



Military Macaw in Sierra de Huautla, Morelos, Mexico

Guacamaya verde en la Sierra de Huautla, Morelos, México

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Abstract

The Military Macaw (*Ara militaris*) is not considered within the avifauna of Morelos due to a lack of solid evidence confirming the presence of the species in the state. We conducted systematic surveys from elevated viewpoints in the tropical dry forest of the Sierra de Huautla Biosphere Reserve from August to December 2017 and 2020-2022 to confirm the presence of the Military Macaw in the reserve. We obtained 36 records of the Military Macaw, with photographic evidence, and observed a mean of 10.0 ± 11.2 macaws per record, registering flocks of 32-39 individuals on three occasions. We identified sites within the reserve that Military Macaws recurrently used for resting, foraging, and roosting. We also observed macaws foraging in three tree species, with another six plant species reported in the diet by local people. We could not confirm nesting by macaws in the reserve as observations were conducted outside the breeding season. Some sightings occurred outside the biosphere reserve, in an area of the Mixteca Baja Poblana (Puebla) proposed as a new protected area. Our findings provide the first systematic and photographic evidence of the presence of the Military Macaw in Morelos state, confirm the relevance and effectivity of the Sierra de Huautla Biosphere Reserve for regional conservation of the species and the tropical dry forest, and provide additional support for the proposal to create a new protected area and conservation corridor in the Balsas Basin that could benefit the conservation of this endangered bird species.

Keywords: *Ara militaris*; Biosphere Reserve; protected area conservation; endangered species; Psittacidae; tropical dry forest.

Resumen

La Guacamaya Verde (*Ara militaris*) no se considera dentro de la avifauna de Morelos debido a la falta de evidencia sólida que confirme presencia de la especie en el estado. Realizamos censos

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sistemáticos, desde puntos de observación elevados, en el bosque tropical seco de la Reserva de la Biosfera Sierra de Huautla, Morelos, durante los meses de agosto a diciembre de 2017 y 2020-2022, para confirmar la presencia de la Guacamaya Verde en la reserva. Obtuvimos 36 registros de Guacamaya Verde, con evidencia fotográfica, y observamos un promedio de 10.0 ± 11.2 guacamayas por registro, registrando bandadas de 32-39 individuos en tres ocasiones. Identificamos sitios dentro de la reserva que fueron utilizados recurrentemente por la especie para descansar, alimentarse y posarse. También observamos individuos de Guacamaya Verde alimentándose de tres especies de árboles, y la población local informó sobre otras 6 especies de plantas en la dieta. No pudimos confirmar la anidación de la especie en la reserva ya que las observaciones se realizaron fuera de la temporada de reproducción. Algunos avistamientos se produjeron fuera de la reserva de la biosfera, en una zona de la Mixteca Baja Poblana (Puebla) que ha sido propuesta como nueva área protegida. Nuestros hallazgos proporcionan la primera evidencia sistemática y fotográfica de la presencia de la Guacamaya Verde en el estado de Morelos, confirman la relevancia y efectividad de la Reserva de la Biosfera Sierra de Huautla para la conservación regional de la especie y del bosque tropical seco y brindan apoyo adicional a la propuesta para crear una nueva área protegida y corredor de conservación en la Cuenca del Balsas, en beneficio de la conservación de esta especie de ave amenazada.

Palabras clave: *Ara militaris*; conservación de Área Natural Protegida; especie en peligro; Reserva de Biosfera; Psittacidae; bosque tropical seco.

Introduction

The historical distribution of the Military Macaw (*Ara militaris*) in Mexico extended on the Pacific side from southern Sonora along the Sierra Madre Occidental to portions of the lowlands of Oaxaca and Chiapas (Álvarez del Toro 1980, Binford 1989) and along the Gulf of Mexico from eastern Nuevo León state to northeastern Querétaro (Howell and Webb 1995). The species has been observed from sea level to 2,500 masl predominantly in lowland semi-deciduous forests and on slopes with Pine-Oak forests (Iñigo-Elias 1999, Rivera-Ortíz et al. 2007, 2008).

