The number ($\bar{x}$ ± SE) of pellets cast per evening at this roost was estimated at 5.2 ± 0.8 pellets/m^2 for an estimated total of 62,400 pellets. Although the number of these pellets per plot ranged from 0–11, probably varying with the bird density within the site, the rate of deposition did not vary significantly ($F = 0.40$, $P = 0.67$) among the three nights.

Ten randomly selected pellets were fragmented and their composition by volume estimated by a random plot method (Dolbeer et al., Wilson Bull. 90:31–44, 1978) to include 90% hulls, chaff, and other vegetable residue (primarily corn), 5% rock, 4% insect exoskeletons, and 1% bone and shell.

Pellet casting has been well summarized for raptors by Duke et al. (Comp. Biochem. Physiol. 53A:1–6, 1976) and has been reported for several other species including: Northwestern Crows (*Corvus caurinus*) (Butler, Can. Field-Nat. 88:313–316, 1974) and Killdeer (*Charadrius vociferus*) (DeVlaming, Wilson Bull. 79:449–450, 1967). Additionally, Warham (Emu 57:78–81, 1957) collected pellets cast by Splendid Blue Wrens (*Malurus splendens*) from beneath their roosting site. However, to the best of my knowledge, this is the first reported observation and quantification of pellets cast by Common Grackles.—DANIEL J. TWEDT, *U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Kentucky Research Station, 334 15th Street, Bowling Green, Kentucky 42101. Accepted 28 Mar. 1984.*

Wilson Bull., 96(3), 1984, pp. 471–477

Preflight behavior of Sandhill Cranes.—The purpose of this paper is to describe and quantify preflight behavior of Sandhill Cranes (*Grus canadensis*), including the exit of cranes from overnight roost sites. Preflight behaviors are social signals that convey information from one individual or group to another (Heymer, Ethological Dictionary, Garland Publ. Inc., New York, New York, 1977), and understanding the preflight behavior of Sandhill Cranes may assist in interpretation of social organization.

Methods.—Preflight behavior of Sandhill Cranes was studied from early January through February 1978–1980 near Rich Lake, Terry Co., Texas; during March and early April 1978–1980 along the Platte River between Sutherland and North Platte in Lincoln Co., Nebraska; during the last 2 weeks of April 1980 near the north end of Last Mountain Lake, Saskatchewan; during May 1980 near Delta Junction, Alaska; and immediately prior to nesting in May 1980 near Old Chevak, Clarance Rhode National Wildlife Refuge, Alaska.

Observations were aided by a 15 × 60 telescope. Postures and movements were photographed (35 mm) and filmed (16 mm). Descriptions and social interactions were recorded on tape during 1109 observation periods totaling 369.7 h. Behaviors were recorded continuously for 20 min during these observation periods using behavioral categories defined in this paper (preflight behaviors) and elsewhere (Tacha, Ph.D. diss., Oklahoma State Univ., Stillwater, Oklahoma, 1981).

Juvenile (young-of-the-year) cranes were distinguished from adults by brown feathering on the nape (Lewis, J. Wildl. Manage. 43:211–214, 1979). Sex of some cranes was determined in the field by observation of the unison call (Archibald, Ph.D. diss., Cornell Univ., Ithaca, New York, 1975). Sex was determined during 54 of the observation periods when both members of a pair were present, by assuming that females follow males. None of these sex identifications was found to be incorrect when unison calls were subsequently observed. Observation of one crane of a pair following another was used to designate sex during some observation periods in which the unison call was not observed. Pairs (two adults) and family units (two adults and one or two juveniles) were identified by their close proximity (compared to other cranes in larger flocks); the tendency was for adult females of pairs to follow the

