

SHORT COMMUNICATIONS

Exponential population growth of Monk Parakeets in the United States.—In the United States, at least nine species of introduced parrots now have established breeding populations (Lever 1987). The most abundant of these is the Monk Parakeet (*Myiopsitta monachus*). The exact date at which Monk Parakeets established breeding colonies in the United States is unclear because of uncertainty over when and where birds were released or escaped. The first confirmed sighting was in 1967 in New York City (Lever 1987), and the species was breeding there shortly thereafter (Bull 1973). By the early 1970s, the species was so widespread that the United States Fish and Wildlife Service (USFWS) initiated a control and removal program on the basis of the species' reputation in South America as an agricultural pest (Bump 1971, Bucher et al. 1992). By 1975, the year this program ended, the population of parakeets had been reduced by approximately one-half (Neidermyer and Hickey 1977). Since then, the numbers of Monk Parakeets have increased and the species has begun a dramatic population expansion to levels far above the pre-control numbers in the early 1970s. In this paper we document and analyze population trends of the Monk Parakeet in the United States from 1972 to the present.

Methods.—We summarized Christmas Bird Count (CBC) records published in "American Birds" (now "Field Notes"), personal communications solicited from bird watchers and ornithologists, and a continuing study of Monk Parakeets in Hyde Park, Chicago, that was initiated in 1992 (Hyman and Pruett-Jones 1995, Van Bael and Pruett-Jones pers. obs.).

We summarized CBC records from the 1971–1972 count to the 1994–1995 count. In examining these data for the 1972–1973, 1981–1982, 1986–1987, 1992–1993, and 1994–1995 counts, we checked records for every reporting locality in the contiguous United States. For the intervening years, we checked records for every locality within all states that reported at least one Monk Parakeet during at least one of the five counts listed above. For each CBC locality, we noted the total number of birds reported as well as the number of party hours. The regional reports were checked each year. For some years, Monk Parakeets were recorded during the "count week" at a given locality and mentioned in the regional summaries, but no birds were actually observed on the formal count day. In tabulating numbers of individuals recorded, we counted "count week" records as one parakeet at that given locality.

To calculate the rate of population growth, we used the standard equation defining exponential growth $N_{t+1} = N_t e^r$ where N_{t+1} is the population size at time $t+1$, N_t is the population size at time t , r is the rate of population growth, t is the time interval, and e is the natural logarithm base. This equation can be rewritten as $r = (\ln N_{t+1} - \ln N_t)/t$. We calculated r for each one-year time interval beginning in 1975 (the year the USFWS control program ended). A plot of r versus population size indicates whether a population is expanding, declining, or has reached a stable equilibrium size. The equation above defining r can be rewritten as $t = \ln 2/r$ to calculate the time interval for a population to double in size.

Results.—The Monk Parakeet was already widely distributed in the United States by the early 1970s. This appears to have been the result of geographically separated releases and escapes of captive birds (Neidermyer and Hickey 1977). The USFWS control program reduced the population size very successfully. This reduction is indicated both by the published records of the USFWS (Neidermyer and Hickey 1977) and by CBC records. At the start of the control program, birds were reported from 21 localities in seven states on the

