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Cover Photo: The cover photo shows the species [*Buceros hydrocorax, Gallirallus calayanensis, Prionailurus bengalensis heaneyi, Pithecophaga jefferyi, Pteropus pumilus, Otus megalotis, Crocodylus mindorensis* (top to bottom)] included in the articles focusing on species conservation.
Photo Credit: R. Sta. Ana, DG. Tabaranza, D. Fernandez, R. Sta. Ana, DG. Tabaranza, A. Pascua, JC. Gonzalez [from top to bottom]
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Message of the Secretary

Biodiversity plays a very important role in our lives – for food, medicine, and a myriad ecosystem services. The Philippines takes pride in being one of the planet's 17 megadiverse countries, or those with the highest levels of biodiversity. However, because of habitat loss and other threats, our country is also regarded as a biodiversity hotspot. Thus, conservation is imperative.

For our conservation initiatives to succeed, there is an urgent need to systematically communicate research findings to the scientific community and the general public. This is where the DENR's Sylvatrop, the Technical Journal of Philippine Ecosystems and Natural Resources, proves its value. Through this publication, the DENR provides scientists, policy makers, and environmentalists with timely research results that can guide efforts to curb species decline in our country.

For the eighth time now, Sylvatrop and the Biodiversity Conservation Society of the Philippines (formerly Wildlife Conservation Society of the Philippines) pursued this collaboration of publishing scientific findings about Philippine biodiversity. The articles found in this issue highlight how we humans can shape our actions to reverse negative trends afflicting Philippine biodiversity. Of special interest is an article proposing an updated national list of threatened terrestrial fauna.

Congratulations to the members of the Sylvatrop Editorial Board headed by the Ecosystems Research and Development Bureau, for many years of furnishing peer-reviewed scientific information to our readers and subscribers, both national and international. May this edition of Sylvatrop inspire us all to work harder in the protection and conservation of the rich biodiversity that forms part of our environmental heritage.

Mabuhay!

ROY A. CIMATU
Secretary, DENR

Message from the BCSP President

The Biodiversity Conservation Society of the Philippines (BCSP) is an organization that aims to advance biodiversity conservation in the Philippines. Through the BCSP's programs, we hope to bridge the gaps in research and policy by bringing together experts and practitioners in the field and developing resources that can contribute to national and local resource management and governance.

This special issue of Sylvatrop is an example of the BCSP's commitment to achieving its goal. The issue presents studies that have great impact to the management of some of the country's iconic species such as the conservation milestones of the Philippine crocodile and the range and ecology of the leopard cat in the Palawan region. It also brings to light studies of lesser-known species and ecosystems such as assessing the threats of feral cats to the island endemic Calayan Rail and understanding of the odonata species in Negros Island—which have implication to the conservation of these species and habitats.

The issue also presents a significant contribution of the BCSP's members in the development of an updated National List of Threatened Terrestrial Faunal Species. The experts within the Society, through the Threatened Species Technical Working Group (TWG), have been involved in reviewing and evaluating species to be included in the list. BCSP is pleased to present the process employed by the TWG in coming up with the list that will serve as basis for the national policy recommendations by the Biodiversity Management Bureau. A great feat in bringing together various experts and practitioners within the Philippine conservation front!

The BCSP Publications Committee did an exemplary job in putting together this issue. I applaud the Editorial Board and the reviewers for their commitment and hard work. I also wish to thank our partners from DENR—the Biodiversity Management Bureau and the Ecosystems Research and Development Bureau—for continuing to work with the BCSP in our efforts to contribute to advocacies and policies on Philippine wildlife.

I thank the presenters and authors for sharing their research outputs through the BCSP. I'm most especially grateful to our partners in organizing the Philippine Biodiversity Symposium and supporting one of the largest gatherings of biodiversity researchers and conservationists in the Philippines. With your support, we were able to stage public fora to deliver meaningful studies and programs dedicated to Philippine wildlife and engage stakeholders in crafting plans and policies relevant to our country's biodiversity.

May this issue inspire us to advocate a culture of partnership and camaraderie among us who are working for Philippine biodiversity research and conservation.

Maraming salamat!

Cynthia Adeline A. Layusa-Oliveros
President, BCSP

Biodiversity Conservation Society of the Philippines

MBCFI
Mindoro Biodiversity Conservation Foundation, Inc.

The 25th Philippine Biodiversity Symposium
25 Years of Collaborative Biodiversity Conservation in the Philippines: Global Relevance, Local Realities
5–9 April 2016 * Filipiniana Hotel, Calapan City, Oriental Mindoro

About the Biodiversity Conservation Society of the Philippines

The Biodiversity Conservation Society of the Philippines (BCSP), formerly the Wildlife Conservation Society of the Philippines (WCSP), is a professional organization of wildlife researchers, managers, scientists, and conservationists. It aims to advance biodiversity research and conservation in the Philippines by facilitating communication and contributing to improved research and conservation capabilities of those working on Philippine biodiversity, particularly the members of the association, and to increase public awareness, appreciation, and understanding of Philippine biodiversity.

Vision
A community that appreciates and conserves Philippine biodiversity.

Mission
Catalyst for effective biodiversity conservation through science-based research, education, and management anchored on collaboration for the Philippine society.

Key Programs

- **Conservation Awareness**: promotes biodiversity and conservation through information, education and public awareness
- **Mentoring**: provides capacity building of students and professionals through short courses and trainings, site visits, and networking
- **Publication**: facilitates exchange of knowledge and research through publications of knowledge products
- **Policy**: contributes to national and local policy development by integrating scientific facts and experts' knowledge on key biodiversity issues

Special Programs

- **Annual Philippine Biodiversity Symposium**: yearly gathering of local and international biodiversity researchers and conservationists
- **Philippine Threatened Species Committee**: provides recommendations on the Philippines' Red List of Threatened Fauna as stipulated in the Wildlife Act of the Philippines (RA 9147).

About the 25th Philippine Biodiversity Symposium

25 Years of Biodiversity Conservation in the Philippines:
Global Relevance, Local Realities
5–9 April 2016 | Filipiniana Hotel, Calapan City, Oriental Mindoro

The Philippine Biodiversity Symposium is an annual gathering of Filipino and international researchers and practitioners working in the fields of wildlife studies and biodiversity conservation in the Philippines. The symposium is organized by the Biodiversity Conservation Society of the Philippines.

Symposium activities include an institutional exhibit of organizations involved in biodiversity research and conservation, keynote presentations from distinguished wildlife scientists and conservation practitioners, concurrent workshops, and contributed oral and poster presentations.

The symposium draws over 250 participants from the academic and research institutions, government agencies, non-governmental organizations, independent researchers, and high school, undergraduate and graduate students.

The 25th Annual Philippine Biodiversity Symposium was organized by the Biodiversity Conservation Society of the Philippines (BCSP) and co-hosted by the City Government of Calapan, Oriental Mindoro and the Mindoro Biodiversity Conservation Foundation, Inc. (MBCFI) in partnership with the Department of Environment and Natural Resources-Biodiversity Management Bureau (DENR-BMB), the Provincial Environment and Natural Resources Office of Oriental Mindoro, and the Provincial Government of Oriental Mindoro.

For more information, please visit:
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Facebook: @biodiversity.conservation.ph
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Spatial ecology of a male and a female leopard cat (*Prionailurus bengalensis heaneyi* Groves 1997) in Aborlan, Palawan, Philippines

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*The spatial ecology of Palawan leopard cats (**Prionailurus bengalensis heaneyi**) was studied using live trapping, radio telemetry, and small mammal trapping from May 2013 to July 2014 in Aborlan, Palawan, Philippines. One adult female and 3 adult male **P. b. heaneyi** were captured. Radio-collars were attached to one adult male and one adult female individual then released in their respective capture sites. Radio telemetry was conducted for 32 days per season. Non-volant small mammals were captured using box traps and released to determine prey species availability. Results showed that the habitat types utilized by the 2 **P. b. heaneyi** include: forest (71.09%), mixed brushlands (25.78%), coconut plantations (2.60%), and built-up areas (0.52%). The mean 95% minimum convex polygon (MCP) home range of the male (6.2917 km^2) was larger than that of the female (3.9236 km^2). An increase in mean home range size from dry season (3.5658 km^2) to wet season (4.0611 km^2) for both sexes could be related to the decrease in small mammal abundance during wet season. Small mammal species captured in the area included **Rattus exulans**, **Rattus tanezumi**, **Sundasciurus steerii**, **Maxomys panglima**, and **Tupaia palawanensis**. When prey availability decreases, leopard cats may be driven to occupy larger ranges in search of food.*

Keywords: Spatial ecology, habitat use, home range, leopard cat

THE LEOPARD CAT IS A SPECIES OF WILD CAT THAT IS SIMILAR IN SIZE TO A domestic cat but with yellow-orange leopard-like spotted fur. The Palawan leopard cat (***Prionailurus bengalensis heaneyi***) is a subspecies occurring in mainland Palawan (Esselstyn et al. 2004), and in the islands of Busuanga and Culion (Paguntalan et al. 2015). The International Union for Conservation of Nature (IUCN) Red List of Threatened Species categorizes the leopard cat as Least Concern because it is relatively widespread, abundant, and adaptable to disturbed areas (Sanderson et al. 2008). However, there are still threats to this species such as hunting for bush meat, live pet trade, fur, and traditional medicine (Calawagan 2014; Cruz et al. 2007; Nash 1997).

Among numerous ecological research techniques, radio telemetry has become one of the most valuable for remotely studying cryptic carnivores such as wild felids (Fuller and Fuller 2012). Small to medium felid species are generally under-represented in field studies due to the greater popularity of larger species such as lions, tigers, leopards, and cheetahs. While many leopard cat radio telemetry studies have been published, such as those from Thailand (Rabinowitz 1990; Grassman 2000; Grassman et al. 2005; Austin et al. 2007), Malaysia (Rajaratnam et al. 2007), and Japan (Tajiri et al. 1996; Oh et al. 2010; Nakanashi et al. 2005), none has been done in the Philippines. Studying the relationship between the leopard cats' use of space and the availability of necessary resources in its surrounding environment is important in determining how this animal's behavior and survival could be affected by environmental changes brought about by natural or anthropogenic phenomena. Thus, the general objective of this research is to study the spatial ecology of leopard cats in Aborlan, Palawan, Philippines. Specifically, the habitat use and home range size were determined for a male and a female leopard cat.

Materials and methods

Study area

Palawan province lies on the western edge of the Philippine archipelago (Fig. 1). Aborlan is a municipality located in south central mainland Palawan and is comprised of 19 barangays, one of which is Barangay Cabigaan. This barangay encompasses 30.91 km^2 and has an elevation from 50-600 meters above sea level (masl) on a terrain with 18%-30% slope. The climate is Type III, in which dry and wet seasons are not distinct (Aborlan 2012). However, mean precipitation is relatively lower from November to April, and higher during the rest of the year (Kintanar 1984). In this study, the dry season was considered as the period from November to April, while the wet season was from May to October.

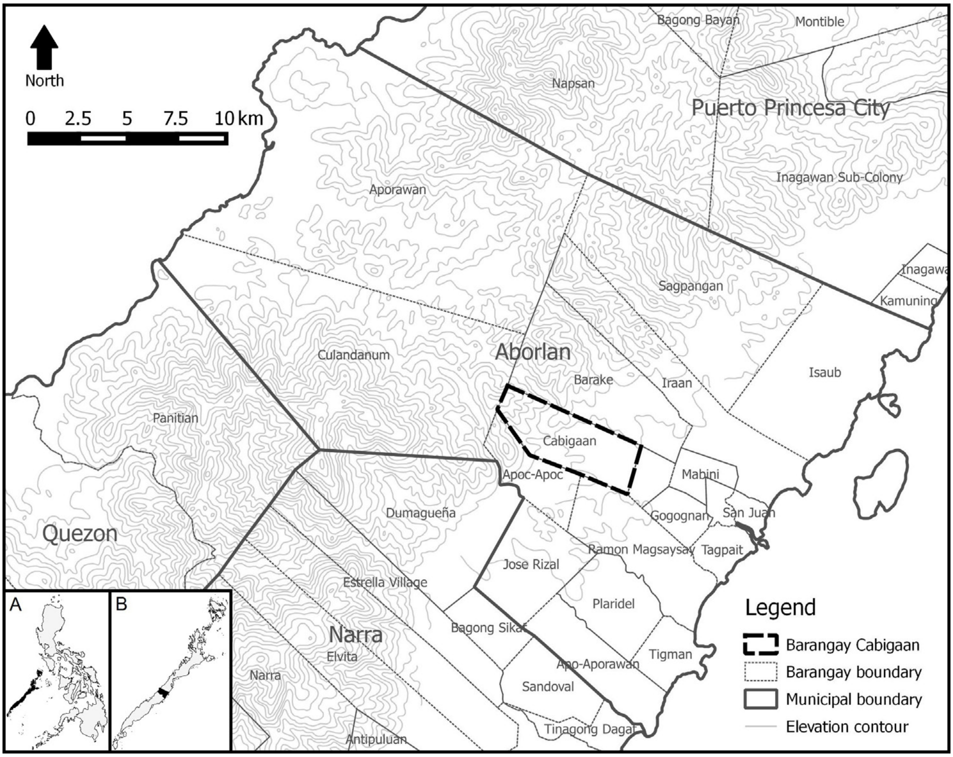

Figure 1 Location of Barangay Cabigaan. Insets: (A) Palawan province in the Philippines and (B) Aborlan municipality in Palawan province

Habitats in the area were mapped in QGIS v. 2.6.1 (Brighton), ground-truthed, and classified into major land cover and land use types. The 4 most dominant habitat types were forest, mixed brushland, coconut plantation, and built-up areas (Fig. 2). The forest area is a tropical lowland evergreen rain forest dominated by *Symplocos odoratissima, Cinnamomum mercadoi, Microdesmis caseariifolia, and Mallotus miquelianus*. The mixed brushland area is composed of shrubs, grasses, bamboo, fruit trees, and crops such as *Colocasia esculenta* and *Zingiber officinale*. The coconut plantation areas are composed mainly of coconut trees with vegetable crops or smaller fruit trees sometimes planted within or around the plantations. The built-up areas are the residential areas where there are roads, small houses, stores, schools, and barangay facilities. Other minor habitat types in the area include crop lands dominated by rice, grasslands for grazing animals, and a small oil palm plantation.

Figure 2 Major habitat types in Aborlan, Palawan, Philippines. From top to bottom: forest, mixed brushland, coconut plantation, and built-up areas

Trapping and radio telemetry

Trap locations were determined through interviews and transect walks. From May 20 to 24 and November 24 to 30, 2013, local hunters, residents, and barangay officials were asked regarding direct sightings and captures of *P. b. heaneyi* in their respective localities. Locations showing strong possibility of leopard cat presence were visited and recorded using a Global Positioning System (GPS) device.

Trapping was conducted in 3 phases: a 5-day preliminary phase from May 20 to 24, 2013, a 12-week dry season phase from December 10, 2013 to March 10, 2014, and an 8-week wet season phase from May 20 to July 18, 2014. Twelve box traps with a single door opening tripped by a foot treadle were set over a 2-km transect. Based on the results of the reconnaissance, traps were set purposively at about 50–100 m apart near or within areas where they are likely to be present (Fig. 3). Live week-old chicks were placed in a separate bait compartment attached to the end of the trap. Traps were visited twice daily to change the feed and water of the bait and then transferred to a different location every week. Trap success was computed as capture per unit effort (CPUE).

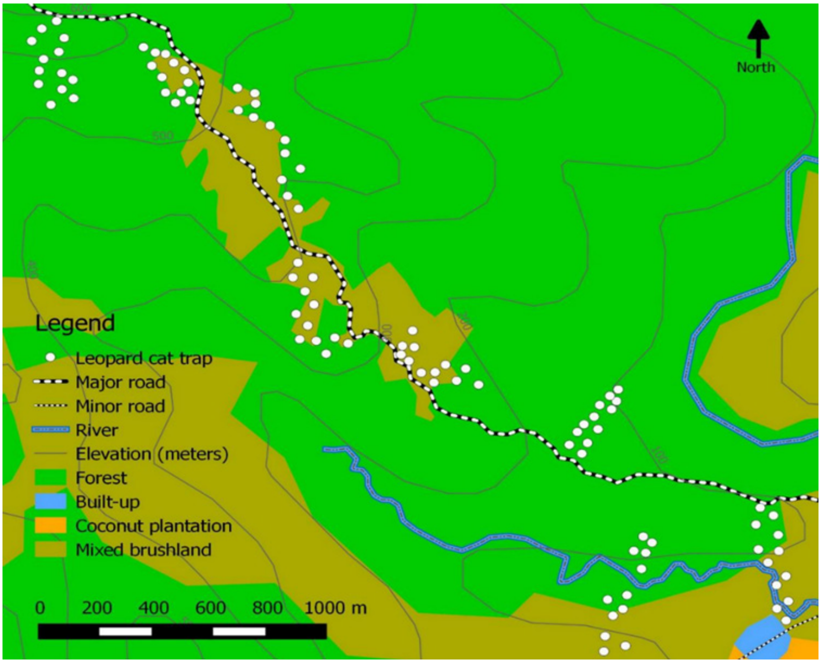

Figure 3 Locations of traps used to capture Palawan leopard cats in Aborlan, Palawan, Philippines

Upon capture, each cat received an injection of atropine sulfate by a licensed veterinarian. After 15 minutes, Zoletil® sedative (Virbac Laboratories, France) was injected intramuscularly (10 mg/kg). Once completely sedated (5–10 minutes), each cat was sexed, aged, measured, weighed, and photographed.

Before release, each cat was fitted with a radio transmitter collar around the neck (148–149 MHz, Advanced Telemetry Systems, USA). Radio telemetry was then conducted for 32 days in the dry season from January to March 2014, and 32 days in the wet season from May to July 2014. Approximately 24 hours after each leopard cat release, tracking with a receiver unit (Advanced Telemetry Systems, USA) and a 3-element yagi antenna commenced. This was conducted at 4 to 6-hour interval, 3 to 5 days per week, with sampling from 00:00 to 23:00. At least 3 azimuths were taken from different telemetry stations with a total interaction angle of at least 120^{o} within 10–15 minutes.

Prey diversity and abundance

Diversity and abundance of small non-volant mammals were also determined per season by trap-and-release in 2 habitat types, namely, forest and mixed brushland, located within the known home range of captured cats. Fifteen live traps were opened for 50 nights per season, for a total of 1500 trap nights. Traps were baited with ripe banana, earthworms, or roasted coconut with peanut butter, and set 5–10 m apart, where tracks and burrows were observed. Traps were checked every morning, rebaited every afternoon, and transferred to a different zone every week.

Analysis of data

The locations of cats were triangulated using the Triangulate plug-in for QGIS and overlaid on a land cover map. Home range sizes were computed using the Home Range Analysis and Estimation (HoRAE) for GIS OpenJUMP 1.6.3. Home range areas were calculated for each cat using 95% Minimum Convex Polygon (MCP), and core areas were determined using 50% MCP. Home range estimates were exported as different shapefiles based on percent MCP, gender, and season. Habitat use was computed for each individual as the number of location points occurring within each habitat type, and their corresponding percentages. However, due to the inadequate number of individuals radio-tracked ($n = 2$), statistical analyses were not performed to definitively establish a correlation between seasonality, prey availability, home range, and habitat use. However, trends in the ratio of these parameters were observed.

Results and discussion

Trapping success

In a total of 1860 trap nights, one female and 3 male leopard cats were captured (Fig. 4). Of these, 2 individuals were declared by the attending veterinarian as unfit for collar attachment due to signs of illness. The 2 healthy individuals chosen for radio tracking were LC-02, a male, and LC-03, a female. Other species also captured and released included one Palawan collared mongoose (*Herpestes semitorquatus*) and 3 palm civets (*Paradoxus hermaphroditus*).

Trapping success was 0.215% or one leopard cat per 465 trap nights. This is comparable to the trapping success of leopard cats in Thailand, which was 0.247% or one leopard cat per 405 trap nights (Grassman et al. 2005). This shows that the trapping success for leopard cats is very low and emphasizes the difficulty of capturing and studying cryptic carnivores. Leopard cats were captured in forest areas that are

Figure 4 Leopard cats caught through live trapping in Aborlan, Palawan, Philippines

near the edges of mixed brushland habitats in Barangay Cabigaan and in areas with validated local reports. This underscores the value of conducting ethnobiological surveys in order to gain helpful indigenous knowledge that may not be available in published scientific literature.

However, due to the low number of *P. b. heaneyi* captured, statistically valid conclusions cannot be made in this study to accurately represent the spatial ecology of the subspecies. Aebischer et al. (1993) suggest capturing at least 6 individuals per age, sex, habitat, or season, to be viable for statistical analysis. Nonetheless, this is the first study focused on *P. b. heaneyi*, thus providing valuable preliminary insights regarding their spatial ecology.

Habitat use

A total of 384 location points (Table 1, Fig. 5), with 96 points per animal per season, were found across 4 different habitat types, namely, forest, mixed brushland, coconut plantation, and built-up areas. Both leopard cats used forest areas more frequently (71.09%). Less utilized were mixed brushlands (25.78%), coconut plantations (2.60%), and built-up areas (0.52%). Use of forest areas was higher during the dry season while use of the more disturbed mixed brushlands, coconut plantations, and built-up areas was higher during the wet season.

Forest areas seem to be the most valuable habitat for *P. b. heaneyi* as forests provide both prey and cover, which are known from numerous studies to be the 2 most important resources for leopard cats (Mohd-Azlan and Sharma 2006; Rajaratnam et al. 2007; Simcharoen et al. 2014; Bashir et al. 2014). However, *P. b. heaneyi* also seem to tolerate more disturbed habitats such as mixed brushlands, coconut plantations, and built-up areas. The same tendency was reported for other species of leopard cats. The Visayan leopard cats (*Prionailurus bengalensis rabori*)

Table 1 Frequency of capture in different habitats and seasons from a male and female Palawan leopard cat in Aborlan, Palawan, Philippines

ID No.	Habitat Type											
	Forest			Mixed Brushland			Coconut Plantation			Built-Up		
	Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total
LC-02 (Male)	61	40	101	32	47	79	2	8	10	1	1	2
LC-03 (Female)	86	86	172	10	10	20	0	0	0	0	0	0
Total			273			99			10			2

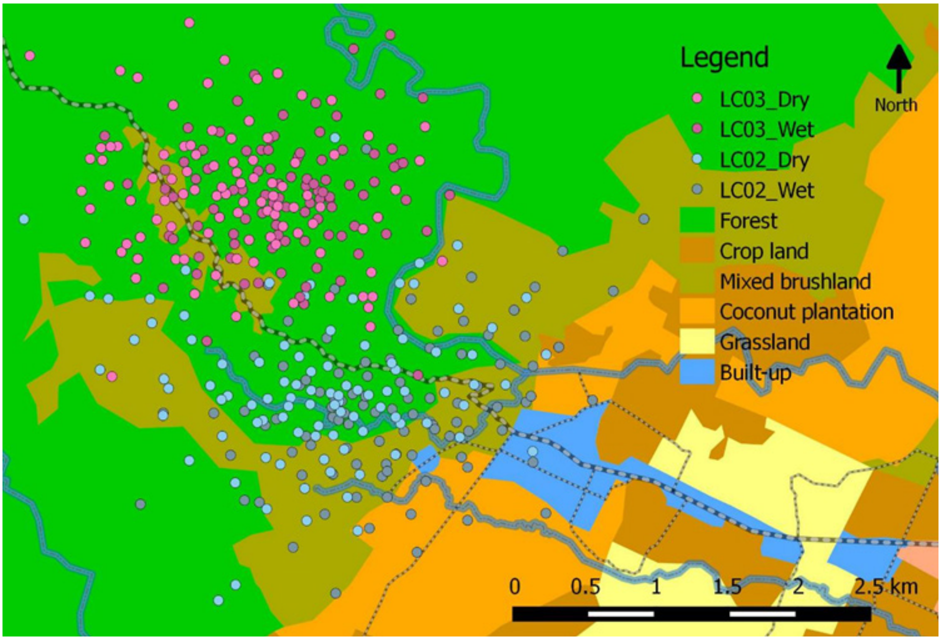

Figure 5 Location points of a male (LC-02) and a female (LC-03) Palawan leopard cat during different seasons in Aborlan, Palawan, Philippines

survived massive conversion of forests into sugarcane plantations in Negros Island, Philippines (Lorica and Heaney 2013) and Bornean leopard cats (*Prionailurus bengalensis borneoensis*) from the massive conversion of forests into oil palm plantations in Borneo (Rajaratnam et al. 2007), in both cases, by consuming exotic rodent pests that are abundant in agricultural landscapes.

Location points of leopard cats in Palawan can be found in very close proximity to both major and minor roadways (Fig. 5). Other researches have shown that leopard cats frequently make use of roads and manmade walking trails in Indonesian Borneo (Cheyne and Macdonald 2011), Malaysian Borneo (Sollmann et al. 2013), and in Iriomote Island, Japan (Díaz-Sacco and Izawa 2013).

The absence of the female leopard cat in coconut plantations and built-up areas could be due to its occurrence in a more forested area that is limited by steep ridges along the northern edge of its range and the territoriality of the male occupying the southern edge. Otherwise, it is expected that habitat selection between male and female leopard cats would not be significantly different given a greater sample size, as shown in previous studies (Grassman et al. 2005; Rajaratnam et al. 2007).

Home range

The estimated mean home range sizes of the male were 6.2917 km^2 at 95% MCP and 1.2683 km^2 at 50% MCP, while those of the female were smaller with 3.9236 km^2 at 95% MCP and 0.9558 km^2 at 50% MCP, with a 0.7209-km^2 overall overlap in the 95% MCP of both individuals (Table 2). Mean home range size for both sexes combined was 5.1077 km^2 at 95% MCP and 1.1121 km^2 at 50% MCP. There were no overlaps between core ranges (50% MCP) of both leopard cats during either season (Fig. 6 and Fig. 7), which may indicate territorial behavior.

Table 2 Estimated home range sizes of a male and female Palawan leopard cat during different seasons in Aborlan, Palawan, Philippines

	Mean			Dry Season			Wet Season		
ID No.	95% MCP (km^2)	50% MCP (km^2)	Over-lap (km^2)	95% MCP (km^2)	50% MCP (km^2)	Over-lap (km^2)	95% MCP (km^2)	50% MCP (km^2)	Over-lap (km^2)
LC-02 (Male)	6.2917	1.2683	-	4.2515	1.1145	-	5.1509	1.1914	-
LC-03 (Female)	3.9236	0.9558	0.7209	2.8801	0.6243	0.4844	2.9713	0.7329	0.0045
Mean	5.1077	1.1121	-	3.5658	0.8694	-	4.0611	0.9622	-

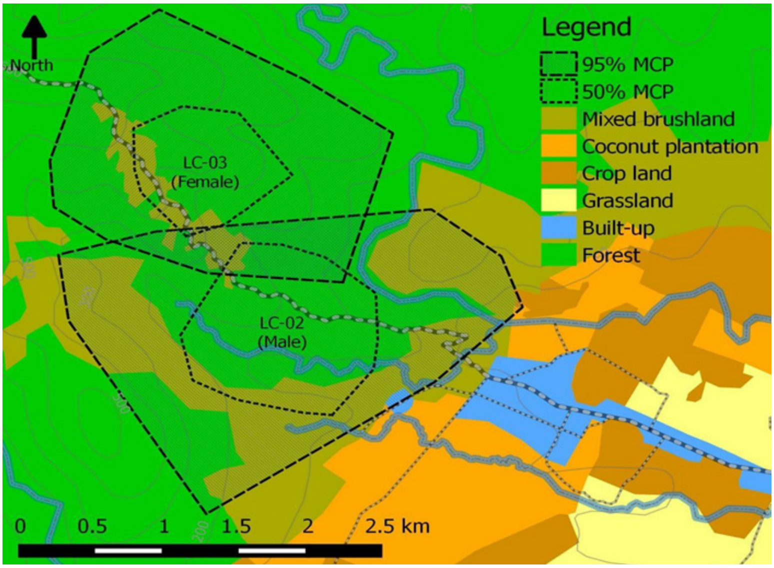

Figure 6 Dry season home range size estimates for a male and female Palawan leopard cat in Aborlan, Palawan, Philippines

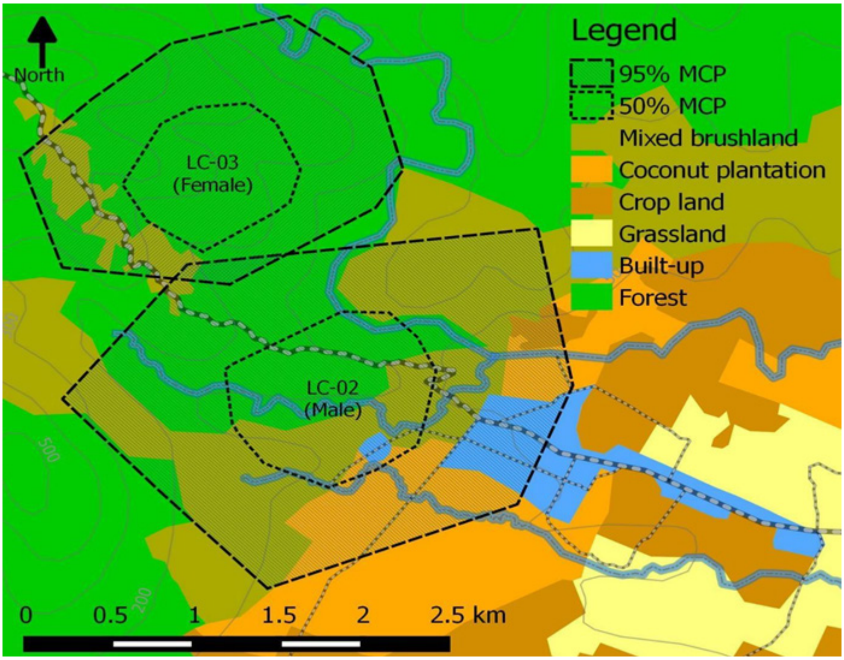

Figure 7 Wet season home range size estimates for a male and female Palawan leopard cat in Aborlan, Palawan, Philippines

Territoriality, as indicated by the exclusivity of core ranges among individuals, has also been observed in other leopard cat populations such as those in westcentral Thailand (Rabinowitz 1990) and northcentral Thailand (Grassman et al. 2005). However, large overlaps among the core ranges of Iriomote leopard cats (*Prionailurus bengalensis iriomotensis*) were detected in Iriomote Island, Japan (Schmidt et al. 2003). Schmidt and colleagues suggested that the isolation and small size of Iriomote Island (284 km^2) may have led to an increased frequency of encounters between individuals and a decreased tendency toward strict territorial behavior in order to maximize access to limited resources. Thus, leopard cat populations in continental Asia or islands such as Palawan (11,785 km^2), which is more than 40 times larger than Iriomote Island, may have a higher tendency towards exhibiting territorial behavior.