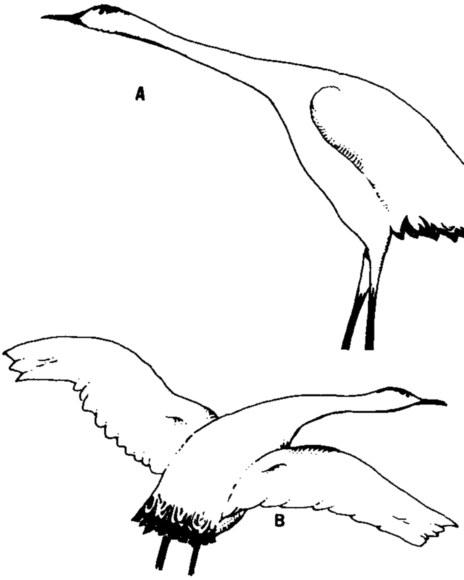

FIG. 1. Neck stretch (A) and neck stretch-wings-spread (B) preflight signals of Sandhill Cranes (A from 35 mm slides, B from 16 mm films).

male, and juveniles of family units to follow their parents. The sex of juveniles could not be determined in the field, and no juveniles were ever observed to be members of a mated pair. The sex of adults not in pairs or family units could not be determined.

When behavioral observations were transcribed from tapes, the durations of behaviors were rounded to the nearest full second. Cranes were selected for observation using stratified random sampling as follows: observations were obtained in all major habitats used by cranes at all hours of the day; sampling was stratified by age groups to ensure adequate sampling

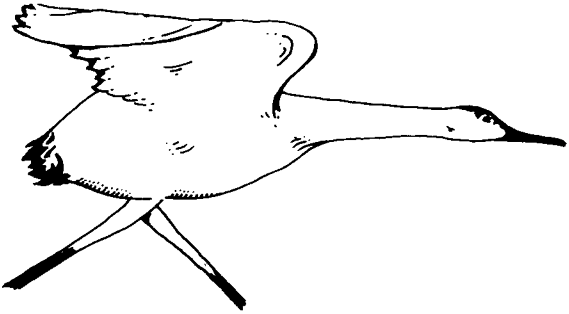

FIG. 2. The neck stretch-wings-spread-run preflight signal of Sandhill Cranes (from 35 mm slides).

TABLE 1

PERCENTAGE OCCURRENCE OF PREFLIGHT SIGNALS IN TIME BUDGETS OF SANDHILL CRANES

Age/sex/social status	N	$\bar{x}$%	Z	P
Adult	1050	6.19	0.76	0.45
Juvenile		5.01		
Male	291	8.00	0.78	0.43
Female		5.67		
Adults[a]				
Alone	365	7.81	0.41[b]	0.81
Pair		6.67		
Family		5.26		
Juveniles[a]				
Alone	272	6.45	1.09	0.27
Family		3.33		
Males[a]				
Pair	90	7.04	0.28	0.78
Family		5.26		
Females[a]				
Pair	118	6.98	0.79	0.43
Family		3.13		

[a] Data for time budgets on cranes of known social status.

[b] χ^2 value.

of juveniles; and cranes which had been marked (neck collar and leg band) for fewer than 7 days were not sampled. Three methods of quantifying preflight behaviors were used: frequency of occurrence of behaviors using each observation period as an experimental unit; duration of each behavior using each observation of the behavior as the experimental unit; and the percentage of total time spent in each behavior using observation periods as the experimental units. Results were considered to be statistically significant when $P < 0.05$.

Stepwise multiple regression was used to evaluate the association between frequency of occurrence of preflight signals and various environmental variables. The initial model used seven classification variables (each variable had two or more class levels) including period of the year, hour of the day, habitat, general flock activity, flock size (seven levels), and year. Non-significant variables were removed one at a time, in descending order of the P-level for their partial sums of squares.

Preflight intention movements.—Preflight intention movements were divided into two categories based on their presumed message content following Smith (Science 165:145–150, 1969). The first category, signaling "I may fly soon" sometimes led to the second category, "I am going to fly," if the stimulus persisted. The second category did not necessarily need an external stimulus; motivation to change location appeared sufficient.

