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Cover Use and Activity Time Budget of Blue-Winged Teal, Mallard, and Pintail Broods

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COVER USE AND ACTIVITY TIME BUDGETS OF BLUE-WINGED TEAL, MALLARD, AND PINTAIL BROODS

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor Date

Head, Wildlife and Fisheries Sciences Department Date

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COVER USE AND ACTIVITY TIME BUDGETS OF BLUE-WINGED TEAL, MALLARD, AND PINTAIL BROODS

Abstract

JAMES K. RINGELMAN

Blue-winged teal (Anas discors), mallard (A. platyrhynchos), and pintail (A. acuta) broods were observed on 17 days between 25 June and 30 July, 1976. Brood activities and cover uses were recorded continuously from first light until dark. Observations of 269 broods from three wetlands were evaluated by species and brood age-class. Activity time budgets revealed significant ($p < .01$) age specific differences in total feeding time and visibility among age-classes of all species combined and age-classes of blue-winged teal broods. Feeding modes also varied among age-classes. Daily patterns of cover use varied among brood age-classes and species. Morning and evening feeding peaks became more pronounced, and overall visibility increased, with brood age. Interspecific differences in daily activity patterns were observed among broods of the same age-class.

Duration of active periods increased with age in blue-winged teal broods. Active periods recurred at regular intervals in all broods throughout the day, suggestive of polycyclic behavior patterns similar to those of adult ducks.

A progressive increase in brood visibility was attributed primarily to seasonal changes in brood age structure and to wetland water loss. Temperature and wind speed influenced brood visibility during most observation days. Climatic conditions favorable to

nighttime brood activity influenced brood behavior during the following day. Accuracy of present brood inventory techniques could be improved if considerations were made for brood behavior patterns and environmental factors which alter brood cover use.

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INTRODUCTION

Behavior patterns are useful in evaluating the environmental requirements of a species and interpreting census data. Although past research has examined general trends in brood visibility, accurate quantification of brood behavior is lacking for dabbling duck species.

Numerous investigators have concluded that broods are more active, and hence more visible, in the morning (before 1000) and evening (after 1700) hours (Mendall 1958:131, Diem and Lu 1960). Most brood production surveys are timed to coincide with one or both of these active periods.

Some researchers have observed that behavior patterns vary among broods of different ages or species. Beard (1964) quantified time budgets for broods of seven duck species, and noted differences in feeding duration and methods among species. Ball (1973) suggested that young broods tended to utilize emergent cover to a greater extent than did older broods of the same species. It has been hypothesized (Chura 1963) that the periodicity in behavior exhibited by broods may be likened to the field-feeding flights of adult ducks described by Bellrose (1944), Hochbaum (1955:73), and Winner (1959). These field-feeding flights of adult ducks were concentrated in the early morning and evening hours. Detailed work on the activity budgets of adult blue-winged teal (Anas discors) (Owen 1968), gadwall (A. strepera) (Dwyer 1975), shoveler (A. clypeata) (Poston 1974), and lesser scaup (Aythya affinis) (Siegfried 1974) indicated peaks of activity in breeding adults which corresponded to the morning and evening activity peaks observed in broods.

This study quantitatively evaluates the daytime activities of dabbling duck broods in sufficient detail to detect differences in behavior among broods of different species and age-classes.

The objectives of the study are:

1. to obtain information on brood behavior through continuous observations during daylight periods.
2. to quantify the cover use and activity time budgets of blue-winged teal, mallard (*Anas platyrhynchos*), and pintail (*A. acuta*) broods according to brood age-class and species.
3. to examine similarities and differences in behavior patterns which exist among broods of different species and age-classes.
4. to determine the influence and relative importance of selected environmental factors on brood behavior.

STUDY AREA

General Description

Study wetlands were located in eastern Kingsbury and central Deuel Counties, South Dakota, in the Coteau des Prairies physiographic region (Westin et al. 1967). Glacial wetlands in this region attract large numbers of breeding ducks, sustaining breeding densities of 14.9 and 7.8 pairs per km^2 in 1973 and 1974 respectively (Brewster et al. 1976). Land use is primarily devoted to livestock production and the cultivation of corn and small grain.

The region is dominated by a continental climate characterized by annual extremes of both high and low temperatures. Average daily maximum and minimum July temperatures were 29.2 C and 14.7 C respectively. The eastcentral South Dakota region experienced drought conditions during 1976. Precipitation from 1 January to 31 July totaled 23.0 cm, as compared to a 77 year average of 33.6 cm for this same period (South Dakota State University Weather Station records). Frontal activity, often accompanied by high winds and intermittant heavy rain, is common during the summer.

Sample Wetlands

Brood observations were conducted on three semipermanent wetlands (Stewart and Kantrud 1971). All wetlands possessed a central open water region surrounded by a peripheral band of emergent vegetation.

The Kingsbury County wetland was located in proximity to three lakes which annually serve as breeding and stopover areas for large numbers of migratory waterfowl. Lake Whitewood, the nearest of these lakes, is located within 1.6 km of the sample area. The 6.9 ha sample marsh is contained within the Warne Waterfowl Production Area, located in the southeast quarter of section 7, T110N, R53W.

The wetland retained water throughout the months of June and July. Mud bars and mounds composed of dead emergent vegetation were exposed by mid-Judy. Water depth averaged approximately 15 cm by 30 July.

The circular wetland was dominated on all but the western edge by dense stands of cattail (Typha spp.). The sparsely vegetated western edge was dominated by the river bulrush (Scirpus fluviatalis) and sedge (Carex spp.). Sago pondweed (Potamogeton pectinatus) was an abundant submergent. The surrounding upland vegetation consisted of alfalfa and grasses (primarily Bromus inermis) which remained unmowed until mid-July. Mowing was permitted at this time through special legislation intended to relieve a hay shortage brought about by drought conditions.

Deuel County wetland number 1 was situated in hilly topography in the eastern escarpment of the Prairie Coteau. The 5.1 ha marsh was located in the southeast quarter of section 31, T115N, R47W, on a Game Production Area owned by the South Dakota Department of Game, Fish and Parks.

Water level in the marsh decreased during June and July, and exposed shorelines were evident by 1 July. The wetland was "L" shaped, with the base of the "L" oriented in an east-west direction.

Cattail fringed the entire shoreline and occurred in dense stands along the north and east sides of the wetland. Hardstem bulrush (*Scirpus acutus*) and bur reed (*Sparganium eurycarpum*) were sparsely represented. Approximately 30 percent of the open water region contained dense growths of pondweeds (*Potamogeton* spp.). Upland vegetation consisted primarily of smooth brome (*Bromus inermus*) of sufficient density to provide good nesting cover. The region was subjected to light cattle grazing during the study.

Deuel County wetland number 2 served as a sample wetland on 15 July. Subsequent observations on this marsh were not conducted because of the small number of broods present and frequent human disturbance. The 4.0 ha wetland was located in the southeast quarter of section 36, T117N, R49W, 0.4 km north of Lake Alice, a permanent body of water. Water level in the marsh was high due to the stabilizing influence of Lake Alice. A dense fringe of cattail bordered all but a small portion of the southern edge of the wetland. This region was sparsely vegetated with sedges interspersed along a rocky shore. No submergent vegetation was observed. Land use beyond the dense cattail growth was devoted to cattle grazing and cultivation of corn and oats. Nesting cover was poor.

METHODS

General

The field season was timed to coincide with the height of the brood rearing season in eastcentral South Dakota (Evans and Black 1956). Wetlands were selected in accordance with predetermined criteria. Suitable wetlands were natural, semipermanently wet basins with a substantial open water phase and a peripheral band of emergent vegetation. This corresponds to the class IV, cover type 3 wetland classification of Stewart and Kantrud (1971). Use of wetlands with the same cover type minimized bias introduced through differential brood visibility caused by vegetative growth. Sample wetlands were further restricted to being under 8.0 ha in size with an upland topography suitable for placement of an observation blind.

Observations were conducted from approximately one-half hour prior to sunrise to one-half hour after sunset, an average of 16.2 hours. Two observers were required for a full-day observation, the second observer replacing the first at approximately mid-day. Manpower shortages occassionally necessitated half-day observations. In such cases, morning and evening observations were alternated on successive days.

I assumed that during the course of an observation day, all broods present on the marsh would be seen at least once. Evans et al. (1952) provided evidence to support this assumption.

The timing of brood activities was critical in this study. Solar time, rather than civil time, was utilized with the assumption that broods were more likely to synchronize their behavior to a natural photoperiod. Sunrise was arbitrarily designated as 0200 hours. Watches were synchronized by use of a sunrise schedule.

Observation Techniques

An observation blind measuring 1.2 m square and 1.3 m high was constructed utilizing a three-quarter inch plastic pipe frame covered with fitted camouflage net material. The blind was situated so that the observer could view the entire wetland. Observation points were at least 50 m from the wetland edge, thereby minimizing disturbance to the broods. A tripod mounted 15X-60X variable power spotting scope enabled detailed brood observations.

Broods were identified by species, age-class, and number of ducklings. Species determination was frequently accomplished by identification of the hen, which was usually present with the brood. Ducklings without an accompanying hen were identified by physical characteristics (Bellrose 1976:385). Broods were aged according to the pattern of down replacement (Table 1).

Individual broods could be identified through a combination of species, age-class, and size (number of young) characteristics. Beard (1964) found this technique satisfactory for distinguishing individual broods in most instances. A protractor mounted between the spotting scope and tripod allowed an observer to record the position of broods on the marsh. The protractor further aided in following brood movements and re-establishing brood identity.

Brood characteristics were described on standardized field

Table 1. Description of duckling plumage subclasses (after Gollop and Marshall 1954).

Subclass	Description
Ia	"Bright ball of fluff". Down bright. Patterns distinct. Body rounded; neck and head are not yet prominent.
Ib	"Fading ball of fluff". Down color fading, patterns less distinct. Body still rounded; neck and tail are not yet prominent.
Ic	"Gawky-downy". Down color and patterns faded. Neck and tail becomes prominent. Body becomes long and oval.
IIa	"First feathers". First feathers show on side. Stays in this class until side view shows one-half of side and flank feathered.
IIb	"Mostly feathered". Side view shows one-half of side and flank feathered. Primaries break from sheaths. Stays in this class until side view shows down in one or two areas only.
IIc	"Last down". Side view shows down in one or two areas only. Sheaths visible on erupted primaries through this class. Stays in this class until profile shows no down.
III	"Feathered flightless". No down visible. Primaries completely out of sheaths but not fully developed. Stays in this class until capable of flight.

observation forms (Appendix A). The marsh was scanned at 15 to 20 minute intervals, during which time the activities, cover use, and location of visible broods were recorded. The time of each observation was also noted. Previously described broods which were not visible in the open water region of the marsh were assumed to be utilizing the peripheral emergent vegetation. Study wetlands were sufficiently isolated that interwetland brood movement was minimal. Two separate sightings during an observation day were required to verify the presence of each brood. Changes in brood activity were recorded between scans when noticed by the observer. A portable cassette tape recorder was utilized for recording brood behavior during periods of peak activity. The activity of a brood was designated as that behavior exhibited by a majority of the ducklings in the brood.

