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# Use of abandoned buildings by mammals in tropical forest sites with no forest control

# Uso de edificaciones abandonadas por mamíferos en sitios selváticos sin control forestal

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Mammal species can proliferate in abandoned buildings located in areas with medium evergreen tropical forest. This study assessed the wildlife that currently inhabits the abandoned buildings within the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (Tropical Wildlife Ecological Park; PFFT, in Spanish), located in the Emiliano Zapata municipality, Tabasco, México; this site has been abandoned for more than 3 decades. We placed rodent traps and bat nets within the PFFT facilities in 2019 and 2021. This site currently comprises areas of medium evergreen tropical forest, pastures, and *acahual* (a successional stage of medium evergreen tropical forest). Besides, we conducted sightings of mammal species in access roads and within abandoned buildings. Twenty-two species of terrestrial mammals were recorded in medium evergreen tropical forest, pastures, and *acahual* patches; bats attained the highest capture rate, followed by rodents. The individuals observed in the medium evergreen tropical forest belonged to the orders Didelphimorphia, Carnivora, Cingulata, Primates, and Lagomorpha. Two species are under a conservation status in national and international listings. Today, PFFT is an area where multiple mammal species coexist in a tropical habitat. The recorded mammal species are considered locally abundant and were observed in buildings surrounded by different types of plant cover. This work shows the establishment of a mammal community typical of medium evergreen tropical forest in sites with abandoned buildings undergoing a recolonization process by the local vegetation.

**Key words:** Abandoned buildings; biocultural heritage; biological heritage; colonization; conservation; ecological succession; management; México; Tabasco.

Las especies de mamíferos pueden proliferar en una serie de edificaciones abandonadas construidas en sitios de selva mediana perennifolia. Se evaluó la fauna silvestre que colonizó las edificaciones del Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT) en el municipio Emiliano Zapata, Tabasco, México; sitio abandonado desde hace más de 3 décadas. Colocamos trampas para roedores y redes para murciélagos en 2019 y 2021 dentro de las instalaciones del PFFT. El sitio está actualmente embebido por el crecimiento de selva mediana perennifolia, pastizales y acahuales (estado sucesional de selva mediana perennifolia). Adicionalmente, se realizaron observaciones de especies de mamíferos en los caminos de acceso y dentro de las edificaciones abandonadas. Se registraron 22 especies de mamíferos terrestres, con la mayor tasa de captura de murciélagos, seguida de roedores, en selva mediana perennifolia, pastizales y acahuales. Se observaron ejemplares de los órdenes Didelphimorphia, Carnivora, Cingulata, Primates y Lagomorpha en selva mediana perennifolia. Dos especies están enlistadas en algún estado de conservación, en listados nacionales e internacionales. El PFFT es actualmente un área donde coexisten diversas especies de mamíferos en un ambiente tropical. Las especies de mamíferos registradas se consideran localmente abundantes y fueron registradas en edificaciones rodeadas de diferentes tipos de cobertura vegetal. En este trabajo se muestra el reclamo de una comunidad de mamíferos típicos de la selva mediana perennifolia en sitios con edificaciones abandonadas y en proceso de recolonización por flora nativa.

**Palabras clave**: Colonización; conservación; lugares abandonados; manejo; México; patrimonio biocultural; patrimonio biológico; sucesión ecológica; Tabasco.



Anthropocene is the geological epoch characterized by the presence of humans and the effects of deforestation, intensive agriculture, and urbanization on ecosystems (Lewis and Maslin 2015). The accelerated growth and needs of human populations, cultural and political changes, and disasters (both natural and anthropogenic) that characterize this epoch have frequently resulted in the abandonment of military facilities, household complexes, parks, and even entire cities. This is the case of the exclusion zone (30 km approximately) and areas adjacent to the Chernobyl power plant in Ukraine, which were severely polluted after a nuclear reactor collapsed in 1986 (Chesser and Baker 2006), or of the Rocky Mountain Arsenal chemical weapon factory, located in Denver, Colorado, U.S., which was abandoned in 1992 (Salcido 2014).