Table 2 shows that the mean home range size estimate for the male is larger than the female, agreeing with the results of other studies. In westcentral Thailand, the MCP home range of a male leopard cat was larger at 7.5 km^2 while that of a female was only 6.6 km^2 (Rabinowitz, 1990). In southcentral Thailand, the mean MCP home range of 3 male leopard cats was also larger at 4.1 km^2 while that of a female was only 2.5 km^2 (Grassman 2000). However, this is contrary to the results of Grassman, et al., (2005) in Phu Khieo Wildlife Sanctuary, Thailand, where females had larger home range sizes.

Table 2 and Figs. 6 and 7 show the variation of home range size during different seasons. For both sexes, the sizes of both 95% and 50% MCP home ranges were smaller during the dry season and larger during the wet season. Studies by Rabinowitz (1990), Grassman (2002) and Austin et al., (2007) agree that leopard cats tend to have larger home range sizes during the wet season. However, Grassman, et al., (2005) measured an increase in home range size during the dry season, but this was not found to be statistically significant. These aforementioned studies all linked seasonal changes in home range to changes in the availability of prey items. It is possible that when prey density decreases, leopard cats must travel farther distances in search of food.

Prey species diversity

A total of 59 individuals representing 5 species of non-volant small mammals were recorded over 1500 trap nights (Table 3). Overall trapping success was 4.13%. Trapping success during the dry season was relatively higher (5.07%) than during the wet season (3.20%). Trapping success was also relatively higher in the mixed brushland habitat (4.93%) than in the forest habitat (3.33%).

Table 3 Small non-volant mammals recorded across different habitat types and seasons in Aborlan, Palawan, Philippines

Order	Family	Species	Forest		Mixed Brushland	
			Dry	Wet	Dry	Wet
Scandentia	Tupaiidae	*Tupaia palawanensis*	6	4	4	3
Rodentia	Sciuridae	*Sundasciurus steerii*	0	0	3	0
	Muridae	*Maxomys panglima*	10	5	6	4
		Rattus exulans	0	0	4	4
		Rattus tanezumi	0	0	5	4

These results suggest that seasonal changes in habitat use and home range size of leopard cats may be related to the lower abundance of small mammals during the wet season. Utilization of more disturbed habitats such as mixed brushlands, coconut plantations, and built-up areas versus forest areas during the wet season may be due to the decrease in abundance of small mammals in the forest and relative stability of exotic rodent pest populations in disturbed habitats. The increase in home range size during the wet season can also be explained by the overall decrease in small mammal abundance that could drive leopard cats to travel farther away in search of food. Several studies have also linked seasonal increases in leopard cat home range to decreases in the availability of prey items (Rabinowitz 1990; Austin et al. 2007; Grassman et al. 2005).

Conclusion

The spatial ecology of one adult male and one adult female *P. b. heaneyi* in Barangay Cabigaan, Aborlan, Palawan, Philippines from May 2013 to July 2014 showed that both leopard cats tracked used forest areas more frequently, with 273 points (71.09%). Other habitats utilized with less frequency were mixed brushlands with 99 points (25.78%), coconut plantations with 10 points (2.60%), and built-up areas with 2 points (0.52%). Use of forest areas was higher during the dry season while use of the more disturbed mixed brushlands, coconut plantations, and built-up areas was higher during the wet season.

Home range estimates showed that the mean 95% MCP home range of the male (6.2917 km^2) was larger than that of the female (3.9236 km^2). There were no overlaps between core ranges (50% MCP) of both individuals during either season. There was an increase in mean home range size from dry season (3.5658 km^2) to wet season (4.0611 km^2) for both sexes.

Small mammals captured included *Rattus exulans*, *Rattus tanezumi*, *Sundasciurus steerii*, *Maxomys panglima*, and *Tupaia palawanensis*. More small mammals were captured in mixed brushlands possibly due to the higher diversity of food sources present in the area. The abundance of small mammals was lower during the wet season for both habitat types and sexes.

Although forest areas were the most frequently used overall, this study suggested that *P. b. heaneyi* had an increased frequency of use of disturbed habitats (mixed brushland, coconut plantations, and built up areas) during the wet season and this appeared to be related to the decrease in the abundance of prey species. During this season, the relative abundance of *M. panglima* and *T. palawanensis* found in the forest area decreased sharply during the wet season, while that of exotic species such as *R. exulans* and *R. tanezumi* in the disturbed habitats remained the same or decreased only slightly. This may have caused leopard cats to travel toward disturbed areas farther away from forests in search of prey. This may also have led to the increase in home range sizes of *P. b. heaneyi* during wet season.

In future studies, it is recommended that trapping be conducted for multiple years during the driest months from January to February. It is further recommended that both leopard cat and small mammal traps be set in coconut plantations and built-up areas within Barangay Cabigaan, as these habitats were also utilized.

Due to the number of other carnivoran species unintentionally captured, it is recommended that these species should also be included in future studies using similar trapping methods. These are closely related species that may share habitat and dietary requirements, and it will be of great interest to study these ecological dynamics. Mammalian carnivores such as leopard cats serve as keystone species in many ecosystems as they are at the top of the food chain. They are also highly charismatic and could serve as flagship species for the conservation of other wildlife and their habitat.

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Literature cited

Aborlan Municipal Comprehensive Land Use Plan (CLUP). 2012. Aborlan, Palawan, Philippines: Aborlan Municipal Government. [unpublished].

Aebischer NJ, Robertson PA, Kenward RE. 1993. Compositional analysis of habitat use from animal radio-tracking data. Ecology. 74(5):1313–1325.

Austin SC, Tewes ME, Grassman LI, Silvy MJ. 2007. Ecology and conservation of the leopard cat and clouded leopard in Khao Yai National Park, Thailand. Acta Zool Sinica. 53:1–14.

Bashir T, Bhattacharya T, Poudyal K, Sathyakumar S, Qureshi Q. 2014. Integrating aspects of ecology and predictive modelling: implications for the conservation of the leopard cat (*Prionailurus bengalensis*) in the Eastern Himalaya. Acta Theriol. 59(1):35–47. doi:10.1007/s13364-013-0145-x

Calawagan CLG. 2014. Endoparasites and selected microbial pathogens of Palawan leopard cats (*Prionailurus bengalensis heaneyi* Groves, 1997) in Aborlan, Palawan, Philippines [MS thesis]. Los Baños, Laguna (Philippines): University of the Philippines Los Baños.

Cheyne S, MacDonald DW. 2011. Wild felid diversity and activity patterns in Sabangau peat-swamp forest, Indonesian Borneo. Oryx, 45(1), 119-124. doi:10.1017/S00306053100 0133XZ

Cruz RM, Villafuerte-Van Den Beukel D, Lacerna-Widmann I, Schoppe S, Widmann P. 2007. Wildlife trade in Southern Palawan, Philippines. Banwa. 4(1):12–26.

Diaz-Sacco JJ, Izawa M. 2013. Road use by the Iriomote cat (Prionailurus bengalensis iriomotensis) on Iriomote-jima Island in relation to its herpetile prey. Mammal Study, 38, 73-80.

Esselstyn JA, Widmann P, Heaney LR. 2004. The mammals of Palawan Island, Philippines. P Biol Soc Wash. 117(3):271–302.

Fuller MR, Fuller TK. 2012. Radio-telemetry equipment and applications for carnivores. In: Boitani L, Powell RA, editors. Carnivore Ecology and Conservation: A Handbook of Techniques. Oxford (United Kingdom): Oxford University Press. p. 506.

Grassman LI. 2000. Movements and diet of the leopard cat *Prionailurus bengalensis* in a seasonal evergreen forest in south-central Thailand. Acta Theriol. 45:421–426.

Grassman LI, Tewes ME, Silvy NJ, Kreetiyutanont K. 2005. Spatial organization and diet of the leopard cat (*Prionailurus bengalensis*) in north-central Thailand. J Zool London. 266:45–54.

Kintanar RL. 1984. Climate of the Philippines. Quezon City (Philippines): Department of Science and Technology (DOST) - Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Report, 38.

Lorica MRP, Heaney LR. 2013. Survival of a native mammalian carnivore, the leopard cat *Prionailurus bengalensis* Kerr, 1792 (Carnivora: Felidae), in an agricultural landscape on an oceanic Philippine island. J Threatened Taxa. 5(10):4451–4560.

Mohd-Azlan J, Sharma D. 2006. The diversity and activity patterns of wild felids in a secondary forest in Peninsular Malaysia. Oryx. 40(1):36–41.

Nakanashi N, Okamura M, Watanabe S, Izawa M, Doi T. 2005. The effect of habitat on home range size in the Iriomote cat *Prionailurus bengalensis iriomotensis*. Mamm Study. 30:1–10.

Nash SV. 1997. Fin, Feather, Scale and Skin: Observations on the Wildlife Trade in Lao PDR and Vietnam. Vietnam: Traffic Southeast Asia.

Oh DH, Moteki S, Nakanishi N, Izawa M. 2010. Effects of human activities on home range size and habitat use of the Tsushima leopard cat *Prionailurus bengalensis euptilurus* in a suburban area on the Tsushima Islands, Japan. J Ecol Field Biol. 33(1):3–13. doi:10.5141/JEFB.2010.33.1.003

Paguntalan LJ, Jakosalem PG, Reintar AR, Doble KJ, Ramilo RV, Espinosa AF. 2015. Terrestrial biodiversity conservation status of Busuanga Island: Preliminary report. London, United Kingdom: Community Centered Conservation. 17 pp.

Rabinowitz A. 1990. Notes on the behavior and movements of leopard cats, *Felis bengalensis*, in a dry tropical forest mosaic in Thailand. Biotropica. 22:397–403.

Rajaratnam R, Sunquist M, Rajaratnam L, Ambu L. 2007. Diet and habitat selection of the leopard cat (*Prionailurus bengalensis borneoensis*) in an agricultural landscape in Sabah, Malaysian Borneo. J Trop Ecol. 23:209–217.

Sanderson J, Sunarto S, Wilting A, Driscoll C, Lorica R, Ross J, Grassman L. 2008. *Prionailurus bengalensis*. The IUCN Red List of Threatened Species 2012.2 [retrieved 2012 Nov 01]. http://www.iucnredlist.org

Schmidt K, Nakanishi N, Okamura M, Doi T, IZAWA M. 2003. Movements and use of home range in the Iriomote cat (Prionailurus bengalensis iriomotensis). Journal of Zoology, London (261), 273–283

Simcharoen S, Umponjan M, Duangchantrasiri S, Pattanavibool A. 2014. Non-Panthera cat records from big cat monitoring in Huai Kha Khaeng Wildlife Sanctuary. CATnews (Special Issue 8):31–35.

Sollmann R, Mohamed A, Samejima H, Wilting A. 2013. Risky business or simple solution – Relative abundance indices from camera-trapping. Biological Conservation, 159, 405-412.

Tajiri H, Doi T, Izawa M, Tatara M. 1996. Home range size and habitat selection of the Tsushima leopard cat (*Felis bengalensis euptilura*) in the Tsushima Islands, Japan. Isl Stud Okinawa. (14):31–38.

Sylvatrop, *The Technical Journal of Philippine Ecosystems and Natural Resources 28 (1): 17-30*

Ecological implications of domestic cat ranges on the Calayan rail in the forest sanctuary of Calayan Island, Cagayan, Philippines

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*Studies show that domestic cats are considered as one of the biggest threats to wildlife. They have been implicated in species decline on islands and on continents, and affect mammals, birds, reptiles, and amphibians. A preliminary assessment of the threats to the Calayan rail (**Gallirallus calayanensis)** showed that introduced domestic cats have effects on its conservation status from being vulnerable to being extinct. This study aims to determine domestic cat diet and ranges on Calayan Island; confirm if there is an overlap between cat and **G. calayanensis** habitat range; identify human perceptions on the possible impact of domestic cats on **G. calayanensis**; and provide basis for future management options. Results showed that cats traveled an average distance of 112.38 m and overlapped with the habitat of the **G. calayanensis.** Although cats were not perceived to be threats to local wildlife by the respondents, the cats sampled in the study were able to cross buffer areas into the wildlife sanctuary, implying a possible impact on species vulnerable to predation. Calayan Island, because of its size and importance to biodiversity, can be a possible model for island conservation through the control of introduced predators and management of pet ownership.*

Keywords: Calayan Island, Calayan rail, cats, invasive species management

SEVERAL STUDIES HAVE DEMONSTRATED THE VULNERABILITY OF BIRDS, REPTILES, and mammals to cat attacks (Longecore et al. 2009; Peck et al. 2008; Nogales et al. 2004; Jessup 2004; Bonnaud et al. 2007; Mosby and Read 2006), which may cause significant fluctuation in populations of wildlife (Peck et al. 2008). Domestic and feral cats have been observed to travel greater distances particularly when they are prone to hunt. Home ranges for a feral cat range from 0.028-3.947 ha (Nutter 2005); cat populations that subsist by hunting have been observed to have wider home ranges than those fed in households.

The Calayan rail (*Gallirallus calayanensis*) (Fig. 1) was discovered by Carmela Española in 2004 and described in the same year by Allen et al. (2004). It is a member of the cosmopolitan Rallidae family, which also includes coots and gallinules. The bird is generally dark olive with red-orange legs and feet and yellow to red bill (Allen et al. 2004). The species is restricted to Calayan Island, Babuyan Group of Islands, and lives in primary and secondary forest on limestone substrate. They seem to prefer areas near streams. In fact, the nest and eggs described by Oliveros and Layusa (2011) was located beside a temporary stream. The species is closely associated with *Odontonema strictum*, a bush that is abundant in the habitat. About 85% of sightings were associated with recently disturbed forests, and animals occur as individuals or in small family groups that forage on the ground and feed on snails, beetles, millipedes; a gastrolith and grass-like plant material was seen upon examination of the holotype (Allen et al. 2004).

Figure 1 Calayan rail *(Gallirallus calayanensis)* (Photo by Natural, Jr. 2016)

G. calayanensis was provided a provisional "Vulnerable" status under the International Union for Conservation of Nature (IUCN) categories of threat on the basis of its limited range, known population size, and threats to its population (Allen et al. 2004). The provisional conservation status was given as a precautionary measure and based on preliminary assessment of the species and its habitat upon its discovery. Threats of habitat destruction, hunting, and the impact of introduced species have been identified to affect rail population. The ISLA Biodiversity Conservation, Inc. have worked in the island to conserve the Calayan Rail through community engagement, population surveys and education activities to address habitat destruction and hunting (Española and Oliveros 2007; Broad and Oliveros 2006; Oliveros and Layusa 2007), however the effect of introduced species has not been fully explored, and thus has not been managed.

Field surveys have found that *G. calayanensis* inhabits most of the island's forests (Oliveros and Layusa 2011). Population surveys from 2005 to 2006 determined that *G. calayanensis* has a wide distribution (Española and Oliveros 2007), with observation in 5 out of the 7 barangays. Anecdotal information revealed that *G. calayanensis* used to occur near houses in the lowland barangays of Magsidel, Dadao, Dilay, and Dilam, but have now been driven to elevations above 81 masl (Española and Oliveros 2007). The habitat of the species has declined predominantly because of land clearing and conversion, and habitat incursion (Layusa 2012). Since domestic cats are closely associated with human settlements, it is possible that cats may impact the *G. calayanensis* populations around these areas if their ranges overlap.

This study aimed to profile the diet and range of domestic cats on Calayan Island, determine if an overlap between cats and *G. calayanensis* exists, identify human perceptions on the possible impact of domestic cats on the *G. calayanensis* and local wildlife, and lastly, provide a basis for future management modalities.

Materials and methods

Study location

The study was conducted in Calayan Island, Babuyan Group of Islands, Cagayan province, a small group of islands situated above mainland Luzon and below the Batanes Group of Islands (Fig. 2). Together with the Batanes Group of Islands, they comprise the northernmost Important Bird Area in the Philippines (IBA code PH001) (Mallari et al. 2001). It is also included in the list of the country's Secondary Areas (SA 94) for endemic birds. The Babuyan Group of Island lies on a major bird migration route from Siberia, Japan, Korea, and China through Taiwan to the Philippine archipelago (Española and Oliveros 2007).

Calayan Island (N19°20′, E121°27′) has a land area of 196 km^2 and a maximum elevation of 499 meters above sea level (masl). This low-lying island has extensive primary and regenerating forests in its central area, which have intermittent

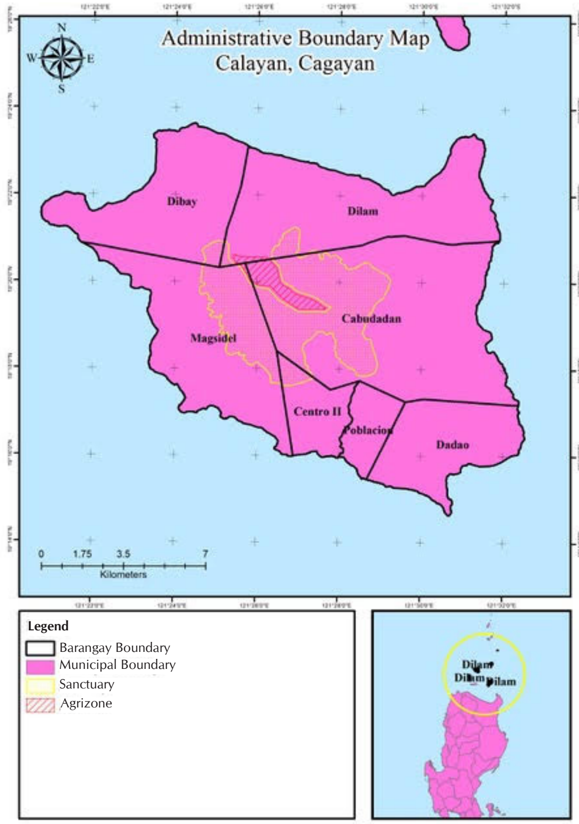

Figure 2 Administrative boundary map of Calayan Island, Cagayan Valley, Philippines showing the barangays with Calayan Rail

clearings, often containing plots of land cultivated for rice, yam, corn, and coconut (Española and Oliveros 2007). Extensive grassland covers the eastern coastline and the island's northwestern tip. The main settlement areas are located on the southern and northern coasts, where rice fields and coconut plantations extend 1–2 km inland. A wildlife sanctuary was established through participative methods in 2011 where the community identified zones allocated for the sanctuary and agricultural use (Fig. 3) (ISLA 2009, 2010). A reconnaissance visit was conducted from May 22 to 27, 2013 and fieldwork and data collection was conducted from May 30 to June 7, 2013.

Interviews

To analyze human perceptions on the possible impact of domestic cats on *G. calayanensis*, owners of domestic cats living in Barangay Magidel were interviewed.

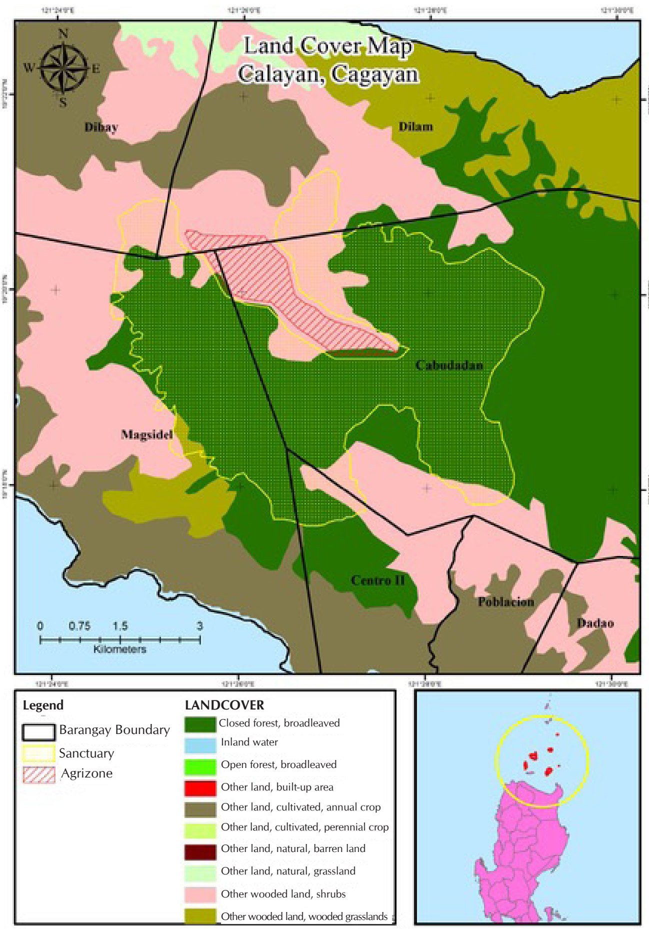

Figure 3 Land use map of Calayan Island showing the designated sanctuary bordered in yellow line

The extent of human attitudes on pet ownership, disease prevention and treatment, methods of population control, and their opinions on how cats affect *G. calayanensis* and other wildlife species were determined.

Six households that were directly adjacent to the wildlife sanctuary were visited. Individual and focus group interviews were done in Sitio Longgog, Barangay Magsidel. Respondents were chosen using snowball technique (Nutter 2005), where each respondent suggested other possible respondents. Only those respondents that were identified more than once were qualified for the interview. Open-ended interview questions were formulated in English and translated to Ilocano by a local resident. Interview categories included respondent information, pet ownership and care, and awareness of the impacts of cats on wildlife. Translated interviews were tested on 3 locals before the interview proper. At least 2 individuals were interviewed from each household, with each interview lasting about 10-15 minutes. The results of the interviews were collated. Common keywords that arose were extracted and their frequencies were counted under each category to determine top answers.

Cat tracking

The location of each respondent's household was plotted using a global positioning system (GPS) device, and cats that live in each of these households were identified using an assigned household number (Fig. 4). Eight domestic cats—4 males and 4 females—from households within the agricultural zone were assessed. The cats' ages ranged from 3 to 72 months. The location of the households in relation to adjacent forest cover was noted. Hunting ranges of domestic cats were estimated using data from published sources (Nutter 2005; Ogan and Jurek 1997; Burrows et al. 2003), while the spool and line technique using spool collars (Fig. 5) was employed to observe cat movements and range (Shanahan et al. 2007). Data gathered from this technique (i.e. location points, cat movements, and ranges) as well as household locations in relation to the protected area boundaries, buffer zones, and *G. calayanensis* sightings were plotted on a map using a Geographic Information System (GIS) Software (ArcGIS 10.1) to provide a graphical representation of the data. All 8 cats observed in this study were collared with a spool and line attachment, released, and revisited after 12 hours. While domestic cats were targeted during this study, the presence of dogs, other domestic animals, and feral cats were also noted, as well as anthropogenic activities that may affect *G. calayanensis*. All relevant government and institutional permits were obtained prior to the conduct of the study.

Figure 4 Sample cat tagged for tracking at the sampling site in Calayan Island, Cagayan Valley, Philippines

Figure 5 Spool collars that were used to tag cats for tracking at the sampling site Calayan Island, Cagayan Valley, Philippines

The cat tracking data were overlaid with *G. calayanensis* sightings obtained from census surveys conducted by Isla Biodiversity Conservation from 2005 to 2009. Percentage of overlap between cat and *G. calayanensis* ranges were presented as x/y values and plotted on a scatter chart for analysis. Correlation (r) was calculated using Pearson's technique and student t-test ($p = 0.05$) was used to test significance.

Results and discussion

Domestic cat range and potential overlap with the *G. calayanensis* habitat

All households interviewed were located within 200 m of the forest, the habitat of the *G. calayanensis* and other forest wildlife. Cat tracks further confirm that cat ranges go towards the forest zones and overlapped with known *G. calayanensis* sighting areas, with 2 cats penetrating the wildlife sanctuary buffer zone (Fig. 6).

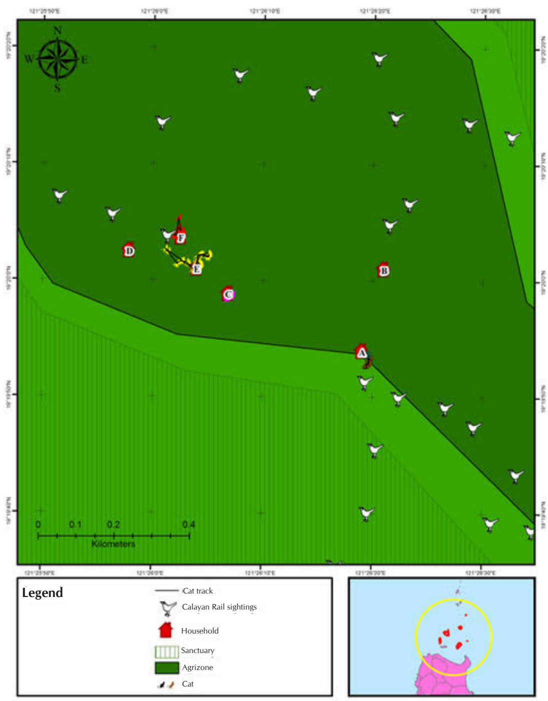

Figure 6 Cat tracks from each household showed 2 cats from household A enter the wildlife sanctuary buffer zone

Distances traveled by the cats observed ranged from 30.42-577.17 m, with an average distance of 112.38 m. Older cats traveled further, covering longer distances and affecting bigger areas. Cat ages (in months) is strongly positively correlated with distance (m) traveled (r = 0.8723) (Fig. 7), indicating that older cats tend to travel further than kittens. This shows that special attention should be given to households with cats that are older and can travel to known *G. calayanensis* habitat.

A projection of the average distance traveled per cat per household was plotted, which considered that cats traveled farther as they age. At 22.25 months, a cat may travel an average of 112.382 m, greatly overlapping with and possibly disturbing *G. calayanensis* ranges. On the other hand, if all cats traveled as far as the oldest cat (72 months, 577.171 m), all cats will be able to cross the agricultural zone towards the strict protection zone of the wildlife sanctuary (Fig. 8). This is crucial because entry into the sanctuary can result in threats to other animals that are vulnerable to cat predation. This estimated area may still increase, as cats that live in wild areas will tend to travel farther and ranges may reach as wide as 12 km^2 (Burrows et al. 2003), possibly disturbing *G. calayanensis* nests and altering behavior patterns related to the bird's breeding and nesting, or affecting other wildlife on the island (Longecore et al. 2009; Nogales et al. 2004). This possibility should be enough to prompt conservation managers to revisit the potential impact of domestic cats not only within the sanctuary but within the distributional range of *G. calayanensis* .

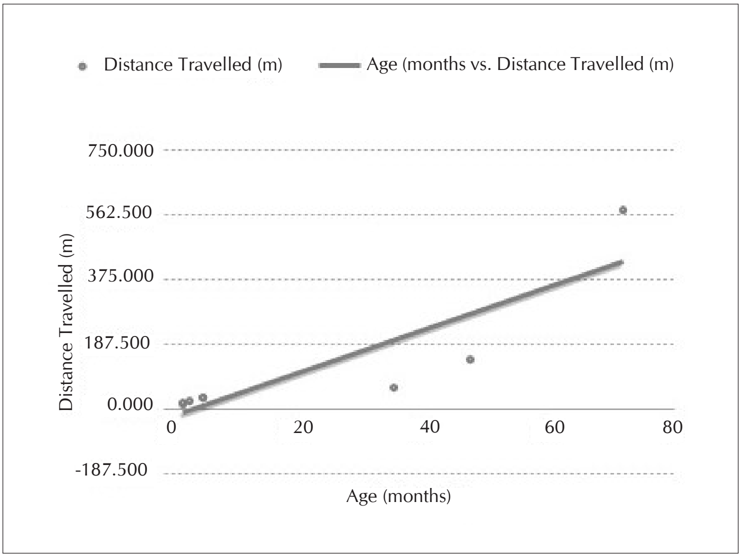

Figure 7 Scatter plot showing a strong positive relationship (r = 0.8723) of the cats' ages (months) and the distance traveled (m) by each animal

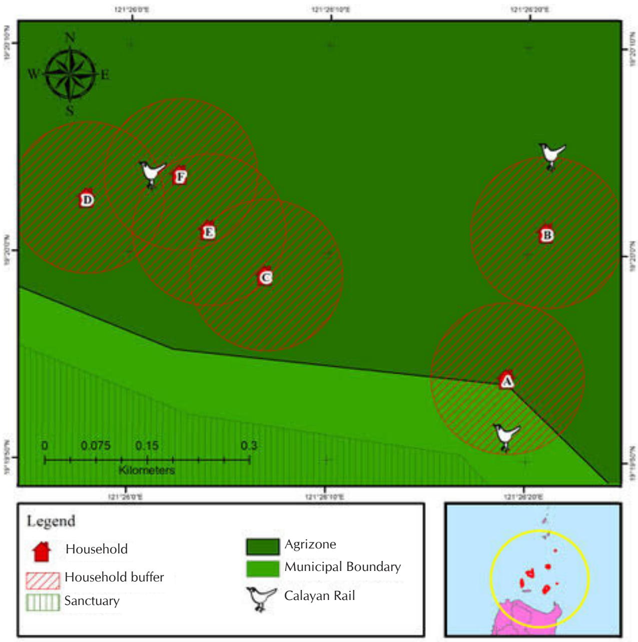

Figure 8 Distance traveled by cats (if all will grow up to 72 months) shows that all the cats will reach the strict protection zone

Domestic cat profile, diet, and population control

The cats were obtained from households in other sitios in lowland barangays. It has been a practice by some community members to get rid of kittens by leaving them in areas several kilometers away from their house.