The two displays that signaled "I may fly soon" were wing flapping (Tacha 1981) and leaping into the air with wings outspread and flapping. Wing flapping also often resulted in activities other than flight. Leaping with wings flapping had a higher stimulus threshold and led to flight if the stimulus (usually danger) approached or persisted. Wing flapping and

TABLE 2

PERCENTAGE OF TIME SANDHILL CRANES SPENT EXHIBITING PREFLIGHT SIGNALS

Age/sex/social status	N	$\bar{x}$ %	SE	t	P
Adults	711	0.074	0.021	0.01	0.99
Juveniles	339	0.074	0.027		
Males	150	0.007	0.031	0.57[a]	0.57
Females	141	0.116	0.083		
Adults					
Alone	128	0.131	0.545[b]	0.11[c]	0.090
Pair	180	0.102			
Family	57	0.080			
Juveniles					
Alone	62	0.117	0.074		
Family	210	0.013	0.006		
Males					
Pair	71	0.038	0.019	0.27	0.79
Family	19	0.053	0.053		
Females					
Pair	86	0.170	0.135	1.11[a]	0.27
Family	32	0.018	0.018		

[a] Unequal variances, $P < 0.05$.

[b] ANOVA error mean square × 10^{-4}.

[c] ANOVA F-value.

leaping with wings flapping were observed only twice during observation periods in a preflight context, and were considered displacement activities resulting from conflicting motivations to depart or to stay.

Sandhill Cranes exhibited a stereotyped preflight intention display that signaled "I am going to fly." This neck-stretch display had three distinct intensities (Figs. 1a, b, 2). The simple neck-stretch display consisted of a crane standing on both legs and arching the neck foward. The body was held upright at about 20–30° above horizontal with wings folded. The orientation of the bill indicated the direction of intended takeoff.

The function of the neck-stretch display may be to elicit other cranes of a pair or family to take flight with the displaying bird. If the simple neck-stretch display did not provoke signal receivers into flight, the next highest intensity of display was employed. The simple neck-stretch was augmented by fully or partially spreading the wings (Fig. 1b). The displaying crane would turn its head, presumably to observe the response of intended signal receivers. If no response occurred, the third level display was employed by running for a short distance with neck stretched forward and wings outspread (Fig. 2).

Forty-nine of the 54 neck-stretch signals observed resulted in flight; the five exceptions occurred when juveniles exhibited the simple neck-stretch. The neck-stretch-wings-spread display preceded flight each of the five times it was observed. The neck-stretch-wings-spread-run was exhibited only twice and led to flight both times.

Frightened cranes went directly to the neck-stretch-wings-spread-run while uttering an

TABLE 3

FREQUENCY OF OCCURRENCE OF PREFLIGHT SIGNALS IN TIME BUDGETS USING SIGNIFICANT VARIABLES FROM REGRESSION ANALYSIS[a]

Habitat	N	$\bar{x}$	DMRT[b]	Location	N	$\bar{x}$	DMRT[b]
Plowed	39	0.333	A	AK-DJ	64	0.313	A
Cotton	114	0.167	A B	TX	350	0.120	B
Native hay	91	0.165	A B	NE	457	0.077	B
Marsh	69	0.159	A B	SK	120	0.075	B
Alfalfa	122	0.107	B	AK-OC	56	0.054	B
Milo	227	0.079	B				
Corn	203	0.074	B				
Tundra	35	0.057	B				
Wheat	69	0.043	B				
Barley-planted	18	0.000	B				
Barley-stubble	12	0.000	B				
Mixed alfalfa-hay	48	0.000	B				

Year	N	$\bar{x}$	DMRT[b]
1979	193	0.165	A
1980	854	0.090	B

[a] Regression analysis: habitat partial SS = 12.7, $F = 4.35$, OSL = 0.001; location partial SS = 12.0, $F = 11.23$, OSL = 0.001; and year partial SS = 1.1, $F = 4.19$, OSL = 0.04. Full model df = 16,1030; error mean square = 0.266; $F = 4.12$; OSL = 0.001; $R^2 = 0.06$.

[b] Duncans Multiple Range Test.

alarm call (Archibald 1975). Archibald (1975:11) described a "flight intention call" for Sandhill Cranes. I did not notice any call associated with preflight intention movements of Sandhill Cranes other than the rare alarm call.

The preflight neck-stretch or a variation occurred in 5.5% of the observation periods. No difference ($P > 0.27$) in frequency of occurrence of preflight signals (hereafter referring to the neck-stretch and its variations) was observed between age, sex or social classes of Sandhill Cranes (Table 1).

