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SYNANTHROPY AND POPULATION GROWTH IN SOUTH FLORIDA'S EXOTIC MITRED PARAKEET (*Psittacara mitrata*)

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Abstract.—Since the introduction of cliff-nesting Mitred Parakeets (*Psittacara mitrata*) to Miami-Dade County, they have steadily increased their population and range and nest solely on anthropogenic structures, forming a synanthropic relationship with humans. We examined their population growth since 2004 using data from the Cornell Lab of Ornithology's eBird project and the National Audubon Society's Christmas Bird Counts. Our results from both datasets indicate continued population growth. We conclude their success is in part due to a well-studied colonization process by which the colonizer uses a similar niche in its new environment with few competitors—in this case by using building cavities instead of cliffs, a nesting strategy not shared by other exotic parrots in the area.

Key words: exotics, Florida, parrots, synanthropy

For species that colonize new territories, the ability to adapt defines their success or failure. Within this framework birds prove to be ideal model organisms in studying adaptation, both as natural colonizers and as introduced species (Diamond 1970, Marlzuff et al. 2001). Islands (including urban islands) offer a case in which a colonizing species can establish itself by occupying its prior niche in the new environment without competition (Sax and Brown 2000). In the case of urban islands, when an invasive species benefits from a commensal relationship from humans, it is known as synanthropy (Tomialojć 2017).

The most successful invasive species are often associated with human habitation in their native range (Tomialojć 2017). This hypothesized long-term association with humans is not a prerequisite for synanthropic adaptation: in South Florida the introduced Mitred Parakeet (*Psittacara mitrata*) offers a notable exception. They tolerate the presence of humans in their native range of western South America but are not associated with them, living primarily in semi-arid montane regions (O'Neill 1982, Waring 1997). Although a few have been noted to nest in tree cavities, the Bolivian and Peruvian populations nest strictly on cliffs (Fjeldså and Krabbe 1990, Silva 1993).

Pranty and Garrett (2003) noted that the pet trade imported 140,000 Mitred Parakeets from 1981 to 1990, including 35,000 from the cliff-dwelling Bolivian population. Their subsequent release or escape

from captivity resulted in breeding populations in Hawaii, California, and Florida. The Hawaiian population has since been the subject of systematic eradication because they were outcompeting native species (Runde et al. 2007, Radford and Penniman 2014). Although the California population is estimated to be >1,000 individuals, only South Florida's population shows a consistently increasing number of individuals within a small area (Butler 2005, National Audubon Society 2019, eBird Basic Dataset 2020). Unlike Red-masked Parakeets (*Psittacara erythrogenys*), which have a stable population in the Miami and Fort Lauderdale area (Chatfield-Taylor and Epps 2020), Mitred Parakeets are experiencing consistent growth. The dichotomy between these two population trends deserves investigation. We propose that the steady population increase in Mitred Parakeets is in part due to their ability to exploit buildings as an anthropogenic substitute for their native cliff-nesting niche, demonstrating a case of colonization as described by Sax and Brown (2000) and representing a classic synanthropic relationship (Tomialojć 2017).

Methods

Data collection.—We obtained data on distribution, counts, and nesting observations from 2004 to 2019 from the eBird basic dataset (2020), the National Audubon Society (2019) Christmas Bird Counts (CBC), Diamond and Ross (2019), personal observations and unpublished data by the senior author, and personal communications from local birding guides Larry Manfredi and Paul Bithorn. The CBC data incorporates data from three count circles (Kendall, Fort Lauderdale, and Dade County) and provides a consistent means of tracking exotic species, including parrots (Runde et al. 2007, Chatfield-Taylor and Epps 2020). Uehling et al. (2019) used eBird data to monitor multiple exotic parrot species in the United States. We restricted the use of eBird and CBC data for statistical purposes to after 2004 because of the difficulty in identifying *Psittacara* species prior to their wider inclusion in field guides in the early 2000s. We recorded all observation of nesting and associated notes (where applicable) separately.

Data correction and population trends.—Chatfield-Taylor and Epps (2020) studied trends in South Florida's Red-masked Parakeet population and found that from 2004 to 2018 yearly individual high counts from the eBird Basic Dataset (2020) did not differ significantly from total CBC counts (unpublished data). We concluded that the CBC data did not need to be normalized for the party hours spent in the circles. We repeat this approach, comparing the yearly high counts in the eBird Basic Dataset (2020) to the CBC counts from 2004 to 2019 (Table 1). We compared means using a two-sample *t*-test.

