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ORIGINAL ARTICLE

The Bats (Chiroptera) of Utila Island, Honduras: species checklist and recommendations to conserve a cave roost

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ABSTRACT

This report catalogues the bats of Utila Island (Honduras) by providing a preliminary checklist of 13 species. We conclusively identified eight primary and five secondary records for bat species on Utila, including three new records that increase the total known species in the Bay Island department to 15. Phyllostomidae was the most represented on Utila, with four genera and six recorded species, followed by Vespertilionidae, two genera and two species, and Emballonuridae, one genus and two species. The families Molossidae, Natalidae, and Noctilionidae each had one species represented. We highlight the ecological importance of bats for the island ecosystem, ongoing threats to their communities and describe a long-term cave roosting site. We aim to raise regional awareness and suggest appropriate conservation action for bats and their habitats on Utila.

RESUMEN

Este informe cataloga los murciélagos de la isla de Utila (Honduras) proporcionando una lista preliminar de 13 especies. Identificamos de manera concluyente ocho registros primarios y cinco secundarios para especies de murciélagos en Utila, incluidos tres nuevos registros que aumentan el total de especies conocidas en el departamento de la Islas de la Bahía a 15. Phyllostomidae fue el más representado en Utila, con cuatro géneros y seis especies registradas, seguido de Vespertilionidae, con dos géneros y dos especies, y Emballonuridae, con un género y dos especies. Las familias Molossidae, Natalidae y Noctilionidae cuentan con una especie representada. Destacamos la importancia ecológica de los murciélagos para el ecosistema de la isla, las amenazas constantes a sus comunidades y describimos un sitio de descanso en cuevas a largo plazo. Nuestro objetivo es crear conciencia regional y sugerir acciones de conservación adecuadas para los murciélagos y sus hábitats en Utila.

INTRODUCTION

Bats (Chiroptera) are a highly diversified mammalian order containing more than 1400 species worldwide (Burgin et al. 2018) that represent around 20% of global mammal diversity (Simmons 2005, Teeling et al. 2018). Located in Mesoamerica, Honduras forms part of a global biodiversity hotspot that contains a significant diversity of unique flora and fauna (Myers et al. 2000). Mesoamerica is among the regions of the world with the highest diversity of bat genera; a total 66 of genera containing more than 170 recorded species are known from this region so far (Reid 2009, Rodríguez Herrera & Sánchez 2015), of which over 65%, approximately 113 species, occur in Honduras (Mora 2016, Turcios-Casco et al. 2020b), around 8% of the world's bat species.

Though the total species recorded in countries throughout Mesoamerica will be subject to future changes, Honduras presently has the second-highest recorded diversity of bats in Central America (Turcios-Casco et al. 2020b), second only to Costa Rica, which has ca. 120 recorded species (York et al. 2019), but so far greater than Guatemala which has a minimum of 100 species (Kraker-Castañeda et al. 2016, Colombo et al. 2017), El Salvador with 68 species (Rodríguez Herrera & Sánchez 2015) and Nicaragua, with 111 species identified (Medina-Fitoria & Martínez-Fonseca 2019, Saldaña Tapia et al. 2020). With a total of 139 reported species, Mexico has the greatest chiropteran diversity known for any Mesoamerican country (Ramírez-Pulido et al. 2014). While historically few regional datasets have contributed to the knowledge of bats in Honduras, substantial efforts have been made to remedy this lack of knowledge in recent years,

including the first taxonomic keys for the identification of Honduran bats (Mora 2016, Mora et al. 2021), a systematic review and various comprehensive studies made to document the ecology, and to register the distributions of species in departments across mainland Honduras (Mora et al. 2018, Turcios-Casco et al. 2019a, 2019b, Ávila-Palma et al. 2020, Gómez-Corea et al. 2020, Medina van Berkum et al. 2020, Mejía-Quintanilla et al. 2020, Turcios-Casco et al. 2020a, 2020b, 2021a, 2021b). Still, extensive gaps remain in our understanding of species taxonomy, natural history, ecology, distribution, and community composition within mainland habitats of Honduras.

While bats occurring in the mainland habitats of Honduras are receiving increasing amounts of scientific attention, the species occurring on the Honduran Bay Islands remain largely unknown, and historically, there have been few mammalian studies on these islands. Bermingham et al. (1998) listed seven bat species from the Bay Islands of Cayos Cochinos and Roatan that included two species of the family Emballonuridae, *Saccopteryx bilineata* (Greater White-lined Bat) and *S. leptura* (Lesser White-lined Bat); four representing Phyllostomidae, *Artibeus jamaicensis* (Jamaican Fruit-eating Bat), *Dermanura* (previously *Artibeus*) *phaeotis* (Pygmy Fruit-eating Bat), *Glossophaga soricina* (Common Long-tongued Bat), *Micronycteris schmidtorum* (Schmidts Big-eared Bat); and one Molossidae, *Molossus molossus* (Velvety Free-tailed Bat). On the Bay Island of Utila, only five species have been identified during four previous studies, which included *Glossophaga soricina* (Common Long-tongued Bat) in Webster (1983), *Natalus mexicanus* (Mexican Funnel-eared Bat) in McCarthy et al. (1993), as well as *Vampyrum spectrum* (Great False Vampire Bat) in Dinets (2016), *Artibeus jamaicensis* (Jamaican Fruit-eating Bat) and *Lonchorhina aurita* (Common Sword-nosed Bat) in a thesis by Miller (2014). Besides these few reports, data on the known bat populations and other potential species inhabiting Utila and the Bay Islands is overall depauperate. Turcios-Casco et al. (2021b) reviewed and updated the available information to provide a revised list of Honduran bats by department, in which 12 species were confirmed throughout the Bay Islands.

Here, we expand on the knowledge of Honduran bats by providing an inventory of 13 bat species conclusively identified during surveys on the Bay Island of Utila. Three species we report here were unknown from the Bay Island department, raising the current total to 15. We present morphological data and collection notes for deposited museum specimens, as well as photographic vouchers, basic ecological information, and a brief comparison with available data on mainland populations. Lastly, we discuss threats to bats on Utila and provide recommendations to conserve an important long-term cave roost for the island.

