

# Inventory of terrestrial vertebrate wildlife species in a private-owned forest patch in Tagum City, Mindanao, Philippines

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**Abstract.** Gamalo LED, Cabrera SME, Delos Reyes NC, De Cadiz AE, Chavez Jr JB, Raganas AFM, Quibod MANRM. 2023. Inventory of terrestrial vertebrate wildlife species in a private-owned forest patch in Tagum City, Mindanao, Philippines. *Biodiversitas* 24: 1104-1116. The 93-hectare Hijo Forest, owned by the Hijo Resources Corporation, is known for its rich flora and fauna species, most especially on its exceptionally large populations of long-tailed macaques (*Macaca fascicularis*) and Philippine warty pigs (*Sus philippensis*). In 2021, the Hijo management reported a mass die-off of Philippine warty pigs in the area due to the African Swine Fever Virus (ASFV) outbreak. In response to this, conservation actions and more research initiatives were initiated. This includes the inventory of wildlife vertebrate fauna in the forest through day and night transect surveys, mist netting, trapping, and opportunistic sampling. A total of 12 mammals, 16 reptiles, 10 amphibians, and 67 bird species were recorded in this current study. Local reports also contributed to the addition of seven taxa not recorded during the survey. In total, 122 terrestrial vertebrate wildlife species inhabiting the Hijo forest were identified based on past and present fieldwork and local reports. These include species considered as Philippine endemics (i.e., *Cynocephalus volans*, *Limnonectes leytensis*, *Leptomantis bimaculatus*, *Naja samarensis*), Endangered species (i.e., *Macaca fascicularis*, *Cuora amboinensis*, *Penelopides affinis*), and Vulnerable and Near-threatened species (i.e., *Sus philippensis*, *Carlito syrichta*, *Hydrosaurus pustulatus*, *Ophiophagus hannah*). There were also two species listed as Critically-endangered on a national scale recorded in this study, the Colasisi (*Loriculus philippensis*) and Amethyst brown dove (*Phapitreron amethystinus*). The high species richness of vertebrate fauna, and the presence of numerous endemic and threatened species highlight the importance of the Hijo forest in biodiversity conservation in the region. The presence of threats, such as the recent local extinction of Philippine warty pigs in Hijo forest due to ASFV, signals an immediate call for continuous and long-term protection of the forest. Long-term education programs that include collaboration with research universities, local government units, and other non-government organizations is highly recommended to be implemented for the protection of this important forest patch in this region.

**Keywords:** Beach forest, Mindanao Island, terrestrial vertebrate fauna, threatened species, wildlife

## INTRODUCTION

Private-owned forests have large potential conservation values, which often harbor relics of historical forests that serve as habitats for diverse life forms, especially for threatened species. That is why it is important to consider private lands in planning biodiversity conservation, especially since conservation can depend on the motivation of the owners (Mölder 2016; Mölder et al. 2021). In the Philippines, large companies are mandated by the government to follow the concept of Corporate Social Responsibility (CSR), which directs them to address social and environmental issues that include environmental management and greening programs (Manto-Beltran 2022). Fortunately, in Davao Region, privately-owned forest patches, such as the Hijo Forest in Tagum City, have been active in ecotourism activities and biodiversity conservation purposes as part of their CSR obligations (Montero 2010).

The Hijo forest, which is part of the Hijo Resources Corporation (HCR), is approximately a 93-hectare area

surrounded by agricultural lands and water bodies. The forest is classified as a beach forest with flat terrain with an elevation of 8 to 26 meters above sea level. In 2010, a biodiversity assessment (Montero, 2010) was conducted in the forest to document the four major terrestrial vertebrate fauna groups (i.e., amphibians, reptiles, birds, and mammals) using standard sampling methods such as transect walks for birds and herps, standard live cage traps for non-volant mammals, and mist nets for bats and birds. Forty-seven (47) birds, three reptiles, two amphibians, and 11 mammalian species were documented to inhabit the Hijo forest including huge populations of large and medium-sized mammals such as long-tailed macaques (*Macaca fascicularis*) and Philippine warty pigs (*Sus philippensis*) (Montero 2010). However, in early 2021, the whole population of wild pigs in the forest was wiped out due to the onslaught of the African Swine Fever virus (Chavez et al. 2021). The disappearance of all wild pigs might have an influence on the local biodiversity of the Hijo forest, especially that they are considered ecological engineers

(Luskin et al. 2021).

In response to the mass die-off of the Philippine warty pigs, a one-year biodiversity survey was conducted in an attempt to characterize the potential impacts of their eradication in Hijo forest. Part of this larger objective is to list all flora and fauna in the area, including threatened and endemic terrestrial vertebrate wildlife species. These data are important to Hijo Resources Corporation's forest conservation efforts and future management programs to mitigate further wildlife loss.

## MATERIALS AND METHODS

### Permits and clearances

Before the conduct of the study, Prior Informed Consent from the Hijo Resources Corporation and a gratuitous permit (GP) from the Department of Environment and Natural Resources Region XI (GP No. XI-2021-25) were secured. Whenever necessary, voucher specimens were collected for identification and further verification. The specimens were deposited in the Department of Biological Sciences and Environmental Studies (DBSES) Wildlife Collection at the College of Science and Mathematics, University of the Philippines Mindanao.

### Study site and duration

The Hijo Plantation, where the survey was conducted, is a popular tourist destination in Barangay Madaum, City of Tagum, Province of Davao del Norte, and is managed by the Hijo Resources Corporation (HRC). The Hijo Plantation is a 325-hectare land area which covers coconut plantations, coastline, and forest reserve. The area is also surrounded by water bodies like Libuganon River on the western side, Nabintad River on the northern portion and the southern side facing the Davao Gulf. The area has a flat to nearly flat terrain based on its elevation that ranges from 8-26 meters above sea level (masl). The study site's main attraction is its hanging bridges built on the vast boles of 'dao' (*Dracontomelon dao*) trees and is used as pathways for visiting tourists. Overstory species such as 'anahaw' (*Saribus rotundifolius*), 'katmon' (*Dillenia philippinensis*), and 'dao' (*D. dao*) are among the dominant species in the area. The survey of the terrestrial wildlife species was conducted in the 93-hectare forest patch beside the Hijo Plantation. The sampling was conducted for 3-5 days per visit, with a total of four visits in one year.

### Wildlife survey

#### Mammals

A 1000-m transect traversing the center of the forest was established in the area. Four to six observers traversed the transect with flashlights in the evening from 18:00-22:00 to record all nocturnal non-volant mammalian species encountered. The transect was also traversed in the morning (6:00-9:00) to document mammals active during the day (e.g., long-tailed Macaques). Diurnal mammal species encountered during the point count method for birds were also recorded. Standard live cage traps with baits (cooked coconut with peanut butter) and camera traps (Bushnell

camera traps) were placed along the transect with intervals of approximately 20 meters and positioned in suspected areas where these animals can be captured or observed. For the volant mammals, standard mist netting was implemented and placed along the transect and in known flyways of bats (Quibod et al. 2021). Mist nets were established in the afternoon and were visited with three-hour intervals from 18:00-24:00. The mist-nets are then closed from 24:00-6:00, and reopened to capture birds in the daytime. With the aid of photographic guides (Ingle and Heaney 1992; Heaney et al. 2016), species were identified *in situ*.

#### Herpetofauna

Following the nocturnal and diurnal transect activities for mammal sampling, frogs and reptiles were documented using the visual encounter and cruising technique. This involves searching for frogs and reptiles in common microhabitats such as sources of water, rocks, fallen logs, leaf litter, leaf axils, and in other moist habitats (Dela Torre and Nuneza 2021). Frogs and reptiles which were opportunistically encountered outside the 1000-m transect were also recorded (e.g., 15:00-17:00 during placement of traps and mist nets). Identification was done *in situ* with the aid of photographic guides and other published literature (Alcala and Brown 1998; Diesmos et al. 2015; Sanguila et al. 2016; Pitogo et al. 2021).

#### Birds

In the same 1000-m transect, the team conducted a point count method for birds. The survey started at around 6:00 and ended at about 10:00 in the morning. Birds were recorded mainly through general observations with the aid of binoculars and through calls. Furthermore, mist netting during the day and multiple Hijo management-initiated birding activities inside and on the boundaries of the forest were also conducted to increase species records. Opportunistically observed and heard birds during nocturnal surveys for mammals and herps were also recorded. The bird species were identified by morphology and distribution using the field guide by Kennedy et al. (2000).

### Secondary data and local reports

Secondary data on terrestrial vertebrate wildlife was obtained from the technical report by Montero (2010). Local reports were also considered in the list upon the presentation of proofs (e.g., carcass, pictures, etc.). Accounts of the species' conservation status were based on the updated International Union for Conservation of Nature (IUCN 2022-1) and from the Philippine Red list of Threatened Wildlife Fauna (DAO 2019-09).

