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A Time Budget Study of Wintering Mallards on the Southern High Plains of Texas, USA

Sang-Don Lee*

Department of Range and Wildlife Ecology, Texas Tech University, Lubbock, TX 79409, USA

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The playas of the Southern High Plains (SHP) of Texas, USA are an important habitat for over one million wintering waterfowl. However, the recent trend toward the modification of playas for agricultural use is threatening winter habitat of waterfowl in this region. Diurnal activity budgets of wintering mallards (*Anas platyrhynchos*) were conducted from 1 October to 31 March, 1983-1984, and 1984-1985) at three habitat types; steep-sided pits, terraced pits, and open lakes. All seven activity patterns (feeding, locomotion, resting, comfort, courtship, alert, and agonistic) were different ($P<0.05$) among the three habitat types for wintering mallards on the SHP of Texas. Terraced pits supported more feeding activity (27.8%) ($P<0.001$) than steep-sided pits (11.2%) or open lakes (2.6%) due to their abundance of natural seeds and aquatic invertebrates. Hens (17.5%) fed more than drakes (11.7%) ($P<0.05$). Locomotion (32.2%) and alert (2.8%) behavior across the three habitat types showed the highest level during the early morning (6:00-9:00 AM). Paired mallards rested more (37.9%) than unpaired mallards (25.8%) ($P<0.05$). Agonistic activity was highest (2.4%) in terraced pits throughout the season.

Time budgets have been a useful technique for gathering ecological, behavioral, and physiological information on numerous avian species (Verner, 1965; Schartz and Zimmerman, 1971; Wolf and Hainsworth, 1971). Among waterfowl during migratory and breeding seasons, activity rhythms have been studied for lesser scaup (*Aythya affinis*) (Siegfried, 1974), gadwalls (*Anas strepera*) (Dwyer, 1975), black ducks (*A. rubripes*) (Hepp, 1989), and mallards (*A. platyrhynchos*) (Gruenhagen and Fredrickson, 1990).

However, a paucity of information for post-breeding waterfowl remains, and waterfowl investigators have emphasized that more research is needed during the 6 to 9 months when birds are not on the breeding grounds (Fredrickson and Drobney, 1979; Reinecke et al., 1982; Anderson and Batt, 1983; Rave and Baldassarre, 1989).

To survive and reproduce, a bird must effectively perform a variety of activities, each requiring an expenditure of time. By recording how much time is spent in each activity, a time budget can be constructed. Verner (1965) suggested that even subtle differences in time budgeting can affect an individual's reproductive success and thus have evolutionary implications (i.e., natural selection may favor the 'efficiency expert' that hypothetically has the 'best' time budget for any given set of circumstances). Selection, therefore, will favor those individuals whose budgets most closely achieve this goal.

The objectives of this project were (1) to determine the activity patterns of mallards by sex and pairing status in relation to selected environmental factors and different habitat types and (2) to relate these data to the winter management of mallards.

Study Area

The Southern High Plains (SHP) is a tableland stretching across the Texas Panhandle and eastern New Mexico. The prominent hydrological features of the SHP are the 16,000-20,000 playa basins dotting the prairie landscape (Baldassarre and Bolen, 1993).

The SHP is a semi-arid region where the annual rainfall is less than 51 cm. The rainy season comes in May-June and September-October, but approximately 90% of the water collected by playas is lost to evaporation and transpiration (Baldassarre and Bolen, 1993). Due to the playas' shallow depths and high evaporation rates, the modified pits concentrate water in a much reduced area; usually, this is accomplished with the excavation of a deep, steep-sided pit in the lowest part of the playa basin. The steep-sided pits reduce evaporation and allow increased use of run-off water for irrigation because a more favorable ratio of volume to surface area of water is attained than in a natural playa. However, these modifications also change both the vegetative and physical characteristics of playas. In particular, the steep-sided pits drain

* Tel: 82-2-3488-7671, Fax: 82-2-3488-7688

much of the littoral zones in playas, thereby reducing important areas of habitat where many waterfowl find food and cover. Dabbling ducks exploit food resources in littoral zones. Fredrickson and Drobney (1979) determined that pintails (*A. acuta*) and mallards prefer feeding in water depths of 11 to 21 cm. Seeds and macroinvertebrates produced in littoral zones are particularly important food sources for waterfowl (Gray and Bolen, 1987).