The neck-stretch display had a mean duration of 17.6 sec among adult females, 10.1 sec among juveniles, and 8.2 sec among adult males. These differences were not significant (ANOVA EMS = 126.6, df = 2.51; $F = 2.44$; $P = 0.097$). Only one adult male exhibited the neck-stretch-wings-spread display; juveniles exhibited the neck-stretch-wings-spread-run twice during observation periods. Preflight signals from adult males resulted in flight with signal receivers more quickly and more often (100%, N = 23) than preflight signals from either adult females (75%, N = 16) or juveniles (53%, N = 17). The reduced duration and high response rate to preflight signals from adult males suggests that adult males may play a leadership role in determining when to fly.

Sandhill Cranes spent an average of 0.074% of their time performing preflight intention movements (Table 2). No differences in percentage of time spent exhibiting preflight displays were observed between age, sex or social classes.

I hypothesized that frequency of preflight signals was associated with environmental variables. The best regression model (Table 3) included habitat, location, and year variables with an R^2 of only 0.06. Differences within variables suggested that higher frequencies of preflight signals were associated with the Delta Junction area of Alaska and plowed fields in Texas. Cranes flew into and out of plowed fields in Texas and the Delta Junction Alaska area more often than they did in other habitats or locations (based on marked cranes, Oklahoma Cooperative Wildlife Research Unit, unpubl.). The low R^2 from regression anal-

TABLE 4
SEQUENCES OF BEHAVIORS OF SANDHILL CRANES ON ROOSTING AREAS AFTER WAKING BUT BEFORE TAKING FLIGHT

Behavior category	Order of behaviors after waking and before flight								
	1	2	3	4	5	6	7	8	Total
Double wing stretch	15	15	1	1	0	0	0	0	32
Wing flap	3	6	7	6	8	5	2	0	35
Body shake	0	7	13	5	6	2	0	0	33
Loafing	18	5	4	6	6	5	3	0	49
Preening	2	4	9	9	3	3	3	0	33
Walking	1	2	5	4	4	2	4	0	22
Preflight	0	0	0	2	5	6	8	9	30
Total	39	39	39	33	32	23	13	9	

ysis suggested that most of the variation in use of preflight signals was not associated with variables I could measure in this study.

Departure from roosting areas.—Individual cranes were observed during the interval from when they awakened until flight from roost sites in Texas and Nebraska on 39 occasions (Table 4). Seven types of behavior (Tacha 1981) were observed during the sequences of activity characteristic of this interval. Each of the behaviors occurred only once, if at all, in each sequence, except for loafing which occurred an average of 1.26 times per sequence. The double wing-stretch was observed in 82% of the sequences, nearly always as the first or second behavior after waking. Wing flapping was observed in 90% of sequences and occurred throughout the interval. Body shakes were observed in 85% of sequences and tended to occur in the middle of a sequence. Preening was seen in 85% of roost exit sequences and throughout the order of behaviors. Walking was noted in 56% of sequences and occurred toward the middle of the order of behaviors. Preflight signals occurred in 77% of sequences and were always the terminal behavior of the sequence. A typical sequence was as follows: awaken-loafing up-double wing stretch-body shake-walking-preen-wing flapping-preflight-flight.

Members of mated pairs and families appeared to remain together in two or three bird groups during roost departure with a coordinated takeoff that resulted from preflight intention movements. Cranes without mates or young appeared to take off alone or in small (5–15 birds) groups. Once airborne, pairs, families, and unmated adults would form larger flocks as distance from the take off point increased. Cranes flying a distance of less than 2–3 km remained in an unstructured group at low altitudes. Cranes flying further than this formed long lines at right angles to the direction of flight and flew higher than 300 m.

Sandhill Cranes often formed communal roosts of as many as 100,000 birds in western Texas and Nebraska (Oklahoma Cooperative Wildlife Research Unit, unpubl.). On 12 occasions, these large aggregations of cranes flushed all at once from roost sites. On each occasion, many cranes appeared to have become separated from members of their social units. The use of preflight signals and a somewhat standardized sequence of behaviors after waking apparently allowed a coordinated takeoff of pairs and family units, limited confusion resulting from separation of these social units, and reduced potential for in-flight collision during departure of cranes from roost sites.

