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Gary R. Gaston
University of Mississippi

Jeanne C. Nasci

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BEHAVIORAL ECOLOGY OF TWO TEAL SPECIES (BLUE-WINGED TEAL, *ANAS DISCORS*, AND GREEN-WINGED TEAL, *ANAS CRECCA*) OVERWINTERING IN MARSHES OF COASTAL LOUISIANA, USA

GARY R. GASTON[1] AND JEANNE C. NAŞCI[2]

[1]*Department of Biology, University of Mississippi, University, Mississippi 38677*

[2]*3186 Worthington Avenue, Fort Collins, Colorado 80526*

ABSTRACT Feeding and other dominant activities of Blue-winged Teal (BWT; *Anas discors*) and Green-winged Teal (GWT; *Anas crecca*) were compared from October 1987 to March 1988 in southwestern Louisiana, USA. Three observation towers were constructed near similar intermediate marsh habitats in areas where BWT and GWT concentrated for feeding. These observation towers allowed activities of the two species to be compared throughout the nonbreeding season. Although BWT and GWT often fed together, time spent in various activities differed. Feeding was the most frequent activity of both BWT (64.5%) and GWT (55.3%), but BWT spent more time feeding ($P < 0.01$) and alert ($P < 0.05$), but spent less ($P < 0.01$) time resting than GWT. Within each species there were differences in activity budgets among daily time blocks and among months, but few differences among the three habitats studied. Temperature and light intensity were correlated with resting (+), feeding (-), locomotion (-), and preening (+). Daily and monthly activity budgets of BWT and GWT were similar, as were ingested foods, suggesting that these two species used the study areas primarily for foraging, and left the areas for other activities. Predation and diminished resources during late winter may have affected activities of BWT and GWT as well.

Introduction

Blue-winged Teal (BWT; *Anas discors*) and Green-winged Teal (GWT; *Anas crecca*) are two of the most common waterfowl species in North America. Most BWT migrate to Central and South America during the nonbreeding season, but some remain along the U.S. Gulf Coast and overwinter with GWT and other waterfowl. This is the first comparative study of the two species.

Most previous studies of BWT concerned breeding or postbreeding feeding ecology (reviewed by DuBowy, 1985); however, several studies were conducted recently on activities of nonbreeding GWT (Tamisier, 1976; Baldassarre and Bolen, 1984; Quinlan and Baldassarre, 1984; Euliss and Harris, 1987; Rave, 1987; Rave and Baldassarre, 1989; Gaston, 1992). The purpose of this study was to compare activities of BWT and GWT concurrently. This allowed us to compare the two species under identical conditions, which is not possible unless the birds are observed simultaneously. Specifically, our goals were to (1) determine whether BWT and GWT required similar foraging times in habitats used primarily for feeding (intermediate marshes), since previous studies indicated that BWT and GWT food preferences differed during winter (Bellrose, 1980); (2) determine whether predators affected BWT and GWT foraging and habitat selection, as suggested in studies of other waterfowl species in these coastal Louisiana marshes (Gaston and Nasci, 1989); and (3) determine whether the role of their habitat changed as food resources diminished during winter.

Materials and Methods

Blue-winged Teal were observed at the 30,756 ha Rockefeller State Wildlife Refuge (SWR) in southwestern Louisiana (see Paulus, 1982). The area is closed to hunting, public access is limited, and much of it is impounded to control water levels.

Birds were observed from blinds (4 m high) located on levees adjacent to three intermediate marsh impoundments. Intermediate marshes are generally lower salinity (annual salinity range: 0-5 ppt.) than brackish marshes, and are transition zones between salt marshes and fresh marshes. The dominant vegetation of intermediate marshes in the study area was wiregrass (*Spartina patens*), cattail (*Typha* spp.), bulrush (*Scirpus californicus*), common reed (*Phragmites australis*), and bearded sprangletop (*Leptochloa fascicularis*). Levees surrounding the study areas supported dense stands of common reed, which allowed access to the towers with minimal disturbance to waterfowl. The three areas were described by Gaston and Nasci (1989). The areas were generally similar, but varied in water level ranges and pond sizes. Observation was planned in these similar areas in order to compare effects of water depth, weather, and temporal factors. Previous investigators compared vastly different habitats (e.g., Quinlan and Baldassarre, 1984; Rave, 1987; Rave and Baldassarre, 1989), where extreme variance in teal behavior would be most likely, but effects of specific habitat factors could not be assessed adequately.