MATERIALS AND METHODS

Utila is the smallest and westernmost of the three major Bay Islands (Utila, Roatan, and Guanaja) and adjacent to the Cayos Cochinos archipelago, situated off the Caribbean coast of Honduras. Of the three major Bay Islands, Utila is positioned closest to the mainland, located approximately 42 km northwest from the city of La Ceiba in the Honduran

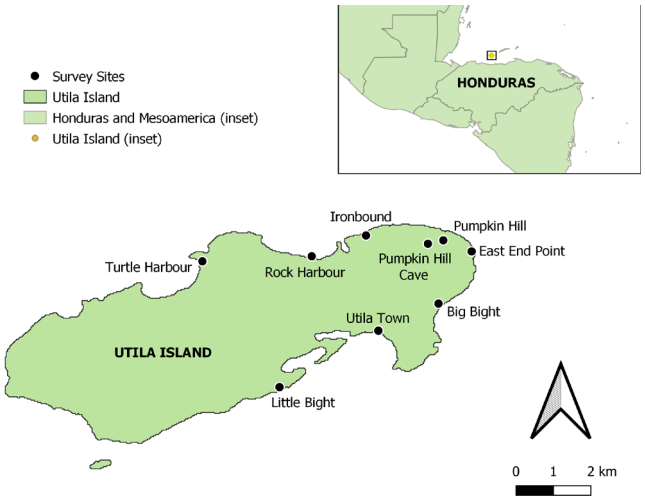

Fig. 1 - Map showing the location of bat survey sites on Utila Island, with inset indicating the position of Utila off the Honduran coastline in Mesoamerica.

department of Atlántida. The total geographic area of Utila is 41 km², approximately 11 km long x 4 km wide, and the western region is primarily unexplored and only accessible by boat. Its topography is predominantly flat, with the highest point being an extant volcano (Pumpkin Hill) at 74 m asl (McCranie et al. 2005). The climate of Utila is neo-tropical, with one distinct rainy season from October to January. Island habitats consist of mangroves, marshes, neo-tropical savannahs, hardwood forests, limestone caves, iron shore formations, and coastal vegetation (for floristic zones on Utila, see Fickert & Grüninger 2010).

Bats were captured in the vicinity of nine different localities within the Utila island (Fig. 1; generated in QGIS 3.6.0): Pumpkin Hill [PH] (16°07’10”N, 86°53’07”W), Iron Bound [IB] (16°07’14N, 86°53’48”W), Rock Harbor [RH] (16°07’06”N, 86°54’23”W), Turtle Harbor [TH] (16°06’47”N, 86°56’25”W), Little Bight [LB] (16°04’59”N, 86°55’16”W), Big Bight [BB] (16°06’16N, 86°52’53W), East End Point [EEP] (16°07’00”N, 86°52’25”W), Utila Town [UT] (16°05’49”N, 86°53’57”W); all GPS coordinates are presented in ‘WGS84’. Data was also collected outside and from within Pumpkin Hill Cave [PHC] GPS: 16°07’09.8”N 86°53’06.0”W) from 2012-2019, adjacent to the Kanahau Utila Research and Conservation Facility [KURCF]. The western portion of Utila was not sampled due to logistical difficulties accessing those regions.

We sampled bats in the field using four different kinds of mist nets (Ecotone monofilament 2.4 x 6 m with 28- and 40-mm mesh, Avinet polyester 2.6 x 6 m with 38 mm mesh, and a nylon canopy net 3 x 6 m with 38 mm mesh). In PHC, hoop nets and hand capture techniques were used; dead specimens were also collected from PHC floor for additional verification. Mist nets were set before dusk and left until dawn. They were monitored from a distance and checked closely at frequent intervals of c. 15 minutes. For all bats captured, we recorded species, sex, age, and reproductive status. Standard measurements following the methods of Reid (2009) were also recorded, including total head-body length (HBL), forearm length (FA), tail length (TL), hindfoot

length (HF), ear length (EL), nose leaf length (NL) and body mass (BM). Body dimensions were measured using callipers to the nearest millimetre, and mass using either a 20, 50 or 100g spring-scale balance. Age was determined using the methods of Brunet-Rossini & Wilkinson (2009). All species of bat were identified upon capture or collection, primarily according to Timm et al. (1999), Medellín et al. (2008), Reid (2009), Mora (2016), and Turcios-Casco et al. (2020b). When new species were encountered, voucher specimens were collected, except for *Vampyrum spectrum,* which was not captured and only had a photographic record due to scarcity of sightings. We collected morphological data on all specimens, which were fluid-preserved and deposited in the Natural History Museum of the National Autonomous University of Honduras (MHN-UNAH). Voucher specimen data is presented separately.

Trapping took place opportunistically without a standardised schedule irregularly across four years. Data for this study were collected during June 2010, March 2011, June-December 2012, and June-July 2013. Most data collection occurred in 2012 when regular mist-netting took place for 1-5 hours from sunset until midnight (17:00-23:59 h) or starting in the early morning until dawn 03:00-05:30h. One net was deployed for each survey. Although we used primarily 2.4x6 m (14.4 m^2) monofilament nets, we did not discriminate consistently which mist nets were used on each survey occasion. We rounded the total time of annual sample efforts to the nearest hour, then calculated capture effort in mist net hours following the method of Straube & Bianconi (2002). Annual catch per unit effort ratios were calculated by dividing the sampling effort (minutes) by the number of bats captured.

RESULTS

We sampled for a total of 139h across 64 days in 2010-2013. Our total sampling effort was approximately 2001.6 h-m^2, calculated as the total amount of square meters of mist net open each night (c. 14.4m^2) and multiplied by the total number of sampling hours in the entire study. A total of 542 individual bats were captured during surveys with an approximate average catch-per unit effort of 1 bat per c. 15 minutes of mist netting (Table 1).

We conclusively identified eight species that were previously unverified on the island of Utila, obtaining the first morphological data and island voucher records for *Dermanura phaeotis* (Pygmy Fruit-eating Bat), *Eptesicus furinalis* (Argentine Brown Bat), *Glossophaga commissarisi* (Brown Long-tongued Bat), *Molossus nigricans* (cf. Black Mastiff Bat), *Noctilio leporinus* (Greater Fishing Bat), *Rhogeessa menchuae* (Menchu's Little Yellow Bat), *Saccopteryx bilineata* (Greater White-lined Bat) and *Saccopteryx leptura* (Lesser White-lined Bat). Furthermore, we obtained secondary voucher records reaffirming the presence of *Glossophaga soricina* (Common Long-tongued Bat – Webster 1983), *Natalus mexicanus* (Mexican Funnel-eared Bat - McCarthy et al. 1993), *Artibeus jamaicensis* (Jamaican Fruit-eating Bat), *Lonchorhina aurita* (Common Sword-nosed Bat) (Miller 2014), as well as *Vampyrum spectrum* (Great False Vampire Bat) on Utila (Dinets 2016).

