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A TECHNIQUE FOR STATISTICALLY DIFFERENTIATING RUFFED GROUSE DRUMMING LOGS FROM NON-DRUMMING LOGS IN EAST TENNESSEE

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Abstract

From February to May of 1974, 22 logs used for drumming by ruffed grouse (*Bonasa umbellus*) and 34 non-drumming logs were located on Newmans Ridge, Hancock County, Tennessee. To test statistically the validity of classifying ruffed grouse drumming logs on the basis of variables associated with the logs, ten variables were measured on each log and analyzed by multivariate analysis. This analysis was used to determine the weighting vector which, when applied to some newly observed and unclassified log, will assign this log to either a drumming log or non-drumming log class with the smallest probability of error. Fourteen percent of the drumming logs and six percent of the non-drumming logs were classified incorrectly by using the presented criteria. By knowing which logs are most suitable, a manager can make better judgments about ruffed grouse drumming site selection.

Introduction

Drumming is a territorial "song," an announcement to female birds of the male ruffed grouse's (*Bonasa umbellus* Linnaeus) presence and an expression of exuberance (Bump et al., 1947). The use of drumming to establish territory is unique to the ruffed grouse. Within the confines of his territory, the male selects one or two logs (or as many as five) which become established as drumming logs (Gullion, 1967).

The drumming behavior and drumming sites of ruffed grouse have been studied extensively in the northern sections of their range. Gullion (1967) defined the drumming stage as the 13 cm² area on the log where the grouse stands to drum; the drumming log is where the stage is located, and the drumming territory is the area of most intense activity of the attendant male. Gullion et al. (1962) investigated many aspects of the breeding biology of male ruffed grouse, including location and site characteristics of drumming territories. Berner and Gysel (1969) discussed vegetational and cover types of ruffed grouse habitat as well as location of drumming sites. Eng (1959) investigated the importance of cover directly over the drumming stage. A major study done in New York (Bump et al., 1947) addressed itself, in part, to the question of log and cover type preferences. Boag and Sumanik (1969) discussed several aspects of drumming sites in Alberta, including direction of the log and the log's relationship to the slope. They also discussed such factors as site selection and predation. From a sample of 40 drumming logs, Palmer (1963) described species of log, location of stage, and height, width, and length of log. He also pointed out some problems in comparing drumming logs and non-drumming logs, and examined those factors which encourage the repeated use of logs by grouse.

Only two studies on site characteristics of drumming logs have been carried out in the more southern extension of ruffed grouse range. In Indiana, Muehrcke and Kirkpatrick (1970) measured 25 drumming logs for diameter, length, and distance from ridgetop. Hardy (1950) studied the relationship of 18 drumming logs to the ridgetops in Kentucky.

Young birds, from 17-20 weeks old, which establish territories during their first fall, often select logs which have been used perennially by other birds—when there is often no possible physical connection with their predecessors, who are absent for a variety of reasons (Gullion, 1967). Two possibilities might be drawn from the above: either the original grouse marks his log (with droppings, feathers, etc.), rendering it desirable to a possible successor, or there are inherent factors associated with the drumming site or log which make it uniquely attractive as a drumming site. In the second possibility lies the main objective of this study, which is the determination of that factor or those factors which render a log acceptable as a site for drumming.

Study Area

Newmans Ridge, located in Hancock County in northeastern Tennessee, is part of the Great Valley of East Tennessee. The relief and elevation of the Great Valley Region is diverse, with two ridges—Clinch Mountain and Newmans Ridge—being dominant physiographic features. In general, the elevation ranges from 259 m to more than 624 m (Hubbard, 1948). The mountainous region of this section of the Great Valley is rugged, with steep-walled valleys and narrow, even-crested mountain divides (Morris, 1948). The main soil types are derived from limestone, sandstone, shale and dolomites (Korstian, 1962).

The summers are moderately hot, with cool nights; the winters are mild, with nightly freezes and daily thaws. There are rare temperature variations of 10°C to 39°C. The mean temperature is 14°C. The mean annual precipitation is 113 cm.

Much of the timber of Newmans Ridge has been cut over (Hubbard, 1948), except for that on inaccessible ridgetops. These ridgetops are of primary importance, as most of the drumming logs are located here. There is much variation in overstory vegetation by elevation. The lowland and northeast slopes are, in general, composed of beech (*Fagus grandiflora* Ehrhart), sugar maple (*Acer saccharum* Marsh), and yellow poplar (*Liriodendron tulipifera* Linnaeus). The dominant species of the southeast and northwest slopes are chestnut oak (*Quercus prinus* Linnaeus), northern red oak (*Q. rubra* Linnaeus), pignut hickory (*Carya glabra* (Mill.) Sweet), and shagbark hickory (*C. ovata* (Miller) Britton). The ridgetops are generally dominated by red cedar (*Juniperus virginiana* Linnaeus), chestnut oak, chiquapin oak (*Q. muehlenbergii* Engelm.), white oak (*Q. alba* Linnaeus), and post oak (*Q.

stellata Wangenh.) (Wolfe, 1956). The major components of the understory are wild grape (*Vitis* spp.), blueberries (*Vaccinium* spp.), red maple (*Acer rubrum,* Linnaeus), and greenbrier (*Smilax* spp.).

