shows that variations in summer precipitation and survival are nonetheless important factors in determining the abundance of this species.

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USE OF PRAIRIE POTHOLE HABITAT BY BREEDING MALLARDS

Detailed information on the use by mallards (*Anas platyrhynchos*) of prairie pothole habitat during the nesting season is necessary to interpret habitat needs of the species during the breeding period. Many data have been collected and published relating pair counts to habitat use and water conditions (e.g., Evans and Black 1956; Smith 1971; Stoudt 1971; Stewart and Kantrud 1973, 1974). However, use of pair-count data to assess wetland use tends to emphasize individual

Table 1. Total home range size and laying home range size for 6 female mallards.

	Total home range			Laying home range		
	Area (ha)	Maximum length (km)	Maximum width (km)	Area (ha)	Maximum length (km)	Maximum width (km)
	306.6	3.9	1.2	38.9	1.4	0.3
	718.9	5.1	1.8	38.1	0.8	0.7
	311.0	3.3	1.3	239.8	3.0	1.2
	573.1	3.6	2.2	126.4	2.6	0.7
	437.0	5.1	1.5	136.2	2.1	0.9
	460.4	3.2	2.0	86.1	1.9	0.9
Mean	467.8	4.0	1.7	110.9	2.0	0.8

wetland units and does not consider total wetland habitat required to sustain a breeding pair on a daily or seasonal basis. We therefore attempted to determine habitat use by individually radio-marked mallards during the breeding period. This paper describes home range characteristics and habitat use of a radio-marked sample of mallard hens breeding in North Dakota during 1973–75. Time budget data are also presented for 2 marked pairs of mallards.

STUDY AREA AND METHODS

Data for this study were gathered on a 93.2-km^2 area of the Missouri Coteau in south central North Dakota, 9.6 km south of Medina. The topography results from extensive stagnation of the last ice sheet and consists mainly of stagnation moraine, with smaller areas of glacial outwash and perched lacustrine plain (Winters 1963). The land has the typical knob-and-kettle type characteristics of the prairie pothole region.

Wetland basins ranged in density from 2 to 12 per km^2 and averaged 1.6 ha in area. According to the classification system of Stewart and Kantrud (1971), the 41.4-km^2 center part of the study area, where most of the observations took place, contained 10% ephemeral wetlands, 33% temporary wetlands, 35% seasonal wetlands, and 15% semipermanent wetlands. Descriptions of plant communities representative of particular pond classes were given by Stewart and Kantrud (1971). Three permanent lakes on the area exceeded 20 ha, and several dugouts and fens made up the remaining wetlands. About 40% of the upland area was pasture and forage crops, and 60% was cropland planted to small grains.

Data from 8 marked, paired, mallard hens formed the basis of the home range and habitat-use part of this paper. Mallards were trapped at baited shoreline sites with cannon nets and marked with radio-packages (Dwyer 1972). Transmitter signals were monitored and locations plotted on base maps to determine home range characteristics and habitat use, and to locate birds quickly for periods of visual observation. Home range sizes for the entire tracking period (total home range) and for the laying part of the reproductive period were calculated by connecting the outermost locations to form a polygon that contained all other locations (Odum and Kuenzler 1955). On the average, birds were tracked for 43 days, and 3.9 locations were plotted per bird per day.

Wetland classes were ranked in the order of their use (% of radio fixes) and availability (% of area in the home range of each bird). The lower the rank, the higher the order of use or availability.

Table 2. Average differences between ranks of wetland class use and the availability of that class within the home ranges of 5 female mallards.

Pond class	Average difference in rank[a]
Ephemeral	0.16
Temporary	−0.50
Seasonal	−0.33
Semipermanent	0.00
Permanent lakes	0.50

[a] Negative differences in rank indicate preferred wetland classes.

Preference for various wetland classes was then examined by using the difference between the rank of usage and rank of availability. Negative ranks indicate the most preferred wetland classes. Differences were averaged across birds for each wetland class to obtain an average difference in rank, which was tested by an analysis of variance (ANOVA).