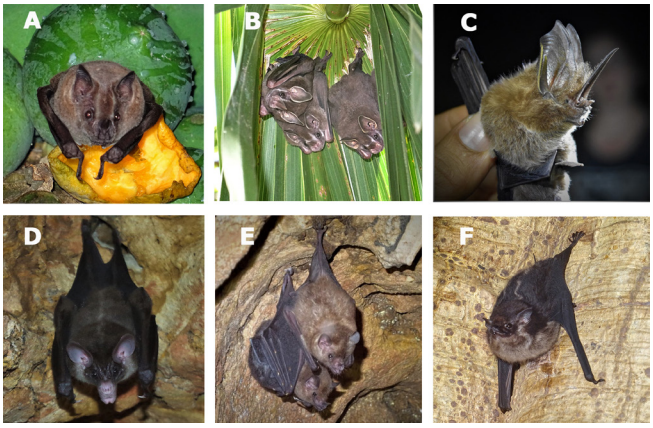

Fig. 2 - Photographs for six of 13 bats confirmed on Utila, taken in the vicinity of Pumpkin Hill Cave (PHC); **A)** *Artibeus jamaicensis* feeds on a ripened fruit of *Carica papaya* [photo taken in 2018]; **B)** *Dermanura phaeotis* roosting in modified palm tent [2019]; **C)** *Lonchorhina aurita* [2018]; **D)** *Vampyrum spectrum* roosting in PHC prior to its local extinction [2014]; **E)** *Glossophaga soricina* adults with a juvenile in PHC [2018]; **F)** *Saccopteryx bilineata* roosting on a hollow trunk of *Ficus aurea* [2020]. © A, B, C, E, F - Tom W. Brown & D - Steve M. Clayson

The family Phyllostomidae was the best represented on Utila, with four recorded genera and six species. Vespertilionidae followed this with two genera and two species, and Emballonuridae with one genus and two species. The families Molossidae, Natalidae, and Noctilionidae had one genus and one species each. We confirmed eight new and five secondary records for the bat species present on Isla de Utila, updating the total recorded species to 13 (Fig. 2). Five of the aforementioned species were already known from Cayos Cochinos and Roatan (Bermingham et al. 1998) and in total, ten of the species mentioned above were known in the Bay Island department (Turcios-Casco et al. 2021b). Three species, E. *furinalis, R. menchuae* and G. *commissarisi,* are new records for the Bay Islands. All 13 documented species are known to occur widely in Honduras and Central America (Reid 2009, Turcios-Casco et al. 2020b). Hereafter, we describe the morphological, ecological and occurrence data collected on these species and catalogue the biometrics and numbers for the specimens deposited at MHN-UNAH (Table 2).

Emballonuridae Gervais, 1856

***Saccopteryx bilineata* (Illiger 1811)**

Six individuals were captured using mist and hoop nets; average measurements, 8.25 g [7-10] BM, 44.1 mm [42-46] FA, 11.1 mm [10-12] EL, 16.8 mm [14-21] TL, 10.2 mm [10-11] HF). Three female specimens were collected (Table 2; UNAH 20140027 - 29), from PH (4 June and, 27 October 2012), and at the entrance of PHC Cave on the trunk of a strangler fig tree (*Ficus aurea*) (21 September 2010). This species is readily observed roosting on mature canopy branches and the trunks of hollow trees (e.g. *F. aurea* – Fig. 2F) at numerous sites across the island. It is distinguished from *S. leptura* by its larger adult size and dorsal colouration, i.e. dark blackish fur and two prominent wavy stripes extending from the neck to the rump (Reid 2009). Turcios-Casco & Medina-Fitoria (2019) also found *S. bilineata* roosting outside hollow trees, which indicates some similarities in the behavioral ecology of this species among insular and mainland habitats in Honduras.

Table 1 - Annual sampling effort and catch per unit effort for bats on Utila Island, Honduras.

	2010	2011	2012	2013	Total
Total survey nights	3	1	49	11	64
Total number of sites	2	1	9	8	9
Total hours	8	Hoop	111	20	139
Mist net hours (h/m^2)	115.2 h-m^2	net only	1598.4 h-m^2	288 h-m^2	2001.6 h-m^2
Total individual captures	20	3	459	60	542
Total species identified (accumulative)	5 (5)	1 (6)	12 (12)	9 (13)	13
Catch per-unit effort (minutes)	1:23	N/A	1:15	1:20	1:15

Table 2 - List of 13 bat species detected during our surveys. External measurements (mean and range in mm) are provided for the specimens deposited at MHN-UNAH. Sex: male or female (M/F) with the total number of specimens measured in brackets. Abbreviations: total head-body length (HB), length of the tail (TL) if present or not applicable (N/A), length of the hindfoot (HF); length of the ear from notch (EL); length of the forearm (FA); body mass (BM); * Locally extinct (no morphological data available).

Family	Species	Sex	HB	TL	HF	EL	FA	BM
Emballonuridae	***Saccopteryx bilineata***	F (3)	49.3 (49-50)	17.6 (17-19)	8.5 (7-.5)	12.8 (12-4)	45.8 (45-46)	9.6 (9-10)
	Saccopteryx leptura	M (2)	41.2 (41-42)	13.5 (11-6)	7 (6-8)	11 (10-12)	39.2 (39-40)	3
Molossidae	***Molossus nigricans***	M (3)	75 (73-77)	48 (44-50)	11	14.3 (14-15)	50.5 (50-52)	37.6 (36-39)
Natalidae	***Natalus mexicanus***	M (1)	44	46	7	14	39	4
		F (1)	43	51	7.5	12.5	39	5
Noctilionidae	***Noctilio leporinus***	F (1)	86	19	32.5	24	85	64
Phyllostomidae	***Artibeus jamaicensis***	F (5)	76 (76-80)	N/A	14.8 (14-5)	19.1 (18-20)	60.4 (58-64)	49 (46-53)
	Dermanura phaeotis	M (3)	46.2 (45-48)	N/A	9.6 (9-10)	14 (13-15)	37.8 (37-39)	12 (11-13)
		F (4)	44.7 (43-46)	N/A	9.2 (9-10)	13.8 (13-14)	39.3 (38-41)	13.2 (12-15)
	Glossophaga soricina	M (4)	50.8 (48-53)	8 (7.5-10)	10.5 (10-11)	13.5 (13-14)	37 (36-38)	10.7 (9-11)
		F (2)	50 (48-53)	7.5 (6-9)	10 (9-11)	13.5	37.2 (37-38)	10 (9-11)
	Glossophaga commissarisi	M (4)	50.3 (50-51)	7.2 (6-8.5)	9.2 (8-10)	12.8 (12-14)	36.5 (36-37)	9.75 (9-10)
		F (1)	55	7	10	13.5	37	11
	Lonchorhina aurita	M (1)	48	32	13	25	45	10
		F (1)	50	50	14	30	51.5	13
	Vampyrum spectrum*	-	-	-	-	-	-	-
Vespertilionidae	***Eptesicus furinalis***	M (2)	48.9 (48-50)	32 (31-33)	7.2 (6.5-8)	13.5 (13-14)	37.7 (37-38)	8
		F (2)	46.8 (46-48)	33 (32-34)	8.5 (8-9)	14	38 (36-40)	9
	Rhogeessa menchuae	M (4)	40.1 (39-41)	30 (27-32)	5.1 (5-5.5)	11.7 (11-12)	29.5 (29-31)	6
		F (4)	38.7 (36-41)	27.6 (24-30)	5.7 (5-6)	11.6 (11-12)	30 (29-31)	6.5 (6-8)