Weekly observations of BWT and GWT were made concurrently at three stations from October 1987 to March 1988. Observations were made from 15 minutes before sunrise to 15 minutes after sunset. Days were divided into three equal time blocks (morning, midday, and afternoon), and each time block was divided into equal numbers of 15-minute time periods. Random numbers tables were used to select 30 to 36 observation periods per tower each day.

A single scan was made during selected 15-minute time periods with a 60x spotting scope using scan sampling techniques (*sensu* Baldassarre *et al.*, 1988), and all BWT and GWT within 200 m were included in the observations. The activities (*sensu* Paulus, 1988) were recorded on tally meters as resting (sleeping and loafing), feeding (ingestion of surface or subsurface food), locomotion (swimming, walking, or flying), courting (pair formation and social displays), preening (body maintenance or bathing), alert (attentive to disturbance), and agonistic activities (threat displays). The sex of each individual was recorded. All teal within view were counted during every 15-minute period to estimate number of teal using the study areas.

During each 15-minute observation period, ambient temperature, cloud cover, wind velocity, rainfall intensity, and light intensity were recorded. Light was measured with an Environmental Concepts LIM 2300 light-intensity meter mounted on a ring stand to measure reflected light from a photographic gray card. Percent cloud cover was estimated by the observer at Station 2, and wind velocity was measured by an anemometer at the Rockefeller SWR weather station.

Analysis of variance (ANOVA) and Duncan's multiple range test were used to test for significant differences among activities, time blocks, and months. Activities were compared among stations using ANOVA and Duncan's test (BWT: Stations 1 to 3, $\underline{n}$ = 297, 254, 196; GWT: Stations 1 to 3, $\underline{n}$ = 264, 368, 135). Specific activities and differences between sexes (paired sets) of the two species were tested with $\underline{t}$-tests. Percent-time data were arcsine transformed for these analyses. Numbers of individuals were totaled for each time block, then percent time spent in each activity was calculated by dividing the number of observations of an activity by the total number of observations, times one hundred. Pearson's correlation analyses were used to determine relationships between activities and physical variables. Progressive values were used for correlations involving factors of time: 1 to 6 for months, and 1 to 3 for daily time periods (morning, midday, afternoon). To compare the variables of habitat and how they affected each species, principal components analyses were conducted on untransformed data to determine which physical factors varied most with activities.

RESULTS

Activities

Observations of BWT and GWT totaled 424 hours (no occurrence was not recorded as time). Throughout most of the study, there were more males than females of BWT (9:1) and GWT (10:1) observed; however, there were no significant differences ($P > 0.05$) between sexes in time spent in any activity. Sex of BWT could not be confidently determined during October and early November, because most BWT individuals were in eclipse plumage. Male and female BWT observed after November were not significantly different in their activities. Thus, sexes were not distinguished in the analyses below.

Generally BWT spent more time ($P < 0.01$) feeding (65.4%), more time ($P < 0.05$) alert (3.1%), and less time ($P < 0.01$) resting (15.8%) than GWT (Table 1). There were no differences ($P > 0.05$) between the species in locomoting, courting, or preening activities. Feeding (BWT: 18.4 to 75.8%; GWT: 10.5 to 77.7%) was the most frequent activity of these species ($P < 0.05$) during most months, followed by resting (8.2 to 50.9%; 5.0 to 64.1%) and locomotion (8.2 to 40.7%; 5.5 to 25.5%). Neither species spent much time courting (until March) or alert. Agonistic behavior never represented over 0.12% of activities per month, and therefore was excluded from further analyses.