To compensate for the loss of littoral zones on modified playa lakes terraces were constructed on one side of the pit. To determine if artificial littoral zones might partially compensate for the loss of wintering habitat in modified playas, 8-m wide terraces were constructed at 60 cm intervals. Supposedly, the terraced-pits create functional littoral zones at any water depth in the pit as water levels change (i.e., irrigation pumping, return of tailwater, etc.). Therefore, terraces encourage plants such as pondweeds (*Potamogeton* spp.), cattails (*Typha* spp.), bulrushes (*Scirpus* spp.), smartweeds (*Polygonum* spp.) and millet (*Echinochloa crusgalli*) as well as aquatic invertebrates (Gray and Bolen, 1987). Open lakes where large number of ducks were gathered served as controls. In the middle of the lakes water was deep (1-2 m) and not feasible for feeding compared to less calm, shallow water areas.

Methods

Data were collected from 1 October to 31 March, 1983-84 and 1984-85, on three terraced pits, two steep-sided pits and two open lakes. Each day was divided into 4 time periods: early morning (6:00-9:00), late morning (9:01- 12:00), early afternoon (12:01-15:00), and late afternoon (15:01-18:00). Each of the seven lakes was sampled primarily on weekends. The study season was divided in the following manner: early winter (1 Oct.-30 Nov.), mid- winter (1 Dec.-31 Jan.), and late winter (1 Feb.-31 Mar.). Observations were made with a 15-60x zoom spotting scope from a truck or a man-made blind. Behavioral data were collected from individual birds for 15 min each, using an instantaneous sampling procedure (Altman, 1974; Dwyer, 1975). To reduce the effect of human interference, I waited an average of five min after entering the blind before recording. Four birds were observed each hour with two males and two females randomly selected. Pairing status was determined using methods described by Paulus (1984). Most ducks on open lakes were on the water, so that when possible, birds on the water in pits were selected for comparisons of time budgets.

Seven activities were categorized as (1) feeding, (2) locomotion (walking and swimming), (3) resting (loafing and sleeping), (4) comfort (preening and bathing), (5) courtship (displays), (6) alert (head upright), and (7) agonistic (bill threats, chasing, and biting) as described by Dwyer (1975), and Paulus (1984). Weather conditions such as temperature, wind velocity, and percentage cloud cover were recorded for each observation period.

An arcsine transformation was applied to non-normal percentage data (Zar, 1982). A completely randomized design with a factorial arrangement of treatments was used with the three habitat types serving as treatments. A Tukey mean separation test was used to compare the three treatments while sex and pair status were tested using an F-test. Correlations between activity patterns and weather variables were determined by a Spearman correlation coefficient.

Results and Discussion

The amount of feeding time was different ($P<0.001$) among the three habitat types studied. Interactions could exist between sexes where male diving ducks may control food supply by excluding hens from feeding areas when food is scarce (Nichols and Haramis, 1980). Hepp and Hair (1984) also suggested that late-pairing females are subordinate to earlier-pairing females and are more likely to be excluded from preferred feeding sites when food becomes limited. This does not seem to apply to the waterfowl on the SHP of Texas. First, most mallards were paired by January so that males and females could not be segregated. Second, it seems that food was not scarce on the SHP because mallards in this region fed extensively on an abundant corn supply, and maintained better body condition than those wintering elsewhere (Baldassarre and Bolen, 1984; Whyte et al., 1986). Last, although exact food abundances in the study lakes was unknown, mallards never fed more than an average of 30% throughout the day. This suggests that their food needs were satisfied rather easily. Indeed, gadwalls in Louisiana fed more than 60% of the time (Paulus, 1984), while mallards in Nebraska fed (in water) 55% of the time during the winter of 1979 (Jorde et al., 1984).