***Saccopteryx leptura* (Schreber 1774)**

Two male specimens were captured and collected (Table 2; UNAH 20140025 - 26) at PH (4 June 2012) and at the entrance of PHC (21 September 2010). It is sympatric with *S. bilineata* at these locations but roosts intermittently at different albeit similar sites outside PHC. Brown et al. (2020) also identified *S. leptura* on Utila, by the skull and dental morphology, as prey of a Green Vinesnake (*Oxybelis fulgidus*), 30 m from the entrance of PHC. Externally, it is primarily distinguished from *S. bilineata* by its smaller adult size and FA, exhibiting brown fur on its upper parts instead of black (Reid 2009). The high-flying nature of *Saccopteryx* on Utila has resulted in few captures within mist nets, though it would seem to be an abundant species.

Molossidae Gervais, 1856

***Molossus nigricans* (Miller 1902)**

On single occasions during March 2011, June 2012 and November 2013, a total of seven individuals (two females, five males), including one juvenile female, were sampled opportunistically using a hoop net from their roost in the roof of Utila Lodge, a business located in UT; average measurements, 31 g [20-40] BM, 50.4 mm [49-52] FA, 13 mm [10-16] EL, 40.2 mm [34-45] TL, 10.7 mm [10-13] HF. Three male specimens were collected (Table 2; UNAH 20140038 - 40). Loureiro et al. (2020) proposed the division of *Molossus rufus* Geoffroy, 1805 into three distinct clades previously synonymous with *M. rufus*, of which so far only *M. nigricans* is confirmed to occur in Honduras. Gómez-Corea et al. (2020) reported this species from 16 mainland departments in Honduras but were logistically unable to verify its occurrence on the Bay Islands. Turcios-Casco et al. (2021b) verified records of this species for the Bay Islands and confirmed its occurrence in 17 departments. Notably, a record of congener *Molossus molossus* was made by Bermingham et al. (1998) on Roatan Island, which, among other characteristics, can be distinguished from *M. nigricans* by its much smaller adult size.

Natalidae Gray, 1866

***Natalus mexicanus* (Gray 1838)**

On 10 June 2013, two adult specimens (one male, one female) were captured and collected (Table 2; UNAH 20140023 - 24) from within PHC using a hoop net; as an aerial insectivore *N. mexicanus* has otherwise remained uncaptured during mist-netting. Our regular observations within PCH from 2013-2021, indicate it is an important long-term breeding site for *N. mexicanus.* Adults are reproductively active from May to July, and several specific areas are used annually for maternity roosts (25m depth - Fig. 3). Observations from PHC suggest females will initially carry their newborn until a greater size is reached at c. 5-7 days of age before depositing the hairless pup in a communal maternity colony, consisting solely of dependent offspring attended separately by the females. The juveniles develop rapidly to become independent and fly within one month of their birth and are clearly distinguished from mature adults by their dark grey instead of a tan-coloured pelage. McCarthy et al. (1993) collected three males and one female from the northern region of Utila. From within PHC, Miller (2014) sampled 30 *N. mexicanus* and found they had a higher ectoparasite load of bat fly (Streblidae) than *G. soricina* and *A. jamaicensis* on Utila. Brown & Diotallevi (2019) also reported this species as prey of Tropical Ratsnake (*Psuedoelaphe flavirufa*) in PHC. *Natalus* spp. are unique among small bats of other genera in having a TL longer than its HBL (Reid 2009). The specimens we observed and collected on Utila did not possess the key external characteristic of a recently reported congener in Honduras, *Natalus lanatus* Tejedor, 2005, i.e., hairy legs and feet with ungual tufts (Medina van Berkum et al. 2020, Turcios-Casco et al. 2020b). Consistent with our observations in PHC, *N. mexicanus* are known to exhibit sexual segregation during gestation and lactation periods because females are located at specific sites forming maternity colonies, while males roost separately (Torres-Flores et al. 2012). *Natalus mexicanus* is reported to associate in cave roosts with at least 60 other bat species (López-Wilchis et al. 2020), which includes the majority of species recorded within the area of PHC during this study, i.e. *A. jamaicensis, G. soricina, G. commissarisi, L. aurita, S. bilineata* and *V. spectrum*. Currently, *N. mexicanus* is known to occur within ten departments of Honduras, whereas *N. lanatus* is only recognised at present in two departments (Turcios-Casco et al. 2021b). Neither member of the genus *Natalus* are currently known from Atlántida, the closest mainland department to Utila.

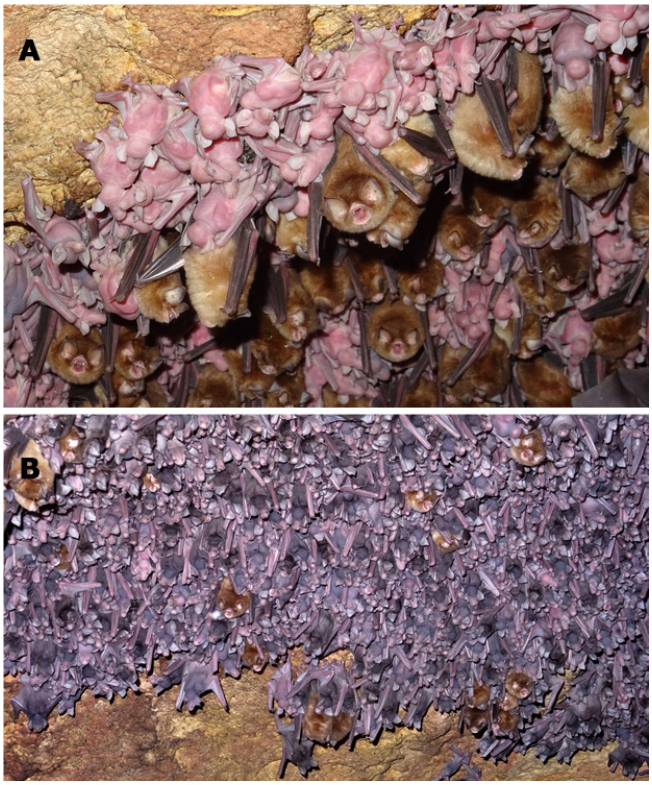

Fig. 3 - Resident breeding colony of *Natalus mexicanus* reproduce within Pumpkin Hill Cave [PHC], c. 25m depth. **A)** Adults (tan-orange fur) with naked juveniles at their maternity site (18 May 2018); **B)** The same maternity site photographed c. 15 days later, juveniles beginning to develop dark grey fur (4 June 2018). © Tom W. Brown