## RESULTS AND DISCUSSION

### Species accounts

A total of 122 terrestrial vertebrate wildlife species were identified in the Hijo forest from the current field surveys, previous records (Montero 2010), and from local reports by the forest guards and Hijo management. Overall, 17 mammalian species were identified in the area. An

additional five species, namely, common palm civet (*Paradoxurus hermaphroditus*), Geoffroy's rousette (*Rousettus amplexicaudatus*), large footed myotis (*Myotis macrosternus*), Nepalese whiskered bat (*Myotis muricola*), and the Philippine forest rat (*Rattus everetti*) were observed in recent surveys (Table 1). There were species recorded in the 2010 study that was not observed in the recent fieldwork, namely Philippine tree squirrel (*Sundasciurus philippinensis*), Philippine warty pig (*Sus philippensis*), Philippine forest round leaf bat (*Hipposideros cf. obscurus*), and the Philippine tarsier (*Carlito syrichta*). However, there are still sightings of tarsiers in 2019 according to the park managers and forest guards. Of these species, long-tailed macaques, Philippine warty pig and the Philippine tarsier are listed as Endangered, Vulnerable, and OTS, respectively, by the IUCN and/or DENR Administrative Order (DAO) 2019-09.

For amphibians, a total of 11 species were identified. Ten species from the recent study were observed on the site. From the three species recorded by Montero (2010), only the Mindanao flying frog (*Leptomantis bimaculatus*) was not observed in the recent assessments (Table 1). The survey also documented 16 species of reptiles, of which 14 species were added to the list in the recent surveys. Additionally, five species were locally reported by the management and forest guards, namely, paradise tree snake (*Chrysopelea paradisi*), Philippine bronzeback tree snake (*Dendrelaphis philippinensis*), red-tailed green rat snake (*Gonyosoma oxycephalum*), Bornean keeled viper (*Tropidolaemus subannulatus*), and king cobra (*Ophiophagus hannah*). The king cobra, Philippine sailfin lizard (*Hydrosaurus pustulatus*), red-tailed green rat snake, Southeast Asian box turtle (*Cuora amboinensis*), tokay gecko (*Gekko gekko*), intermediate flying gecko (*Gekko intermedium*), Bornean keeled viper, reticulated python (*Malayopython reticulatus*), Philippine water monitor lizard (*Varanus cumingi*), and Samar cobra (*Naja samarensis*) are under threat (IUCN 2022; DAO 2019-09).

The recent survey also added a total of 25 species of birds from the 47 recorded by Montero (2010), totaling to 72 avian species recorded in the area. However, five species were not observed in the recent fieldwork, which includes the yellow wagtail (*Motacilla flava*), short-tailed glossy starling (*Aplonis minor*), metallic-winged sunbird (*Aethopyga pulcherrima*), red-keeled flowerpecker (*Dicaeum australe*), and the short-crested monarch (*Hypothymis helenae*). Threatened bird species recorded in the study site include the Mindanao hornbill (*Penelopides affinis*), Amethyst brown dove (*Phapitreron amethystinus*), and colasisi (*Loriculus philippensis*).

## Profile of threatened and other wildlife species

### Mammals

#### *Sus philippensis*

Endemic to the Philippines, the species is present in Luzon, Samar, Leyte, Mindanao islands, and in nearby

smaller islands. The species' unique morphological characteristics include black with gray-colored fur and a crown tuft and nuchal mane extending along the back, and two pairs of warts in males (Cabañas et al. 2022). They are considered vulnerable under the IUCN and DAO 2019-09. Threats to the species include hunting, habitat destruction, and pathogens such as the African Swine Fever Virus (ASFV) virus. The whole population was eradicated due to the local infection of ASFV in the area (Chavez et al. 2021), but bones of warty pigs were observed in the forest during the study.

#### *Macaca fascicularis*

This species is native to the Philippines and is present all throughout the archipelago (Yao et al. 2017). They are the only monkey species in the country and are characterized by its very long tail, which is longer than their body and head length. Being an adaptive species, they can inhabit different habitats. The species was recently considered endangered in the updated IUCN red list due to the numerous threats to its population in all its range (Hansen et al. 2022), thus studies on their population and ecology in the wild are urgently needed for their conservation in the Philippines (Gamalo et al. 2021). In the study area, they are frequently observed inside the forest, and sometimes beside the road and in the nearby coconut plantations foraging for food (Figure 1A).

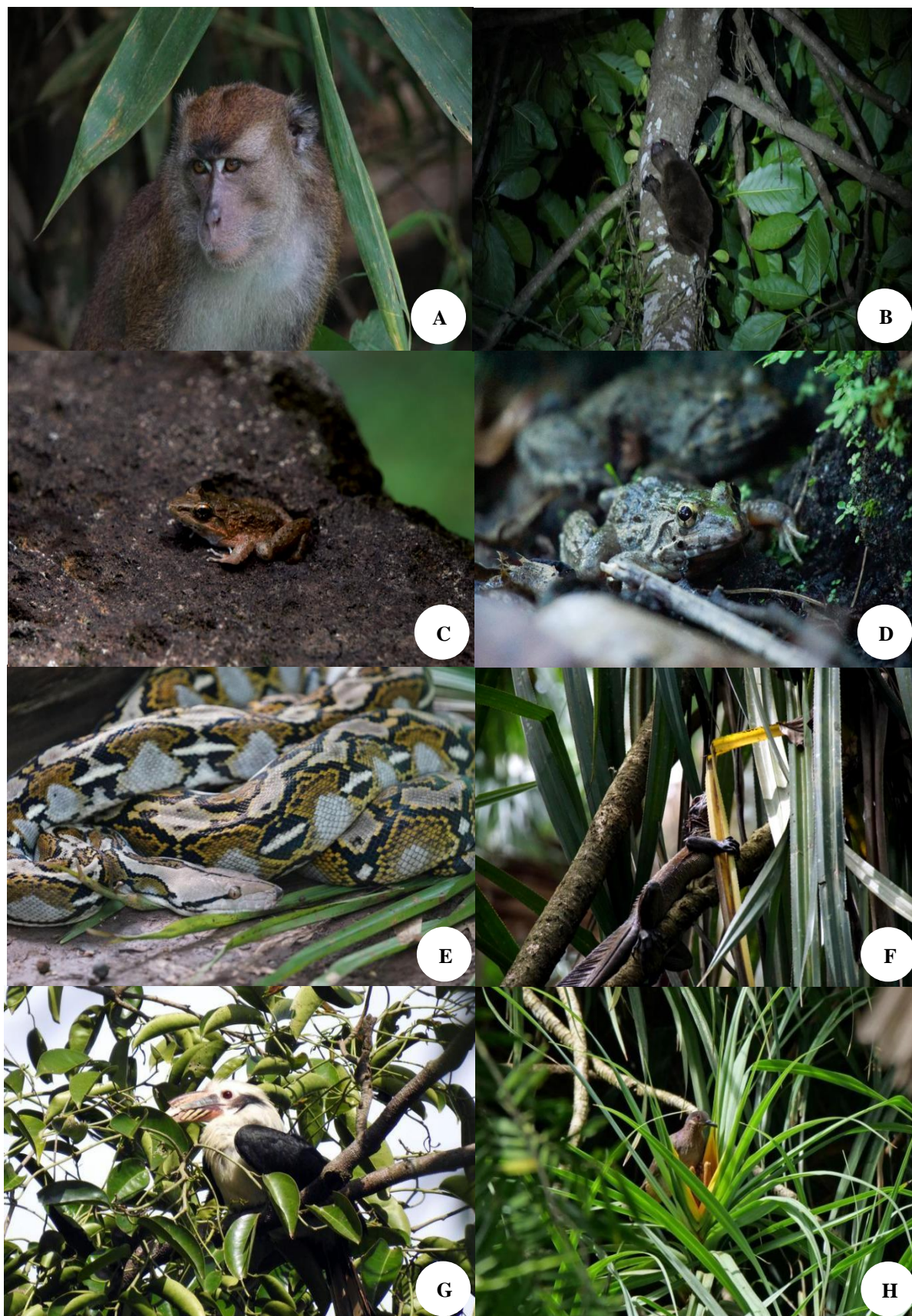
#### *Carlito syrichta*

Philippine tarsiers are endemic in the Mindanao Faunal Region and are considered threatened under DAO 2019-09. The most recent genetic data suggests that the Mindanao tarsier is genetically different from Dinagat and Bohol-Samar-Leyte populations (Brown et al. 2014; ). The species is active during the night, foraging insects and other small animals. They can be found in different habitat types, including karst forests, secondary forests, and beach forests. The species was recorded by Montero (2010) and local reports inside the forest and on its boundaries in 2019.

#### *Cynopterus cf. brachyotis*

This species is easily recognized with its ear having pale or white anterior edges. It can be identified from other similar species (*Ptenochirus jagori* and *Ptenochirus minor*) by its four upper and four lower incisors (Ingle and Heaney 1992). It is widely distributed throughout Southeast Asia and recorded as abundant in disturbed lowland habitats, like residential, agricultural, and urban areas (Heaney et al. 2016). However, the latest genomic data suggest that the Philippine population, particularly those from Mindanao island, might be a different species from other *C. brachyotis* outside the country (Gaite et al. 2022). The species was not reported during the 2010 assessment but was observed to be the most abundant among all bat species recorded in the recent assessment.