With *a priori* knowledge that single point counts in eBird data and personal observations are not affected by effort, we plotted both the yearly eBird high counts and CBC data against time to visualize population trends. We conducted all statistics in R (R Foundation for Statistical Computing, Vienna, Austria) using the car package (Fox and Weisberg 2019).

Results

Nesting records.—Personal observations, communications, and the eBird Basic Dataset (2020) provided 12 specific observations of nesting

Table 1. Yearly high counts of Mitred Parakeets in South Florida from single observations in eBird and compiled Christmas Bird Count (CBC) data.

Year	Single observation eBird high count	CBC count	Location	County	Date
2004	50	120	Kendall	Miami-Dade	13 Apr 2004
2005	50	24	Miami Springs	Miami-Dade	27 Jul 2005
2006	30	211	Kendall	Miami-Dade	12 Nov 2006
2007	105	370	Kendall Baptist Hospital	Miami-Dade	22 Nov 2007
2008	200	309	Kendall	Miami-Dade	3 Jan 2008
2009	70	378	Kendall Baptist Hospital	Miami-Dade	5 Dec 2009
2010	100	319	Kendall Baptist Hospital	Miami-Dade	11 Jan 2010
2011	200	156	Datran Drive and US 1	Miami-Dade	18 Feb 2011
2012	205	273	Datran Drive and US 1	Miami-Dade	3 May 2012
2013	260	273	Datran Drive and US 1	Miami-Dade	6 Feb 2013
2014	373	484	Dadeland Mall	Miami-Dade	27 Dec 2014
2015	285	640	King Creek Greenway Area	Miami-Dade	26 Dec 2015
2016	400	573	Datran Drive and US 1	Miami-Dade	20 Jan 2016
2017	515	671	Dadeland Mall	Miami-Dade	21 Jan 2017
2018	200	320	Guitar Center, Kendall Drive	Miami-Dade	31 Dec 2018
2019	225	423	Dadeland Mall	Miami-Dade	21 Dec 2019

Mitred Parakeet, including an observation as recent as February 2020 (Table 2). Juvenile and immature birds were regularly observed. Unlike Red-masked Parakeet, Mitred Parakeets are not flagged in eBird and do not require notes when reported. This is likely responsible for the lack of nesting data in eBird, despite a conservative estimate of 4 times the number Mitred Parakeets than Red-masked Parakeets (National Audubon Society 2019, Chatfield-Taylor and Epps 2020, eBird Basic Dataset 2020)

Three specific locations (Dadeland Mall, the Fair Haven Center, and the Kendall Baptist Hospital) have generally unreported but consistently observed nesting for 10, 20, and 22 years, respectively (eBird Basic Dataset 2020; P. Bithorn, Paul Bithorn's Birding Tours, pers. comm.; L. Manfredi, Larry Manfredi Birding Tours, pers. comm.). All observations of nesting were on various anthropogenic structures. A detailed survey of cavity nesting species in Miami-Dade County by Diamond and Ross (2019) did not detect Mitred Parakeet, though they did report the birds nesting on an apartment building.

Data correction and post hoc analysis.—The results of the comparison between the average eBird high count data and the CBC counts was statistically significant ($t = 2.49$, $P = 0.02$), indicating that they were not equal. However, when the two datasets are plotted against time, they show a similar pattern of growth (Fig. 1). This could indicate that although the count numbers are different, the population trend may be the same. We conducted a *post hoc* analysis to determine if this is the case. Using the interaction term from a two-way analysis of variance, we found that the slopes were homogeneous ($F = 0.24$, $P = 0.63$), indicating that the eBird data showed the same population trend as the CBCs. We therefore used the CBC data uncorrected for effort.

Discussion

Since 2004, the Mitred Parakeet population has consistently grown, with 120 counted on the 2004 CBCs and a high of 671 on the 2017 CBCs, a pattern corroborated by eBird data (Fig. 1). This may indicate that there are few limiting resources for this species within the South Florida urban landscape, specifically nesting sites. Fjeldså and Krabbe (1990) and Silva (1993) both noted that Mitred Parakeets nest in cliff cavities in their native range and the evidence indicates that when introduced to South Florida they adapted to nesting in building cavities. They have bred for 20 years in cavities in the Fair Havens Center and the Kendall Baptist Hospital and records exist of breeding in other buildings throughout Miami-Dade and Broward County (Table 2), but an exhaustive survey of cavity nesting birds by Diamond and Ross (2019) did not find any nesting in natural cavities (though they found 3 other species of parrot).

