Mammals of Cleopatra's Needle Critical Habitat: Outcomes of a rapid assessment

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ABSTRACT

A rapid biodiversity assessment of mammalian fauna was conducted in the Cleopatra's Needle mountain range in the biodiversity hotspot province of Palawan, Philippines to determine species diversity of, anthropogenic activities affecting and conservation status of the species in the area. Standard methods of research sampling for capturing or observing volant and non-volant mammalian species included: baited cage trapping, drift-fenced pitfall trapping, camera trapping, mist-net trapping and opportunistic hand-capturing or observing. A total of 12 mammalian species were documented. *Maxomys panglima* and *Crucidura palawanensis* were the most commonly captured species with the use of baited cage traps and pitfall traps, respectively. The rare *Chiropodomys calamianensis* was also captured with a baited cage trap. *Aonyx cinereus* is listed as Vulnerable in the International Union for Conservation of Nature Red List of Threatened Species; *Prionailurus bengalensis heaneyi* and *Sus ahoenobarbus*, are listed as Vulnerable under the Department of Environmental and Natural Resources' 2017 National List of Threatened Philippine Fauna and their Categories. The results revealed this area is an important habitat for threatened and poorly studied species of mammals, most of which are imperiled by individual threats and habitat loss.

Keywords: biodiversity, mammals, Red List, survey

INTRODUCTION

Tropical forests support at least two-thirds of the world's biodiversity (Raven 1988). Unfortunately, global biodiversity rates are steadily declining, with anthropogenic land use change being of primary concern to the sustenance of terrestrial ecosystems (Balmford et al. 2003; Jenkins et al. 2003; Butchart et al. 2010). Alroy (2017) estimates global biodiversity loss will cause the 6th mass extinction event if tropical deforestation persists at the same

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degree. Conserving tropical forest biodiversity thus lies in the proper management of vital protected area networks that house threatened species and global ecosystem functions (Laurance et al. 2012).

The Philippines is home to at least 5% of the world's endemic mammals (Ceballos et al. 2005). The unique Philippine island of Palawan boasts mammal diversity that is reflected in its distinctive biogeographical history: Palawan is part of the Sunda shelf and may have been connected to Borneo via a land bridge; all other Philippine islands are oceanic and were probably never connected to mainland Asia (Heaney 1986; Esselstyn et al. 2004). Thirteen of Palawan's 58 native mammal species are endemic to the island region; while 8 of Palawan's 11 native rodent species are endemic to the province (Esselstyn et al. 2004). Although Palawan's mammals have been documented for over a century, there is a general lack of information regarding their ecology, distribution, and phylogenetic relationships (Esselstyn et al. 2004).

In 2016, the Cleopatra's Needle mountain range (CNMR) in Puerto Princesa City, Palawan, Philippines was officially protected as a 'critical habitat' – a local conservation initiative which aims to safeguard valuable, endemic and/or endangered species in areas adjacent to national protected areas in the Philippines. This 41,350-hectare critical habitat, named Cleopatra's Needle Critical Habitat (CNCH), is home to 85% of Palawan's endemic and endangered plant and wildlife species (Hoevenaars and van Beijnen 2015). The declared critical habitat aims to protect the flora and fauna within its domain from logging, mining, and land-grabbing activities that continue to occur throughout Palawan. However, even with the protected status of the forest, approximately 20 hectares of newly cleared swidden agriculture have been recorded in the core zone of the critical habitat between February and April of 2017 alone (Karina Reyes-Antonio Pers. Comm.). Hence, continuous research and cooperation with the Batak and Tagbanua tribes in the area is necessary to innovate effective management strategies within the CNCH that will respect the traditional practices and welfare of indigenous communities without compromising conservation.

An assessment conducted by Ambal et al. (2012) shows this area is among the key biodiversity areas in the Philippines in need of conservation action. Yet, mammalian surveys surrounding the CNMR are minimal. Esselstyn et al. (2004) was able to record three non-volant mammal species and two bat species between 1300 and 1600 masl on Cleopatra's Needle over 740 trap nights; while Marler et al. (2015) was able to record eight medium-bodied mammals using camera traps throughout the CNMR over a five-month period. We initiated this survey as a prerequisite for declaring the CNMR a critical habitat. The survey further aimed to determine the mammalian species diversity, the anthropogenic threats, and the conservation status of species in the CNCH.

METHODS

Study Area

This study was conducted in two political districts (locally called 'barangays') within the CNCH in Puerto Princesa, Palawan, the Philippines: Langogan and Concepcion. These two districts have direct contact with the Sulu Sea on their eastern coasts and touch Cleopatra's Needle Mountain on their land locked borders (Figure 1). The CNCH is adjacent to the Puerto Princesa Subterranean River National Park (PPSRNP), which extends to the west coast of the island. Together, these two protected forest areas comprise a corridor connecting the northern and southern portions of Palawan. Habitat types in the CNCH include riverine, montane, beach or littoral, lowland evergreen, secondary, and swamp forests (Marler 2016).