All of the households visited had pets that were neither vaccinated nor dewormed. Two households also had pigs and chickens. All pets were fed with leftovers from the respondents' meals, dessicated coconut, cooked rice, and scraps from food preparation such as raw fish innards. All pets were offered food 3 times a day; one male cat was fed with fish 3 times a day.

The pets lived outside or in the vicinity of their house. Domestic cats are free to roam in their surrounding areas, which is adjacent to the forest, unmonitored especially during daytime.

It is significant to note that in the households included in this study, 2 male dogs were found to be neutered, while all adult male cats (n = 3) were neutered using rubber bands wound around the base of the testicles as a modified burdizo.

Perceptions on pet ownership

The respondents had a low awareness of animal welfare methods where 100% of the respondents claim that they do not treat sick animals or give prophylactic medication such as preventive vaccination or deworming. Typically, these medications are sponsored by the local government units (LGUs), however, respondents claimed that veterinarians have not visited the island to provide this service. The Provincial Veterinarian in the city of Tuguegarao, the capital of Cagayan province, confirmed that vaccination activities on dogs and cats have not been conducted on Calayan Island. There have been no cases of rabies on the island, prompting a call to declare Calayan Island as rabies-free. This requires that all pets be vaccinated, which in turn requires an island-wide census of all household pets (2012 pers. comm with JA Guillermo, Provincial Veterinarian; unreferenced), which, to date, has not been done. Furthermore, disease testing for zoonotic pathogens (i.e. *T. gondii*) has not been performed. Health monitoring of animals entering the island is not mandated, as observed by the authors and confirmed by the Provincial Veterinarian. Animals enter and leave Calayan Island freely, without being subjected to precautionary quarantine measures.

All of the 15 respondents accepted neutering and spaying as management options. Spaying is one of the more effective methods of cat population control, as opposed to neutering (Andersen et al. 2004) because female cats affect population growth rates more effectively than male cats. All respondents were willing to have their pets vaccinated and wormed if the services are offered for free. None of the female pets were spayed, and respondents were surprised that this can be done to their female pets. Likewise, all of the respondents were willing to have their female pets spayed if the service is offered for free. None of the respondents considered euthanasia as a form of animal population control. Euthanasia is considered to be more effective in the control of cat populations, as compared to neutering (Andersen et al. 2004).

Perceived and potential impacts of domestic cats on wildlife

Answers pertaining to the potential effect of cats on *G. calayanensis* indicated that respondents do not consider cats or dogs as a threat to the species. Respondents have observed cats take in mice, but have not seen the animals eat other wildlife. On the other hand, 4 respondents said that their dogs catch monitor lizards. While respondents claimed that their own pets have no impact on wildlife, studies show that cats have been known to prey on wildlife (Longecore et al. 2009; Galbreath and Brown 2004). It is possible that cats were not presumed to hunt because hunting grounds are away from their homes and respondents were not able to monitor their pets during the course of the day.

While neutering male cats may help stem the population of cats on the island, the method of disposing kittens might increase the numbers of feral cats in the area, possibly causing problems for *G. calayanensis* and other wildlife populations that are vulnerable to cat predation. During the reconnaissance visit, a male feral cat was observed in the vicinity of the first household, 100 m from the forest edge, but was not observed during the subsequent field surveys. This reaffirms the presence of feral cats reported by previous researchers (Española and Oliveros 2007; Allen et al. 2004). But as observations along the trail did not yield further feral cat sightings, an estimate of existing feral cat populations cannot be given. However, it can be inferred that the continued practice of indiscriminate kitten disposal can result in an exponential increase in the number of cats, creating a new colony of true feral cats (McLeod 2004) which can travel wider distances and cause great damage to wildlife (Burrows et al. 2003).

Conclusion

While cats were not perceived by the respondents to be a threat to wildlife, respondents have claimed that their cats often roam unmonitored around the area during the day and sometimes at night. Actual cat ranges prove that cats can enter into the habitat of *G. calayanensis*, which may cause direct predation. The practice of leading kittens into the forest as a form of disposal may eventually create an established feral cat population; feral cats have been observed by researchers, including the authors of this study, on numerous occasions.

An island-wide survey of household pets in Calayan Island is recommended to provide a baseline of their population on the island for future monitoring. Registration of pets is recommended to monitor and regulate the influx of animals, and determine the population trends of pets. Fitting pet cats with bells in their collars were readily accepted and this should be upheld to help protect wildlife. The efficacy of collar-mounted devices such as bells and sonic devices were investigated by some authors, who recommend the use of either to help warn wildlife of possible cat attacks (Nelson et al. 2005).

Information dissemination on the importance of responsible pet ownership and the impact of domestic animals on wild population should be prioritized, particularly in the areas near forests. Education on the ecological and health impacts of cats is also helpful, and a multimethod approach involving all stakeholders should be implemented to better ascertain effective and acceptable ways of management (Zavaleta 2002; Stoskopf and Nutter 2004). Cat population management methods are costly but these should be weighed against the cost of conservation (McLeod 2004). Thus approaches need to be balanced, effective, and should benefit all stakeholders, including the cat (Jessup 2004).

Current efforts to conserve the *G. calayanensis* are spearheaded by ISLA Biodiversity Conservation, Inc. and the local government and community of Calayan. The Calayan Rail Project utilises participatory and community-based approaches in research for the monitoring to the *G. calayanensis* and its habitat, as well as capacity building of local stakeholders. Because of this project, the *G. calayanensis* has since been adopted to be the ambassador for conservation efforts in Calayan Island, increasing education and awareness both locally and nation-wide. In addition to these efforts, recommendations for future management of the *G. calayanensis* and its habitat should include further investigation of the presence of free-roaming cats in the sanctuary with measures to eradicate individuals with no owners. This will remove the foreseen pressure on threatened animals, not just on the *G. calayanensis*, but on other endemic wildlife in the area as well.

Calayan Island, because of its size and importance to biodiversity, can be a feasible model for island conservation through the control of introduced predators in the Philippines. Promoting *G. calayanensis* as the island's flagship species for conservation may enable the human population to further appreciate the benefits of cat population management. This approach was helpful in the conservation of birds on Ascension Island (Ratcliffe et al. 2009) and prompted the populace to actively participate not just in population control, but also in the elimination of free-roaming and feral cats.

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Literature cited

Allen D, Oliveros C, Española C, Gonzales JCT. 2004. A new species of *Gallirallus* from Calayan Island, Philippines. Forktail. 20(2004):1–7.

Andersen MC, Martin BJ, Roemer GW. 2004. Use of matrix population models to estimate the efficacy of euthanasia versus trap-neuter-return for management of free-roaming cats. J Am Vet Med Assoc. 225(12):1871–1876.

Bonnaud E, Bourgeois K, Vidal E, Kayser Y, Trenchant Y, Legrand J. 2007. Feeding ecology of a feral cat population on a small Mediterranean island. J Mammal. 88(4):1074–1081.

Broad G, Oliveros C. 2006. Biodiversity and conservation priority setting in the Babuyan Islands, Philippines. Sylvatrop. 15(1&2):1–30.

Burrows ND, Algarb D, Robinson AD, Sinagrab J, Ward B, Liddelow G. 2003. Controlling introduced predators in the Gibson Desert of Western Australia. J Arid Environ. 55: 691–713.

Española C, Oliveros C. 2007. Conservation of an island endemic: Calayan Rail *Gallirallus calayanensis*. Unpublished report. 51 pp.

Galbreath R, Brown D. 2004. The tale of the lighthouse-keeper's cat: discovery and extinction of the Stephens Island wren (*Traversia lyalli*). Notornis. 51:193–200.

[ISLA] Isla Biodiversity Conservation. 2009. Establishing a wildlife sanctuary in Sitio Longog, Calayan Island: Public Hearing Proceedings. Las Piñas City (Philippines): Isla Biodiversity Conservation. Unpublished report. 25 pp.

[ISLA] Isla Biodiversity Conservation. 2010. Establishing a wildlife sanctuary in Sitio Longog, Calayan Island. Technical Report 2. Las Piñas City (Philippines): Isla Biodiversity Conservation. 45 pp.

Jessup DA. 2004. The welfare of feral cats and wildlife. J Am Vet Med Assoc. 225(9):1377–1383.

Layusa CAA. 2012. Distributional predictions and the implication of habitat loss to the conservation of the Calayan Rail *Gallirallus calayanensis* [MS thesis]. Diliman, Quezon City (Philippines): University of the Philippines-Diliman. 101 pp.

Longecore T, Rich C, Sullivan LM. 2009. Critical assessment of claims regarding management. Conserv Biol. 23(4):887–894.

Mallari NAD, Tabaranza BR Jr, Crosby MJ. 2001. Key conservation sites in the Philippines: a Haribon Foundation & BirdLife International directory of important bird areas. Makati City (Philippines): Bookmark. 485 pp.

McLeod R. 2004. Counting the cost: impact of invasive animals in Australia 2004. Canberra (Australia): Cooperative Research Centre for Pest Animal Control.

Mosbey KE, Read JL. 2006. The efficacy of feral cat, fox and rabbit exclusion fence designs for threatened species protection. Biol Conserv. 127(2006):429–437.

Nelson SH, Evans AD, Bradbury RB. 2005. The efficacy of collar-mounted devices in reducing the rate of predation of wildlife by domestic cats. Applied Anim Behav Sci. 94:273–285.

Nogales M, Martin A, Tershy BR, Donlan JC, Veitch D, Puerta N, Wood B, Alonso J. 2004. A review of feral cat eradication on islands. Conserv Biol. 18(2):310–319.

Nutter FB. 2005. Community meetings to facilitate consensus on feral cat management. In: Evaluation of a trap-neuter-return management program for feral cat colonies: population dynamics, home ranges, and potentially zoonotic diseases [PhD dissertation]. Raleigh, NC (USA): North Carolina State University. 241 pp.

Ogan CV, Jurek RM. 1997. Biology and ecology of feral, free-roaming, and stray cats. In: Harris JE, Ogan CV, editors. Mesocarnivores of northern California: biology, management, and survey techniques, workshop manual. August 12–15, 1997, Humboldt State University, Arcata, CA. Arcata, CA (USA): The Wildlife Society, California North Coast Chapter. pp. 87–92.

Oliveros C, Layusa C. 2007. Calayan Rail Project II: Building stakeholder capacity to Conserve an Island-endemic Species. Unpublished report. 39 pp.

Oliveros C, Layusa C. 2011. First description of the nest and eggs of the Calayan rail. J Yamashina Inst for Ornithol. 42:143–146.

Peck DR, Faulquier L, Pinet P, Jaquemet S, Le Corer M. 2008. Feral cat diet and impact on sooty terns at Juan de Nova Island, Mozambique Channel. Anim Conserv. 11(2008):65–74.

Ratcliffe N, Bell M, Pelembe T, Boyle D, White RBR, Godley B, Stevenson J, Sanders S. 2009. The eradication of feral cats on Ascension Island. Oryx. 44(1):20–29.

Shanahan DF, Mathieu R, Seddon PJ. 2007. Fine-scale movement of the European hedgehog: an application of spool-and-thread tracking. New Zeal J Ecol. 31(2):160–168.

Stoskopf MK, Nutter FB. 2004. Analyzing approaches to feral cat management—one size does not fit all. J Am Vet Med Assoc. 225(9):1361–1365.

Zavaleta ES. 2002. It's often better to eradicate, but can we eradicate better? In: Veitch CR, Clout MN, editors. Turning the tide: the eradication of invasive species. Gland (Switzerland) and Cambridge (United Kingdom): IUCN, IUCN SSC Invasive Species Specialist Group. p. 393–403.

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Conservation milestones of the critically endangered Philippine crocodile (*Crocodylus mindorensis* Schmidt 1935)

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*Conservation efforts to save the rarest crocodile species in the world, the Philippine crocodile (**Crocodylus mindorensis**), were exerted through the years from 1891 to 2016. This study aimed to provide insights for the conservation management of the species by documenting the milestones that could form part of future conservation programs. The review of historical accounts and published scientific articles identified species milestones in a timeline format. Results showed that **C. mindorensis** became known to science as early as 1891, based on specimens collected from the island of Mindoro (FMNH 11135), and was originally described by Karl Schmidt as **Crocodylus mindorensis** in 1935. It was later considered as a subspecies of the New Guinea crocodile (**Crocodylus novaeguineae mindorensis**) until Philip M. Hall provided new evidence for its designation as a totally separate species in 1989. Wild populations severely declined in the early 1940s to 1980s due to human persecution and indiscriminate hunting for skin trade. This triggered distribution studies to locate and estimate the abundance of extant wild populations. Upon the conclusion of these studies in the early 1990s, the International Union for Conservation of Nature (IUCN) declared the species as critically endangered in 1996. Ex-situ conservation breeding program was deemed the only hope for the species in the late 1990s to early 2000s. The successful initiation and continuous development of the collaborative breeding programs have resulted into a restocking of the species to form nucleus populations in its natural habitat from 2009 to 2016. Over the course of 125 years, wild populations have been unearthed and the species was finally released in protected sanctuaries starting in the year 2009.*

Keywords: Philippine crocodile, conservation, historical account

CROCODILES ARE ESSENTIALLY IDENTICAL TO THEIR PREDECESSORS THAT LIVED among the dinosaurs, to which they are closely related, up to 200 million years ago. For that reason, they are often referred to as living fossils. Much of their secret lives have been carefully unraveled over the past decades, but there is still more to learn and understand about them (Webb and Manolis 2009).

In the Philippines, crocodiles were once a prominent part of the lowland fauna usually thriving in rivers, lakes, estuaries, and marshes. Today, they are threatened with extinction. Conservationists have long been concerned with the rapid deterioration of the lowland habitats in the Philippines and the effect of commercial agriculture and development on the lowland terrestrial and aquatic fauna. Crocodiles are especially vulnerable, restricted as they are to aquatic habitats that are easily modified for human utilization, as fishponds or rice paddies (Ross and Alcala 1983). At present, known populations of the 2 species of crocodiles naturally occurring in the Philippines—the Indo-Pacific crocodile (*Crocodylus porosus)* and Philippine crocodile (*Crocodylus mindorensis)* (Fig. 1)—are sparsely distributed all over the country.

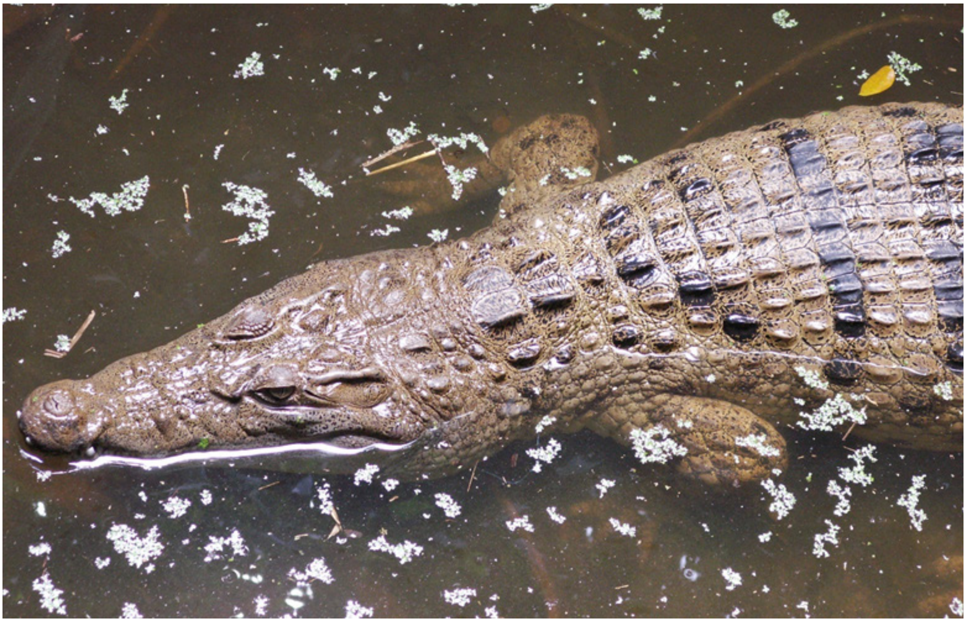

Figure 1 Philippine crocodile (*Crocodylus mindorensis),* an endangered wildlife species endemic in the province of Mindoro

In the case of the endemic and more threatened *C. mindorensis*, it was once prevalent all over the country but now restricted to inland freshwater wetland pockets of northeastern Luzon and central Mindanao. Surveys of its wild populations in the country have picked up during the more recent years. Researchers noted that populations of this crocodile species are highly fragmented, often with only as many as one breeding pair occupying one river or creek with a few juveniles or subadults thrown in (van Weerd et al. 2006; Pomares et al. 2008; Manalo et al. 2013). Land conversion has posed more of a threat to the fragmented wild extant populations than direct hunting, illegal trading, and human persecution (Manalo et al. 2015). Favorably, conservation efforts have been exerted through the years to save *C. mindorensis* from the brink of extinction.

This study aimed to provide useful insights for the conservation management of *C. mindorensis* and to document milestones that could guide future conservation programs.

Materials and Methods

Forty-seven historical accounts and published scientifc articles were collected and reviewed to identify and document conservation milestones of the *C. mindorensis* in a timeline format. Findings were presented based on the clustered significant contributions on the general concept of species recovery and conservation. The presentation of timelines based from key notable events on Philippine crocodile species management were supported by literatures from both national and international efforts.

Results and discussion

What follows is a selection of key historical events and milestones related to the conservation management of *C. mindorensis* from national and international levels—events that continue to shape attitudes, national laws, and policies concerning the advancement of crocodilian conservation today.

Species discovery

The quest for species discovery started with the Menage Scientific Expedition collections of distinguished natural historians led by Dr. JB Steere in 1891, followed by the Crane Pacific Expedition of the Field Museum of Natural History in 1929. A crocodile head specimen that exhibited 6 post-occipital scutes was known to have been collected together with 3 other smaller skulls from the vicinity of Lake Naujan in Mindoro. These were presented to the Field Museum by the Philippine Bureau of Science for cleaning and examination in 1935. These 4 Mindoro specimens proved to be distinct and new to science. The descriptions of Dr. Karl P. Schmidt, former curator of herpetology at the Field Museum of Natural History in Chicago, led to the discovery of a new Philippine freshwater crocodile species then named as *Crocodylus mindorensis* sp. nov. This new crocodile species was assumed by many to be conspecific with New Guinea crocodile (*Crocodylus novaeguineae*) until 1989 when Philip M. Hall pointed out a distinct morphologic characteristics which ultimately distinguished *C. mindorensis* as a totally separate species.

1891: The first crocodile specimen (FMNH 11135) was said to have been collected from the Island of Mindoro either by the Menage Expedition led by Dr. JB Steere or from his personal collections (Schmidt 1935; Ross 1982b).

1929: Three small crocodile skulls, presumably from the vicinity of Lake Naujan, were presented to the Crane Pacific Expedition of Field Museum by the Philippine Bureau of Science (Schmidt 1935).

1935: Dr. Karl P. Schmidt first described the new Philippine freshwater crocodile as *Crocodylus mindorensis* sp. nov. on the basis of skulls presumed to be from the vicinity of Lake Naujan in the Island of Mindoro (Schmidt 1935).

1989: Distinct morphologic characteristics noted by Philip M. Hall provided convincing evidence to declare *C. mindorensis* as a new crocodile species (Hall 1989).

Drastic population decline

Indiscriminate hunting for skin trade and human persecution of both *C. mindorensis* and *C. porosus* were rampant all over the Philippines during the period of 1940s to the late 1980s.

1958: A *C. mindorensis* was killed and owned by an unrecorded private collector from the Mandaon area, west central Masbate. The specimen was included in the collections of the United States National Museum (USNM Field Series 121077).

1970s and 1980s: The number of *C. mindorensis* was reduced mainly due to habitat loss, indiscriminate killing, and commercial harvest (Ross and Datuin 1981; Banks 2005; van Weerd et al. 2016).

1983: The continued existence of *C. mindorensis* in the wild was in jeopardy. It was in immediate danger of extinction and considered as one of the world's most threatened crocodilian species. This was primarily due to agricultural and industrial development of lowland habitats. Crocodile conservation was an unlikely prospect as crocodiles were unfavorably perceived as predators of domestic animals and elicited little sympathy while habitat protection conflicted with government priorities for the socioeconomic improvement of Filipinos in the rural areas.

Saving crocodiles from extinction

Persecution of crocodiles and rapid habitat loss through agricultural growth brought *C. mindorensis* to the brink of extinction. From 1980 to 1982, the international nongovernment organization (NGO) World Wildlife Fund funded the Smithsonian Institution/World Wildlife Fund (SI/WWF) Philippine Crocodile Project that signified the first coordinated conservation effort for the species. Through this project and in cooperation with the Forest Research Institute (FORI) in Los Baños, Laguna, the Bureau of Forest Development, and Silliman University in Dumaguete City, studies were conducted to determine the distribution, status, and conservation potential for *C. mindorensis*. The continued population assessments estimated the presence of about 500 to 1000 individuals in the wild and in captivity. There was a little chance for the species to survive in the wild even in sanctuaries and protected areas without immediate intervention. In 1992, the Crocodile Specialist Group (CSG) concluded that abandoning the remnant population in their natural habitat before the real protection could begin could probably have resulted in the final extinction of the species (Messel et al. 1992). Captive breeding management formed the principal component of crocodile conservation in the Philippines (Ortega et al. 1994).

In the early 1980s, the SI/WWF and Silliman University Environmental Center (SUEC) recorded the first known nesting and propagation of *C. mindorensis* in captivity. Progenies of this successful breeding program were transferred to international zoological facilities and private collections for Cooperative Breeding and Conservation Program in 1988 (Banks 2005). In order to prevent further decline of the crocodiles, the RP-Japan Crocodile Farming Institute (RP-Japan CFI) was established in 1987 through the joint partnership of the Philippine government (through DENR) and the government of Japan. A nucleus population was acquired from the wild and other private collections from 1987 to 1994. The results of the successful *C. mindorensis* captive breeding from 1989 to 2001 in the Palawan Wildlife Rescue and Conservation Center (PWRCC), formerly CFI, was shared with private institutions under loan agreements for conservation breeding, education, and other conservation activities (Fig. 2).

1980: The SI/WWF Project studied the distribution, status, and conservation potential of *C. mindorensis* and estimated the remaining population to be between 500 to 1000 individuals. This further led to the establishment of the SUEC, the first captive breeding facility for *C. mindorensis* which also recorded the first nesting and breeding in captivity (Ross 1982a, 1982b; Ross and Alcala 1983; Alcala et al. 1987).

Figure 2 Philippine crocodile hatchlings from the Palawan Wildlife Rescue and Conservation Center (PWRCC)

1987: The RP-Japan CFI, later renamed as PWRCC, was established to conserve the 2 species of crocodiles in the Philippines and to develop a crocodile farming technology. It was considered as one of the best crocodile research facilities in the world (Ortega 1996, 1998).

1988: Successful breeding of a nucleus population in PWRCC reached the 200 breeding adult management goal. International institutions like the Gladys Porter Zoo (GPZ) in the USA and the Royal Melbourne Zoological Gardens in Australia obtained parental stocks from SUEC for Cooperative Breeding and Conservation Program.

1993: Eight progenies from GPZ were repatriated to the Philippines in 1993 and 2000 for future release into secured sanctuaries (Sibal et al. 1992; Ortega et al. 1994; Manalo and Alcala 2015).

2006: Fifteen young *C. mindorensis* were lent to the Danish Krokodille Zoo by the Philippine Government to initiate the first Philippine crocodile captive breeding program in Europe. The first edition of Philippine Crocodile European Studbook (ESB) was published by Cologne Zoo with its first breeding record in May 2013 (Manila 2008; Ziegler et al. 2013).

Contributions for the long-term conservation of the species

The *C. mindorensis* distribution, based on the field works of CA Ross and AC Alcala in 1983, became the main blueprint of researchers and conservationists in investigating extant populations and suitable habitats for restocking. New extant populations were recorded in Northern Luzon and Central Mindanao. This triggered the crafting of the Philippine Crocodile National Recovery Plan which led to the successful initiation and continuous development of the collaborative breeding programs of *C. mindorensis*. This also paved the way for the discovery and mapping out of new populations and locality records of *C. mindorensis* within the entire Philippine archipelago. In support of the discovery of new populations in northeastern Luzon, the local government of San Mariano, Isabela adopted the protection of *C. mindorensis* in their area as part of their environmental protection program.

In 2007, the Forum on Crocodiles in the Philippines generated 3 major resolutions for the conservation of the *C. mindorensis* and 4 other resolutions concerning both crocodile species present in the Philippines. One of the important outcomes is the realization of the head-starting program (Res. No. 1-4) and the reintroduction of captive-bred *C. mindorensis* to Lake Dicatian in Divilacan, Isabela (Res. No. 1-5) led by the Mabuwaya Foundation Inc. (MFI). A reintroduction resolution in selected areas in Mindanao (Res. No. 1-6) was drafted with the assistance of the Crocodylus Porosus Philippines Inc. (CPPI).

Among the major contributions of the Forum are the preliminary discovery of genetic differences between island subpopulations (Louis and Brenneman 2008), the presence of extant populations in high elevations (Manalo 2008) and in small islands (Oliveros et al. 2008), existence of population in Ligawasan Marsh (Tabora 2008; Pimental et al. 2008; Pomares et al. 2008), and the in-situ conservation efforts in San Mariano, Isabela (Miranda et al. 2008; van der Ploeg et al. 2008). However, one of the major events was the technical dialogue in the head starting with the release program of the MFI which eventually demonstrated its viability through a more than 3-fold increase in its wild population in 1999.

1999: The studies on the distribution, abundance, and population genetics in the Philippines led to the discovery of 2 extant populations of *C. mindorensis*, the previously unknown populations in San Mariano, Isabela and in Pulangi River, Bukidnon, Mindanao (Pontillas 2000; van Weerd et al. 2000).

2000: A Philippine Crocodile National Recovery Team (PCNRT) was formed by the Philippine Government to take charge of recovering *C. mindorensis* from near extinction and to oversee the implementation of the first Philippine Crocodile

National Recovery Plan. Collaborative efforts of the Philippine Government and NGOs confirmed the occurrence of fragmented new populations in the foothills of Northern Sierra Madre Natural Park (NSMNP), Babuyan Group of Islands, and highlands of Cordillera Central. Several crocodile sanctuaries were established in the NSMNP (DENR 2000; Manalo 2008; Oliveros et al. 2005; Banks 2005; Oliveros et al. 2008; van Weerd and van der Ploeg 2012).

2007: A Forum on Crocodiles in the Philippines was held at the National Museum of the Philippines and attended by representatives from 14 countries (Fig. 3). It was organized by the Crocodylus Porosus Philippines Inc. (CPPI) in partnership with the National Museum of the Philippines, Silliman University, and the Veterinary Office of the City of Manila. This dialogue advanced the in-situ conservation program through the release of more than 100 captive-raised juveniles from the nest protection scheme and head-starting program in San Mariano, Isabela. The preliminary findings of the population genetics studies found differences between island sub-populations. Active search for new habitats have recorded the presence of *C. mindorensis* in high altitudinal ranges in South Cotabato, Mindanao (van de Ven et al. 2012; van Weerd et al. 2008; van de Ven et al. 2009; van Weerd and van der Ploeg 2008; Hinlo 2010; Manalo et al. 2013; van Weerd and van der Ploeg 2012).

Figure 3 Participants of the Forum on Crocodiles in the Philippines held from Jan. 31 to Feb. 2, 2007

Managing wild populations

After two decades of successful breeding, the progenies of Philippine crocodiles from the PWRCC nucleus populations were released back into their natural habitats. In 2009, 50 sub-adult *C. mindorensis* were first reintroduced in northeastern Luzon and 3 adults in Central Mindanao.

The PWRCC reintroduction programs, in partnership with the MFI in Divilacan, Isabela and CPPI in Santo Tomas, Davao del Norte, have both utilized matured individuals and hard release protocols. The human and crocodile coexistence was compromised during the process of establishing new crocodile territories and adapting to their new environment due to the inherent captive-bred behavior of released individuals. These releases, which were considered partly unsuccessful, have tailored the refinement of restocking criteria guided by the Philippine experiences (van Weerd et al. 2012). The concern on the population genetics, with the presence of hybrids in PWRCC, was also concluded in 2010 (Hinlo 2010; Hinlo et al. 2014).

The 36 juvenile crocodiles (<100 cm) which were introduced in the Paghungawan Marsh, Pilar, Siargao Island Protected Landscapes and Seascapes (SIPLAS) (Mercado et al. 2013) through soft release in 2013 have shown an increase in growth (Mean = 0.084 cm/day and 11.76 g/day), which translates into better adaptability to its new environment. With the more terrestrial behavior of *C. mindorensis*, the decline in regular sightings to about 53% of the introduced population was attributed to the observed wariness related to the increasing size of the crocodiles, a higher number of crocodiles concealed in the vegetation (Manalo et al. 2015), and the impact communities have committed for the implementation of Community-Based Sustainable Tourism (CBST), along with the growing support of local government leading to sustainable management of their wetland resources (Manalo et al. 2016). Twenty-two deputized Wildlife Enforcement Officers have been deployed to support the community-based biophysical monitoring and enforcement (DENR RSO No. 2015-555, October 14, 2015). Several municipal resolutions have been crafted such as the request for an enhancement release (Mun. Res. No. 070 s.2015) and the local government declaration of crocodile conservation month (Mun. Res. No. 067 s.2015).

Upon the creation of the National Crocodile Conservation Committee (NCCC) in 2015, the Conservation and Management Plan for Crocodile Species in the Philippines for 2016 to 2020 was adopted and implemented. This strengthened the national priority in the conduct of plans of actions in selected priority conservation sites for restocking of *C. mindorensis*. International conservation partners contributed and pledged support for the Plan (Adams and Manalo 2014). To date, crocodile awareness campaigns are ongoing in Luzon and Mindanao.

2009: The first reintroduction of PWRCC captive-bred mature individuals was initiated in northeastern Luzon and Central Mindanao. Although this restocking program was partially considered unsuccessful, the experience gained in the process provided the basis for the policy recommendation on the revision of release criteria tailored for Philippine setting.