**Figure 1.** Select photos of species found in Hijo forest, Tagum City, Mindanao, Philippines. A. Long-tailed Macaque; B. Philippine Flying Lemur; C. Leyte Wart Frog; D. Luzon Wart Frog; E. Reticulated Python; F. Philippine Sailfin Lizard; G. Mindanao Hornbill; H. Amethyst Brown Dove

**Table 1.** Checklist of vertebrate wildlife species recorded in Hijo Forest with their resident and conservation status

| Species   | Common name                      | Status                |                  |                 |
|---|----------------------------------|-----------------------|------------------|-----------------|
|   |                                  | Philippine<br>Endemic | IUCN Red<br>List | DAO 2019-<br>09 |
| <b>MAMMALS</b>  |                                  |                       |                  |                 |
| <b>Cercopithecidae</b>  |                                  |                       |                  |                 |
| <i>Macaca fascicularis</i> (Raffles, 1821)                              | Long-tailed Macaque              | No                    | EN               | OWS             |
| <b>Cynocephalidae</b>   |                                  |                       |                  |                 |
| <i>Cynocephalus volans</i> (Linnaeus, 1758)                             | Philippine Flying Lemur          | Yes                   | LC               | OWS             |
| <b>Megadermatidae</b>   |                                  |                       |                  |                 |
| <i>Megaderma spasma</i> (Linnaeus, 1758)                                | Lesser False Vampire bat         | No                    | LC               | OWS             |
| <b>Muridae</b>  |                                  |                       |                  |                 |
| <i>Rattus everetti</i> (Günther, 1879)                                  | Philippine Forest Rat            | Yes                   | LC               | OWS             |
| <i>Rattus tanezumi</i> Temminck, 1844                                   | Oriental House Rat               | No                    | LC               | OWS             |
| <b>Pteropodidae</b>   |                                  |                       |                  |                 |
| <i>Cynopterus</i> cf. <i>brachyotis</i> (Müller, 1838)                  | Common Short-nosed Fruit Bat     | -                     | -                | -               |
| <i>Macroglossus minimus</i> (É. Geoffroy Saint-Hilaire, 1810)           | Dagger-toothed Flower Bat        | No                    | LC               | OWS             |
| <i>Ptenochirus jagori</i> (Peters, 1861)                                | Lesser Musky Fruit Bat           | Yes                   | LC               | OWS             |
| <i>Rousettus amplexicaudatus</i> (É. Geoffroy Saint-Hilaire, 1810)      | Geoffroy’s Rousette              | No                    | LC               | OWS             |
| <b>Rhinolophidae</b>  |                                  |                       |                  |                 |
| <i>Hipposideros</i> cf. <i>obscurus</i> (Peters, 1861)                  | Philippine Forest Round Leaf Bat | -                     | -                | -               |
| <b>Sciuridae</b>  |                                  |                       |                  |                 |
| <i>Sundasciurus philippinensis</i> (Waterhouse, 1839)*                  | Philippine Tree Squirrel         | Yes                   | LC               | OWS             |
| <b>Suidae</b>   |                                  |                       |                  |                 |
| <i>Sus philippensis</i> Nehring, 1886*                                  | Philippine Warty Pig             | Yes                   | VU               | VU              |
| <b>Tarsiidae</b>  |                                  |                       |                  |                 |
| <i>Carlito syrichta</i> (Linnaeus, 1758)*                               | Philippine Tarsier               | Yes                   | NT               | OTS             |
| <b>Viverridae</b>   |                                  |                       |                  |                 |
| <i>Paradoxurus hermaphroditus</i> (Pallas, 1777)                        | Common Palm Civet                | No                    | LC               | OWS             |
| <b>Vespertilionidae</b>   |                                  |                       |                  |                 |
| <i>Myotis macrotarsus</i> (Waterhouse, 1845)                            | Large-footed Myotis              | No                    | LC               | OWS             |
| <i>Myotis muricola</i> (Gray, 1846)                                     | Nepalese Whiskered Bat           | No                    | -                | OWS             |
| <i>Myotis</i> sp.*  | -                                | -                     | -                | -               |
| <b>AMPHIBIANS</b>   |                                  |                       |                  |                 |
| <b>Bufonidae</b>  |                                  |                       |                  |                 |
| <i>Rhinella marina</i> (Linnaeus, 1758)                                 | Cane Toad                        | No                    | LC               | OWS             |
| <b>Dicroglossidae</b>   |                                  |                       |                  |                 |
| <i>Fejervarya moodiei</i> (Taylor, 1920)                                | Crab-eating Frog                 | Yes                   | DD               | OWS             |
| <i>Fejervarya vittigera</i> (Wiegmann, 1835)                            | Luzon Wart Frog                  | Yes                   | LC               | OWS             |
| <i>Limnonectes leytensis</i> (Boettger, 1893)                           | Leyte Wart Frog                  | Yes                   | LC               | OWS             |
| <i>Hoplobatrachus rugulosus</i> (Wiegmann, 1834)                        | Chinese Edible Frog              | No                    | LC               | OWS             |
| <b>Microhylidae</b>   |                                  |                       |                  |                 |
| <i>Kalophrynus sinensis</i> Peters, 1867                                | Philippine Sticky Frog           | No                    | -                | OWS             |
| <i>Kaloula conjuncta</i> (Peters, 1863)                                 | Philippine Narrow-mouth Toad     | Yes                   | LC               | OWS             |
| <i>Kaloula pulchra</i> Gray, 1831                                       | Banded Bullfrog                  | No                    | LC               | OWS             |
| <b>Rhacophoridae</b>  |                                  |                       |                  |                 |
| <i>Kurixalus appendiculatus</i> (Günther, 1858)                         | Friilled Tree Frog               | No                    | LC               | OWS             |
| <i>Leptomantis bimaculatus</i> (Peters, 1867)*                          | Mindanao Flying Frog             | Yes                   | LC               | OWS             |
| <i>Polypedates leucomystax</i> (Gravenhorst, 1829)                      | Common Tree Frog                 | No                    | LC               | OWS             |
| <b>REPTILES</b>   |                                  |                       |                  |                 |
| <b>Agamidae</b>   |                                  |                       |                  |                 |
| <i>Draco bimaculatus</i> Günther, 1864                                  | Two Spotted Flying Lizard        | Yes                   | LC               | OWS             |
| <i>Hydrosaurus pustulatus</i> (Eschscholtz, 1829)                       | Philippine Sailfin Lizard        | Yes                   | VU               | OTS             |
| <b>Colubridae</b>   |                                  |                       |                  |                 |
| <i>Chrysopelea paradisi</i> H. Boie in F. Boie, 1827*                   | Paradise Tree Snake              | No                    | LC               | OWS             |
| <i>Dendrelaphis philippinensis</i> (Günther, 1879)*                     | Philippine Bronzeback Snake      | Yes                   | -                | OWS             |
| <i>Gonyosoma oxycephalum</i> (Boie, 1827)*                              | Red-tailed Green Ratsnake        | No                    | LC               | OTS             |
| <i>Lycodon capucinus</i> H. Boie in F. Boie, 1827                       | Common Wolf Snake                | No                    | LC               | OWS             |
| <b>Elapidae</b>   |                                  |                       |                  |                 |
| <i>Naja samarensis</i> Peters, 1861                                     | Samar Cobra                      | Yes                   | LC               | OTS             |
| <i>Ophiophagus hannah</i> (Cantor, 1836)*                               | King Cobra                       | No                    | VU               | OTS             |
| <b>Gekkonidae</b>   |                                  |                       |                  |                 |
| <i>Cyrtodactylus annulatus</i> (Taylor, 1915)                           | Small Bent-toed Gecko            | Yes                   | LC               | OWS             |
| <i>Gekko gekko</i> (Linnaeus, 1758)                                     | Tokay Gecko                      | No                    | LC               | OTS             |
| <i>Gekko</i> c.f. <i>monarchus</i> (Schlegel in Duméril & Bibron, 1836) | Spotted House Gecko              | -                     | -                | -               |