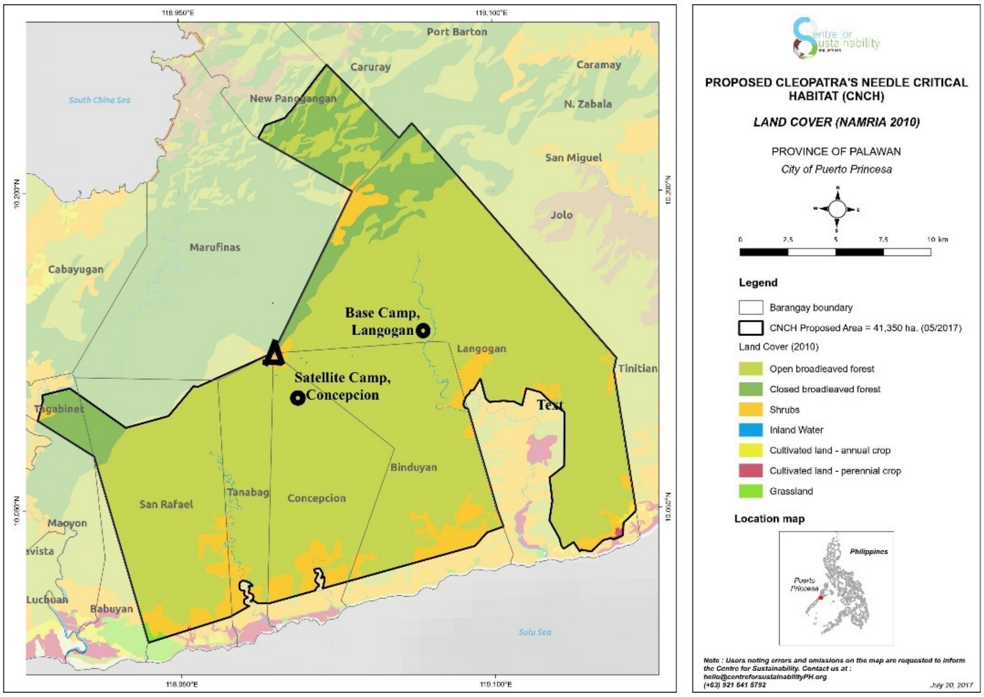

Figure 1. Map of Cleopatra's Needle Critical Habitat (the two dark circles indicate the base camps and the triangle represents Cleopatra's Needle Mountain). ©Centre for Sustainability PH, Inc.

The study areas were approximately 50 km north of Puerto Princesa City proper. The sampling areas were focused in the forest surrounding Cleopatra's Needle (CN) mountain (10° 07' 26" N, 118° 59' 43" E; 1,593 masl), the centerpiece of the critical habitat, two years prior to its declaration. A base camp was established in Langogan approximately 15.5 km from the main highway and 300 m from the Langogan River (Figure 1). Secondary succession vegetation was evident in the surroundings of the area, which is mainly caused by seasonal slash-and-burn farming systems by local inhabitants. From the base camp, we created three sub-sites: L_{S1}, L_{S2}, and L_{S3} (Figure 2). Sub-sites L_{S1} (180 masl) and L_{S2} (324 masl) were in riparian habitat, where large dipterocarp trees dominate, and smaller understory trees create dense vegetation on the forest floor. Sub-site L_{S3} (1010 masl) was located on a mountain ridge; this sub-site had similar ground foliage to L_{S1} and L_{S2} with large Almaciga *Agathis philippinensis* trees interspersed throughout the terrain. In Concepcion, our surveys were centralized around a satellite camp located approximately 12.6 km from the main highway at 828 masl (Figure 1). From this camp, three sub-sites were created: C_{S1}, C_{S2}, and C_{S3} (Figure 2).