Although gadwalls feeding in Louisiana did not show any difference between the sexes (Paulus, 1984), in the present study mallard females fed more than males ($P<0.05$) (Table 1) with unpaired females feeding the most (44.5%). During breeding, greater demands are placed upon mallard females than upon males because of incubation and brood care. Most males leave the breeding areas before females, and many females, especially late nesters, may not have adequate time to accumulate abundant fat reserves for migration (Fredrickson and Drobney, 1979). As a result, adult hens on the SHP have their lowest body weight (1084 g) in early winter (Whyte et al., 1986). The low body weight is probably the reason why unpaired females (fall hens) fed more than paired females and males. Paired females fed slightly, but not significantly, more than males, perhaps in response to molting, migratory and pre-nesting needs.

Table 1. Percentage time spent in activities by paired and unpaired wintering mallards on the Southern High Plains of Texas

Activity	Habitat Type	Paired		Unpaired	
		Male	Female	Male	Female
Feeding[b]	Open	2.7(127[a])	3.0(173)	1.7(88)	4.7(32)
	Steep	9.5 (55)	12.2 (68)	4.4(21)	19.4 (9)
	Terraced	17.6 (52)	22.7 (66)	34.5(29)	44.5(31)
Locomotion	Open	43.4(127)	47.1(173)	49.6(88)	46.0(32)
	Steep	24.4 (55)	21.1 (68)	28.4(21)	28.9 (9)
	Terraced	15.4 (52)	14.2 (66)	19.4(29)	21.3(31)
Resting[c]	Open	35.3(127)	35.5(173)	25.9(88)	23.5(32)
	Steep	39.1 (55)	41.7 (68)	38.3(21)	22.2 (9)
	Terraced	40.9 (52)	42.3 (66)	29.8(29)	16.6(31)
Comfort	Open	11.0(127)	9.7(173)	15.9(88)	16.5(32)
	Steep	17.4 (55)	18.2 (68)	21.4(21)	24.8 (9)
	Terraced	16.1 (52)	16.8 (66)	10.1(29)	11.3(31)
Courtship	Open	4.2(127)	2.9(173)	4.5(88)	6.1(32)
	Steep	3.1 (55)	2.3 (68)	2.5(21)	1.3 (9)
	Terraced	1.8 (52)	0.9 (66)	1.1(29)	1.6(31)
Alert	Open	1.2(127)	0.6(173)	1.1(88)	1.8(32)
	Steep	4.7 (55)	3.1 (68)	2.6(21)	1.1 (9)
	Terraced	4.9 (52)	1.3 (66)	1.6(29)	2.2(31)
Agonistic	Open	2.2(127)	1.2(173)	1.3(88)	1.3(32)
	Steep	1.9 (55)	1.4 (68)	2.4(21)	2.2 (9)
	Terraced	3.2 (52)	1.7 (66)	3.5(29)	2.5(31)
Total number of observations		234	307	138	72
Total hours of observations		58.5	76.8	34.5	18.0

[a]Number of mallards observed, [b]$P<0.05$ sex differences in feeding activity, [c]$P<0.05$ pair status difference in resting activity.

Fat accumulation and depletion are major influences on body weight changes in waterfowl (Raveling, 1979; Reinecke et al., 1982). Whyte et al. (1986) showed body weight and lipid reserves increase from November to the middle of December when most unpaired females gain mates. Hen mallards showed a change both in body weight and lipid reserves, which probably resulted from greater feeding activity during early winter before pairing.

Mallards using terraced pits spent more time feeding (32.4%) ($P<0.05$) than in the other habitat types during the early winter (Fig. 1). Presumably, mallards in early winter have nutritional demands associated with fall migration and molting (King, 1972). The fact that mallards using terraced pits never fed less than 20% of the time was a reflection of this demand.