Internationally, the Military Macaw is considered vulnerable, with declining populations

of fewer than 7,000 mature individuals (Birdlife International 2020). It is included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2013). In Mexico, the Military Macaw is considered an endangered species (SEMARNAT 2010), and a priority species for conservation action (SEMARNAT-CONANP 2012).

In Morelos, Mexico, the possible presence of the Military Macaw has been inferred based on reports made by inhabitants of some rural communities. In 1999, in northwestern Morelos, six individuals of the species were reported, but with no confirmed evidence, by local inhabitants near the town of Tetlama, and individuals were also reported, possibly nesting, near the town of Cuentepec (Urbina-Torres et al. 2009). Furthermore, 14 Military Macaws were reported to have escaped from a zoo in the town of Tepoztlán and were later observed frequently in the surroundings of the towns of Tepoztlán and Amatlán (Urbina-Torres et al. 2009). In the southern area of the state, there have been scattered reports of informal sightings (without confirming evidence) made by residents in the last 15 years (CONANP 2005, Urbina-Torres 2017).

Nonetheless, Morelos was not included in the Action Program for the Conservation of the Military Macaw (SEMARNAT-CONANP 2012) as part of the historical or current distribution of the species in Mexico. The species is also not considered as present in Morelos in the comprehensive book on the birds of Morelos written by Gaviño de la Torre (2015), maybe because of the lack of solid evidence confirming the presence of the species in Morelos.

Therefore, the present study aimed to obtain the first systematic and photographic evidence of presence of the Military Macaw in Morelos and confirm the species' year-round use of the Sierra de Huautla Biosphere Reserve. We also aimed to provide information on some aspects of the Military Macaw's ecology at the study site.

Methods

We conducted observations within an area of 11 km² (98.997529° -99.025381° W and 18.373383° -18.405017° N) of the Rancho Viejo community lands ('ejido') in the south-central portion of the Sierra de Huautla Biosphere Reserve (6.5 km² within the reserve limits; Fig. 1). This area comprises mainly conserved tropical dry forest (>80% landscape cover) and presents a rugged topography with steep-

sided creeks and ravines. Common plant species at the observation sites include *Bursera copallifera*, *B. aloexylon*, *B. grandiflora*, *Conzattia multiflora*, *Lysiloma divaricata*, *Ficus cotinifolia*, *Jacaratia mexicana*, *Acacia acatlensis*, *Ceiba aesculifolia*, *Pseudobombax ellipticum*, *Cyrtocarpa procera*, *Spondias purpurea*, *Neobuxbaumia mezcalaensis*, *Pachycereus grandis* and *Cephalocereus chrysacanthus*.

From August to December during the years of 2017 and 2020-2022, we carried out between 1 and 4 field trips of 4 days each per year to confirm sightings of Military Macaws. We established 2-3 fixed survey sites each sampling year at a variable number of elevated viewpoints (4-6 each sampling year) located ≤ 600 m from a recent sighting of macaws reported by the inhabitants of Rancho Viejo. On each field trip, we conducted surveys from these elevated viewpoints twice daily, from 06:00 to 11:00 hrs. and 16:00 to 18:00 hrs. We obtained a

total cumulative effort of 142 hours of observation in 22 distinct sampling sessions.

During each survey period, groups of 4-6 people conducted observations to locate, observe, count, and photograph Military Macaws using Vortex binoculars Crossfire 12 x 50, Nikon® brand DSLR cameras, D5100 and D3400 models, as well as an AF-S Nikkor® 200-500mm f / 5.6E ED VR telephoto. Whenever macaws were detected, we recorded the survey point, geographical coordinates, date, time, and number of individuals. We also conducted observations to document behavioral activity (perched on a tree or rocky wall, preening, short flights, or social interactions), and where possible, we recorded plant species used by macaws for perching or foraging.