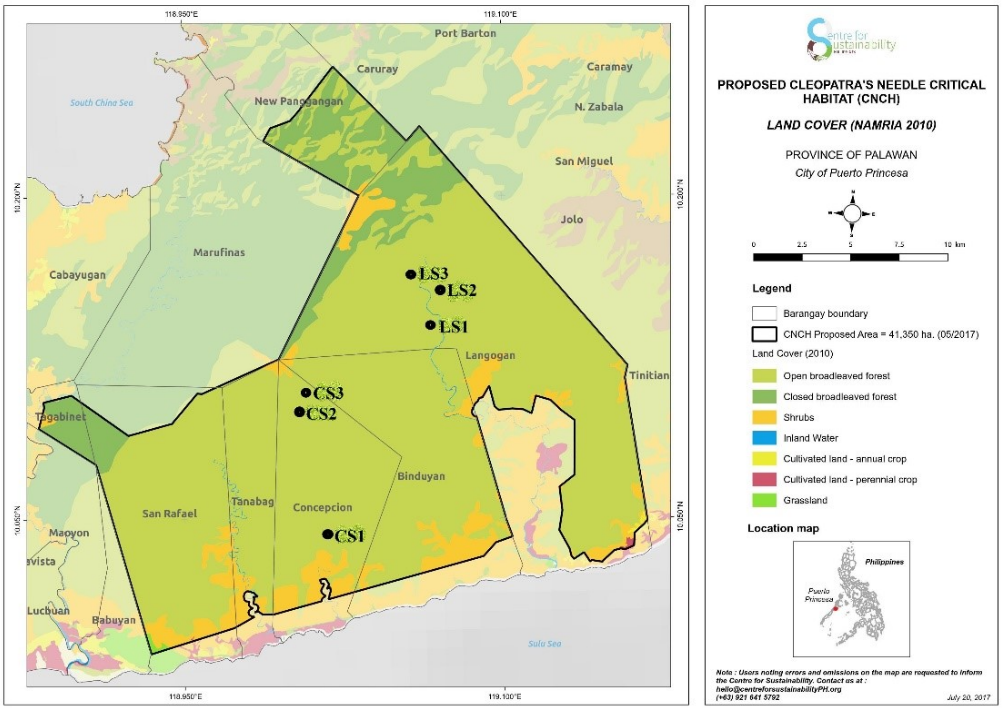

Figure 2. Map indicating the location of subsites that were surveyed for mammals. ©Centre for Sustainability PH, Inc.

Sub-site C_{S1} (151 masl) was in riparian habitat and sub-sites C_{S2} (796 masl) and C_{S3} (805 masl) were in lowland evergreen habitat. Large dipterocarp trees with smaller understory trees again dominated these three habitats. However, *A. philippinensis* was found throughout sub-sites C_{S2} and C_{S3}. For one night each, a camera trap and one cage trap were placed near the peak of Cleopatra's

Needle Mountain (1584 masl) in montane habitat dominated by *Nepenthes mira* pitcher plants, ferns and moss-covered trees.

Rapid Assessment Survey

This rapid assessment occurred at the end of the rainy season in the first two weeks of December 2014. Approximately five days were spent surveying each barangay. Considering the rapid nature of the research, five methods were employed for short periods of time to document and, when possible, capture all possible species present in the area. Unfortunately, due to varying numbers of team members over the brief time frame of the expedition, it was not possible to replicate all methods for each of the six sub-sites; in some cases, only one method was employed at certain sub-sites throughout the expedition. The five methods are discussed below:

Cage Trapping. Forty-five single-door cage traps with dimensions of approximately 30 cm x 15 cm x 15 cm were used to catch ground-dwelling small non-volant mammals. Four different baits were used to attract the animals: coconut (*Cocos nucifera*), banana (*Musa cf. acuminata*), peanut butter (store bought), (Esselstyn et al. 2004) and oats (store bought). Baits were used at relatively equal proportions for each of the trapping sub-sites. Various bait types were employed to ensure mammal captures as information was not found to determine which bait would prove most effective. For one cage trap, one bait was selected, placed into a hand-made mesh bag and tied inside the cage. Line transects were then created in each of the different study areas on the forest floor; for each transect, cages were placed in approximately 20 m intervals in a line transect (Pearson and Ruggiero 2003). The number of cages per transect varied from 10 to 26 cages, depending on the terrain and availability of cages when reaching each of the sub-sites. Geographic Positioning System (GPS) coordinates were taken from a central location in each sub-site. These traps were checked daily. Any animals caught were collected and prepared as voucher specimens following the instructions and limitations specified in the Wildlife Gratuitous Permit 2014-15, issued by the Palawan Council for Sustainable Development (PCSD). The cages were then reset for the next day.

In Langogan, one transect was established each at sub-sites L_{S1} and L_{S2} for three nights each for a total of 120 trap/nights. In Concepcion, one transect was established each at sub-sites C_{S1}, C_{S2}, and C_{S3} for four, two and two nights, respectively, for a total of 92 trap/nights. One cage trap was placed at the peak of CN for one night.

Drift-fenced Pitfall Trapping. Twenty-five-liter water buckets, polyethylene plastic sheets and iron stakes and/or wooden sticks were used to construct the drift-fenced pitfall traps (DPTs). The DPTs were created approximately 50 m from cage trap transects, with one DPT being independent of a cage trap location. We followed Voss et al. (2001), using a linear design for the pitfall traps by digging 10 holes at about 70 cm deep and large enough to fit a 25-L water bucket. Ten buckets were spaced an average of 3 m from one another and polyethylene plastic sheets were affixed between buckets with iron stakes or wooden sticks to create a barrier between each bucket (Voss et al. 2001). DPTs were inspected daily and any animal caught was collected.

For sub-sites L_{S1}, L_{S2}, and L_{S3}, DPTs were left to function for three, three, and two nights, respectively. In Concepcion, only one DPT transect was established in sub-site C_{S2} for two nights.

Camera Trapping. For our Langogan site, a Truth Cam 35 was used. In Concepcion, we used a Bushnell 8MP Trophy Cam. We followed Gerber et al. (2010) and placed camera traps opportunistically alongside the trail. When possible, camera trap placement was near a sign of animal presence; examples of such include: animal feces and feeding sites (O'Brien et al. 2003; Meek et al. 2012). Once a camera trap location was found, a camera was strapped to a nearby tree approximately 30 cm from the ground and 1 m to 2 m in front of a clearing (Ancrenaz et al. 2012; Meek et al. 2012). The cameras use a passive infrared motion sensor to detect heat within the detection cone of the infrared sensor, triggering the camera. A five-second delay was used in between trigger events. Once camera traps were retrieved, their SD cards were safely stored. The photographs were analyzed from a computer and labeled according to the species recorded.