2012: *C. mindorensis* was maintained in the Critically Endangered (CR) category but the criteria used in its categorization were changed from A1c, C2a to A2, C.D., (ver. 3.1) in the IUCN Crocodile Specialist Group revised Red List Assessment during the 21st World Crocodile Conference in Manila (Manalo and Alcala 2015; van Weerd et al. 2016).

2013: Thirty-six juveniles were introduced in a marshland area in SIPLAS (Fig. 4). The released animals demonstrated better adaptability in their new environment. They were expected to breed in 2017 and produce young that can survive in the wild in the near future. A community-based sustainable ecotourism was introduced, with the *C. mindorensis* as its flagship species. Subsequently, the municipality of Pilar declared the month of May as “Crocodile

Figure 4 Release of 36 juvenile Philippine crocodiles (*Crocodylus mindorensis*) in Paghungawan Marsh of the Siargao Island Protected Landscapes and Seascapes (SIPLAS) in Pilar, Surigao del Norte

Conservation Month" for the municipality and requested for an enhancement release (Mercado et al. 2013; Manalo and Alcala 2015; CPPI Report 2015).

2015: The PCNRT was reconstituted as the NCCC to address the conservation needs of the 2 species of crocodiles present in the Philippines (DSO No. 2015-1010, dated 28 October, 2015). The national management plan for crocodiles was developed, adopted, and implemented.

2016: Public Education and Community Participation (PECP) activities are ongoing in Luzon, Mindanao, and Palawan (Cureg et al. 2015; CPPI Report 2015).

Figure 5 shows the Conservation timeline of Philippine crocodile (*Crocodylus mindorensis)* from 1891 to 2016.

Conclusion

The identified historical events and milestones could help in better understanding and recognizing the challenges in the past, present, and those that might emerge in the future, while dealing with the conservation of *C. mindorensis*. These could also allow recognizing opportunities that may be useful in further addressing the existing and emerging threats. Moreover, the milestones of *C. mindorensis* conservation provided reliable basis for developing more effective, consistent, and wide-ranging management strategies to ensure the long-term survival of the remaining wild populations. History has shown that the conservation of *C. mindorensis* is highly dependent on management practices that allow for human and crocodile coexistence. This requires the vital role of public awareness, information, and education.

There should be programs that give people incentives to conserve both the crocodiles and their habitat. Aside from this, establishment of sanctuaries in strategic areas should be done to prevent or at least minimize habitat disturbances. Moreover, further research is needed to monitor the current status of endemic crocodile species in order to create, adapt, and put into action an efficient and suitable conservation action plans for them. Indeed, social acceptance and unwavering commitment among the local communities, stakeholders, and decision makers form substantial catalyst for the advancement of crocodile conservation in the Philippines.

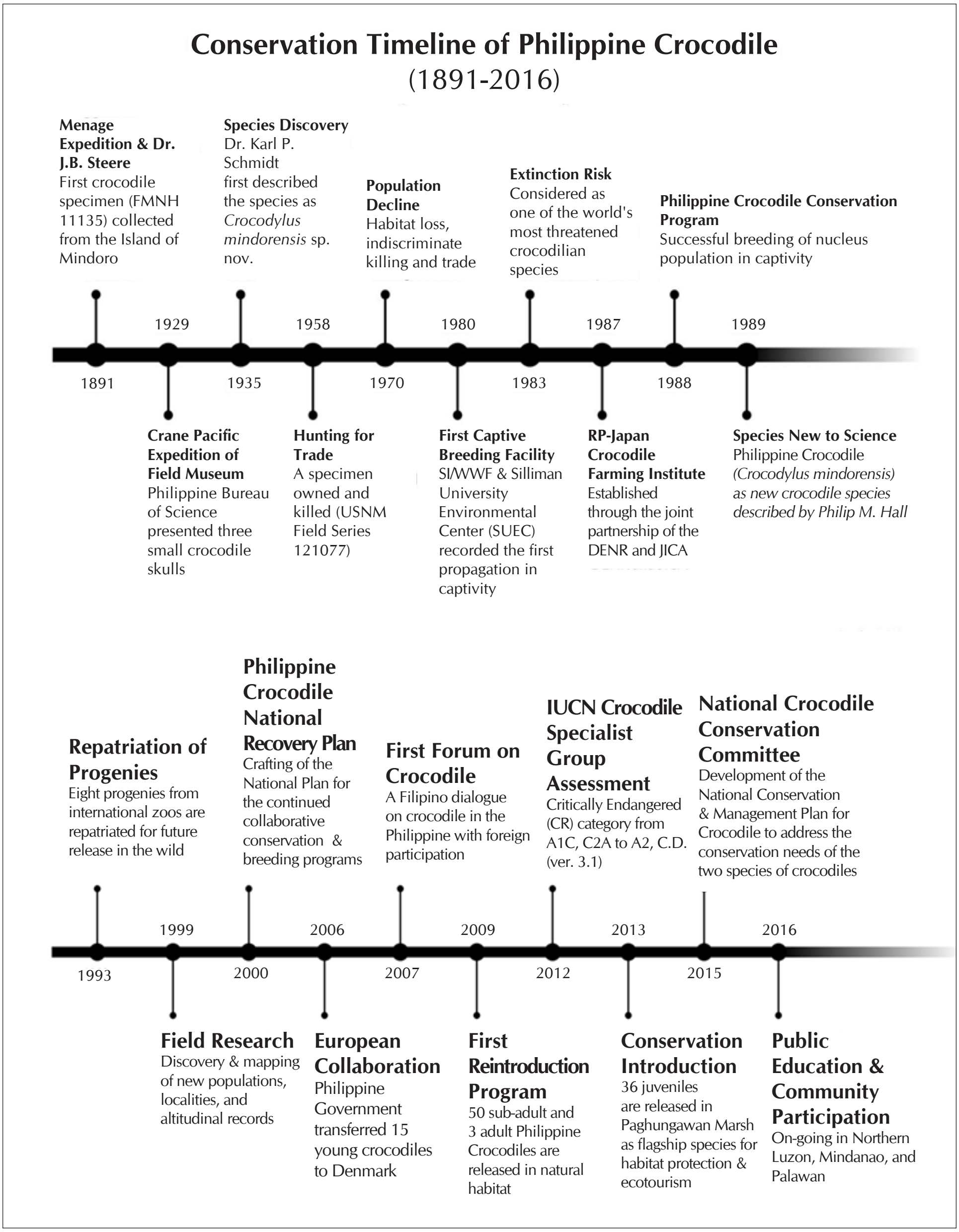

Figure 5 **Conservation timeline of Philippine crocodile (*Crocodylus mindorensis*) from 1891 to 2016**

Literature cited

Adams C, Manalo RI. 2014. Minutes of the Philippine Crocodile Meeting at the 23rd Working Meeting of the Crocodile Specialist Group; 2014 May 26–30; Lake Charles, Louisiana (USA): [publisher unknown].

Alcala AC, Ross CA, Alcala EL. 1987. Observation on reproduction and behavior of captive Philippine Crocodiles (*Crocodylus mindorensis* Schmidt). Silliman J. 34 (1–2):18–28.

Banks CB. 2005. National recovery plan for the Philippine crocodile, *Crocodylus mindorensis,* 2005–2008. 2nd edition. Quezon City (Philippines): Department of Environment & Natural Resources-Protected Areas and Wildlife Bureau (DENR-PAWB).

[CPPI] Crocodylus Porosus Philippines Inc. 2015. Crocodile Research and Conservation, Crocodylus Porosus Philippines Inc. Annual Program Progress Report, January–December 2015. (Philippines): Crocodylus Porosus Philippines Inc.

Cureg MC, Bagunu AM, Van Weerd M, Balbas MG, Soler D, Van Der Ploeg J. 2015. A longitudinal evaluation of the Communication, Education and Public Awareness (CEPA) campaign for the Philippine crocodile *Crocodylus mindorensis* in northern Luzon, Philippines. Int Zoo Yearb. 50:1–16.

[DENR] Department of Environment and Natural Resources (PH). 2000 March 3. DENR Special Order 2000-231: Creating Philippine Crocodile National Recovery Team (PCNRT). (Philippines): Department of Environment and Natural Resources (PH).

[DENR] Department of Environment and Natural Resources (PH). 2015 October 13. DENR Regional Special Order 2015-555: Deputation of selected individuals represents various agencies/organizations as Wildlife Enforcement Officers. (Philippines): Department of Environment and Natural Resources (PH).

[DENR] Department of Environment and Natural Resources (PH). 2015 October 28. DENR Special Order 2015-1010: Reconstituting the Philippine Crocodile National Recovery Team (PCNRT) to be known as the National Crocodile Conservation Committee (NCCC). (Philippines): Department of Environment and Natural Resources (PH).

Hall PM. 1989. Variation in geographic isolates of the New Guinea crocodile (*Crocodylus novaeguinae* Schmidt) compared with the similar, allopatric Philippine crocodile (*C. mindorensis* Schmidt). Copeia. 1989(1):71–80.

Hinlo MRP. 2010. Population genetics and conservation of the Philippine crocodile [MS thesis]. Manawatu (New Zealand): Massey University. [cited 2016 March 30]. http://mro.massey.ac.nz/xmlui/handle/10179/2054#sthash.D4qi56X7.dpuf

Hinlo MRP, Tabora JAG, Bailey CA, Trewick S, Rebong GG, Van Weerd M, Pomares CC, Engberg SE, Brenneman RA, Louis EE Jr. 2014. Population genetics implications for the conservation of the Philippine Crocodile *Crocodylus mindorensis* Schmidt, 1935 (Crocodylia: Crocodylidae). J Threatened Taxa. 6(3):5513–5533. DOI: http://dx.doi.org/10.11609/JoTT.o3384.5513-33

Louis EE Jr., Brenneman RA. 2008. Philippine Crocodile systematics and population genetics —Preliminary Report. Natl Mus Papers. 14-2007(Spec Issue: Proc Forum Crocodiles Phil):123–227.

Manalo RI. 2008. Occurrence of *Crocodylus mindorensis* in the Cordillera Central, Abra Province, Luzon Island. Natl Mus Papers. 14-2007(Spec Issue: Proc Forum Crocodiles Phil):109–115.

Manalo RI, Alcala AC. 2015. Conservation of the Philippine crocodile *Crocodylus mindorensis* (Schmidt 1935): in-situ and ex-situ measures. Int Zoo Yearb. 49:113–124.

Manalo RI, Alcala AC, Mercado AVP, Belo WT. 2016. Conservation introduction of Philippine crocodile in Paghungawan Marsh, Siargao Island Protected Landscapes and Seascapes (SIPLAS), Surigao del Norte, Philippines. In: Soorae PS, editor. Global re-introduction perspectives: 2016: Case studies from around the globe. Gland (Switzerland): IUCN SSC Re-introduction Specialist Group. p. 51–55.

Manalo RI, Pomares CC, Mercado VP, Belo WT, Saljay G, Tupas TD. 2013. A new distribution record for the Philippine crocodile (*Crocodylus mindorensis*, Schmidt 1935). In: de Silva A, compiler. World Crocodile Conference. Proceedings of the 22nd working meeting of the IUCN-SSC Crocodile Specialist Group; 2013 May 21–23; Negombo, Sri Lanka. Gland (Switzerland): International Union for Conservation of Nature. p. 208–214.

Manalo RI, Alcala AC, Bucol AA, Belo WT, Mercado VP, Baltazar PC. 2015. Philippine Crocodile Release Program: an update on the status of the introduced Philippine Crocodiles (*Crocodylus mindorensis*) in Paghungawan Marsh, Siargao Island

Protected Landscapes and Seascapes, Pilar, Surigao Del Norte, Philippines. 13 p. In: Proceeding of the First East & South-East Asia Regional Meeting of the IUCN Crocodile Specialist Group; 2015 May 25–29; Siem Reap, Cambodia.

Manila AC. 2008. Status of crocodiles in captivity in the Philippines. Natl Mus Papers. 14-2007 (Spec Issue: Proc Forum Crocodiles Phil):38–39.

Mercado VP, Alcala AC, Belo WT, Manalo RI, Diesmos AC, de Leon J. 2013. Soft release introduction of the Philippine crocodile (*Crocodylus mindorensis*, Schmidt 1935) in Paghungawan Marsh, Siargao Island Protected Landscape and Seascape, Southern Philippines. Crocodile Specialist Group Newsl. 32(2):13–15.

Messel HF, King W, Webb GJW, Ross CA. 1992. Summary report on the workshop on the prospect and future strategy of crocodile conservation of the two species (*Crocodylus mindorensis*, *Crocodylus porosus*) occurring in the Philippines. In: Ross JP, editor. Crocodile conservation action: a special publication of the Crocodile Specialist Group of the Species Survival Commission of the IUCN-The World Conservation Union. Gland (Switzerland): IUCN Species Survival Commission (SSC), Crocodile Specialist Group. p. 98–101.

Miranda JSQ, Gelacio MA, Balayan M. 2008. Local attitudes and sightings of crocodiles in Ligawasan Marsh the role of the Local Government of San Marinao, Isabela, in Philippine Crocodile conservation. Natl Mus Papers. 14-2007 (Spec Issue: Proc Forum Crocodiles Phil):46–54.

Oliveros CH, Telan SP, Guerero JP. 2008. Philippine Crocodile (*Crocodylus mindorensis*) Conservation on Dalupiri Island, Babuyan Island Group, Northern Philippines. Natl Mus Papers (Spec Issue: Proc Forum Crocodiles Phil). 14-2007:98–108.

Oliveros CH, Manalo RI, Coñate E Sr, Tarun B, Telan S, van Weerd M. 2005. Philippine crocodile recorded on Dalupiri Island. Crocodile Specialist Group Newsl. 24(3):14–15.

Ortega GV. 1996. The beauty of the beast: conserving the crocodiles of the Philippines. Crocodile Farming Institute Comprehensive Report (1987–1995). Puerto Princesa (Philippines): Department of Environment and Natural Resources (PH).

Ortega GV. 1998. Philippine crocodile conservation: comprehensive report. In: Crocodiles: Proceedings of 14th working meeting of the Crocodile Specialist Group; 1998 July 13–17; Singapore. Gland (Switzerland) and Cambridge (United Kingdom): IUCN-The World Conservation Union. p. 101–134.

Ortega GV, Regoniel P, Ross CA. 1994. Status of crocodile in the Philippines: an update. In: Crocodiles: Proceedings of the 12th working meeting of the Crocodile Specialist Group of the Species Survival Commission of IUCN-The World Conservation Union; 1994 May 2–6; Pattaya, Thailand. Gland (Switzerland) and Cambridge (United Kingdom): IUCN-The World Conservation Union. p. 115–154.

Pimentel JL, Pomares CC, Tabora AAG. 2008. Local attitudes and sightings of crocodiles in Ligawasan Marsh. Natl Mus Papers. 14-2007 (Spec Issue: Proc Forum Crocodiles Phil):190–196.

Pomares CC, Pomares MP, Escalera CMR. 2008. The existence of wild crocodiles in Ligawasan Marsh and its tributaries. Natl Mus Papers. 14-2007 (Spec Issue: Proc Forum Crocodiles Phil):197–203.

Pontillas UFA. 2000. New breeding sites for the Philippine crocodile. Crocodile Specialist Group Newsl. 19(2):10–12.

Ross CA. 1982a. Philippine Crocodile Project: Final Report. Washington, DC (USA): Smithsonian Institution/World Wildlife Fund. WWF Project # 1489.

Ross CA. 1982b. The crocodile must stay. Habitat Magazine. 3(1):14–19.

Ross CA, Alcala AC. 1983. Distribution and status of the Philippine crocodile (*Crocodylus mindorensis*). Kalikasan: Phil J Biol. 12(1–2):169–173.

Ross CA, Datuin CP. 1981. Crocodiles in peril. Canopy Int. 1981:7.

Schmidt KP. 1935. A new crocodile from the Philippine Islands. Field Mus Nat Hist Zool Ser. 20:67–70.

Sibal MC, Sarsagat IG, Satake Y. 1992. Captive breeding of *C. mindorensis* and *C. porosus*. In: Proceedings of the workshop on the prospects and future strategy of crocodile conservation of the two species (*Crocodylus mindorensis* and *Crocodylus porosus*) occurring in the Philippines. Puerto Princesa (Philippines): RP-Japan Crocodile Farming Institute. p. 36–44.

Tabora JAG. 2008. Ligawasan Marsh and its role in Philippine biodiversity. Natl Mus Papers. 14-2007 (Spec Issue: Proc. Forum Crocodiles Phil):95–97.

van de Ven W, Balbas M, Rodriguez D, Telan S, Guerrero J, van Weerd, M. 2012. Head-starting as a tool for crocodile conservation. In: Crocodiles. Proceedings of the 21st working meeting of the IUCN-SSC Crocodile Specialist Group; 2012 May 22–25; Manila, Philippines. Gland (Switzerland): International Union for Conservation of Nature. p. 106.

van de Ven W, Guerrero JP, Rodriguez DG, Telan SP, Balbas MG, Tarun BA, van Weerd M, van der Ploeg J, Wijtten Z, Lindeyer FE, de Longh HH. 2009. Effectiveness of head-starting to bolster Philippine crocodile *Crocodylus mindorensis* populations in San Mariano municipality, Luzon, Philippines. Conserv Evidence. 6:111–116.

van der Ploeg J, Cureg MC & van Weerd M. 2008. Mobilizing public support for in-situ conservation of the Philippine crocodile in the Northern Sierra Madre: something to be proud of! Natl Mus Papers. 14-2007 (Spec Issue: Proc Forum Crocodiles Phil):68–94.

van der Ploeg J, Rodriguez D, Tarun B, Guerrero J, Balbas M, Telan S, Masipiqueña A, Cureg M, van Weerd M. 2008. Crocodile Rehabilitation, Observance and Conservation (CROC) Project: the conservation of the critically endangered Philippine crocodile (*Crocodylus mindorensis*) in northeast Luzon, the Philippines. Final report of the BP Conservation Program Consolidation Award. Cabagan, Isabela (Philippines): Mabuwaya Foundation Inc.

van Weerd M, Balbas M, van de Ven W, Rodriguez D, Telan S, Guerrero J, Jose E, Macadangdang A, Calapoto W, van der Ploeg J, et al. 2012. Philippine crocodile conservation in NE Luzon: an update and a proposal for a national Philippine crocodile reintroduction strategy. In: Crocodiles. Proceedings of the 21st working meeting of the IUCN-SSC Crocodile Specialist Group; 2012 May 22–25; Manila, Philippines. Gland (Switzerland): International Union for Conservation of Nature. p. 49.

van Weerd M, General A, van Boven G. 2000. Update on Philippine crocodile conservation in the Northern Sierra Madre Natural Park. Crocodile Specialist Group Newsl. 19(4):11–14.

van Weerd M, van der Ploeg J. 2008. Philippine crocodile hatchling head-start and re-enforcement program in San Mariano, Isabela Province, Luzon, Philippines. In: Soorae PS, editor. Global re-introduction perspectives: re-introduction case-studies from around the globe: Abu Dhabi (UAE): IUCN-SCC Re-introduction Specialist Group. p. 79–83.

van Weerd M, van der Ploeg J. 2012. The Philippine crocodile: ecology, culture and conservation. Philippines: Mabuwaya Foundation.

van Weerd M, van der Ploeg J, Rodriguez D, Guerrero J, Tarun B, Telan S, de Jonge J. 2006. Philippine crocodile conservation in Northeast Luzon: an update of population status and new insights into *Crocodylus mindorensis* ecology. In: Crocodiles: Proceedings of the 17th Working Meeting of the IUCN-SSC Crocodile Specialist Group; 2004 May 24–29; Darwin, Northern Territory of Australia. Gland (Switzerland): IUCN. p. 306–321

van Weerd M, Pomares C, de Leon J, Antolin R, Mercado V. 2016. *Crocodylus mindorensis*. The IUCN Red List of Threatened Species 2016: e.T5672A3048281. [downloaded on 14 January 2017]. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T5672A3048281.en

Webb G, Manolis C. 2009. Green Guide: Crocodiles of Australia. Chatswood (Australia): New Holland Publishers.

Ziegler T, Rauhaus A, Karbe D. 2013. Philippine Crocodile (*Crocodylus mindorensis*). European Studbook (ESB) 1st Edition. Cologne (Germany): Cologne Zoo.

Sylvatrop, The Technical Journal of Philippine Ecosystems and Natural Resources 28 (1): 49-72

Odonata communities and habitat characteristics in Mount Kanlaon Natural Park, Negros Island, Philippines

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A study on the diversity, abundance, and habitat preference of odonates on different habitat types and altitudinal gradients in Mount Kanlaon Natural Park was conducted from May 18 to June 2, 2015 using line transect, visual searching techniques aided by sweep nets, hand catching, and photo documentation. A total of 72 plots with a size of 10 x 10 m each was established in the study area for habitat assessment. Eleven species, in which 8 are Philippine endemics, were recorded. Highest diversity (H′ = 2.05) and endemicity (70%) were recorded in secondary lowland forest. Areas with low elevation had the highest species richness (S = 10). Furthermore, all species found in high elevation were considered endemic. The Philippine endemic ***Cyrano unicolor*** *was the most abundant species. Canonical Correspondence Analysis showed that height of understory level seems to influence the abundance of* ***Drepanosticta*** *cf.* ***pistor****, canopy cover and elevation might influence the abundance of* ***Heteronaias heterodoxa,*** *and stream depth might affect the abundance of* ***Neurobasis subpicta****. Multiple Regression Analysis identified water pH as an important factor influencing the occurrence of* ***C. unicolor*** *while occurrence of* ***Risiocnemis rolandmuelleri*** *might be dependent on tree density.*

Keywords: Damselflies, dragonflies, Mount Kanlaon National Park, *Cyrano unicolor*, *Risiocnemis rolandmuelleri*

ODONATA COMMUNITIES ARE KNOWN AS SIGNIFICANT BIOLOGICAL INDICATORS of the health and condition of wetlands (Samways and Steytler 1996; Oppel 2006; Silva et al. 2010). Adults and larvae are sensitive and vulnerable to the physical and ecological changes affecting and degrading their terrestrial and aquatic habitats (Remsburg and Turner 2008), such as increased erosion and thinning of forests (Clausnitzer et al. 2009). Odonata rely heavily on the presence of aquatic habitats in forests (Cayasan et al. 2013). A sudden decrease in the population of odonates may indicate changes in the environmental stability of the immediate area or upstream (Klym and Quinn 2003) as their distribution is dependent on the ability of their habitats to support them (Cayasan et al. 2013). This group is also a possible species richness indicator for invertebrates (Briers and Biggs 2003) and macrophytes (Sahlen and Ekestubbe 2001). Adult Odonata link terrestrial and aquatic food webs and function as both opportunistic predators and prey for wetland vertebrates (Hornung and Rice 2003; Bried and Ervin 2005).

The Philippines is an outstanding center of odonate endemicity (Moore 1994) in which more than 60% (Kalkman et al. 2008) out of approximately 300 species are endemic (Hämäläinen and Müller 1997). Thirty-five species of dragonfly have been recorded in Negros and 30 of these are known to occur in Mount Kanlaon Natural Park (MKNP) and its surrounding areas (Moore 1994). Sadly, only 4% of the original forest of Negros exists today, including MKNP. This causes a lot of pressure on the remaining endemic species which made Negros-Panay region to rank 10th in the world's priority conservation areas considering that the region has the most endemic species or subspecies that are regarded as critically endangered or extinct (NFEFI 2011; Tamblyn 2011).

It was only until recently that the preservation of the insect diversity and their importance in ecosystems were duly acknowledged. One of the first insect orders to be given full attention for conservation priority is the Odonata. Species of this order are primarily threatened by habitat alteration. Therefore, a better understanding and improvement on the knowledge about odonate assemblages and their habitat preferences are needed for future conservation measures and actions (Carchini et al. 2003).

This study aimed to identify the Odonata species in MKNP, determine the diversity and abundance of odonates across habitat types and altitude gradients, correlate the abundance and occurrence of the species to different habitat variables, and identity the different direct local threats to the odonates in the area.

Materials and methods

Study area

Mount Kanlaon (Fig. 1) is an active volcano located in Negros Island and is regarded as the highest peak in central Philippines. Mt. Kanlaon has a land area of 24,577 ha, an altitude of 306–2,465 meters above sea level (masl), and a base diameter of 30 km. It extends across Negros Occidental and Negros Oriental in the Visayas region (10°25'N, 123°08'E) and is situated approximately 35 km southeast of Bacolod City (Mallari et al. 2001; PHIVOLCS 2002).

Figure 1 A panoramic view of Mount Kanlaon Natural Park

Sampling sites

The different forest habitat types and their corresponding bodies of water in the municipality of Murcia and the cities of Bago and La Carlota were chosen as the sampling sites.

Primary montane forest

The surveyed area (Fig. 2) is situated in the mountainous part of Barangay Mailum, Bago City with an altitude ranging from 1,400–1,700 masl. Ten transects were established in the forest interior (10°28'10.90"N, 123°7'42.20"E) and 4 transects in Asya (10°28'24.90"N, 123°7'26.40"E) and Bangkuyo Rivers (10°28'29.82"N, 123°7'28.56"E). Most of the forest is characterized by an almost closed canopy created by large and tall trees, particularly dipterocarps growing on very steep slopes. The canopy along the streams is partially closed by tall trees on the banks and the sides of riverbeds are densely covered by ferns. The 2 bodies of water have rocky and sandy substrates.

Figure 2 Primary montane forest habitat ranging from 1,400–1,700 masl

Secondary montane forest

The forest located in Barangay Guintubdan, La Carlota City is classified as secondary montane forest (Fig. 3) reaching an elevation of 1,000–1,300 masl. A total of 15 transects was marked in the forest habitat (10°25'40.0"N, 123°05'32.2"E) and 4 transects on the bodies of water surveyed, namely Siya River (10°25'42.9"N, 123°05'40.6"E); Buslugan River (10°25'63.3″N, 123°06'18.0″E); and Abaga, Mayor, and Oro Falls (10°29'22.9"N, 123°07'05.1"E). The overstory provides a full shade to the terrain and the lower canopy consists of smaller trees of less than 20 m in height. Buslugan River, with dark and still water, has a canopy which gradually opens towards the downstream, with trees 5–10 m tall and semi-dense understory vegetation. The remaining waters have similar tree height and understory condition with the previous river described. Siya River has canopies on both sides of the river overlapping on the river bank while the 3 waterfalls have an open canopy condition. The water in the falls has a moderate flow while Siya River is a still and temporary body of water.

Figure 3 Secondary montane forest habitat ranging from 1,000–1,300 masl

Secondary lowland forest

This habitat type (Fig. 4) is present in Sitio Wasay, Barangay Minoyan, Murcia, along an elevation gradient of 650–800 masl. Ten transects were established in the forest interior (10°29'38.00"N, 123°6'16.79"E) and 2 transect lines were put up in Pula River (10°29'46.58"N, 123°5'55.37"E). The forest floor is slightly steep and consists largely of young trees (10–20 cm) and a few scattered large trees. The thick undergrowth is covered with shrubs, small plants, and ferns. The aquatic habitat has a murky and slow to fast moving water surrounded by short trees which slightly extend their canopy over the river channel. This forest fragment is near a plantation and farm.

Figure 4 Secondary lowland forest habitat ranging from 650–800 masl (Photos by Ryno Sanchez)

Plantation

The plantation in Sitio Wasay, Barangay Minoyan, Murcia (Fig. 5) has an elevation of 500–600 masl and is located at 10°30'10.63"N, 123°6'11.69"E. The dominant trees present include *Swietenia macrophylla*, *Pterocarpus indicus*, *Gmelina arborea*, and *Coffea arabica*. Ten transects were established on this site. The area can be characterized by the presence of huge trees arranged in rows at the entrance and smaller trees surrounded by shrubs and small plants with increasing altitude. Thinly dispersed and scattered understory vegetation was observed in the lower areas that eventually become abundant with increasing elevation. Outside this cultivated area is a clearing area for farming and agricultural purposes.

Figure 5 Plantation habitat ranging from 500–600 masl (Photos by Earl Maglangit)

Mixed forest

The mixed forest in Sitio Wasay, Barangay Minoyan, Murcia (10°30'0.91"N, 123°5'44.56"E; ca. 500–650 masl) is low and flat lands (Fig. 6). Gayas River occurs at 10°30'2.33"N, 123°6'26.32"E. This forest area is covered with a mix of exotic and native trees. Some of the introduced and planted tree species are *P. indicus*, *G. arborea*, and *C. arabica*. Majority of the trees in the forest interior and surrounding the stream are 10–15 meters tall, which are mostly immature based on their narrow crowns. A total of 15 transect lines was established in the forested portion and 2 transect lines in the aquatic habitat.

Figure 6 Mixed forest habitat ranging from 500—650 masl (Photos by Ryno Sanchez)

Survey and data collection

Field survey and assessment of Odonata fauna were conducted from May 18 to June 2, 2015 and were carried out between 0900 and 1700 H on the different habitat types and altitudinal gradients of MKNP under Wildlife Gratuitous Permit No. R6-2014-001 issued by the Department of Environment and Natural Resources (DENR). Line transects with a length of 100 m each were marked out and surveyed in both terrestrial and aquatic habitats in the 5 forest types. The elevation gradients of each habitat type were divided and categorized into low elevation (500–800 masl), middle elevation (801–1,100 masl), and upper elevation (1,101–1,800 masl). Visual searching techniques with direct observation and opportunistic sample collection of odonates from different habitats and elevations were applied. A sweep net with approximately 46-cm diameter opening and 2-m long handle was used in collecting specimens (Cayasan et al. 2013). Live Odonata samples were stored in small brown envelopes with the wings folded over the back (Quisil et al. 2013). The specimens were subjected to ethyl acetate and then submerged in acetone for 24 hours (Reece and Mcintyre 2009). Dried specimens were placed in paper triangles, stored in a sealed or airtight container, and organized by collection site. The Odonata samples were photographed right after their collection. Initial identification was referred to published references and was verified.

