SHORT COMMUNICATIONS

Diurnal time budgets of breeding Common Goldeneyes. — Studies of time allocation during nesting allow comparison of how waterfowl cope with energetic and nutrient demands within environmental constraints. In general, larger species tend to nest earlier, forage less, and rely on endogenous resources accumulated before arrival at breeding areas (e.g., Common Eiders [*Somateria mollissima*] and Lesser Snow Geese [*Chen c. caerulescens*]) (Korschgen 1977, Ankney and MacInnes 1978). In contrast, smaller species usually nest later and spend relatively more time foraging after arrival in nesting areas (e.g., Northern Shovelers [*Anas clypeata*] and Ruddy Ducks [*Oxyura jamaicensis*]) (Afton 1979, Tome 1984). Dependence on endogenous resources during nesting appears to be related positively to body size and incubation constancy and negatively to the time spent foraging (Afton 1980). This generalization can vary depending on how physical properties of the nest environment and thermal requirements of developing embryos affect incubation constancy (Afton and Paulus 1992).

Studies of Common Goldeneyes (*Bucephala clangula*) provide additional insight. Females are cavity-nesters (Delacour 1954) that weigh 600–700 g during incubation (Zicus, unpubl. data). Although nesting begins while many wetlands are ice-covered, laying rates are low compared to other similar-sized waterfowl (cf, Palmer 1976). Males vigorously defend foraging territories from congeneric waterfowl during laying and incubation (Savard 1984). Early nesting suggests that stored resources are important, but foraging defense and low laying rates indicate foods obtained in the breeding areas may be essential. We describe the diurnal time budget of breeding Common Goldeneye pairs and discuss its relevance to resource acquisition and nesting.

Study area and methods. — We studied time-activity budgets in northcentral Minnesota from 1983 to 1985 on a 16-ha pond with a 30-ha adjoining sedge meadow and floating sedge mat. Water depths were <1.5 m, and stands of hardstem bulrush (*Scirpus acutus*), waterlily (*Nymphea tuberosa*), and various pondweeds (*Potamogeton* spp.) occurred throughout. Human access was limited to the site from April to June. Four pairs of goldeneyes defended territories in 1983, while six pairs occupied the pond in 1984 and 1985 (R. Eberhardt, unpubl. data). Females nested in nest boxes around the pond. We trapped females in nest boxes (Zicus 1989) as they searched for nest sites and individually marked them with plastic nasal saddles (Doty and Greenwood 1974). Activities of marked females and their unmarked mates were sampled during egg-laying and incubation periods using the focal animal method (Altmann 1974). We used 1-h observation sessions during egg laying. The period from 0.5 h before sunrise to 0.5 h after sunset was divided into four equal-length blocks that were adjusted daily to account for changing sunrise and sunset times. For each block, a random start time was selected such that the latest possible start would be one hour before the end of the time block. Activities of both pair members were recorded simultaneously every 30 sec using a metronome (Wiens et al. 1970). Goldeneyes were observed when our work schedule permitted, but we attempted to balance the observations made in each time block. Marked females were assigned randomly to each day. When an observation session was to begin, the assigned female was searched for. If this female could not be found when one or more other marked females were present, the one observed least recently was selected, or the only marked female present was observed. Nesting status was determined by monitoring marked pairs using nest boxes.

Activities were categorized as (1) foraging (dive, dive-pause, food sorting at the surface), (2) alert, (3) locomotion, (4) agonistic, (5) comfort movements, (6) courtship, (7) resting, or (8) out of sight. Observations during the laying period were analyzed if birds were visible

TABLE 1
PERCENT OF DIURNAL TIME SPENT IN VARIOUS ACTIVITIES BY COMMON GOLDENEYE PAIRS DURING EGG LAYING IN NORTHCENTRAL MINNESOTA, 1983–1985

