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# PATTERNS OF FLOCK SIZE, DIET, AND VIGILANCE OF NATURALIZED MONK PARAKEETS IN HYDE PARK, CHICAGO[1]

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*Abstract.* We examined patterns of diet, foraging group size, and vigilance effort of naturalized Monk Parakeets (*Myiopsitta monachus*) in Hyde Park, a neighborhood of Chicago, Illinois. Parakeets exhibited a highly seasonal and varied diet consisting of fruits, seeds, and buds, and they fed almost exclusively on birdseed provided at backyard feeding stations during the winter months. Birds foraged in groups of 1 to 31 birds, but most flocks were of 10 birds or less. Foraging group size was greatest in the fall and early winter, and smallest at the beginning of the spring when breeding began. Monk Parakeets adjusted their vigilance effort with changes in flock size. Individual vigilance effort declined with increasing flock size through a decrease in time spent scanning as well as the number of times scans were initiated. The number of parakeets exhibiting vigilance in a flock at any given time also decreased with flock size. It is likely that the highly adaptable and varied diet of Monk Parakeets contributes greatly to the persistence and growth of populations in a variety of North American habitats.

*Key words: flock size, foraging behavior, Monk Parakeet,* Myiopsitta monachus.

## INTRODUCTION

The ecology of Psittaciformes generally remains poorly known, even though they are one of the most recognizable and diverse (> 330 spp.) orders of birds (Forshaw 1989). The relative dearth of studies on wild parrots is noteworthy, given that many species are endangered or considered important agricultural pests (Bucher 1992). Recently, the sociality of many parrots has garnered the attention of researchers hoping to understand the nature of flocking in birds (Chapman et al. 1989, Gilardi and Munn 1998). Cannon (1984) suggested that Australian parrots exhibit increased gregariousness with increasing aridity of their habitat, presumably in response to variation in the availability or predictability of resources. This scenario suggests that group size influences the rate at which food sources are discovered in patchy environments (Pulliam and Caraco 1984). Westcott and Cockburn (1988), on the other hand, concluded that risk of predation is the dominant factor influencing flocking in parrots, and found that individuals devoted less time to vigilance behavior as flock size increased. It is unlikely, however, that one explanation sufficiently explains group size in parrots.

The Monk Parakeet (*Myiopsitta monachus*) is one of the most interesting species of parrot in that it is the only species to construct a free standing nest, it nests in large communal groupings, and may exhibit cooperative breeding (Forshaw 1989, Eberhard 1998). This species also has established naturalized breeding populations in many areas of the world, including Puerto Rico, Kenya, Japan, the United States, and several European countries (Lever 1987), as the result of purposeful or accidental releases of birds imported through the pet trade. In the United States, Monk Parakeets are now common in many localities. An analysis of Christmas Bird Count records from 1971–1995 reported a total of 1,816 individuals from 76 localities in 15 states, and the rate of increase fit an exponential model of population growth (Van Bael and Pruett-Jones 1996, Pruett-Jones and Tarvin 1998). The species appears to be increasing in numbers in Europe as it is in the United States (Sol et al. 1997).

Although Monk Parakeets have received study in their natural range (Bucher et al. 1990, Navarro et al. 1992, Eberhard 1998), very little is known of the ecology of the introduced populations (Spreyer and Bucher 1998). This lack of knowledge is noteworthy given the species' status as a potential agricultural pest in South

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America (Bucher 1992, Dahlem 1994). A naturalized population of Monk Parakeets has occupied the Hyde Park neighborhood of Chicago, Illinois since 1979 (Hyman and Pruett-Jones 1995). In this study, we examined the diet of Monk Parakeets in Chicago as well as patterns of flocking in relation to vigilance effort and seasonal changes in resources.

## METHODS

### STUDY SITE

We conducted field observations from July 1998 to June 1999 in Hyde Park, a residential community approximately 11 km south of Chicago. The study area encompassed all breeding colonies of the Hyde Park population of Monk Parakeets, but these colonies were not distributed evenly throughout the study site. The study area is highly developed, but open spaces exist in several parks and along the shore of Lake Michigan (Hyman and Pruett-Jones 1995).

### DIET AND FLOCK SIZE

Three to five days each week, we searched the study site for a period of 1–4 hr for flocks of foraging Monk Parakeets. All observations were collected between 09:00 and 16:30. We tried to search all areas equally, but no systematic procedure was used. When one or more birds were encountered feeding, we recorded the location, date, group size, and food source.