The activity classifications used in this study are surface feeding, bill-dip feeding, head-duck feeding, tip-up feeding, swimming, loafing, and sleeping. A "not visible" designation was assigned to a brood utilizing emergent cover. The feeding activity classifications follow those used by Sugden (1973). Surface feeding describes the act of gleaning food from the surface of the water. Both bill-dip feeding and head-duck feeding are forms of subsurface feeding; the former involves submersion of the bill, while the latter requires the immersion of the entire head. Tip-up feeding is a more active type of subsurface feeding during which the body is held in a vertical position by a paddling motion of the feet while the head and neck are fully extended under water. Loafing activity took place both on land and water. The loafing classification is used to describe a general state of sleepless inactivity. A duckling was considered asleep if it's head was tucked under it's wing or if it's eyes were closed.

Four cover use classifications were utilized in this study. The emergent cover designation corresponded to a region of dense aquatic plant growth which completely obscured broods from the observer. The interface cover type was that narrow region at the boundary between the emergent vegetation and the central water area. The transition zone was a region of water extending from the interface 6 m outward into the marsh. The remaining, centrally located water region was designated the open water region.

Air temperature was measured on location. Wind speed was determined using the Beaufort wind scale, and percent cloud cover was determined by ocular estimate.

Data Analysis

Activity and cover use information for all broods was coded, verified, and keypunched onto 80 column IBM computer cards. One card contains the activity information for a single brood during one observation day (one "brood-day"). An IBM 370 computer was utilized for data analysis. Time budget information is expressed as the percent of broods involved in a particular activity at any specified time. The percentage is calculated as the number of broods exhibiting a particular behavior at a given time divided by the total number of broods observed on the wetland during that specified day times 100. Data were graphed to illustrate the distribution of these activities and cover uses over the course of a day.

Since a wetland was sampled on numerous occasions, the same broods were observed on a number of days. Brood-day data were grouped into individual broods, thereby allowing an estimate of the actual number of broods observed during the study. Grouping of brood-day data was accomplished through consideration of the species, age-class, and size of the brood as well as the pond on which that brood was found. A schedule of midpoint ages for each plumage subclass was used to estimate the expected age of a brood according to the number of days elapsed between observations. Average mortality rates were considered when grouping broods. A chi-square analysis was performed to compare the variability in behavior between individual broods with variability in behavior within a brood on different observation days.

Polynomial regression functions were used to describe daily patterns of brood visibility. Individual broods were examined for regularities in behavior.

The effect of environmental factors on brood behavior was evaluated using forward, stepwise-multiple linear regression analysis. The analysis was approached from two perspectives. The first evaluation dealt with assessing the relative contribution of each of eight independent variables to the percent of broods not visible during a specified time of day. In this case, observation days were subdivided into 10, one and one-half hour periods, then equivalent periods pooled for all days. A second evaluation assessed the influence of temperature, wind speed, and percent cloud cover on the percent of broods not visible during each observation day.

Ball (1973) and Swanson and Sargeant (1972) observed broods actively feeding throughout the night. Independent variables relating to nighttime environmental conditions were evaluated to determine the effect that night activities had on brood behavior the subsequent day. These variables were entered under the assumption that broods which were abnormally restricted in their night activities would tend to compensate by increasing the frequency or intensity of these repressed activities when environmental conditions became more favorable. Conversely, satiation of a night activity, especially feeding, might have resulted in decreased activity of this type the following day.

Table 2. Sources and hypothesized influence of independent variables used in multiple regression analysis.

Independent variable	Source	Hypothesized effect on brood behavior
Interval temperature (°C)	On-site weather data	Suppression of activity and increased use of emergent cover during periods of temperature extremes (Kendeigh 1934, Diem and Lu 1960).
Interval wind speed (km/hr)	On-site weather data	General suppression of activity and increased use of emergent cover during periods of high wind. Possible increase in feeding activity in low and moderate wind (Diem and Lu 1960).
Interval cloud cover (%)	On-site weather data	Cloud cover may delay onset of activity in early morning or initiate evening activities prematurely. In conjunction with temperature, may affect activity by reduction of incident solar radiation (Diem and Lu 1960).
Number of days elapsed between 1 June and date of observation	An arbitrarily selected reference date	The age structure and species composition of sample brood populations changes continuously during the summer brood season. Water levels change during this same time interval. All of these factors may influence the overall behavior and visibility of broods (Diem and Lu 1960).
0100 temperature Central Daylight Time[a] (°C)	South Dakota State University Weather Station records	Time 0100 hours corresponds to the approximate midpoint of a night period. The temperature at this time may reflect alterations in night-time activities brought about by night-time temperatures.
Average overnight wind speed[a] (km/hr)	South Dakota State University Weather Station records	Wind speed may alter brood behavior as previously described in interval wind speed.
Moon phase[a] (fraction visible)	Schedule of moonrises and moonsets	Available light during the darkness period may influence brood activities. Feeding on emerging aquatic insects may be limited to light conditions.
Moonlight duration[a] (minutes)	Schedule of moonrises and moonsets	Coupled with moon phase, moonlight duration may influence brood activities at night. The number of food items acquired by night-feeding broods may be proportional to the duration of moonlight.

[a]Data refers to the night prior to an observation day.

RESULTS

Brood observations were conducted on 17 days during the period 25 June to 30 July, 1976. Three species were represented in 269 brood-days (3410 brood-hours) of observations (Table 3). Broods sampled, in order of decreasing abundance, were those of blue-winged teal, mallard, and pintail. With the exception of pintail age-class I broods, all species were represented in each brood age-class.

The time devoted to all activities during each of 4, 15-minute periods was averaged to obtain an overall activity summary by hour. These activity time budgets are presented graphically for blue-winged teal and mallard broods. Inadequate sample size precluded detailed activity budget graphs for pintail broods. Each of the 16 hourly activity summaries were averaged for all species and age-classes to obtain overall daily activity budgets (Table 4). Significant ($p < .05$) interspecific and age specific differences were observed among broods.

Interspecific Differences in Behavior

Activity budgets. Age-class I blue-winged teal and mallard broods show similarities in general behavior patterns (Fig. 1). Broods of both species utilized emergent cover for 59 percent of the daylight period. Mallard broods preferred emergent cover during the morning and early afternoon periods, restricting much of their swimming activity to late afternoon and evening. In contrast, blue-winged teal showed more consistent swimming behavior and use of emergent cover throughout the day. Loafing activity was limited in both species, especially in age-class I mallard broods. Feeding

Table 3. Distribution of sampling effort by species, age-class, wetland, and date.

	Species			
	Blue-winged teal	Mallard	Pintail	Total
Age-class				
Ia	23	8	0	31
Ib	32	6	0	38
Ic	17	1	0	18
Total I	72	15	0	87
IIa	14	7	1	22
IIb	40	12	5	57
IIc	24	5	3	32
Total II	78	24	9	111
III	26	40	5	71
Species total	176	79	14	269
Wetland -Date				
Kingsbury				
25 June	18	7	4	29
29 June	11	5	2	18
5 July	16	2	2	20
12 July	10	3	1	14
13 July	8	4	1	13
19 July	10	3	0	13
20 July	7	5	0	12
26 July	5	5	0	10
29 July	5	3	0	8
30 July	5	4	0	9
Total	95	41	10	146
Deuel-1				
1 July	16	5	0	21
7 July	18	7	2	27
8 July	20	6	2	28
21 July	9	5	0	14
22 July	9	3	0	12
28 July	9	2	0	11
Total	81	28	4	113
Deuel-2	0	10	0	10
Grand total	176	79	14	269

Table 4. Mean percent of day devoted to activity modes.

Age-class	Activity	Species															Means
		Blue-winged teal					Mallard					Pintail					
I																	
	Not visible	69.4[c]					69.8					--					69.6[a]
	Swim		4.3					6.6					--				5.4
	Loaf			1.2					0.1					--			0.7
	Sleep				0.3					0.3					--		0.3
	Feed					24.8[d]					23.2					--	24.0[b]
II																	
	Not visible	62.1[c]					57.4					57.3					58.9[a]
	Swim		2.0					2.3					2.9				2.4
	Loaf			6.8					12.4					12.0			10.4
	Sleep				1.6					1.2					0.4		1.1
	Feed					27.5[d]					26.7					27.3	27.2[b]
III																	
	Not visible	44.1[c]					55.3					37.0					45.5[a]
	Swim		1.8					2.9					1.4				2.0
	Loaf			8.8					13.7					19.0			13.8
	Sleep				3.6					1.3					1.4		2.1
	Feed					41.7[d]					26.8					41.2	36.6[b]
	Means	58.6	2.7	5.6	1.8	31.3	60.8	3.9	8.8	0.9	25.6	47.1	2.2	15.6	0.9	34.2	

[a] The mean percent of broods not visible differs significantly among age-classes ($p<.01$).
[b] The mean percent of broods feeding differs significantly among age-classes ($p<.05$).
[c] The percent of blue-winged teal broods not visible differs significantly among age-classes ($p<.01$).
[d] The percent of blue-winged teal broods feeding differs significantly among age-classes ($p<.01$).