Table 2. Location of nesting records of Mitred Parakeets in South Florida from 1998 to 2020 and literature sources.

Locality	County	Date	Comments[a]
Kendall Baptist Hospital	Miami-Dade	1998–2019	Approximate range of nesting at this location.*
Fair Haven Center	Miami-Dade	1999–2019	Nesting in the terra cotta scuppers [of the nursing home].*
Prudential Building: Las Olas Boulevard and NE 9th Avenue	Broward	5 Aug 1999	Learned that they nest in the attic of the Prudential Building. There are holes in the wooden eaves.†
Prudential Building: Las Olas Boulevard and NE 9th Avenue	Broward	11 Jan 2000	Saw several using nest holes in the eaves of the Prudential Building.†
Dadeland Mall	Miami-Dade	2001–2018	Approximate date of first nesting at this location.*
Prudential Building: Las Olas Boulevard and NE 9th Avenue	Broward	29 Feb 2002	Several pairs at the nest holes in the Prudential Building.†
Law Office in 500 block of SE 7th Avenue	Broward	20 May 2002	A pair with 2(?) juveniles at a nest. The nest is in the vent to the crawl space in a law office 500 block of SE 7th Avenue. Got pictures of an adult near the nest and an adult feeding a juvenile.†
Rio Vista Health Spa	Broward	1991– 3 Jul 2001	Small flock feeding in a strangler fig in the parking lot of the Rio Vista Health Spa. An employee there told me that the parrots have been nesting in their courtyard for 10 years. She said, they nest in the flues of the chimney. There are now 8 pairs nesting on the property.†
Spanish style home in Broward (possible nesting)	Broward	3 Jul 2001	I [also] saw 2 go into a rainwater runoff (?) at a Spanish style home on the river. Both entered; I don't know if they went through a passage or if there is a cavity there. †

[a]Sources: ‡ = Diamond and Ross (2019); * = personal communications; † = senior author's personal observations; all other records from eBird Basic Dataset (2020).

Table 2. (Continued) Location of nesting records of Mitred Parakeets in South Florida from 1998 to 2020 and literature sources.

Locality	County	Date	Comments[a]
Kings Creek Condominium	Miami-Dade	2 Jul 2003	40+ nesting in eaves and vents of Kings Creek Condominium. Kendall Dr. just W of 826. 79th right from Kendall by Larry Manfredi.*
Kendall Baptist Hospital	Miami-Dade	17 Apr 2010	Nesting on the Baptist Hospital! At least four active nests with the parrots in them.
Dadeland Mall	Miami-Dade	29 Oct 2011	Big roosting site for over a decade for this species, which nests inside buildings instead of natural tree cavities.
Kendall Baptist Hospital	Miami-Dade	26 Nov 2015	Hanging from dangling fixtures just below roof line on north face of hospital at west end of the visitor parking lot. Two adults perched with one immature occasionally peeking out from cavity. Green-bodied with mottled red facial markings and lack of red.
Miami	Miami-Dade	2019	...during our searches we found a large nesting colony of Mitred Parakeets (*Psittacara mitrata*) nesting in the roof of an apartment building.‡
Kings Creek Shopping Center	Miami-Dade	7 Feb 2020	Going in and out of the soffit.*

[a]Sources: ‡ = Diamond and Ross (2019); * = personal communications; † = senior author's personal observations; all other records from eBird Basic Dataset (2020).