In Langogan, a camera trap was set for two nights at an animal feeding site, 200 m from L_{S3}. In Concepcion, two cameras were established at C_{S3}; one camera was directed towards carnivore scat and the other camera was set up 100 m from this site for two nights each. One camera was set up on CN Mountain peak for one night. Camera traps were used to survey for a total of seven trap/nights.

Mist-net Traps. A 12 m by 3 m mist-net was used. Both sides of the net were hung on trees at about 8 m in height in fly ways. The nets were checked every hour starting from 17:00 until 6:00 the next morning. If an animal was caught in the net, the nets were lowered to untangle the volant mammals, such as bats, and other animals caught were promptly released.

In Langogan, a mist-net was set up in sub-site L_{S1} for two nights. In Concepcion, a mist-net was set up and monitored in sub-site C_{S3} for one night only, due to time constraints that hindered the researchers from staying in one site for more than one night.

Hand Capturing, Observing and/or Opportunistic Sampling. When possible, hand-captures of small volant and non-volant mammals were

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employed. During daylight hours, crevices on big rocks were inspected for roosting bats and tree holes were inspected for arboreal mammals. Large-bodied mammals that were seen, heard, smelled or encountered by opportunity were also recorded. Animals identified by their tracks, such as droppings, were also recorded.

Preservation of Specimens

Only the allocated number of specimens under the Wildlife Gratuitous Permit 2014-15 were preserved. Others were promptly released from where they were caught after taking the necessary information. The collected specimens were humanely euthanized by either injecting ethanol directly into the heart or snapping the neck. Each specimen was photo-documented and preserved in 10% formalin for 24 hours and then transferred to 70% ethanol for long-term preservation. The specimens are currently being used for educational purposes at Western Philippines University, Puerto Princesa Campus and will be later transferred for museum purposes.

Anthropogenic Activities

Human activities and disturbances in the area were noted from actual observations, key informant and informal interviews, and Google Earth© satellite images.

Data Analysis

Species identification was guided using synopses and the aid of individuals with previous small Philippine mammal field experience. Cumulative number of species recorded every sampling day were plotted to determine the satisfactory of sampling over the sampling period. Generated data were analyzed for diversity and abundance using standard diversity indices (Shannon H and E) and statistics.

RESULTS

Twelve mammalian species under seven orders were confirmed to occur in the CNCH during this study, wherein eight are endemic to Palawan and four are native species (Table 1). Eight species captured in this study were photo-documented (Figure 3).

Table 1. Species recorded during the Rapid Assessment of Cleopatra's Needle Critical Habitat with their corresponding IUCN category, method of capture/observation, number of individuals, and location. Categories: LC=Least Concern, NT=Near Threatened, VU=Vulnerable, EN=Endangered, DD=Data Deficient, NA=Not Yet Assessed. $^{+}$Category provided by Department of Environmental and Natural Resources (DENR 2017).

Order	Scientific name	Common Name/Local name	Category	Method	Number of Individuals	Location
Carnivora	*Paradoxurus hermaphroditus* Pallas, 1777	Asian Palm Civet "musang"	LC	Camera Trap	1	Langogan
	Aonyx cinereus Illiger, 1815	Asian Small-clawed Otter "dungon"	VU	Opportunistic sampling	NA	Concepcion
	Mydaus marchei Huet, 1887	Palawan Stink Badger "pantot"	LC	Opportunistic sampling	NA	Langogan, Concepcion
	Prionailurus bengalensis heaneyi Groves, 1997	Palawan Leopard Cat "singgarong"	NA, VU^{+}	Opportunistic sampling	NA	C_{S2}
Cetartiodactyla	*Sus ahoenobarbus* Huet, 1888	Palawan Bearded Pig "baboy-ramo"	NT, VU^{+}	Observed from hunters	2	Langogan
Chiroptera	*Cynopterus brachyotis* Müller, 1838	Lesser Short-nosed Fruit Bat "bayakan"	LC	Hand Capture	3	Langogan
Eulipotyphyla	*Tupaia palawanensis* Thomas, 1894	Palawan Shrew	LC	DPT	16	L_{S1}, L_{S2}, C_{S2}
Primates	*Macaca fascicularis* ssp. *philippensis* I. Geoffroy, 1843	Philippine Long-tailed Macaque "unggoy"	NT	Observed	~7	Langogan
Rodentia	*Chiropodomys calamianensis* Taylor, 1934	Palawan Pencil-tailed Tree Mouse	DD	Cage Trap, coconut bait	1	L_{S2}
	Hylopetes nigripes Thomas, 1893	Palawan Flying Squirrel "buyatat"	NT	Hand Capture	3	Langogan
	Maxomys panglima Robinson, 1921	Palawan Spiny Rat	LC	Cage Trap, coconut & banana baits	20	L_{S1}, L_{S2}, C_{S1}, C_{S2}, C_{S3}
Scandentia	*Crocidura palawanensis* Taylor, 1934	Palawan Treeshrew	LC	Cage Trap, banana bait	1	L_{S2}