|   |                                 |     |    |     |
|---|---------------------------------|-----|----|-----|
| <i>Gekko intermedium</i> (Taylor, 1915)                         | Intermediate Flying Gecko       | Yes | NT | OTS |
| <i>Gehyra mutilata</i> (Wiegmann, 1834)                         | Stump-toed Gecko                | No  | LC | OWS |
| <i>Hemidactylus frenatus</i> Schlegel in Duméril & Bibron, 1836 | Common House Gecko              | No  | LC | OWS |
| <i>Hemidactylus platyurus</i> (Schneider, 1792)                 | Flat-tailed House Gecko         | No  | LC | OWS |
| <b>Geoemydidae</b>  |                                 |     |    |     |
| <i>Cuora amboinensis</i> (Riche in Daudin, 1801)                | Southeast Asian Box Turtle      | No  | EN | OTS |
| <b>Pythonidae</b>   |                                 |     |    |     |
| <i>Malayopython reticulatus</i> (Schneider, 1801)               | Reticulated Python              | No  | LC | OTS |
| <b>Scincidae</b>  |                                 |     |    |     |
| <i>Parvoscincus</i> sp.   | -                               | -   | -  | -   |
| <i>Lamprolepis smaragdina</i> (Lesson, 1826)                    | Emerald Skink                   | No  | LC | OWS |
| <i>Sphenomorphus fasciatus</i> (Gray, 1845)*                    | Banded Sphenomorphus            | Yes | LC | OWS |
| <b>Varanidae</b>  |                                 |     |    |     |
| <i>Varanus cumingi</i> Martin, 1839                             | Philippine Water Monitor Lizard | Yes | LC | OTS |
| <b>Viperidae</b>  |                                 |     |    |     |
| <i>Tropidolaemus subannulatus</i> (Gray, 1842)*                 | Bornean Keeled Viper            | No  | LC | OTS |
| <b>BIRDS</b>  |                                 |     |    |     |
| <b>Acanthazidae</b>   |                                 |     |    |     |
| <i>Gerygone sulphurea</i> Wallace, 1864                         | Golden-bellied Gerygone         | No  | LC | OWS |
| <b>Accipitridae</b>   |                                 |     |    |     |
| <i>Accipiter trivirgatus</i> (Temminck, 1824)                   | Crested Goshawk                 | No  | LC | OWS |
| <i>Butastur indicus</i> (Gmelin, 1788)                          | Grey-faced Buzzard              | No  | LC | OWS |
| <i>Haliastur indus</i> (Boddaert, 1783)                         | Brahminy Kite                   | No  | LC | OWS |
| <i>Spilornis holospilus</i> (Vigors, 1831)                      | Philippine Serpent Eagle        | Yes | LC | OWS |
| <b>Alcedinidae</b>  |                                 |     |    |     |
| <i>Todiramphus chloris</i> (Boddaert, 1783)                     | Collared Kingfisher             | No  | LC | OWS |
| <b>Anatidae</b>   |                                 |     |    |     |
| <i>Dendrocygna arcuata</i> (Horsfield, 1824)                    | Wandering Whistling Duck        | No  | LC | OWS |
| <b>Apodidae</b>   |                                 |     |    |     |
| <i>Aerodramus amelis</i> (Oberholser, 1906)                     | Ameline Swiftlet                | No  | NL | OWS |
| <i>Cypsiurus balasiensis</i> (Gray, 1829)                       | Asian Palm Swift                | No  | LC | OWS |
| <i>Collocalia isonota</i> Oberholser, 1906                      | Ridgetop Swiftlet               | No  | NL | OWS |
| <b>Ardeidae</b>   |                                 |     |    |     |
| <i>Bubulcus coromandus</i> Linnaeus, 1758                       | Cattle egret                    | No  | LC | OWS |
| <i>Butorides striata</i> (Linnaeus, 1758)                       | Striated Heron                  | No  | LC | OWS |
| <i>Nycticorax caledonicus</i> (Gmelin, 1789)                    | Rufous Night-heron              | No  | LC | OWS |
| <i>Nycticorax nycticorax</i> (Linnaeus, 1758)                   | Black-crowned Night Heron       | No  | LC | OWS |
| <b>Artamidae</b>  |                                 |     |    |     |
| <i>Artamus leucorhynchus</i> (Linnaeus, 1771)                   | White-breasted Woodswallow      | No  | LC | OWS |
| <b>Bucerotidae</b>  |                                 |     |    |     |
| <i>Penelopides affinis</i> Tweeddale, 1877                      | Mindanao Hornbill               | Yes | EN | OWS |
| <b>Campephagidae</b>  |                                 |     |    |     |
| <i>Lalage nigra</i> (Forster, 1781)                             | Pied Triller                    | No  | LC | OWS |
| <b>Capitonidae</b>  |                                 |     |    |     |
| <i>Psilopogon haemacephalus</i> (Müller, 1776)                  | Coppersmith Barbet              | No  | LC | OWS |
| <b>Caprimulgidae</b>  |                                 |     |    |     |
| <i>Caprimulgus manillensis</i> Walden, 1875                     | Philippine Nightjar             | Yes | LC | OWS |
| <b>Columbidae</b>   |                                 |     |    |     |
| <i>Phapitreron amethystinus</i> Bonaparte, 1855                 | Amethyst brown dove             | Yes | LC | CR  |
| <i>Chalcophaps indica</i> (Linnaeus, 1758)                      | Common Emerald Dove             | No  | LC | OWS |
| <i>Macropygia tenuirostris</i> Bonaparte, 1854                  | Philippine Cuckoo-dove          | No  | LC | OWS |
| <i>Treron vernans</i> (Linnaeus, 1771)                          | Pink-necked green pigeon        | No  | LC | OWS |
| <i>Phapitreron brevirostris</i> Tweeddale, 1877                 | Short-billed Brown Dove         | Yes | LC | OWS |
| <i>Spilopelia chinensis</i> (Scopoli, 1786)                     | Spotted Dove                    | No  | NL | OWS |
| <i>Geopelia striata</i> (Linnaeus, 1766)                        | Zebra Dove                      | No  | LC | OWS |
| <b>Corvidae</b>   |                                 |     |    |     |
| <i>Corvus macrorhynchos</i> Wagler, 1827                        | Large-billed Crow               | No  | LC | OWS |
| <b>Cuculidae</b>  |                                 |     |    |     |
| <i>Eudynamis scolopacea</i> (Linnaeus, 1758)                    | Asian Koel                      | No  | LC | OWS |
| <i>Cacomantis variolosus</i> (Vigors & Horsfield, 1826)*        | Brush Cuckoo                    | No  | LC | OWS |
| <i>Chrysococcyx minutillus</i> (Gould, 1859)                    | Little Bronze Cuckoo            | No  | LC | OWS |
| <i>Centropus viridis</i> (Scopoli, 1786)                        | Philippine Coucal               | Yes | LC | OWS |
| <i>Surniculus velutinus</i> Sharpe, 1877                        | Philippine Drongo-Cuckoo        | Yes | LC | OWS |
| <b>Dicaeidae</b>  |                                 |     |    |     |
| <i>Dicaeum hypoleucum</i> Sharpe, 1876*                         | Buzzing flowerpecker            | Yes | LC | OWS |
| <i>Dicaeum australe</i> (Hermann, 1783)*                        | Red-keeled flowerpecker         | Yes | LC | OWS |