Furthermore, to obtain information on habitat use by the Military Macaw, we followed the movements of the birds from the moment the individuals were sighted until they left, or were

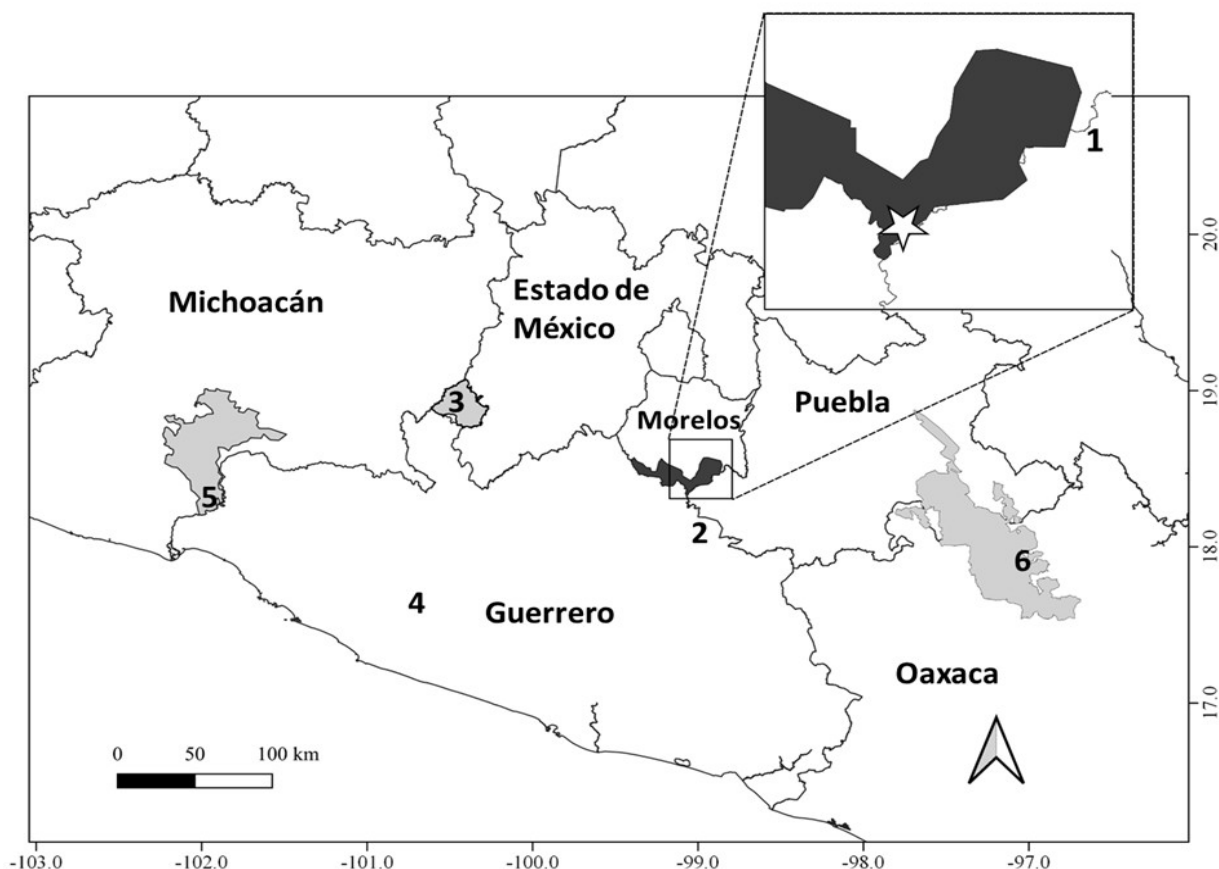


Figure 1. Location of the Sierra de Huautla Biosphere Reserve (black polygon), Morelos, in central Mexico and of the Military Macaw registration points in the reserve (star), and at other sites within the Balsas Basin: 1- Teotlalco, Puebla (Hernández-Castán et al. 2012); 2 - Papalutla, Guerrero (Jiménez-Arcos et al. 2012; Villaseñor and Botello, 2012); 3 - Sierra de Nanchititla, State of Mexico (Urbina-Torres et al. 2012); 4 - Tecpan de Galeana, Guerrero (Almazán-Núñez and Nova-Muñoz, 2006; Blancas-Calva et al. 2016); 5 - Zicuirán Infiernillo Biosphere Reserve, Michoacán (Monterrubio-Rico et al. 2011); 6 - Tehuacán Cuicatlán Biosphere Reserve and surrounding areas, Puebla and Oaxaca (Salazar Torres, 2001; Salazar Torres et al. 2010; Bonilla-Ruz et al. 2007; Rivera-Ortiz et al. 2007).