Habitat Comparisons

Stations 1 and 2 were generally similar habitats, but Station 3 had deeper water and some different vegetation. However, the only significant differences ($\underline{F}$ = 6.47, 2 $\underline{d.f.}$, $P < 0.05$) in activities among the three stations occurred in BWT during December and January, when BWT at Station 2 fed less than those elsewhere (Table 2). Numbers of BWT at Station 2 (15,533 observed) greatly exceeded those at Stations 1 (5919) and 3 (5922). GWT were also more numerous at Station 2 (36,782) than at either Stations 1 (7825) or 3 (3356). Relatively few BWT or GWT were observed at Station 3 after December, probably due to high water (greater than 1 m depth).

Temporal Effects

During October, most BWT and GWT had a regular pattern of morning feeding, resting during midday, and preening for up to an hour thereafter. Few BWT or GWT were seen using the study areas when the observers arrived before dawn, but teal began arriving soon thereafter. During October and November, many BWT and GWT were observed leaving the observation areas at Stations 1 and 3

TABLE 1
Activity budgets by month for Blue-winged Teal and Green-Winged Teal wintering at Rockefeller SWR, (Cameron Parish, Louisiana).

Blue-winged Teal							
Activity	October	November	December	January	February	March	Mean*
Resting	15.6^{a}	14.1^{a}	9.0^{a}	8.2^{a}	14.1^{a}	50.9^{b}	15.8
Feeding	66.0^{a}	68.3^{a}	43.9^{b}	75.8^{a}	64.8^{ab}	18.4^{c}	65.4
Locomotion	8.2^{a}	8.4^{a}	40.7^{b}	10.3^{a}	11.8^{a}	10.9^{a}	8.8
Courting	0.5	0	0	0.3	1.3	6.0	0.6
Preening	5.9	8.8	1.9	4.6	7.0	12.2	6.2
Alert	3.8	0.4	4.5	0.8	1.0	1.7	3.1

Green-winged Teal							
Activity	October	November	December	January	February	March	Mean*
Resting	25.6^{a}	5.0^{b}	64.1^{c}	32.2^{ab}	7.2^{b}	35.0^{c}	27.1
Feeding	56.9^{a}	76.9^{a}	10.5^{b}	51.8^{a}	77.7^{a}	29.3^{b}	55.3
Locomotion	5.5^{a}	11.8^{b}	19.8^{b}	11.0^{b}	9.1^{ab}	25.5^{c}	10.5
Courting	0	0	0.3	2.0	1.2	2.8	1.0
Preening	8.0^{a}	5.2^{ab}	5.2^{ab}	2.8^{bc}	3.8^{bc}	0.9^{c}	4.8
Alert	4.0	1.1	0	0.1	1.0	6.6	1.3

a,b,c Percentages for each month denoted by different letters are significantly different ($P \leq 0.05$).

* Calculated from total numbers of individuals observed.

TABLE 2
Activity budgets by month and station for Blue-winged Teal (BWT) and Green-winged Teal (GWT) wintering at Rockefeller SWR, Louisiana.