The Monk Parakeet's diet was quantified as the relative frequency of feeding observations of individual birds on different food sources. We quantified the diversity of food sources utilized by parakeets and the relative importance of each item throughout the year, but did not quantify the amount of time spent feeding on each source or the amount ingested. We used this method because entire feeding bouts of parrots can rarely be observed (Galetti 1993).

We defined feeding group size as the number of parakeets concurrently foraging on the same food source; birds engaged in other activities at the same time and location were not counted. Because it was presumed that the size of the parakeet population would fluctuate seasonally during the course of the study (Hyman and Pruett-Jones 1995), the average numbers of foraging groups and individuals seen per hour of observer effort were examined along with the average group size for each month of the study.

### VIGILANCE

We recorded the vigilance of individuals, defined here as a period that a foraging bird spent with its head up scanning the horizon (Bertram 1980). For these observations, feeding groups were categorized according to the number of individuals they contained. We used the following group-size categories, modified from Westcott and Cockburn (1988): 1, 2, 3, 4, 5, 6–10, 11–15 and 16+. When flocks of foraging parakeets were encountered, we waited a few minutes before collecting data to allow the birds to become acclimated to the observer. We assumed that this procedure was adequate to remove observer effects, given that these birds are frequently exposed to humans and are often unperturbed by people passing within 5 m of them. We observed flocks at a distance of at least 10 m unless the birds were foraging in a tree, in which case they were observed at closer distances.

We quantified vigilance for no more than four individuals from a single flock. The observer tried to select a focal individual at random, but no formal randomization procedure was used. For periods of 1 min, we recorded the initiation and completion of vigilance scans by individuals, and from these records we calculated two measures of vigilance effort, scan length and scan rate (scans $min^{-1}$). These data were vocally recorded on to a tape recorder and later transcribed. Because none of the birds observed in this study were marked, we recognize the possibility of pseudoreplication in our data. We may have recorded vigilance data for the same individual more than once although we made a concerted effort not to do this, at least while watching a given flock of birds.

We recorded corporate vigilance effort, defined here as the proportion of individuals in a foraging group that were vigilant at the same time, with an instantaneous sampling method (Altmann 1974). Every 30 sec we recorded the behavior of each individual in a flock until a total of 3 min of data was collected. From these data, we calculated the average percentage of birds that were vigilant and foraging in the flock at any one time. Behaviors other than foraging and vigilance were seldom recorded and did not occur often enough for analysis. If birds joined or left the flock during the 3-min observation period and changed the size category to which the flock was assigned, the data were omitted.

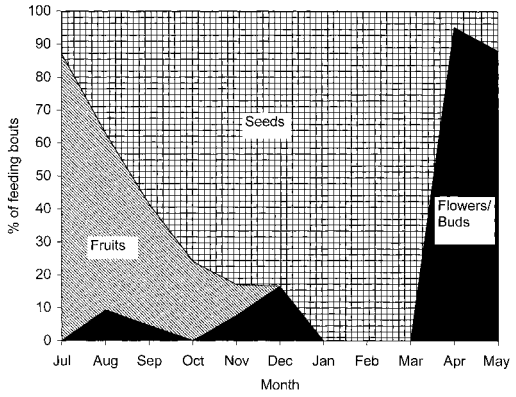


FIGURE 1. Monthly diet as a percentage of feeding bouts of Monk Parakeets in Hyde Park, Chicago.

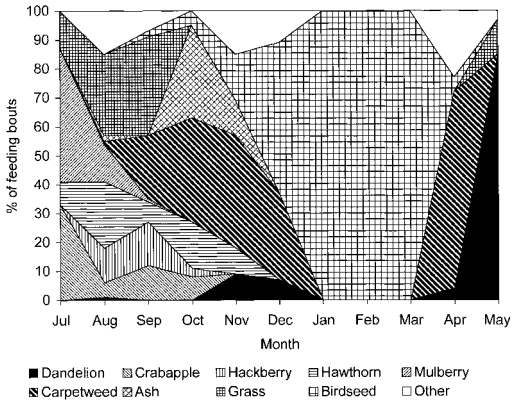


FIGURE 2. Monthly percentages of feeding bouts of the nine most common food resources of Monk Parakeets in Hyde Park, Chicago.

### STATISTICAL ANALYSES

To test for the significance of seasonal changes in flock size and changes in vigilance effort with flock size, we used Kruskal–Wallis one-way analyses of variance. The Spearman rank order correlation coefficient was used to measure the degree and direction of association between flock size and vigilance effort (Sokal and Rohlf 1995). We employed a significance level of $P < 0.05$. All analyses were conducted using SPSS, version 9.0 (SPSS Inc. 1998). Values are presented as means ± SE.

