

DIRECTIONAL DIFFERENCES IN THE SOUND INTENSITY OF RUFFED GROUSE DRUMMING¹

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STUDENTS have long been intrigued by the drumming of the Ruffed Grouse (*Bonasa umbellus*). Physically, drumming is a wingbeating display performed from a stationary position, usually upon an elevated object known as a "drumming log." The drumming performance has been described in detail by Bump et al. (1947: 274-276) and Hjorth (1970: 220-225). Functionally, drumming is believed to correspond fully to song, which is lacking in the species (Hjorth 1970: 497), to facilitate spacing of males (Allen 1934, Fowle 1953: 91), stimulate female sexual development (Hjorth 1970: 497), and to attract females (Allen 1934, Brander 1967).

Numerous ideas have been advanced about how the noise is produced (cf. Bump et al. 1947: 276-278). Recently, Hjorth (1970: 225-233) has suggested new explanations of the related questions of how the sound is generated and how the grouse is able to maintain its balance during the drumming performance. The number of wingbeats in and the duration of a drum are variable both within and among individuals (Aubin 1972). The drumming sound is audible to the human ear up to distances of $\frac{1}{8}$ to $\frac{1}{4}$ mile (Sumanik 1966: 38) or more. Although grouse have been reported to turn their heads in reaction to neighbors' drums (Hjorth 1970: 489), no reports of how far a grouse can perceive drumming are available in the literature.

Use of the radiotelemetric method has enabled the remote determination of several kinds of activity patterns including drumming (Marshall and Kupa 1963). By listening to both the sound of the drums and transmitter signal of a radio-marked grouse, I found that the distance I could hear drums seemed to vary according to the direction in which the drumming bird faced. The purpose of the investigation reported here was to confirm the observation that the drumming sound, independent of vegetation and topographic features, is directional.

MATERIALS AND METHODS

The drumming sound and performance of an adult male grouse (No. 1616) were recorded on video tape with Sony videorecording equipment in conjunction with four microphones. On the afternoon of 3 June 1970, equipment was set up and field tested at the Cedar Creek Natural History Area in east central Minnesota. Recordings were made early on the clear, windless mornings of 4 and 5 June.

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At the drumming log a television camera (Sony Model TC-303, F 1.4) was lashed to a small tree about 7 feet from the drumming stage (the place on the log where the grouse habitually stands when drumming). The partially camouflaged camera was placed directly behind the bird when it drummed. Omnidirectional microphones (Shure Model 420, 15,000-ohms impedance) were placed directly in front, to each side, and to the rear of the stage. Each microphone, attached to a thin iron rod driven into the ground, was suspended at "bird height," about 5 feet from and pointed directly at the drumming grouse.

Several hundred feet from the drumming log, the videorecorder (Sony Model EV-210) and camera power supply-control unit (Sony Model TP-110) were set up in a vehicle and connected to the camera and a nearby 110-volt source. Each microphone cable was connected to a 10,000-ohm potentiometer in a specially constructed switch box. By adjusting the potentiometers, the microphones were equalized so that each caused the same deflection on a strip chart recorder in response to a standard sound source. The switch box was designed to permit input of any of the four microphones to either of the two audio channels of the videorecorder. When recording, pairs of microphones were systematically connected to the recorder on successive drums, thus permitting later comparison of the sound level of each drum from two directions.

The drumming sounds on video tape were played back, amplified (Ampex Model 620 speaker-amplifier), and measured with a sound level meter (General Radio Co. Type 1565-A, set on the C_F scale). Measurements were made of the seventh or first "loud" wingbeat, described by Hjorth (1970: 223) as "regular stroke number six." This stroke was selected because it was readily identifiable and well separated temporally from adjacent beats.

RESULTS AND DISCUSSION

Drumming sound levels recorded directly in front of the grouse averaged 14.3 and 16.2 dB greater than to the sides and 9.3 dB greater than to the rear (Table 1). Although the bird did turn around several times between drums, it consistently faced the "front" microphone when drumming.

As the decibel scale is logarithmic, these data demonstrate substantial directional differences in the intensity of the sound of drumming. It should be pointed out that these measurements are relative and do not represent actual sound levels at 5 feet from a drumming grouse.