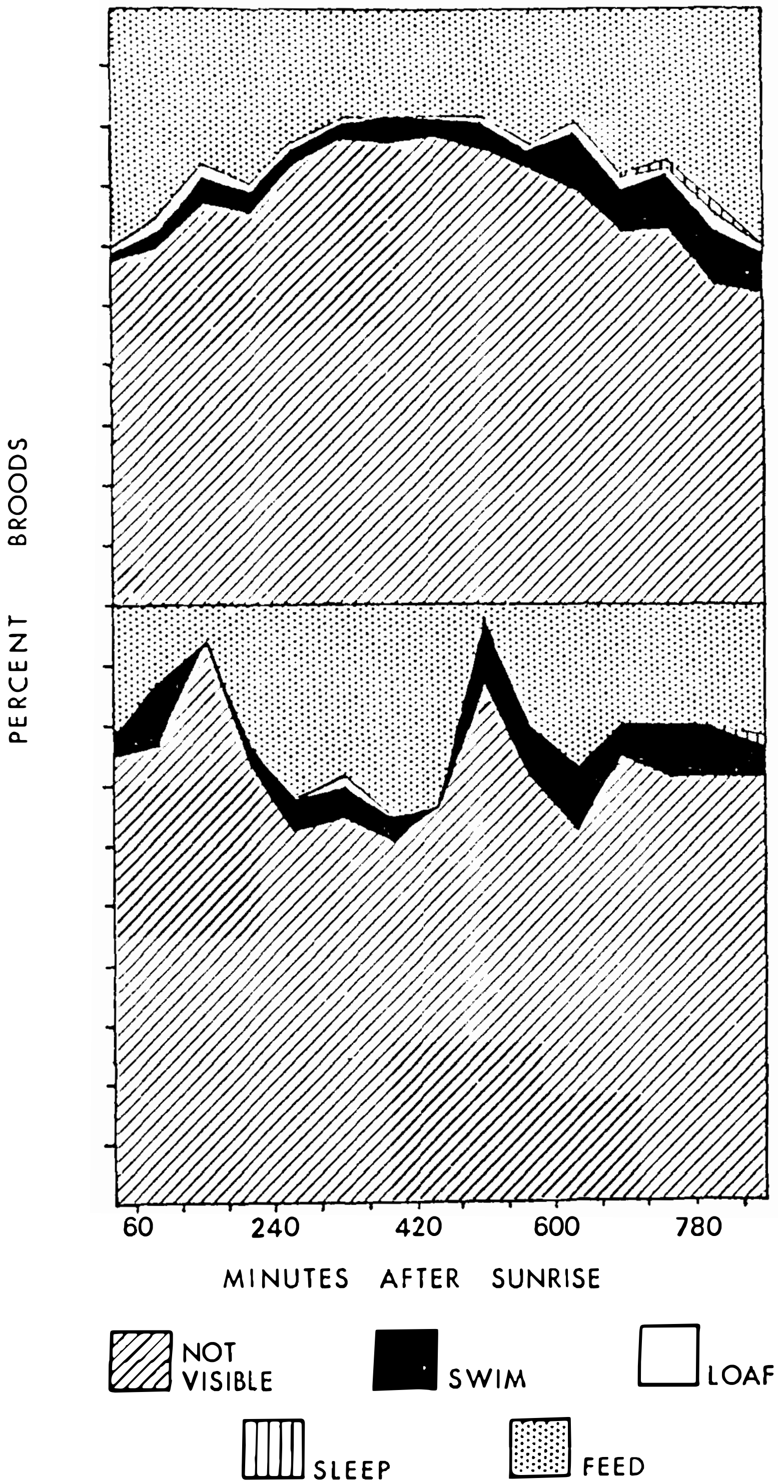

Fig. 1. Activity time budgets for age-class I blue-winged teal (upper) and mallard (lower) broods. The vertical axis is scaled at 10 percent intervals.

activity peaked in the morning and evening in blue-winged teal, whereas mallard broods were prone to initiate intermittent feeding bouts throughout the day. Age-class I broods of both species seldom slept within view of an observer.

Behavior among all age-class II broods was more uniform than that observed between age-class I broods. Blue-winged teal, mallard, and pintail broods exhibited the same daily activity budgets for visibility, swimming, and sleeping behavior (Table 4). Moreover, the timing of these activities was similar between mallard and blue-winged teal broods (Fig. 2). Feeding activity in both species peaked in the morning and evening. The only apparent difference in behavior was the timing and extent of loafing activity shown by mallard broods. Mallards spent approximately twice as much time loafing out of emergents as did blue-winged teal. Afternoon and evening loafing was particularly evident in mallard broods. Pintail age-class II broods closely resembled mallard broods in their daily activity budget.

Age-class III broods showed more disparate behavior among species than did younger broods (Fig. 3). Mallards slept, loafed, and swam uniformly throughout the day, in contrast to blue-winged teal which exhibited pronounced mid-day and evening peaks in sleeping and loafing respectively. Swimming activity occurred infrequently in age-class III blue-winged teal broods, but morning and evening feeding peaks were observed in both species. Age-class III pintail broods more closely resembled blue-winged teal than did mallard broods in their daily activity budget. Pintails were more visible and loafed to a greater extent than either mallard or blue-winged teal.

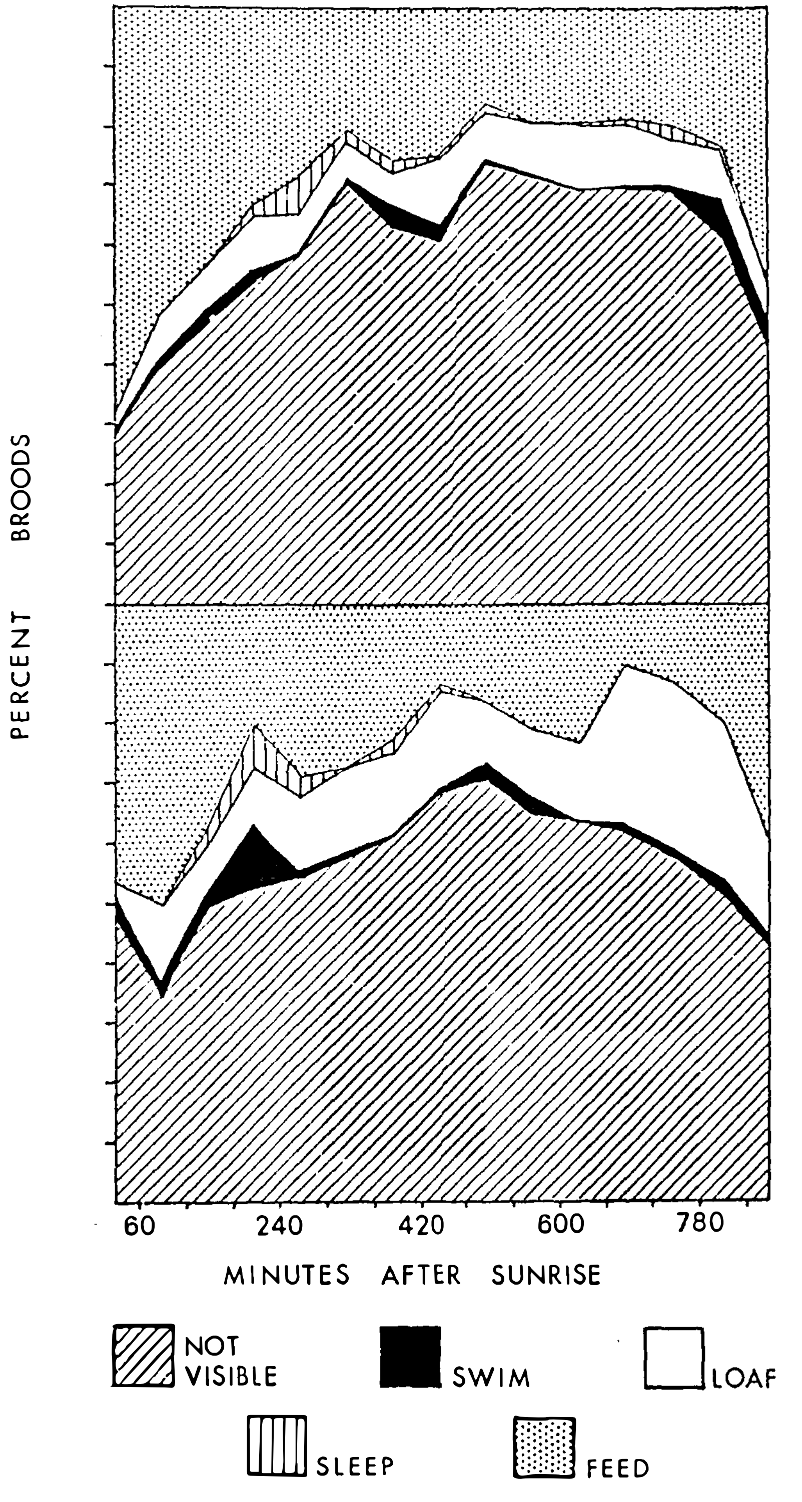

Fig. 2. Activity time budgets for age-class II blue-winged teal (upper) and mallard (lower) broods. The vertical axis is scaled at 10 percent intervals.

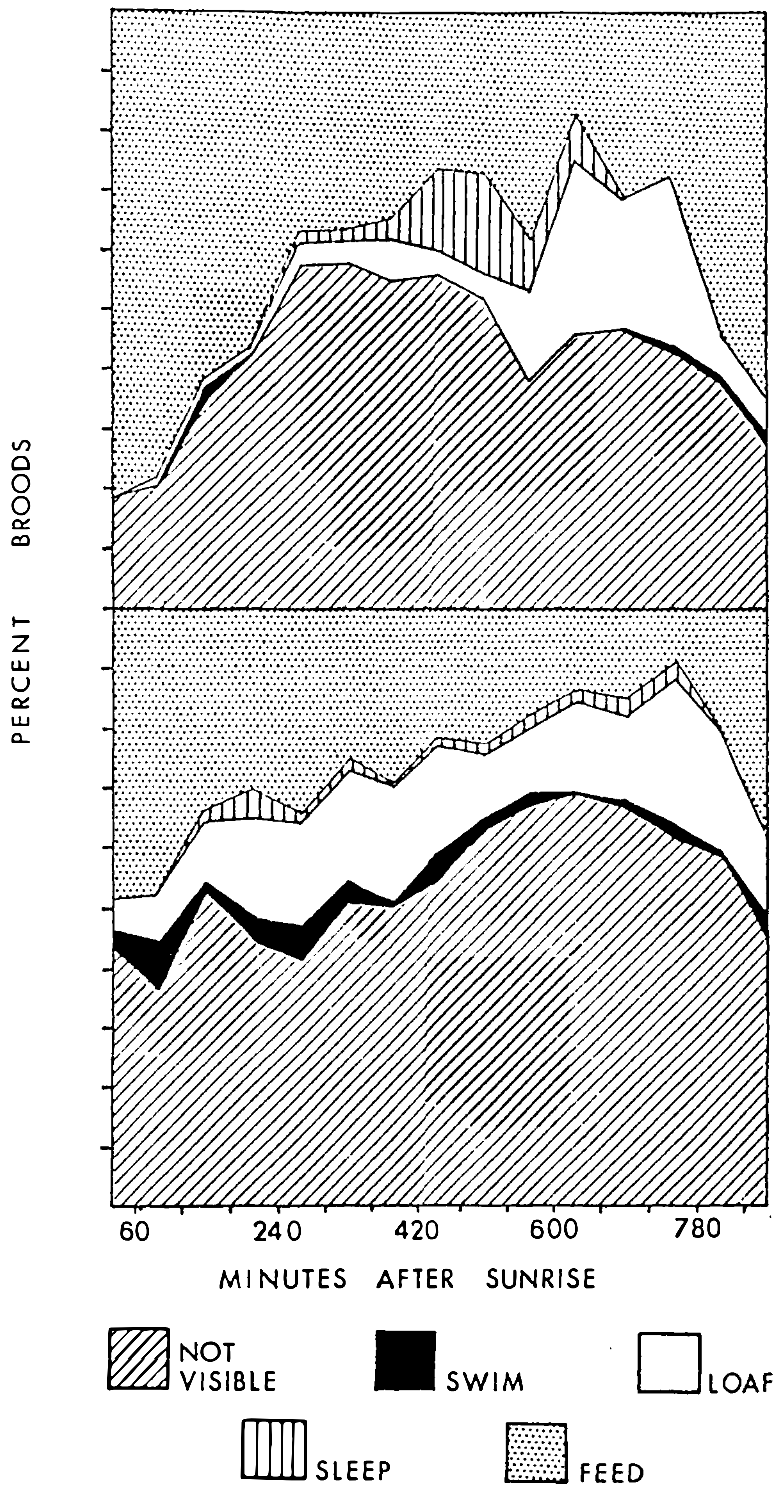

Fig. 3. Activity time budgets for age-class III blue-winged teal (upper) and mallard (lower) broods. The vertical axis is scaled at 10 percent intervals.

Mallard broods spent less time in feeding activities than did broods of the other two species.

