Time Budgets of Mallards and Wood Ducks Wintering in a Flooded Bottomland Hardwood Forest

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Abstract: Flooded bottomland hardwood forests are critical habitat for mallards (*Anas platyrhynchos*) and wood ducks (*Aix sponsa*) during winter. How these species allocate their time in such habitats is unknown, however. Therefore, diurnal time budgets of 48 mallards and 330 wood ducks wintering in such a forest were examined during a 554-hour sampling period from 19 January through 31 March 1991. Time budgets of the species differed ($P<0.001$). Mallards spent more time feeding, resting, and alert, and less time locomoting and perching than wood ducks. Intraspecific time budgets of mallard and wood duck drakes, hens, and pairs differed ($P<0.001$) as did those for early morning, mid-day, and late afternoon time blocks ($P<0.001$). Both species spent much more time locomoting and less time feeding than did ducks in other habitats. To compensate, mallards reduced resting time; wood ducks swam as they fed, thus locomoting and feeding behaviors were often indistinguishable.

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Time budgets quantify the percentage of time animals allocate to different activities (Rave and Baldassarre 1989). Resultant data can increase understanding of habitat use and niche separation among species because natural selection should favor individuals that best apportion their time among each activity, habitat, and climatic condition (Titman 1981, Rave and Baldassarre 1989).

Wintering habitats have an important function in maintaining waterfowl populations (Fredrickson 1980, Fredrickson and Heitmeyer 1988). Time budgets may be used as a tool for determining the role of wetlands as habitat for waterfowl during winter (Reinecke 1981). Although flooded bottomland hard-

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wood forests are critical migratory and wintering habitat for mallards and breeding and wintering habitat for wood ducks (Bellrose 1976), no published time budget studies for either species in that habitat exist. Our objectives were to compare diurnal time budgets of mallard and wood duck drakes, hens, and pairs in a flooded bottomland hardwood forest and to relate the role that this important habitat has in determining the time budgets we observed.

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Methods

Study Area

The study took place on the Stephen F. Austin Experimental Forest (SFAEF), which is approximately 14.5 km southwest of Nacogdoches, Texas, in Nacogdoches County. The 1,085-ha SFAEF is comprised of forest types ranging from pure pine uplands to seasonally flooded hardwood bottoms. The study was performed in a portion of the 728-ha mature bottomland hardwood forest described by Conner et al. (1994). The area is flooded seasonally by the Angelina River. Soils are Fluvaquents dominated by frequently flooded Mantachie clay loams. Overstory of the 175-ha study area was comprised of a variety of species, including 6 oak (*Quercus* spp.), 2 gum (*Nyssa* spp.), 2 maple (*Acer* spp.), 2 hickory (*Carya* spp.) species and sweetgum (*Liquidambar styraciflua*). Many of the same species occurred in the midstory. Other seed-producers in the midstory included 2 holly (*Ilex* spp.) species and flowering dogwood (*Cornus florida*). As the overstory and midstory created a closed canopy, the understory was sparse and the ground cover was primarily litter, debris, and fallen trees (Miller 1992). The bottomland forest of the study area has not been subjected to a commercial harvest in at least 70 years (Conner et al. 1994).

Data Collection

Eight observers trained together by monitoring domesticated mallards and wood ducks on a pond on the Stephen F. Austin State University campus. After 3 separate sessions, all observers classified correctly each activity. After 3 days of field data collection, a refresher session was held to minimize observer bias.

Waterfowl were observed from 8 of 15 blinds that were spaced approximately 300 m apart on a 3 × 5 grid. In a previous study, neither blinds nor observers appeared to frighten waterfowl (Cornes 1991). The blinds initially selected were those from which relatively high numbers of ducks had been recorded the previous year (Cornes 1991). However, in order to gather as much

data as possible, observers changed blinds from day to day as usage patterns of ducks changed. In all cases, the blinds to be used were determined beforehand, and observers were instructed not to change blinds during the day.

Observers monitored ducks approximately once a week from 19 January through 31 March 1991. In most instances, all observers gathered data on the same day. Observers either waded or canoed to blinds, arrived approximately 30 minutes before sunrise, and remained until sunset, weather permitting.

Data recorded were categorized by species and by sex or pair. Ducks were categorized as pairs only if they met criteria established by Paulus (1983, 1984, 1988*a*).