Habitat assessment

Plots were established in each habitat type. A 10-m circular plot was marked in every transect being studied (AFCD 2004). The plots were divided into quadrants and the habitat characteristics of each quadrant were individually studied and surveyed to assess information regarding the habitat selection of the species. Number of trees, canopy cover, canopy height, canopy openness, understory cover, moss cover, air temperature during the day, and relative humidity were the variables measured for both terrestrial and aquatic habitat plots. Additional factors applicable only to the water habitats, namely, water temperature, stream depth, water flow, water pH, turbidity, and stream type (temporary or permanent) were also recorded.

Data analysis

Species diversity was evaluated and analysed using Shannon-Wiener and Simpson Indices, which were calculated using Paleontological Statistics (PAST) software. Relative abundance was calculated by dividing the number of individuals of a specific species found in each habitat and altitudinal range to the total number of the different species present in that said area and extent and then multiplying the result by 100%. Canonical Correspondence Analysis (CCA) which is a method used to correlate the abundance of species to the different habitat variables was performed using CANOCO software. Multiple Regression Analysis (MRA) was used to correlate the relationship between the occurrence of species and the different habitat parameters. Kruskal-Wallis Test was applied in order to test if the habitat variables significantly vary among the different habitat types and altitude gradients.

Results and discussion

Species composition

Eleven species with a total of 144 individuals were collected from MKNP in this study (Fig. 7). Five odonates are classified as least concern (IUCN 2015) while the conservation status of the 6 other species have not been assessed. Eight (73%) out

Figure 7 **Odonata species from Mount Kanlaon Natural Park [*Anax* cf. panybeus (Hagen, 1867); *Cyrano unicolor* (Hagen in Selys, 1869); *Diplacina bolivari* (Selys, 1882); *Drepanostica* cf. *pistor* (van Tol, 2005); *Heteronaias heterodoxa (*Selys, 1878); *Neurobasis subpicta* (Hamalainen, 1990); *Orthetrum pruinosum clelia* (Burmeister, 1839); *Sangabasis* cf. *cahilogi* (Villanueva & Dow, 2014); *Pseudagrion pilidorsum pilidorsum* (Brauer, 1868); *Rhinocypha colorata* (Hagen in Selys, 1869); *Risiocnemis rolandmuelleri* (Hamalainen, 1991)]**

of the 11 Odonata species recorded were Philippine endemics. The endemicity of suborder Zygoptera is 86% (6 out of 7 species), which is greater than Anisoptera with 50% endemicity (2 out of 4 species) (Table 1). This result is in agreement with the findings of Villanueva and Mohagan (2010) that there are more endemic damselflies (94%) compared to dragonflies (33.3%). In addition, Kalkman et al. (2008) stated that Philippine zygopterans have 86% endemicity while nisopterans have 31% endemicity. The semi-pristine characteristics of the forested landscapes that hold many bodies of water support the development of a variety of damselflies. However, it fails to sustain the elevated thermal requirements of most dragonflies. It was found that landscapes with little human activities have a higher proportion of Zygoptera than Anisoptera population (Stewart and Samways 1998; Clausnitzer 2003).

Species richness

Secondary lowland forest harbored the highest number of species in this study (10 out of 11 species) (Table 2). Although there is a higher proportion of Zygoptera, species of Anisoptera recorded are all present in this habitat. Dragonflies are mainly generalists in nature and are likely to be found in open habitats, penetrating into open secondary forests (Samways and Steytler 1996; Dijkstra and Clausnitzer 2006; Stewart and Samways 1998). A study conducted by Orr (2006) showed that the presence of Anisoptera is generally not associated with heavily forested areas and they were usually present and commonly observed on exposed hilltops and forest canopies. Furthermore, plantation habitat had the least number of species (Table 2). Lower records of species in the plantation could be due to the habitat alteration brought about by agriculture and other human uses. Human-induced disturbances negatively impact the odonates and other invertebrates in tropical rain forest (Lawton et al. 1998; Liow et al. 2001; Hanski et al. 2007; Clausnitzer et al. 2009; Sodhi et al. 2009) by reducing their species richness and leading to an evidently altered species composition (Dolny et al. 2012). However, the presence of *Drepanosticta* cf. *pistor* in the secondary lowland forest, mixed forest, and plantation forest of MKNP (Table 2) might be an indication that these areas in MKNP, although subjected to physical alterations and disturbances, are still capable of supporting the existence of sensitive species. The family Platystictidae, wherein *D.* cf. *pistor* belongs to, can only exist in restricted range of habitats or specific ecological conditions (Chovanec and Raab 1997; Orr 2003; Watanabe et al. 2004) and is greatly affected by habitat alterations and will vanish completely when degradation of riparian forests happens (Subramanian 2008). This may also indicate that *D.* cf. *pistor* is a species that could tolerate habitat modification to an extent.

Table 1 Odonata species of Mount Kanlaon Natural Park in Negros Island, Philippines

Taxonomic rank		Scientific name	Distribution status	Conservation status	Reference
Suborder	Family				
Anisoptera	Aeshnidae	*Anax* cf. *panybeus*	Oriental Species	Least Concern	Hagen 1867
	Corduliidae	*Heteronaias heterodoxa*	Philippine Endemic	Least Concern	Selys 1878
	Libellulidae	*Diplacina bolivari*	Philippine Endemic	—	Selys 1882
		Orthetrum pruinosum clelia	Oriental Species	Least Concern	Burmeister 1839
Zygoptera	Calopterygidae	*Neurobasis subpicta*	Philippine Endemic	—	Hämäläinen 1990
	Chlorocyphidae	*Cyrano unicolor*	Philippine Endemic	Least Concern	Hagen in Selys 1869
		Rhinocypha colorata	Philippine Endemic	Least Concern	Hagen in Selys 1869
	Coenagrionidae	*Sangabasis* cf. *cahilogi*	Philippine Endemic	—	Villanueva and Dow 2014
		Pseudagrion pilidorsum pilidorsum	Oriental Species	—	Brauer 1868
	Platycnemididae	*Risiocnemis rolandmuelleri*	Philippine Endemic	—	Hämäläinen 1991
	Platystictidae	*Drepanosticta* cf. *pistor*	Philippine Endemic	—	van Tol 2005

cf. – refers to species which cannot be identified with certainty

Table 2 **Occurrence of odonate species across habitat types of Mount Kanlaon Natural Park in Negros Island, Philippines**

List of species	Primary montane forest		Secondary montane forest		Secondary lowland forest		Mixed forest		Plantation
	Stream	Forest	Stream	Forest	Stream	Forest	Stream	Forest	Forest
Anax cf. *panybeus*	-	-	-	-	+	-	-	-	-
Cyrano unicolor	+	-	+	-	+	-	+	-	-
Diplacina bolivari	-	-	-	-	+	+	-	-	-
Drepanosticta cf. *pistor*	-	-	-	-	+	-	-	+	+
Heteronaias heterodoxa	+	+	+	-	+	-	+	-	-
Neurobasis subpicta	+	-	+	-	+	-	-	-	-
Orthetrum pruinosum clelia	-	-	-	-	-	+	-	-	-
Sangabasis cf. *cahilogi*	-	-	+	+	-	-	-	-	-
Pseudagrion pilidorsum pilidorsum	-	-	-	-	+	-	-	-	-
Rhinocypha colorata	-	-	-	-	+	-	+	-	-
Risiocnemis rolandmuelleri	-	-	-	-	+	+	+	-	+
Total no. of species	3		4		10		5		2
Total no. of endemic species	3		4		7		5		2

+ *indicates presence of the species*

Species richness decreases as elevation increases (Table 3). Species richness of tropical odonates is inversely proportional to elevation owing to the fact that tropical species can only manage to disperse and inhabit lower elevation ranges (Stevens and Bailowitz 2009). According to Hofmann and Mason (2005) and Sato and Riddiford (2008), water velocity in aquatic habitats largely influences distribution and abundance of Odonata. Current velocity increases as gradient (slope) increases with elevation, giving rise to reduced species richness. The observation on the decrease of Odonata species with increasing altitude is further verified by several investigations (Borisov 1987; Samways 1989; Vick 1989; Campbell et al. 2010) and Laidlaw (1934) found that few or no Odonata occur above 2,000 masl in some places.

Table 3 Occurrence of odonate species across altitudinal gradients of Mount Kanlaon Natural Park

List of species	Lower elevation	Middle elevation	Upper elevation
Anax cf. *panybeus*	+	-	-
Cyrano unicolor	+	+	+
Diplacina bolivari	+	-	-
Drepanosticta cf. *pistor*	+	-	-
Heteronaias heterodoxa	+	+	+
Neurobasis subpicta	+	+	+
Orthetrum pruinosum clelia	+	-	-
Sangabasis cf. *cahilogi*	-	+	-
Pseudagrion pilidorsum pilidorsum	+	-	-
Rhinocypha colorata	+	-	-
Risiocnemis rolandmuelleri	+	-	-
Total no. of species	10	4	3
Total no. of endemic species	7	4	3

+ *indicates presence of the species*

Diversity

Simpson and Shannon-Wiener Diversity Indices were highest in secondary lowland forest (D = 0.84; H′ = 2.05) and lowest in secondary montane forest (D = 0.29; H′ = 0.61). Odonata in secondary lowland is moderately diverse (H′ = 2.05) and low

(H′ = 0.60 to 0.92) in the remaining habitat types. Secondary lowland forest, although associated with clearing activities, yields the highest diversity. A positive shift on the number of certain species is possible in disturbed landscapes because of the increased canopy openness and more sunlight penetration (Korkeamäki and Suhonen 2002; Dijkstra and Lempert 2003). This serves as a great advantage to species that are naturally deprived of accessible source of their needed sunlight while odonates that do not specifically depend on canopy cover can adapt and withstand this habitat modification by migrating into shadier parts upstream (Oppel 2006). Thus, the high level of diversity for secondary lowland forest does not necessarily display a richer and more equitable diversity of species but instead a relative absence of several of the rarest species in the community. On the other hand, montane areas in tropical rainforests are expected to contain the heterogeneous water microhabitats suitable for a wide array of odonate species (Furtado 1969; Vick 1999, 2002; Dijkstra and Lempert 2003) and act as their regional refugia (Kalkman et al. 2008). However, both primary and secondary montane habitats in this study ranked the least in terms of odonate diversity. A possible explanation for the low diversity obtained is the limited sampling time which decreased the chances of finding secluded and rare odonates. Rare odonates that thrive in the tropical forests depend mainly on primary forest. Rare species that occur in low abundance cannot be efficiently detected and gathered by the span of time allocated for sampling and observation (Morse et al. 1988; Godfray et al. 2000; Moore 1997).

Odonates are moderately diverse in the lower elevation and less diverse in the remaining altitudinal gradients. Diversity is highest in lower elevation (D = 0.73; H′ = 1.76) and then decreases in both middle (D = 0.31; H′ = 0.64) and upper elevation (D = 0.39; H′ = 0.70). Larvae of dragonflies and damselflies are rarer in upland streams and are observed to have increasing species diversity with decreasing altitudes (Fielding and Haworth 1999). However, upper elevation with primary forest exhibited a higher diversity than middle elevation with secondary forests. This can be explained by the pristine nature of the primary forest promoting species diversity.

Relative abundance

The Philippine endemic *Cyrano unicolor* was the most abundant among all species collected, with 48 individuals. The species was recorded from old-growth montane forests to disturbed habitats in the lowland. A study conducted by Villanueva (2010) reported that Chlorocyphidae species were present in both pristine and disturbed (e.g. mining operations) sites in Surigao del Sur, Mindanao Island. The distinct metallic reflection of the wings aid in their quick detection which result to their frequent record as they are more visible (Villanueva 2010).

The members of the families Coenagrionidae and Libellulidae have the least number of individuals: *Pseudagrion pilidorsum pilidorsum* (2) and *Pericnemis* cf. *cahilogi* (3) under Coenagrionidae family; and *Diplacina bolivari* (4) and *Orthetrum pruinosum clelia* (3) under Libellulidae family. Members of families Coenagrionidae and Libellulidae are usually present in open unshaded habitats like low gradient natural watercourses (Reels et al. 2012) located in the reduced forest covers of secondary lowland forest which is the habitat the samples are restricted to. The forest is not an essential habitat for these open land species and is only used as an option when feeding or mating (Orr 2006).

In primary forest and secondary montane forest, *C. unicolor* has the highest abundance. Despite having the greatest overall abundance compared to other species, they only have the greatest count in the montane habitat types and are lesser or absent in the remaining habitats. The dominance of this species in the montane habitat types corroborates the findings that they rely so much on shaded areas with streams and rivers (Villanueva 2009a). Chlorocyphidae species are intolerant of human disturbance, and are very sensitive to ecological changes and alterations (IUCN 2015). *Risiocnemis rolandmuelleri* under Platycnemididae is the most abundant in secondary lowland forest and mixed forest, favoring the clear flowing or running waters with a vegetation-covered sunny riparian zone (Silsby 2001; Manci 2012). *D.* cf. *pistor* has a higher relative abundance value versus *R. rolandmuelleri* in plantation. Being classified as shadow damsels (Platystictidae), odonates of this family prefer to rest on the shades of forest streams situated in lowlands and highlands and occasionally perch in dense vegetation of rivulets (Oppel 2005).

The results on the relative abundance of upper and middle elevation show that *C. unicolor* is the most abundant for both gradients. Species of the family Chlorocyphidae commonly reside on clear woodland streams and rivulets from the lowlands reaching up to 1,700 m (Claveria 2013). *R. rolandmuelleri* is found to be highly abundant in the lower elevation of MKNP. Genus *Risiocnemis* population ranges across lowland up to lower montane forest restrictively to small clear aquatic bodies of shady rainforests (Gassmann and Hämäläinen 2002).

Habitat assessment

Kruskal-Wallis test showed that all the categorized habitat types varied significantly in 9 out of 14 habitat factors measured (p-value of <0.001), namely, number of trees, canopy cover, canopy height, canopy openness, understory cover, moss cover, air temperature during the day, relative humidity, water temperature, stream depth, water flow, water pH, turbidity and stream type. Nine habitat variables differ significantly in all categorized habitats (p-value of <0.001).

CCA indicates that *D.* cf. *pistor* and *Heteronaias heterodoxa*, species captured in the forest interior, are significantly affected by the habitat variables. Abundance of *D.* cf. *pistor* seems to be dependent on understory cover while abundance of *H. heterodoxa* might be influenced by both, understory cover and elevation (Fig. 8). Representatives of the genus *Drepanosticta* normally opt to stay at streams of the forest understory (Orr 2004 and 2005) because they are poor flyers and hence, cannot disperse effectively in higher grounds.Consequently, they are being restricted and reliant to the understory level (van Tol et al. 2009). *H. heterodoxa* frequently dwell in the heavily tree-covered creeks of higher altitudes (Lung and Sommer 2001). Their nature is to patrol a certain portion of the stream, then quickly fly back to the forest canopy where they settle (Villanueva 2009b). This is in agreement with the result of this study wherein they are substantially abundant on the higher elevation and primary forest characterized by a thicker and more predominant canopy layer in contrast to the understory. It can be inferred that a dominant understory covDreer decreases the odds in finding this species.

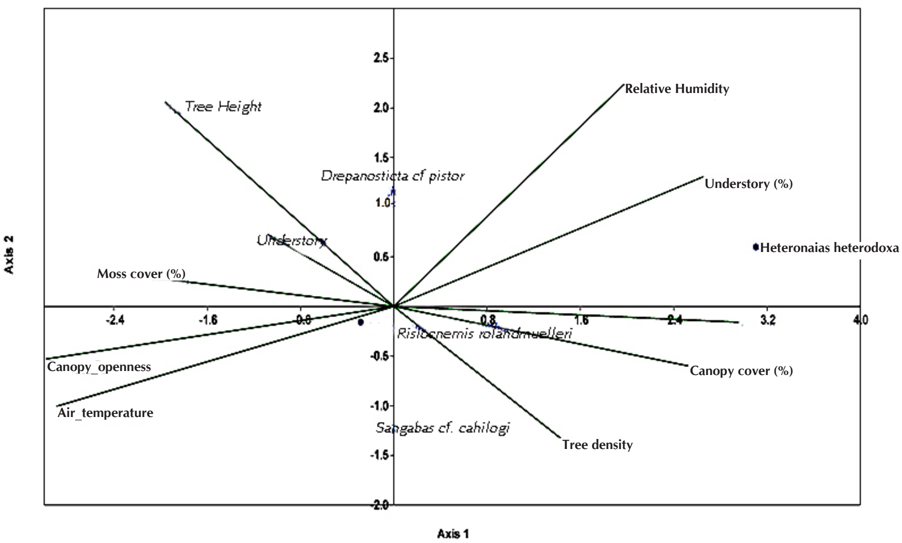

Figure 8 Canonical Correspondence Analysis biplot showing the relationship between the abundance of Odonata species found in the forest interior and the different habitat variables

On the other hand, out of all the odonates collected from the streams, the only species appeared to have been influenced by a stream habitat factor is *Neurobasis subpicta* (Fig. 9). Stream depth might impact the abundance of the species which is a factor influencing their ovipositional site selection. *Neurobasis* species generally lay their eggs on surfaces floating at a depth of 5–15 cm below the water like plants or aggregate of roots (Günther 2006).

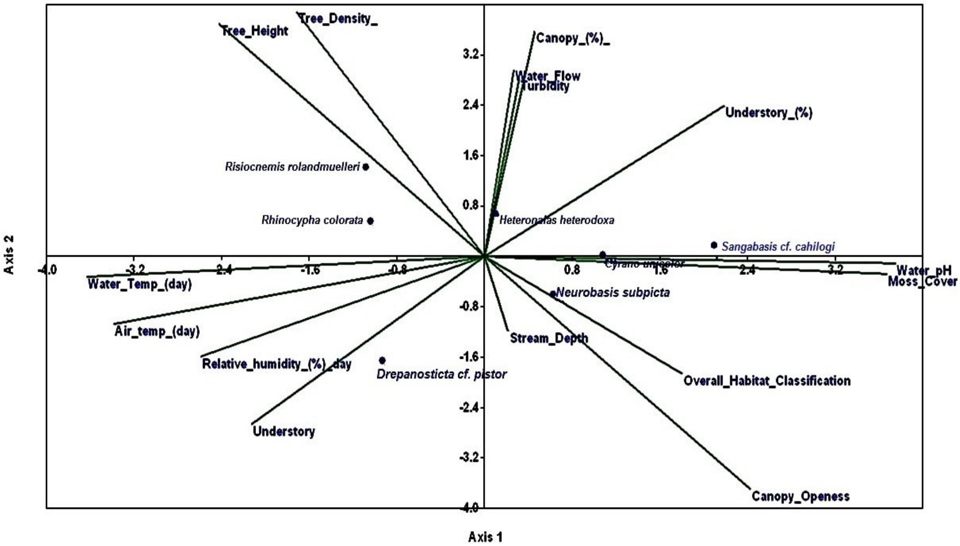

Figure 9 Canonical Correspondence Analysis biplot presenting the relationship between the abundance of Odonata species collected from aquatic bodies and the different habitat variables

MRA implied that the absence and presence of *C. unicolor* is perhaps affected by water pH. Moreover, occurrence of *Risiocnemis rolandmuelleri* may be correlated positively with tree density. Acidity (pH) is one of the parameters affecting the composition, diversity, and distribution of the odonate larvae in various habitats (Corbet 1999). Thru a Principal Component Analysis (PCA) in a study conducted by Maneechan and Prommi (2015), it was shown that Chlorocyphidae, under which *C. unicolor* is classified, is one of the aquatic insect families that is affected by the pH of water. Platycnemididae species like *R. rolandmuelleri* are very particular with their habitat requirements and one of their preferences is a riverside with dense emergent vegetation, making tree density essential (Taylor 2013).

Existing local threats

The odonates in the area are subjected to direct threats such as deforestation (e.g. logging and clearing for farming and settlements). Logging activities were heard and seen in the mixed forest and near Gayas River of Sitio Wasay, Brgy. Minoyan, Murcia. Farming was also observed near Pula River in the same barangay. Loggers were seen carrying sacks of charcoal within the secondary lowland forest of the same area. Other disturbances seen in the area are the barriers constructed and the garbage and litter left in Asya River which obstructs the normal flow of the water.

Additional threats observed in the area include the ongoing illegal hunting and exploitation of wildlife species. Butterfly traps using animal feces were found in the plantation of Sitio Wasay, Brgy. Minoyan, Murcia. Bird hunting was very rampant in the area. Three gunshots were heard which is estimated to be 1.5 km away in Guintubdan, Brgy. Ara-al, La Carlota City. Two gun shots, which were estimated to be 1 km away from point 1,750 of the transect established in the plantation of Sitio Wasay, were also heard. Caged birds were also seen in the Wasay Trail of Brgy. Minoyan, Murcia. A total of 26 snare traps for civet cat were spotted in the primary forest of Brgy. Mailum, Bago City, while 4 traps were found in the secondary montane forest of Guintubdan, Brgy. Ara-al.

Despite the status of MKNP as a natural park, the wildlife is not totally protected and still vulnerable and susceptible to the illegal activities and habitat destruction.

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Literature cited

[AFCD] Agriculture, Fisheries and Conservation Department (HK). 2004. Methodologies for Terrestrial and Freshwater Ecological Baseline Surveys. Environmental Impact Assessment Ordinance (Cap. 499) Guidance Note.

Borisov SM. 1987. Ecology of two closely related dragonfly species in Tajikistan. Ekologiya. 1:85–87.

Bried JT, Ervin GN. 2005. Distribution of adult Odonata among localized wetlands in East-central Mississippi. Southeastern Nat. 4(4):731–744.

Briers RA, Biggs J. 2003. Indicator taxa for the conservation of pond invertebrate diversity. Aquat Conserv. 13(4):323–330. doi:10.1002/aqc.576

Campbell WB, Novelo-Gutiérrez R, Gómez-Anaya JA. 2010. Distributions of odonate richness and diversity with elevation depend on windward or leeward aspect: implications for research and conservation planning. Insect Conserv Diver. 3(4):302–312. doi:10.1111/j.1752-4598.2010.00108.x

Carchini G, Domenico MD, Pacione T, Solimini AG, Tanzilli C. 2003. Species distribution and habitat features in lentic Odonata. Ital J Zool. 70(1):39–46. doi:10.1080/11250000309356494

Cayasan RD, Limitares DE, Gomid JVS, Nuñeza OM, Villanueva RT. 2013. Species richness of Odonata in selected freshwater systems in Zamboanga del Sur, Philippines. Aquac Aquar Conserv Legis. 6(4):378–393.

Chovanec A, Raab R. 1997. Dragonflies (Insecta, Odonata) and the ecological status of newly created wetland: Example for long term bioindication programmes. Limnologica. 27: 381–392.

Clausnitzer V. 2003. Dragonfly communities in coastal habitats of Kenya: indication of biotope quality and the need of conservation measures. Biodivers Conserv. 12(2):333–356. doi:10.1023/a:1021920402913

Clausnitzer V, Kalkman V, Ram M, Collen B, Baillie J, Bedjaniç M, Darwall W, Dijkstra K, Dow R, Hawking J, et al. 2009. Odonata enter the biodiversity crisis debate: The first global assessment of an insect group. Biol Conserv. 142(8):1864–1869. doi:10.1016/j.biocon.2009.03.028

Claveria CXW. 2013. Family Chlorocyphidae—The damselflies of Sabah. [retrieved 2015 October 27]. http://wongchunxing.com/Damselfly/Family__Chlorocyphidae.htm

Corbet PS. 1999. Dragonflies: Behaviour and Ecology of Odonata. Colchester (United Kingdom): Harley Books.

Dijkstra KDB, Clausnitzer V. 2006. Thoughts from Africa: how can forest influence species composition, diversity and speciation in tropical Odonata? In: Rivera AC, editor. Forest and dragonflies. Proceedings of 4th WDA International Symposium of Odonatology; 2005 July; Pontevedra, Spain. Sofia (Bulgaria) and Moscow (Russia): Pensoft. p. 127–151.

Dijkstra KDB, Lempert J. 2003. Odonate assemblages of running waters in the Upper Guinean forest. Archiv für Hydrobiologie. 157:397–412.

Dolný A, Harabiš F, Bárta D, Lhota S, Drozd P. 2012. Aquatic insects indicate terrestrial habitat degradation: changes in taxonomical structure and functional diversity of dragonflies in tropical rainforest of East Kalimantan. Trop Zool. 25(3):141–157. doi:10.1080/03946975.2012.717480

Fielding AF, Haworth PF. 1999. Upland habitats. London (United Kingdom): Routledge.

Furtado JI. 1969. Ecology of Malaysian odonates: biotope and association of species. Verhandlungen Internationaler Verein für Limnologie. 17:863–887.

Gassmann D, Hämäläinen M. 2002. A revision of the Philippine subgenus *Risiocnemis (Igneocnemis)* Hämäläinen (Odonata: Platycnemididae). Tijdschrift voor Entomologie, 145:213–266.

Godfray HC, Lewis OT, Memmott J. 2000. Studying insect diversity in the tropics. Changes and Disturbance in Tropical Rainforest in South-East Asia. p. 87–100. doi:10.1142/9781848160125_0008

Günther A. 2006. Reproductive behaviour of *Neurobasis kaupi* (Odonata: Calopterygidae). Int J Odonatol. 9(2):151–164.

Hämäläinen M, Müller RA. 1997. Synopsis of the Philippine Odonata, with lists of species recorded from forty islands. Odonatologica. 26(3):249–315.

Hanski I, Koivulehto H, Cameron A, Rahagalala P. 2007. Deforestation and apparent extinctions of endemic forest beetles in Madagascar. Biol Letters. 3(3):344–347.

Hofmann TA, Mason CF. 2005. Habitat characteristics and the distribution of Odonata in a lowland river catchment in eastern England. Hydrobiologia. 539:137–147.

Hornung J, Rice CL. 2003. Odonata and wetland quality in Southern Alberta, Canada: a preliminary study. Odonatologica. 32(2):119–129.

[IUCN] International Union for Conservation of Nature. 2015. The IUCN Red List of Threatened Species. [retrieved 2015 November 25]. http://www.iucnredlist.org

Kalkman VJ, Clausnitzer V, Dijkstra KDB, Orr AG, Paulson DR, van Tol J. 2008. Global diversity of dragonflies (Odonata) in freshwater. Hydrobiologica. 595:351–363.c

Klym M, Quinn M. 2003. Introduction to dragonfly and damselfly watching. Austin, TX (USA): Texas Parks and Wildlife.

Lawton JH, Bignell DE, Bolton B, Bloemers GF, Eggleton P, Hammond PM, Hodda M, Holt RD, Larsen TB, Mawdsley NA, Stork NE, Srivastava DS, Watt AD. 1998. Biodiversity inventories, indicator taxa and effects of habitat modification in tropical forests. Nature, 391, 72—75.

Liow LH, Sodhi NS, Elmqvist T. 2001. Bee diversity along a disturbance gradient in tropical lowland forests of south-east Asia. J Appl Ecol. 38(1):180–192. doi:10.1046/j.1365-2664.2001.00582.x

Lung M, Sommer S. 2001. Suborder: Anisoptera (Dragonflies). [retrieved 2015 November 29]. http://imnh.isu.edu/digitalatlas/bio/insects/drgnfly/cordfam/corddex.htm

Mallari NA, Tabaranza BR, Crosby M. 2001. Key conservation sites in the Philippines: a Haribon Foundation & Bird Life International directory of important bird areas. Makati City (Philippines): Bookmark.

Manci CO. 2012. Dragonfly Fauna (Insecta: Odonata) from Romania [PhD thesis abstract]. Cluj-Napoca (Romania): Babes-Bolyai University, Faculty of Biology and Geology, Department of Taxonomy and Ecology (RO).

Maneechan W, Prommi T. 2015. Diversity and distribution of aquatic insects in streams of the Mae Klong watershed, Western Thailand. Psyche. 1–7. http://dx.doi.org/10.1155/2015/912451

Moore NW. 1994. Report of the 8th meeting of the IUCN Odonata specialist group. Bilthoven (Netherlands): Societas Internationalis Odonatologica.

Moore NW, compiler. 1997. Dragonflies—Status Survey and Conservation Action Plan. IUCN-SSC Odonata Specialist Group. Gland (Switzerland) and Cambridge (United Kingdom): IUCN. v+28 pp.

Morse DR, Stork NE, Lawton JH. 1988. Species number, species abundance and body length relationships of arboreal beetles in Bornean lowland rain forest trees. Ecol Entomol. 13(1):25–37. doi:10.1111/j.1365-2311.1988.tb00330.x

[NFEFI] Negros Forests and Ecological Foundation, Inc. 2011. The Diminishing Natural Treasure. [retrieved 2015 November 25]. http://www.negrosforests.org/diminishing-natural-treasure

Oppel S. 2005. Habitat associations of an Odonata community in a lower montane rainforest in Papua New Guinea. Int J Odonatol. 8(2):243–257.

Oppel S. 2006. Comparison of two Odonata communities from a natural and a modified rainforest in Papua New Guinea. Int J Odonatol. 9:89–102.

Orr AG. 2003. A guide to the dragonflies of Borneo: their identification and biology. Kota Kinabalu, Sabah (Malaysia): Natural History Publication (Borneo) Sdn. Bhd.

Orr AG. 2004. Critical species of Odonata in Malaysia, Indonesia, Singapore and Brunei. Int J Odonatol. 7(2):371–384. doi:10.1080/13887890.2004.9748222

Orr AG. 2005. Dragonflies of Peninsular Malaysia and Singapore. Kota Kinabalu (Malaysia): Natural History Publications (Borneo).

Orr AG. 2006. Odonata in Bornean tropical rain forest formations: diversity, endemicity and implications for conservation management. In: Cordero-Rivera A, editor. Forests and Dragonflies. 4th International Symposium of Odonatology; 2005 July; Pontevedra, Spain. Sofia (Bulgaria): Pensoft. p. 51–78.

[PHIVOLCS] Philippine Institute of Volcanology and Seismology. 2002. Kanlaon Volcano. [retrieved 2015 May 1]. http://www.phivolcs.dost.gov.ph/html/update_VMEPD/Volcano/VolcanoList/kanlaon.htm

Quisil S., Arreza J, Nuñeza O, Villanueva R. 2013. Species richness of Odonata in Lanuza and San Agustin, Surigao del Sur, Philippines. Aquac Aquar Conserv Legis. 5(3):245–260.