Activity Station	October	November	December	January	February	March
Resting						
1 (BWT)	18.2	8.5	2.5	7.3	17.1	50.1
1 (GWT)	43.6	10.7	--	9.4	15.0	34.9
2 (BWT)	15.7	8.2	17.9	28.3	7.2	--
2 (GWT)	14.6	2.9	64.2	33.0	5.1	--
3 (BWT)	13.9	19.5	0	0	--	--
3 (GWT)	15.8	10.2	0	82.4	--	--
Feeding						
1 (BWT)	46.0	70.9	70.0[a]	76.9[a]	63.7	18.4
1 (GWT)	31.0	71.0	--	71.6	70.7	29.3
2 (BWT)	69.2	67.4	11.9[b]	41.7[b]	67.5	--
2 (GWT)	75.4	78.1	10.5	51.1	79.6	--
3 (BWT)	68.6	68.3	50.0[a]	96.2[c]	--	--
3 (GWT)	66.3	77.3	0	11.8	--	--
Locomotion						
1 (BWT)	12.5	15.0	18.8	9.9	9.6	10.9
1 (GWT)	8.2	12.2	--	15.7	6.5	25.5
2 (BWT)	9.1	14.5	68.7	26.7	17.0	--
2 (GWT)	4.5	12.1	19.8	10.9	9.8	--
3 (BWT)	2.9	2.7	25.0	0	--	--
3 (GWT)	3.0	9.4	0	0	--	--
Courting						
1 (BWT)	2.6	0	0	0.1	1.9	6.0
1 (GWT)	0	0	--	0	1.2	2.8
2 (BWT)	0	0	0	0	0	--
2 (GWT)	0	0	0.3	2.1	1.2	--
3 (BWT)	0.7	0	0	3.9	--	--
3 (GWT)	0.1	0	0	0	--	--
Preening						
1 (BWT)	13.5	3.2	0	4.9	7.4	12.2
1 (GWT)	10.7	4.0	--	2.0	6.3	0.9
2 (BWT)	2.9	9.7	1.5	3.3	6.0	--
2 (GWT)	4.9	5.8	5.2	2.9	3.2	--
3 (BWT)	10.0	9.6	25.0	0	--	--
3 (GWT)	9.1	3.2	99.0	5.9	--	--
Alert						
1 (BWT)	7.2	2.4	8.8	0.9	0.4	1.7
1 (GWT)	6.6	2.1	--	1.3	0.3	6.6
2 (BWT)	3.0	0.2	0	0	2.4	--
2 (GWT)	0.6	1.0	0	0.1	1.2	--
3 (BWT)	3.9	0	0	0	--	--
3 (GWT)	5.8	0	1.0	0	--	--

a,b,c Percentages for each station denoted by different letters are significantly different ($P \leq 0.05$).

after morning feeding, presumably to rest elsewhere. Hundreds of BWT and GWT were observed resting in densely vegetated salt marsh areas (outside the study area) near Station 3 during midday. Similarly, most resting within the observation areas occurred during midday (Table 3).

The greatest differences in activities between the two species occurred during December, when GWT spent 64.1% of the time resting and BWT spent only 9% of the time resting (Table 1). After December, BWT and GWT locomotion was most frequent during morning (Table 3). Time spent courting and alert did not differ ($P > 0.05$) among time blocks in either species.

Physical and Biological Factors

Generally BWT and GWT responded to physical conditions in similar manners. In both species, resting and feeding were highly correlated (BWT: $\underline{n} = 747$; GWT: $\underline{n} = 767$; $P < 0.01$) with temperature (+) and light intensity (-). Locomotion was highly correlated with light intensity (-), and preening was highly correlated with temperature (+; Table 4). However, the responses of the two species to physical conditions were not identical. Locomotion was highly correlated with rainfall intensity (+) only in BWT. Preening was most closely correlated with time of day in BWT, but not so in GWT. Courting by GWT was related ($P < 0.01$) to both temperature (-) and light intensity (-), but the factors were not related ($P > 0.05$) in BWT. The significant relationships among feeding, resting, preening, temperature, and light support the observations of teal resting and preening after morning feeding. The consistent pattern of afternoon preening during early months of the study accounted for the inverse relationship ($P < 0.01$) between preening and date. Not unexpectedly, courting increased ($P < 0.01$) during the study period (Table 4) and was most frequent in March (Table 1).