## RESULTS

### DIET

A total of 300 foraging groups of Monk Parakeets was observed, comprising 1,426 individual feeding observations. The birds fed on 14 genera of plants from 13 families, as well as several unidentified genera of turf grasses and birdseed (complete data available on request from the second author). The plant families most utilized were Poaceae and Rosaceae, comprising 11.9 and 14.5% of feeding observations, respectively. Birdseed was the most common item in the parakeet's diet, accounting for 25.7% of feeding observations.

The diet changed seasonally (Fig. 1 and 2). Fruit eating was highest (87.2%) in July (Fig. 1), when mulberries (*Morus* sp.) and crabapples (*Malus* sp.) accounted for the bulk of observations (Fig. 2). The fruits of hackberry trees (*Celtis* sp.) and crabapples continued to be consumed throughout the late summer and early autumn. Hawthorn berries (*Crataegus* sp.) were the last fruits widely available from mid October to late November and were regularly eaten by parakeets during this time. The consumption of seeds of ash trees (*Fraxinus* sp.), carpetweed (*Mollugo* sp.), and several turf grasses steadily increased through late summer until these foods were no longer available in autumn and early winter (Fig. 2). A brief period of unseasonably warm weather in early December caused the flowering of dandelions (*Taraxacum* sp.) and budding of elm trees (*Ulmus* sp.), and the parakeets utilized these plants during that month (16.5% of feeding observations).

Seeds were consumed throughout the year but accounted for 100% of feeding observations from mid December through March (Fig. 1), when parakeets exclusively consumed birdseed from backyard feeding stations (Fig. 2). These stations were common in the study area during the winter months and usually contained either a commercial mixture of seeds and grains (sunflower, millet, milo, wheat, and corn), or sunflower seeds alone. The extent to which parakeets favored certain items over others at these stations was not determined.

The flowers of dandelions, carpetweed, and the leaf buds of elm trees were the main forage items in April and May (Fig. 2). Flower and bud eating was highest in these months, accounting for 95.1 and 87.9% of feeding observations, respectively (Fig. 1).

### PATTERNS OF FLOCK SIZE

Flock size was highly variable (range = 1–31), but in general parakeets formed relatively small

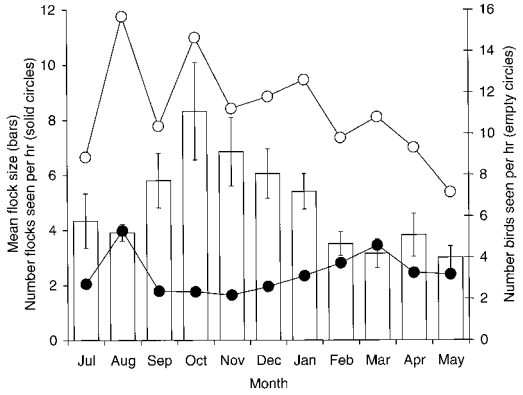


FIGURE 3. Mean size of Monk Parakeet flocks (bars), number of flocks seen per hour of observer effort (solid circles), and number of individuals seen per hour of observer effort (empty circles) on a monthly basis in Hyde Park, Chicago from July 1998 to May 1999. Vertical lines represent ± SE of the mean. The primary axis (left) corresponds to mean flock size and flocks seen per hour of observer effort, and the secondary axis (right) to individuals seen per hour of observer effort.

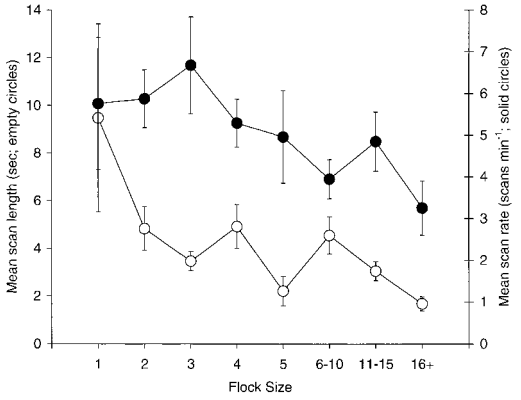


FIGURE 4. Mean length (sec) of an individual's vigilant scans (empty circles), and mean scan rate (scans $min^{-1}$; solid circles) in flocks of differing sizes. Vertical lines represent ± SE of the mean.