Feeding Modes. Interspecific differences in feeding modes exist within brood age-classes (Table 5). Age-class I mallard broods relied upon surface feeding more and on bill-dip feeding less than did blue-winged teal broods of the same age. Pintail age-class II broods head-duck and tip-up fed more than their mallard and blue-winged teal counterparts, whereas feeding modes between the latter two species were quite similar. Age-class III mallard and pintail broods utilized head-duck and tip-up feeding to a great extent, yet blue-winged teal broods of this age-class relied on shallow subsurface feeding modes. Collias and Collias (1963) observed that interspecific differences in brood feeding behavior among mallard, blue-winged teal, and pintail ducklings were due primarily to differences in bill structure.

Age Specific Differences in Behavior

Activity Budgets. Age related changes in brood behavior were apparent in all species sampled. The mean percent of time not visible differed significantly ($p < .01$) among age-classes of all species combined and age-classes of blue-winged teal broods (Table 4). Visibility of brood age-classes increased 24 percent for all species between age-classes I and III. A change in the pattern of visibility is also evident. The magnitude of morning and evening activity peaks (visibility) increased with brood age in all species.

Swimming activity decreased, whereas loafing and sleeping activities increased with brood age. The difference in time devoted to visible loafing activity is most apparent between brood age-classes I and II, in which loafing time increased fifteenfold (Table 4). This increase in loafing activity was accomplished through a reduction in the use of emergent vegetation and swimming activity. Visible sleeping activity increased between age-classes II and III, with age-class III broods showing a preference for mid-afternoon sleeping (Figs. 1, 2, 3). Feeding activities were concentrated in the morning and evening periods in older broods. Mallard broods showed little increase in mean daily feeding activity between age-classes, whereas blue-winged teal and pintail broods exhibited large increases in feeding activity, especially between age-classes II and III. Although all species combined devoted significantly ($p < .05$) more time to visible feeding activities with an increase in brood age, this level of significance may be primarily due to age specific changes in blue-winged teal and pintail feeding activity independent of mallard feeding behavior. Blue-winged teal exhibited the greatest differences ($p < .01$) in feeding activity among age-classes.

Feeding Modes. Feeding modes differed to a much greater extent among brood age-classes than among species (Table 5). The frequency and depth of subsurface feeding increased with brood age. Age-class I mallard and blue-winged teal broods obtained most of their food by surface feeding, while age-class II broods of all species relied upon bill-dip and head-duck feeding almost exclusively. Mallard and pintail age-class III broods fed deeper than did blue-winged teal, which bill-dip fed more frequently than age-class III mallards and pintails.

Table 5. Percent occurrence of feeding modes among species and age-classes of broods.

Age-class	Feeding mode	Species												
		Blue-winged teal				Mallard				Pintail				Means
I	Surface feed	60.9				77.9				--				69.4
	Bill-dip		36.7				18.8				--			27.8
	Head-duck			2.4				3.3				--		2.8
	Tip-up				0				0				--	0.0
II	Surface feed	6.7				8.3				5.1				6.7
	Bill-dip		42.6				41.1				5.1			29.6
	Head-duck			48.3				44.7				54.5		49.2
	Tip-up				2.4				5.9				35.3	14.5
III	Surface feed	0.5				0.7				0				0.4
	Bill-dip		60.6				18.8				10.4			29.9
	Head-duck			38.7				65.8				76.6		60.4
	Tip-up				0.2				14.7				13.0	9.3
	Means	22.7	46.7	29.8	0.8	29.0	26.2	37.9	6.9	2.6	7.7	65.6	24.1	

Cover Use

Species and age specific differences in behavior are evident when nonemergent cover use is expressed as a percent of the total time visible (Table 6). Age-class I mallard broods primarily utilized the transition zone of the marsh, while blue-winged teal broods of the same age preferred the interface region. Both species increased their use of the interface region with age. Pintail age-class III broods frequented the transition zone to a much greater extent than did either blue-winged teal or mallard broods. Open water use decreased with age in blue-winged teal and pintail broods. All species exhibited the same overall tendencies in cover use. Differences in brood cover use between wetlands were not significant ($p > .05$).

Brood Visibility

Diurnal patterns in brood visibility (non-use of emergent cover) were examined in detail for blue-winged teal and mallard broods. Blue-winged teal were further evaluated for age specific differences in visibility. Second degree polynomial regression functions describe the influence of time of day on brood visibility. All functions are highly significant ($p < .01$).

The percent of blue-winged teal broods visible was dependent upon brood age and time of day (Fig. 4). Age-class I blue-winged teal broods were generally less visible than were age-class II or III broods of the same species. However, from 660 minutes after sunrise until dark, age-class I blue-winged teal were more visible than age-class II broods. This exception to the generalization of

Table 6. Mean use of cover types by broods, expressed as a percent of the total time visible.

Age class	Cover type	Species: Blue-winged teal			Mallard			Pintail			Means
I	Interface[a]	53.5			36.6			--			45.1
	Transition[b]		34.9			53.0			--		43.9
	Open water[c]			11.6			10.4			--	11.0
II	Interface	59.7			59.9			55.4			58.4
	Transition		31.0			16.3			18.8		22.0
	Open water			9.3			23.8			25.8	19.6
III	Interface	63.8			54.8			46.4			55.0
	Transition		31.6			29.9			52.0		37.8
	Open water			4.6			15.3			1.6	7.2
	Means	59.0	32.5	8.5	50.4	33.1	16.5	50.9	35.4	13.7	

[a]Defined as that narrow region at the emergent vegetation-water boundary.

[b]Defined as that water region which extends 6 m outward from the interface region.

[c]Defined as the centrally located water region over 6 m from the interface region.

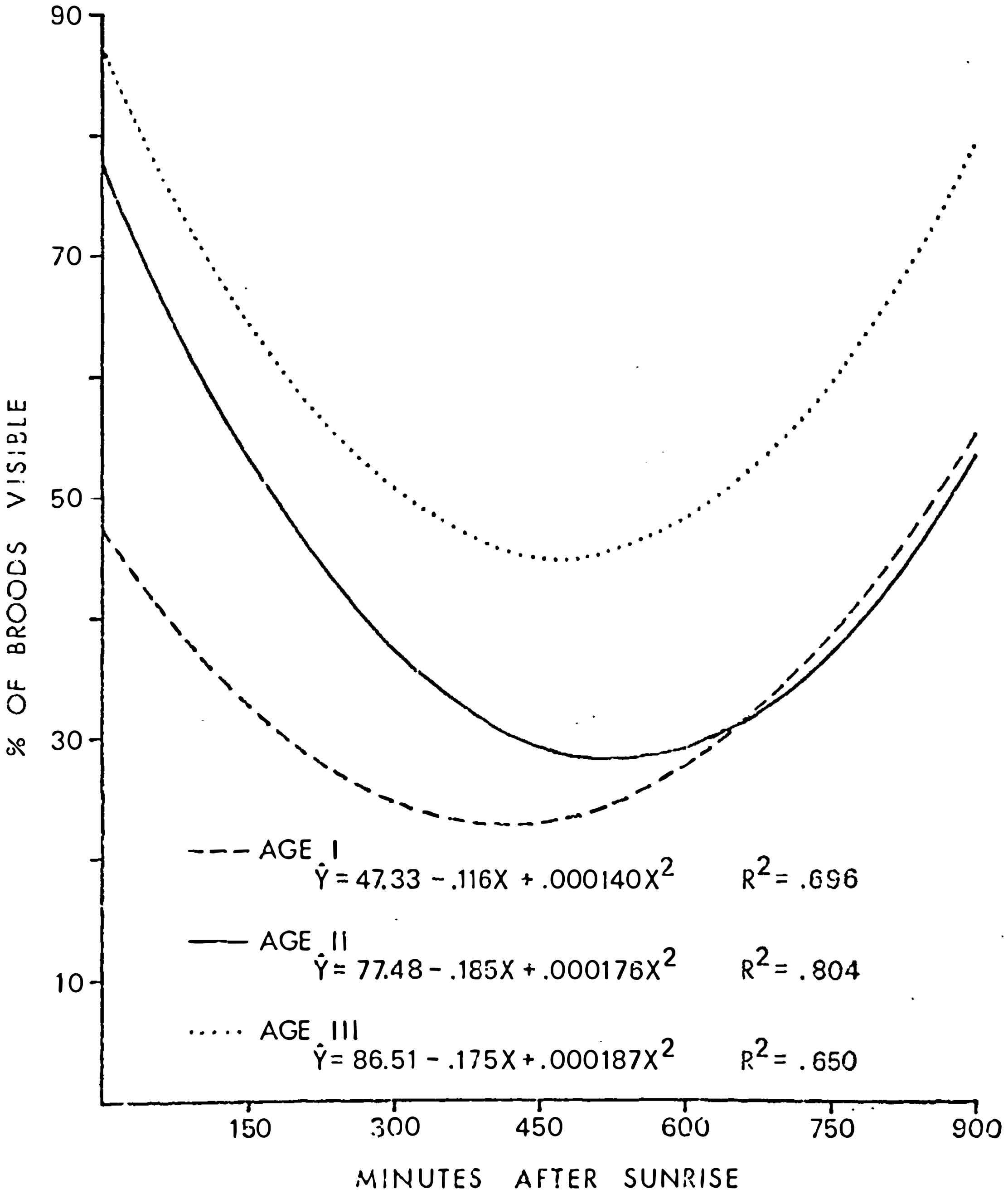

Fig. 4. Polynomial regression curves of the daily visibility patterns for age-class I, II, and III blue-winged teal broods. All regression functions were highly significant ($p < .01$).

increasing visibility with age is caused by the timing of activity peaks in age-class I and II broods; the regression function depicts an evening peak in visibility for age-class I blue-winged teal, and a morning peak for age-class II broods. Age-class III blue-winged teal broods also showed a tendency for increased morning visibility. Maximum use of emergents occurred at 420, 540, and 465 minutes after sunrise in age-class I, II, and III blue-winged teal broods respectively.

The mean visibility of each blue-winged teal age-class was averaged for all periods to characterize the general visibility pattern for the species (Fig. 5). Mallard brood visibility was also described in this manner (Fig. 6). A comparison between the polynomial regression functions reveals interspecific differences in visibility. Although both species are most visible in the first morning period, the fluctuations in mean daily visibility are higher in blue-winged teal. Broods of this species are more visible in the morning and evening periods, but less visible during mid-day than are mallard broods. Relative visibility of both species is the same at 180 minutes and 615 minutes after sunrise.