Principal components analysis was conducted on a matrix of percent time spent per activity and physical variables including data from all stations and time blocks. The BWT first principal component (PC-I) showed loadings with five variables: water depth, month, temperature, light intensity, and cloud cover (Table 5). In GWT, the first principal component (PC-I) showed high correlation with four variables: month, temperature, light intensity, and cloud cover (Table 5). The correlation with so many variables indicates that the activities of both species generally varied as a group. PC-II was not highly correlated with any variables. Thus, most separation of the BWT and GWT activities occurred along a single axis (vertical) when the first two principal component scores were plotted in two dimensions (Figure 1). In both species, feeding and resting were separated from other activities, indicating that physical data (especially temperature and light intensity, Table 4) were very useful in interpreting teal feeding and resting behavior. Several factors (cloud cover, time, temperature, and light intensity) also distinguished the activities (horizontally), but to a lesser degree. Together PC-I and PC-II accounted for 36.7% of the variance in BWT and 35.4% in GWT.

DISCUSSION

Feeding values of BWT (65.4%) were similar to those reported during postbreeding (68.6%, DuBowy, 1985) and incubating (60%, Miller, 1976), and GWT values (55.3%) were similar to those for GWT feeding in natural marshes of South Carolina (56%, Hepp, 1982). However, GWT feeding values were well above averages reported elsewhere along the Gulf Coast (Texas, < 23%, Quinlan and Baldassarre, 1984; Louisiana, 33.3%, Rave and Baldassarre, 1989). Some of the discrepancy among studies likely resulted from variation in the habitats studied. For example, studies in Texas were conducted in agricultural areas where less foraging may be necessary to meet metabolic needs (< 23%, Quinlan and Baldassarre, 1984). Also, inclusion of several habitats in a study may lower the overall values for time spent feeding, assuming the activities vary with habitat. We used only intermediate marshes for our study. Rave and Baldassarre (1989), who also studied GWT on Rockefeller SWR, observed at several habitats, including intermediate marshes where GWT fed 41.3% of the time.

Overall, BWT spent more time feeding (65.4%) than GWT (55.3%). Bellrose (1980) reported that these two teal species often feed together, although GWT have a greater preference for seeds, and species that feed on seeds may allocate less time to feeding (Paulus, 1984). Gut contents of BWT and GWT collected during the study period indicated they fed on similar diets, primarily of wild seeds and chironomids, and seldom ingested agricultural seeds. Therefore, though the differences between the two species in time spent feeding could have resulted solely from greater preference for seeds by GWT, we suggest that the differences resulted from discrepancies in selections of habitats as well.

The frequency of feeding and locomotion of both species increased with decreasing temperatures (Table 4), probably a response to greater metabolic needs (Jorde *et al.*, 1983), but perhaps also because food availability decreased from fall to winter. At Rockefeller SWR, chironomid and seed densities diminished from fall to winter in the three study areas (Gaston and Nasci, 1989). Mean number of chironomids during fall (October to December) was 912 m^{-2} (range 20 to 2422 m^{-2}), while winter (January and February) means were 365 chironomids m^{-2} (range, 60 to 760 m^{-2}). Total number of seeds averaged 8917 m^{-2} during the fall (range, 1240 to 23,660 m^{-2}) and 4075 m^{-2} (range, 2400 to 6650 m^{-2}) during the winter.

TABLE 3
Activity budgets by month and time of day for Blue-winged Teal (BWT) and Green-winged Teal (GWT) wintering at Rockefeller SWR, Louisiana.