The successional process of the ecosystem started soon after these sites were abandoned, with no human influence thereafter. For instance, changes in the composition of tree species through time have been documented in Pripyat, a city located 3 km from the Chernobyl nuclear plant that was abandoned after the plant exploded. Initially, ornamental plants were more abundant than local species. After more than 40 years of abandonment, the most abundant plants are local species such as pine, oak, and maple trees (Laćan *et al.* 2015). As regards urban mammals, Baker *et al.* (1996) concluded that rodent populations have proliferated in the absence of predators. The same is true for larger wildlife, including wild pigs (*Sus scrofa*) and elks (*Cervus canadensis*; Chesser and Baker 2006).

These data correspond to abandoned sites in contexts of nuclear disasters, but buildings colonized by bats after abandonment or underuse have also been documented around the world (González 2007; Li and Wilkins 2015; Pérez-García *et al.* 2019). In México, there are several cases of abandoned sites, including infrastructure, that remain devoid of human activities. Sites currently abandoned were built over a period from pre-Columbian times (Ortega and Martínez-Rodríguez 2011; Pech-Canché *et al.* 2014) to recent years. Different studies have focused on sites with hundreds of years of abandonment, but places recently colonized by native wildlife are less known. Such is the case of the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT, in Spanish; a tropical ecological wildlife park) that stretches across 56 hectares, which was abandoned about three decades ago.

The Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT) is located in the municipality of Emiliano Zapata, state of Tabasco, México. It was open to the public in December 1982 under the term of Leandro Rovirosa Wade (1977–1982) and was one of the largest family leisure centers in the Los Ríos productive sub-region. At the time, the PFFT included a small zoo that housed jaguars and other small mammal species representative of the region; a museum of the Maya-Olmec cultures; an orchid farm; an aviary with exotic birds; an exhibit of crocodiles, manatees, spider monkeys, and howler monkeys; an auditorium for various events; a swimming pool and a paddling pool with slides for kids; and a fishing lagoon (Nazur 2018); it even had a guest house, equipped with fireplace and jacuzzi.

The park facilities were abandoned definitively in 1988 and, as of the time of the present study, no maintenance works have been performed that would influence the natural plant succession and wildlife colonization process (Nazur 2018; Figure 1). Today, only a small area is preserved as a municipal plant nursery.

Wildlife succession processes in anthropized areas are hugely important for understanding the recovery capacity of altered areas. For this reason, this study was carried out to identify the mammalian species that can potentially recolonize a site that has remained abandoned for over 3 decades in a tropical region.


**Figure 1.** Views of the current (2021) infrastructure of the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa", Emiliano Zapata, Tabasco, México. a) Slide of the paddling pool and bathrooms; b) paddling pool; c) guest house; d) entrance to the pool slide; e) aviary; f) auditorium; g and h) trails. Photographs taken by C. Lorenzo (a-f, h), and J. E. Bolaños (g).

The park is located at coordinates 17° 43′ 33.38″ N, 91° 45′ 3.95″ W, at an altitude of 34 m in the municipality of Emiliano Zapata, Tabasco, México (Figure 2). Two field trips (18–20 February 2019; 29 September–1 October 2021) were conducted at the PFFT.

In 2019, for 2 consecutive nights, 180 Sherman traps were placed to capture rodents, in addition to 2 mist nets (12 m long x 3 m wide) at ground level and 1 harp trap to capture bats. In 2021, for 3 consecutive nights, 180 Sherman traps, 2 mist nets (12 m long x 3 m wide) at ground level, and 1 harp trap were placed. This yielded a total of 900 Sherman trap-nights and 756 m mist net-nights. Sherman traps were baited with a mixture of oats, vanilla, and sunflower seeds. Traps and nets were placed in the aviary, the paddling pool, the auditorium, the guest house, the museum, and the area where the annual livestock fair was held (Figure 2). These facilities are currently abandoned and surrounded, almost hidden, by medium evergreen tropical forest (SMP in Spanish; Figure 1). A brief description of these facilities is provided in Table 1.