Table 1. Mean ($\pm$ SD) number of Military Macaws per observation at four sites in the Sierra de Huautla Biosphere Reserve, Morelos, Mexico, by year. Data within parenthesis are range values, and n = number of observations.

Year	Peña de las Guacamayas	El Talarín	Falda del Tzompantle	Las Juntas
2017	7.9 $\pm$ 6.3 (1 – 20, n = 12)	4.3 $\pm$ 2.6 (2 – 7, n = 4)	-	-
2020	12.5 $\pm$ 17.7 (2 – 39, n = 4)	8.7 $\pm$ 6.7 (1 – 13, n = 3)	4.5 $\pm$ 4.9 (1 – 8, n = 2)	2 (n = 1)
2021	34.0 $\pm$ 7.1 (29 – 39, n = 2)	10.3 $\pm$ 11.9 (2 – 24, n = 3)	4.0 $\pm$ 2.8 (2 – 6, n = 2)	14 (n = 1)
2022	20.5 $\pm$ 16.3 (9 – 32, n = 2)	-	-	-



Figure 2. First photographic records of the Military Macaw (*Ara militaris*), obtained between 2017 and 2022 at sites in the ejido of Rancho Viejo, municipality of Tlaquiltenango, Morelos, within the Sierra de Huautla Biosphere Reserve (Photographs by Juan Carlos Martínez-Montes).

lost from sight within surrounding vegetation or when they entered a cavity in the rocky walls. Groups of observers then walked along existing local pathways and streams ('arroyos') around each survey viewpoint to approach sites and trees where macaws had been observed perching to obtain ad hoc observations and geographic coordinates with a GPS. We identified arboreal plant species used by macaws based on photographs of foliage, fruits, or other characteristics. We also identified species by their common name provided by local inhabitants. We confirmed species' scientific names in collaboration with botanists who had previous conducted research in the study area to associate the common name and the photographs with the scientific name of each species. All the observations we gathered were recorded in a database for the species of registration points, number of individuals observed, geographical coordinates, date and time, observed behaviors, and, when possible, the identification of plant species observed at the registration point.

Results

We obtained 36 recorded observations of the Military Macaw, including photographic evidence (Fig. 2). Just under half of the observations (44%) were obtained in 2017, and the rest between 2020 and 2022. We obtained more observations of Military Macaws during the afternoon sampling period (54% of all records) than during the morning (36%), and the remaining 9% of observations were gathered ad hoc between the daily sampling periods.

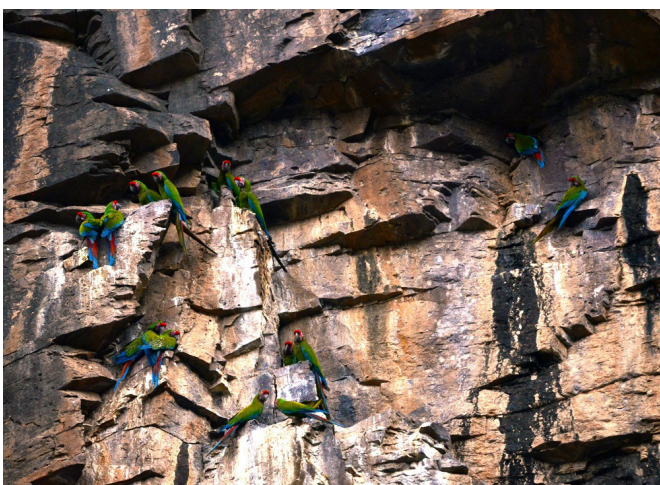


Figure 3. Military Macaw pairs perched on a rock wall at La Peña de las Guacamayas site, within the Sierra de Huautla Biosphere Reserve. Photograph taken on 5 December 2017 by Juan Carlos Martínez-Montes.