|   |                              |     |    |     |  |
|---|------------------------------|-----|----|-----|--|
| <b>Estrildidae</b>                              |                              |     |    |     |  |
| <i>Lonchura atricapilla</i> (Vieillot, 1807)    | Chestnut Munia               | No  | LC | OWS |  |
| <i>Lonchura leucogastra</i> (Blyth, 1846)       | White-bellied Munia          | No  | NL | OWS |  |
| <b>Fregatidae</b>                               |                              |     |    |     |  |
| <i>Fregata ariel</i> (Gray, 1845)               | Lesser Frigatebird           | No  | LC | OWS |  |
| <b>Hirundinidae</b>                             |                              |     |    |     |  |
| <i>Hirundo rustica</i> Linnaeus, 1758           | Barn Swallow                 | No  | LC | OWS |  |
| <i>Hirundo tahitica</i> Gmelin, 1789            | Pacific Swallow              | No  | LC | OWS |  |
| <b>Laniidae</b>                                 |                              |     |    |     |  |
| <i>Lanius cristatus</i> Linnaeus, 1758          | Brown Shrike                 | No  | NL | OWS |  |
| <b>Laridae</b>                                  |                              |     |    |     |  |
| <i>Chlidonias hybrida</i> (Pallas, 1811)        | Whiskered Tern               | No  | LC | OWS |  |
| <b>Meropidae</b>                                |                              |     |    |     |  |
| <i>Merops americanus</i> P. L. S. Müller, 1776  | Blue-throated Bee-eater      | Yes | LC | OWS |  |
| <b>Motacillidae</b>                             |                              |     |    |     |  |
| <i>Motacilla cinerea</i> Tunstall, 1771         | Grey Wagtail                 | No  | LC | OWS |  |
| <i>Motacilla flava</i> Linnaeus, 1758*          | Yellow Wagtail               | No  | NL | OWS |  |
| <b>Musicapidae</b>                              |                              |     |    |     |  |
| <i>Hypothymis azurea</i> (Boddaert, 1783)       | Black-naped Monarch          | No  | LC | OWS |  |
| <i>Muscicapa griseisticta</i> (Swinhoe, 1861)   | Grey-streaked Flycatcher     | No  | LC | OWS |  |
| <i>Rhipidura nigritorquis</i> Vigors, 1831      | Philippine Pied Fantail      | No  | LC | OWS |  |
| <i>Hypothymis helenae</i> (Steere, 1890)*       | Short-crested Monarch        | Yes | NT | OTS |  |
| <b>Nectariniidae</b>                            |                              |     |    |     |  |
| <i>Antheptes malacensis</i> (Scopoli, 1786)     | Brown-throated Sunbird       | No  | LC | OWS |  |
| <i>Aethopyga pulcherrima</i> Sharpe, 1876*      | Metallic-winged Sunbird      | Yes | LC | OWS |  |
| <i>Cinnyris jugularis</i> (Linnaeus, 1766)      | Olive-backed Sunbird         | No  | LC | OWS |  |
| <b>Oriolidae</b>                                |                              |     |    |     |  |
| <i>Oriolus chinensis</i> Linnaeus, 1766         | Black-naped Oriole           | No  | LC | OWS |  |
| <b>Pandionidae</b>                              |                              |     |    |     |  |
| <i>Pandion haliaetus</i> (Linnaeus, 1758)       | Osprey                       | No  | LC | OWS |  |
| <b>Passeridae</b>                               |                              |     |    |     |  |
| <i>Passer montanus</i> (Linnaeus, 1758)         | Eurasian Tree Sparrow        | No  | LC | OWS |  |
| <b>Phasianidae</b>                              |                              |     |    |     |  |
| <i>Gallus gallus</i> (Linnaeus, 1758)           | Red Junglefowl               | No  | LC | OWS |  |
| <b>Pittidae</b>                                 |                              |     |    |     |  |
| <i>Pitta sordida</i> (Müller, 1776)             | Hooded Pitta                 | No  | LC | OWS |  |
| <b>Psittacidae</b>                              |                              |     |    |     |  |
| <i>Loriculus philippensis</i> (Müller, 1776)    | Colasisi                     | Yes | LC | CR  |  |
| <i>Bolbopsittacus lunulatus</i> (Scopoli, 1786) | Guaiabero                    | Yes | LC | OWS |  |
| <b>Pycnonotidae</b>                             |                              |     |    |     |  |
| <i>Hypsipetes philippinus</i> (Forster, 1795)   | Philippine Bulbul            | Yes | LC | OWS |  |
| <i>Pycnonotus goiavier</i> (Scopoli, 1786)      | Yellow-vented Bulbul         | No  | LC | OWS |  |
| <i>Pycnonotus urostictus</i> (Salvadori, 1870)  | Yellow-wattled Bulbul        | Yes | LC | OWS |  |
| <b>Rallidae</b>                                 |                              |     |    |     |  |
| <i>Gallirallus torquatus</i> (Linnaeus, 1766)   | Barred Rail                  | No  | LC | OWS |  |
| <i>Amaurornis olivacea</i> (Meyen, 1834)        | Philippine Bush-hen          | Yes | LC | OWS |  |
| <i>Amaurornis phoenicurus</i> (Pennant, 1769)   | White-breasted Waterhen      | No  | LC | OWS |  |
| <b>Scolopacidae</b>                             |                              |     |    |     |  |
| <i>Actitis hypoleucos</i> Linnaeus, 1758        | Common Sandpiper             | No  | LC | OWS |  |
| <i>Numenius phaeopus</i> (Linnaeus, 1758)       | Whimbrel                     | No  | LC | OWS |  |
| <b>Sturnidae</b>                                |                              |     |    |     |  |
| <i>Aplonis panayensis</i> (Scopoli, 1783)       | Asian Glossy Starling        | No  | NL | OWS |  |
| <i>Aplonis minor</i> (Bonaparte, 1851)*         | Short-tailed Glossy Starling | No  | LC | OWS |  |
| <b>Sylviidae</b>                                |                              |     |    |     |  |
| <i>Megalurus timoriensis</i> Wallace, 1864      | Tawny Grassbird              | No  | NL | OWS |  |
| <b>Timaliidae</b>                               |                              |     |    |     |  |
| <i>Macronus striaticeps</i> Sharpe, 1877        | Brown tit Babbler            | Yes | LC | OWS |  |
| <b>Turdidae</b>                                 |                              |     |    |     |  |
| <i>Copsychus mindanensis</i> (Boddaert, 1783)   | Philippine Magpie-robin      | Yes | LC | OWS |  |
| <b>Tytonidae</b>                                |                              |     |    |     |  |
| <i>Tyto longimembris</i> (Jerdon, 1839)         | Eastern Grass Owl            | No  | LC | OWS |  |

Note: \*species recorded by Montero/reported by the management and or local forest guards. E: Endemic; CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; NL: Not Listed; OTS: Other Threatened Species; OWS: Other Wildlife Species; LC: Least Concern; DD: Data Deficient.

*Ptenochirus jagori*

This fairly large fruit bat is endemic to the Philippines and is widely distributed throughout the country except Batanes, Babuyan, and Palawan faunal regions. They have four upper and two lower incisors (Ingle and Heaney 1992). *Ptenochirus jagori* can thrive in lowland forests and montane forests and can adapt to disturbed habitats with small pockets of forest mixed with agricultural land, such as in the study site. They also roost in tree hollows found within the forest. Along with *C. brachyotis*, the species is one of the most abundant in the study site. The species is not considered threatened under the IUCN Red List and DAO 2019-09.

*Megaderma spasma*

Chiropterologists described *Megaderma spasma* as a “spectacular bat” because of its huge and unique ears that are joined over its forehead, further characterized with a long and slender tragus. In the Philippines, the species is found in the entire archipelago from sea level up to 1600 m (Heaney et al. 2016). They can be found in bamboo thickets, mixed agroforest, primary or mature secondary forest but also in abandoned buildings, caves, big tree hollows, culverts, tunnels, and rock-boulder crevices, where they usually roost in small groups (Heaney et al. 1998; Gaikwad et al. 2012). Only a few individuals were recorded in the entire survey and were observed roosting in ‘dao’ (*Dracontomelon dao*) tree hollows within the forest. The species is not classified as threatened under IUCN Red List and DAO 2019-09.

*Sundasciurus philippinensis*

This medium-sized, endemic squirrel in the Philippines can be characterized by its dark brown hairs tipped with pale brown dorsally and gray or pale brown ventrally, although there is a geographic variation in the coloration of their pelage. It can be found in the primary and secondary lowland and montane forests, up to elevations of approximately 2100 meters. The species can also be found close to agricultural lands, such as in the study site. The species is widespread, locally abundant, and regarded as a crop pest in certain places in the country because they feed primarily on seeds and fruits of crops (Heaney et al. 1998). The species was only recorded in the area in the 2010 assessment by Montero (2010).

*Cynocephalus volans*

Locally known as “kagwang”, *Cynocephalus volans* is endemic to the Mindanao Faunal Region. This highly distinctive animal has a gliding membrane between the forelimbs and hindlimbs and extends to its hind legs and in-between its toes of the foot, making them an arboreal species (Heaney et al. 1998). The species is common in lowland and mountain forests and sometimes in mixed forests, orchards, coconut plantations and rubber plantations. Flying lemurs are threatened by forest habitat destruction due to deforestation and land conversion for agriculture but are known to persist in disturbed habitats (Heaney et al. 1998). They are the primary prey of Philippine eagles in Mindanao and are also hunted for food by humans. The species is currently considered as Least concern by the IUCN Red List.

In the area, two individuals were observed in the recent sampling (Figure 1B).

*Rattus everetti*

This endemic rodent to the Philippines has a tail feature very distinct from the other rodents in the family Muridae, which has a dark base and 20-50% white tip. They are commonly distributed in Greater Luzon and Greater Mindanao faunal region, with the exception of most or all of the Palawan Fauna Region, Sulu, Batanes/Babuyan Archipelago, and Greater Negros Panay Island (CONserve-KAIGANGAN 2019). They are not commonly found in secondary forests and are usually absent in agricultural areas (Heaney et al. 2016). The species is not listed as threatened by the IUCN Red List and DAO 2019-09. Individuals were captured through standard live cage traps.

**Amphibians***Limnonectes leytensis*

This species of frog is endemic throughout the Mindanao faunal region and is known to inhabit streams, swamps, riverbanks, and other wetlands. It can be easily identified through the “v” mark on its scapular region, its wrinkled skin, and its small body size (Siler et al. 2009; Diesmos et al. 2015). It was observed to be the most dominant frog species found in the area (Figure 1C). Currently, *L. leytensis* is not considered threatened by IUCN and DAO 2019-09.

*Fejervarya moodiei*

Endemic to the Philippines, crab-eating frogs are known to occur in coastal habitats such as mangroves, brackish water swamps, and river mouth estuarine areas (Sanguila et al. 2016). This IUCN red list ‘data deficient’ species is characterized by its medium to large body size, dark markings on the dorsal side of the hind and forelimbs, and skinfolds that are not arranged in series (Yodthong et al. 2019). They were frequently encountered in water bodies inside the forest, especially during rainy days.

*Fejervarya vittigera*

A Philippine endemic species is locally consumed for its large hind limbs (Solania et al. 2021). Luzon wart frog is a least concerned species classified by the IUCN red list and is usually found in muddy substrates, artificial ponds, and lakes. They can also be seen along agricultural fields and in non-forest areas up to 600 meters above sea level (Diesmos et al. 2014; Solania and Fernandez-Gamalinda 2018). They were frequently found in the swampy areas of the forest (Figure 1D).