Activity Time	October	November	December	January	February	March
Resting (BWT)						
Morning	6.2	12.7	0	10.8	15.4	23.9
Midday	26.2	14.7	30.0	6.9	7.9	70.0
Afternoon	15.9	26.6	6.9	17.7	29.7	42.1
Resting (GWT)						
Morning	11.9[a]	9.0[a]	15.1[a]	13.4[a]	16.7[a]	--
Midday	63.3[b]	18.6[b]	48.8[b]	37.7[b]	5.6[b]	--
Afternoon	15.5[a]	12.2[b]	52.2[b]	18.8[a]	21.5[a]	29.8
Feeding (BWT)						
Morning	76.8[a]	70.8[a]	72.0[a]	71.0[a]	45.4[a]	30.8[a]
Midday	54.8[b]	72.1[a]	30.0[b]	66.6[b]	77.1[b]	8.9[b]
Afternoon	60.9[b]	55.3[b]	29.6[b]	62.7[b]	53.9[a]	23.6[b]
Feeding (GWT)						
Morning	76.1[a]	68.6[a]	50.0[a]	59.5[a]	53.4[a]	--
Midday	25.3[b]	48.5[b]	24.4[b]	43.6[b]	84.2[b]	--
Afternoon	63.6[a]	67.8[a]	25.1[b]	64.8[a]	63.3[a]	26.7
Locomotion (BWT)						
Morning	8.8	13.1[a]	14.6[a]	17.9[a]	25.9[a]	23.2[a]
Midday	10.1	2.6[b]	40.0[b]	16.3[a]	8.1[b]	6.3[b]
Afternoon	8.7	11.7[b]	51.5[b]	7.9[b]	7.6[b]	12.6[b]
Locomotion (GWT)						
Morning	4.8	17.6[a]	21.1	21.0	22.8[a]	--
Midday	0.9	25.7[b]	21.4	15.5	5.0[b]	--
Afternoon	7.1	14.3[a]	19.4	10.0	6.6[b]	33.2
Courting (BWT)						
Morning	0.3	0	0	0	2.6	12.6
Midday	0.8	0	0	4.2	0.6	3.0
Afternoon	0.3	0	0	0.2	0.6	5.4
Courting (GWT)						
Morning	0	0	0.1	4.0	1.3	--
Midday	0.1	0	0.8	0.9	1.3	--
Afternoon	0.1	0	0	0.8	0.8	2.7
Preening (BWT)						
Morning	3.4	2.5	0	0.2	7.9	9.5
Midday	6.8	10.6	0	1.4	3.5	11.4
Afternoon	9.3	6.3	6.3	11.2	7.4	12.9
Preening (GWT)						
Morning	4.5[a]	4.7	13.7[a]	1.8	3.2	--
Midday	9.3[b]	6.1	4.6[b]	1.2	3.8	--
Afternoon	8.7[b]	4.5	3.4[b]	4.0	7.4	0.9
Alert (BWT)						
Morning	4.5	0.9	13.4	0.1	2.8	0
Midday	1.2	0	0	4.6	2.9	0.4
Afternoon	4.8	0	5.6	0.3	0.9	3.3
Alert (GWT)						
Morning	2.6	0	0	0.3	2.6	--
Midday	1.1	1.1	0	1.1	0.1	--
Afternoon	5.1	1.2	0	1.5	0.4	6.7

a,b Percentages for each time of day denoted by different letters are significantly different ($P \leq 0.05$).

TABLE 4
Correlation coefficients of selected physical variables and activities of Blue-winged Teal and Green-winged Teal wintering at Rockefeller SWR, Louisiana.

			Blue-winged Teal			
Variable	Resting	Feeding	Locomotion	Courting	Preening	Alert
Date	0.073	-0.087*	0.106*	0.139**	-0.001	-0.028
Time	0.102*	-0.142*	-0.047	-0.026	0.172**	0.034
Rainfall	-0.045	-0.022	0.238**	-0.026	-0.086*	0.053
Wind	-0.005	0.007	-0.107*	-0.060	0.081*	-0.021
Temperature	0.186**	-0.193**	-0.121**	0.011	0.139**	0.028
Light intensity	0.138**	-0.118**	-0.141**	-0.005	0.085*	-0.015
Cloud Cover	-0.144**	0.076	0.141**	-0.056	-0.047	0.050