We recorded an average number of 10.0 ± 10.6 (SD) Military Macaws per observation (range: 1 - 39 birds; $n = 36$). We counted a total of 39 individuals on two occasions, once in 2020 and again in 2021, and a group of 32 individuals in 2022, all at Peña de las Guacamayas, a vertical rock wall of 50-60 m height and at least 50 m width, used as a resting place by macaws (Fig. 3). On 50% of occasions macaws were only detected flying, for 30% of observations individuals were perched (on trees or rock walls), 12% of observations were of macaws flying and then perching, and on 8% of the 36 records macaws were observed foraging on seeds or fruits.

Our locations of Military Macaws occurred in an altitudinal range of 848 to 1191 m asl. Most of these sighting points (79%) occurred in the ravines along the final sections of two relatively large, temporary streams, Arroyo Atlipa and Arroyo Grande. Arroyo Atlipa drains into Arroyo Grande, leading into the permanent Amacuzac River. Throughout their courses, the streams vary in altitude between 900 and 700 masl and 15 and 25 m in width, with conserved riparian vegetation along both banks that are surrounded by steep mountains (maximum altitude between 1000 and 1380 masl) covered mostly with conserved tropical deciduous forest. All but one of the Military Macaw records were obtained at locations 2.4 - 4.2 km (mean: 3.08 ± 0.60 km, $n = 36$) from the nearest rural town, and 1.0 - 3.1 km (mean: 2.45 ± 0.47 km, $n = 36$) from agricultural land.

We identified four sites recurrently used by Military Macaws (Table 1) for resting, foraging, and roosting, located in places known to the residents of Rancho Viejo as Falda del Tzompantle, Peña de las Guacamayas, Las Juntas, and El Tallarín. These sites were located on very steep slopes (45-70° of inclination) and with rock walls >30 m high. These sites occurred along the ravines of Arroyo Atlipa and Arroyo Grande and were separated by a mean of 1.57 ± 0.63 km (range: 0.60 - 2.48 km). At these sites, macaws perched together in pairs (Fig. 3). It was possible to observe interactions of allopreening or play-fighting between individuals, and macaws were observed entering cavities in the rock wall. This may indicate cavity exploration as part of nesting behavior, as has been suggested by other researchers (Rivera-Ortíz et al. 2016). However, although these interactions were noted frequently, they were not recorded systematically. Therefore, we could not determine whether this cavity exploration

was associated with nesting behavior or obtaining a roosting site.

We observed macaws consuming the seeds or fruits of three tree species: *Acacia acatlensis*, *Bursera copallifera*, and another unidentified species of *Bursera* (Table 2). Local inhabitants also reported that they had seen Military Macaws at these sites consuming fruits and seeds of another six plant species: *Cyrtocarpa procera*, *Ceiba aesculifolia*, *Bursera aloexylon*, *Ficus cotinifolia*, *Spondias purpurea*, and *Vitis spp.* (Table 2). Furthermore, we recorded macaws perched on three tree species: *Conzattia multiflora*, *Bursera copallifera*, and *Acacia acatlensis* (Table 2).

Discussion

Our results show that the Military Macaw is resident or at least has been periodically using isolated areas of the Sierra de Huautla Biosphere Reserve for over six years, confirming presence of the species in this protected area and Morelos. Our highest count of 39 Military Macaws recorded on two occasions is higher than macaw numbers reported for 7 of 16 study sites across Mexico (range 4-215 individuals; Jimenez-Arcos et al. 2012, Monterrubio-Rico et al. 2021) and one of the highest reported for sites in the Cuenca del Río Balsas. This suggests that the Sierra de Huautla reserve may be particularly relevant for

the regional conservation of the Military Macaw in the tropical dry forest of central Mexico.

We also provide evidence that Military Macaws are foraging within the reserve and exploring cavities in cliff faces that may be potential nesting or roosting sites. There is scarce information on plant species used by Military Macaws in Mexico. A total of 86 different species of 60 genera and 30 families are reported to be used/consumed by the Military Macaw at various sites in Mexico (Hernández-Castán et al. 2012, Juárez et al. 2012, Villaseñor and Botello 2012, Flores-López et al. 2020). Of the species reported in the diet of the Military Macaw in Mexico, 31 are also present and abundant in the Sierra de Huautla Biosphere Reserve. For another 31 plant species, the same genera are present in the reserve (CONANP 2005, Dorado 2021, Ramirez-Rodriguez 2021). Our results add one family, three genera, and seven new species to the list of plant species used/consumed by Military Macaws.

