NOTES

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Natural history

Using iNaturalist as a tool to monitor roosting behavior of bats in Panama

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Resumen

Los quirópteros son mamíferos importantes de interés para la conservación en las regiones neotropicales, que enfrentan una serie de amenazas, incluido el aumento de los niveles de urbanización, lo que lleva a la pérdida de hábitat. A pesar de esto, muchas especies de murciélagos utilizan regularmente una variedad de hábitos de percha, que incluyen estructuras tanto naturales como artificiales. Los métodos para monitorear poblaciones de murciélagos incluyen aplicaciones de ciencia ciudadana. Los hábitos de percha de los murciélagos tropicales rara vez se han evaluado en la aplicación de ciencia ciudadana más extendida: iNaturalist. Para ello se caracterizaron imágenes de observaciones de murciélagos en Panamá. Se revisaron 344 observaciones, con un 59.9% descansando en hábitats naturales frente a un 29.6% descansando en entornos creados por el hombre. Las especies más comúnmente observadas incluyen *Rhynchonycteris naso*, *Uroderma bilobatum*, y *Artibeus jamaicensis*. El total de observaciones aumento anualmente, lo que indica el potencial para el futuro monitoreo de la conservación. Recomiendo a los investigadores de murciélagos que utilicen iNaturalist como una herramienta para estudiar la selección de hábitos de percha y el uso del hábitat por parte de los murciélagos, ya que es probable que esta aplicación aumente su uso.

Palabras clave: ciencia ciudadana, murciélagos neotropicales, biodiversidad, conservación.

Abstract

Chiropterans are important mammals of conservation concern across Neotropical regions, facing a number of threats, including increasing levels of urbanization, leading to habitat loss. Despite this, many species of bats regularly utilize a variety of roosting sites, including both natural and man-made structures. Methods for monitoring bat populations include citizen science applications. The roosting habits of tropical bats has seldom been assessed on the most widespread citizen science app, iNaturalist. To this end, I characterized images of observations of bats in Panama. I report on 344 observations, with 59.9% roosting in natural habitats versus 29.6% roosting in man-made environments, respectively. The most commonly observed species include *Rhynchonycteris naso*, *Uroderma bilobatum*, and *Artibeus jamaicensis*. Total observations increased annually, indicating the potential for future conservation monitoring. I recommend bat researchers utilize iNaturalist as a tool to study roosting selection and habitat use by bats, as this application is likely to increase in use.

Key words: citizen science, neotropical bats, biodiversity, conservation.

Citizen science has been recognized as an important tool for ongoing wildlife population monitoring and for conservation efforts (Dickinson et al. 2012). Among the many citizen science initiatives widely available, iNaturalist is a frequently used wildlife identification tool that also offers an online database of observations (www.inaturalist.org). Similar to other mammals, bats are currently facing numerous threats such as habitat loss and fragmentation (Frick et al. 2020), which is alarming in tropical regions where there are a variety of species that are ecologically important. Previous citizen science programs have been successfully used to detect trends in bat populations in Great Britain (Barlow et al. 2015), study artificial light impacts on bats (Lewanzik et al. 2022), as well as monitoring adherence to proper bat handling practices using iNaturalist (Van der Jeucht et al. 2021). The use of anthropogenic structures and rural landscapes as roosting habitat has been documented for tropical bats (Lopez-Baucells et al. 2017). Subsequently, iNaturalist may provide an avenue to fill in research gaps regarding use of man-made roosting habitats. Panama provides an ideal location to investigate bat roosting in urban and natural settings, since it includes large cities interspersed with agricultural and natural forested areas. Herein, I include an assessment of bat species reported on iNaturalist, and outline the potential use of this citizen science database to study the roosting site selection of neotropical bats in Panama, in both natural and man-made structures.

All data for this study were accessed on 03/31/2023 on iNaturalist. I entered "Chiroptera" for the species search tab, and "Panama" as location tab in iNaturalist explorer tab. I applied the following additional filters: "wild" and "research grade", to filter out any potential captive individuals and ensure at least two naturalist confirmed identifications. This resulted in 562 total observations across 68 species, with 104 identifiers, and 242 observers (app users) from 2001-2023. Seven species included more than 20 observations, *Rhynchonycteris naso*, *Uroderma bilobatum*, *Artibeus jamaicensis*, *A. lituratus*, *Saccopteryx bilineata*, *Phyllostomus hastatus*, & *Lonchophylla robusta*. The five most commonly observed species were the Proboscis Bat (*R. naso*) with 99 observations, followed by 77 observations of the Tent-making bat (*U. bilobatum*), 55 observations of the Jamaican Fruit-eating bat (*A. jamaicensis*), 33 observations of the Great Fruit-eating bat (*A. lituratus),* and 30 observations of the Greater Sac-winged bat (*S. bilineata*). For species with more than 20 observations, including the mentioned species in addition to the Greater Spear-nosed bat (*P. hastatus*) and Orange Nectar bat (*L. robusta*), I characterized the percentage of natural versus man-made roosting sites used and the total number of bats in the reported images. The remaining species with more than 5 observations are listed in Table 1. The annual number of observations and monthly trends were also assessed by downloading the iNaturalist Explorer search, and data sorting observations in the downloaded CSV file.