Ducks using open lakes had the lowest (2.6%) ($P<0.05$) feeding activity followed by ducks using steep-sided pits (11.2%) throughout the season (Fig. 1). Mallards were using large open lakes for non-feeding activities even though large open lakes especially near feedlots, contained an abundance of macroinvertebrates (e.g., Chironomidae, Corixidae, Baetidae). Open lakes have large areas in the center where the water is 1-2 m deep. Most ducks present on the lake used this center area, where feeding was not feasible.

Tamisier (1976) suggested that diurnal resting activity can be a direct consequence of avian predation. He observed numerous attacks on flocks of waterfowl by avian predators (e.g., northern harrier, *Circus cyaneus*). However, this does not seem to apply to mallards wintering on the SHP as I observed only one attack by a northern harrier during this study.

Large open lakes may serve as 'information centers' (Ward, 1965) when ducks unfamiliar with the area mix with ducks previously established in the area. This is particularly useful in the choice of feeding grounds; the best informed birds lead others to more favorable feeding locations (Tamisier, 1974). Tamisier (1974, 1976) stated that green-winged teals (*Anas carolinensis*) are concentrated on large open lakes where they spend time feeding, preening and swimming. A similar explanation can be given for most of the Anatidae in which gregarious behavior is characteristic in winter (Tamisier, 1974).

Differences also occurred ($P<0.05$) in feeding activity across the daily period (Fig. 2). For terraced pits, feeding activity was inversely proportional to resting activity, especially during early winter. Quinlan and Baldassarre (1984) also noted a similar pattern between feeding and resting activity in open lakes. Feeding on native foods by mallards throughout the season is

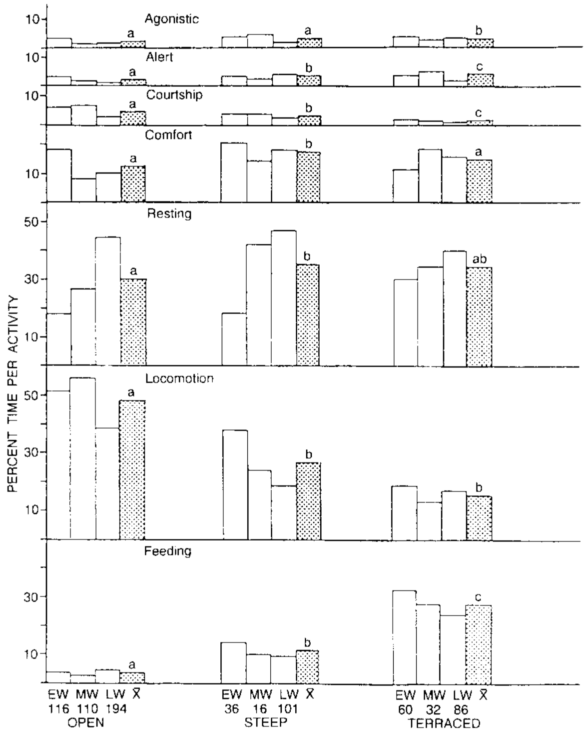

Fig. 1. Habitat and seasonal activity budgets (% of time spent for each activity) of wintering mallards on the Southern High Plains of Texas. Habitat types for an activity denoted by the same letter do not differ (P>0.05). Number of mallards observed are listed below each time period. EW=Oct-Nov, MW=Dec-Jan, LW=Feb-Mar.