We cannot be sure that the Military Macaw is nesting within the Sierra de Huautla Biosphere Reserve. However, this is possible based on our behavioral observations of interactions between adult pairs and cavity exploration activity. Furthermore, a reproductive population of the species has been reported at another site, 40 km from our study site, with similar ecological

Table 2. Plant species observed or reported as used by Military Macaws in the Sierra de Huautla Biosphere Reserve, Morelos, Mexico. * Indicates plant species not previously reported as used by the Military Macaw.

Plant Species	Local name	Part consumed/perched	Record type
Anacardiaceae			
<i>Cyrtocarpa procera</i>	Chupandillo	seed, fruit	Local report
<i>Spondias purpurea</i> *	Ciruelo	seed, fruit	Local report
Burseraceae			
<i>Bursera aloexylon</i> *	Linaloe	seed, fruit	Local report
<i>Bursera copallifera</i> *	Copal	seed, fruit / perched	Direct observation
<i>Bursera sp.</i>	Copal	seed, fruit / perched	Direct observation
Fabaceae			
<i>Acacia acatlensis</i> *	Árbol del Borrego	seed, fruit / perched	Direct observation
<i>Conzattia multiflora</i> *	Guayacán	perched	Direct observation
Malvaceae			
<i>Ceiba aesculifolia</i>	Pochote	seed, fruit	Local report
Moraceae			
<i>Ficus cotinifolia</i> *	Tlaligo	seed, fruit	Local report
Vitaceae			
<i>Vitis sp.</i> *	Uva silvestre	seed, fruit	Local report

conditions (Jiménez-Arcos et al. 2012). Therefore, the population of Military Macaws may be breeding within the Sierra de Huautla reserve. However, some authors consider that the reproductive period of Military Macaw populations in the central region of Mexico is typically observed between March and September (Rivera-Ortíz et al. 2008; Jimenez-Arcos et al. 2012), and although we have nine observations of individuals obtained in August, we could not confirm that they were nesting. Therefore, further sampling is needed between May and September to determine whether the Military Macaw is reproducing within the reserve.

Our confirmation of a population of the Military Macaw in the Sierra de Huautla Biosphere Reserve increases the relevance of this protected area for conserving the tropical dry forest and its associated biological diversity in the Cuenca del Alto Balsas in central Mexico. It adds to evidence of the effectiveness of the reserve in achieving its conservation goals. Recent records document the resurgence of previously extirpated species such as the Collared Peccary (*Dicotyles angulatus*; Mason-Romo et al. 2008), or the first record of the Jaguar (*Panthera onca*) in the reserve (Valenzuela-Galván et al. 2015, 2020). Additionally, a general increase in wildlife populations is reported (Castro-Campos 2016; López-Medellín et al. 2017), as well as high population densities of species such as the White-tailed Deer (*Odocoileus virginianus*) that require well-conserved habitats (Hernández-Silva et al. 2011, Corona et al. 2010). Indeed, the available evidence underscores that the ecosystemic integrity of the Sierra de Huautla reserve remains relatively high and that forest cover of primary vegetation has not only been maintained but has also experienced expansion (https://monitoreo.conabio.gob.mx/i-effectiveness/reports_html/6104.html accessed 25 October 2020; Sorani et al. 2020).

While most of our Military Macaw records were within the biosphere reserve's boundaries, some were obtained outside the reserve, on community lands in Puebla state. Consequently, we emphasize that it is essential to establish a new protected area that will conserve tropical dry forest in the Mixteca Baja Poblana region. Notably, at two sites within the Teotlalco municipality, Puebla, ca. 21 km northeast of our observation sites in the Rancho Viejo community, Hernández-Castán et al. (2012) documented a population of the Military Macaw at 5-6 km from the southeastern limit of the Sierra

de Huautla reserve, documenting flocks of 28 to 44 macaws. Hernández-Castán et al. (2012) consider that the species could reproduce in the area where it can be found between October and November and between May and June. Another close record is that of a reproductive population in Papalutla, Guerrero, nearly 40 km south of the Sierra de Huautla Biosphere Reserve (Jimenez-Arcos et al. 2012, Villaseñor and Botello 2012), where flocks of up to 30 individuals were seen.