*Leptomantis bimaculatus*

The Mindanao flying frog is endemic to the Philippines, known to occur in southern Luzon, Bohol, and Mindanao (Diesmos et al. 2008). The genus *Leptomantis*, where the *L. bimaculatus* is now placed, was formerly considered part of the genus *Rhacophorus* (Jiang et al. 2019). These frogs are mostly found on understory vegetation and on rocks near swamps and rivers (Sanguila et al. 2016). However, the species was only reported by a previous assessment by



Montero (2010). The Mindanao flying frog is considered a Least Concern species by the IUCN red list.

## Reptiles

### *Ophiophagus hannah*

The only representative of the genus *Ophiophagus*, this species is known for its diet on other snakes. King cobras are native to the Philippines, inhabiting forests and agricultural areas. Latest genetic and morphological analysis suggests that the species might be of distinct evolutionary lineages (Shankar et al. 2021). The species is currently listed as Vulnerable by the IUCN and as Other Threatened Species (OTS) under the DAO 2019-09 because of the decreasing population due to habitat destruction and direct persecution. In the study area, two dead individuals were found along the road, which was most likely killed by guards for safety purposes.

### *Naja samarensis*

A Philippine endemic species which is restricted to the Mindanao Faunal Region, inhabiting a wide range of habitats such as forests and agricultural and urban areas. The species can be easily identified by their hood when threatened and its yellowish-dark body (Pitogo et al. 2021). Threats to the species include direct persecution (Ravalo et al. 2019) and the collection of food and/or traditional medicine. They were mainly observed opportunistically during the day. Samar cobra is considered Other Threatened Species (OTS) under the DAO 2019-09 classification.

### *Gonyosoma oxycephalum*

The species is native to Asia, including many islands of the Philippines. They can be found in forests, plantations and urban gardens. The species is considered Other Threatened Species (OTS) under the DAO 2019-09 classification. The species has been reported by the management but neither recorded during the recent fieldwork and by Montero (2010).

### *Malayopython reticulatus*

Reticulated python is a species of snake widely distributed throughout Southeast Asia and almost all of the Indonesian archipelago. This species is considered as Other Threatened Species (OTS) under the DAO 2019-09 classification and has become one of the most traded snakes, making it more vulnerable to extinction (Murray-Dickson et al. 2017). The species was not observed during actual fieldwork, but multiple sightings of the species were reported by the local forest guards and the management (Figure 1E). The most recent was the predation of the species by a stray dog on the road going to the forest.

### *Tropidolaemus subannulatus*

A species of venomous snake occurs in Brunei, Indonesia, Malaysia, and many islands of the Philippines (Leviton et al. 2014; Das and Charles 2015). Currently listed as threatened (OTS) by the DAO 2019-09 and Least Concern by the IUCN red list, Bornean keeled viper is known to inhabit a wide range of habitats, including lowland primary or mature secondary forests, riverine, and coastal forests. Juvenile and adult males have a yellowish green belly and vibrant upper sides patterned with generally white

bars and a red and white stripe behind the eye. Adult females have a complex color pattern of cream, with broken turquoise bands and a stripe of the same color on both sides of the head (Vogel et al. 2007). In addition, this species is often targeted for the international and local pet trade due to its vibrant colorations (Sy 2018). No individual was observed during the fieldwork, but an individual was observed by the Hijo management.

### *Hydrosaurus pustulatus*

Philippine sailfin lizard is a semi-aquatic reptile endemic to the Philippines. They can be found in wetland habitats which include forests and agricultural lands. The species is considered threatened by IUCN (VU) and under DAO 2019-09 (OTS) because of its decreasing population. Further genetic investigations are needed to confirm the evolutionary relationship of the Mindanao population to other populations in the Philippines (Sanguila et al. 2016; Pitogo et al. 2021). There were two individuals documented, one was in the forest resting on a pandan plant (Figure 1F), and the other was crossing the coastal road near the beach forest. The species was also reported by the local forest guards inhabiting riparian habitats of the area.

### *Gekko intermedium*

The declining population of this Philippine endemic gecko made it to be listed as Near Threatened according to the IUCN Red List and Other Threatened Species (OTS) according to DAO 2019-09. The species preferred forested habitats and can be found between sea level and 892 above sea level (Diesmos and Brown 2009; Gamalo et al. 2022). A single individual was observed in a firing range shed inside the forest.

### *Gekko gekko*

Tokay geckos are ubiquitous, geographically occupying a wide range of habitats that include both natural and man-made environments. The species is famous for its relatively large size and for its familiar and unique vocalization. Tokay gecko is currently considered as Least Concern by the IUCN Red List. In the Philippines, the species is considered OTS under the DAO 2019-09. Threats to the species include massive hunting for consumption and trade (Sy and Shepherd 2020). It was not sighted during the survey, but the calls can be heard in the forest.

### *Cuora amboinensis*

A native species of turtle in the Philippines are classified as endangered by the IUCN Red List because of threats, especially on trading. Southeast Asian box turtles are widely distributed throughout the Southeast Asian archipelago, from the Nicobar Islands through Indonesia, Moluccas, and the Philippines (Cota et al. 2020), inhabiting many types of habitats with water bodies. During the survey, multiple individuals were seen in the forest, particularly when raining.

### *Varanus cumingi*

Yellow-headed water monitor lizards are endemic to the Philippines and restricted in Mindanao (Welton et al. 2014). The species has a wide range of habitats but prefers mangroves and small ponds. This species is classified as the

least concern by the IUCN but is considered as OTS under the DAO 2019-09. Their population is decreasing due to heavy harvesting for food, pet, and leather (Sy et al. 2009). They were the most encountered reptile, mostly seen basking along the forest trails and the swampy areas.

## Birds

### *Penelopides affinis*

Mindanao hornbills, sometimes called Mindanao tarictic hornbills, are endemic in the greater parts of Mindanao and neighboring islands. This bird is found in forest edges and forest interiors, often in pairs or small groups. Their presence can be noted easily as this species is noisy. During the survey, they were seen flying above the canopy spotted moving from one tree to another (Figure 1G). They are classified as endangered (DAO 2019-09) and have a decreasing population due to habitat loss and exploitation.

### *Phapitreron amethystinus*

This Philippine endemic bird has a deep “hoop” call and can also be heard with a deep growling sound. They can be easily distinguished from other brown dove species because of their larger bill, less apparent white ear, violet upper back, and cinnamon under tail coverts (Kennedy et al. 2000). In the Hijo forest, an individual was seen and photographed by the group birders who visited last year in 2019 (Figure 1H). However, during the survey, they were only heard. This bird is classified as the least concern species by the IUCN but is considered critically endangered under the DAO 2019-09.

### *Loriculus philippensis*

Also known as the Philippine Hanging Parrot or Colasisi, this Philippine endemic species is considered the smallest of the parrots found within the country. They can be easily identified through their unique calls, redhead, and rump (Kennedy et al. 2000). They are classified as the least concern species by the IUCN and critically endangered under the DAO 2019-09. Sadly, there has been a decline in these bird populations as they are vulnerable to the pet trade and habitat destruction. They were usually seen foraging in trees within the forest.

### *Hypothymis helenae*

The endemic Short Crested Monarch is a poorly known species, particularly on larger islands such as Mindanao and Luzon. The species is believed to have a declining population because of habitat loss; thus, it is considered as threatened (OTS) under the DAO 2019-09. More studies are needed as there is very little information on the threats to their population. Multiple birding activities and the recent fieldworks were not able to confirm the presence of the species within the Hijo forest, but it was previously recorded by Montero (2010). The possible reasons for this could be the rarity of the species in the mainland or a possible misidentification of a closely related species, the black-naped monarch (*Hypothymis azurea*), which was commonly observed in the forest.

### *Spilornis cheela*

This bird of prey is found in the major islands of the Philippines and nearby countries. They are commonly seen soaring in forest clearings, open woodland, and sometimes in cultivated lands with scattered trees. During the survey, they are often seen flying above the canopy with an echoing “pheeeeuw-pheeeeuw” call. The species is the most common bird of prey in the area. Luckily, they are still not considered threatened by IUCN or DAO 2019-09.