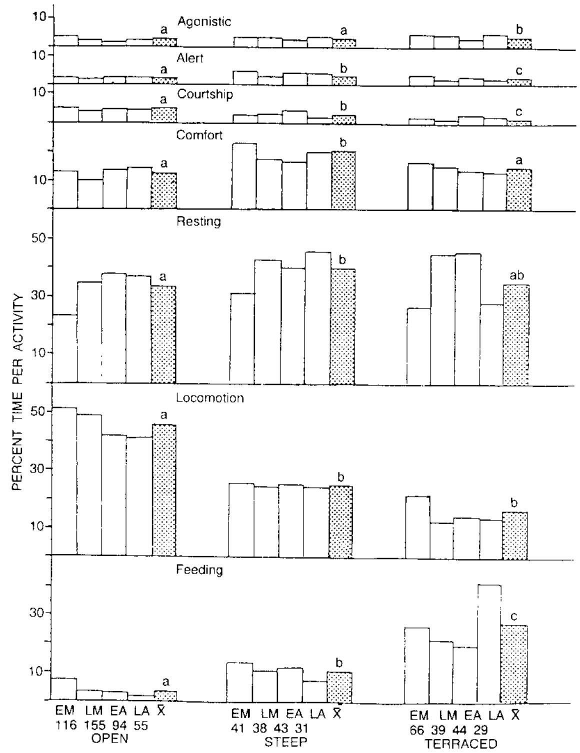

Fig. 2. Habitat and daily activity budgets (% of time spent for each activity) of wintering mallards on the Southern High Plains of Texas. Habitat types for an activity denoted by the same letter do not differ (P>0.05). Number of mallards observed are listed below each time period. EM=6:00-9:00, LM=9:01-12:00, EA=12:01-15:00, LA=15:01-18:00.

important to help balance possible nutritional deficiencies caused by a corn diet. Feeding on native foods may be especially important during the molting period after fall migration (Quinlan and Baldassarre, 1984).

Locomotion was different (P<0.001) among the three habitat types and also among seasons (P<0.05) (Fig. 1). Mallards using open lakes showed the highest locomotion activity (48%) because in open lakes there were fewer calm, shallow water areas and less shoreline per water area for mallards to rest on. Mallards on steep-sided pits showed more time resting than on open lakes. This might be advantageous during energetically stressful periods (e.g., cold weather) for mallards on steep-sided pits or terraced pits.

No differences (P>0.05) resulted from sex or pair status (Table 1). During early winter, locomotion was highly correlated with feeding activity. In late winter, mallards showed lower feeding and locomotion reflecting conservation of energy for spring migration. Daily change of locomotion also was different (P<0.05) among the four daily periods (Fig. 2). Mallards showed the highest amount of locomotion time in the early morning throughout the habitat types (50.5%, 24.9%, 21.2%, for open lakes, steep-sided pits and terraced pits, respectively) due to swimming around after field-feeding.

Resting activity was different (P<0.05) among the three habitat types and seasons (Fig. 1). Resting activity was higher in paired (37.9%) than in unpaired mallards (25.8%) (P<0.05) (Table 1). Paired birds may have better body condition than unpaired birds, thus spending less time feeding and more time resting. In American wigeon (*Anas americana*), protein and lipid reserve levels seem to be correlated with the ability of males to obtain and defend mates during the winter (Wishart, 1979). On terraced pits, mallards showed the highest resting activity (45.3%) (P<0.05) in late morning and early afternoon (Fig. 2).

Comfort activity also differed (P<0.05) across the three seasonal periods (Fig. 1). The highest figure occurred during September-October on open lakes (18.8%) and steep-sided pits (20.6%). During the early winter, a relatively high percentage of time was spent in energetically costly activities (e.g., comfort, feeding and agonistic behavior) reflecting an adaptive metabolic strategy during the period of mild temperatures (Quinlan and Baldassarre, 1984). Comfort movements (e.g., bathing and wing flapping) use about three times as much energy as resting (Wooley and Owen, 1978). In terraced pits, comfort movements were the lowest (11.6%) and the feeding was the highest (32.4%) during the early winter. Comfort activity was not different (P>0.05) across the four daily periods (Fig. 2).