Activity	Sex	1983 ($N_f = 4$[a]) ($N_m = 4$)	1984 ($N_f = 4$) ($N_m = 4$)	1985 ($N_f = 4$) ($N_m = 4$)
Foraging	Female	86.0 (4.0)[b]	78.9 (2.8)	60.7 (10.4)
	Male	69.8 (2.7)	42.4 (5.3)	39.2 (4.3)
Locomotion	Female	4.7 (0.7)	7.3 (1.3)	6.8 (2.1)
	Male	13.0 (2.1)	17.9 (0.8)	12.6 (2.8)
Resting	Female	1.9 (1.6)	7.5 (1.6)	18.6 (9.9)
	Male	2.9 (1.3)	17.0 (5.6)	22.8 (6.5)
Comfort	Female	5.6 (2.6)	4.0 (0.3)	12.1 (7.3)
	Male	8.1 (2.1)	7.0 (0.9)	15.4 (4.1)
Agonistic	Female	0.1 (0.1)	0.0 (0.0)	0.0 (0.0)
	Male	3.2 (1.3)	12.8 (4.8)	6.4 (1.5)
Alert	Female	1.0 (0.5)	1.5 (0.4)	1.3 (0.5)
	Male	2.2 (0.4)	1.4 (0.7)	2.5 (1.4)
Courtship	Female	0.6 (0.2)	0.7 (0.3)	0.4 (0.2)
	Male	0.8 (0.3)	1.5 (0.6)	1.0 (0.2)

[a] N_f = number of females, N_m = number of males.
[b] Mean (SE).

for ≥ 30 min. Because the timing of incubation recesses was unpredictable, varying greatly in duration (Zicus, unpubl. data), we observed recessing birds for as long as possible and analyzed the observations regardless of their length. Activities were summarized as the percent of the observation that they comprised while the bird was in sight.

Effects of sex, year, and their interaction on percent time spent in each activity were examined using a two-way factorial ANOVA on the arcsine-transformed data. We accounted for the fact that we observed the same marked birds throughout the spring by analyzing time period means for each bird. To reduce type II error rates, given small samples, we considered differences significant at $P < 0.1$. We maintained the overall α level by preceding the ANOVAs with a single two-way factorial MANOVA on the transformed data for all activities using SAS PROC GLM (SAS Institute Inc. 1991). Significant multivariate main effects were then followed by their corresponding univariate ANOVAs.

Results.—We observed males and females for 126 h during the egg-laying period. Wilk's Lambda test criterion indicated both sex and year influenced activity budgets (MANOVA $F = 7.80$; df = 7, 12; $P = 0.001$ and $F = 1.97$; df = 14, 24; $P = 0.069$). Foraging was the most frequent diurnal activity for both sexes while the female was away from the nest (Table 1). Females foraged more than males ($F = 30.66$; df = 1, 18; $P < 0.001$) each year, but foraging by both sexes differed among years ($F = 12.66$; df = 2, 18; $P < 0.001$) and was lowest in 1985. Males consistently moved more than females ($F = 30.77$; df = 1, 18; $P < 0.001$), but locomotion was similar among years ($F = 2.35$; df = 2, 18; $P = 0.124$). Time spent resting varied among years ($F = 5.52$; df = 2, 18; $P = 0.014$), but not between sexes ($F = 1.14$; df = 1, 18; $P = 0.299$). Males were more agonistic than females ($F = 18.04$; df = 1, 18; $P < 0.001$), and agonistic activity may have varied among years ($F = 2.58$; df = 2, 18; $P = 0.104$). Time alert and courting were the least observed activities. Males may

TABLE 2

PERCENT OF DIURNAL TIME SPENT IN VARIOUS ACTIVITIES BY COMMON GOLDENEYE PAIRS
DURING INCUBATION RECESSES IN NORTHCENTRAL MINNESOTA, 1984–1985

Activity	Sex	1984 ($N_f = 3^a$) ($N_m = 3$)	1985 ($N_f = 3$) ($N_m = 3$)
Foraging	Female	75.4 (5.9)[b]	78.9 (4.7)
	Male	18.7 (10.7)	55.1 (0.4)
Locomotion	Female	6.4 (2.3)	3.7 (2.1)
	Male	27.7 (12.5)	10.3 (1.9)
Resting	Female	2.3 (1.3)	3.5 (2.1)
	Male	18.9 (3.0)	14.9 (2.1)
Comfort	Female	9.3 (5.5)	11.4 (2.2)
	Male	6.7 (3.9)	8.7 (0.9)
Agonistic	Female	0.0 (0.0)	0.0 (0.0)
	Male	21.5 (7.1)	4.6 (4.6)
Alert	Female	6.5 (1.2)	2.0 (0.1)
	Male	6.6 (2.9)	6.0 (3.3)
Courtship	Female	0.0 (0.0)	0.5 (0.2)
	Male	0.0 (0.0)	0.4 (0.1)

[a] N_f = number of females, N_m = number of males.
[b] Mean (SE).

have spent more time courting than females ($F = 2.96$; df = 1, 18; $P = 0.102$). Otherwise, time spent in these activities was similar among years and between sexes.