Acknowledgments.—This study was funded by Contract 14-16-0008-2133, Accelerated

Research Program for Migratory Shore and Upland Game Birds, administered by the Central Management Unit Technical Committee and the Migratory Bird and Habitat Research Laboratory, U.S. Fish and Wildlife Service. The Oklahoma Cooperative Wildlife Research Unit has Oklahoma State University, Oklahoma Department of Wildlife Conservation, U.S. Fish and Wildlife Service, and Wildlife Management Institute cooperating. I thank P. A. Vohs for his advice and manuscript review, G. C. Iverson and D. C. Martin for assistance during fieldwork, and W. D. Warde for assistance with statistical analyses.—THOMAS C. TACHA, *Cooperative Wildlife Research Unit, 404 Life Sciences West, Oklahoma State Univ., Stillwater, Oklahoma 74078.* (Present address: *Cooperative Wildlife Research Laboratory, Southern Illinois Univ., Carbondale, Illinois 62901.*) *Accepted 15 Dec. 1983.*

Wilson Bull., 96(3), 1984, pp. 477–482

Vocal mimicry of Nashville Warblers by Yellow-rumped Warblers.—Many recent studies have emphasized the importance of learning in avian song development (surveyed by Kroodsma and Baylis, pp. 311–337 *in* Acoustic Communication in Birds, Kroodsma and Miller, eds., Academic Press, New York, New York, 1982). Birds are known to discriminate among potential song tutors (Marler and Peters, Science 198:519–521, 1977; West and Stroud, Wilson Bull. 95:635–640, 1983), yet misdirected song learning does occur (Baptista and Morton, Auk 98:383–385, 1981). Among the Parulinae, interspecific vocal learning has been demonstrated for only one species, the Common Yellowthroat (*Geothlypis trichas*) (Kroodsma et al., Wilson Bull. 95:138–140, 1983). This note describes a striking similarity between the songs of some Yellow-rumped Warblers (*Dendroica coronata*) and Nashville Warblers (*Vermivora ruficapilla*) in northern Michigan, which apparently arose from misdirected song learning by Yellow-rumped Warblers.

Methods.—The study area consisted of 37 islands (0.01–20.6 ha) at the northeastern tip of Isle Royale National Park, Michigan. The vegetation on these islands is typical boreal forest (Edwards, Ph.D. diss. Univ. Michigan, Ann Arbor, Michigan, 1978). During June 1983 I recorded singing warblers using a Marante PMD 200 tape recorder and an Audio-technica AT9100 directional microphone. Audiospectrograms of the recordings were made on a Kay Elemetrics Vibralyzer 6030-A at wide band setting (300 Hz). In this paper, a song "element" is defined as a sound that appears as an uninterrupted mark on an audiospectrogram; a series of elements of the same type is called a "phrase" (Wolffgramm and Todt, Behaviour 81:264–286, 1982). Songs of Nashville Warblers ordinarily consist of two phrases; those of Yellow-rumped Warblers consist of one to three phrases. Yellow-rumped Warblers which sing Nashville-type songs are termed "mimics" here.

I made two censuses of the breeding bird population on each island between 11 June and 12 July. The purpose was to assess the relationship between Yellow-rumped Warbler song characteristics and the abundance of singing Nashville Warblers in the immediate vicinity.

I made five measurements on each audiospectrogram: song duration (msec), maximum frequency (kHz), minimum frequency, and average time between elements within first and last phrases of the song. For Yellow-rumped Warblers with songs consisting of a single phrase, the latter two measurements were identical. These data were analyzed using Discriminant Function Analysis (Nei et al., Statistical Package for the Social Sciences, McGraw-Hill, New York, New York, 1975) to determine if the songs of typical Yellow-rumped and Nashville warblers could be distinguished by measures of frequency and tempo, and to predict the group membership of mimic Yellow-rumped Warblers by the same criteria. Two central assumptions of linear discrimination, homogeneity of variances among groups and