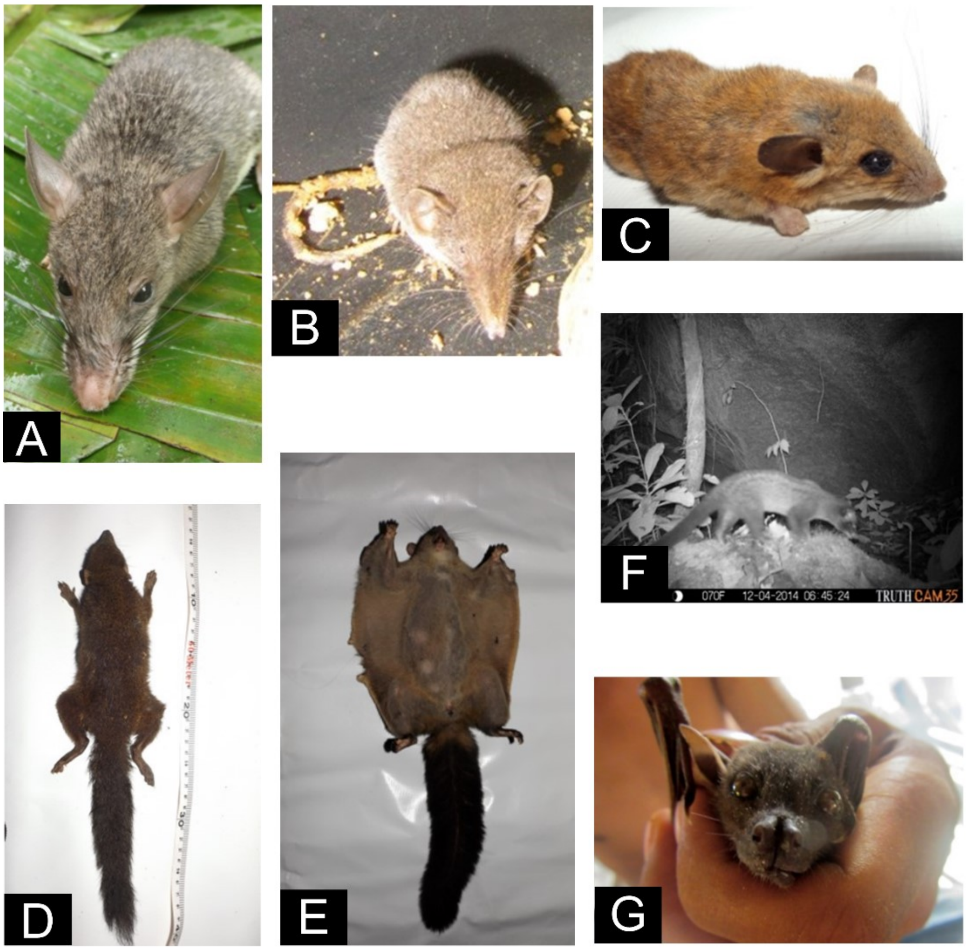

Figure 3. Photo-documentation of eight species captured during the survey: A) *Maxomys panglima* B) *Crocidura palawanensis* C) *Chiropodomys calamianensis* D) *Tupaia palawanensis* E) *Hylopetes nigripes* F) *Paradoxurus hermaphroditus* G) *Cynopterus brachyotis*.

Aonyx cinereus spraints were found alongside a river at 240 masl. *Mydaus marchei*'s distinct odor was smelled in lowland evergreen forest and riparian habitats. The droppings found near sub-site C_{S2} are likely from *P. b. heaneyi* due to their resemblance to feline droppings and the visible presence of hair, which could belong to rodent prey. A group of *M. fascicularis* ssp. *philippensis* was observed in the tree canopies in riparian habitat. *Hylopetes nigripes* were captured from their tree nest approximately 15 m from the ground (Figure 3E). *Cynopterus brachyotis* were captured from their roost in a rocky outcrop (Figure 3G). Hunters were observed retrieving two, medium and large-sized, *S. ahoenobarbus* individuals from a hunting site at a higher elevation from our surveying sites.

Satisfaction of sampling (Figure 4), diversity indices (Figure 5), and cumulative density (Figure 6) were analyzed using species richness and number of individuals caught and observed per species. As shown in the cumulative number of species recorded per day of sampling (Figure 4), sampling efforts in both sites proved inadequate to determine the totality of species in the study areas. Similarly, the diversity and evenness are apparently not so high, with a Shannon H value and evenness value of 1.789 and 0.6648, respectively, for Langogan and 1.496 and 0.6378, respectively, for Concepcion (Figure 5). Assuming our traps can attract animals from 10-meter distances in the surroundings, the estimated density results show the area had approximately 102 individuals per hectare. This would be dominated by 43% *M. panglima* and 36% *C. palawanensis*.