We observed goldeneyes during incubation recesses 33 times in 1984 and 1985. Observation sessions ranged from 17 to 62 min ($\bar{x} = 48$). Wilk's Lambda indicated a significant overall sex effect (MANOVA $F = 92.78$; df = 7, 1; $P = 0.080$), but we detected no difference between years (MANOVA $F = 17.60$; df = 7, 1; $P = 0.182$). Pairs spent most of the recess time foraging and less time in other activities (Table 2). Females foraged more during a recess than males ($F = 31.37$; df = 1, 7; $P < 0.001$), but males may have moved more ($F = 3.15$; df = 1, 7; $P = 0.119$) and rested more ($F = 33.83$; df = 1, 7; $P < 0.001$). Males were involved in agonistic activities more than females ($F = 8.90$; df = 1, 7; $P = 0.020$). We detected no sex related differences in alert, comfort, or courtship activities (all P values > 0.448).

Both sexes spent the greatest proportion of their foraging time in underwater dives and the least sorting items at the surface (Table 3). Foraging components differed between sexes and among years (MANOVA $F = 6.03$; df = 3, 19; $P = 0.005$ and $F = 8.18$; df = 6, 38; $P < 0.001$). Females spent more foraging time sorting items at the surface than males ($F = 9.31$; df = 1, 21; $P = 0.006$), whereas males spent more time pausing between dives ($F = 7.85$; df = 1, 21; $P = 0.011$). Food sorting was greatest in 1983 ($F = 22.72$; df = 2, 21; $P < 0.001$) when pausing between dives was lowest ($F = 8.34$; df = 2, 21; $P = 0.022$).

Discussion. —Activity budgets of Common Goldeneyes resembled those of small- to medium-sized waterfowl that obtain resources for egg laying and incubation on the nesting grounds. For females, foraging was the dominant activity as has been reported for species such as Northern Shovelers and Ruddy Ducks. Afton (1979) and Tome (1991) estimated that females of these species spent 54–61% of the time foraging during prelaying and laying

TABLE 3
PERCENT OF DIURNAL FORAGING TIME SPENT IN VARIOUS ACTIVITIES BY COMMON GOLDENEYE PAIRS IN MINNESOTA, 1983–1985

Activity	Sex	1983 ($N_f = 4$[a]) ($N_m = 4$)	1984 ($N_f = 4$) ($N_m = 4$)	1985 ($N_f = 5$) ($N_m = 5$)
Diving	Female	58.4 (1.7)[b]	59.9 (1.9)	64.4 (1.8)
	Male	59.2 (2.9)	63.9 (1.7)	60.8 (2.4)
Pausing	Female	23.1 (3.3)	34.8 (1.8)	32.9 (1.3)
	Male	32.4 (0.8)	34.0 (2.3)	38.4 (2.1)
Sorting	Female	18.5 (4.0)	5.3 (0.6)	2.8 (0.6)
	Male	9.5 (3.2)	2.1 (0.6)	0.7 (0.5)

[a] N_f = number of females, N_m = number of males.
[b] Mean (SE).

periods (when not at the nest). Diurnal foraging time during egg laying by female goldeneyes exceeded this level. Median length of the diurnal period during egg laying was 944 min, and Common Goldeneyes spent approximately 15% of the time at the nest (Zicus, unpubl. data). Thus, goldeneyes foraged 487–690 min/day compared to approximately 441 min/day by female Northern Shovelers (calculated from Afton 1979).

Although the proportion of an incubation recess during which a female foraged was the same in both years, females on our study wetland had longer daily incubation recess times in 1984 ($\bar{x} = 347$ min) than 1985 ($\bar{x} = 255$ min) (Zicus, unpubl. data). As a result, actual foraging time averaged 265 min/day in 1984 versus 199 min/day in 1985. Less foraging in 1985 was consistent with differences during egg laying and suggests food was more available in 1985. Einarsson (1990) likewise noted that female Barrow's Goldeneyes (*B. islandica*) on food-rich inshore territories foraged for less time than those elsewhere on the lake. Incubation constancies and female weights at the end of incubation also were lower in 1984 than in 1985 on two other lakes (Zicus, unpubl. data), further supporting speculation that food availability may have changed between years.

