6	
1.4		5.1		8.9		12.7	
1.5		5.2		9.0		12.8	
1.6		5.3		SUBTOTAL		12.9	
1.7		5.4		9.1		13.0	
1.8		5.5		9.2		SUBTOTAL	
1.9		5.6		9.3		13.1	
2.0		5.7		9.4		13.2	
SUBTOTAL		5.8		9.5		13.3	
2.1		5.9		9.6		13.4	
2.2		6.0		9.7		13.5	
2.3		SUBTOTAL		9.8		13.6	
2.4		6.1		9.9		13.7	
2.5		6.2		10.0		13.8	
2.6		6.3		SUBTOTAL		13.9	
2.7		6.4		10.1		14.0	
2.8		6.5		10.2		SUBTOTAL	
2.9		6.6		10.3		14.1	
3.0		6.7		10.4		14.2	
SUBTOTAL		6.8		10.5		14.3	
3.1		6.9		10.6		14.4	
3.2		7.0		10.7		14.5	
3.3		SUBTOTAL		10.8		14.6	
3.4		7.1		10.9		14.7	
3.5		7.2		11.0		14.8	
3.6		7.3		SUBTOTAL		14.9	
3.7		7.4		11.1		15.0	
				11.2		SUBTOTAL	
						GRAND TOTAL	

* VISIBILITY IS RECORDED AT 0.1-MILE INTERVALS.

FORM 3. VISIBILITY AND VEGETATION FOR DEER SPOTLIGHT SURVEY TRANSECT

MANAGEMENT UNIT _____ OBSERVER _____ LINE _____ DATE _____

* MILE START	VEG. VIS.		VIS. VEG.		4.0	VEG. VIS.		VIS. VEG.		8.0	VEG. VIS.		VIS. VEG.		12.0
	UNIT	L	R	UNIT		UNIT	L	R	UNIT		UNIT	L	R	UNIT	
0.1					4.1					8.1					12.1
0.2					4.2					8.2					12.2
0.3					4.3					8.3					12.3
0.4					4.4					8.4					12.4
0.5					4.5					8.5					12.5
0.6					4.6					8.6					12.6
0.7					4.7					8.7					12.7
0.8					4.8					8.8					12.8
0.9					4.9					8.9					12.9
1.0					5.0					9.0					13.0
1.1					5.1					9.1					13.1
1.2					5.2					9.2					13.2
1.3					5.3					9.3					13.3
1.4					5.4					9.4					13.4
1.5					5.5					9.5					13.5
1.6					5.6					9.6					13.6
1.7					5.7					9.7					13.7
1.8					5.8					9.8					13.8
1.9					5.9					9.9					13.9
2.0					6.0					10.0					14.0
2.1					6.1					10.1					14.1
2.2					6.2					10.2					14.2
2.3					6.3					10.3					14.3
2.4					6.4					10.4					14.4
2.5					6.5					10.5					14.5
2.6					6.6					10.6					14.6
2.7					6.7					10.7					14.7
2.8					6.8					10.8					14.8
2.9					6.9					10.9					14.9
3.0					7.0					11.0					15.0
3.1					7.1					11.1					
3.2					7.2					11.2					
3.3					7.3					11.3					
3.4					7.4					11.4					
3.5					7.5					11.5					
3.6					7.6					11.6					
3.7					7.7					11.7					
3.8					7.8					11.8					
3.9					7.9					11.9					

* VISIBILITY AND VEGETATION
ARE RECORDED AT
0.1-MILE INTERVALS.

FORM 4. VISIBILITY CALCULATIONS FOR DEER SPOTLIGHT SURVEY

MANAGEMENT UNIT _____		LINE _____		LENGTH IN MILES _____		DATE _____	
VEG. TYPE: _____	MILES: _____	NO. STATIONS: _____	TOTAL VIS. IN YARDS: _____	AVERAGE VIS./STATION: _____	TOTAL ACREAGE VEG. TYPE: _____		
VEG. TYPE: _____	MILES: _____	NO. STATIONS: _____	TOTAL VIS. IN YARDS: _____	AVERAGE VIS./STATION: _____	TOTAL ACREAGE VEG. TYPE: _____		
VEG. TYPE: _____	MILES: _____	NO. STATIONS: _____	TOTAL VIS. IN YARDS: _____	AVERAGE VIS./STATION: _____	TOTAL ACREAGE VEG. TYPE: _____		
VEG. TYPE: _____	MILES: _____	NO. STATIONS: _____	TOTAL VIS. IN YARDS: _____	AVERAGE VIS./STATION: _____	TOTAL ACREAGE VEG. TYPE: _____		
VEG. TYPE: _____	MILES: _____	NO. STATIONS: _____	TOTAL VIS. IN YARDS: _____	AVERAGE VIS./STATION: _____	TOTAL ACREAGE VEG. TYPE: _____		

- CALCULATIONS:
1. LENGTH OF LINE IN YARDS = MILES X 1,760
 2. AVG. WIDTH IN YARDS = $\frac{\text{TOTAL VISIBILITY IN YDS.}}{\text{NUMBER OF STATIONS}}$
 3. SQ. YDS IN LINE = LENGTH OF LINE X AVG. WIDTH IN YDS
 4. ACRES OF VISIBILITY = $\frac{\text{SQUARE YDS IN LINE}}{4,840}$

* THE NUMBER OF STATIONS IS THE NUMBER OF 0.1-MILE READINGS IN EACH VEGETATIVE TYPE.

1 MILE = 1,760 YARDS
1 ACRE = 4,840 SQ. YARDS

END

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