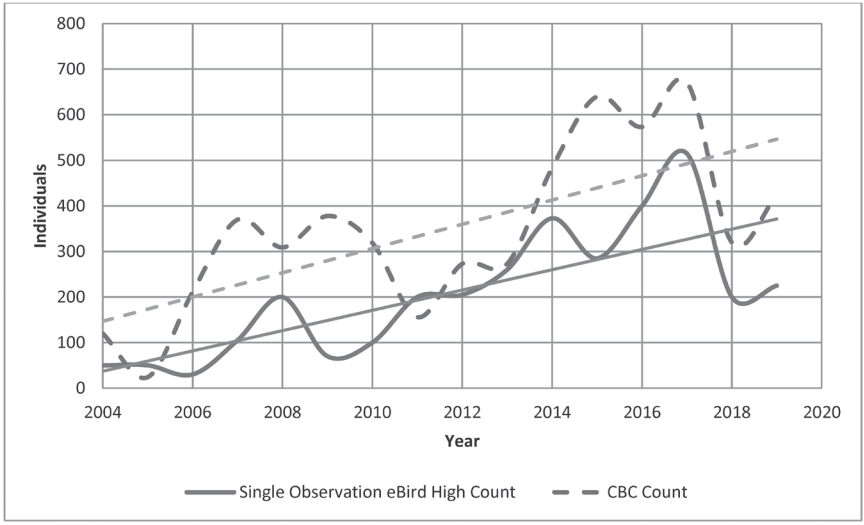

Figure 1. Population trends of Mitred Parakeet in South Florida over time from eBird Data and the Dade County, Fort Lauderdale, and Kendall, Florida Christmas Bird Count (CBC), "uncorrected for effort and fitted with trend lines.

The colonization of Miami and Fort Lauderdale by Mitred Parakeets appears to follow the model presented by Sax and Brown (2000) in which the urban setting formed a likely anthropogenic substitute for their native cliff-nesting niche. Successful island colonization postulates a necessary lack of competition in the colonizer's new niche from existing species (Sax and Brown 2000). The data indicate that this holds true for Mitred Parakeet; the remaining exotic parrot species nest in natural cavities (with the exception of the nest-building Monk Parakeet [*Myiopsitta monachus*]; Pranty and Epps 2002, Diamond and Ross 2019). Future study is needed to determine if Mitred Parakeets face competition from other synanthropic species such as Rock Pigeon (*Columba livia*).

Potential checks on continued population growth for many species include limited food sources, human efforts to discourage nesting, and the exotic parrot trade (Newton 1980, L. Manfredi, pers. comm.; S. Epps, pers. obs.). Although certain species in Florida such as Snail Kites (*Rostrhamus sociabilis*) are restricted to a narrow dietary range (Sykes 1987), the senior author documented Mitred Parakeet feeding on 34 native and introduced plant species in Florida (Table 3). The staff at Baptist Hospital used sheet metal to cover cavities but only had marginal success in curbing breeding and the site is still active; conversely, some buildings in Broward County had cavities enlarged by the parakeets, making nesting easier (L. Manfredi, pers. comm.).

Table 3. Documented food sources of Mitred Parakeets in South Florida.

Common name	Scientific name
Australian pine	*Casuarina equisetifolia*
Bald cypress	*Taxodium distichum*
Ball moss	*Tillandsia recuruata*
Banyan	*Ficus* spp.
Black olive	*Bucida buceras*
Brazilian pepper	*Schinus terebinthifolius*
Camphor	*Cinnamomum camphora*
Coconut palm	*Cocos nucifera*
Common guava	*Psidium guajava*
Eucalyptus	*Eucalyptus* spp.
Gumbo limbo	*Bursera simaruba*
Japanese magnolia	*Magnolia liliiflora*
Juniper	*Juniperus* spp.
Laurel fig	*Ficus nitida retusa*
Java plum	*Syzgium cuminii*
Live oak	*Quercus virginiana*
Loquat	*Eriobotrya japonica*
Lychee	*Litchi chinensis*
Magnolia	*Magnolia grandiflora*
Mahogany	*Swietenia mahagoni*
Mango	*Mangifera indica*
Mimosa	*Albizia julibrissan*
Mountain apple	*Syzgium malaccense*
Papaya	*Carica papaya*
Persimmon	*Diospyros* spp.
Red ironbark	*Eucalyptus sideroxylon var. rosea*
Rose apple	*Syzgium jambos*
Royal palm	*Roystonea elata*
Royal poinciana	*Delonix regia*
Sea grape	*Coccoloba uvifera*
Shortleaf fig	*Ficus citrifolia*
Strangler fig	*Ficus aurea*
Strawberry guava	*Psidium cattleianum*
Woman's tongue	*Albizia lebbeck*

Although no data exists on the continued release and escape of captive birds, the number of releases is likely far exceeded by those trapped for the exotic parrot trade (S. Epps. pers. obs.).

Since their first observation in 1987, Mitred Parakeets have colonized the urban islands of Broward and Miami-Dade Counties as defined by Sax and Brown (2000), forming a synanthropic relationship. Like the Italian population of Rose-ringed Parakeet (*Psittacula krameri*), we expect continued urbanization to reinforce and increase Mitred Parakeet numbers as they exploit an abundance of nesting sites and food sources (Battisti and Dodaro 2016). Although human

efforts to discourage nesting and the effects of active trapping may slow population growth, they are unlikely to have a significant effect on the overall trend.

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