Individual Brood Behavior

Grouping of brood-day data into individual broods provided an estimate of the actual number of broods sampled during this study. The 269 brood-days were estimated to represent 123 individual broods. The variability in behavior between individual broods was compared with variability in behavior within a brood on different observation

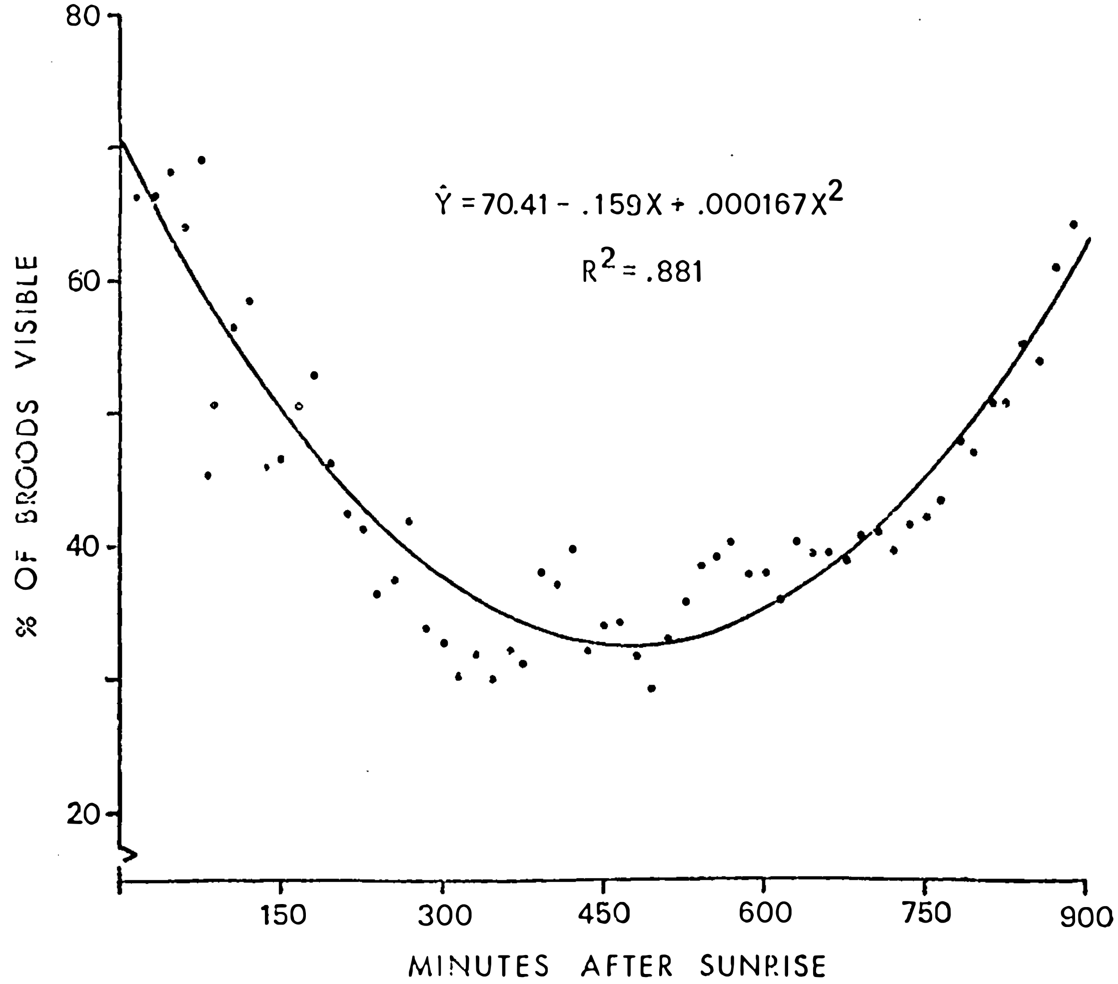

Fig. 5. Polynomial regression curve of the daily visibility pattern for blue-winged teal broods. Period visibility for three age-classes was averaged to characterize general brood visibility.

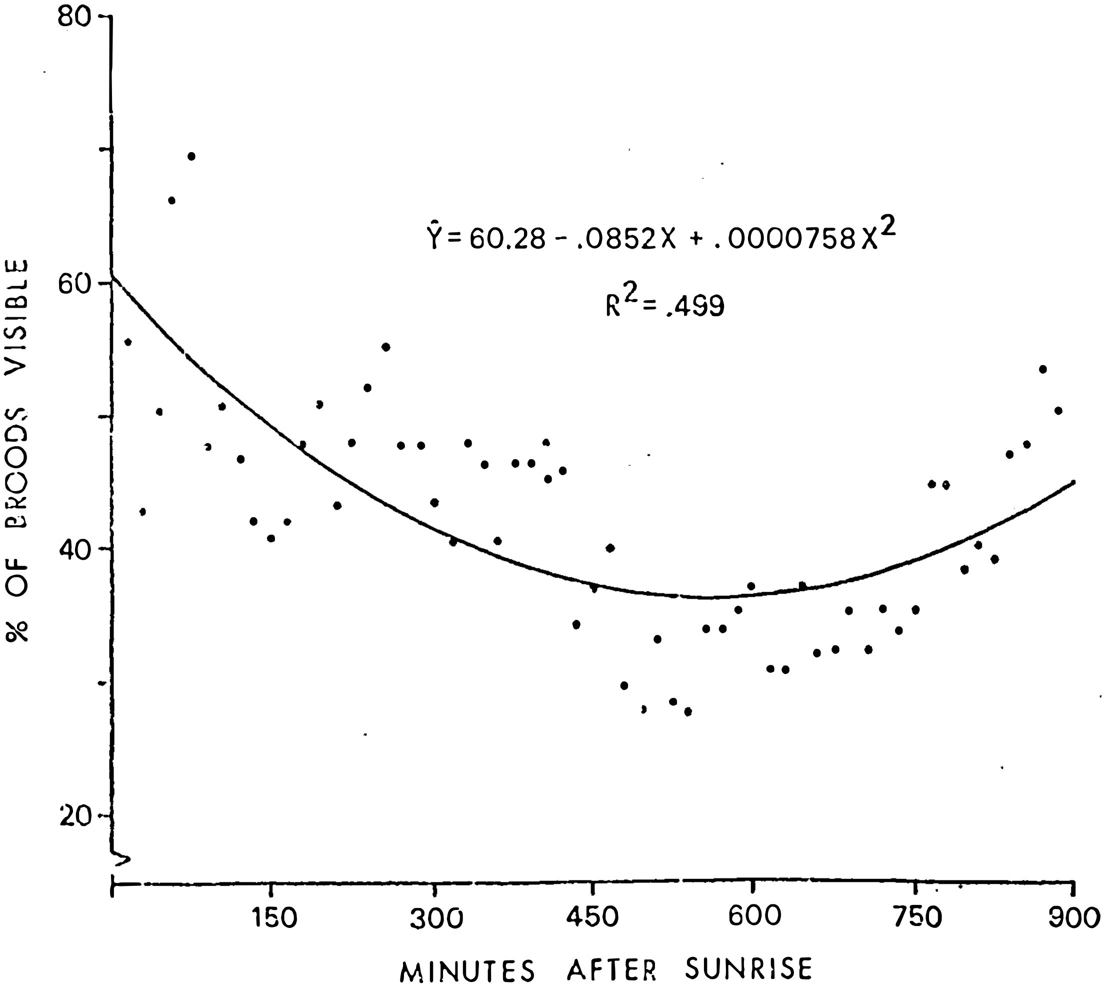

Fig. 6. Polynomial regression curve of the daily visibility pattern for mallard broods. Period visibility for three age-classes was averaged to characterize general brood visibility.

days. Observation records reveal tendencies of individual broods to utilize preferred regions of a wetland for loafing, sleeping, and to a lesser extent, feeding activities. Individual brood preference for particular loafing and sleeping sites has also been documented by Beard (1964). In general, the overall timing of activities was as variable within the same brood on different days as among different broods ($p > .05$).

Activity Cycles

Duration of Activity Bouts. Examination of individual brood behavior suggested a regularity in the duration of active periods (bouts). An activity bout was defined as a continuous period longer than 15 minutes in duration which consisted of either feeding or swimming activities, or a combination thereof. Mean duration of activity bouts were evaluated by age-class for blue-winged teal and mallard broods. The average activity duration for age-class I, II, and III blue-winged teal was 41.9, 54.3, and 103.0 minutes, respectively. Corresponding activity durations for mallard broods were 51.4, 43.4, and 56.0 minutes. The differences in activity duration were highly significant ($p < .01$) among age-classes of blue-winged teal broods, but not significant ($p > .05$) among age-classes of mallard broods. Mallard activity bouts lasted an average of 50.3 minutes for all brood age-classes, differing significantly ($p < .05$) from the 66.4 minute bouts of blue-winged teal broods.

Polycyclic Activity. The term "polycyclic" is used to describe animals which exhibit several periods of activity in 24 hours

(Kleitman 1949). Raitasuo (1964:13) observed polycyclic behavior in breeding adult mallards and stated that such behavior was also typical of other *Anas* species. He noted that activity in adult mallards was regulated by a "short-periodic rhythm which divides the day into numerous phases of high activity lasting about 45-75 minutes, with intervening rest periods of 30-45 minutes". Each adult pair was observed to follow its own schedule independent of other pairs, resulting in a general asynchrony of pair behavior.

Examination of individual brood behavior suggested polycyclic behavior patterns characteristic of breeding adults. As with adults, brood behavior during a given observation day appeared asynchronous with the behavior of other broods.

Polycyclic behavior was examined by shifting brood data ahead or back 60 minutes in order to synchronize individual brood activities. The 60 minute time shift was the maximum time required to synchronize two broods originally 180 degrees out of phase. An activity null was defined as the period between activity bouts. Activity nulls occurring within plus or minus 60 minutes of mid-day (8 hours after sunrise) were aligned so that the midpoint of each null occurred at precisely 8 hours after sunrise. Although the timing of activities was thereby distorted, the pattern of polycyclic behavior still progressed in a gradient from morning to evening. Broods with fewer than two activity bouts or requiring shifts greater than 60 minutes were not evaluated since alignment of mid-day nulls was not possible with data of this type. Activities of 176 broods (brood-day data) consisting of all species (blue-winged teal, mallard, pintail) and age-classes were aligned in this manner.

Polycyclic behavior was evident in the brood populations sampled (Fig. 7). Activity peaks occurred at regular intervals, with the height of each peak reflecting the general trend of greater morning and evening brood activity. Activity bouts were of longer duration than were the activity nulls between bouts. Differences in the duration of both activity peaks and nulls were not apparent among brood species and age-classes. The pattern of brood activity closely resembles the description of polycyclic activity for adult mallards (Raitasuo 1964).

Effect of Environment on Brood Visibility

Multiple regression analysis revealed that one or more environmental variables (Table 2) may affect brood visibility. The degree of influence and the variables involved differ among the 10, one and one-half hour time periods (Table 7). Date, a variable reflecting brood age and species composition as well as wetland characteristics (primarily changes in water level), was the most important factor affecting brood visibility. In each period, the percent of broods not visible decreased with an increase in the number of days elapsed between the observation date and 1 June. Hence, brood visibility increased as the brood season progressed.