When a bird or flock came into view, the bird or pair nearest the center of the field of view was chosen for observation (Jorde et al. 1984). Individual activities were recorded at 5-second intervals for either a single duck or members of a pair. The observer recorded up to 60 (5 minutes) instantaneous activity samples for each bird or pair. Once a bird was selected, it was observed for 5 minutes or until it was out of view for 1 minute, then another bird was chosen using the same criteria. If only 1 bird was visible, the observation period continued as long as the bird was in view. Our methods were very similar to those of Losito et al. (1989).

We classified waterfowl activities following 9 categories, 8 of which were defined by Quinlan and Baldassarre (1984), previously defined by Dwyer (1975). The eight previously-defined activities were: (1) feeding, (2) locomoting, (3) resting, (4) comfort movements, (5) courtship, (6) alert, (7) agonistic behaviors, and (8) out-of-sight. We added the ninth category, (9) resting on woody vegetation (i.e., perching), because Higgins (1979) noted that areas containing stumps and logs were commonly used by both mallards and wood ducks for loafing.

Data Analyses

Time budgets were calculated by dividing number of instantaneous samples for each activity by total number of samples (Baldassarre et al. 1988), yielding an estimate of percentage of time spent in each activity. Activity data were initially sorted by species, and species-specific time budgets constructed. Species-specific time budgets were then sorted as drake, hen, or pair. Additionally, species-specific time budgets were subdivided into early morning (sunrise–1030 hours), mid-day (1031–1430 hours), and late afternoon (1431–sunset) time blocks (Bergan et al. 1989). The 72-day study period was divided into mid-winter (19 Jan–12 Feb), late winter (13 Feb–5 Mar), and early spring (6–31 Mar).

Data were tested for normality using the Chi-square test of normality. Chi-square tests of homogeneity were used to compare time budgets. Species-specific time budgets were tested between species, while group time budgets and species-specific time-of-day and season budgets were compared within species.

Results

Observers spent approximately 554 hours in the blinds. However, ducks were in view only 20.09 hours or 3.63% of the time observers were in blinds. Nineteen mallard drakes, 4 mallard hens, 25 mallard pairs, 151 wood duck drakes, 31 wood duck hens, and 148 wood duck pairs were observed. From these birds, 1,759 and 12,707 instantaneous activity samples were collected for mallards and wood ducks, respectively (Table 1). Because of small sample size, statistical comparisons made with mallard data should be viewed with care.

Species-specific time budgets of mallards and wood ducks were different ($P<0.001$). Mallards spent more time feeding, resting, alert, and performing comfort movements than did wood ducks. Conversely, wood ducks allocated more time to locomoting, courting, and perching than did mallards (Table 1).

Intraspecific time budgets of mallard drakes, hens, and pairs were significantly different ($P<0.001$). Mallard drakes locomoted more and rested less than hens or pairs and were not observed in courtship activities. Mallard hens fed less, rested more, and were alert more often than drakes or pairs and were not observed in agonistic behaviors or perching. Mallard pairs performed comfort movements and perched more than drakes or hens (Table 1).

Time budgets of wood duck drakes, hens, and pairs also were different ($P<0.001$). Wood duck drakes spent more time in agonistic behaviors and less time locomoting than did hens or pairs; time spent resting was similar to that of pairs, as was perching to that of hens. Wood duck hens rested, performed comfort behaviors, and fed less than drakes or pairs, and were not observed in courtship behaviors. Wood duck pairs fed more and perched less than either

Table 1. Proportional time budgets for mallard and wood duck drakes, hens, and pairs. Data were gathered 19 January–31 March 1991 on the Stephen F. Austin Experimental Forest in Nacogdoches County, Texas.

	N		Percent time								
Species	Birds	Instant. samples	Feeding	Locomoting	Resting	Comfort	Courtship	Alert	Agonistic	Perching	Total
Mallards											
Drakes	19	485	21.6	57.7	7.0	4.1	0.0	3.1	3.0	3.5	100
Hens	4	254	3.9	28.3	54.3	3.5	0.9	9.1	0.0	0.0	100
Pairs	25	1,020	23.0	39.9	10.5	11.1	0.4	5.0	1.0	9.1	100
Total/$\bar{x}$[a]	48	1,759	19.9	43.0	15.9	8.1	0.3	5.1	1.4	6.3	100
Wood ducks											
Drakes	151	5,110	2.8	49.1	8.7	3.4	0.2	1.8	1.1	32.9	100
Hens	31	892	1.8	57.4	5.6	1.6	0.0	1.3	0.1	32.2	100
Pairs	148	6,705	6.5	57.3	9.2	3.2	1.2	1.3	0.2	21.1	100
Total/$\bar{x}$	330	12,707	4.7	54.0	8.7	3.2	0.7	1.5	0.6	26.6	100

[a]Averages are weighted.

drakes or hens; proportions of time in alert and agonistic behaviors were similar to those of hens (Table 1).