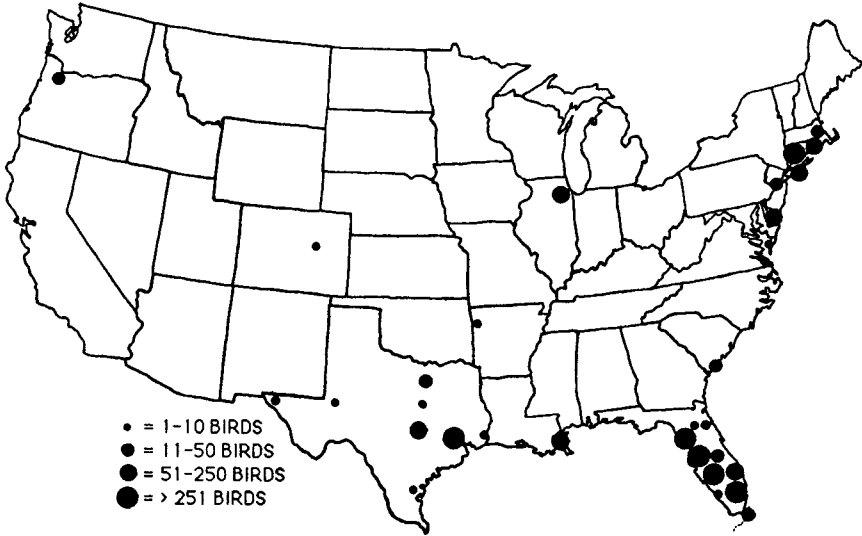


FIG. 1. Distribution and relative abundance of Monk Parakeets in the contiguous United States during the last five years as indicated by records from Christmas Bird Counts and unpublished observations.

1972–1973 CBC. Three years later, this was down to seven localities in five states (1975–1976 CBC).

Since 1975, the number of states and localities at which Monk Parakeets have been reported and the total number of individuals counted have all increased. Over the last five years (since the 1990–1991 CBC), the species has been reported from 76 localities in 15 states (Fig. 1). This includes 62 localities in 13 states from CBC records and regional summaries and an additional 14 localities in two states from personal communications to us from ornithologists. The population increase has been dramatic; on CBCs, 1816 birds were counted in 1994–1995 compared to 33 birds in 1975–1976. Monk Parakeets are not, however, evenly distributed across the United States. Two states, Florida and Texas, accounted for 1463 (80.6%) of the birds recorded on the 1994–1995 count (see Fig. 1).

The increase in numbers of Monk Parakeets fits an exponential model of population growth (Fig. 2). Regression of number of individuals recorded per party hour of effort (\ln) by year from 1975 to 1995 is linear and statistically significant (Fig. 2, $F = 188.94$, $R^2 = 0.908$, $df = 19$, $P = 0.0001$). The average annual rate of population growth (r) equals 14.6% ($N = 19$, range = $-58 - 76\%$), yielding a population doubling time of 4.8 years. A plot of population growth rate as a function of population size (Fig. 3) shows considerable fluctuation, but there is not yet any indication that the population is approaching an equilibrium level. The geographical range of Monk Parakeets has also increased since 1975. A plot of the number of CBC localities (\ln) reporting the species since 1975 is linear and statistically significant ($F = 123.01$, $R^2 = 0.865$, $df = 19$, $P = 0.0001$).

In Hyde Park, Chicago, the population of Monk Parakeets increased from 64 in 1992 to 95 in 1993 (see Hyman and Pruett-Jones 1995). The population was not censused in 1994, but in 1995 we counted a minimum of 85 nesting chambers, indicating a population size of approximately 170 adults. This population has almost tripled in three years.

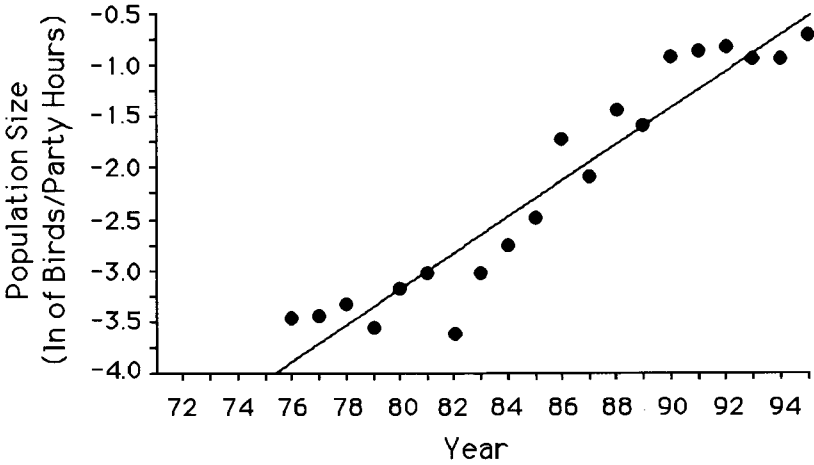


FIG. 2. Regression of total number (ln) of Monk Parakeets recorded on Christmas Bird Counts in the contiguous United States each year since 1975.