## Discussion

Aside from the complete eradication of the population of the Philippine Warty Pigs due to ASF (Chavez 2021), there are other possible reasons why some of the species previously observed by Montero (2010) were not observed during the recent fieldwork. Failure to detect some species, such as tarsiers and the banded sphenomorphus (*Sphenomorphus fasciatus*), can be attributed to the cryptic behavior of these species. It was reported by the forest guards that hunting sometimes happened in the past (e.g., for warty pigs, squirrels), which could have contributed to the decline of the species in the area (personal communication with Mr. Harry D. Morris, Hijo Resources Corporation Director for Sustainability). Nonetheless, a more surprising result in the recent fieldwork was the significant increase in the number of species observed, especially for birds, frogs, and reptiles. The possible reasons that contributed to this increased detection of species are the extensive sampling efforts (e.g., number of visits, etc.) and the use of multiple sampling techniques (e.g., mist nets, transects, camera traps, point counts, and opportunistic). Unlike the sampling conditions during the fieldwork of Montero in 2010, which was conducted during the summer months and an El Niño event (Montero 2010; Yumul Jr et al. 2010), frequent rains throughout the course of the study must have played a role in the increase in the prevalence of frog and reptile encounters in the area. Most wildlife species are sensitive to moisture and temperature. For instance, amphibian skin is permeable to water, thus the presence or absence of moisture can directly affect their temperature and hydration (Mitchell and Bergmann 2016). Reptiles, such as the threatened Philippine Sailfin Lizard and Southeast Asian Box Turtle, prefer riparian habitats and other water bodies (Sanguila et al. 2016). Moreover, for birds, extreme temperatures during El Niño can significantly affect bird migration, survival, and reproduction (McKechnie and Wolf 2010; Paxton et al. 2014). The additional local reports and other biodiversity activities (e.g., birding and biodiversity photography) must have contributed to the number of recorded species in the area, particularly for snakes, birds, and tarsiers. This highlights the importance of citizen science in providing important information on wildlife distribution and ecology (Wojciechowski et al. 2021; Wangyal et al. 2022).

The high species richness of vertebrate wildlife observed adds to the conservation value of the Hijo Forest. Private forest patches can serve as a stepping stone that promotes connectivity in other highly modified environments (Manning et al. 2006). They also play a role in food and wood production, pollination, increased water regulation and supply, natural pest and erosion control, and most

importantly, provide refuge to different species of animals (Decocq et al. 2016). The willingness and motivation of landowners, whose decisions are frequently influenced by their social-ecological environment, which includes their knowledge, values, sociodemographic variables, beliefs, cultural backgrounds, etc., are crucial to saving private forests and the wildlife that lives there (Tiebel et al. 2021). Therefore, it is important to consider private forest dynamics and the landowners' perspectives and motivations in crafting or initiating forest management and conservation initiatives.

The updated list of vertebrate wildlife fauna in Hijo Forest provides important data for future conservation management plans and actions. The high species richness and the recent mass die-off of Philippine warty pigs in the area signal immediate conservation interventions, especially since the area is currently the home for threatened and ecologically important species, which includes long-tailed macaques, Philippine tarsiers, Samar cobra, intermediate flying geckos, Southeast Asian box turtles, Philippine sailfin lizard, and Mindanao hornbills. Considering that the Hijo Forest is partly used for ecotourism activities (e.g., bird watching, archery area, etc.), tourists should be reminded of important conservation practices such as no feeding of wildlife. Additionally, because the local wildlife is not confined to the forest and has the potential to be hunted, education campaigns such as the installation of wildlife infographic materials for the general public are essential for the overall protection of these species. To be able to achieve long-term protection of the forest and wildlife, continuous monitoring should be carried out, and the private-public partnerships, including academe, other government and non-government organizations, should be strengthened. Future researchers can also help in forest monitoring by capacitating the forest guards and tour guides to conduct biodiversity sampling and compel them to support long-term educational programs.

In conclusion, the high species richness of vertebrate wildlife and the presence of several threatened species in the area justifies the need for continuous and long-term conservation management actions for the Hijo forest. It is important to highlight the importance of privately owned forests for biodiversity conservation, especially since the area is located near a growing urban city. The study calls for constant and sustainable environmental actions, especially since the area is partly used for ecotourism activities. Protection of the forest is a must as it serves as home to a variety of wildlife species. Existing threats such as hunting, direct persecution of some species, diseases, and effects of climate change should be mitigated to minimize its impact and prevent further loss of wildlife species in the area.

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## REFERENCES

- Alcala AC, Brown WC. 1998. Philippine Amphibians: An Illustrated Field Guide. Bookmarks Inc, Makati City.
- Bejar SGF, Roño JGA, Duya MRM. 2021. Genetic divergence of Philippine tarsiers, based on the 12S rRNA gene, and its implication for their taxonomic and conservation status. *Philipp J Sci* 150 (S1): 551-562. DOI: 10.56 899/150.S1.41.
- Brown RM, Weghorst JA, Olson KV, Duya MR, Barley AJ, Duya MV, Shekelle M, Neri-Arboleda I, Esselstyn JA, Dominy NJ, Ong PS, Moritz GL, Luczon A, Diesmos ML, Diesmos AC, Siler CD. 2014. Conservation genetics of the Philippine tarsier: Cryptic genetic variation restructures conservation priorities for an island archipelago primate. *Plos One* 9 (8): p.e104340. DOI: 10.1371/journal.pone.0104340.
- Cabañas A, de Guia APO, Vega RS, Dimalibot J. 2022. Occurrence and distribution of Philippine warty pig (*Sus philippensis* Nehring, 1886) in Mt. Banahaw de Tayabas, Luzon Island, Philippines. *Philipp J Sci* 151 (5): 1605-1621. DOI: 10.56899/151.05.06.
- Chavez J, Morris HD, Suan-Moring GL, Gamalo LED, Lastica-Ternura EA. 2021. Suspected African Swine Fever (ASF) mass die-offs of Philippine Warty Pigs (*Sus philippensis*) in Tagum City, Mindanao, Philippines. *Suiform Sound* 20 (1): 8-11.
- CONserve-KAIGANGAN Program Website. 2019. <https://www.kaigangan.uplb.edu.ph/index.php/database2/animal-collection/item/203-rattus-everetti>.
- Cota M, Hoang H, Horne BD, Kusri MD. 2020. *Cuora amboinensis*. The IUCN Red List of Threatened Species 2020:e.T5958A3078812.
- Das I, Charles JK. 2015. Venomous snakes and envenomation in Brunei. In: Gopalakrishnakone K, Faiz A, Fernando R, Gnanathanan CA, Habib AG, Yang CC. (eds). *Clinical Toxinology in Asia Pacific and Africa*. Springer Dordrecht, The Netherlands.
- Decocq G, Andrieu E, Brunet J. 2016. Ecosystem services from small forest patches in agricultural landscapes. *Curr For Rep* 2: 30-44. DOI: 10.1007/s40725-016-0028-x.
- Dela-Torre V, Nuneza OM. 2021. Species diversity, distribution, and microhabitats of anurans on Mt. Kalo-Kalo of the Mt. Kalatungan Range Natural Park, Bukidnon, Philippines. *Asian Herpetol Res* 12 (1): 58-75. DOI: 10.16373/j.cnki.ahr.200023.
- DENR Administrative Order 2019-09. 2019. Updated National List of Threatened Philippine Fauna and their Categories. <https://bmb.gov.ph>.
- Diesmos AC, Alcala A, Brown R, Afuang LE, Gee G. 2008. *Rhacophorus bimaculatus*. The IUCN Red List of Threatened Species 2008: e.T58980A11853445.
- Diesmos AC, Brown RM. 2009. *Ptychozoon intermedium*. The IUCN Red List of Threatened Species 2009: e.T169907A6 688910.
- Diesmos AC, Alcala A, Siler CD, Brown RM. 2014. Status and conservation of Philippine Amphibians. *Conserv Biol Amphib Asia* 11: 310-336.
- Diesmos AC, Watters JL, Huron NA, Davis DR, Alcala AC, Crombie RI, Afuang LE, Gee-Das G, Sison RV, Sanguila MB, Penrod ML. 2015. Amphibians of the Philippines, part I: Checklist of the species. *Proc Calif Acad Sci* 62 (20): 457-539.
- Gaikwad MC, Narwade SS, Fartade KM, Korad VS. 2012. A review of the distribution of bats in southwestern region of Deccan, Maharashtra-India and conservation recommendations. *Taprobanica* 4 (1): 27-36. DOI: 10.4038/tapro.v4i1.4379.
- Gaite PLA, Aala WF Jr, Bacus MG, Labrador CC, Numeron AMM, Gamalo LED, Murao LAE. 2022. The first complete mitochondrial genome sequence of *Cynopterus brachyotis* (Chiroptera, Pteropodidae) from the Philippines. *Biodivers Data J* 10: e72768. DOI: 10.3897/BDJ10.e72768.
- Gamalo LED, Sabanal BT, Ang A. 2021. Three decades of Philippine nonhuman primate studies: Research gaps and opportunities for Philippine primatology. *Primates* 62 (1): 233-239. DOI: 10.1007/s10329-020-00847-w.
- Gamalo LED, Sabanal BT, Torrefiel JT. 2022. Predation on a Parachute Gecko *Gekko* sp. by Long-tailed Macaques *Macaca fascicularis* (Raffles, 1821) in Mt. Apo Natural Park, Philippines. *Philipp J Sci* 151 (1): 153-156. DOI: 10.56899/151.01.11.