**Table 1.** Characteristics of the facilities or sites where field work was carried out in Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT), Emiliano Zapata, Tabasco, México.

| Type of facility / site | Description / vegetation type |
|---|---|
| Auditorium | A circular building with a high vault. It still conserves the entrance doors. Surrounded by medium evergreen tropical forest (Figure 1f). |
| Guest house | The building is surrounded by lush trees and *acahual* areas. On the shore of San Marcos lagoon (Figure 1c). |
| Aviary | High-rise metal structure, approximately 50 m height (Figure 1e). Surrounded by medium evergreen tropical forest. |
| Trails | Running across medium evergreen tropical forest, with *acahual* and pasture patches (Figure 1g, 1h). |
| Edge of the PFFT | Transition zone between medium evergreen tropical forest and crops and pastureland. |

The dominant vegetation comprises trees of the following species: guayacan (*Handroanthus guayacan*), trumpet tree (*Tabebuia rosea*), mahogany (*Swietenia macrophylla*), silk plant (*Albizia longipedata*), cedar (*Cedrela odorata*), teak (*Tectona grandis*), and turpentine tree (*Bursera simaruba*; Manzo Rodriguez pers. comm.). The PFFT nursery cultivates these species, as well as orange trees (*Citrus cinensis*) and mandarin orange trees (*Citrus reticulata*; Manzo Rodriguez pers. comm.).

Nets were left open from 18:00 to 22:00 hr. The specimens captured and their traces were identified using specialized keys (Aranda 2012; Álvarez-Castañeda *et al.* 2017); each individual captured was measured, weighed, and sexed before releasing it at the capture site. Additionally, some individuals were sighted and recorded, and photographs of their traces were captured along several trails in patches of SMP, *acahual*, and pastures.

A total of 22 terrestrial mammal species, corresponding to 7 orders, 13 families, and 20 genera, were recorded across 5 sites (Table 2). No mammals were recorded in the livestock-fair area. The sites with the highest number of mammalian records were the trails (10) and the auditorium (9; Table 2). The latter has turned into a humid and dark place where colonies of bats have been established (Table 2; see video in Appendix 1). Besides, the presence of the black howler monkey, *Alouatta villosa*, was observed in areas adjacent to the auditorium and the aviary. This species is listed as threatened according to the IUCN (Cortes-Ortíz *et al.* 2020) and as endangered of extinction in the Mexican Official Norm NOM-059-SEMARNAT-2010 (SEMARNAT 2010). On the other hand, the tropical porcupine, *Sphiggurus mexicanus*, listed as threatened in NOM-059-SEMARNAT-2010 (SEMARNAT 2010) was recorded in the guest house.

**Table 2.** Species of mammals recorded by type of facility at the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT), Emiliano Zapata, Tabasco, México. *Sighting. The species listed as threatened according to IUCN and NOM-059-SEMARNAT-2010 are marked in bold.

| Order | Family | Species | Auditorium - Paddling pool | Guest house | Aviary - Museum | Trails | Edge of the PFFT |
|---|---|---|---|---|---|---|---|
| Didelphimorphia | Didelphidae | *Didelphis marsupialis** | | | | X | |
| | | *Philander opossum** | X | | | | |
| Cingulata | Dasypodidae | *Dasypus novemcinctus** | | | | X | |
| Chiroptera | Emballonuridae | *Saccopteryx bilineata* | X | | | | |
| | | *Mormoops megalophylla* | X | | | | |
| | Mormoopidae | *Pteronotus davyi* | X | | | | |
| | | *Pteronotus mesoamericanus* | X | | | X | |
| | | *Desmodus rotundus* | X | | | | |
| | | *Glossophaga soricina* | X | X | | X | |
| | Phyllostomidae | *Artibeus lituratus* | | | X | X | |
| | | *Artibeus phaeotis* | | X | | | |
| | | *Sturnira parvidens* | X | X | | | X |
| | Vespertilionidae | *Rhogeessa tumida* | | | | | X |
| Primates | Atelidae | ***Alouatta villosa**** | X | | X | | |
| Lagomorpha | Leporidae | *Sylvilagus floridanus** | | | | | X |
| Rodentia | Sciuridae | *Sciurus deppei** | | | | X | |
| | Erethizontidae | ***Sphiggurus mexicanus**** | | X | | | |
| | | *Reithrodontomys mexicanus* | | X | | | |
| | Cricetidae | *Oligoryzomys fulvescens* | | | | X | |
| | | *Sigmodon toltecus* | | | | X | |
| Carnivora | Canidae | *Urocyon cinereoargenteus* | | | | X | |
| | Procyonidae | *Procyon lotor** | | | | X | |