Methods and Materials

Log Selection

From February through May 1974, drumming and non-drumming logs were located on Newmans Ridge. A log was adjudged a drumming log when two or more fecal droppings were found on or near the log. This criterion was based on the rate of deposition of droppings, which is an average of four droppings per hour (Gullion, 1966). An accumulation of droppings indicates more than passing visitation.

In order to be classified as fallen trees, non-drumming logs were identified on the basis of remains of stumps at the axial ends of logs. In the absence of fecal droppings on or around the logs, these logs were classified as non-drumming logs.

Characteristics of the drumming stage and of the immediate

TABLE 1: *Description of the 10 variables used to describe the characteristics of the stage and immediate area of each individual log on Newmans Ridge, Tennessee.*

Mnemonic	Variable	Methods
LENLOG	Length of log	Obtained by simple measurement in meters.
DIALOG	Diameter of log	Obtained by simple measurement in meters at drumming stage.
HELOGUP	Height of log on the upside	Height in meters at drumming stage of the side of the log which is closest to the ridgetop.
HELOGDON	Height of log on the downside	Height in meters at drumming stage of the side of the log which is farthest away from the ridgetop.
DIRLOG	Direction log points (axial end)	Expressed in compass degrees 1=0° 4=135° 7=270° 2=45° 5=180° 8=315° 3=90° 6=225° 9=360°
CONFIG	Configuration	Expressed in terms of concavity (=1), convexity (=2), or flatness (=3).
TEXTURE	Texture	Expressed in terms of roughness (=1) or smoothness (=2).
TAXON	Taxon	Taxonomic classification of log to species 01 = *Casanea dentata,* Borkh. 02 = *Acer* spp. 03 = *Carya* spp. 04 = *Liriodendron tulipifera,* Linnaeus 05 = *Quercus alba,* Linnaeus 06 = *Pinus* spp. 07 = Hardwood 08 = *Quercus rubra,* Linnaeus 09 = *Pinus virginiana,* Mill. 10 = *Robinia pseudoacacia,* Linnaeus 11 = *Cornus florida,* Linnaeus 12 = Unknown 13 = *Quercus* spp. 14 = *Pinus strobus,* Linnaeus 15 = *Nysa sylvatica,* Marsh. 16 = *Juglans nigra,* Linnaeus 17 = *Oxydendron arboreum,* (L.) DC
SLOPEDE	Slope of the ridge line	Expressed in degrees as measured by a clinometer. 1 = 0° –10° 2 =10° –20° 3 =20° –30° 4 =30° –40° 5 =40° –50°
ASPECT	Aspect of the ridge from SW to NE	Expressed in compass degrees 1 = 360°N 2 = 45°NE 3 = 180°S 4 = 135°SE 5 = 90°E 6 = 270°W 7 = 225°SW 8 = 315°NW 9 = no more one than another

area associated with 56 individual logs were collected. For each individual log, 10 structural measurements of the stage and immediate area were recorded. These 10 variables (Table 1) were chosen to quantify the structure of the stage and the environment associated with a given individual log. Table 1 contains a mnemonic for each of these variables, for what each variable measures, and for methodological descriptions.

Analytical Methods

Variables that can distinguish a drumming log from a non-drumming log are designated "selected variables." In our analysis, we view the problem of drumming log selection as one of identifying variables having the strongest ability to classify an individual log either as a drumming log or as a non-drumming log.

Discriminant function analysis is the classification of an individual (or in this instance, a log) into one of two populations or categories (Fisher, 1936). We are given two classes of logs, drumming and non-drumming; t measurements have been made on each log and we wish to find the weighting vector which, when applied to some newly observed and unclassified log, will assign this log to one or the other of these classes with the smallest probability of error. We assume that in the populations from which the classes are drawn, the t variables have a common multivariate normal distribution. The vector of weights (w) which provides the optimum assignment is given by $w = V^{-1} d$, where d is the vector of differences between the t pairs of means of the two classes, and V is the weighted average of the dispersion matrices of the two classes.

The analogy with the multiple regression equation $b = R^{-1} k$ should be evident. Both w and b are vectors of weights. The vector of differences between group means on the variables (d) is analogous to the vector of correlations between the predictor variables and the criterion variable (k). R, as in V, is the weighted average of the disperson matrices of the two classes. We used the multiple regression equation to determine the vector of weights. Calculations were done on an IBM 360/65 computer using the Statistical Analysis System.

RESULTS AND DISCUSSION

Ruffed grouse appear to select drumming logs by factors not immediately connected with their survival (Svardson, 1949), so that their log selection is based on proximate rather than ultimate factors (Lack, 1933). Ultimate factors are directly connected with an individual's survival, but are dependable and easily perceived predictors of proximate factors (e.g., a given vegetative structure indicates a high likelihood of finding food or shelter). One might expect highly mobile animals such as ruffed grouse to use proximate factors to sort favorable from unfavorable drumming logs.