In 1975, time budget observations were collected on 2 pairs to determine the proportion of time spent in various activities during the breeding season. A metronome timing device (Wiens et al. 1970) was used to established a sampling interval for time budget studies. The activity of birds under observation was coded directly on a columnar form each time the tone sounded. Sampling periods were usually of 1-hour duration, with the tone set at a 12-second interval.

RESULTS AND DISCUSSION

Total home range size for 6 females for which the most detailed data were available averaged about 468 ha (Table 1). Home range shape was elongate; maximum length and width averaged 4.0 km and 1.7 km. Home range sizes for mallards appeared to be larger in south central North Dakota than in forested areas to the east. Gilmer et al. (1975:786) showed that average home range size of 12 female mallards in Minnesota was only 210 ha.

Home range size of hens during the laying period was always less than total home range size, averaging less than ¼ of total home range (Table 1). Small home range size reflects the use of only a few ponds during the egg-laying period. It apparently is advantageous for a female to be less mobile during this energy-demanding period, and to restrict movements primarily to foraging ponds. Prenesting home range size was not calculated because we were not certain that all nests were found for each hen.

Radio-tracking data indicated that breeding hens spent 77% of the daytime hours in wetland habitats and the remaining time in upland habitats. Upland habitats and the percentage of locations in each were as follows: wheat stubble or fallow cropland (52%), seeded cropland or emerging cereal grain (21%), pasture (26%), and other upland areas (1%). No locations were recorded in forage crops or idle cropland habitats, except when nests were in these habitats.

Marked hens occupied from 7 to 22 wetlands ($\bar{x}$ = 15) during the tracking period. Hens spent 22–61% of the time on the single, most-used wetland. Five hens most frequently occupied semipermanent wetlands, 2 used seasonal wetlands most often, and 1 relied most on a permanent lake. Overall, mallard hens appeared to use temporary and seasonal wetlands in their home ranges to a greater degree than their available area, whereas ephemeral wetlands and permanent lakes were used to a lesser degree than their relative availability (Table 2). The use of semipermanent wetlands was directly related to their availability. However, the ANOVA test for differences among the uses of wetland classes resulted in a nonsignificant F value.

Activity patterns of drakes and hens re-

Table 3. Percentage of time spent by mallard pairs in various activities during major phases of the reproductive cycle. (Number of hours of observation in parentheses.)

Activity	Male time budget (%)			Female time budget (%)		
	Prenesting (88)	Egg laying (45)	Incubation (57)	Prenesting (70)	Egg laying[a] (14)	Incubation[a] (15)
Resting	65.5	54.4	69.0	67.5	28.3	16.7
Feeding	14.7	20.0	8.7	17.6	54.8	38.3
Comfort movements	4.5	14.9	10.1	4.7	9.0	31.1
Locomotion	8.5	6.2	3.1	7.1	7.1	10.0
Alert	6.3	4.6	9.0	2.5	0.8	3.8
Other	0.4		tr[b]	0.7		tr

[a] Excludes period spent on the nest.
[b] Trace = tr; less than 0.1%.

flect the differing reproductive roles of each during the nesting period (Table 3). The time budgets of the pair are most similar during prenesting, when each member spent about ⅔ of the time resting. Among hens, time spent resting declined markedly during laying and incubation. Feeding time by hens increased from 18 to 55% from prenesting to laying. Feeding by drakes remained at a relatively low level throughout the nesting period. The marked increase in comfort movements by females during incubation reflects increased preening and bathing while they were off the nest.

Time spent resting and feeding in major habitats used during the nesting period (Table 4) differed between hens and drakes. Drakes rested most of the time while on temporary wetlands; no feeding was observed during 8 hours of observation. The highest level of feeding activity for both sexes occurred in seasonal wetlands, probably reflecting greater availability of preferred foods. Laying hens spent 45% of the time foraging while in seasonal wetlands. Most of the feeding by hens in uplands occurred during incubation.

CONCLUSIONS

Large home range size of marked mallard hens monitored on our prairie study area, in comparison with those in north central Minnesota (Gilmer et al. 1975), presumably reflects major differences in type and distribution of water areas. The size of the home range is a measure of the area a pair requires to meet its breeding requirements. A large home range encompassing diverse wetland types appears advantageous in the semiarid cli-

Table 4. Percentage of time spent by mallards in major habitat types in south central North Dakota. (Hours of observation shown in parentheses.)