Courtship activity was the highest (P<0.05) in

Table 2. Spearman correlation coefficients among activities of wintering mallards and climatic variables

Activity	Season[a]	Habitat	Number[b]	Temp	Wind speed	Cloud cover
Feeding	EW	Open	116			
		Steep	36	0.41*		
		Terraced	60			
	MW	Open	110			- 0.25**
		Steep	16			- 0.53*
		Terraced	32		0.54**	0.66***
	LW	Open	194		- 0.23**	
		Steep	101	- 0.35***		
		Terraced	86	0.25*		
Locomotion	EW	Open	116	- 0.27**		
		Steep	36			
		Terraced	60			
	MW	Open	110	0.53***	0.42***	- 0.27***
		Steep	16	- 0.68**	- 0.53*	- 0.59*
		Terraced	32			
	LW	Open	194		0.16*	
		Steep	101	- 0.24*		
		Terraced	86			
Resting	EW	Open	116			
		Steep	36			
		Terraced	60			
	MW	Open	110	- 0.47***	- 0.36***	0.35***
		Steep	16	0.54*		0.67**
		Terraced	32		- 0.50**	- 0.65***
	LW	Open	194			
		Steep	101	0.22*	0.22*	
		Terraced	86			
Comfort	EW	Open	116	0.38***	- 0.18 *	- 0.20*
		Steep	36			
		Terraced	60			
	MW	Open	110	0.19*		- 0.24*
		Steep	16			
		Terraced	32		- 0.43 *	- 0.45*
	LW	Open	194			
		Steep	101			0.24*
		Terraced	86			

[a]EW=Oct-Nov MW=Dec-Jan, LW=Feb-Mar, [b]Number of mallards observed, *=P<0.05, **=P<0.01, ***=P<0.001.

mid-winter when birds were forming pair bonds after which time it began to decline. Weller (1965) reported a similar trend in mallards wintering in Louisiana. When compared to other habitat types sampled, courtship activity was highest (4.3%) (P<0.05) in open lakes presumably due to high intraspecific competition. Courtship activity was not different (P>0.05) throughout the day (Fig. 2).

Alert activity was not different (P>0.05) among the three seasons (Fig. 1), but there were differences (P<0.05) among the three habitat types. Steep-sided (3.1%) and terraced pits (3.1%) had the highest values due to the small size of pits. Alert activity also was different (P<0.05) across the four daily periods (Fig. 2). Alert activity was the highest (2.9%) in the early morning before the birds settled down from field-feeding.

Agonistic activity was similar (P>0.05) throughout the three seasons (Fig. 1). Chasing activity was the major type of agonistic behavior demonstrated by mallards during this study. The highest value (2.4%) was noted on terraced pits where mallards showed the highest feeding activity. Similarly, Paulus (1984) demonstrated that agonistic activity is highly correlated with feeding for wintering gadwalls in Louisiana. Mallards' agonistic behavior was different (P<0.05) across the four daily periods (Fig. 2). During late afternoon, mallards showed the highest agonistic activity (3.2%) on terraced pits. However, agonistic activity accounted for less than 5.0% of the total activity during the day.

Weather factors influencing behavior of wintering mallards

Selection of favorable microhabitats could conserve a bird's energy (King, 1974). In mid-winter, there was a positive correlation between locomotion and temperature and wind speed, and a negative correlation between resting in open-lakes (Table 2). Open lakes are wide open, leaving ducks more exposed to wind and waves. Therefore, ducks using those lakes were moving more than ducks using other types of pits. Quinlan and Baldassarre (1984) noted that green-winged teal rested to conserve energy when the temperature was cold. Comfort movements were correlated negatively with cloud cover, indicating that mallards preferred cloudless days for comfort activities (e.g., preening). On windy days, mallards sit and swim facing the wind to reduce their energy requirements. Similar behavior also was demonstrated by black ducks (Hepp, 1989).

Conclusions

Ducks fed in terraced pits with more available food three times longer than in steep-sided pits. Terraced pits gave waterfowl greater opportunities to feed on natural seeds and aquatic invertebrates because there was twice as much area of surface water at depth of less than 30 cm in terraced pits than in steep-sided pits. Management on the SHP should attempt to preserve aquatic habitats capable of providing natural seeds and aquatic invertebrates to balance the wintering diet of mallards.

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