feeding groups, usually of five birds or fewer (4.8 ± 0.3, median = 4). Of the 300 flocks observed, 81 (27.0%) contained more than 5 birds, but only 29 (9.7%) were larger than 10 birds. The largest group seen consisted of 31 birds feeding on carpetweed (*Mollugo* sp.) seeds in October 1998. The largest mean flock sizes were recorded for October through January (Fig. 3), with a significant decrease in the number of birds feeding together in late winter ($\chi^2_{10} = 30.5$, $P < 0.01$). By February, smaller flocks were seen, usually consisting of one or two pairs of birds. The mean flock size of 3.0 ± 0.4 calculated for May was the lowest of any month. This time of year coincided with the period when parakeets were most actively attending to their nests. In July and August, several of the observed flocks appeared to consist of a pair of birds accompanied by one to three juveniles begging for food.

The number of flocks seen per hour of observer effort each month was relatively constant, whereas the number of birds seen per hour decreased from October to May, approximately coinciding with the pattern for average monthly flock size (Fig. 3).

## PATTERNS OF VIGILANCE

Individual vigilance behavior was recorded for 79 birds from 46 flocks. Mean scan length differed significantly across flock sizes ($\chi^2_7 = 25.5$, $P < 0.001$) and decreased with increasing flock size ($r_s = -0.79$, $P < 0.05$; Fig. 4). Mean scan rate (scans $min^{-1}$) also decreased with flock size ($r_s = -0.88$, $P < 0.01$), but the differences in scan rate across flock sizes were not significant ($\chi^2_7 = 10.9$, $P = 0.14$; Fig. 4).

The decrease in the mean vigilance effort of individuals with flock size was matched by a decrease in corporate vigilance effort ($r_s = -0.91$, $P < 0.01$), or the instantaneous percentage of vigilant birds in a foraging group (Fig. 5). Differences in corporate vigilance among flock sizes were significant ($\chi^2_7 = 17.3$, $P < 0.05$). Corporate vigilance behavior was record-

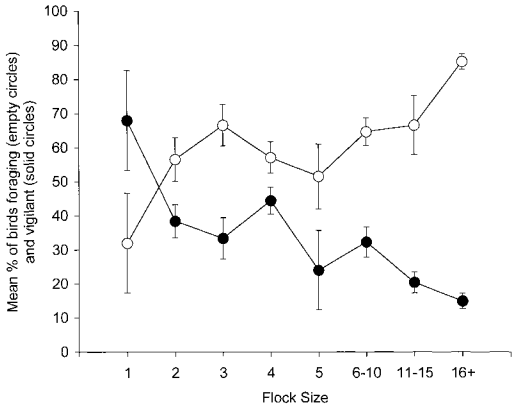


FIGURE 5. Mean instantaneous percentage of vigilant (solid circles) and foraging (empty circles) individuals in flocks of differing sizes. Vertical lines represent ± SE of the mean.

ed for 63 flocks of foraging birds. The mean percentage of birds in these flocks that were foraging increased with flock size ($r_s = 0.72$, $P < 0.01$), but the differences in percentages across flock sizes were not significant ($\chi^2_7 = 13.2$, $P = 0.07$; Fig. 5).

We often observed that all parakeets in a foraging flock would raise their head and scan for up to several minutes after detecting a potential predator. Vocalizations or the appearance of groups of American Crows (*Corvus brachyrhynchos*) most often caused such an increase in vigilance. On five occasions from August to October 1998, Red-tailed Hawks (*Buteo jamaicensis*) caused groups of foraging Monk Parakeets to sound alarm calls (Martella and Bucher 1990) and either fly to a higher perch or form large flocks in the air. Such flocks circled high over the foraging site for several minutes until the hawk had passed. A passing Cooper's Hawk (*Accipiter cooperii*) also elicited this same evasive behavior in October 1998.

## DISCUSSION

The diet of Monk Parakeets in Chicago changed frequently during this study, presumably in response to the availability of different food items (Cannon 1981). Parakeets successfully exploited a large variety of native and introduced plants and readily survived on a diet consisting solely of birdseed in the winter, results that correspond to observations in Hyman and Pruett-Jones (1995). The high adaptability of the Monk Parakeet's diet, as well as its capacity to utilize a wide variety of nesting substrates (Hyman and Pruett-Jones 1995), may help explain the persistence of this species in a variety of conditions outside of its native range. Monk Parakeets exhibit many additional characteristics of successful invading species, including a large native range (Spreyer and Bucher 1998), broad diet, gregariousness, and an association with humans (Ehrlich 1989). Parrots also generally have a relatively large forebrain, which may be associated with a high degree of behavioral flexibility and capacity for foraging innovations (Lefebvre et al. 1998). The observation that Monk Parakeets in Chicago readily adapt to a diet of seed obtained almost exclusively from artificial feeding stations during the winter suggests that they are adept are foraging innovations, which may contribute to their success in new environments (D. Sol, pers. comm.).