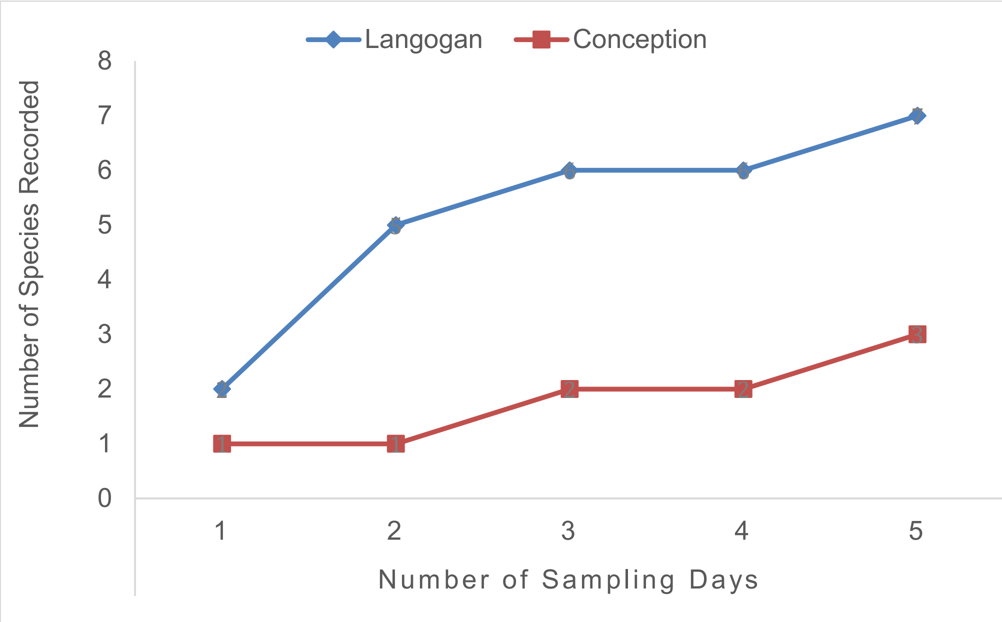

Figure 4. Cumulative number of species recorded per day from December 3 to 12 in both localities.

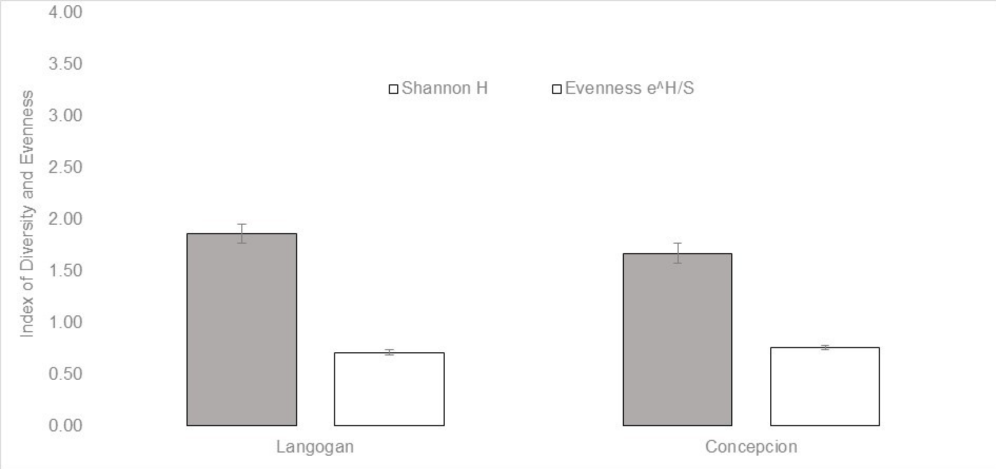

Figure 5. Diversity index revealed from the number of captured individuals per species in two sampling localities in CNCH.

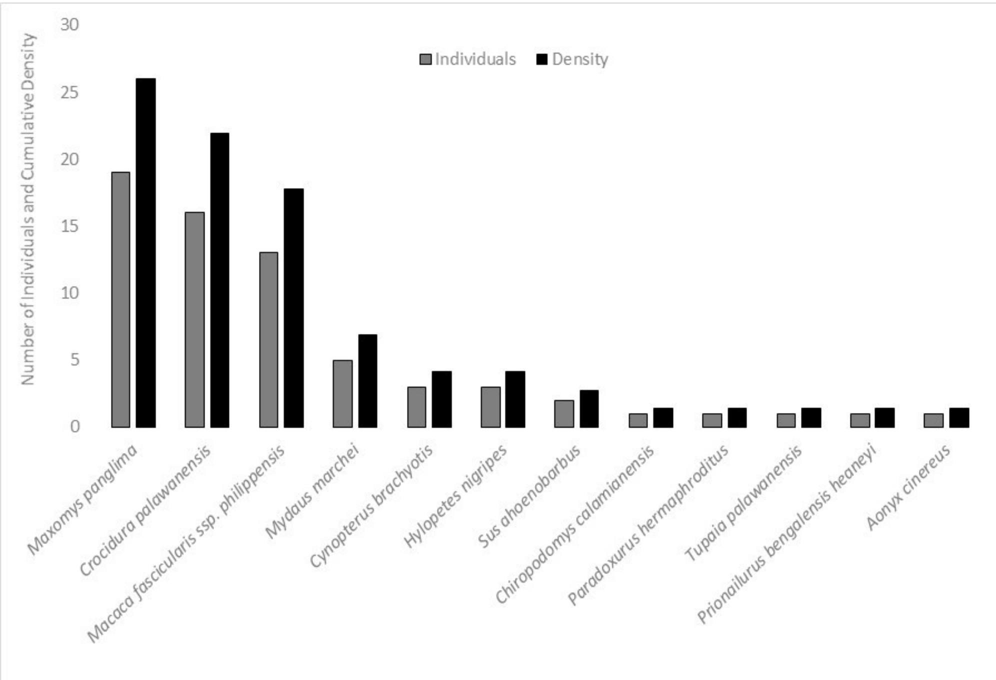

Figure 6. Cumulative density of the 12 species for each sampling locale.