An increase in wind speed during period 1 resulted in an increase in the percent of broods utilizing emergent cover. Previous night climatic conditions also influenced brood visibility. Increased average overnight wind speed resulted in increased brood visibility

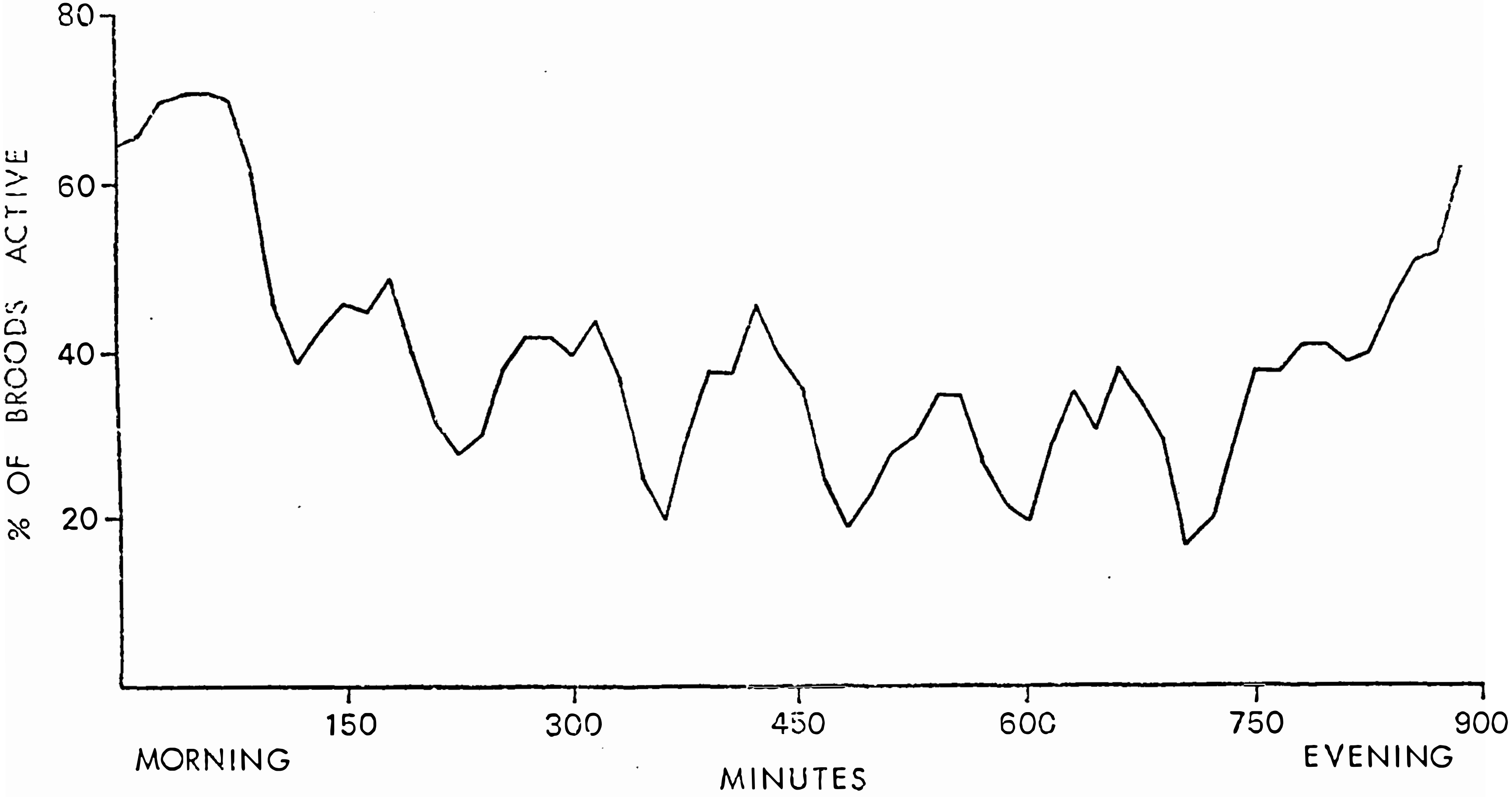

Fig. 7. Polycyclic activity patterns of 176 duck broods.

Table 7. Relationship of variables to the percent of broods not visible during each of ten time periods as indicated by multiple regression analysis.

Period	Factor	Relationship	Cumulative R^2
1	Date	Negative[a]	.878[c]
	Overnight wind speed	Negative	.918
	Wind speed	Positive[b]	.967
2	Date	Negative	.705
3	Date	Negative	.555
4	Date	Negative	.428
5	Date	Negative	.604
6	Date	Negative	.503
	Moon phase	Positive	.685
7	Date	Negative	.377
	Overnight temperature	Positive	.475
	Overnight wind speed	Negative	.648
8	Date	Negative	.334
	Overnight temperature	Positive	.568
	Overnight wind speed	Negative	.765
9	Date	Negative	.379
10	Date	Negative	.699
	Overnight temperature	Positive	.900

[a]Negative response indicates an inverse relationship between variable value and percent of broods not visible.

[b]Positive response indicates a direct relationship between variable value and percent of broods not visible.

[c]Corresponds to the fractional reduction in variance attributable to the successive combination of independent variables.

during periods 1, 7, and 8 of the following day. Higher 0100 temperatures decreased the percent of broods visible during periods 7, 8, and 10. Decreasing moon phase (fullness) negatively influenced emergent cover use during period 6 of the following day.

The fractional reduction in variance attributable to the combination of independent variables (R-squared) ranged from .967 to .379. Variables accounted for the largest portion of the variation in the morning and evening periods, which correspond to those periods of greatest brood activity. Multiple correlation coefficients for periods 7 and 9 were significant ($p < .05$). Correlation coefficients for all other periods were highly significant ($p < .01$).

Daily patterns in brood visibility were examined in relation to selected environmental factors. Temperature, wind speed, and cloud cover were the only factors used in this analysis, all other independent variables being constant when data were analyzed on a daily basis. The effect and relative importance of each of the three climatic factors varied among observation days (Table 8).

Temperature, alone and in combination with wind and cloud cover, frequently accounted for the largest variation in brood visibility. Increasing temperature increased brood use of emergent cover on all days except 29 June, and significantly ($p < .10$) influenced visibility on 11 of the 16 days analyzed. Decreased cover use was correlated with decreasing wind speed on 8 observation days. Cloud cover of 7 percent or less increased brood visibility whereas cloud cover greater than this amount had an insignificant ($p > .10$) or negative effect on brood visibility.

Table 8. Daily relationship of temperature, cloud cover, and wind speed to the percent of broods not visible, as indicated by multiple regression analysis.

Date	Factor	Relationship	Mean value	Cumulative R^2
25 June	Cloud cover	Negative[a]	7.0	.727[c]
29 June	Cloud cover	Positive[b]	40.2	.542
	Temperature	Negative	20.8	.965
	Wind speed	Positive	27.2	.984
1 July	Temperature	Positive	24.3	.629
5 July	Temperature	Positive	25.2	.714
7 July	Wind speed	Negative	2.9	.458
	Temperature	Positive	25.4	.802
	Cloud cover	Negative	5.6	.999
8 July	Wind speed	Positive	53.4	.989
12 July	Wind speed	Unknown[d]	41.5	.304
	Cloud cover	Unknown	9.4	.591
	Temperature	Unknown	33.8	.603
13 July	Temperature	Positive	28.8	.815
	Cloud cover	Positive	14.8	.966
	Wind speed	Positive	43.4	.999
15 July	Wind speed	Positive	35.4	.695
19 July	Cloud cover	Unknown	57.1	.231
	Wind speed	Unknown	27.3	.274
	Temperature	Unknown	21.4	.303
20 July	Temperature	Positive	24.6	.382
21 July	Temperature	Positive	25.4	.436
22 July	Temperature	Positive	30.7	.884
26 July	Wind speed	Positive	6.8	.842
28 July	Temperature	Positive	23.1	.351
30 July	Wind speed	Positive	29.6	.667
	Cloud cover	Positive	53.8	.833

[a]Negative response indicates an inverse relationship between variable value and percent of broods not visible.
[b]Positive response indicates a direct relationship between variable value and percent of broods not visible.
[c]Corresponds to the fractional reduction in variance attributable to the successive combination of independent variables.
[d]Unknown response indicates that variable was not significantly ($p > .10$) correlated with the percent of broods not visible.

The three climatic variables, alone or in combination with one another, influenced brood visibility on 14 of 16 observation days. However, the overall R-squared values ranged widely (from .999 to .310) and in no apparent pattern among days. Multiple correlation coefficients for 12 July and 19 July were not significant ($p > .10$). Remaining coefficients were significant ($p < .10$) or highly significant ($p < .01$). Highly significant ($p < .01$) intercorrelations among independent variables on 29 July necessitated the exclusion of this data from the analysis.

DISCUSSION

Feeding Behavior and Brood Resource Utilization

The variations in behavior observed in this study reflect differences in resource utilization by broods. Age specific differences in brood feeding behavior were apparent in all species sampled; morning and evening feeding peaks became more pronounced, and feeding occupied a larger portion of the total day, in older broods. These differences may be caused in large part by relative food availability.

Chura (1963) observed diurnal peaks in mallard brood activity which correlated with feeding activity. He found the number of food items in the stomachs of mallard ducklings greater in the morning and evening than during the afternoon. However, he made no considerations for possible changes in invertebrate food availability. Ball (1973) used floating sampling devices to assess aquatic insect abundance in sparse and dense cover during 2-hour time periods throughout a day. Significant ($p < .05$) changes in insect food availability were observed among time periods. Swanson and Sargeant (1972) speculated that brood movements and habitat use patterns were largely influenced by the emergence and activity patterns of insect food resources.

Differences in the total time devoted to feeding activity may have a physiological basis. Ducks digest animal matter faster than vegetative items (Swanson and Bartonek 1970), and gullet-gizzard capacity increases with brood age. Hence, age-class I ducklings feeding on invertebrate foods would satiate sooner, and digest faster, than age-class II or III ducklings which consume large amounts of plant matter. Metabolic rate is also higher in age-class I ducklings because of their high surface area to volume ratio. Both food selection and metabolic requirements are probably responsible for the evenness in daily feeding activity and the shorter but more frequent activity bouts observed in younger broods.

Collias and Collias (1963) found that the distribution of age-class I broods was correlated with the abundance of invertebrate foods. These food items are found both in and out of emergent plant cover. In contrast, vegetative food items are usually portions of submergent vegetation which grow most abundantly in open water regions. Since the consumption of vegetable foods increases with duckling age (Cottam 1939, Mendall 1949, Sugden 1973), older ducklings would be expected to feed mostly in the open water regions of a marsh. Ducklings observed in this study followed this pattern of feeding behavior.

Ducklings of different age-classes exhibited characteristic modes of feeding. Age-class I ducklings commonly obtained food through surface feeding, yet this feeding method was rarely utilized by older ducklings. Sugden (1973) found that newly-hatched ducklings of different species all possessed bills which were similar in structure. Their bills are unspecialized and generally adapted for the gaping action (Goodman and Fisher 1962). Daily food requirements are at a minimum when ducklings are small, so young ducklings, physically limited in their ability to utilize deep water food sources, rely primarily on easily obtained surface food items.

Terrestrial (flying) insects constitute most of the surface food available to ducklings (Sugden 1973). Although insects provide a high energy food source, the energy required to obtain these items increases with duckling age (size). Sugden (1973) found that surface feeding by lesser scaup ducklings was an inefficient means of obtaining food, and suggested that surface invertebrates did not occur in sufficient density to sustain a duckling beyond the first few days after hatching. The increase in total energy requirements and decrease in surface feeding efficiency in older ducklings necessitates a change in feeding behavior. Alternate food items are obtained by shifting to the more abundant plant foods and feeding in other regions of the wetland (Sugden 1973).