This study exemplifies the mammalian species that are able to colonize and thrive in abandoned sites with human facilities located in tropical environments. Today, the PFFT is a unique area where multiple mammal species coexist for being an environment that provides suitable habitats for them. A 2021 satellite image (refer to Figure 2) shows that the PFFT still includes a patch of tropical forest, which favors the presence of native fauna.

All the mammalian species recorded in the present study are considered locally abundant, living in more than one type of habitat, from sites covered by native forest to areas with secondary vegetation, and the conservation status of some of them has been established as per national and international listings. Besides, some species, mainly of bats, have successfully colonized the infrastructure that still persists in the PFFT; for example, the auditorium serves as shelter for several bat species, such as *Desmodus rotundus*, *Mormoops megalophyla*, *Pteronotus davyi*, *P. mesoamericanus*, and *Saccopteryx bilineata*, as well as for other mammals, such as the gray four-eyed opossum, *Philander opossum*, which was observed leaving the auditorium through the gate of the main entrance.

It is remarkable how the native rainforest vegetation has prospered in and around the man-made PFFT facilities and how these have deteriorated over time, since some have partly collapsed and the trails have been completely covered by overgrown vegetation. The presence of domestic species, such as cats and dogs, is also evident in the surroundings of the museum, as these areas are close to humans working in the park.

This study is the first to document the use by mammals of recreational buildings that have remained abandoned for decades in southern México. Other works conducted in northern México have recorded the use of abandoned mines by bats (Wilson *et al.* 1985; López-González and Torres-Morales 2004; López-González and García-Mendoza 2006).

Worldwide, several studies report buildings still inhabited by humans used by bats as shelters (Whitaker 1998; Siles *et al.* 2005; Debernardi and Patriarca 2007; González 2007; Mialhe 2013; de Paz *et al.* 2015; Li and Wilkins 2015; Alcalde *et al.* 2017; Pérez-García *et al.* 2019), unlike the PFFT infrastructure. This study describes abandoned buildings currently occupied by native fauna; some of these buildings are used as shelters for the bats that inhabit them, as is the case of the auditorium (see video in Appendix 1).

The findings of this study should be shared with the local and federal authorities to ensure that, if the park is reactivated