Noctilionidae Gray, 1821

***Noctilio leporinus* (Linnaeus 1766)**

Two adult individuals (one female, one male) were captured using mist nets. The single female specimen was collected in August 2012 (Table 2; UNAH 20140020) near a freshwater cave at BB, along Gabourel Road; two *N. leporinus* had entered the net on that occasion, but one escaped before we could retrieve it. The other adult male was captured and released on 25 June 2013 at the same location; measuring, 120 g BM, 87.5 mm FA, 21 mm EL, 34 mm TL, 29 mm HF. This species' active roosting or potential breeding sites remain undiscovered on Utila, though the BB freshwater cave by which we caught *N. leporinus* represents one potential location. Most of our mist-net sites were inland away from water sources, which may account for our low capture rates of this species. However, *N. leporinus* seems relatively abundant and is consistently observed at some coastal localities. On regular occasions from 2016-2020, from sunset onwards during the twilight hours, at least five individuals had been observed flying simultaneously at dusk whilst skimming for small fish near illuminated ocean docks beside the main port and throughout UT. In Honduras, it is reported from 11 departments (Turcios-Casco et al. 2021b), where it is associated with rivers, streams, estuaries, and coastlines (Galdamez 2020). Descriptions of fishing behaviour are consistent on mainland Honduras and throughout its Caribbean range; these bats seem unaffected by the presence of artificial light, but in some circumstances may use it as a hunting aid because the light attracts prey such as insects and small fish to the water's surface (Reid 2009, Galdamez 2020).

Phyllostomidae Gray, 1825

***Artibeus jamaicensis* (Leach 1821)**

326 *A. jamaicensis* were captured in mist nets and examined during our study; average measurements, 45g [41-53] BM, 58.1 mm [50-64] FA, 15 mm [13.5-16.5], EL, 11.7 mm [11-12.5] NL, 13.8mm [13.5-15] HF. Five female specimens were collected (Table 2; UNAH 20140045-49) at PH (21 September 2010, and 27 October 2012), IB (7 November 2010), and BB (25 October 2012). This species is the most captured and widespread throughout the island. *A. jamaicensis* has been observed roosting in forests under palm and tree branches, within savannah outcrops of Tique palm *Acoelorrhaphe wrightii* and *Sabal* sp..palms (including old *D. phaeotis* tents), and at several small caves. However, the largest roosts are found within derelict buildings scattered across Utila's southern coastline. At night, it is readily observed eating fruits such as yellow hog plum *Spondias mombin*, Tropical Almond *Terminalia catappa,* Trumpet Tree *Cecropia peltata* and wild papaya *Carica papaya* (Fig. 2A). Bermingham et al. (1998) noted that *A. jamaicensis* occurred at a high density during their surveys on Cayos Cochinos and Roatan, and also reported those bats feeding on two of the aforementioned fruits. Miller (2014) examined 30 individuals on Utila. Davis (1970) reported the subspecies *A. jamaicensis yucatanicus* for Roatan and Guanaja. This subspecies, and *A. j. richardsoni,* which occur on the Atlantic slope of Honduras, are larger than the subspecies *A. j. paulus* recorded in southern Pacific Honduras. However, six records in our Utila dataset of *A. jamaicensis* were noted for having morphological data that overlaps with that described for *A. inopinatus,* a rarely identified but sympatrically occurring species in southern Honduras often confused with *A. j. paulus*, distinguished in part by its proportionately smaller FA and HBL (Turcios-Casco et al. 2020a, 2020b). The morphological overlap highlights that the *Artibeus* diversity on the island requires future investigation and confirmation through targeted survey efforts. Average measurements collected for mainland *A. jamaicensis* (39 adults, 53.06g [46.18–59.95] BM, 62.58mm [60.26–64.91] FA) by Turcios-Casco et al. (2020b) are considerably larger than most individuals captured in our study, thus warranting a more thorough comparison of morphological variance in this species, widespread throughout all 18 departments of Honduras (Turcios-Casco et al. 2021b).

***Dermanura phaeotis* (Miller 1902)**

50 individuals (22 females, 28 males) were captured in mist nets; average measurements, 13 g [11-20] BM, 38.1 mm [36-41] FA, 13.2 mm [11-14] EL, 11.1 mm [10-13] NL, 8.7 mm [8-10] HF. Seven specimens (three males, four females) were collected (Table 2; UNAH 20140050-56) from PH (6 and 17 June 2012), LB (3 July 2012), BB (1 August and 25 October 2012), and EEP (26 October 2012). On Utila, this species is widespread along the interior coastline and found near-exclusively roosting in umbrella-like tents made by gnawing and modifying the leaves of Tique palm – *Acoelorrhaphe wrightii* (Fig. 2B); it is also observed to feed on this palm's fruits. Short grey fur and two distinct pale stripes on the face distinguish it from *D. watsoni*. However, *D. watsoni,* a close relative, very similar in morphology and appearance, is known from Roatan. We did not collect any evidence of *D. watsoni* on Utila, given the 7 *Dermanura* specimens we examined, each possessed two instead of three lower molars, consistent with the descriptions of *D. phaeotis*. In the field, captured *Dermanura* were identified as *D. phaeotis* considering they had short grey pelage on the back (4-6mm), as appose to longer, fluffier, greyer fur (6-7mm) of *D. watsoni*, as described by Reid (2009). *Dermanura phaeotis* is presently recorded in 15 departments of Honduras (Turcios-Casco et al. 2021b).

***Glossophaga soricina* (Pallas 1776)**

73 individuals (40 females, 33 males) of *Glossophaga* sp. were captured using mist nets; average measurements, 10.6g [8-15] BM, 36.1 mm [33-39] FA, 11.4 mm [9-15] EL, 7.1 mm [5-10] TL, 6.4 mm [5-11] NL, 9.2 mm [6-11] HF. Six specimens (four males, two females) verified as *G. soricina* were collected (Table 2; UNAH 20140060 – 62, 63, 64, 66, 67) from PH (6 June, 27 October, and 25 November 2012), RH (7 October 2012) and BB (25 October 2012). Large breeding populations occur within PHC (Fig. 2E); females are reproductively active between May and August. In PHC, Webster (1983) collected this species from within a 'non-descript' cave in the northeast region of Utila, indicating that the site has been used for at least 40 years. Miller (2014) captured 61 individuals of *G. soricina* on Utila, the most abundant species sampled in that study. *Glossophaga soricina* is known from all 18 departments of Honduras

(Turcios-Casco et al. 2021b). A recent morphometric study proposed separating the *G. soricina* complex into four cryptic species (Calahorra-Oliart et al. 2021), of which Díaz et al. (2021) considered *G. mutica* Merriam, 1898 as the replacement of *G. soricina* in Mexico, Central America and the Caribbean.