Individuals and pairs of both species were most often observed during the early morning. Mallard hens and wood duck pairs were least active at mid-day. However, mallard and wood duck drakes and wood duck hens were least often observed during the late afternoon (Clark 1992).

There were differences ($P<0.001$) in the way the 2 species allocated their time during the day. For mallards, resting and perching activities increased during early morning, and locomoting, alert, and agonistic behaviors peaked during mid-day. Comfort movements remained fairly constant throughout the day, and feeding and courtship activities peaked in the afternoon (Table 2). Wood ducks fed, locomoted, displayed comfort movements, and courted more during mid-day than during early morning or late afternoon. Resting and perching were most common during the early morning (Table 2).

Seasonal data proved to be too limited during early spring to statistically analyze. However, examination of trends indicated that agonistic behavior of both species increased during early spring. Likewise, comfort movements of mallards and locomoting by wood ducks increased during spring (Clark 1992).

Discussion

Both species spent more time locomoting than in any other activity (Table 1). Our values for mallards (43%) and wood ducks (54%) are much higher than those reported by Turnbull and Baldassarre (1987) for mallards, or by Paulus (1988*b*:137–138) for other North American dabbling ducks (3%–34%, $\bar{x} < 20\%$).

The differences were probably due to the ducks' feeding strategies in flooded bottomland hardwood forests. Generally, other authors suggested that

Table 2. Proportional time budgets of mallards and wood ducks during early morning (sunrise–1030 hours), mid-day (1031–1430 hours), and late afternoon (1431–sunset) time blocks. Data were gathered 19 January–31 March 1991 on the Stephen F. Austin Experimental Forest in Nacogdoches County, Texas.

	N		% time								
Species	Birds	Instant. samples	Feeding	Locomoting	Resting	Comfort	Courtship	Alert	Agonistic	Perching	Total
Mallards											
Early morning	29	1,304	19.6	41.0	16.7	8.5	4.8	0.7	0.3	8.4	100
Mid-day	10	142	2.7	66.7	9.3	8.0	2.0	9.3	2.0	0.0	100
Late afternoon	9	313	29.4	40.6	15.3	6.4	7.7	0.3	0.0	0.3	100
Wood ducks											
Early morning	188	7,668	4.1	51.0	9.2	3.0	1.3	0.4	0.5	30.5	100
Mid-day	77	2,460	5.9	60.5	7.2	3.5	2.1	0.4	1.1	19.3	100
Late afternoon	65	2,579	5.3	56.5	8.8	3.3	1.6	1.2	1.0	22.3	100

ducks they observed fed on relatively concentrated food sources in agricultural fields, marshes, or open water (Jorde et al. 1984, Quinlan and Baldassarre 1984, Turnbull and Baldassarre 1987, Hohman and Rave 1990). Conversely, in flooded bottomland hardwood forests, food resources are often widespread. In the SFAEF study area, Miller (1992) found that acorns comprised >93% of the aggregate dry weight of the foods consumed by both mallards and wood ducks. Most of the acorns consumed were those of Nuttall oak (*Q. texana*). Trees of that species were widely scattered throughout the study area. Also, the continual flow of floodwater through the study area prevented food items from being concentrated.

These factors would seem to dictate that feeding strategies of ducks in flooded bottomland hardwood forests include much time swimming. Paulus (1988*b*) wrote that nonbreeding waterfowl spend most of their time resting or feeding and that the time allocated to the 2 activities is inversely related. Our data indicate that locomoting is a major activity in flooded forests. However, where food sources are not concentrated, ducks must swim to feed, thus feeding behavior may be indistinguishable from locomoting behavior.

We observed mallards and wood ducks regularly pecking at food items on the surface of the water as they swam. The feeding behavior of wood ducks was very similar to that described by Drobney and Fredrickson (1979). The birds were continually moving and often were in view for very short periods of time. Mallards usually did not move as rapidly or as continually as wood ducks.

Both species searched the upstream side of floating, non-moving plant material which trapped food items. Pairs and solitary mallards occasionally fed in a small area for several minutes. Such birds regularly tipped for food whereas swimming birds seldom did; wood ducks were not observed tipping.