Discussion.—Our analysis shows that the Monk Parakeet is currently experiencing exponential growth in both its population size and geographical range in the United States. There is evidence to suggest that this increase is due to reproduction within existing populations rather than an increase in observer effort on CBCs or continued releases. First, the number of states reporting parakeets has remained relatively stable for the last ten years, fluctuating from five to nine. The increase in localities reporting parakeets has come from additional localities in those states already reporting the species. This suggests that the

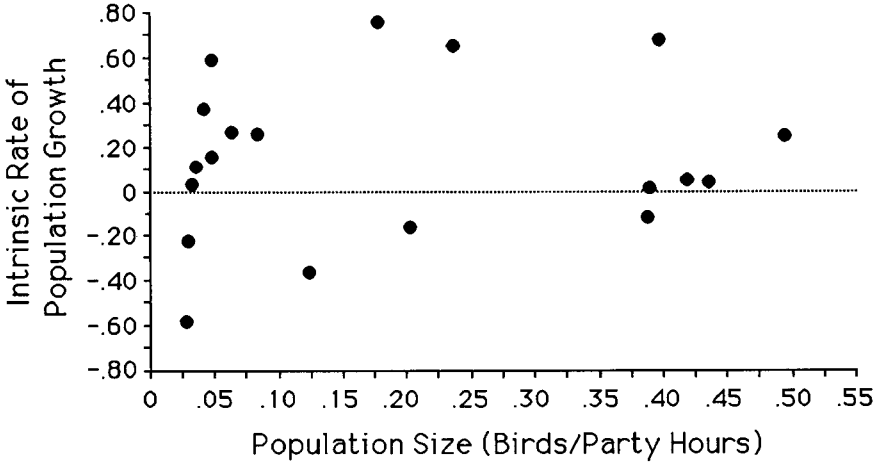


FIG. 3. Plot of annual rate of population growth of Monk Parakeets in the contiguous United States for the period 1975–1994.

populations in those states are increasing and expanding into new areas. Second, of the 1816 individuals counted on the 1994–1995 CBC, 1253 (69%) were in localities which have had populations of Monk Parakeets continuously for the last eight to 10 years. At most of these localities, the numbers of parakeets reported has increased steadily over this time period. Finally, a known population in Hyde Park, Chicago, has experienced a dramatic increase in recent years believed to be entirely due to local production and recruitment of offspring. If other populations of parakeets are as productive as the birds in Hyde Park, Chicago, the nationwide pattern of exponential population growth can easily be explained. Although accidental or purposeful releases of Monk Parakeets probably continue, we consider it unlikely that these contribute to or explain their population growth.

The total population of Monk Parakeets is obviously much larger than indicated by the CBCs. In order to estimate the total population size, we need values of two parameters: the proportion of breeding populations of parakeets that are covered by the CBC count circles and the proportion of birds resident in the count circles that are actually recorded. As indicated in Results, over the last five years, Monk Parakeets have been recorded at 76 localities in 15 states. The CBCs comprised 49 (64.5%) of these localities. We can use this value (0.645) to estimate the proportion of parakeet populations that are covered by the CBCs. The second parameter, the proportion of resident birds that are actually counted is much more difficult to estimate. Unfortunately, there are no CBC localities reporting Monk Parakeets for which separate censuses of parakeets are also available. For example, in Hyde Park, Chicago, our census data are from an area not included in any of the Chicago CBC count circles. Without actual data, we cannot estimate this second parameter. If, hypothetically, the CBCs counted an average of half of the parakeets actually present in any one count circle, we can calculate what we consider to be a very conservative estimate of the total population as $1816/(0.645 \times 0.50) = 5631$. If, in contrast, the CBCs counted only an average of 10% of the parakeets in an area, the estimate would be $1816(0.645 \times 0.10) = 28,155$. The large range in these values illustrates how important census data will be to accurately estimate total population size.

Unless some decision is made to control the population of Monk Parakeets, it seems likely that the species will continue its range expansion and population increase in North America. As indicated by the success of the USFWS control program, the species is relatively easy to control through eradication of birds at their colonial nests. Nevertheless, the social and ethical issues associated with eradicating parakeets have lately proven much more difficult than the practical issues (cf. Temple 1992). In Hyde Park, Chicago, for example, a decision by the United States Dept. of Agriculture in the mid-1980s to remove the birds resulted in the formation of a citizen's action group to protect the parakeets and a threatened lawsuit. At present, it appears that in many areas the novelty of having a resident parrot species and concerns over animal welfare outweigh potential risks of the birds' becoming a threat to agriculture. Because Monk Parakeets may have that potential, continued monitoring of their populations and initiation of more detailed studies seems warranted.

