MOTION-SENSITIVE RADIO COLLARS FOR ESTIMATING WHITE-TAILED DEER ACTIVITY

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Abstract: Telemetric data from radio-collared white-tailed deer (*Odocoileus virginianus*) were compared to concurrent visual observations of deer behavior to evaluate accuracy of telemetrically determined behavior. A 2-channel telemetric pattern of constant amplitude and head-up tip-switch position reliably indicated bedded deer in most cases. Variable amplitude and other tip-switch positions indicated active deer but specific activity could not be distinguished by our system. In 3 of 196 cases (98% correct) an active deer was erroneously classified as bedded. In 1 of 27 cases (96% correct) a bedded deer was classified as active.

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Determining behavior of free-ranging animals by radio telemetry could be a powerful tool in wildlife research. Gillingham and Bunnell (1985) posed 3 questions: (1) if the specified telemetric pattern is observed, can it be inferred that a particular behavior or group of behaviors has occurred; (2) if the specified pattern is not observed, can it be assumed the behavior has not occurred; and (3) can the proportion of time active be predicted? These questions are related; a telemetric pattern can be used to construct a time-activity budget only if the answer to the first 2 questions is positive.

Gillingham and Bunnell (1985) reported negative answers for all 3 questions in their study of captive black-tailed deer (*O. hemionus columbianus*), using 2 types of motion-sensitive collars and a sampling interval of 1 minute. The objective of our study was to evaluate the correspondence between telemetric patterns and behavior of free-ranging white-tailed deer, using tip-switch radio collars and a sampling interval of 5.25 minutes.

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METHODS

The study was conducted on the University of Michigan's George Reserve. The reserve is a 464-ha, deer-proof fenced area near Pinckney, Michigan. Radio collars (Telonics, Inc., Mesa, Ariz.) were fitted to 7 male and 6 female adult white-tailed deer. Each collar contained a mercury tip-switch oriented to indicate head-up or head-down positions by altering signal pulse intervals. Radioed animals were free to move about the reserve. Telemetry data were received via a 2.4-m omnidirectional antenna mounted on a 9.1-m tower located on high ground near the center of the area, approximately 1.5 km from the farthest corner of the reserve. The signals were processed by 2 parallel receiving-recording systems (Telonics, Inc., Mesa, Ariz.), each consisting of a receiver combined with a scanner-programmer, digital processor, and 2-channel chart recorder geared to move at 40.6 cm/hour. The signal from each radio collar was sampled for a 5.25-minute interval before the scanner automatically switched to the next programmed radio frequency. On average, 10 collars were transmitting at 1 time, data from 5 being recorded on each receiving-recording system. We marked the time on the recorder charts at the beginning and end of each period of visual observation of behavior. Chart times between these points were accurately determined by counting the number of 5.25-minute intervals elapsed.

Visual observations of behavior were made on all collared deer encountered on the reserve from 1 July 1982 through 25 July 1983. Unique collars and eartags assured correct identification of deer. Observations were made while spotlighting from a vehicle, from tree blinds, or on foot. Deer were recorded as bedded or active, with 6 categories of activity recognized: running, walking, standing alert, head-up feeding, head-down feeding, and other. Time and duration of each behavior was recorded, using the same clock used to mark the recorder charts.

The chart recorder traced signal amplitude and pulse interval. Each 5.25-minute trace was

Table 1. Correspondence between telemetric patterns and directly observed white-tailed deer behavior for 223 5.25-minute samples on the George Reserve, Michigan.

		Telemetric pattern									
		Constant signal, head up (% of sampling interval)					Variable signal, head up (% of sampling interval)				
Behavior[a]	n[b]	0	1–40	41–60	61–99	100	0	1–40	41–60	61–99	100
Bedded	27					26					1[c]
Walk/run	11				5					3	3
Stand alert	3					3[c]					
Head-up feed	35		3	5	4			4	4	15	
Head-down feed	88	5	22	4	2		5	40	4	6	
Other	59	1	3	7	11		1	9	5	21	1

[a] Standing or walking while feeding was categorized as feeding. When >1 behavior occurred, the observation was assigned to other.
[b] No. samples in which behavior was observed.
[c] Errors classifying bedded vs. active behavior.

assigned 1 of 10 codes based on its combination of 2 possible signal amplitude codes and 5 possible pulse interval codes. Signal amplitude was characterized as either constant or variable. A tracing of constant signal amplitude, against which variable traces could be judged, was produced by a radio collar placed in a tree 1 km from the receiving station for 24 hours. Pulse interval data were classed into 5 categories, based on the head-up pulse interval predominating for zero, 1–40, 41–60, 61–99, or 100% of the 5.25-minute interval. The zero and 100% categories were narrower than the others because they could be unambiguously determined, and because bedded animals were expected to produce the head-up signal for 100% (but not 99%) of the trace. The 41–60% category allowed rapid coding of traces with the head-up signal predominating for roughly half the trace. The remaining 2 categories indicated that the head-up or head-down signal predominated for most but not all of the trace.