For two different species of Macaws in the Amazon basin, it has been noted that individuals can move an average distance of 44 km and up to 151 km between different core areas of their home ranges (Brightsmith et al. 2021). Hence, a segment of a larger Military Macaw population may move among sites observed in the Sierra de Huautla reserve and nearby sites in Puebla or Guerrero (Hernández-Castán et al. 2012, Jiménez-Arcos et al. 2012, Villaseñor and Botello 2012), at less than 40 km from our study site. Such movements could be to establish nesting sites or could be related to seasonal and spatial variation in the availability of food resources, as happens in many species of Psittaciformes that present short or long-distance movements to exploit food resources, particularly in environments with high seasonal variation in food availability (Renton et al. 2015).

At a larger spatial scale, our observations may interconnect sites where Military Macaws have been recorded in the Cuenca del Balsas region. Urbina-Torres et al. (2012) recorded Military Macaws in the Sierra de Nanchititla, Estado de Mexico, about 157 km northwest of the Rancho Viejo area. In Guerrero, in the region of Tecpan de Galeana, about 220 km west of the Sierra de Huautla reserve, flocks of up to 17 macaws have been observed, and their reproductive activity recorded (Almazán-Núñez and Nova-Muñoz 2006, Blancas-Valva et al. 2016). About 300 km west of our study site, in the Zicuirán Infiernillo Biosphere Reserve, Michoacán, a reproductive population of the Military Macaw was recorded (Monterrubio-Rico et al. 2011). Finally, in the Tehuacán-Cuicatlán Biosphere Reserve and its surroundings, about 200 km west of the Rancho Viejo area, there is a record of a large reproductive population of about 100 individuals of the Military Macaw (Salazar-Torres 2001, Bonilla-Ruz et al. 2007, Salazar-Torres et al. 2010, Rivera-Ortíz et al. 2008, 2013).

In a recent paper, Monterrubio-Rico et al. (2021)

stated that the Cuenca Alta del Balsas harbors a relatively limited population of the Military Macaw, scattered in small numbers (≤ 50) with protected macaws found only in the Tehuacán-Cuicatlán Biosphere Reserve. Our results present solid evidence of the presence of a small population of the Military Macaw in the Sierra de Huautla Biosphere Reserve, confirming that the species occurs in another protected area, increasing its chances of conservation in the Central Mexico region. We consider that our evidence of the presence of the Military Macaw in the Sierra de Huautla reserve and adjacent areas strengthens the justification for establishing a new protected area in the Mixteca Baja Poblana region.

This entire region and adjacent tropical dry forest areas in Guerrero, southwest of Morelos, are vital to maintaining connectivity among the Military Macaw reproductive populations in the Cuenca del Alto Balsas. This conservation objective is facilitated considering that the detailed study required to propose establishing a new natural protected area has been submitted to the Commission for Natural Protected Natural Areas in Mexico. The achievement of this endeavor will carry substantial positive implications for the conservation of the Military Macaw in this region since it has been argued that the different populations reported in the area could function as a metapopulation (Salazar-Torres et al. 2010). Therefore, it is necessary to protect most of the population subunits effectively. This is also imperative to avoid genetic isolation of populations in large physiographic areas, such as the Cuenca del Rio Balsas, thereby requiring protection of large expanses of habitat suitable for the species, as well as to maintain connectivity among sites used by the species by restoring and establishing biological corridors (Rivera-Ortiz et al. 2013).

Supporting the development of monitoring and research (in conjunction with local communities) on different aspects of the ecology of the species in the Sierra de Huautla reserve should be a priority. We also consider that a viable alternative to support conservation of the Military Macaw in the reserve would be to develop, together with the community of Rancho Viejo, an ecotourism project for observation of Military Macaws, like that established in the Tehuacán Cuicatlán Biosphere Reserve (Salazar-Torres 2001; Arizmendi et al. 2013). This would generate additional incentives for local inhabitants, reinforcing their already positive attitude regarding

the conservation of the species.

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