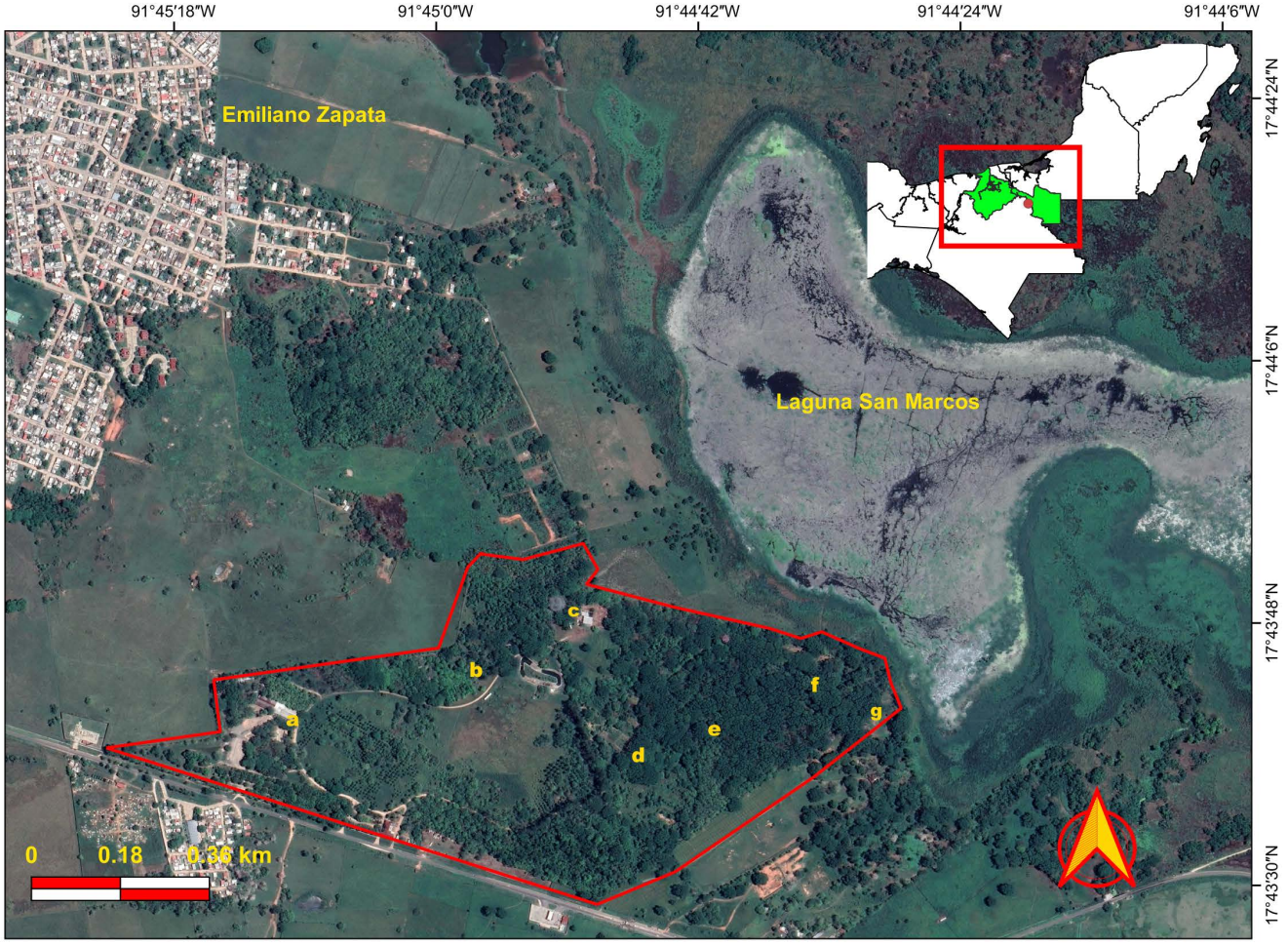


**Figure 2.** Collection and sighting sites (in yellow) of terrestrial mammals at the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT), Emiliano Zapata, Tabasco, México (red polygon). a) Site of the livestock fair, b) trail, c) aviary-museum, d) trail, e) auditorium-paddling pool, f) guest house, g) edge of the PFFT.

in the future, the mammals and wildlife living in it are managed properly to avoid their local extinction. In addition, the future conservation of this park is part of the plans approved by UNESCO (2017) for the protection of the world heritage, which seeks to identify, protect, conserve, restore, and pass to future generations the cultural and natural heritage.

Throughout history, mankind has transformed the environment for its own use and benefit, and in the worst case, this has led to the destruction and abandonment of natural habitats. The case of the PFFT is an example of the latter; however, the local wildlife has found suitable habitats in this abandoned environment. Although the creation of this natural and cultural site for recreational, cultural, and artistic purposes was a laudable project in its early days, no public policies have been issued to recreate the ancient splendor of this important biocultural heritage site of the state of Tabasco.

The PFFT of the municipality of Emiliano Zapata, Tabasco, built in the decade of the 1980s, sought not only to provide knowledge about the local flora and fauna to visitors, but also to rescue the cultural heritage of ancient Olmec and Mayan cultures in a regional museum. It is up to us to rethink the safeguarding of our biocultural heritage and the wild mammals inhabiting abandoned places. Last, the protection of PFFT as the natural and cultural heritage of the region is necessary to turn it into a sustainable model about the use of natural and cultural resources guided by ethical and professional principles.

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## Appendix 1

Video of the interior of the auditorium, Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT), Emiliano Zapata, Tabasco, México. Author: A. M. Romero-Lorenzo.

https://drive.google.com/file/d/1Ftc9NHiVb4740V6idGC5HiaNC_nWupsg/view?usp=sharing