***Glossophaga commissarisi* (Gardner 1962)**

Five specimens (four males, one female) were collected (Table 2; UNAH 20140057 – 59, 61, 65) from PH (4 June and 25 November 2012 and 5 July 2013) and IB (7 November 2010). Notably, *G. commissarisi* and *G. soricina* are problematic to distinguish by sight/or in-hand as their morphological measurements overlap and occurrence is sympatric, though it would seem *G. soricina* is the dominant species on Utila. Both species were confirmed by the cranial and dental traits of collected specimens deposited at MHN-UNAH. Opportunistic collection of numerous *Glossophaga* carcasses and skulls from cave guano reaffirm that both *G. soricina* and *G. commissarisi* occur in PHC. In *G. commissarisi,* the pterygoid alae in the skull are absent, and lower incisors are small with distinct gaps; whereas in *G. soricina,* the pterygoid alae are present and frequently well developed, and lower incisors tightly fill the space between canines (Alvarez et al. 1991, Webster & Jones Jr. 1993, Timm et al. 1999). Another potentially sympatric species in Honduras, *G. leachii,* was ruled out on the basis that no *Glossophaga* specimens examined possessed a distinctly large median gap between the inner lower incisors, which is clearly detectable (Reid 2009). Including our new records, *G. commissarisi* is now known from 12 departments of Honduras (Turcios-Casco et al. 2021b).

***Lonchorhina aurita* (Tomes 1863)**

Two individuals were captured (one juvenile male, one female) in mist nets and collected (Table 2. UNAH 2014-0021 - 22) from outside a freshwater cave near BB (3 November 2012) and outside PHC (10 June 2013). A reproductive colony (c. <50 individuals) was also located in the deepest chamber of PHC, c. 80 m depth (5 August 2019); during revisits in May 2020, we also observed adult females carrying young pups with hair and larger juveniles clinging to the cave wall. *Lonchorhina aurita* is the only representative of its genus to occur in Honduras (Ávila-Palma et al. 2020) and is immediately identifiable on Utila by its iconic sword-shaped nose leaf (Fig. 2C). Miller (2014) previously captured a single *L. aurita* from the vicinity of PHC on Utila. This species is known only from five departments in Honduras (Turcios-Casco et al. 2021b). Ávila-Palma et al. (2020) provided morphological data for five individuals (15.0-18.0 g BM, 49.5-54.3 mm FA, 47.7-52.2 mm TL, 10.0-10.2 mm HF, 27.6-28.3mm EL, 44.4-54.4 mm HBL) and mentioned that between February and July no reproductive individuals were found at sites in the mainland. The two specimens we collected had HBL consistent with the above ranges (Table 2). However, HF (13-14mm) were longer and EL (25-30mm) ranged more, BM (10-13g) was lower, and the juvenile male FA (45mm) and TL was shorter (32mm). We speculate any differences in reproductive timing are likely constrained by seasonality and periods of higher resource availability; May-August coincides with the middle-late dry season on Utila.

***Vampyrum spectrum* (Linnaeus 1758)**

A solitary individual was observed roosting at the same site within PHC from 2008-2015 (Miller 2014, Dinets 2016) before disappearing in mid-2016, being at least eight years old. Assumedly the same individual was photographed at its long-term cave roost site in 2014 by SMC (Fig. 2D); though two individuals roosting together had originally been photographed from PHC pre-2008. While it cannot be confirmed, during the rainy season (30-31 October 2012), AMM believed to witness *V. spectrum* in flight during two survey occasions on PH road; apparently, *V. spectrum* came close to the mist net when *R. menchuae* and *G. soricina* made distress calls. Recent observations and surveys on Utila and several caves (2016-2021) have sadly failed to locate *V. spectrum.* Despite over five years of biodiversity monitoring on Utila and considering the absence of *V. spectrum* records from other Bay Islands, we deduce that the species should be considered extinct from this department. Turcios-Casco et al. (2021b) also considered *V. spectrum* absent on the Bay Islands. This should raise concern for the national conservation of *V. spectrum*, considering this species could be the first bat to become extirpated from an entire department in Honduras, representing the extinction of the species from its only known insular locality in the country. It is unclear whether natural mortality or anthropic disturbance had contributed to the disappearance of *V. spectrum* on Utila (Dinets 2016), though it was likely an amalgamation of both these factors, as well as potential reductions in the dispersal rates of adults from the Honduran mainland, that led to their eventual demise. The local extinction of this species on Utila might also indicate a decline in *V. spectrum* populations inhabiting coastal regions of mainland Honduras, such as the closest known overseas department of Atlántida, from which Utila populations (only two known individuals) may have originated. Despite being the largest-sized bat in Honduras, *V. spectrum* is rarely captured, and it is among those species with the least published records in the country, currently known only in four departments (Mejía-Quintanilla et al. 2020, Turcios-Casco et al. 2021b). *Vampyrum spectrum* is classified as Near Threatened on the IUCN Red List owing to various anthropogenic threats (Solari 2018), but its populations are data deficient in Honduras.

Vespertilionidae Gray, 1821

***Eptesicus furinalis* (d'Orbigny & Gervais 1847)**

16 individuals (ten females, six males) were captured in mist nets; average measurements, 8.1g [7-10] BM, 37.1mm [37-41] FA, 11.2mm [10-14] EL, 33.8mm [29-45] TL, 7.2mm [7-8] HF). Four specimens (two males, two females) were collected (Table 2. UNAH 20140041 - 44) from PH (4 June and 9 July 2012) and BB (1 August 2012). On 14 May 2016, a small roost of five individuals was coincidentally located c. 2.5 m high in a hollow dead black-mangrove trunk at IB. *Eptesicus furinalis* was identified by its morphology and small size, distinguished from two other congeneric species known in Honduras, by not reaching adult FA lengths greater than 37-41mm, as found in *E. brasiliensis* (39-43mm) and *E. fuscus* (46-52mm) by Reid (2009). Seven individuals (7 [4-9] BM, 30.2mm [28-35] FA, 9mm [9] EL, 30.2mm [28-32] TL, 6.4mm [6-7] HF) captured in mist nets and identified

Fig. 4 - Pumpkin Hill Cave (PHC). A) View from outside the cave; a mature Strangler fig (*Ficus aurea*) guards the entrance (top right). B & C) Entrance roosting chambers contain colonies of *Natalus mexicanus* and *Glossophaga soricina*. D) In the deepest chamber (c. 80m), bat guano feeds a thriving micro-ecosystem of endemic freshwater shrimps *Typhylata utilaensis*, amphipods (*Gammurus* sp.), Isopods (Asellidae), and the occasional visiting blue land crab *Cardisoma guanhumi*. © Tom W. Brown

as *E. furinalis* during fieldwork on Utila, were discounted from the dataset considering they exhibited morphology inconsistent with the known ranges for that species. We are unable to retrace and verify the identity of these records in this study, as the genus *Eptesicus* can be easily mistaken for similar-sized *Myotis* species, such as *Myotis nigricans* or *M. albescens* (Reid 2009). We advise that efforts should be made to discriminate between those genera in future surveys in the island. *Eptesicus furinalis* was previously recorded from 15 Honduran departments (Turcios-Casco et al. 2021b); our new records raise it to 16.