Reece BA, McIntyre NE. 2009. Community assemblage patterns of odonates inhabiting a wetland complex influenced by anthropogenic disturbance. Insect Conserv Divers. 2:73–80.

Reels G, Dow R, Hämäläinen M, Do MC. 2012. The status and distribution of dragonflies and damselflies (Odonata) in Indo-Burma. In: Allen DJ, Smith KG, Darwall WRT, compilers. The status and distribution of freshwater biodiversity in Indo Burma. Cambridge (United Kingdom) and Gland (Switzerland): IUCN. p. 90–101

Remsburg AJ, Turner MG. 2008. Aquatic and terrestrial drivers of dragonfly (Odonata) assemblages within and among north-temperate lakes. J N Am Benthol Soc. 28(1): 44–56. doi: 10.1899/08-004.1

Sahlen GS, Ekestubbe K. 2001. Identification of dragonflies (Odonata) as indicators of general species richness in boreal forest lakes. Biodivers Conserv. 10:673–690.

Samways MJ. 1989. Taxon turnover in Odonata across a 3000 m altitudinal gradient in Southern Africa. Odonatologica. 18:263–274.

Samways MJ, Steytler NS. 1996. Dragonfly (Odonata) distribution patterns in urban and forest landscapes, and recommendations for riparian management. Biol Conserv. 78(3):279–288.

Sato M, Riddiford N. 2008. A preliminary study of the Odonata of S'Albufera Natural Park, Mallorca: status, conservation priorities and bio-indicator potential. J Insect Conserv. 12:539–548.

Silsby J. 2001. Dragonflies of the world. Plymouth (United Kingdom): Natural History Museum.

Silva D, De Marco P, Resende DC. 2010. Adult odonate abundance and community assemblage measures as indicators of stream ecological integrity: a case study. Ecol Indic. 10(3):744–752.

Sodhi NS, Lee TM, Koh LP, Brook BW. 2009. A Meta-Analysis of the Impact of Anthropogenic Forest Disturbance on Southeast Asias Biotas. Biotropica. 41(1):103–109. doi:10.1111/j.1744-7429.2008.00460.x

Stevens LE, Bailowit RA. 2009. Odonata biogeography in the Grand Canyon ecoregion, southwestern USA. Annals of the Entomological Society of America. 102:261–274.

Stewart DAB, Samways MJ. 1998. Conserving dragonfly (Odonata) assemblages relative to river dynamics in an African savanna game reserve. Conserv Biol. 12:683–692.

Subramanian KA. 2008. Damselflies and Dragonflies of Peninsular India—A Field Guide. New Delhi (India): Vigyan Prasar, Department of Science and Technology (IN). 168 pp.

Tamblyn A. 2011. Negros Rainforest Conservation Project – Biodiversity Assessment and Sustainable Development Project. [retrieved April 26, 2015]. http://www.solutions-site.org/node/40.

Taylor M. 2013. Dragonflight: in search of Britains dragonflies and damselflies. London United Kingdom: Bloomsbury Publishing.

van Tol J, Reijnen BT, Thomassen HA. 2009. Phylogeny and biogeography of the Platystictidae (Odonata). In: van Tol J. Phylogeny and biogeography of the Platystictidae (Odonata) [PhD thesis]. Leiden (Netherlands): University of Leiden. p. 3–70.

Vick GS. 1989. List of the dragonflies recorded from Nepal, with a summary of their altitudinal distribution (Odonata). Opusc Zool Flumin. 43:1–21.

Vick GS. 1999. A checklist of the dragonflies of the South West Province of Cameroon with a description of a new species of the genus *Phyllogomphus* Selys, 1854. Odonatologica. 28:219–256.

Vick GS. 2002. Preliminary biodiversity assessment of odonate fauna of the Takamanda Forest Reserve, Camerooon. IDF-Report 4. (1):1–10.

Villanueva RJT. 2009a. *Cyrano unicolor*. The IUCN Red List of Threatened Species 2009: e.T169273A6605110. [downloaded on 2015 December 29]. http://dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T169273A6605110.en
.

Villanueva RJT. 2009b. *Heteronaias heterodoxa*. The IUCN Red List of Threatened Species 2009:e.T169281A6606228. [downloaded on 2015 December 29]. http://dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T169281A6606228.en.

Villanueva RJ. 2010. Adult Odonata community in Dinagat Island, the Philippines: impact of Chromium ore mining on density and species composition. Odonatologica. 39(2):119–126.

Villanueva RJ, Mohagan AB. 2010. Diversity and status of Odonata across vegetation types in Mt. Hamiguitan Wildlife Sanctuary, Davao Oriental. Asian J Biodiv. 1(1): 25–35.

Watanabe M, Matsuoka H, Taguchi M. 2004. Habitat selection and population parameters of *Sympetrum infuscatum* (Selys) during sexual mature stages in a cool temperate zone of Japan (Anisoptera: Libellulidae). Odonatologica. 33:169–179.

Review and update of the 2004 National List of Threatened Terrestrial Fauna of the Philippines

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In 2004, the Philippines' Department of Environment and Natural Resources issued the National List of Threatened Fauna Species. Between 2015 and 2017, this was reviewed by assessing 1994 taxa, including 57 mammals, 683 birds, 355 reptiles, 115 amphibians, and 784 invertebrates, using the threatened categories specified in the 2001 Wildlife Resources Conservation and Protection Act. Another group evaluated the initial assessment if the criteria were properly applied and the taxa were assigned to their appropriate categories. Fifty-five percent or 1105 species were placed under four threatened categories: Critically Endangered (CR) – 60; Endangered (EN) – 61; Vulnerable (VU) – 439; Other Threatened Species (OTS) – 545. For the first time, invertebrates were included in the assessment and accounted for nearly 70% of species listed. Among the vertebrates, an increase in the number of taxa in all categories was notable and most pronounced in birds in all threatened categories. For reptiles, the number doubled but half of these were under OTS. For amphibians, the increase was due to species classified under CR and OTS. For mammals, the number of threatened species also increased except under VU. The number of threatened endemic species increased to 168 species, representing 15% of all threatened taxa.

NATIONAL RED LISTS, ALSO CALLED RED DATA BOOKS OR THREATENED species lists, are important tools in conservation especially after the Convention of Biological Diversity (CBD) adopted a set of targets to significantly reduce the rate of biodiversity loss at the national, regional, and global levels (Butchart, et al., 2006; Vie et al., 2009; Sachs et al., 2009) – a firm commitment by world leaders (Balmford et al. 2005) that will continue forward until 2028 (Szabo et al. 2012).

A National Red List can provide an evaluation of the status and extinction risks of local species. As most conservation work is usually at the local and national levels, a National Red List can provide initial information that can aid any conservation planning (Brito et al. 2010). Especially for this purpose, having a National Red List has an advantage such that it reflects extinction risks and rarity of species, cultural values, conservation importance and priorities, population declines, international response to conservation, or combinations of these factors (Miller et al. 2007) that may not be reflected at a globally-scaled threatened species list. Further, there is internal bias in regional or global red lists towards locally rare, but globally abundant species, or globally threatened but locally common species (Hoffman et al. 2008). An example provided by Hoffman and colleagues (2008) include the Herald petrel (*Pterodroma heraldica*) categorized as Least Concern under the International Union for the Conservation of Nature (IUCN) Red List but Critically Endangered in the Australian National Red List. Another example is the Dugong (*Dugong dugon*), which is Vulnerable globally but is not in the red list of Australia. Although one country does not accord a species the same conservation status as another country, excluding falsely one species from a threatened list could lead to extinction (Brito et al. 2010).

In response to the growing public advocacy on environmental protection legislation (Posa et al. 2008), the constitutional obligations provided by Article II of the 1987 Philippine Constitution that states the rights of its people to a balanced ecology in harmony with nature, and the mandates of the conventions it is signatory to, the Philippines enacted national laws to conserve the wildlife and natural heritage of the country. The Wildlife Resources Conservation and Protection Act of 2001 or Republic Act 9147 (otherwise known as the Wildlife Act) is the overarching law that promotes the conservation of the country's wildlife species and their habitats, which includes the regulation of wildlife collection and trade, stipulates the country's commitments to international conventions, and supports scientific studies on biodiversity conservation. Article II Section 22 of the Wildlife Act calls for the determination and classification of threatened species or subspecies based on the best available scientific information while taking into consideration internationally accepted criteria.

The Department of Environment and Natural Resources (DENR) List of Threatened Species was signed into effect by virtue of 2 DENR Administrative Orders (DAO) in pursuant to the Wildlife Act: DAO Number 15 Series of 2004 established the list of terrestrial faunal species, and DAO Number 1 Series of 2007 enumerated the threatened flora. The document is legally binding and has implications for national law enforcement and monitoring. The DENR List of Threatened Species is the country's basis for the collection and trade of wildlife and their derivatives, issuance of permits for transport of such species, the possession of threatened species, and conservation propagation; the same applies to look-alike species (Joint implementing rules... 2004). However, the list has yet to be updated since its enactment in 2004.

As new species are discovered and more information are gathered from the field as well as from advances in science, it is imperative that the National List of Threatened Species be updated to reflect the best scientific evidence currently available. The Wildlife Act stipulates reviewing the list regularly in consultation with scientific institutions, academe, and other stakeholders (Joint implementing rules... 2004). However, it has neither been revised since it was published in 2004, nor initiated an assessment based on the mechanism set under RA 9147. The list is clearly outdated and will benefit from a comprehensive review. The list in DAO 2004-15 shows not only disparities with the species assessed under the IUCN criteria, but also shows gaps for specific taxonomic groups, namely, reptiles, invertebrates, and plants. There is a need to assess these groups to regulate biases and produce better information on threatened species. Further, the DENR List of Threatened Species contains categories for Other Threatened Species (OTS) and Other Wildlife Species (OWS), which are vaguely defined categories. With more studies, reclassifying the species under these categories can reflect a more appropriate conservation status. There is a need to carefully identify, assess, and categorize species in the Philippines to come up with a standard and robust species list that can benefit not only the wildlife permitting system, Biodiversity Monitoring System (BMS), protected area planning, and wildlife enforcement activities, but also research and conservation strategies for species and ecosystems in the country.

Materials and methods

The DENR officially created the Philippine Red List Committee (PRLC) through the issuance of Special Order No. 2015-62 on 22 January 2015 to lead the development of a DENR Administrative Order comprising the proposed amendments to the National List of Threatened Terrestrial Fauna of the Philippines and their categories. The PRLC, together with the Technical Working Group (TWG) of the Biodiversity Management Bureau (BMB) formed from members of the Biodiversity Conservation Society of the Philippines (BCSP), reviewed and assessed the status of Philippine species based on the criteria stipulated under Article II Section 22 of the Wildlife Act. Members of the TWG consisted of wildlife researchers, managers, and conservation practitioners from academic, government, and non-governmental organizations (NGOS). Four TWG subcommittees were formed to represent the taxonomic groups that will be assessed for the DAO: mammals, birds, reptiles and amphibians, and invertebrates (mainly arachnids, insects, and land snails). The 2004 version of the DAO did not include terrestrial invertebrates in its assessment.

Each subcommittee thoroughly discussed all information, justification, and recommendations provided by TWG members. The subcommittees compiled all inputs from members as well as other stakeholders and contributors, and drafted a species account for each species incorporating all the information mentioned above. The review underwent a consultative process held through continuous email exchanges, subcommittee meetings, workshops, constituency consultations, and public presentations made between 2015 and 2017 (see Annex 6 for list of meetings and workshops). The species list and profiles were compiled, reviewed, finalized, and agreed upon by the subcommittees before submission to PRLC for consideration.

Criteria for determination of threatened fauna species and their categories

The classification of species as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), and Other Threatened Species (OTS) are generally based on the best scientific and internationally accepted criteria, including but not limited to the following: (1) destruction, modification, fragmentation, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) other natural or manmade factors affecting existence of wildlife; 4) perceived/observed reduction in population size and area of occupancy; and 5) small population size and/or restricted population and continuing decline in such population. Apart from the 4 threat categories, Other Wildlife Species (OWS) refers to all other species of fauna native to the Philippines but not categorized as threatened.

These 4 threat categories, as defined in DAO 2004-15 and amended by the PRLC for adoption in the proposed update DAO, are as follows:

- **Critically Endangered (CR)** - a species that is facing an extremely high risk of extinction in the wild in the immediate future; presumed extinct species upon rediscovery of a population shall be automatically categorized as Critically Endangered.
- **Endangered (EN)** - a species that is not Critically Endangered but whose survival in the wild is unlikely if the causal factors continue operating.
- **Vulnerable (VU)** - a species that is neither Critically Endangered nor Endangered but is under threat from adverse factors throughout its range and is likely to be moved to the endangered category in the future.
- **Other Threatened Species (OTS)** - a species that is not Critically Endangered,

Endangered, or Vulnerable but is under threat from adverse factors such as overcollection throughout its range and is likely to be moved to the vulnerable category in the near future. It also includes species that have the tendency to become threatened due to predation, destruction of habitats, or other similar causes; new species; and species with insufficient scientific information. Such species may be included in the threatened species list upon the recommendation of the PRLC and endorsement of the National Wildlife Management Council (NWMC).

Parameters used for assessment

Recognizing the unique conditions from each taxonomic group, assessment for threat status was justified differently, without necessarily basing the evaluation on—but referencing if needed—the IUCN conservation status. Assessments were limited to Philippine populations as opposed to their global distribution, while subspecies and island populations (e.g. Luzon bleeding-heart subspecies) at risk, as well as ongoing conservation efforts targeting the species or its known habitat (e.g. designation as protected area or critical conservation area, ongoing conservation projects, etc.) were taken into account. For instance, known localities outside of protected areas may increase the threat scores of little-known and endemic invertebrates, while threatened island populations or subspecies also increase extinction risk.

The TWG subcommittee for mammals came up with an initial, general list of species considered priority species for discussion based on prior assessments and new information. The subcommittee identified several aspects of the species ecology and distribution that were necessary for assessing the proposed changes in species threat status and inclusion. Each species was evaluated based on the following information: (1) original distribution of the species and the consequent changes; (2) reproductive characteristics; (3) patterns of abundance i.e. change in the abundance of the species, abundance of the species in different habitats, ability to maintain population in response to disturbance gradients and the extent of their effects; (4) threat from invasive species; (5) the status of management in protected areas where species are found; and (6) the current need for research resulting from gaps in knowledge. Using the threatened mammal list in DAO 2004-15 as the initial list, the group identified 28 priority species for assessment. The subcommittee evaluated these species and recommended actions for either upgrading, downgrading, delisting, or inclusion in the updated National Red List. All other species in the DAO 2004-15 were also evaluated and found that their current threat status remain applicable and thus retained.

Three threat criteria guided the reptile and amphibian assessments: (1) degree to which a species is threatened by illegal wildlife trade; (2) degree to which a species is being threatened by loss of habitat; and (3) degree to which a species is being threatened by hunting or overharvesting (i.e. for subsistence or local commerce). The subcommittee assessed 115 amphibians and 355 reptiles using current data on taxonomy and phylogenetic significance, population status, range and protected habitat within its distributional range, and the range of threats to species. The Amphibian Conservation Needs Assessment (ACNA), a parallel assessment based on the IUCN categories, enhanced the assessment of amphibian species. Species currently listed as CR by the IUCN assumed this conservation status, while species were listed as OTS if illegal trade is still negligible at present, but may intensify in the near future.

The TWG subcommittees for both birds and invertebrates adopted a cumulative scoring system to support the classification of threat status, which was based on three parameters for birds and five for invertebrates. Scores were set at three points for each criterion with increasing severity of impact (0–3), thus, a maximum total score of nine for birds and 15 for invertebrates.

Justification for the scoring system employed by the birds subcommittee referred to the following parameters:

1. Population score referred to individual counts, number of individuals and subpopulations, taking note of size and trend, with 0 being a score for stable or increasing population and 3 being a score for extremely low or rapidly decreasing population;

2. Occurrence score referred to the area of occurrence and distribution, which includes geographical location, spread, habitat use and range of species, with 0 as the score for widespread distribution and 3 being limited in occurrence or distribution; and

3. Threat score referred to the prevailing threat or suspected pending threat (next 5 years) which can include anthropogenic or natural threats, with 0 as no or very few threats and 3 as extremely threatened.

The total of the scores was classified under the following: OWS (0), OTS (1–2), VU (3–5), EN (6–7), CR (8–9). The subcommittee assessed at subspecies level species with multiple subspecies or evolutionary significant unit (ESU). The overall score for the species followed the category of the subspecies with the highest score. Other considerations by the subcommittee included accidental, extirpated, and extinct species. Species with less than 30 observations were classified as accidental or vagrant species, in which case, the global IUCN status was followed. Species presumed extirpated in the Philippines but whose global population is not threatened and contain no Philippine endemic subspecies were classified as OTS. Presumed extirpated Philippine endemic subspecies were categorized as CR. Taxonomic format and nomenclature followed the International Ornithological Congress (IOC) World Bird List v6.1 (Gill and Donsker 2014). Information was gathered from IUCN Red List of Threatened Species (IUCN 2015), BirdLife International species factsheets (BirdLife International 2015), The Internet Bird Collection website (https://www.hbw.com/ibc), A Guide to the Birds of the Philippines (Kennedy et al. 2000), Wild Bird Club of the Philippines (WBCP) reports, survey reports, and experts' knowledge of the species and their habitat. The subcommittee assessed a total of 683 species, based on the evaluation of 724 bird species, subspecies, and ESUs.

The parameters used for evaluation of terrestrial invertebrates included: (1) known from the original collection >30 years and/or has not been seen for the last 30 years despite active research efforts; (2) known only from extremely limited range and habitat; (3) obligate association with a threatened species; (4) taxa susceptible to poaching and illegal trade; and (5) known from localities that are under severe threat (e.g. deforestation, mining, land conversion, pollution, unregulated tourism, etc.). The total scores were divided into the following categories: OWS (0–3), OTS (4–6), VU (7–9), EN (10–12), CR (13–15) from de Chavez (in litt. 2018).

The bird, mammal, reptile, and amphibian subcommittees assessed known and described species recognized as valid until 30 January 2016. New taxonomic discoveries or splits beyond the specified date were no longer included in the assessment. In case of conflict between the scientific name and the common name of species, the scientific name became the controlling interpretation. A set of external reviewers evaluated the robustness of the parameters used by the subcommittees as well as their justification for assigning a species under a certain threat category.

Results and discussion

Assessment of threatened terrestrial fauna

The TWG assessed 57 mammals, 683 birds, 355 reptiles, 115 amphibians, and 784 invertebrates. A total of 1,105 species were recommended for inclusion in the updated National Red List: 60 as Critically Endangered, 61 as Endangered, 439 as Vulnerable, and 545 as OTS (Fig. 1).

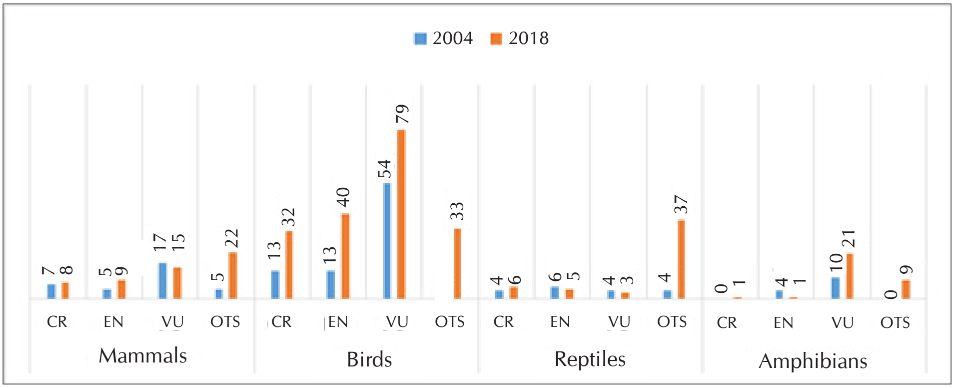

Figure 1 **Summary of threatened Philippine terrestrial fauna listed in DAO 2004-15 and in the proposed amendments to the DAO**

In DAO 2004-15, the birds represented more than half (55%) of the total threatened species listed, whereas, in the proposed updated list, 71% of the listed species are represented by invertebrates (Fig. 2).

While (57%) of the species listed in DAO 2004-15 fell under the VU category, majority (49%) of species in the proposed list are classified as OTS (Fig. 3). There is an overall decrease in the CR (16% to 5%), EN (18% to 6%), and VU (57% to 39%) categories, but a significant increase in OTS (6% to 49%).

There is a notable increase in the number of species for all taxonomic groups in all 4 threatened categories, but most pronounced increase in birds. The number of reptiles doubled, largely from the contributions of OTS, whereas for amphibians, the increase was largely based on the rise in VU and OTS. For mammals, threat categories—except for VU—increased in the proposed updated list.There is a drastic increase in both the number of threatened (CR, EN, VU) and OTS categories from DAO 2004 to the proposed updated list. Notably, the number of OTS had nearly quadrupled (Fig 4). The increased number of assessed birds and amphibians considerably influenced the proportion of threatened species, whereas for reptiles and mammals, the proportion remains constant.

Changes in the conservation status of Philippine threatened fauna list

In the proposed amendment to the list, 97 (9%) species retained their 2004 status, 32 (2.9%) species were elevated to a higher threat category, while 12 (1.1%) species were downlisted to a lower category. Seven species were delisted (Fig. 5). Added to the list are 964 (87%) species, 784 of which are invertebrates.

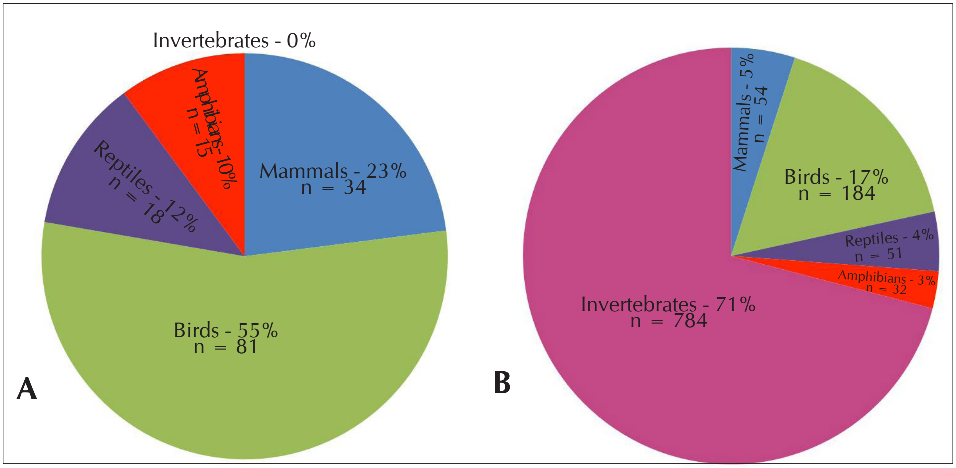

Figure 2 Comparison of Philippine threatened fauna listed in (A) DAO 2004-15 and (B) the proposed amendments to the DAO according to taxonomic groups

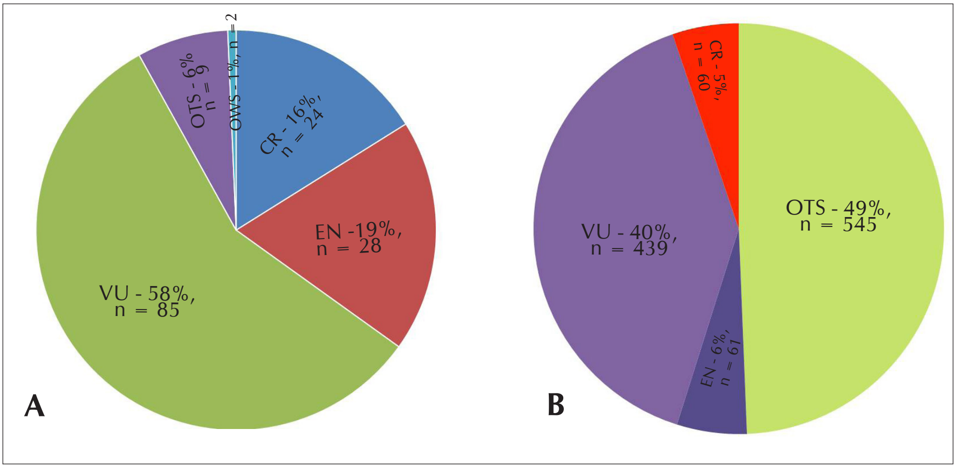

Figure 3 Comparison of Philippine threatened fauna listed in (A) DAO 2004-15 and (B) the proposed amendments to the DAO according to the 4 threat categories

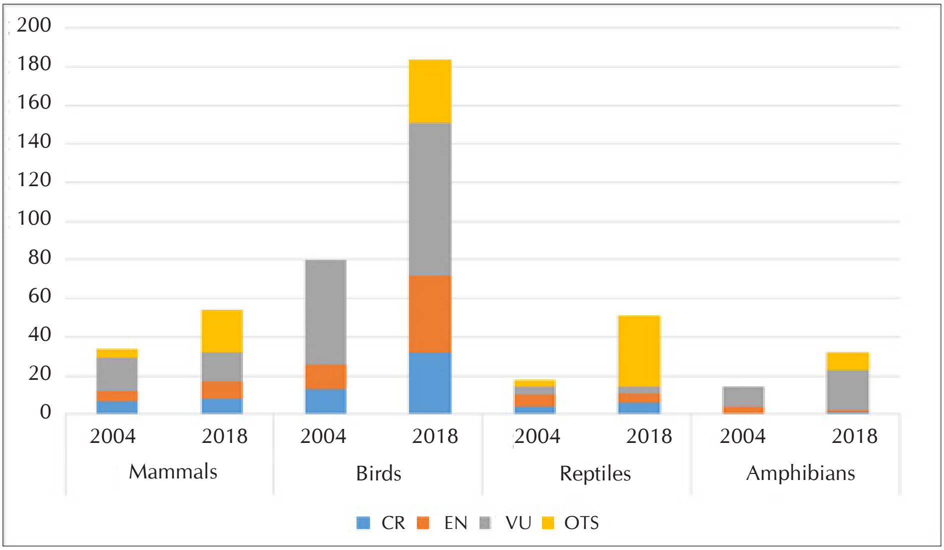

Figure 4 Comparison of Philippine threatened vertebrate fauna listed in DAO 2004-15 and in the proposed amendments to the DAO based on the number of species distributed among 4 threat categories

Mammals

A total of 54 species belonging to 13 families were recommended to be included in the amended list. Twenty-four species listed in DAO 2004-15 retained their conservation status, including the 7 CR species: Tamaraw (*Bubalus mindorensis*), Visayan warty pig (*Sus cebifrons*), Visayan spotted deer (*Cervus alfredi*), the Philippine bare-backed fruit bat (*Dobsonia chapmani*), Dinagat hairy-tailed cloud rat (*Crateromys australis*), Ilin hairy-tailed cloud rat (*Crateromys paulus*), and dugong (*Dugong dugon*). The Sulu warty pig (*Sus* sp. from the Sulu Archipelago), Calamian deer (*Cervus calamianensis*), Philippine tube-nosed fruit bat (*Nyctimene rabori*), and Panay bushy-tailed cloud rat (*Crateromys heaneyi*) all retained their EN status. From the original list, 11 species remained as VU and 2 species retained their OTS status.

Six species were uplisted from the DAO 2014-15. The golden-crowned fruit bat (*Acerodon jubatus*) was elevated from EN to CR because recent observations indicated a declining population due to heavy hunting, continuous roost disturbance, and reduction of the extent of lowland forest where the species depends for food and roosting. The Palawan pangolin (*Manis culionensis*), and Palawan flying fox (*Acerodon leucotis*) were moved from VU to EN, while the giant flying fox (*Pteropus vampyrus*) was elevated from OTS to EN. Twenty-three previously unlisted species were added

Table 1 List of Philippine threatened mammal species and their status in DAO 2004-15, in the proposed amendments to the DAO, and in the IUCN Red List

Family	Scientific name	Common name	DAO 2004-15	Proposed status	IUCN	Justification
Bovidae	*Bubalus mindorensis*	Tamaraw	CR	CR	CR	
Suidae	*Sus barbatus*	Palawan bearded pig	VU	VU	VU	
	Sus sp. from Sulu Is.	Sulu warty pig	EN	EN	NE	
	Sus cebifrons	Visayan warty pig	CR	CR	CR	
	Sus ahoenobarbus	Palawan bearded pig	VU	VU	NT	
	Sus oliveri	Mindoro warty pig	-	EN	VU	
Tragulidae	*Tragulus nigricans*	Balabac mouse deer	VU	VU	EN	
Cervidae	*Cervus calamianensis*	Calamian deer	EN	EN	EN	
	Cervus mariannus	Philippine deer	VU	EN	VU	Heavily hunted for local consumption and commercial trade of meat, horn and skin. In Mindoro, the species is also heavily hunted by local and international hunters.
	Cervus alfredi	Visayan spotted deer	CR	CR	EN	
Dugongidae	*Dugong dugon*	Dugong	CR	CR	VU	

Legend:
CR – Critically Endangered, EN – Endangered, VU – Vulnerable, OTS – Other Threatened Species (DAO), OWS – Other Wildlife Species (DAO), NT – Near Threatened (IUCN), DD – Data Deficient (IUCN), LC – Least Concern (IUCN), NE – Not Evaluated/Assessed (IUCN)

Table 1 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	IUCN	Justification
Pteropodidae	*Acerodon jubatus*	Golden-crowned fruit bat	EN	CR	EN	Heavily hunted, continuous roost disturbance, and reduction of extent of lowland forest where the species depends for food and roosting areas. Recent observations indicate that the population of *A. jubatus* decreases faster than that of *P. vampyrus* (Heaney et al. 2016). Under CITES Appendix I.
	Dobsonia chapmani	Philippine bare-backed fruit bat	CR	CR	CR	
	Nyctimene rabori	Philippine tube-nosed fruit bat	EN	EN	EN	
	Acerodon leucotis	Palawan flying fox	VU	EN	VU	Heavily hunted, roost disturbance, and reduction of extent of lowland forest where the species depend for food and roosting area. Limited distribution, found only in Palawan; Under CITES Appendix II.
	Pteropus vampyrus	Giant flying fox	OTS	EN	NT	Heavily hunted, continuous roost disturbance, and reduction of extent of lowland forest where the species depend for food and roosting area. Formerly occurred in many large colonies in the Philippines, but these are now greatly reduced in size and number (Heideman and Heaney 1989; Mickleburgh et al. 1992; Mildenstein et al. 2005; Mudar and Allen 1986; Rickart et al. 1993; Stier and Mildenstein 2005; Utzurrum 1992); Under CITES Appendix II.
	Pteropus dasymallus	Wooly flying fox	VU	VU	VU	
	Pteropus speciosus	Philippine gray flying fox	VU	VU	DD	

Table 1 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	IUCN	Justification
	Pteropus leucopterus	White winged fruit bat	VU	VU	LC	Heavily hunted, roost disturbance, and reduction of extent of lowland forest where the species depend for food and roosting areas.
	Eonycteris robusta	Philippine dawn bat	-	VU	NT	Lowland forest within its range has been reduced to not more than about 8% of its original extent (ca. 2% old growth, 6% secondary) (Walpole 2010). Additionally, the caves where these bats roost (and maintain maternity colonies) have been very heavily disturbed throughout the Philippines through mining of guano, severe hunting of bats (often by use of smoke from fires), treasure hunting, and mining of the limestone in which the caves exist.
	Styloctenium mindorensis	Mindoro striped-faced fruit bat	-	VU	DD	Found only in Mindoro Island. Current data indicated the species is less widespread and less abundant compared to *D. microleucopterus*. Report from local people suggested that the species is regularly hunted. Continuous reduction of the remaining lowland forest in Mindoro where the species occur further threatens the survival of the species.
	Desmalopex microleucopterus	Mindoro pallid flying fox	VU	VU	NE	Known only from patches of forest in the lowlands of Mindoro which have undergone extensive deforestation; previously listed as *Pteropus* sp. A in DAO 2004-15.