Activity	Male				Female		
	Temporary wetland[a] (8)	Seasonal wetland (81)	Semi-permanent wetland (36)	Upland (42)	Seasonal wetland (41)	Semi-permanent wetland (8)	Upland (31)
Resting	89.0	52.5	68.5	69.3	42.7	60.8	61.0
Feeding	0.0	22.3	10.5	5.3	29.7	25.8	23.5
Other	11.0	25.2	21.0	25.5	27.6	13.4	15.5

[a] Drake time budget data for temporary wetlands were obtained while their mates were on nests.

mate of the south central North Dakota study area. A reproductive strategy that favors familiarity with several wetlands of diverse types increases potential options for meeting breeding requirements under rapidly changing water conditions. A tendency for a sizable segment of the mallard hen population to home to areas where they have previously hatched a nest (Doty and Lee 1974) is probably enhanced by familiarity with a wetland complex. A core of relatively stable water areas amid numerous shallow wetlands could provide important habitats for pair isolation and foraging during years of favorable water conditions. Low population density (1–3 pairs/km^2) may also have contributed to observed home range size.

Data showing that mallard hens occupy 7–22 wetlands during the nesting season underscore the importance of wetland complexes to breeding pairs. Dzubin (1969) noted that 1 pond does not contain all the breeding requirements of a pair unless it is larger than 3 acres, and referred to a community of potholes, i.e., a wetland complex, where several wetlands contribute to successful breeding by a pair. Our findings suggest that mallard hens seek out several wetlands to provide breeding requirements before the brood-rearing period.

Activity patterns of mallards varied with reproductive status. The major nutrient and energy demands of producing a clutch of eggs is reflected in the marked rise in feeding activity by hens during the period of egg formation. Low nest success rates of recent years have placed greater importance on renesting, which further increases hen demands on the wetland environment. Because water levels change rapidly during the nesting season, causing marked fluctuations in availability of food supply, hens must often rely on new foraging sites when making renesting attempts. The proximity of numerous wetlands of varying types increases the likelihood that adequate habitat will be present to meet diverse needs of breeding pairs.

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WEIGHTS OF LESSER SNOW GEESE TAKEN ON THEIR WINTER RANGE

Geese are assumed to accumulate fat on the winter range (Bent 1962, Williams 1967) to sustain them through the long northward migration and early part of the nesting season. However, there are no weights given in the literature of lesser snow geese (*Anser c. caerulescens*) on their winter ranges to compare with weights on the breeding grounds. For many years biologists relied on Kortright (1942) for weights of lesser snow geese, and more recently on Bellrose (1976). In the present study, snow geese from the Garwood Prairie, a rice growing area in Colorado County, Texas, were weighed to determine if weights increased before northward migration. The Garwood Prairie is a segment of the snow goose winter range near the Gulf Coast of Texas.

METHODS

Snow geese shot by hunters were weighed between late October and mid-January 1974–76. We also shot geese in February through early April 1972–76 for weight data. Geese were weighed in the field with a graduated (25-g) tubular spring scale or at a commercial goose cleaner shortly after they were shot. Body weight, sex, and age (on the basis of plumage) were recorded for each goose. Weights of geese collected in all months were separated into 3 biologically meaningful time periods: postfall migration (Oct–Nov), wintering (Dec–Feb), and prespring migration (Mar–Apr). Because some sample sizes were small and means and ranges were usually similar for identical age and sex classes and collection periods among the years, samples for all years were combined. Other physical characteristics, e.g., amount of abdominal or knee strip fat (both legs), were weighed. Condition of sternal muscles or gonad size of males was determined by visual examination in at least 2 of the 5 years of study. Weights were not different ($P > 0.05$) between blue and white color phases or between some sex and age-groups (such as immature males) among periods and therefore are not discussed.

RESULTS AND DISCUSSION

Weights of 196 geese are shown in Table 1 (164 white phase and 32 blue phase). Immature females were lighter ($P < 0.05$) than adult females in the post-