			Green-winged Teal			
Variable	Resting	Feeding	Locomotion	Courting	Preening	Alert
Date	-0.062	-0.055	0.156**	0.241**	-0.125**	-0.065
Time	0.047	-0.032	-0.097*	-0.105*	0.036	0.091*
Rainfall	0.004	-0.073	0.059	0.077	0.027	-0.003
Wind	-0.059	0.063	-0.085*	-0.062	0.005	0.009
Temperature	0.213**	-0.127**	-0.063	-0.159**	0.155**	0.030
Light intensity	0.393**	-0.210**	-0.158**	-0.136**	0.151**	-0.027
Cloud Cover	-0.112*	0.002	0.010	0.057	-0.018	0.053

* $P < 0.05$
** $P < 0.01$

Activity budgets of BWT and GWT were similar among the three areas we studied, even though the habitats varied somewhat in water depth and related variables. We had much less habitat diversity for comparisons than in previous studies in Texas (White and James, 1978), Alabama (Turnbull and Baldassarre, 1987), or Louisiana (Rave and Baldassarre, 1989) where investigators demonstrated significant differences in activity budgets of waterfowl using widely different habitats.

The inverse relationship between feeding and temperature (Table 4) stresses the impact of cold fronts, morning low temperatures, and decreasing temperatures on teal activities. Highest numbers of BWT were observed during October and November, indicating that most of them were on migration flights and later left the area. Thus, since many of the BWT probably arrived in the study areas in association with weather fronts (as suggested by Bellrose, 1980), the relationship between feeding and temperature was not unexpected. The lack of close correlations between time of day and feeding or resting of the teal (Table 4) emphasizes the loss of pattern in activities after fall. We suggest this occurred because metabolic demands increased after December, and because seeds and chironomids, which had been abundant in the study areas during the fall, were more

TABLE 5
Correlations with first and second principal components based on physical variables and activities of Blue-winged Teal and Green-winged Teal wintering in southwestern Louisiana.

	Blue-winged Teal		Green-winged Teal	
Physical Variables	PC-I	PC-II	PC-I	PC-II
Water Depth	-0.51	-0.33	-0.27	-0.11
Date	0.73	0.33	0.78	0.22
Time	-0.31	0.30	-0.24	-0.23
Rainfall Intensity	0.50	0.11	0.40	0.34
Wind Velocity	-0.03	0.08	0.01	-0.31
Temperature	-0.84	0.16	-0.84	-0.02
Light Intensity	-0.79	0.03	-0.84	0.08
Cloud Cover	0.69	0.02	0.62	0.04

scarce after December. This scarcity in food probably accounted for the increased time spent in locomotion during late winter and early spring mornings (Table 3). Apparently, since food was scarce, the BWT and GWT spent more time in search of feeding areas or spent more time feeding elsewhere.

Both teal species fed more during the mornings than during the afternoons. This pattern was especially evident during the fall (Table 3) when thousands of migrating BWT actively fed in the area. Several hypotheses could be proposed to explain the pattern of morning feeding. Perhaps some teal were arriving during morning (migrants) or were fasting overnight, as proposed by Rave and Baldassarre (1989). Perhaps most of the teal left the study area after morning feeding, and those that remained fed little because they had met their metabolic requirements. Perhaps morning feeding was more efficacious than midday or afternoon feeding because of less predation pressure during morning.

Euliss and Harris (1987) hypothesized that disturbance by Northern Harriers (*Circus cyaneus*) played a major role in diurnal activities of GWT. However, Gadwalls (*Anas strepera*) feeding in the same study area were not disturbed by the presence of Northern Harriers (Gaston and Nasci, 1989). We observed that Northern Harriers caused both BWT and GWT in our study areas to take flight regularly, and Northern Harriers were especially active during midday and afternoon. Significantly greater morning feeding by these teal is consistent with the hypothesis that predation pressure influenced the time of day that teal fed, and may account for the use of refuge vegetation during resting periods.