Mallards spent approximately 20% of their time feeding and 16% resting; when perching is included, resting comprised approximately 22% of mallard time budgets. Excluding locomoting, the remaining activities occupied about 15% of the ducks' time (Table 1). Our value for feeding is similar to that reported by Turnbull and Baldassarre (1987) for mallards, but our resting value is much lower than theirs (39%–54%). Most non-breeding anatids spend 20%–70%, 10%–50%, and <22% of their time feeding, resting, and in other activities (including locomoting), respectively (Paulus 1988*b*). Our data indicate that in flooded forest habitats, mallards increase locomoting time at the expense of resting time. The inverse relationship between feeding and locomoting during the morning, mid-day, and late afternoon (Table 2) supports this suggestion.

Wood ducks spent <5% of their time feeding and slightly more than 34% of their time resting and perching (Table 1). Although the time allocated to feeding was much less than that allocated by other species, resting time was compatible (Paulus 1988*b*). As with mallards, other activities composed only a small proportion of the wood duck time budgets (Table 1).

In this study, locomoting time may have been overestimated and feeding time underestimated, especially for wood ducks. The domesticated wood ducks

used for training the observers were on a small, open pond and feeding behavior was obvious. This was not always the case with wild birds. Wood ducks often moved through an observer's field of view without giving an indication that they were feeding. Probably some of these birds were searching for food or moving from one feeding area to another. It is noteworthy that wood duck feeding and locomoting had a direct relationship across the 3 time blocks of a day (Table 2).

Mallard species-specific time budgets varied more across the day than did those of wood ducks; however, there were similarities. Both species perched more during the morning than during the remainder of the day. For mallards, virtually all perching took place in the morning (Table 2). This suggests that perching may be useful as a thermoregulation strategy. Early-morning temperatures were at or below freezing during several sample days.

Wood ducks spent a major portion of their time perching, often in trees. Unpaired birds dedicated much more time to perching than did paired birds; the opposite was true for mallards (Table 1). Wood ducks were often observed calling from trees; this appeared to be used to locate other birds.

Increased feeding in the late afternoon by mallards (Table 2) corresponds with Miller's (1992) observations. He also found evidence that wood ducks fed more in the afternoon than during the remainder of the day. However, in his study, the day was not divided into time blocks.

Most of our data were collected during the early morning (Table 2). Normally, ducks flew into the SFAEF flooded bottomland shortly before sunrise. Although flying birds traded back and forth during the day, most did not leave the area until after sunset.

For both species, few data were collected during mid-day. Paulus (1988*a*) reported that mottled ducks (*Anas fulvigula*) rested mostly during mid-day. In this study, the mid-day time block contained less resting activity than other time blocks (Table 2). Because birds were not seen leaving the area but were observed less often during mid-day, they must have been engaged in an activity which restricted their movements. On numerous occasions, both species could be heard in dense vegetation for extended periods of time during mid-day. This indicates that ducks were seeking cover and perhaps resting and engaging in social behaviors during mid-day. Brushy areas would provide protection from avian predators. During Cornes' (1991) study, a swimming wood duck drake was attacked by a raptor; he escaped and immediately swam into thick cover.

The technique used for gathering time budget data on mallards and wood ducks in flooded bottomland hardwood forests was very inefficient. Thick vegetation severely limited visibility, thus observers collected data for a small proportion of the time they were in blinds. Data were recorded on 205 individual and 173 pairs of ducks. In open-water habitats, other researchers have spent much less time gathering vastly more data. For example, during a 430-hour sampling period, Rave and Baldassarre (1989) observed 2,578 green-winged teal (*Anas crecca*), while Hohman and Rave (1990) watched 4,245 canvasbacks (*Aythya valisineria*) during 350 hours. Unfortunately, we have no suggestions for

increasing the efficiency of gathering waterfowl time budget data in wooded habitats.

Summary

Time budgets of mallards and woods ducks in the flooded bottomland hardwood forest were somewhat different from those of ducks in marsh and open-water habitats. The most obvious differences were in locomoting and feeding. Both species locomoted more and fed less than ducks in other habitats. In a bottomland forest through which floodwater flows, locomoting in the form of swimming allows ducks to effectively use food resources. Ducks most likely use the structure and function of both standing and floating woody vegetation and flowing water to increase feeding efficiency. There were debris traps and thickets in the water around most blinds and ducks obviously searched these areas when feeding.

Differences between mallards and wood ducks in the proportions of time spent feeding and locomoting are behavioral adaptations related to reducing competition for food (Fredrickson and Heitmeyer 1988, Kaminski et al. 1993). Locomoting was more strongly tied to feeding for wood ducks than for mallards. If future research projects such as ours are conducted, consideration should be given to classifying locomoting as to whether it is associated with feeding, especially for wood ducks.

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