Acknowledgments.—We thank the numerous individuals that shared their observations of Monk Parakeets with us, M. Pruett-Jones, D. Lanning, and two anonymous reviewers for helpful comments on the manuscript, and Dept. of Ecology and Evolution, Univ. of Chicago, and National Science Foundation for support.

LITERATURE CITED

- BUCHER, E. H., L. F. MARTIN, M. B. MARTELLA, AND J. L. NAVARRO. 1992. Social behaviour and population dynamics of the Monk Parakeet. Proc. 20th Int. Ornithol. Congress. Christchurch, New Zealand, pp. 681–689.
- BULL, J. 1973. Exotic birds in the New York City area. *Wilson Bull.* 85:501–505.

- BUMP, G. 1971. The South American Monk, Quaker, or Gray-headed Parakeet. U.S. Fish and Wildl. Serv., Special Sci. Rep.-Wild. No. 136.
- HYMAN, J. AND S. PRUETT-JONES. 1995. Natural history of the Monk Parakeet in Hyde Park, Chicago. *Wilson Bull.* 107:510–517.
- LEVER, C. 1987. Naturalized birds of the world. Longman Scientific & Technical, London, England.
- NEIDERMYER, W. J. AND J. J. HICKEY. 1977. The Monk Parakeet in the United States, 1970–1975. *Am. Birds* 31:273–278.
- TEMPLE, S. A. 1992. Exotic birds: A growing problem with no easy solution. *Auk* 109: 395–397.

SUNSHINE VAN BAEL AND STEPHEN PRUETT-JONES, *Dept. of Ecology and Evolution, Univ. of Chicago, 1101 East 57th St., Chicago, Illinois 60637* (address correspondence to SP-J). Received 27 Sept. 1995, accepted 10 Feb. 1996.

Wilson Bull., 108(3), 1996, pp. 588–591

Forest gap use by breeding Black-throated Green Warblers.—Habitat heterogeneity results from environmental gradients and disturbances that create spatiotemporal patchiness (White and Pickett 1985). Fine-grained patchiness resulting from forest gaps is a condition common in temperate forests (Blake and Hoppes 1986) and is typically caused by one to several tree-falls or tree death (snag) ranging in area from 0.0025 ha to about 0.1 ha (see Lorimer 1989). The resulting heterogeneity represents a habitat mosaic important to many species.

While collecting data on the foraging behavior of Black-throated Green Warblers (*Dendroica virens*) along the northern shoreline of Lake Huron in Michigan's eastern Upper Peninsula, we quantified breeding bird use of forest gaps. Data were collected from 14 June through 19 July 1994. Transects were established parallel to the Lake Huron shoreline at distances of 0.4 km (0.25 mile), 0.8 km (0.5 mile), 1.6 km (1.0 mile) and 3.2 km (2.0 mile). Observers followed these transects for a distance of 6.4 km (4.0 mile), collecting observations on males (and females if possible) at each established territory (determined by the presence of a singing male). Because birds were territorial, only one observation per sex was made at any location. A minimum distance of 100 meters between observations was established to ensure the independence of data collected (Heijl and Verner 1990).

We used Brokaw's definition of a forest gap—a hole (minimum of 5 m in diameter) in the forest canopy extending through all levels down to an average height of two meters above ground (Brokaw 1982). A bird was considered to be using a gap if it was observed foraging or singing within 1 m of the canopy edge. We did not count transients—birds flying through the gap or otherwise obviously not using the gap to obtain food or as a territorial boundary.

Forest vegetation in the study area consisted of a mixture of conifers including balsam fir (*Abies balsamea*), northern white cedar (*Thuja occidentalis*), white spruce (*Picea glauca*), eastern white pine (*Pinus strobus*) and deciduous species including paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*) and red maple (*Acer rubrum*). Mature canopy was approximately 13.5 m with an understory principally of balsam fir and white spruce.

Observations within 50 m of roads, open fields or the Lake Huron shoreline were not