There were differences in overall time spent feeding, resting, and alert between BWT and GWT, but the daily and monthly patterns in activities were generally similar and the role of habitat remained unchanged during the study. The study area provided resources for both species, and both apparently used the area for most of their feeding. However, BWT and GWT responded differently to certain environmental and habitat conditions. As food was depleted during middle and late winter, many GWT left the shallow intermediate marsh ponds and fed in salt marsh mudflats (see Gaston, 1992). Those BWT and GWT that remained in the study area spent more time foraging for diminishing resources. During our study, many GWT used salt marshes for midday resting and preening. BWT did not use mudflats or salt marsh areas as often, and either used the intermediate marshes for all of their activities or emigrated from the study area (i.e., across the Gulf of Mexico).

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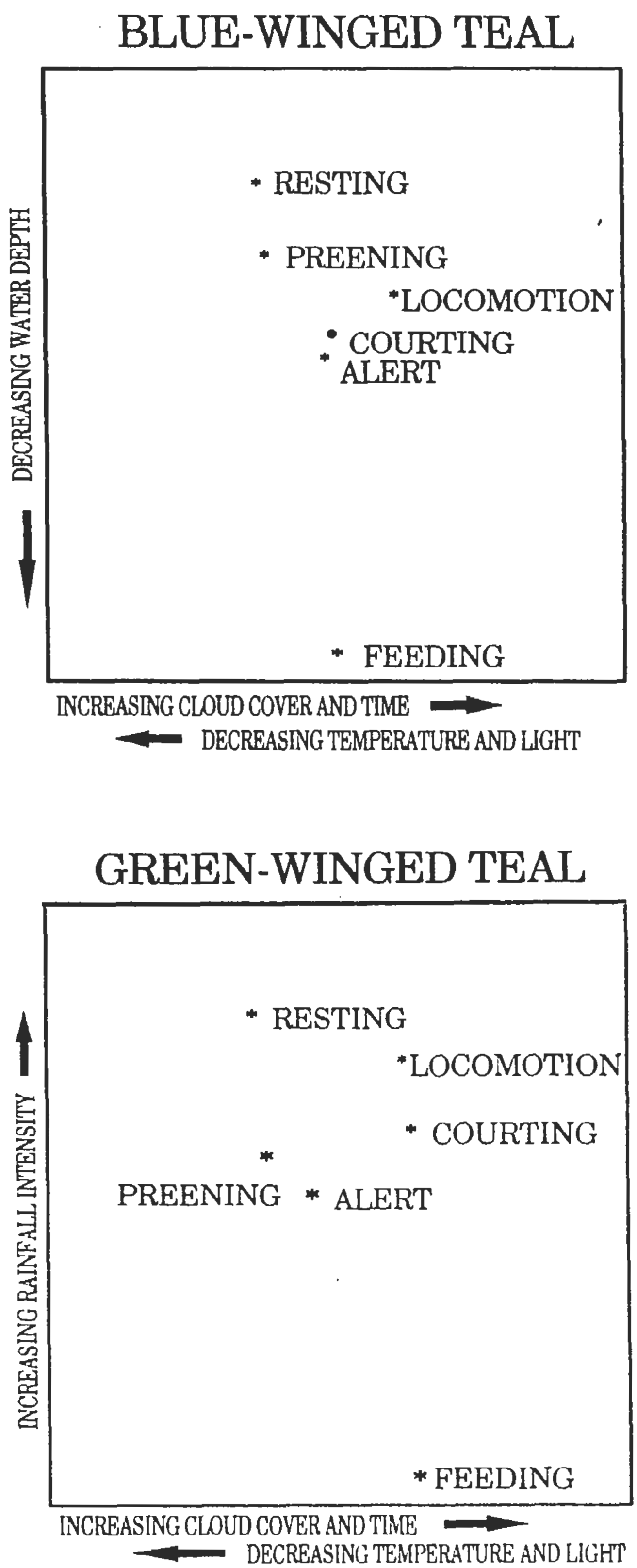

Figure 1. First (abscissa) and second (ordinate) unrotated eigenvectors of a principal components analysis of Blue-winged Teal and Green-winged Teal activities and associated physical variables in southwestern Louisiana.

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