***Rhogeessa menchuae* (Allen 1866)**

31 individuals (16 females, 15 males) were captured in mist nets; average measurements, 4.5g [3-7] BM, 29.6mm [29-31.5] FA, 11.1mm [9-12] EL, 28.3mm [25-33] TL, 5.5mm [4-7] HF. Seven specimens (four males, four females) were collected (Table 2. UNAH 20140030 - 37) from outside PHC (21 September 2010), PH (6 June, and 25 November 2012), LB (3 July 2012), UT (27 July 2012), BB (1 August 2012), and TH (13 November 2012). While there is no comprehensive assessment of *R. menchuae* distribution in Honduras, Turcios-Casco et al. (2020b) recognised the proposals of Baird et al. (2008 & 2012), indicating that *R. menchuae* is most likely to occur on the Atlantic slope; hence it should be expected that this species would occur on the island, as opposed to *R. bickhami*. Including our new records, *R. menchuae* is now known from seven departments of Honduras (Turcios-Casco et al. 2021b). However, it may be more widespread and could potentially overlap with the distribution of *R. bickhami*, especially in central Honduras.

Cave observations

Our primary site of visual observations was 'the Bat Cave' or PHC, a cavernous limestone system traversing at least 80 m in depth from its entrance, immediately adjacent to the Kanahau Utila Research & Conservation Facility, southwest of PH in the north-eastern region of Utila (Fig. 4). It was historically referred to as Brandon Hill Cave (Strong 1935). We explored a total of seven separate cave systems on Utila, including PHC. To our knowledge, PHC supports the densest known roosting and breeding populations of bats on Utila and remains the most suitable site despite receiving the highest amounts of tourism. Of the 13 species reported

in this study, we encountered five within and five around PHC from 2008-2020. The species confirmed roosting within are: *G. soricina*, *G. commissarisi*, *L. aurita*, *N. mexicanus*, and *V. spectrum* (2008-2016)*;* all found at varying depths c. 10-80 m. In the vicinity of PHC, both *S. bilineata* and *S. leptura* intermittently roost in the outer entrance and on the adjacent branches of a mature Strangler Fig (*Ficus aurea*), *D. phaeotis* roost in tents created from modified leaves of *A. wrightii* palms by the entrance, and both *A. jamaicensis* and *R. menchuae* have been captured in mist nets placed c. 30 m away. Other notable fauna inside PHC include populations of an endemic freshwater shrimp *Typhylata utilensis* and various other invertebrates (Fig. 4D; Alvarez et al. 2005) and Tropical Ratsnake *Pseudelaphe flavirufa* (that routinely predate on bats – Brown & Diotallevi 2019).

During August 2018, TWB and five other researchers tallied an average estimated mixed-population size of c. 6000 bats upon their dusk emergence from the main entrance of PHC; however, the true population size may be much greater considering the cave system has alternative smaller exits/entrances that we did not account for. Annual observations from 2016 – 2020 demonstrate that the species composition in PHC is predominantly composed of large resident colonies of *G. soricina* and *N. mexicanus* (Fig. 4B & 4C) that breed between April and July. Those breeding communities also include *G. commissarisi*, though this species cannot be distinguished from *G. soricina* by sight alone. In May 2020, we confirmed that *L. aurita* not only roosts but also breeds in this cave. The latter species is only known from captures at six localities in Honduras, including Utila (Miller 2014, Ávila-Palma et al. 2020). PHC is the first confirmed reproduction site for *L. aurita* in the country.

Notably, as well as *V. spectrum* in PHC during March 2008, Dinets (2016) briefly mentioned observing numerous *G. soricina,* a few *N. mexicanus,* two small clusters of *A. jamaicensis*, one small group of *L. aurita*, as well as a solitary roosting individual of *Carollia castanea* Allen 1890 and *Phyllostomus discolor* Wagner 1843. We have not recorded *A. jamaicensis* roosting in the cave, but *N. mexicanus, G. soricina* and *L. aurita* remain abundant, which suggests that this cave's species composition and colony sizes may have changed over time. As habitat loss continues on Utila, PHC may become an increasingly important refuge for displaced colonies of these species. We found no evidence of *C. castanea* or *P. discolor* in Pumpkin Hill Cave or elsewhere on Utila from 2010-2020, nor were they recorded during the thesis of Miller (2014). The disappearance of these rarer species, much like *V. spectrum*, was linked to the disturbance from tourism (Dinets 2016). However, the reliability of those initial records seems highly dubious given that both individuals of *C. castanea* and *P. discolor* were identified once only by sight with no photographic evidence or additional information provided. For these reasons and lack of veridical evidence, neither *C. castanea, P. discolor* or the locally extinct *V. spectrum* were listed for the Bay Islands by Turcios-Casco et al. (2021b).

DISCUSSION

Bats perform important ecological services such as native plant and cash crop pollination, seed dispersal, reforestation, and biological pest control, as well as providing further economic value from tourism and research (Reid 2009, Kasso & Balakrishnan 2013). The region of the Bay Islands has the lowest bat diversity of any Honduran department reported to date (Turcios-Casco et al. 2021b), a total of 16 known species are listed for the area, counting the three new department records of our study (*R. menchuae, E. furinalis, G. commissarisi*) and the locally extinct *V. spectrum.* On Utila, the 13 species recorded occupy a wide diversity of trophic guilds, i.e. one piscivorous (*N. leporinus*), one carnivorous (*V. spectrum*), two frugivorous (*A. jamaicensis, D. phaeotis*), two nectarivorous (*G. soricina*, G. *commissarisi*), and seven aerial insectivorous species (*S. leptura, S. bilineata, M. rufus, N. mexicanus, L. aurita, E. furinalis, R. menchuae*). Two common species that play especially important roles in seed dispersal and pollination are *A. jamaicensis* and *G. soricina*, as made evident by their abundance in forests throughout Honduras and being the only two species found countrywide in all of the 18 departments (Turcios-Casco et al. 2021b).