I noted a variety of roosting sites used by bats, both man-made and natural areas, as well as variation across total individuals in observations of bats in Panama on iNaturalist (Figure 1). Among the top 7 species with observations, 344 images were evaluated, finding 59.9% in natural roosting habitats, 29.6% in man-made habitats, followed by 10.5% unknown (largely due to being held in hand by researchers in observation images). Across all images and species assessed, 70.1% were taken during daylight hours and 25.9% were taken during the night. For the full dataset combined across 2001-2023 of 562 observations, there were on average 45.3 observations per month being the minimum during January (28 observations) and the maximum during March (69 observations) across all years; whereas only 6.6% of observations in Panama City and 11.6% in Barro Colorado area, with these two areas being either heavily populated or frequented by bat researchers. The remainder of observations were in a combination of rural and natural areas across the country.

The most commonly observed bat in our study, the Proboscis Bat is known to roost in colonies of up to 50 individuals in both trees and man-made structures (Nagy et al. 2013), indicating that man-made structures should be monitored as roosting sites. The third most observed bat on iNaturalist, the frugivore *A. jamaicensis*, is an abundant species documented alongside the second most observed bat, *U. bilobatum*, both species found in surveys across a variety of habitat landscapes in the Panama (Brandel et al. 2020). Moreover, *A. lituratus* is both widespread throughout the neotropics and has been documented consuming fruits in urban environments (de Souza Laurindo & Vizentin-Bugoni 2020), and may be important for seed dispersal. The mean number of bats in images was variable, with most showing more than one individual (Table 1).

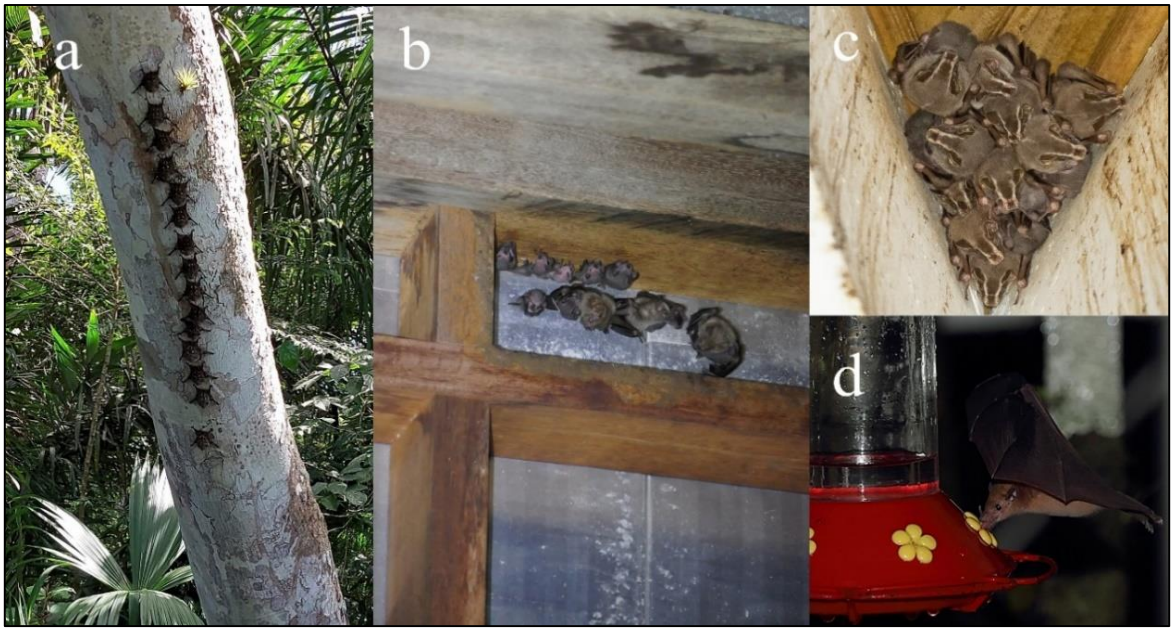

FIGURE 1. Examples of bat observations on iNaturalist in Panama, a) including fifteen *R. naso* in tree, b) ten *A. jamaicensis* adult and juveniles and c) thirteen tent-making bats in man-made structure, and d) *L. robusta* feeding from bird feeder. Images accessed on iNaturalist on 3/31/2023, included here as part of creative commons licensing: *R. naso* by Chelina Batista, *A. jamaicensis* by Micheal Speidel, *U. bilobatum* by Paul Carter (pacapix.com), *L. robusta* by Bill Hubick.

While other studies have used iNaturalist to document sightings of tropical bats (van Toor et al. 2019), this is the first published assessment of tropical bat roosting site selection in Panama using iNaturalist. Interestingly, the number of observations is increasing for bats in Panama annually (Figure 2). Smartphones and citizen science projects can be used to further study roosting of neotropical bats (Unger et al. 2019). Future work should be conducted to use applications to study the role of bats as seed dispersers or their use of bird feeders as I noted for one observation. I recommend researchers consider using iNaturalist to monitor the biodiversity of mammals, for both bats and other potentially rare and common species in tropical areas, especially as we expect the use of both the number of observations and total users of this application to increase over time. However, great care should be taken when using the application, as some bats are not readily identifiable by photograph alone, and may require more hands-on mist-netting or acoustic surveys to ensure correct identification. Therefore, this approach may provide a unique avenue of conservation monitoring of mammalian communities, and possibly identification of rare taxa.