DISCUSSION

There is a need to consider potential biases in capturing method among species as this could skew the species accounts in the study. Insufficient capturing methods previously left the *C. palawanensis* population understudied (Esselstyn et al. 2004); however, recent surveys using pitfall traps have proven the species to be widespread across its known range (Cassola 2016), which is reflected in our findings.

Currently, there is a need to understand species' occurrence, behavior, and population sizes; all of which can be studied using non-invasive methods that survey multiple species over larger areas (Gompper et al. 2006). Some examples include camera trapping, satellite remote sensing, and drone technology (Ancrenaz et al. 2012; Koh and Wich 2012; Pettorelli et al. 2014). Data that can be generated from these methods are relevant in understanding the ecology of study animals such as site fidelity, home range size, social behaviors, habitat use and habitat availability.

A recent LandSat image featuring areas within the sampling sites showed a substantial portion of newly cleared areas for upland farming activities (Figure 7). This was not observed during the 2014 field research. These scenarios are of great interest for biodiversity research that aims to determine effects of land use changes on species composition, abundance and other related ecological studies.

Figure 7. LandSat image of cleared forest along the Langogan River. Image created by Google Earth©.

Esselstyn et al. (2004) captured five mammal species between 1300 and 1600 masl over two weeks of surveys on Cleopatra's Needle: *Rhinolophus arcuatus*, *Pipistrellus javanicus*, *Tupaia palawanensis*, *Maxomys panglima*, and *Rattus tiomanicus*. Although habitats above 1300 masl were only surveyed one night, two of these five species were also recorded. Marler et al. (2015) recorded eight medium-bodied mammals in five months of camera trapping throughout the CNCH: *Hystrix pumila*, *Paradoxurus hermaphroditus*, *Prionailurus bengalensis heaneyi*, *Viverra tangalunga*, *Mydaus marchei*, *Herpestes brachyurus*, *Manis culionensis*, and *Sus ahoenobarbus*. Four of these species were opportunistically sampled and observed, one with the use of a camera trap as well. Further mammalian studies focused within the CNCH were not found in the literature. However, Widmann et al. (2008) recorded 35 species across five study areas in northern Palawan and Dumaran Island, with a significantly greater trapping effort than conducted here; the 12 species recorded in this study were all represented.

Approximately 20% of the 58 native mammal species were sampled in our survey. While the species diversity and evenness were not so high in this study, the species richness within each sampling locale proved unique in composition. *Tupaia palawanensis* was recorded only in Concepcion, while evidence of occurrence of *A. cinereus* and *P. bengalensis heaneyi* were likewise only observed in Concepcion. In contrast, *C. calamianensis*, *H. nigripes, C. brachyotis* and *P. hermaphroditus* were captured only in the Langogan sampling sites.

The Langogan sampling sites have a slightly higher density than in Concepcion, although statistically not significant (Figure 6). Assuming a cumulative area of sampling of 50 m^2 per DPTs and 25 m^2 per cage trap cover, there could be an average of 2.6 individuals and 3.2 individuals per 12.5 m^2 area in Concepcion and Langogan, respectively. From such data, there could be 2,080 individual animals per hectare in Concepcion and 2,560 individuals per hectare in Langogan. The ratio per species can then be determined by the individual percentages based on the total number of captured individuals per species. In this case, *M. panglima* and *C. palawanensis* dominated the species with 43% and 36% respectively. This was followed by *C. brachyotis* and *H. nigripes* (7%) and lastly *C. calamianensis*, *P. hermaphroditus* and *T. palawanensis* (2%).

Aonyx cinereus is among the least studied Asian otter species in the wild (Hussain et al. 2011). The species is widely distributed through Southeast Asia but is only found in Palawan within the Philippines (Wright et al. 2015). *Aonyx cinereus* holds a Vulnerable listing by the IUCN due to a past population decline exacerbated by habitat loss, exploitation, and depletion of prey species (Hussain et al. 2011; Wright et al. 2015). Since otters are effective symbols of environmental quality and are highly susceptible to degradation (Nawab and Gautam 2008), *A. cinereus* presence is seen as a healthy ecosystem indicator within freshwater and wetland systems in Palawan. Unfortunately, high hunting pressure and habitat loss by human modification threaten the species in Palawan (Castro and Dolorosa 2006).