Swimming activity was often associated with surface feeding in age-class I broods. The observed decline in swimming by older broods is probably correlated with a shift away from surface feeding behavior.

Blue-winged teal broods exhibited greater overall visibility than did mallard broods. Cowardin and Higgins (1967) concluded that adult blue-winged teal were significantly ($p < .01$) more visible than adult mallards, suggesting a possible relationship between visibility patterns of broods and adults of the same species.

Effects of Environment on Brood Visibility

When behavior is summarized over the course of a brood season, broods appear remarkably regular in their pattern of emergent cover use. General patterns of visibility lend themselves to mathematical description, and a high degree of confidence can be placed on predictor functions. However, daily patterns of visibility may differ radically from the norm. Environmental conditions may be partially responsible for altering brood behavior (Diem and Lu 1960). Multiple regression techniques provide a means for assessing the influence of environmental factors on brood behavior.

Date. Date was the most important factor influencing brood visibility during each of 10 daily observation periods. It exerted a greater overall influence than those environmental factors which change between time periods: factors including temperature, wind speed, and cloud cover. When mean daily visibility is plotted as a function of each of the 17 observation days, an exponential relationship between visibility and date becomes apparent (Fig. 8). Brood visibility increased from 25 to 88 percent over the course of the study period. The increasing trend in brood visibility reflects the successive change in brood age structure. Wetland water loss, which was accelerated under drought conditions, may have also influenced brood visibility.

Brood studies were conducted over a 36 day period. When this period was subdivided into 3, 12-day intervals, changes in the patterns of brood visibility became apparent (Fig. 9). Broods exhibited evening peaks in visibility, and lower mean daily visibility, during the first 12 days of the study. Diurnal feeding peaks became prominent, and mean visibility increased during the next two intervals. The three interval curves are similar to the age specific visibility curves described for blue-winged teal broods (Fig. 4). This similarity implies that changes in the age structure of the broods sampled during each interval were primarily responsible for the seasonal differences in daily brood visibility patterns.

Previous Night Climatic Conditions. Broods feed extensively at

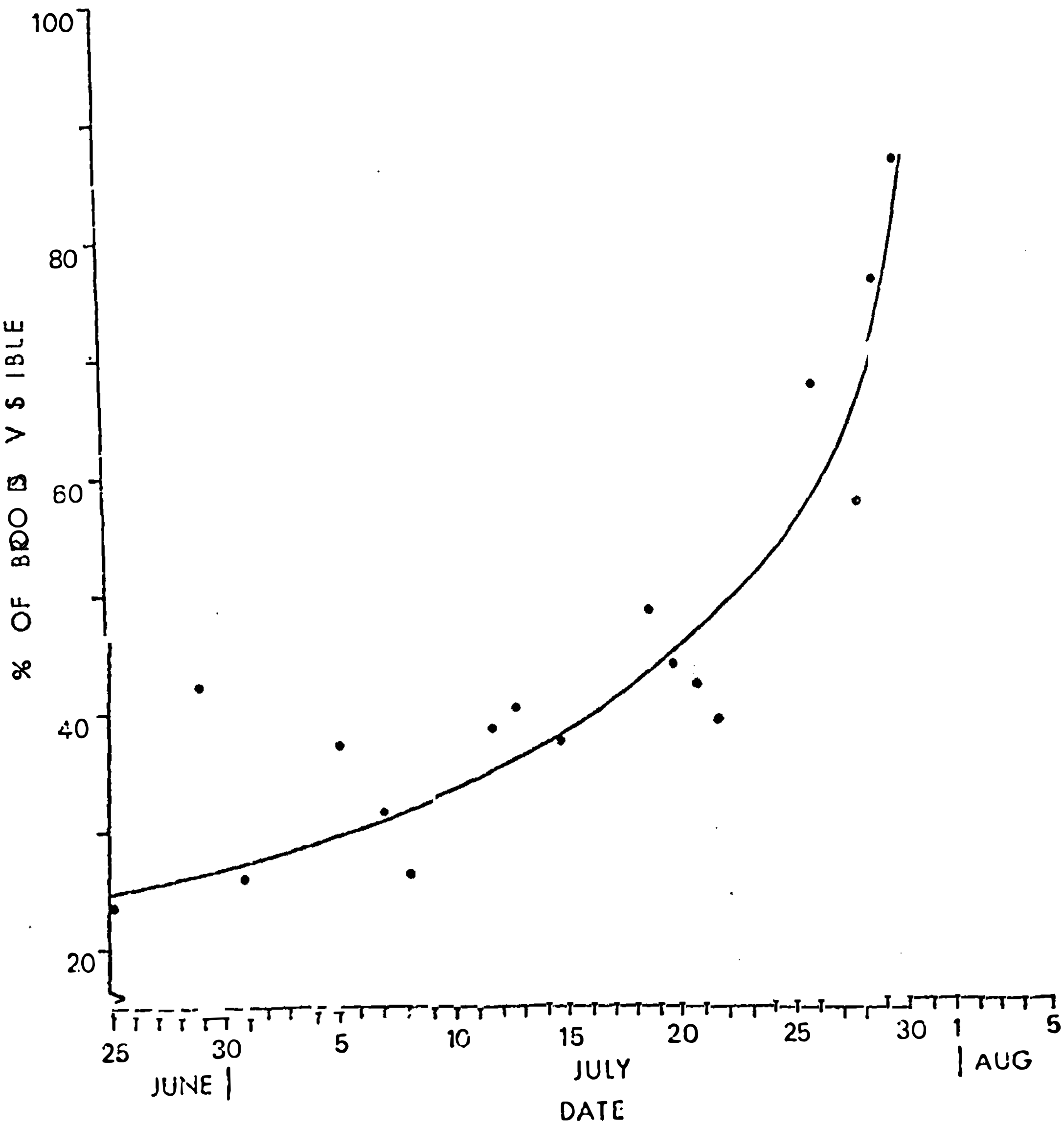

Fig. 8. Mean daily brood visibility from 25 June to 5 August, 1976.

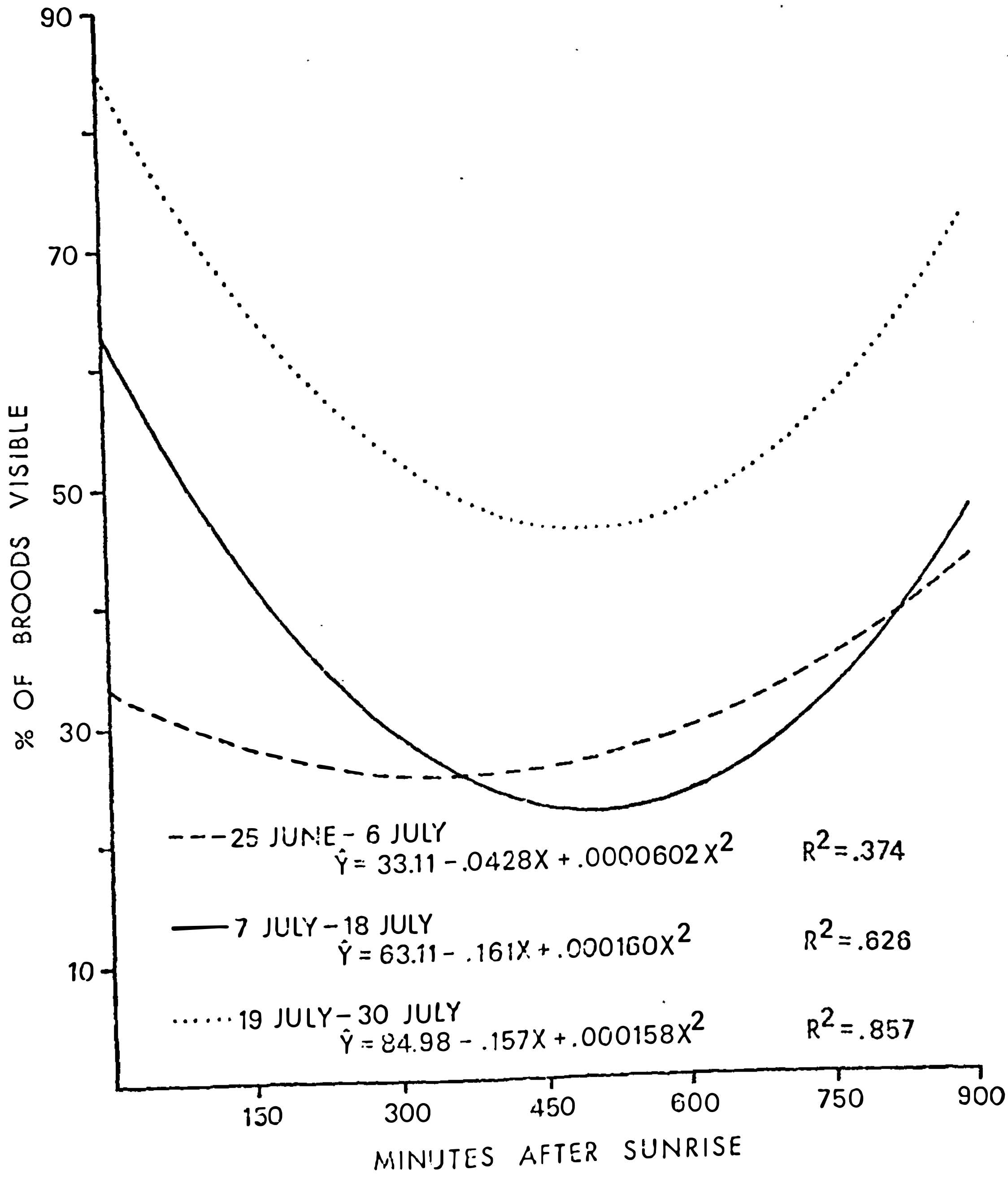

Fig. 9. Duck brood visibility patterns during 3, 12-day observation periods. All regression functions were highly significant ($p < .01$).

night, and are particularly active on warm, calm nights (Swanson and Sargeant 1972). Aquatic insects emerge in greater numbers under these environmental conditions. The broods observed in this study were less active (visible) on days following warm, calm nights, suggesting that daytime brood activity budgets are influenced by nighttime climatic conditions favorable to brood activity.

Adult ducks are active on moonlit nights, but activity subsides on moonless, cloudy nights (Hochbaum 1955:35). Although quantitative data are lacking, evidence suggests that darkness may limit the activity of ducks under some conditions. Moonlight duration and moon phase reflect nighttime light conditions. If ducklings during their first few days take only food items which they can see (Veselovsky 1953), available light might limit nighttime feeding activity and thereby result in an increase in feeding during the following day. Moon phase was not significantly ($p > .05$) correlated with brood activity except during period 6 of the following day. However, only one complete lunar cycle elapsed during the time of this study; therefore brood behavior was not examined in relation to an adequate number of moonlight conditions. The correlation of moon phase with brood visibility in period 6 was probably coincidental, since previous night conditions would not be expected to influence brood behavior so late (1230 to 1400) in the following day. Visibility data spanning a number of brood seasons would be necessary to adequately evaluate the relationship of moonlight to brood behavior.