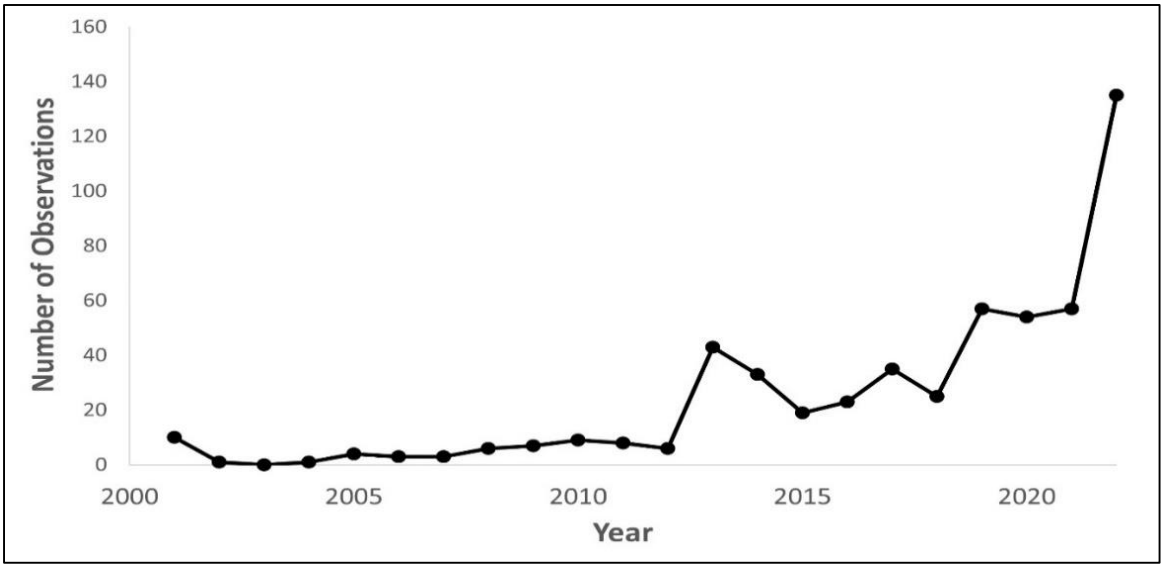

FIGURE 2. Number of observations of Bats in Panama on iNaturalist annually. Data accessed 03/31/2023. 2023 excluded due to bias in only including a portion of that year.

TABLE 1. Common name, species, total number of observations (total), mean number in image (*X*), and percent natural versus man-made roosting (%N/M) for Chiroptera on iNaturalist (www.inaturalist.org) for species with at least five observations. Accessed 3/31/2023. *X* and %N/M presented for species with more than 20 observations.

Common Name	Species	Total	*X*	%N/M
Proboscis Bat	*Rhynchonycteris naso*	99	7.2±4.7	67/33
Tent-making Bat	*Uroderma bilobatum*	77	4.6±5.2	69.5/30.5
Jamaican Fruit-eating Bat	*Artibeus jamaicensis*	55	10.4± 24.5	68.3/31.7
Great Fruit-eating Bat	*Artibeus lituratus*	33	3.7± 3.8	63/37
Greater Sac-winged Bat	*Saccopteryx bilineata*	30	2.3±2.1	43.3/56.7
Greater Spear-nosed Bat	*Phyllostomus hastatus*	26	12.6±17.9	70/30
Orange Nectar Bat	*Lonchophylla robusta*	24	1.6±1.7	90.5/9.5
Common Vampire bat	*Desomodus rotundus*	17	—	—
Fringe-lipped bat	*Trachops cirrhosus*	14	—	
Seba's short-tailed bat	*Carollia perspicilata*	12	—	—
Spix's Disk-winged Bat	*Thyroptera tricolor*	9	—	—
Pale Spear-nosed Bat	*Phyllostomus discolor*	8	—	—
Thomas's Yellow Bat	*Rhogeessa io*	8	—	—
Wrinkle-faced Bat	*Centurio senex*	7	—	—
Striped Hairy-nosed bat	*Gardnerycteris crenulatum*	7	—	—
Greater Bulldog Bat	*Noctilio leporinus*	6	—	—
White-throated Round-eared Bat	*Lophostoma silvicola*	6	—	—
Common Big-eared Bat	*Micronycteris microtis*	6	—	—
Mesoamerican Common Mustached Bat	*Pteronotus mesoamericanus*	6	—	—
Long-legged bat	*Macrophyllum*	5	—	—
Lesser Bulldog bat	*Noctilio albiventris*	5	—	—
Chesnut Sac-winged bat	*Cormura brevirostris*	5	—	—
Vampyrodes bat	*Vampyrodes major*	5	—	—

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