Table 1 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	IUCN	Justification
	Haplonycteris sp. from Sibuyan Is.	Sibuyan pygmy fruit bat	VU	-	NE	Found only in Sibuyan Island but the species is poorly known and has not been formally described. The species is found within a protected area.
Molossidae	*Chaerephon plicatus*	Wrinkle-lipped bat	-	VU	LC	Formerly among the most abundant bats in some large caves (Lawrence 1939; Taylor 1934); some previously recorded colonies in caves now destroyed (Rickart et al. 1993). Currently, the species has limited distribution (Cagayan, Cebu, Rizal, Bulacan). Caves where they occur are threatened by guano mining; collected for food (Cagayan,Bulacan, Cebu and Rizal) or commercially sold (Bulacan).
Muridae	*Crateromys australis*	Dinagat hairy-tailed cloud rat	CR	CR	CR	
	Crateromys paulus	Ilin hairy-tailed cloud rat	CR	CR	CR	
	Crateromys schadenbergi	Bushy-tailed cloud rat	VU	VU	VU	
	Phloeomys cumingi	Southern Luzon giant cloud rat	VU	VU	VU	
	Batomys russatus	Dinagat hairy-tailed rat	VU	VU	VU	
	Crateromys heaneyi	Panay bushy-tailed cloud rat	EN	EN	EN	
	Rhyncomys tapulao	Zambales shrew-rat	-	VU	VU	This species occurs only in mossy forest at high elevations and only in old-growth and lightly-disturbed habitat, and not in areas that have been significantly disturbed (Balete et al., 2009).

Table 1 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	IUCN	Justification
						The recent mining in Mt. Tapulao has removed an uncertain but large percentage of the known habitat for the species. Given the small population and area of habitat that are currently known, the removal of a significant portion of the habitat by mining activities represents a clear and present threat to the species.
	Archboldomys luzonensis	Isarog shrew mouse	VU	OTS	VU	Although restricted to Mount Isarog, population is stable and moderately common in primary montane and mossy forest from 1350 to 1750 m (Heaney et al. 2010, 2016). The species is found within a protected area and no current threat to its habitat.
	Batomys uragon	Mt. Isarog hairy-tailed rat	-	OTS	LC	Described in 2015
	Soricomys kalinga	Kalinga shrew mouse	-	OTS	LC	Described in 2006
	Soricomys leonardocoi	Mingan shrew mouse	-	OTS	DD	Described in 2012
	Soricomys montanus	Southern Cordillera shrew mouse	-	OTS	NE	Described in 2012
	Rhynchomys banahao	Banahao shrew rat	-	OTS	LC	Described in 2007
	Apomys aurorae	Aurora forest mouse	-	OTS	LC	Described in 2011
	Apomys banahao	Banahao forest mouse	-	OTS	LC	Described in 2011
	Apomys brownorum	Tapulao forest mouse	-	OTS	DD	Described in 2011

Table 1 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	IUCN	Justification
	Apomys iridensis	Southern Sierra Madre shrew mouse	-	OTS	NE	Described in 2014
	Apomys lubangensis	Lubang Island shrew mouse	-	OTS	NE	Described in 2014
	Apomys magnus	Lowland Banahaw forest mouse	-	OTS	NE	Described in 2011
	Apomys minganensis	Mingan forest mouse	-	OTS	NE	Described in 2011
	Apomys sierrae	Northern Sierra Madre forest mouse	-	OTS	NE	Described in 2011
	Apomys zambalensis	Zambales forest mouse	-	OTS	LC	Described in 2011
	Archboldomys maximus	Large Cordillera shrew mouse	-	OTS	NE	Described in 2012
	Musseromys gulantang	Banahaw tree mouse	-	OTS	NE	Described in 2009
	Musseromys anacuao	Sierra Madre tree mouse	-	OTS	NE	Described in 2014
	Musseromys beneficus	Mt. Pulag tree mouse	-	OTS	NE	Described in 2014
	Musseromys inopinatus	Amuyao tree mouse	-	OTS	NE	Described in 2014
Erinaceidae	*Podogymnura aureospinula*	Dinagat gymnure	VU	VU	VU	

Table 1 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	IUCN	Justification
Manidae	*Manis culionensis*	Palawan pangolin	VU	EN	EN	Heavily hunted for food and traditional medicine (especially the scales) both at the local and international level; reduction of extent of lowland forest. The species occurs throughout Palawan. Most of the areas where it occur do not have any conservation management system in place.
Felidae	*Prionailurus bengalensis*	Leopard cat	VU	VU	VU	
Viverridae	*Arctictis binturong*	Binturong	OTS	OTS	VU	
Cynoce-phalidae	*Cynocephalus volans*	Philippine flying lemur	OTS	-	VU	Locally common and widespread. Found in different habitat from considerably disturbed habitat, agriculture, secondary forest to primary forest; the species is adaptable and resilient but population is currently unknown.
Tarsiidae	*Tarsius syrichta*	Philippine tarsier	OTS	OTS	NT	Locally common and widespread. Found in different habitat from considerably disturbed habitat, agriculture, secondary forest to primary forest; the species is adaptable and resilient. Main threat: rampant collection for pet trade.
Cercopithe-cidae	*Macaca fascicularis*	Long-tailed macaque	OTS	-	NT	Locally common and widespread. Found in different habitat from considerably disturbed habitat, agriculture, secondary forest to primary forest; the species is adaptable and resilient but population is currently unknown. Several reports by the locals suggested the species as a pest to agricultural crops.

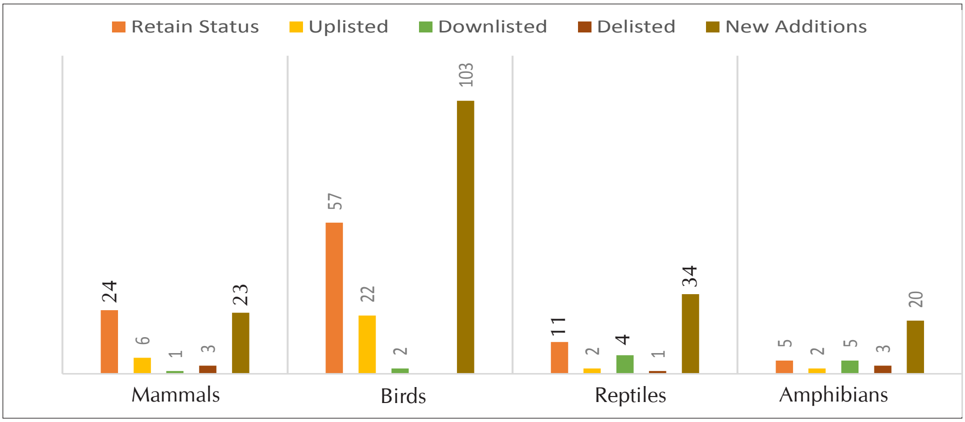

Figure 5 Species movements from the DAO 2004-15 to the proposed amendments to the DAO

to the list— 4 under VU, and 19 under OTS. Several of the species listed are under threat from hunting for local subsistence, habitat fragmentation and disturbance, and mining (i.e. collection of guano). *M. culionensis* is hunted for local consumption as a luxury food item (Gomez & Sy 2018). Anecdotal evidences also suggest that the species is hunted for the international wildlife trade, specifically for the traditional Chinese medicine market. Smuggling activities has apparently increased in the last decade.

Sus ahoenobarbus was previously a subspecies of *S. barbatus* but elevated to a full species by Groves (2001) and Lucchini et al. (2005). This species retained its VU status in the proposed list. *Sus oliveri* was initially a subspecies of *Sus philippensis* which was categorized as Vulnerable under DAO 2014-15, and subsequently recognized as a full species (Groves 2001; Luchini et al 2005; Grubb 2005). This species is elevated to EN. Found only on Mindoro Island where reduction of its lowland forest habitat occur, *S. oliveri* is also reported to be heavily hunted throughout its range for food, bush-meat trade, and local ceremonies

On the other hand, the Isarog shrew mouse (*Archboldomys luzonensis*) was downgraded from VU to OTS as present information suggested a moderately common and stable population in primary montane and mossy forest from 1350 m to 1750 m (Heaney et al. 2016). The Sibuyan pygmy fruit bat (*Haplonycteris* sp.), previously VU, was delisted because of insufficient information to support the listing; the species has not been scientifically described as well. The Philippine flying lemur (*Cynocephalus volans*) and the Long-tailed macaque (*Macaca fascicularis*) were likewise removed owing to their stable population and wide distribution. *C. volans* is believed to be locally common, widespread, and found in varied habitat types from considerably disturbed to pristine primary forests. *M. fascicularis* is likewise fairly common, widespread, and adaptable to different habitat types; some locals also consider this species as a pest to agricultural crops. The complete list showing the updated list of species movement of mammals from DAO 2014-15 to the proposed amendment is in Table 1.

Birds

The threatened list of Philippine birds included 184 species from 57 families (Table 2). Fifty-seven (57) species retained their threat category, including 13 CR, 8 EN, and 36 VU species. Two species—the Mindanao bleeding-heart (*Gallicolumba crinigera*) and the Luzon water redstart *(Rhyacornis bicolor)* — were downlisted from EN to VU. DAO 2004-15 also listed the Isabela oriole (*Oriolus isabellae)* as OWS during the time when little was known of the species. Recent surveys revealed a patchy distribution within degraded forests in Northern Luzon, which warranted a threat status of CR.

The Sulu bleeding-heart (*Gallicolumba menagei)*, a presumed extinct species, and the Visayan hornbill (*Penelopides panini ticaensis)*, a presumed extirpated Philippine endemic subspecies, were categorized as CR. Both species retained their 2004 threat status. Fourteen accidental species followed the IUCN conservation status i.e. the Baer's pochard (*Aythya baeri*), Spoon-billed sandpiper (*Eurynorhynchus pygmeus*), Chinese crested tern (*Thalasseus bernsteini*), and Masked booby (*Sula dactylatra*)—all classified as CR—and the Oriental stork (*Ciconia boyciana*) as EN.

Among the presumed extinct species, the Sarus crane (*Grus antigone*), which is possibly an endemic race *luzonica*, was classified as CR. The Woolly-necked stork (*Ciconia episcopus*), and Spot-billed pelican (*Pelecanus philippensis*) are recommended as OTS. Only the *G. antigone* was previously listed in DAO 2004-15.

Subspecies and ESU of some bird species were individually assessed and weighted (Table 3). For ease of policy and enforcement, the Biodiversity Management Bureau (BMB) recommended to adopt a more conservative approach—in cases where subspecies have different threat categories, the highest status among the subspecies would be followed and assumed, such as in the cases of the Luzon bleeding-heart (*Gallicolumba luzonica*), Amethyst brown dove (*Phapitreron amethystinus*), Mantanani scops-owl (*Otus mantananensis*), Indigo-banded kingfisher (*Ceyx cyanopectus*), Colasisi (*Loriculus philippensis*), and White-browed shama (*Copsychus luzoniensis*). The more threatened subspecies often comes from islands with highly disturbed and fragmented forests. For instance, 4 subspecies of *L. philippensis* (*L. p. philippensis*, *L. p. regulus*, *L. p. worcesteri*, and *L. p. apicalis*) were ranked as OTS while the subspecies from Cebu, *L. p. chrysonotus,* and a potentially extinct *L. p siquijorensis* are more threatened, thus, the species was recommended as CR.

Table 2 List of Philippine threatened bird species and their status in DAO 2004-15 and in the proposed amendments to the DAO

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
Anatidae	*Anas luzonica*	Philippine duck	VU	VU	2	1	2	5	
	Aythya baeri	Baer's pochard	Not listed	CR	-	-	-	0	Accidental species; followed IUCN status
Megapodiidae	*Megapodius cumingii*	Philippine megapode	VU	VU	1	1	3	5	
Phasianidae	*Polyplectron napoleonis*	Palawan peacock-pheasant	VU	EN	2	2	3	7	
Diomedeidae	*Phoebastria immutabilis*	Laysan albatross	Not listed	OTS	-	-	-	0	Accidental species; followed IUCN status
Procellariidae	*Pterodroma sandwichensis*	Hawaiian petrel	Not listed	VU	-	-	-	0	Accidental species; followed IUCN status
	Pseudobulweria rostrata	Tahiti petrel	Not listed	OTS	-	-	-	0	Accidental species; followed IUCN status
Hydrobatidae	*Oceanodroma monorhis*	Swinhoe's storm petrel	Not listed	OTS	-	-	-	0	Accidental species; followed IUCN status
Ciconiidae	*Ciconia episcopus*	Woolly-necked stork	Not listed	OTS	-	-	-	0	Presumed extirpated species / subspecies
	Ciconia boyciana	Oriental stork	EN	EN	-	-	-	0	Accidental species; followed IUCN status
Threskiornithidae	*Threskiornis melanocephalus*	Black-headed ibis	Not listed	OTS	-	-	-	0	Accidental species; followed IUCN status
	Platalea minor	Black-faced spoonbill	Not listed	EN	3	2	2	7	
Ardeidae	*Gorsachius goisagi*	Japanese night heron	EN	EN	3	2	1	6	
	Egretta eulophotes	Chinese egret	VU	VU	1	2	2	5	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
Pelecanidae	*Pelecanus philippensis*	Spot-billed pelican	Not listed	OTS	-	-	-	0	Presumed extirpated species / subspecies; follow IUCN status (NT)
	Pelecanus crispus	Dalmatian pelican	Not listed	VU	-	-	-	0	Accidental species; followed IUCN status
Fregatidae	*Fregata andrewsi*	Christmas Island frigatebird	Not listed	CR	3	3	2	8	
Sulidae	*Sula dactylatra*	Masked booby	Not listed	CR	3	2	3	8	
	Sula leucogaster	Brown booby	Not listed	EN	3	1	2	6	
Anhingidae	*Anhinga melanogaster*	Oriental darter	VU	VU	1	1	1	3	
Accipitridae	*Aegypius monachus*	Cinereous vulture	Not listed	OTS	-	-	-	0	Accidental species; followed IUCN status
	Pithecophaga jefferyi	Philippine eagle	CR	CR	3	3	3	9	
	Nisaetus philippensis	Philippine hawk-eagle	VU	VU	1	2	2	5	
	Nisaetus pinskeri	Pinsker's hawk-eagle	VU	EN	3	2	2	7	
	Haliaeetus ichthyaetus	Grey-headed fish eagle	VU	VU	1	1	1	3	
Rallidae	*Gallirallus calayanensis*	Calayan rail	Not listed	EN	1	3	2	6	
	Lewinia mirificus	Brown-banded rail	Not listed	EN	2	2	2	6	
Gruidae	*Grus antigone*	Sarus crane	CR	CR	-	-	-	0	Presumed extirpated species / subspecies
Turnicidae	*Turnix worcesteri*	Worcester's buttonquail	-	EN	2	2	2	6	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
Burhinidae	*Esacus magnirostris*	Beach stone-curlew	Not listed	EN	3	2	2	7	
Charadriidae	*Charadrius peronii*	Malaysian plover	VU	VU	2	1	2	5	
Scolopacidae	*Limnodromus semipalmatus*	Asian dowitcher	Not listed	VU	2	1	1	4	
	Limosa limosa	Black-tailed godwit	Not listed	VU	1	1	1	3	
	Numenius tahitiensis	Bristle-thighed curlew	VU	VU	-	-	-	0	Accidental species; followed IUCN status
	Numenius arquata	Eurasian curlew	Not listed	OTS	0	1	1	2	
	Numenius madagascariensis	Far Eastern curlew	Not listed	EN	3	2	1	6	
	Tringa erythropus	Spotted redshank	Not listed	EN	3	2	2	7	
	Tringa guttifer	Nordmann's greenshank	EN	EN	3	2	2	7	
	Calidris tenuirostris	Great knot	Not listed	EN	3	2	1	6	
	Eurynorhynchus pygmeus	Spoon-billed sandpiper	VU	CR	-	-	-	0	Accidental species; followed IUCN status
Laridae	*Thalasseus bernsteini*	Chinese crested tern	CR	CR	-	-	-	0	Accidental species; followed IUCN status
	Anous minutus	Black noddy	-	EN	3	1	2	6	subspecies *worcesteri* restricted to Sulu Sea
	Thalasseus bergii	Great crested tern	-	VU	2	1	2	5	
	Onychoprion fuscatus	Sooty tern	-	VU	2	1	2	5	
	Anous stolidus	Brown noddy	-	VU	2	1	2	5	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Onychoprion anaethetus	Bridled tern	-	OTS	0	1	1	2	
Columbidae	*Streptopelia bitorquata*	Island collared dove	Not listed	EN	2	1	3	6	
	Caloenas nicobarica	Nicobar pigeon	VU	EN	3	2	2	7	
	Gallicolumba luzonica	Luzon bleeding-heart	VU	VU	-	-	-	-	Followed the highest status of subspecies *Gallicolumba luzonica rubiventris*
	Gallicolumba crinigera	Mindanao bleeding-heart	EN	VU	1	1	1	3	
	Gallicolumba platenae	Mindoro bleeding-heart	CR	CR	3	3	3	9	
	Gallicolumba keayi	Negros bleeding-heart	CR	CR	3	3	3	9	
	Gallicolumba menagei	Sulu bleeding-heart	CR	CR	3	3	3	9	Presumed extinct species / subspecies
	Phapitreron amethystinus	Amethyst brown dove	Not listed	CR	-	-	-	-	Followed the highest status of subspecies *Phapitreron amethystinus frontalis*
	Phapitreron cinereiceps	Tawitawi brown dove	CR	CR	3	3	3	9	
	Phapitreron brunneiceps	Mindanao brown dove	Not listed	VU	2	1	1	4	
	Treron axillaris	Philippine green pigeon	Not listed	VU	1	1	2	4	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Treron formosae	Whistling green pigeon	VU	VU	1	2	2	5	
	Ptilinopus marchei	Flame-breasted Fruit Dove	VU	EN	2	2	2	6	
	Ptilinopus merrilli	Cream-breasted fruit dove	VU	VU	2	1	2	5	
	Ptilinopus arcanus	Negros fruit dove	CR	CR	3	3	3	9	
	Ducula poliocephala	Pink-bellied imperial pigeon	VU	CR	-	-	-	-	Followed the highest status of ESU *Ducula poliocephala* (Luzon ESU)
	Ducula mindorensis	Mindoro imperial pigeon	VU	EN	3	2	2	7	
	Ducula carola	Spotted imperial pigeon	VU	EN	-	-	-	-	Followed the status of all subspecies
	Ducula pickeringii	Grey imperial pigeon	VU	EN	2	2	2	6	
Cuculidae	*Centropus unirufus*	Rufous coucal	Not listed	OTS	0	0	1	1	
	Centropus steerii	Black-hooded coucal	CR	CR	3	3	2	8	
Strigidae	*Otus gurneyi*	Giant scops owl	VU	EN	2	2	3	7	
	Otus fuliginosus	Palawan scops owl	Not listed	EN	2	2	2	6	
	Otus nigrorum	Negros scops owl	Not listed	VU	1	1	1	3	
	Otus longicornis	Luzon scops owl	Not listed	VU	1	2	2	5	
	Otus mindorensis	Mindoro scops owl	Not listed	VU	1	2	1	4	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Otus mantananensis	Mantanani scops owl	Not listed	VU	-	-	-	-	Followed the highest status of subspecies *O. m. romblonis* and *O. m. sibutuensis*
	Otus elegans	Ryukyu scops owl	Not listed	OTS	0	1	1	2	
	Bubo philippensis	Philippine eagle-owl	VU	EN	2	1	3	6	
	Ninox randi	Chocolate boobook	Not listed	VU	2	1	1	4	
	Ninox spilocephala	Mindanao hawk-owl	Not listed	VU	2	1	2	5	
	Ninox mindorensis	Mindoro hawk-owl	Not listed	VU	1	1	1	3	
	Ninox spilonota	Romblon hawk-owl	Not listed	EN	2	2	2	6	
	Ninox rumseyi	Cebu hawk-owl	Not listed	EN	2	2	2	6	
	Ninox leventisi	Camiguin hawk-owl	Not listed	EN	2	3	2	7	
	Ninox reyi	Sulu hawk-owl	Not listed	VU	1	1	1	3	
Podargidae	*Batrachostomus chaseni*	Palawan frogmouth	Not listed	VU	1	1	1	3	
Apodidae	*Mearnsia picina*	Philippine spine-tailed swift	Not listed	VU	2	1	1	4	
Alcedinidae	*Actenoides hombroni*	Blue-capped wood kingfisher	VU	VU	1	2	1	4	
	Todiramphus winchelli	Rufous-lored kingfisher	VU	VU	1	1	2	4	
	Ceyx melanurus	Philippine dwarf kingfisher	VU	VU	-	-	-	-	Followed the status of all subspecies
	Ceyx margarethae	Dimorphic dwarf kingfisher	Not listed	OTS	0	0	1	1	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Ceyx cyanopectus	Indigo-banded kingfisher	Not listed	CR	-	-	-	-	Followed the highest status of subspecies *Ceyx cyanopectus nigrirostris*
	Ceyx flumenicola	Southern silvery kingfisher	Not listed	VU	1	2	1	4	
	Ceyx argentatus	Northern silvery kingfisher	VU	VU	1	2	1	4	
Bucerotidae	*Buceros hydrocorax*	Rufous hornbill	VU	EN	-	-	-	-	Followed the highest status of subspecies *Buceros hydrocorax hydrocorax*
	Anthracoceros marchei	Palawan hornbill	VU	VU	1	1	1	3	
	Anthracoceros montani	Sulu hornbill	CR	CR	3	3	3	9	
	Rhabdotorrhinus waldeni	Walden's hornbill	CR	CR	2	3	3	8	
	Rhabdotorrhinus leucocephalus	Writhed hornbill	VU	VU	1	2	1	4	
	Penelopides manillae	Luzon hornbill	Not listed	VU	-	-	-	-	Followed the highest status of subspecies *Penelopides manillae subniger*
	Penelopides mindorensis	Mindoro hornbill	EN	EN	2	2	2	6	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Penelopides affinis	Mindanao hornbill	Not listed	EN	-	-	-	-	Followed the highest status of subspecies *Penelopides affinis basilanicus*
	Penelopides panini ticaensis	Visayan hornbill	EN	CR	-	-	-	-	Followed the highest status of subspecies *Penelopides panini ticaensis*
Picidae	*Dendrocopos ramsayi*	Sulu pygmy woodpecker	VU	VU	1	2	1	4	
	Dinopium everetti	Spot-throated flameback	Not listed	OTS	0	1	0	1	
	Chrysocolaptes xanthocephalus	Yellow-faced flameback	Not listed	EN	3	2	2	7	
	Chrysocolaptes erythrocephalus	Red-headed flameback	Not listed	EN	3	2	1	6	
	Mulleripicus pulverulentus	Great slaty woodpecker	Not listed	VU	1	1	1	3	
Cacatuidae	*Cacatua haematuropygia*	Red-vented cockatoo	CR	CR	2	3	3	8	
Psittacidae	*Loriculus philippensis*	Colasisi	Not listed	CR	-	-	-	-	Followed the highest status of subspecies *L. p. chrysonotus* and *L. p. siquijorensis*
	Trichoglossus johnstoniae	Mindanao lorikeet	Not listed	VU	2	2	1	5	
	Prioniturus montanus	Montane racket-tail	Not listed	EN	1	3	2	6	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Prioniturus waterstradti	Mindanao racket-tail	Not listed	VU	2	2	1	5	
	Prioniturus platenae	Blue-headed racket-tail	VU	VU	1	2	2	5	
	Prioniturus luconensis	Green racket-tail	VU	CR	3	3	2	8	
	Prioniturus discurus	Blue-crowned racket-tail	Not listed	OTS	0	0	1	1	
	Prioniturus mindorensis	Mindoro racket-tail	Not listed	EN	2	2	2	6	
	Prioniturus verticalis	Blue-winged racket-tail	EN	CR	3	3	3	9	
	Tanygnathus lucionensis	Blue-naped parrot	VU	CR	-	-	-	-	Followed the highest status of subspecies *T. l. hybridus* and *T. l. lucionensis*
	Tanygnathus sumatranus	Blue-backed parrot	Not listed	CR	-	-	-	-	Followed the highest status of subspecies *T. s. freeri, T. s. burbidgii,* and *T. s. duponti*
Eurylaimidae	*Sarcophanops steerii*	Wattled broadbill	VU	VU	1	2	2	5	
	Sarcophanops samarensis	Visayan broadbill	VU	VU	1	2	2	5	
Pittidae	*Erythropitta kochi*	Whiskered pitta	VU	VU	2	1	2	5	
	Pitta steerii	Azure-breasted pitta	VU	VU	2	1	2	5	
	Pitta nympha	Fairy pitta	Not listed	VU	-	-	-	0	Accidental species; followed IUCN status

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
Campephagidae	*Coracina mindanensis*	Black-bibbed cuckooshrike	Not listed	VU	2	2	1	5	
	Coracina ostenta	White-winged cuckooshrike	VU	VU	1	2	2	5	
	Coracina mcgregori	McGregor's cuckooshrike	VU	VU	2	2	1	5	
	Pericrocotus igneus	Fiery minivet	Not listed	VU	2	2	1	5	
Laniidae	*Lanius validirostris*	Mountain shrike	Not listed	VU	2	2	1	5	
Oriolidae	*Oriolus xanthonotus*	Dark-throated oriole	Not listed	VU	2	2	1	5	
	Oriolus isabellae	Isabela oriole	OWS	CR	3	3	2	8	
Dicruridae	*Dicrurus menagei*	Tablas drongo	Not listed	CR	3	3	2	8	
Rhipiduridae	*Rhipidura sauli*	Tablas fantail	Not listed	EN	1	2	3	6	
Monarchidae	*Hypothymis helenae*	Short-crested monarch	Not listed	OTS	1	1	0	2	
	Hypothymis coelestis	Celestial monarch	VU	CR	-	-	-	-	Followed the highest status of subspecies *Hypothymis coelestis rabori*
	Terpsiphone atrocaudata	Japanese paradise flycatcher	Not listed	VU	2	2	0	4	
Bombycillidae	*Bombycilla japonica*	Japanese waxwing	Not listed	OTS	-	-	-	0	
Paridae	*Periparus amabilis*	Palawan tit	Not listed	OTS	0	1	0	1	
	Parus semilarvatus	White-fronted tit	Not listed	OTS	0	1	0	1	
Pycnonotidae	*Alophoixus frater*	Palawan bulbul	Not listed	OTS	1	0	0	1	
	Hypsipetes rufigularis	Zamboanga bulbul	Not listed	VU	1	2	1	4	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Hypsipetes siquijorensis	Streak-breasted bulbul	EN	CR	-	-	-	-	Followed the highest status of subspecies *Hypsipetes siquijorensis monticola*
Phylloscopidae	*Phylloscopus ijimae*	Ijima's leaf warbler	VU	VU	-	-	-	0	Accidental species; followed IUCN status
Acrocephalidae	*Acrocephalus sorghophilus*	Speckled reed warbler	VU	CR	3	3	2	8	
Locustellidae	*Robsonius rabori*	Cordillera ground warbler	Not listed	VU	1	1	1	3	
	Robsonius thompsoni	Sierra Madre ground warbler	Not listed	OTS	0	1	1	2	
	Robsonius sorsogonensis	Bicol ground warbler	Not listed	VU	1	1	1	3	
Cisticolidae	*Orthotomus samarensis*	Yellow-breasted tailorbird	Not listed	OTS	0	1	0	1	
Timaliidae	*Micromacronus leytensis*	Visayan miniature babbler	Not listed	VU	2	2	1	5	
Pellorneidae	*Ptilocichla falcata*	Falcated wren-babbler	VU	VU	1	2	2	5	
	Malacopteron palawanense	Melodious babbler	Not listed	OTS	0	1	0	1	
Zosteropidae	*Zosterornis striatus*	Luzon striped babbler	Not listed	VU	3	1	0	4	
	Zosterornis latistriatus	Panay striped babbler	Not listed	VU	2	2	1	5	
	Zosterornis nigrorum	Negros striped babbler	EN	EN	2	3	1	6	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Zosterornis hypogrammicus	Palawan striped babbler	Not listed	OTS	1	1	0	2	
	Dasycrotapha speciosa	Flame-templed babbler	EN	EN	2	2	3	7	
	Dasycrotapha plateni	Mindanao pygmy babbler	Not listed	OTS	1	1	0	2	
	Dasycrotapha pygmaea	Visayan pygmy babbler	Not listed	OTS	1	1	0	2	
	Sterrhoptilus dennistouni	Golden-crowned babbler	Not listed	OTS	1	1	0	2	
Sturnidae	*Basilornis mirandus*	Apo myna	Not listed	VU	1	2	1	4	
	Gracula religiosa	Common hill myna	VU	VU	1	1	3	5	*Gracula religiosa palawanensis* (only subspecies in the Philippines out of 8 sbsp)
Turdidae	*Geokichla cinerea*	Ashy thrush	VU	VU	2	1	1	4	
Muscicapidae	*Copsychus luzoniensis*	White-browed shama	Not listed	VU	-	-	-	-	Followed the highest status of subspecies *Copsychus luzoniensis shemleyi*
	Copsychus cebuensis	Black shama	EN	EN	2	2	3	7	
	Muscicapa randi	Ashy-breasted flycatcher	VU	EN	3	1	2	6	
	Vauriella albigularis	White-throated jungle flycatcher	EN	EN	2	2	2	6	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Vauriella insignis	White-browed jungle flycatcher	VU	VU	1	1	1	3	
	Vauriella goodfellowi	Slaty-backed jungle flycatcher	Not listed	VU	1	2	1	4	
	Ficedula basilanica	Little slaty flycatcher	VU	VU	1	1	0	2	
	Ficedula platenae	Palawan flycatcher	VU	VU	1	2	1	4	
Chloropseidae	*Chloropsis flavipennis*	Philippine leafbird	VU	CR	-	-	-	-	Followed the highest status of ESU *Chloropsis flavipennis* (Cebu ESU)
Dicaeidae	*Dicaeum proprium*	Whiskered flowerpecker	Not listed	VU	2	2	0	4	
	Dicaeum anthonyi	Flame-crowned flowerpecker	Not listed	OTS	1	1	0	2	
	Dicaeum haematostictum	Black-belted flowerpecker/Visayan flowerpecker	VU	VU	2	1	1	4	
	Dicaeum retrocinctum	Scarlet-collared flowerpecker	VU	VU	1	1	2	4	
	Dicaeum quadricolor	Cebu flowerpecker	CR	CR	3	3	3	9	
Nectariniidae	*Anthreptes griseigularis*	Grey-throated sunbird	Not listed	OTS	1	1	0	2	
	Aethopyga primigenia	Grey-hooded sunbird	Not listed	OTS	1	1	0	2	
	Aethopyga boltoni	Apo sunbird	Not listed	OTS	1	1	0	2	