Female foraging time during incubation was greater in both years of our study than that reported for most duck species (see review in Afton and Paulus 1992). For example, during incubation, Green-winged Teal (*A. crecca*) foraged 193 min/day (Afton 1978) and Ruddy Ducks foraged 185 min/day (Tome 1991). Extensive foraging allows small-bodied species such as these to acquire nutrients exogenously during incubation (e.g., Tome 1984, Ankney and Afton 1988).

Male activities appeared to be most directed towards maintenance of foraging territories. In 1983, when there were the fewest pairs, male agonistic activity was lowest and foraging was highest. Males foraged less than females, particularly when accompanying females during incubation recesses in 1984. Similar sex-related differences have been reported for many waterfowl species (e.g., Dwyer 1974, Seymour and Titman 1978, Afton 1979). Throughout spring 1984, males allocated more time to locomotion and agonistic activities than in 1985, even though pair numbers were the same both years. This might be expected, given the male's role in maintenance of exclusive feeding areas (Savard 1984), if food acquisition was more difficult in 1984 than in 1985.

Comparisons with activity budgets of other species need to be made cautiously. Like other studies, ours lacked the year and area replication necessary to assess the variability likely

inherent in activity budgets. Nonetheless, goldeneye foraging time varied significantly for both sexes and among the years we studied. In addition to habitat influences, densities of conspecific or congeneric waterfowl no doubt influence time allocation during nesting (Savard 1984). Common Goldeneye activity budgets resemble those of other small- to medium-sized ducks, but their breeding strategy differs from that of other species because goldeneyes begin nesting when many wetlands are ice-covered and food availability probably is low. Goldeneyes lay eggs approximately every other day, which is a rate lower than that of most ducks (Bellrose 1976). This trait combined with frequent foraging during egg laying and incubation may allow them to return to nesting areas with relatively few endogenous resources and yet begin nesting immediately. Early nesting, low egg-laying rates, actively defended territories, and frequent foraging during egg laying and incubation may be essential for a duck the size of the goldeneye to exploit boreal wetlands having relatively low productivities and short open-water periods.

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Rapid colonization of a human-made wetland by Mariana Common Moorhen on Guam.— The Mariana subspecies of the Common Moorhen (*Gallinula chloropus guami*) is endemic to the Mariana Islands in the western Pacific Ocean and is endangered (USFWS 1984). Current populations are found on the islands of Guam, Tinian, and Saipan which support an estimated 100–125, 75, and 100 moorhens, respectively, (Stinson et al. 1990). Degradation and loss of natural wetlands have contributed to the decline of the species, but human-made sites on Guam have supplemented available habitat (USFWS 1984, Stinson et al. 1990). In 1987 and 1988, about 80% of all wetlands used by moorhens during the wet and dry seasons were artificial (Stinson et al. 1990). Many of these sites originally were constructed as aquaculture ponds, ponding basins for flood control, reservoirs for municipal use and livestock, or as scenic ponds on golf courses. They provide nesting and foraging areas for moorhens after suitable aquatic vegetation becomes established. However, many are subject to severe inundation and drying out in response to seasonal rainfall patterns (M. Ritter, unpubl. data).

Since 1985, a dramatic increase in large tourist-related developments has resulted in increased conflicts over wetlands between developers and natural resource management agencies. Conflicts often associated with developments are mitigation, run-off control, erosion control, improved aesthetics, and providing higher wildlife values. On the Manengon Hills Resort, project planners and biologists identified a unique opportunity to integrate both the habitat requirements of moorhens with the design constraints and needs of development-based wetlands into aesthetic and functional wetlands that would benefit moorhens. This report documents the results of the first attempts by a land developer to build wetland habitat for Common Moorhens on Guam. We describe the construction of a wetland and its rapid colonization by moorhens.

The Manengon Hills Resort is located in south-central Guam and covers 531 ha. It is the largest tourist development on the island and will have 3000 housing units, a hotel, a 45-hole golf course, and associated recreational and shopping facilities when completed. The existing watersheds are being maintained, but much of the existing upland grasslands have