The correspondence of each telemetric pattern with observed behaviors was summed for all deer. A telemetric pattern was considered suitable for recognizing a behavior if (1) a particular behavior produced that telemetric pattern and rarely produced other patterns, and (2) that telemetric pattern was rarely produced by other deer behaviors.

RESULTS

A telemetric pattern showing constant signal amplitude and head-up pulse interval for 100% of the trace met the 2 criteria for recognizing a behavior. This pattern reliably indicated bedded behavior (Table 1). All other telemetric patterns indicated active deer, but specific activities could not be distinguished. In 3 of 196 cases (98% correct) an active deer was erroneously classified as bedded. In 1 of 27 cases (96% correct) a bedded deer was classified as active. For 12 of 13 deer studied, the reliability of the technique was better than indicated by Table 1 because the 3 observations of an active animal producing the bedded telemetric pattern were all long episodes of standing alert behavior by 1 deer. This individual (ad M) was more wary than any other collared deer and was frequently observed standing alert continuously for up to 9 minutes. No other collared animal was observed standing alert for >4.5 consecutive minutes.

To estimate the magnitude of the errors for this animal, 1 receiver-recorder system was programmed to monitor this individual continuously for 2 24-hour periods. During these 48 hours, the bedded telemetric trace occurred for 1,795 minutes, of which 54 minutes were in episodes of 5.25–15 minutes in duration. If all of these episodes occurred while the animal was standing alert, our technique would classify them as bedded and would therefore overestimate the length of time bedded by about 3%.

There was 1 case in which a bedded deer (not the same individual discussed above) produced an active telemetric pattern (variable amplitude, head-up 100%). This classification error will result in overestimation of the proportion of time active. However, this overestimate was small. In 58,000 sampling intervals during 1982–83, the relative frequency of the variable amplitude, head-up 100% telemetric pattern was only 1.5%. If 20% of these telemetric records actually corresponded to bedded behavior (Table 1), the average misclassification rate would be 0.3%.

DISCUSSION

The correspondence of the constant amplitude, head up 100% telemetric pattern with bedded behavior requires that the sampling interval be of sufficient duration that brief periods of standing during a bout of activity do not occupy an entire trace. In this study, standing and bedded behaviors were clearly distinguished because most deer stood for shorter durations than the 5.25-minute sampling interval.

Examination of successively shorter intervals within each 5.25-minute interval showed that the proportion of active traces misclassified as bedded increased as the sampling interval was shortened. For instance, 5% of the 196 active traces were misclassified by telemetry when a 4-minute sampling interval was used, 8% when a 2.5-minute interval was used, and 17% when a 1-minute interval was used. The inability of the technique used by Gillingham and Bunnell (1985) to distinguish between standing and bedded behaviors was largely due to their use of a 1-minute sampling interval and captive deer that spent nearly 30% of their time standing for periods of up to 10 minutes. Visual observations of wild elk (Craighead et al. 1973) and muskox (Jingfors 1982) show that these animals stand for about 3 and 5%, respectively, of their total activity time. Thus, for free-ranging ungulates, the confounding of bedded and standing behavior probably is not as serious as the data of Gillingham and Bunnell (1985) suggest. Nonetheless, each study using telemetry to quantify activity time should compare the telemetric patterns with visual observations of behavior to select an appropriate sampling interval.

Although increasing the duration of the sampling interval improved discrimination between bedded and standing behaviors, it also overestimated the time spent active, because when an animal was bedded for part but not all of the sampling interval, an active telemetric pattern was produced. This overestimate can be minimized by selecting the shortest sampling interval that successfully discriminates between standing alert and bedded behaviors.

We conclude that telemetry systems such as used in this study can give highly reliable data on bedded versus active behavior of free-ranging animals, particularly if the sampling interval is adjusted appropriately for the species and environment.

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