To test whether a log is suitable for drumming, the information derived from the 10 variables taken on 22 drumming logs and 34 non-drumming logs was analyzed by discriminant function analysis. We used the results of this analysis as the basis for assigning a log as either a drumming or non-drumming log. The decision to employ a discriminant function for purposes of classification implies a prior decision that the log to be classified belongs to one or the other of the two groups. The classification criterion is determined by a measure of generalized square distance, Mahalanokis' D, and is based on the pooled covariance matrix.

The results of the discriminant function analysis are best summarized in a contingency table. The rows of the table give the actual group to which a log belongs, and the columns give the group to which the analysis assigns it. The contingency table (Table 2) for the 56 logs is without correction for a priori probabilities. Of the 22 logs classified as drumming logs, the analysis indicates 19 were classified correctly while 3 were misclassi,ed. Thirty-two non-drumming logs were classified correctly and 2 were misclassified according to the discriminant analysis.

TABLE 2: *Number of logs classified as drumming or non-drumming by the discriminant function analysis from Newmans Ridge area in eastern Tennessee.*

		Predicted group		
		Drumming	*Non-drumming*	*Total*
Actual group	*Drumming*	19	3	22
	Non-drumming	2	32	34
	Total	21	35	56

The vector of weights (W) which provides the optimum assignment of a log to the drumming or non-drumming group is given by $w = V^{-1} d$, which is analogous with the $b = R^{-1} k$ of multiple regression analysis. The elements of b are the weights which we applied to a log's scores in assessing the probable outcome of its classification (Table 3).

TABLE 3: *The elements of b are the regression weights which, when applied to some newly observed and unclassified log, will assign it to either the drumming group or non-drumming group with the smallest probability of error.*

Variable	b
X_1 LENLOG	−.31
X_2 DIALOG	−9.56
X_3 HELOGUP	14.36
X_4 HELOGDOW	−11.53
X_5 CONFIG	10.47
X_6 TEXTURE	−9.33
X_7 TAXON	.85
X_8 SLOPEDE	11.77
X_9 DIRLOG	−.05
X_{10} ASPECT	.00

In order to use our research to assign a log as either a drumming or non-drumming log, the 10 variables are first quantified and then a score is calculated on the discriminate function using the b weights of the multiple regression analysis as equal to w weights of the discriminate function. If this score exceeds a certain critical value, we assign the log to the non-drumming group; otherwise, it is assigned as a drumming log. The appropriate cutting score is the half-way mark between the means of the two groups. By applying the weights b to the mean values (Table 4) for each variable of the drumming and non-drumming logs from Newmans Ridge, the two scores are calculated as:

$$\text{Drumming score} = b_1X_1 + b_2X_2 + \ldots + b_nX_n$$
$$\text{Non-drumming score} = b_1X_1 + b_2X_2 + \ldots + b_nX_n$$

Where b is the vector of weights (Table 3) and X_i is the mean value for each variable (Table 4), the mean score for drumming logs is −2.50 and the mean score for non-drumming logs is +25.96. The half-way mark is +11.73; this is the point at which a log is adjudged a drumming log or a non-drumming log.

TABLE 4: *Mean values and standard deviation (S.D.) of drumming and non-drumming logs from Newmans Ridge, Tennessee.*

Variable	*Drumming logs*		*Non-drumming logs*	
	mean	*S.D.*	*mean*	*S.D.*
LENLOG	36.34	14.87	30.11	15.28
DIALOG	1.65	.56	1.11	.65
HELOGUP	1.62	.54	1.35	.66
HELOGDOW	1.63	.57	1.40	.67
CONFIG	1.77	1.50	2.67	.53
TEXTURE	1.45	.51	1.59	.49
TAXON	2.09	1.63	4.35	5.04
SLOPEDE	1.59	.85	2.44	1.04
DIRLOG	4.40	1.40	5.17	1.50
ASPECT	2.41	2.15	3.44	2.77

Applied Uses

By knowing which logs are most suitable, a researcher can make better judgments about drumming site selection. The realized critical value, the half-way mark between the means of the two groups, might be useful in a management context to assign an unclassified log as either drumming or non-drumming with the smallest probability of error. This method might eliminate some of the inherent weakness of the current methods of comparing non-drumming sites with drumming sites. The most important of these is that one cannot be entirely sure that a presumed non-drumming log is not actually a drumming log, since the current criterion of drumming log designation is an accumulation of fecal droppings. Their absence might be due to environmental factors (such as wind and rain) which may remove them. Also, "the feces produced by the drumming bird contain many undigested remnants of plant parts, which are used as food items by buff-bellied chipmunks (*Eutamias amoenus*)" in Alberta, Canada (Boag & Sumanik, 1969). There is no reason why a similar species such as the eastern chipmunk (*Tamias striatus*) might not have similar dietary predilections, since its habitat is the deciduous forests of the eastern United States (Burt & Grossenheider, 1964). Thus, though our method will identify a drumming log relative to a given area, it cannot extrapolate beyond the data set to identify positively all drumming logs throughout the range of the grouse.

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