The directional differences in drumming sound intensity reported here are substantiated by Hjorth's (1970: 225) observation of the movement of small, cloth pellets suspended around a drumming grouse at distances of 3-4 dm. He concluded that "the motions of the wings caused the air to rush mainly forward towards the ground in front of the bird." The air movement forward from the grouse commonly produces a fan-shaped space devoid of dry leaves in front of the drumming stage.

Factors such as wind, vegetation, and topography have been recognized as potential influences on the range of audibility of drumming (Petraborg et al. 1953, Dorney et al. 1958, Sumanik 1966: 38-39). Because of

TABLE 1
 DRUMMING SOUND LEVELS (IN RELATIVE dB) OF THE
 SEVENTH WING BEAT

Drum No.	Microphones ¹			
	Front	Side	Side	Rear
1	102.0	88.5		
2	101.2		85.5	
3	102.0			93.0
4	101.0	87.0		
5		86.0	86.2	
6		87.0		93.0
7	100.8		84.0	
8		87.5	86.0	
9			85.8	92.0
10	101.8			93.0
11		87.0		91.5
12			84.5	91.0
Mean	101.5	87.2	85.3	92.2
SD	0.53	0.82	0.88	0.88
Relative to front		-14.3	-16.2	-9.3

¹ Sound levels from two microphones recorded for each drum; each value is the mean of two sound meter readings taken for a given drum and microphone.

directional differences in the intensity of the sound, the probability of a particular observer hearing a drum performed at a given distance is also dependent on the orientation of the grouse relative to him. If drumming grouse were oriented in random directions, the directional factor would appear to be of little consequence to most field procedures relying on drumming counts. As drumming logs in some regions tend to be oriented according to prevailing storm winds (Meslow 1966: 22; Boag and Sumanik 1969), and as drummers often face in a consistent direction relative to the log, the directional factor does need to be considered.

Sound levels of different drums recorded from the same direction were quite similar (Table 1). Yet a grouse apparently is capable of controlling the intensity of the sound of its drumming over a wide range. Gullion (pers. comm.) has found that grouse sometimes greatly reduce the sound level of their drums when an observer approaches.

A complex of characteristics of the drumming log and the surrounding vegetation apparently governs drumming site selection. Boag and Sumanik (1969) found "ruffed grouse selecting sites which give them sufficient height above the ground from which to see other members of the population or approaching ground predators . . . sufficient openess, particularly in the shrub layer, to allow their view to extend at least 20 yards in most directions, and sufficient canopy coverage and stem density to screen them from avian predators." I believe that the directional nature of the drumming sound provides additional insight on the related questions

of why grouse select particular logs for drumming and why many males regularly use more than one drumming log.

Stimulation to drum appears to be partially dependent on a feedback response to the drumming activity of neighboring males (Gullion 1966). Aubin (1972) suggested that male Ruffed Grouse answer the drumming sounds of their neighbors by drumming in turn. If a grouse tries to increase the effect of its drumming on a neighboring male while remaining in his own territory, it follows that he will, as nearly as possible, face directly toward the neighbor when drumming. As most drumming logs are fallen trees (Gullion 1967) and a drumming grouse typically faces at a right angle to its log, this hypothesis suggests selection of an otherwise suitable log with the long axis oriented at approximately 90° to the direction of the rival.

Intensification of the effect of a grouse's drumming upon a neighbor could also be achieved by selection of a drumming position closer to the rival. Gullion (1967) reported several cases of movements of this kind occurring when the density of drumming males was low.

The seemingly important question of why many grouse regularly use more than one drumming log during the same drumming season has received little attention. With several neighbors located in substantially different directions, a grouse could intensify the effect of its drumming on each by selecting several appropriately oriented logs. This idea is supported by the suggestion of Bump et al. (1947: 280) that the number of logs a male uses may tend to vary directly with the degree of competition with other males. Some multiple log use is certainly attributable to seasonal changes (e.g. leaf fall) in the quality of the habitat surrounding drumming logs (Gullion pers. comm.).

Gullion (1967) found that 44% of 168 male grouse known to have used drumming logs for a year or longer "permanently shifted their primary activity from one log to another one or more times." Could some of these changes in log use reflect selection of logs more suitably oriented to surviving or newly established neighbors?

The possible significance of the directional nature of the drumming sound to male social relationships has been stressed here. Moreover attraction of females at maximum distances may be an important selective factor affecting drumming log preference (Muehrcke and Kirkpatrick 1970), and multiple log use may be related to attraction of females at maximum distance in several directions.

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