- Hansen MF, Ang A, Trinh T. 2022. *Macaca fascicularis*. The IUCN Red List of Threatened Species 2022: e. T12551A199563077.
- Heaney LR, Dolar ML, Balete DS, Dolar LL, Ong PS. 1998. A synopsis of the mammalian fauna of the Philippine Islands. *Fieldiana* 68: 1-61.
- Heaney LR, Balete DS, Rickart EA. 2016. The Mammals of Luzon Island: Biogeography and Natural History of a Philippine Fauna. JHU Press, USA.
- Ingle NR, Heaney LR. 1992. A Key to the Bats of the Philippine Islands. Field Museum of Natural History, Chicago.
- IUCN 2022. The IUCN Red List of Threatened Species. Version 2022-1. <https://www.iucnredlist.org>.
- Jiang D, Jiang K, Ren J, Wu J, Li J. 2019. Resurrection of the genus *Leptomantis*, with description of a new genus to the family Rhacophoridae (Amphibia: Anura). *Asian Herpetol Res* 10: 1-12. DOI: 10.16373/j.cnki.ahr.180058.
- Kennedy R, Gonzales PC, Dickinson E, Miranda HC Jr, Fisher TH. 2000. A Guide to the Birds of the Philippines. Oxford University Press, United Kingdom.
- Leviton AE, Brown RM, Siler CD. 2014. The dangerous venomous snakes of the Philippine archipelago with identification keys and species accounts. In: Williams GC, Gosliner TM (eds). The Coral Triangle. The 2011 Hearst Philippine Biodiversity Expedition, California Academy of Sciences, California.
- Luskin MS, Meijaard E, Surya S, Walzer C, Linkie M. 2021. African swine fever threatens Southeast Asia's 11 endemic wild pig species. *Conserv Lett* 14 (3): e12784. DOI: 10.1111/conl.12784.
- Manning AD, Fischer J, Lindenmayer DB. 2006. Scattered trees are keystone structures—Implications for conservation. *Biol Conserv* 132: 311-321. DOI: 10.1016/j.biocon.2006.04.023.
- Manto-Beltran L. 2022. CSR: Green Nature and Calamity Support. <https://www.manilatimes.net/2022/02/28/supplements/csr-green-nature-and-calamity-support/1834474>.
- McKeechnie AE, Wolf BO. 2010. Climate change increases the likelihood of catastrophic avian mortality events during extreme heat waves. *Biol Lett* 6 (2): 253-256. DOI: 10.1098/rsbl.2009.0702.
- Mitchell A, Bergmann PJ. 2016. Thermal and moisture habitat preferences do not maximize jumping performance in frogs. *Funct Ecol* 30 (5): 733-742. DOI: 10.1111/1365-2435.12535.
- Mölder A. 2016. Small forest parcels, management diversity and valuable coppice habitats: An 18th century political compromise in the Osnabrück region (NW Germany) and its long-lasting legacy. *iForest* 9 (4): 518. DOI: 10.3832/for1834-009.
- Mölder A, Tiebel M, Plieninger T. 2021. On the interplay of ownership patterns, biodiversity, and conservation in past and present temperate forest landscapes of Europe and North America. *Curr For Rep* 7: 195-213. DOI: 10.1007/s40725-021-00143-w.
- Montero R. 2010. Inventory of the Flora and Fauna, Site Mapping and Ecosystem Assessment of the Hijo forest. [Report]. Hijo Resources Corporation, Philippines.
- Murray-Dickson G, Ghazali M, Ogden R, Brown R, Auliya M. 2017. Phylogeography of the reticulated python (*Malayopython reticulatus* ssp.): Conservation implications for the world's most traded snake species. *Plos One* 12 (8): e0182049. DOI: 10.1371/journal.pone.0182049.
- Paxton KL, Cohen EB, Paxton EH, Németh Z, Moore FR. 2014. El Niño–Southern Oscillation is linked to decreased energetic condition in long-distance migrants. *Plos One* 9 (5): e95383. DOI: 10.1371/journal.pone.0095383.
- Pitogo KME, Saavedra AJL, Afuang LE. 2021. Amphibians and reptiles of Mount Busa, Sarangani Province: A glimpse of the herpetological community of Southern Mindanao, Philippines. *Philipp J Sci* 150 (5): 1279-1306. DOI: 10.56899/150.05.37.
- Quibod MNRM, Alcantara KNL, Bechayda NA, Estropia CJ, Guntinas J, Obin MA, Raymundo R, Soniega E. 2021. Terrestrial vertebrates in modified landscapes in northeastern Mindanao, Philippines. *J Anim Divers* 3 (3): 72-85. DOI: 10.52547/JAD.2021.3.3.6.
- Ravalo DD, Gersava JR, Alojado J, Achondo MJM, Gamalo LE. 2019. Predation of Samar Cobra *Naja samarensis* Peters, 1861 on the invasive Cane Toad *Rhinella marina* (Linnaeus, 1758) in Davao City, Philippines. *Herpetol Notes* 12: 1023-1025.
- Sanguila MB, Cobb KA, Siler CD, Diesmos AC, Alcalá AC, Brown RM. 2016. The amphibians and reptiles of Mindanao Island, southern Philippines, II: The herpetofauna of northeast Mindanao and adjacent islands. *ZooKeys* 624: 1-132. DOI: 10.3897/zookeys.624.9814.
- Shankar PG, Swamy P, Williams RC, Ganesh SR, Moss M, Höglund J, Das I, Sahoo G, Vijayakumar SP, Shanker K, Wüster W, Dutta SK. 2021. King or royal family? Testing for species boundaries in the King Cobra, *Ophiophagus hannah* (Cantor, 1836), using morphology and multilocus DNA analyses. *Mol Phylogenet Evol* 165: 107-300. DOI: 10.1016/j.ympev.2021.107300.
- Siler CD, McVay JD, Diesmos AC, Brown RM. 2009. A new species of fanged frog, genus *Limnonectes* (Amphibia: Anura: Dicroglossidae) from southeast Mindanao Island, Philippines. *Herpetologica* 65: 105-114. DOI: 10.1655/08-041R1.1.
- Solania CL, Fernandez-Gamalinda EV. 2018. Species composition and habitat association of anurans within water systems of Andanan Watershed, Agusan del Sur, Caraga Region, Philippines. *Environ Exp Bot* 16: 159-168. DOI: 10.22364/eeb.16.15.
- Solania CL, Cuadrado JT, Galolo ARV, Gamalinda EF. 2021. Species richness and community structure of amphibians and reptiles in Andanan Watershed Forest Reserve, Caraga Region, Philippines. *Biodivers J* 12 (3): 673-694. DOI: 10.31396/Biodiv.Jour.2021.12.3.673.694.
- Sy EY, Diesmos A, Jakosalem PG. 2009. *Varanus cumingi*. The IUCN Red List of Threatened Species 2009: e.T169897A6687602.
- Sy EY. 2018. Trading Faces: Utilisation of Facebook to Trade Live reptiles in the Philippines. TRAFFIC, Petaling Jaya, Selangor, Malaysia.
- Sy EY, Shepherd CR. 2020. An Analysis of seizures of Tokay Gecko *Gekko gecko* in the Philippines. *J Nat Stud* 19 (1): 144-150.
- Tiebel M, Mölder A, Plieninger T. 2021. Conservation perspectives of small-scale private forest owners in Europe: A systematic review. *Ambio* 51: 836-848. DOI: 10.1007/s13280-021-01615-w.
- Vogel GP, David M, van Rooijen L, Vidal J. 2007. Revision of the *Tropidolaemus wagleri* complex (Serpentes: Viperidae: Crotalinae). I. Definition of included taxa and redescription of *Tropidolaemus wagleri* (Boie, 1827). *Zootaxa* 1644: 1-40. DOI: 10.11646/zootaxa.1644.1.1.
- Wangyal JT, Bower D, Vernes K, Thinley P. 2022. Employing citizen science to understand amphibian and reptile diversity and distribution in the Himalayan Kingdom of Bhutan. *Glob Ecol Conserv* 37: e02157. DOI: 10.1016/j.gecco.2022.e02157.
- Welton LJ, Travers SL, Siler CD, Brown RM. 2014. Integrative taxonomy and phylogeny-based species delimitation of Philippine water monitor lizards (*Varanus salvator* Complex) with descriptions of two new cryptic species. *Zootaxa* 3881 (3): 201-227. DOI: 10.11646/zootaxa.3881.3.1.
- Wojciechowski FJ, Kaszycka KA, Otadoy JB. 2021. Utilizing local community knowledge of the Philippine tarsier in assessing the Bilar population endangerment risk, and implications for conservation. *J Nat Conserv* 62: 126028. DOI: 10.1016/j.jnc.2021.126028.
- Yao L, Li H, Martin RD, Moreau CS, Malhi RS. 2017. Tracing the phylogeographic history of Southeast Asian long-tailed macaques through mitogenomes of museum specimens. *Mol Phylogenet Evol* 116: 227-238. DOI: 10.1016/j.ympev.2017.08.006.
- Yodthong S, Stuart BL, Aowphol A. 2019. Species delimitation of crab-eating frogs (*Fejervarya cancrivora* complex) clarifies taxonomy and geographic distributions in mainland Southeast Asia. *ZooKeys* 883: 119-153. DOI: 10.3897/zookeys.883.37544.
- Yumul GP Jr, Dimalanta CB, Servando NT, Hilario FD. 2010. The 2009–2010 El Niño Southern oscillation in the context of climate uncertainty: The Philippine setting. *Philipp J Sci* 139 (1): 119-126.