Although Monk Parakeets have not been shown to be a threat to agriculture in the United States (Spreyer and Bucher 1998), the potential for damage exists if large populations occur near grain fields or fruit crops, as has happened in South America (Bucher 1992). Dahlem (1994) found that wheat and cultivated corn made up 10 and 54% of the diet, respectively, of Monk Parakeets nesting in close proximity to agricultural fields in Brazil. In Florida, naturalized Monk Parakeets have been observed feeding on non-native tropical fruit crops such as lychee, black sapote, and mango (A. Van Doorn, unpubl. data). During that study, parakeets were observed wasting large amounts of fruit by taking only a few bites before dropping a fruit to the ground, which might exacerbate agricultural damage. It remains to be seen whether availability of birdseed provided by humans limits the dispersal of Monk Parakeets into more sparsely populated agricultural areas in the midwestern United States, thereby limiting the potential for crop damage by parakeets.

Monk Parakeets are gregarious and often form large flocks when feeding. It is likely that seasonal changes in flock size are due to a number of factors. Gilardi and Munn (1998) found that Neotropical parrots dwelling in dense, humid forests exhibited relatively small flock sizes in the nonbreeding season, supporting the aridity hypothesis proffered by Cannon (1984). Monk Parakeets inhabit open and moderately dry habitat in Chicago and exhibit larger flock sizes in autumn and winter, when food resources are assumed to be less abundant. A seasonal change in foraging group size, as documented here, also has been noted for naturalized Mitred Parakeets (*Aratinga mitrata*) inhabiting arid, open areas in southern California (Collins and Kares 1997), and for mixed-species flocks of Neotropical parrots in Costa Rica (Chapman et al. 1989).

Formation of larger flocks when resources are scarce or widely dispersed may be important to survivorship in Monk Parakeets, especially juveniles during their first autumn and winter. Individuals in flocks would presumably learn the location of food sources more rapidly than they would if they foraged alone (Cannon 1984). However, competition and the limited amount of most food items eventually constrain flock sizes (Pulliam and Caraco 1984). We observed intense competition between Monk Parakeets in flocks for perches at backyard feeding stations during

the winter. The high nutritional value of foods eaten at certain times during the year, such as birdseed rich in oils, also may limit the individual benefit of larger flock sizes (Pulliam and Caraco 1984).

The risk of predation also may significantly influence the flock size of foraging Monk Parakeets. Westcott and Cockburn (1988) hypothesized that Australian parrots join flocks to minimize risk of predation, and that resource utilization has only minor influence. Monk Parakeets spend a significant amount of time scanning for potential predators while foraging. Our results indicate that individuals can significantly decrease their vigilance effort by joining a flock and thus devote more time to other activities, especially foraging. When more eyes are available to scan and detect predators, the likelihood of escape is increased (Pulliam and Caraco 1984). Charnov and Krebs (1975) suggested that this benefit is even greater for species that sound an alarm call when a predator is detected. Monk Parakeets are known to sound their alarm call in response to potential predators (Martella and Bucher 1990), and we also observed this behavior on several occasions during this study. Flocking by parakeets results in a reduction of an individual's vigilance effort, but it is unknown whether the risk of predation influences flock size more than resource availability. Spreyer and Bucher (1998) reported that Monk Parakeets at foraging areas in Argentina exhibit behaviors suggestive of a sentinel system, but we did not observe such behavior in our study.

Flocking by parrots while feeding is likely due to a complex set of ecological factors (Pulliam and Caraco 1984). Our results suggest that predator avoidance and exploitation of heterogeneous food resources both may influence size of foraging groups in Monk Parakeets in Chicago. These results invite further studies on the ecological factors influencing flock size in parrots. Future studies of Monk Parakeets might examine the role that communal roosting plays in the daily movements of individuals and flocks (Chapman et al. 1989, Mabb 1997). Radio telemetry studies of home range and foraging in Monk Parakeets also are needed.

The Monk Parakeet is likely to continue its population increase in North America (Pruett-Jones and Tarvin 1998) and elsewhere. It is a highly gregarious and social species, and appears to exhibit considerable flexibility in its behavior. As we have documented here, it also has an almost catholic vegetarian diet, and one that is highly adaptable to an urban landscape. Such a diet likely facilitates the range expansion and population increase of this species.

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