Excluding *V. spectrum*, 50% (6/12) of the species identified on Utila have not yet been captured on other Bay Islands (McCarthy et al. 1993, Bermingham et al. 1998), i.e. *N. mexicanus*, *G. commissarisi, L. aurita, N. leporinus, E. furinalis* and *R. menchuae*; 80% (12/15) of the total Bay Island chiropteran diversity is known to occur on Utila, whereas only three species known from Cayos Cochinos (*M. molossus*) and Roatan (*D. watsoni*, and *M. schmidtorum* – Bermingham et al. 1998, Turcios-Casco et al. 2021b) were undetected during our study. Insectivorous gleaners such as *M. schmidtorum* are considered indicators of well-conserved areas of Neotropical rainforests (Medellín et al. 2000), a habitat that represents only a small percentage of the total area of Utila, in comparison to Roatan. Apart from *S. leptura*, *N. mexicanus,* and *L. aurita,* all bats occurring on the Bay Islands are also known from the closest continental Honduran department of Atlántida, which ranks the third most diverse region on the mainland with a total of 58 reported species (Turcios-Casco et al. 2021b). The comparably low diversity of bats reported for the Bay Islands stems not only from an overall lack of research on each island, but also from the geographical positioning, climate, limited land area and relative isolation of these habitats from Honduras. Although Utila is the smallest of the three major Bay Islands, it is also situated closest to the mainland; therefore, it is not unexpected that the diversity on Utila could be higher than on Roatan or Guanaja. The probability of overseas dispersal towards Utila may be greater. The provisional number of species recorded on the Bay Islands, and the trophic niches each genus occupy, is comparable to the chiropteran diversity of other islands in the Americas and Caribbean, such as Cozumel's Island, Mexico (19 species – Rivas-Camo et al. 2020); notably, five species on Utila are also known for Cozumel's Island (*N. mexicanus*, *A. jamaicensis, D. phaeotis, G. soricina, E. furinalis*), plus two other congeners similar in ecology to those bats in our study (*Molossus rufus* and *Rhogeessa aeneus*). Unlike the Lesser Antilles, which has low chiropteran diversity but exceptionally high rates of

endemism (Pedersen et al. 2013), no studies have suggested the presence of any endemic subspecies or species to the Bay Islands. However, the biogeography, phylogeny and dispersal patterns of populations remain unstudied. The morphological data we collected on several species tentatively suggests some differences between the mainland populations and those found in this insular portion of their range. The *A. jamaicensis* we captured were comparatively smaller than adults from populations reported on the Honduran mainland. Hence, biogeographical variance in morphology, ecology and phylogeny should be further studied.

Bat diversity on Utila may not only be constrained by geographic location, but in past and recent years, also hindered by the effects of humans. Due to the distribution of forest habitat and limestone cave formations that contain valuable freshwater reservoirs, the north-eastern portion of Utila Island and the region surrounding PH provides the most suitable habitat for bat communities. Notably, this region was also important to early human settlers on the island, considering numerous sites containing evidence of aboriginal cave occupancy dating back to the pre-Columbian era (Strong 1935). Since 2010, the eastern region of Utila has seen an exponential rise in the human population, as well as anthropogenic pressure and development, leading to the destruction of large areas of the hardwood forest and mangroves habitat (Currin 2002, Brown et al. 2017). Thus, forest habitats and cave systems should be prioritised for bat conservation on Utila, yet besides unstipulated private land ownership, no hardwood forest or cave systems are currently protected.

Observations during 2016-2021 indicate that bats may be threatened by deforestation and numerous detrimental practices mainly associated with the growing tourist industry and unsustainable economic development. On Utila, threats to bats and their cave roosts may include unregulated tourism and human visitation, as well as other acts of disturbance, such as freshwater pumping, shrimp-fishing, rock quarrying or collecting guano, stalagmites, fossil corals and ancient artefacts (Strong 1935). Hardwood forest habitats contain native flora, fruits and insects on which bat communities depend; these are under threat from land clearance for expanding agriculture and human development. Pesticides are routinely sprayed to combat the spread of mosquito-borne diseases on the island, which generally could have unknown impacts on bats and their prey sources (Hernández-Jerez et al. 2019). Introductions of several invasive species on Utila, including black rats, feral cats, and northern raccoons (T.W. Brown pers. obs.), may disturb cave roosts and increase predation on colonies of bats (Rodríguez-Durán et al. 2010, Cichocki et al. 2021). Lastly, owing to misguided local superstition (e.g. Mejía-Quintanilla et al. 2020), it is not unlikely that humans may indiscriminately persecute and disrupt roosting bat colonies (e.g. by fire-setting in caves, poisoning, and otherwise physically harming individuals).

Bats are especially vulnerable to population decline, as their reproduction rate is slower than that of similarly sized mammals, and because a single cave can be critical to the survival of a large proportion of a species population (Tuttle & Moreno 2005, Furey & Racey 2016). While no standardised monitoring has taken place on Utila, regular observations suggest cave-roosting bat populations may be susceptible to increasing levels of anthropic disturbance, and the apparent local extinction of *V. spectrum* plus dubiously two other species from the island raises concerns for bat conservation and advocates the need for better-regulated cave tourism (Dinets 2016). Information on bat ecology, natural history and their cave roost sites are scarce in Honduras (Turcios-Casco & Medina-Fitoria 2019, Turcios-Casco et al. 2019a). Hernández (2015) discussed two caves presently registered for tourism, but sadly both have been modified in a manner that potentially impacts the resident bats. On Utila, PHC has a high ecological value and should be protected by regulating access to tourism because of its importance to at least 50% of the islands known chiropteran diversity. Only a few caves are found to meet large colony needs (Tuttle & Moreno 2005), and some species breeding in PHC (e.g. *L. aurita)* are among the rarest of all bat species observed in Honduras (Ávila-Palma et al. 2019, 2020), making this cave of special national significance.

CONCLUSION

The presented records and voucher specimens provide key preliminary data on the bat diversity of Utila Island by providing the first conclusive species list as a baseline for future studies. Our research raises the total number of bats known in the Bay Island department from 12 (Turcios-Casco et al. 2021b) to 15, excluding *V. spectrum,* which we advise is now most probably extinct from the islands. Except for *V. spectrum*, classified as Near Threatened on the IUCN Red List (Solari 2018), the remaining 12 species we reported have a wide distribution in Central America (Reid 2009) and are therefore not directly threatened. Because our mist-netting effort was inconsistent and we did not perform acoustic surveys or deploy alternative capture methods such as harp traps, it remains highly probable that more species await confirmation on Utila.

Based on our observations, we consider PHC especially significant for the island's chiropteran diversity. This cave is situated on private property, but the site remains publicly accessible yet entirely unmanaged. To help ensure its recognition and protection, we recommend that this cave should be designated as a SICOM (Spanish abbreviation; Sitios de Importancia para la Conservación de los Murciélagos), and those necessary steps must be taken to justify this in accordance with the regional requirements defined by RELCOM (Red Latinoamericana y del Caribe para la Conservación de los Murciélagos) and enacted in-country by PCMH (Programa para la Conservación de los Murciélagos de Honduras). Conservation action and tourism management plans should be developed before its designation as SICOM to provide guidelines for public visitation, population monitoring and species management. Their implementation should be done by a local NGO collaborating with the landowner and PCMH.

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