<u>Temperature.</u> Temperature influenced brood visibility more frequently than did either wind speed or cloud cover. Temperature was

negatively correlated with brood emergent cover use on 29 June, but positively correlated with cover use on eight other observation days. The relationship becomes evident when the simple correlation coefficient of temperature with percent of broods not visible is plotted as a function of mean daily air temperature (Fig. 10). Only those temperatures which significantly ($p < .05$) influenced brood visibility, along with temperatures and coefficients for 12 and 19 July, were used in this analysis.

At air temperatures below 21 C, slight increases in temperature resulted in an increased number of visible broods. Between 21 C and 24 C, temperature did not influence brood cover use. When temperatures exceeded 24 C, increasing temperature increased brood use of emergent cover. However, the additional correlation (influence) observed with a unit increase in temperature decreased steadily at temperatures above 24 C. This implies that air temperature exerted its maximal influence on brood visibility at the upper reaches of the temperature-correlation curve. This hypothesis is supported by the data of 12 July. During this afternoon (half-day) observation period, the air temperature averaged 33.8 C. Although this extreme temperature would normally be expected to alter brood behavior, temperature did not correlate with brood visibility for this observation day. This suggests that temperature influenced brood visibility earlier in the day prior to the beginning of observations. Similarly, temperature did not correlate with brood visibility on 19 July. The mean air temperature for this date, 21.4 C, fell within the range of temperatures which did not alter brood cover use. The range of 21 C to 24 C

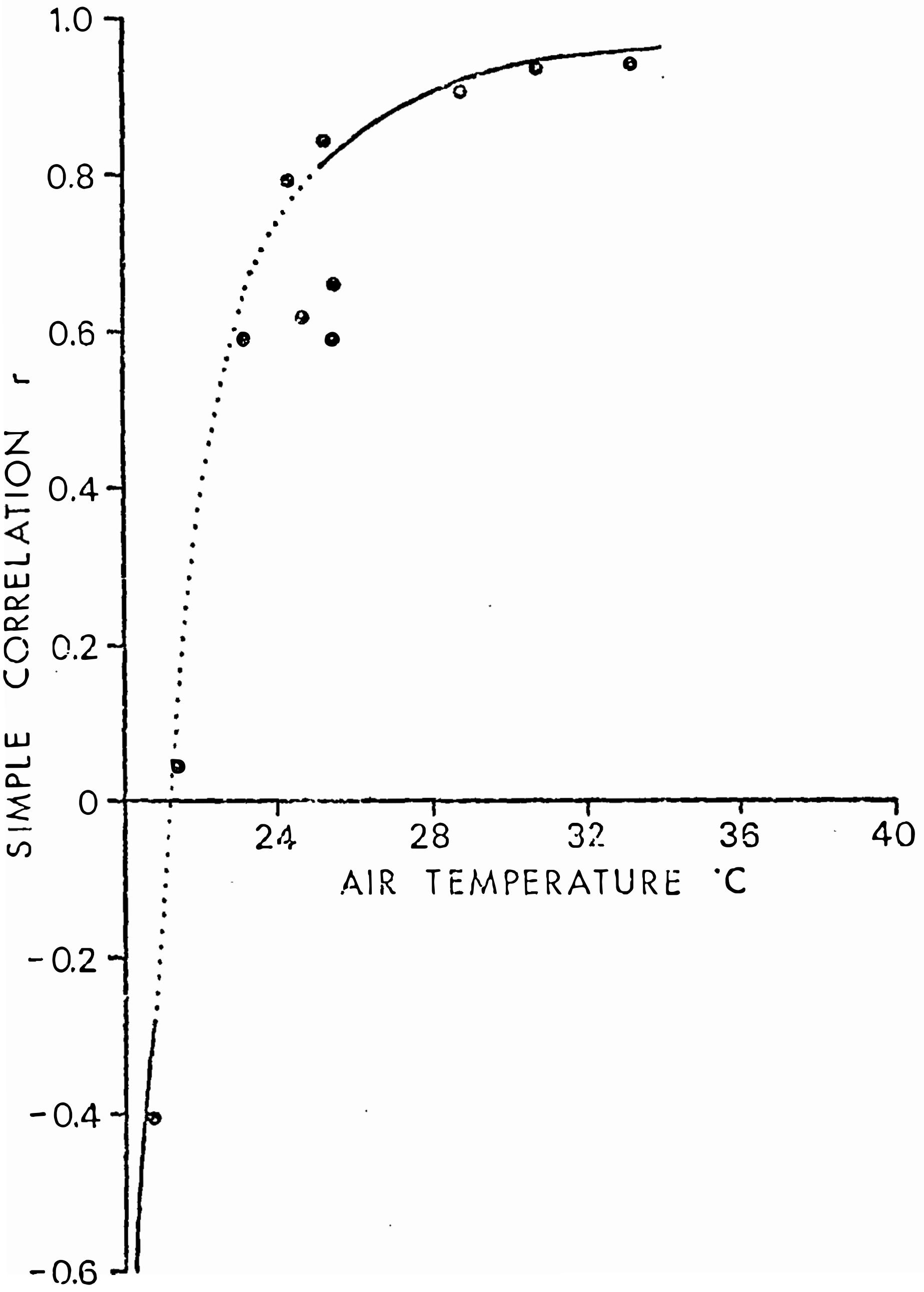

Fig. 10. Relationship between the simple correlation coefficient of temperature and percent broods not visible, and mean daily temperature. Dotted region of curve indicates temperature ranges which did not influence brood visibility.

corresponds to a "temperature comfort zone" for broods observed in this study. Diem and Lu (1960:128) observed that broods moved into dense emergent cover when air temperatures were between 26.7 and 32.2 C, while at moderate temperatures, the number of broods visible in the open water regions of a marsh appeared more representative of the actual brood population. Kendeigh (1934) found that birds were generally more active in cool weather, with increased activity causing an increase in daily food requirements.

Wind Speed. Winds exceeding 24 km/hr were found by Diem and Lu (1960) to alter brood visibility by increasing emergent cover use. Wind significantly ($p < .05$) influenced brood visibility on 7 of 16 observation days in this study. On these days in which wind influenced visibility, mean wind speeds of 6.8 km/hr or greater increased brood use of emergent cover. Wind increased visibility only on 7 July (mean value of 2.9 km/hr). However, six of the nine days in which wind did not significantly ($p > .05$) influence brood visibility had mean wind speeds of under 24 km/hr. Therefore, results in this study reinforce the conclusions reached by other observers; winds 24 km/hr or less generally do not influence brood visibility, but winds in excess of this speed increase brood use of emergent cover.

Cloud Cover. Diem and Lu (1960) suggest that brood use of emergent cover decreases under overcast skies. However, cloud cover significantly ($p < .05$) influenced brood behavior on only 5 of 16 observation days in this study. Extremes in cloud cover were recorded during observation days, therefore the insignificant ($p > .05$) correlations observed between this variable and percent of broods not visible were not caused by sampling bias. In contrast to the findings of other researchers, cloud cover did not appreciably influence the visibility of broods in this study.

Applications to Brood Inventories

Brood inventories are commonly used to estimate waterfowl production since they may provide more accurate information on actual production than either nests or spring breeding pair populations (Evans and Black 1956). Two types of inventory techniques are presently used for assessing production. Large scale surveys are conducted yearly to provide indices of total duck production (Smith and Hawkins 1948, Crissey 1960, Diem and Lu 1960). Such surveys commonly utilize aerial and roadside censusing techniques. Intensive studies aimed at determining actual production are frequently conducted on individual wetlands or small wetland communities (Berg 1956, Rogers 1964). Circuit or beat-out counts, in which the wetland perimeter is walked to flush hidden broods, is a technique commonly used to determine actual production (Evans and Black 1956).

Unfortunately, these inventory techniques sometimes provide data which are inaccurate and misleading. Detection of changes in production may be impossible with some roadside and aerial techniques (Diem and Lu 1960), and circuit counts can be susceptible to bias to the extent that their use in brood inventories is limited (Bennett 1967). Improvements in present brood inventory techniques are needed. The accuracy of production estimates could be increased if climatic conditions, seasonal changes in average brood age and water levels, and activity patterns of waterfowl were considered when conducting brood inventories.

Daily visibility curves may be used to improve production estimates for surveys conducted throughout the day over the course of several weeks. However, mathematical adjustment of data would be necessarily limited to those wetlands of the same cover type and size as the sample wetlands used in this study. Inventories conducted only in the early morning or late evening periods may make most efficient use of available manpower. Brood visibility in surveys lasting over one week will be biased due to the progressive change in brood age structure.

An average of 70 percent of all blue-winged teal broods on cover type 3 wetlands may be observed during the first hour after sunrise and the last hour prior to sunset. A single, hidden observer may obtain a near complete brood count at these times. Such observations may be an efficient means of assessing waterfowl production on wetlands with a substantial open water phase. Because of the polycyclic nature of brood activity, observations should last a minimum of 60 minutes.

Environmental conditions, especially temperature and wind, may alter brood use of emergent cover. Brood inventories should not be conducted when temperatures exceed 28 C or when wind speed is greater than 24 km/hr, unless circuit counts are effective in flushing hidden broods. Nighttime weather conditions favorable to brood activity may result in brood visibility data which is biased in favor of increased brood emergent cover use during the following day.

CONCLUSIONS

Ducklings of blue-winged teal, mallard, and pintail broods exhibited innate patterns of behavior, yet still retained behavior flexibility in response to immediate environmental conditions. Activity time budgets revealed a greater similarity of behavior among species than among brood age-classes. Age specific differences in feeding behavior and cover use were especially apparent. Most behavioral differences were attributed to age related changes in duckling physiology and morphology which directly influenced duckling food selection. Environmental conditions relating to climate appreciably influenced brood cover use. Changes in brood age structure and wetland water loss influenced brood cover use over the course of the brood season, and daily behavior was modified by extremes of temperature or wind. Climatic conditions favorable to nighttime brood activity influenced brood behavior during the following day. The accuracy of brood inventories could be improved if brood behavior patterns were considered within the inventory design.

This study summarizes the daytime brood behavior of three waterfowl species. Extensive use of emergent cover by broods prohibited attainment of a truly complete daytime activity budget. Instead, activities were evaluated in relation to brood visibility. Activities which were observed in the open water undoubtedly occurred, to an unknown extent, within emergent cover. However, behavior within emergent cover, as with nighttime brood activity, remains undocumented for dabbling duck species. These unknown aspects of brood behavior present challenges for further study.

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APPENDIX

Appendix A. Standardized Brood Observation Form

Standardized brood observation forms were used for recording brood behavior. Brood characteristics (species, age-class, size) were described when a brood was first observed, and each data form served as a record of one brood's activity during one observation day. The activity and time of observation were recorded in the appropriate columns. Location refers to the relative position of a brood (in degrees) as determined by the protractor-tripod mount. Weather data were recorded quarter-hourly on a separate observation form.

BROOD OBSERVATION FORM

Jim Ringelman

Page____ of ____

DATE ____________________ WETLAND LOCATION ____________________

SUNRISE TIME ________CDT GENERAL NOTES ____________________

BROOD SPECIES ____________________ AGE-CLASS __________ SIZE ________

TIME*	ACTIVITY	LOCATION

* TIME 0800 CORRESPONDS TO SUNRISE