Chiropodomys calamianensis is greatly understudied, with only a few specimens observed since its first scientific capture in 1918 (Kennerley 2016; Musser 1979). The species is an arboreal mouse endemic to the Palawan Faunal Region (Kennerley 2016). *Chiropodomys calamianensis*' ecological role, population status and conservation needs, if any, cannot be determined without further studies of the species.

Crocidura palawanensis, M. panglima, and *T. palawanensis* are endemic to the Palawan Faunal Region (Cassola 2016; Balete et al. 2016; Kennerley 2017). These three species seem capable to adapt to secondary habitats (Balete et al. 2016; Cassola 2016; Esselstyn et al. 2004; Heaney et al. 1998). *Maxomys panglima* seems widely distributed across primary, lowland, and low montane forests as well (Balete 2016). These three species hold a Least Concern listing, yet further studies on the species' populations will help us assess their unique ecological roles.

Cynopterus brachyotis occurrence ranges throughout South and Southeast Asia (Csorba et al. 2008). The species is common and geographically widespread in the Philippines, carrying a Least Concern listing by the IUCN (Csorba et al. 2008; Esselstyn et al. 2004). However, further taxonomic revision could reveal subspecies or separate species within the populations currently characterized as *C. brachyotis* (Heaney et al. 1998; Csorba et al. 2008). Csorba et al. (2008) fail to include the Philippines in the 'Range Description' for *C. brachyotis*. This survey and past surveys (Heaney et al. 1998; Esselstyn et al. 2004) support a revision of this assessment to incorporate Palawan and other islands in the Philippines in the range description.

Hylopetes nigripes is endemic to the Palawan Faunal Region (Ong et al. 2008). The species appears to be widespread (Heaney et al. 1998; Esselstyn et al. 2004), however, its suspected extent of occurrence is not much greater than 20,000 km^2 (Ong et al. 2008). The Batak and Tagbanua tribes hunt this species for meat. *Hylopetes nigripes* nests in cavities in large trees, thus deforestation may pose a serious risk to the species' survival (Ong et al. 2008). Further surveys are necessary to understand the species and more accurately determine a Red List category (Esselstyn et al. 2004; Ong et al. 2008).

The Philippine subspecies *M. fascicularis* ssp. *philippensis* is known to occur in agricultural areas, primary lowland forests, secondary forests, and montane forests (Heaney et al. 1998; Esselstyn et al. 2004). *Macaca fascicularis ssp. philippensis* plays important roles in seed dispersal within the forest by consuming fruit and carrying seeds on their coat (Paluga 2006).

Within Palawan, the species seems to have relatively stable populations, yet pressures exist from hunting for meat and habitat loss (Esselstyn et al. 2004; Ong and Richardson 2008).

Mydaus marchei is endemic to Palawan, Busuanga, and Calauit islands in the Philippines (Heaney et al. 1998). There seems to be no extreme fluctuations in the population size, although the species inhabits an area under 20,000 km^2 (Widmann 2015). *Mydaus marchei* can be found near human modified areas as well as primary and secondary lowland forests (Widmann 2015). The species appears to be common with threats from occasional hunting and road kills (Widmann 2015).

Paradoxurus hermaphroditus is found throughout the Philippines, where it has been recorded in agricultural and forested areas (Heaney et al. 1998; Esselstyn et al. 2004). *Paradoxurus hermaphroditus* disperses small to large seeds via consuming fruits whole and travelling through the forest as the seed passes through the gut (Nakashima et al. 2010). The species is also known to consume rats, insects, and molluscs (Duckworth et al. 2016). It is usually the most common carnivore found where it is known to occur (Duckworth et al. 2016). However, *P. hermaphroditus* is increasingly kept as a pet and captured to produce civet coffee within Indonesia and the Philippines; the effect of these actions on the wild populations is not yet assessed but likely causing a decline (Duckworth et al. 2016).

The two Philippine subspecies of *P. bengalensis* are important predators of invasive rodents (Lorica and Heaney 2013; Fernandez 2014) and can be found in agricultural fields and forests (Heaney et al. 1998; Esselstyn et al. 2004; Lorica and Heaney 2013). The two subspecies are the only wild felids found in the Philippines and are currently listed as Vulnerable by the DENR (Ross et al. 2015; DENR 2017). The Palawan subspecies has yet to be assessed by the IUCN. Island populations of Leopard Cats in the Philippines are seriously threatened (Lorica 2008; Ross et al. 2015), so population dynamics and area of occurrence for *P.b. heaneyi* must be evaluated to determine further conservation actions.

Sus ahoenobarbus is endemic to the Palawan Faunal Region where it is the largest remaining member of Palawan's megafauna (Meijaard and Widmann 2017). *Sus ahoenobarbus* could play a key role in plant dynamics in the understory, as seen with other native pigs (Ickes et al. 2001), and with forest upkeep by eating carrion. Even though the species is protected under the National Wildlife Act of the Philippines, *S. ahoenobarbus* is still commonly hunted for subsistence and the bushmeat trade (Widmann 2017). *Sus ahoenobarbus* was recently moved from a threatened category to Near Threatened by the IUCN; while the species has a small extent of occurrence and remains heavily hunted, it seems able to adapt to various habitats

(Widmann 2017). The species still holds a Vulnerable listing under the DENR (DENR 2017).

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