Table 2 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification (basis for classification)*				
					1	2	3	4	Remarks
	Aethopyga linaraborae	Lina's sunbird	Not listed	VU	1	2	0	3	
	Aethopyga guamarasensis	Maroon-naped sunbird	Not listed	OTS	1	0	0	1	
	Aethopyga decorosa	Bohol sunbird	Not listed	OTS	1	1	0	2	
Estrildidae	*Erythrura viridifacies*	Green-faced parrotfinch	VU	VU	1	1	2	4	
	Erythrura coloria	Red-eared parrotfinch	Not listed	OTS	1	1	0	2	

***Justification (basis for clasification)**

1 Population score:
Individual counts; number of individuals and sub-population, size, trend
0 – stable / increase;
3 – extremely low or rapidly decreasing

2 Occurrence score:
Area of occurrence and distribution (geographic location, spread, habitat and distribution of species)
0 – widespread;
3 – limited occurrence / distribution

3 Threat score:
Prevailing threat or suspected pending threat (next 5 years); can include anthropogenic or natural threats
0 – none/very few;
3 – extreme

4 Total score:

0	OWS
1-2	OTS
3-5	VU
6-7	EN
8-9	CR

Table 3 List of bird subspecies and evolutionary significant units assessed

Species	Recommended status
***Luzon bleeding-heart (*Gallicolumba luzonica*)**	**VU**
Gallicolumba luzonica rubiventris	VU
Gallicolumba luzonica griseolateralis	OTS
Gallicolumba luzonica luzonica	OTS
***Amethyst brown dove (*Phapitreron amethystinus*)**	**CR**
Phapitreron amethystinus maculipectus	VU
Phapitreron amethystinus frontalis	CR
Phapitreron amethystinus imeldae	VU
***Spotted imperial pigeon (*Ducula carola*)**	**EN**
Ducula carola nigrorum	EN
Ducula carola mindanensis	EN
Ducula carola carola	EN
***Mantanani scops-owl (*Otus mantananensis*)**	**VU**
Otus mantananensis romblonis	VU
Otus mantananensis cuyensis	OTS
Otus mantananensis sibutuensis	VU
Otus mantananensis mantananensis	OTS
***Philippine dwarf kingfisher (*Ceyx melanurus*)**	**VU**
Ceyx melanurus mindanensis	VU
Ceyx melanurus melanurus	VU
Ceyx melanurus samarensis	VU
***Indigo-banded kingfisher (*Ceyx cyanopectus*)**	**CR**
Ceyx cyanopectus cyanopectus	OTS
Ceyx cyanopectus nigrirostris	CR
***Rufous hornbill (*Buceros hydrocorax*)**	**EN**
Buceros hydrocorax mindanensis	VU
Buceros hydrocorax hydrocorax	EN
Buceros hydrocorax semigaleatus	VU

*subspecies, ** evolutionary significant unit (ESU)

Table 3 Continuation

Species	Recommended status
***Luzon hornbill (*Penelopides manillae*)**	**VU**
Penelopides manillae subniger	VU
***Mindanao hornbill (*Penelopides affinis*)**	**EN**
Penelopides affinis basilanicus	EN
***Visayan hornbill (*Penelopides panini*)**	**CR**
Penelopides panini ticaensis	CR
Penelopides panini panini	EN
***Colasisi (*Loriculus philippensis*)**	**CR**
Loriculus philippensis philippensis	OTS
Loriculus philippensis mindorensis	VU
Loriculus philippensis bournsi	VU
Loriculus philippensis regulus	OTS
Loriculus philippensis chrysonotus	CR
Loriculus philippensis worcesteri	OTS
Loriculus philippensis siquijorensis	CR
Loriculus philippensis apicalis	OTS
Loriculus philippensis dohertyi	VU
Loriculus philippensis bonapartei	VU
***Blue-naped parrot (*Tanygnathus lucionensis*)**	**CR**
Tanygnathus lucionensis hybridus	CR
Tanygnathus lucionensis lucionensis	CR
Tanygnathus lucionensis salvadorii	VU
***Blue-backed parrot (*Tanygnathus sumatranus*)**	**CR**
Tanygnathus sumatranus freeri	CR
Tanygnathus sumatranus everetti	EN
Tanygnathus sumatranus burbidgii	CR
Tanygnathus sumatranus duponti	CR
***Celestial monarch (*Hypothymis coelestis*)**	**CR**
Hypothymis coelestis rabori	CR

*subspecies, ** evolutionary significant unit (ESU)

Table 3 Continuation

Species	Recommended status
Hypothymis coelestis coelestis	EN
***Streak-breasted bulbul (*Hypsipetes siquijorensis*)**	**CR**
Hypsipetes siquijorensis siquijorensis	VU
Hypsipetes siquijorensis monticola	CR
Hypsipetes siquijorensis cinereiceps	EN
***White-browed shama (*Copsychus luzoniensis*)**	**VU**
Copsychus luzoniensis parvimaculatus	OTS
Copsychus luzoniensis shemleyi	VU
****Pink-bellied imperial pigeon (*Ducula poliocephala*)**	**CR**
Ducula poliocephala (Luzon ESU)	CR
Ducula poliocephala (other ESU outside Luzon)	EN
****Philippine leafbird (*Chloropsis flavipennis*)**	**CR**
Chloropsis flavipennis (Cebu ESU)	CR
Chloropsis flavipennis (Greater Mindanao ESU)	EN

*subspecies, ** evolutionary significant unit (ESU)

Reptiles

The reptile subcommittee listed 51 species belonging to 13 families (Table 4). Eleven of the 18 reptilian species in the DAO 2004-15 list retained their threat categories, such as the Philippine forest turtle (*Siebenrockiella leytensis*), Philippine crocodile (*Crocodylus mindorensis*), and the hawksbill sea turtle (*Eretmochelys imbricata*), which were all under the CR category. Previously unlisted, the saltwater crocodile (*Crocodylus porosus*) is recommended to the CR category due to continuous habitat destruction and modification (i.e. conversion of mangrove forests to fish ponds) and persecution, while the leatherback turtle (*Dermochelys coriacea*) was uplisted from EN to CR because of the clauses afforded by the Appendix I of Convention on Migratory Species (CMS). Thirty-four previously unlisted species from 9 families were included in the amended list—1 CR, 2 VU, and 31 OTS. Illegal wildlife trade primarily for pets and to a lesser extent for traditional medicine and curio trade is a threat to several reptilian species in the list. Harvesting of the Tokay gecko (*Gekko gecko)*, purportedly for its curative properties, was rampant between 2010 and 2012, until the claims were refuted by health authorities. The BMB has since issued a memorandum to curb the trade.

Table 4 List of Philippine threatened reptile species and their status in the proposed amendments to DAO 2004-15

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification*
Geoemydidae	*Siebenrockiella leytensis*	Philippine forest turtle, Palawan forest turtle	CR	CR	1, 13, 7, 8, 2, 3, 15
Cheloniidae	*Eretmochelys imbricata*	Hawksbill turtle	CR	CR	1, 13, 9
Dermochelyidae	*Dermochelys coriacea*	Leatherback turtle	EN	CR	1, 13, 9
Varanidae	Varanus mabitang	Panay forest monitor lizard	CR	CR	1, 2, 3, 4
Crocodylidae	*Crocodylus mindorensis*	Philippine crocodile	CR	CR	1, 2, 3, 4, 6, 13
Crocodylidae	*Crocodylus porosus*	Indo-Pacific crocodile; saltwater crocodile	-	CR	1, 3, 4, 6, 13
Geoemydidae	*Heosemys spinosa*	Spiny hill turtle	EN	EN	2, 6, 7, 8
Cheloniidae	*Caretta caretta*	Loggerhead turtle	EN	EN	1, 13, 9
Cheloniidae	*Chelonia mydas*	Green turtle	EN	EN	1, 13, 9
Cheloniidae	*Lepidochelys olivacea*	Olive ridley turtle	EN	EN	1, 13, 9
Viperidae	*Trimeresurus mcgregori*	McGregor's pitviper	OTS	EN	1, 2, 3, 7, 8
Geoemydidae	*Cyclemys dentata*	Asian leaf turtle	-	VU	1, 2, 6, 7
Varanidae	*Varanus bitatawa*	Northern Sierra Madre forest monitor lizard	-	VU	1, 2, 6, 7
Varanidae	*Varanus olivaceus*	Gray's monitor lizard	VU	VU	1, 6, 7
Geoemydidae	*Cuora amboinensis*	Malayan box turtle	-	OTS	11, 7, 8
Trionychidae	*Pelochelys cantorii*	Asian giant softshell turtle	EN	OTS	11
Agamidae	*Bronchocela cristatella*	Green crested lizard	-	OTS	7
Agamidae	*Bronchocela marmorata marmorata*	Marbled crested lizard	-	OTS	7
Agamidae	*Gonocephalus interruptus*	Mindanao forest dragon	-	OTS	7

Table 4 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification*
Agamidae	*Gonocephalus semperi*	Dark-spotted forest dragon	-	OTS	7
Agamidae	*Gonocephalus sophiae*	White-spotted forest dragon; Negros forest dragon	-	OTS	7
Agamidae	*Hydrosaurus pustulatus*	Philippine sailfin lizard	OTS	OTS	7
Gekkonidae	*Gekko gecko*	Tokay gecko	-	OTS	7
Gekkonidae	*Pseudogekko smaragdinus*	Green smooth-scaled gecko	-	OTS	7
Gekkonidae	*Ptychozoon intermedium*	Philippine flying gecko	-	OTS	11, 7
Scincidae	*Tropidophorus grayi*	Spiny waterside skink	-	OTS	7
Varanidae	*Varanus bangonorum*	Bangon monitor lizard	-	OTS	11, 7, 5
Varanidae	*Varanus cumingi*	Cuming's monitor lizard	VU	OTS	11, 6, 7
Varanidae	*Varanus dalubhasa*	Enteng's monitor lizard	-	OTS	11, 7, 5
Varanidae	*Varanus marmoratus*	Luzon monitor lizard; marbled monitor lizard	VU	OTS	11, 7
Varanidae	*Varanus nuchalis*	West Visayas monitor lizard	VU	OTS	11, 7
Varanidae	*Varanus palawanensis*	Palawan monitor lizard	-	OTS	11, 7
Varanidae	*Varanus rasmusseni*	Jolo-Tawitawi monitor lizard	-	OTS	11, 2
Varanidae	*Varanus samarensis*	Samar monitor lizard	-	OTS	11, 7, 5
Pythonidae	*Malayopython reticulatus*	Reticulated python	OTS	OTS	11, 7
Colubridae	*Boiga angulata*	Philippine blunt-headed tree snake	-	OTS	11, 7
Colubridae	*Boiga cynodon*	Large blunt-headed tree snake	-	OTS	11, 7
Colubridae	*Boiga dendrophila*	-	-	OTS	7

Table 4 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification*
Colubridae	*Boiga philippina*	-	-	OTS	11, 7
Colubridae	*Coelognathus erythrura*	-	-	OTS	6, 13
Colubridae	*Gonyosoma oxycephalum*	Red-tailed green rat snake	-	OTS	6, 13
Colubridae	*Ptyas carinatus*	Keeled rat snake	-	OTS	6, 13
Colubridae	*Ptyas luzonensis*	Keel-sealed mountain rat snake	-	OTS	6, 13
Elapidae	*Naja philippinensis*	Philippine cobra	-	OTS	6, 13
Elapidae	*Naja samarensis*	Central Philippine cobra	-	OTS	6, 13
Elapidae	*Naja sumatrana*	Equatorial or Sumatran spitting cobra	-	OTS	6, 13
Elapidae	*Ophiophagus hannah*	King cobra	-	OTS	6, 13
Viperidae	*Trimeresurus flavomaculatus*	Philippine pitviper	-	OTS	11, 7, 8
Viperidae	*Trimeresurus schultzei*	Schultz's pitviper	-	OTS	11, 7, 8
Viperidae	*Tropidolaemus philippensis*	Philippine temple pitviper	-	OTS	11, 7, 8
Viperidae	*Tropidolaemus subannulatus*	Temple pitviper	-	OTS	11, 7, 8

***Justification**

1 Under threat due to habitat destruction
2 Limited geographic range
3 Restricted population
4 Small population size
5 Under threat from hunting
6 Over-utilized
7 Under threat from exotic animal trade
8 Used as traditional medicine
9 Threat from trade for commercial use and curio
10 Under threat from high level of trade in leather
11 Species with limited information
12 Limited information on population dynamics
13 Threat from other natural and man made factors
14 Possibly affected by habitat degradation
15 Reduction in population size

Of the *Varanus* species, the Panay forest monitor lizard (*Varanus mabitang*) retained its CR status, while the Northern Sierra Madre forest monitor lizard (*Varanus bitatawa*) and Gray's monitor lizard (*Varanus olivaceus*) are classified as VU due to restricted distributional range and the importance for monitoring illegal trade; *V. bitatawa* is a new addition to the list. All other monitor lizards were placed under the OTS category (3 downlisted from VU) as these species were found to adapt generally well in disturbed habitats; nonetheless, threats due to persecution, bush meat trade, and illegal pet trade still persist. The rough-necked monitor lizard (*Varanus rudicollis)* was listed in DAO 2004-15 but was removed from the proposed amended list because there is no evidence that the species occurs in the country. The Asian giant softshell turtle (*Pelochelys cantorii*) was downgraded to OTS because of insufficient data to justify the EN status. The complete list of reptile species and their categories based on DAO 2004-15, the proposed amendments to the DAO, and from IUCN can be found in Table 4.

Amphibians

The number of amphibians included in the proposed amendments to the threatened species list more than doubled from 15 to 32 species belonging to 7 families (Table 5). Five species retained their status. The Negros limestone frog (*Platymantis spelaeus*) was retained as EN while species such as McGregor's slender stream toad (*Ansonia mcgregori)*, Lawton's cloud frog (*Platymantis lawtoni)*, Negros horned tree frog (*Platymantis negrosensis*), Rabor's horned tree frog (*Platymantis rabori)*, and the Mindoro bush frog (*Philautus schmackeri*) were retained as VU. The Gigantes limestone frog (*Platymantis insulatus*) was proposed to be elevated to CR status because it has a very restricted home range that is also threatened by habitat destruction. The Philippine flat-headed frog (*Barbourula busuangensis)* was elevated to VU because of habitat disturbance from quarrying, conversion for housing and agriculture, and pollution.

The Polillo plaintive tree frog (*Platymantis polilloensis*), Hazel's cloud frog (*Platymantis hazelae*), and Cordilleras torrent frog (*Sanguirana igorota*) were delisted as they are more widespread than previously thought. Five other species were downgraded to a lower threat category: the Negros horned tree frog (*Platymantis negrosensis*) and Cordilleras cloud frog (*Platymantis subterrestris*) from EN to VU; and the Mindanao fanged frog (*Limnonectes magnus*), Basilan caecilian (*Ichthyophis glandulosus*), and Mindanao caecilian (*Ichthyophis mindanaoensis*) from VU to OTS. These species have limited geographical range but with little information to support enlisting in a higher threat category. Majority of the species in the threatened amphibian list are threatened with habitat destruction within their limited geographical range. Table 5 shows the full list of the proposed status per amphibian species.

Table 5 List of Philippine threatened amphibian species and their status in the proposed amendments to DAO 2004-15

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification*
Ceratrobatrachidae	*Platymantis insulatus*	Gigantes limestone frog	VU	CR	1, 4
Ceratrobatrachidae	*Platymantis spelaeus*	Negros limestone frog	EN	EN	2, 4
Bombinatoridae	*Barbourula busuangensis*	Philippine flat-headed Frog	OWS	VU	3, 4
Bufonidae	*Ansonia mcgregori*	McGregor's slender stream toad	VU	VU	3, 4
Ceratrobatrachidae	*Platymantis banahao*	Banahao horned tree frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis bayani*	Walter's limestone frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis biak*	Biak-na-bato limestone frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis indeprensus*	Banahao cliff frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis isarog*	Bicol cloud frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis lawtoni*	Lawton's cloud frog	VU	VU	3, 4
Ceratrobatrachidae	*Platymantis levigatus*	Romblon streambank	-	VU	3, 4
Ceratrobatrachidae	*Platymantis montanus*	Banahao cloud frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis naomiae*	Naomi's montane wrinkled ground frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis negrosensis*	Negros horned tree frog	EN	VU	3, 4
Ceratrobatrachidae	*Platymantis panayensis*	Panay cloud frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis pseudodorsalis*	Banahao streambank frog	-	VU	3, 4
Ceratrobatrachidae	*Platymantis rabori*	Rabor's horned tree frog	VU	VU	3, 4
Ceratrobatrachidae	*Platymantis subterrestris*	Cordilleras cloud frog	EN	VU	3, 4
Dicroglossidae	*Limnonectes diuatus*	White-spined fanged frog	-	VU	3, 4

Table 5 Continuation

Family	Scientific name	Common name	DAO 2004-15	Proposed status	Justification*
Dicroglossidae	*Limnonectes visayanus*	Visayan fanged frog	-	VU	3, 4
Rhacophoridae	*Philautus schmackeri*	Mindoro bush frog	-VU	VU	3, 4
Rhacophoridae	*Philautus surrufus*	Rufous bush frog	-	VU	3, 4
Rhacophoridae	*Philautus worcesteri*	Worcester's bush frog	-	VU	3, 4
Dicroglossidae	*Limnonectes acanthi*	Palawan fanged frog	-	OTS	5, 8
Dicroglossidae	*Limnonectes macrocephalus*	Luzon fanged frog	-	OTS	4, 6, 8
Dicroglossidae	*Limnonectes magnus*	Mindanao fanged frog	VU	OTS	4, 6, 8
Megophryidae	*Leptobrachium mangyanorum*	Mindoro litter frog	-	OTS	3, 4, 8
Megophryidae	*Megophrys ligayae*	Palawan horned frog	-	OTS	7, 8
Megophryidae	*Megophrys stejnegeri*	Mindanao horned frog	-	OTS	7, 8
Ichthyophiidae	*Ichthyophis glandulosus*	Basilan caecilian	VU	OTS	3, 8
Ichthyophiidae	*Ichthyophis mindanaoensis*	Mindanao caecilian	VU	OTS	3, 8
Ichthyophiidae	*Ichthyophis weberi*	Palawan caecilian	-	OTS	3, 8

***Justification for the proposed status**

1 - Restricted within an extremely limited geographic range
2 - Restricted within a very limited geographic range
3 - Restricted within a limited geographic range
4 - Under threat due to habitat destruction
5 - Used as food for local subsistence
6 - Overutilized
7 - Under threat from exotic animal trade
8 - Species with limited information
9 - Information is needed

Invertebrates

The subcommittee assessed 784 species of arachnids, insects, and gastropods, with class Insecta comprising majority of the orders assessed: Blattodea (cockroaches), Coleoptera (beetles), Hemiptera (true bugs), Hymneptora (wasps), Lepideptora (butterflies and moths), Odonata (dragonflies and damselflies), and Phasmatodea (leaf insects and stick insects). Three families under the order Araneae (spiders) were assessed, while for the Gastropods (land snails), 2 families from the order Stylommatophora were reviewed (Table 6).

Table 6 Summary of invertebrate species assessed and their proposed threat categories

Class	Order	Family	Species assessed	Threatened species			
				CR	EN	VU	OTS
Arachnida	Araneae	Araneidae	13	-	-	-	13
		Dipluridae	2	-	-	-	2
		Theraphosidae	9	-	-	-	9
Insecta	Blattodea	Blaberidae	30	-	-	3	27
		Blattidae	11	-	-	2	9
		Ectobiidae	10	-	-	-	10
		Nocticolidae	2	-	2	-	-
		Polyphagidae	4	-	-	-	4
	Coleoptera	Buprestidae	11	-	-	5	6
		Carabidae	12	-	-	-	12
		Cerambycidae	109	-	-	1	108
		Curculionidae	226	-	-	226	-
		Lucanidae	19	-	-	7	12
		Scarabaeidae	32	-	-	-	32
	Hemiptera	Cercopidae	37	-	-	-	37
		Cicadidae	1	-	-	1	-
		Gerridae	2	-	1	1	-
		Helotrephidae	3	-	-	3	-
		Cercopidae	37	-	-	-	37

Table 6 Continuation

Class	Order	Family	Species assessed	Threatened species			
				CR	EN	VU	OTS
	Hemiptera	Hermatobatidae	1	-	-	1	-
		Margarodidae	1	-	-	-	1
		Nepidae	1	-	-	1	-
		Ochteridae	3	-	-	3	-
		Pseudococcidae	2	-	-	1	1
		Saldidae	2	-	-	2	-
	Hymenoptera	Sphecidae	6	-	-	4	2
	Lepidoptera	Erebidae	3	-	-	-	3
		Geometridae	2	-	-	2	-
		Lycaenidae	10	1	1	7	1
		Nymphalidae	10	4	-	6	-
		Papilionidae	6	4	-	2	-
		Saturniidae	2	-	-	1	1
	Odonata	Aeshnidae	1	-	-	1	-
		Amphipterygidae	1	-	-	1	-
		Argiolestidae	2	-	-	2	-
		Chlorocyphidae	3	-	1	2	-
		Coenagrionidae	3	-	-	3	-
		Corduliidae	1	-	-	1	-
		Euphaeidae	1	-	-	1	-
		Platycnemididae	5	1	-	4	-
		Platystictidae	11	1	1	9	-
	Phasmatodea	Aschiphasmatidae	5	-	-	-	5
		Diapheromeridae	46	-	-	1	45
		Heteropterygidae	46	-	-	-	46
		Phasmatidae	54	-	-	1	53
		Phylliidae	11	-	-	11	
		Prisopodidae	2	-	-	-	2
Gastropoda	Stylommatophora	Bradybaenidae	7	1	-	3	3
		Helicarionidae	3	1	-	2	-
		Total	**784**	**13**	**6**	**321**	**444**

Of the 784 species, 13 (1.7%) are CR, 6 (0.8%) are EN, 321 (40.9%) are VU, and 444 (56.6%) are OTS. The family Lepidoptera had the highest rate of species recommended under the CR (69.2%) and EN (6.7%) categories. The order Coleoptera has a high VU category rate owing to the listing of 226 species from the family Curculionidae.

Overharvesting is one of the most commonly cited threats to invertebrate species. Several taxa belonging to Phasmatodea, Coleoptera, and Heminoptera were prone to poaching and illegal trade, often for personal collections. Arachnids are poached for pet trade (Dipluridae, Theraphosidae) and spider wrestling (Araneidae) while Lepidoptera species appear heavily in international trade. The taxa also has a high number of endemic species with unstable populations and its habitats are degraded and heavily polluted. While over 80% of species have limited information available or are known only from type specimens or collections, they have been documented in localities that are under severe human disturbance and habitat degradation (e.g. tourism, mining, land conversion). The Odonata species have limited range but are threatened by habitat conversion and deforestation, especially species that are forest obligate.

Endemic species in the proposed National List of Threatened Terrestrial Fauna

The number of endemic mammals, birds, reptiles, and amphibians listed as threatened (CR, EN, and VU) in the proposed amendments to the list increased to 168 as opposed to the 110 species under the DAO 2004-15 list. Endemic species categorized as OTS increased considerably from 7 to 79 (Table 7).

The proportion of Philippine endemic species listed remained relatively unchanged across the 4 Philippine vertebrate groups represented. All threatened amphibians, half of the threatened reptilian species, nearly three-fourths of threatened birds, and about 80% of the threatened mammals listed were all endemic. Almost all invertebrates listed were endemic to the Philippines. Out of the 784 invertebrate species evaluated, only 60 are so far known to occur outside the Philippines. Majority of the invertebrate groups are poorly studied and most species are presently known only from their type localities.

Conclusion

National red lists are very influential tools in the protection and conservation of threatened species, especially among national organizations (Miller et al. 2007). These lists become more relevant because conservation policies are implemented more at national and subnational levels (Rodriguez 2008) and priorities are set

Table 7 Comparison of the number of threatened *endemic* species in the DAO 2004-15 and in the proposed amendments to the DAO

Version	Category	Mammals	Birds	Reptiles	Amphibians	Total
DAO 2004-15	CR	6	11	4	0	21
	EN	5	10	6	3	24
	VU	14	38	3	10	65
	OTS	3	1	3	0	7
Total		**28**	**60**	**16**	**13**	**117**
Proposed list	CR	7	25	3	1	36
	EN	8	28	1	1	38
	VU	12	59	2	21	94
	OTS	22	23	25	9	79
Total		**49**	**135**	**31**	**32**	**247**

differently in different countries involving political and logistical considerations (Gärdenfors 2001). If carefully assessed, with objectives clearly laid, a national red list will allow the host country to safeguard its own resources and provide apt conservation planning based on local needs.

However, while national red lists can provide important documents on biodiversity loss (Zamin et al. 2010), they should not be used as an inference to changes in biodiversity. Movements in red lists may be the result of improved knowledge, refinements in taxonomy, and improvement in observation and survey techniques (Quayle and Ramsay 2005). As in the case of the proposed updated Philippine Red List of Threatened Terrestrial Fauna, several factors influence the increase in species listed under the threatened categories, particularly VU and OTS, apart from declining biodiversity conditions. First, the number of species assessed in this evaluation period was greater than in 2004. Where previously underrepresented, the proposed list thoroughly assessed amphibians and reptiles, and more notably, included terrestrial invertebrates among the taxonomic groups evaluated.

Secondly, field research and studies have led to discoveries of new species and taxonomic splits, which have increased the number of species. For example, the assessment for the DAO 2004-15 list came before the discovery of the Calayan Rail (*Gallirallus calayanensis*). Subsequent studies have demonstrated the impacts of habitat loss and hunting to the rail that already has a restricted range and patchy distribution which warranted an EN status. In addition, field expeditions led to discoveries of at least 28 non-volant mammals (Heaney et al. 2016), 20 of which were proposed to be listed – two as VU and 18 under OTS. Further, morphological and molecular studies of the water monitor (*Varanus salvator*) complex has yielded 4 new species: *V. rasmusseni, V. palawanensis, V. dalubhasa*, and *V. bangonorum* (Koch et al. 2010; Welton et al. 2014) which were included and classified as OTS in this list.

Thirdly, a wider pool of biodiversity researchers and conservationists were involved in crafting the updated list of threatened species. These resource persons provided on-the-ground information on species and habitats where published information is lacking. The BCSP's TWG yielded better information sharing and communication among researchers and field practitioners working on the same taxonomic group.

The proposed list will be useful for policy makers and implementers to afford stricter enforcement of rules, including the trade of wildlife and introduction of exotic species. Meanwhile, the updated list should also be an opportunity to boost long-term biodiversity research in the Philippines to produce clear baselines and monitoring data that will clearly establish the status of and trends in the country's biodiversity. This can also assist in increasing knowledge on the patterns of biodiversity loss both locally and globally, and in providing information about what is happening to species in different parts of its range (Zamin et al. 2010). Especially for species falling under the OTS, such as data deficient species or newly discovered species, wide assessment across taxa should be encouraged to identify data gaps for species or taxonomic groups to avoid biases towards commonly surveyed and charismatic species. Existing information is available for megafauna (Baillie et al. 2008) but both red lists and scientific efforts should be expanded to lower and lesser-known taxonomic groups such as invertebrates (Martin-Lopez et al. 2011; Walsh et al. 2012). The assessment highlighted species—especially from the invertebrate, reptile, and amphibian groups—that have limited information that would benefit from further taxonomic and ecological studies. More than 80% of the 784 invertebrate species assessed were data deficient and known only from type localities and collection specimen. Similarly, 44% of reptiles and 28% of amphibians listed have limited information, but were are nonetheless threatened by trade or habitat degradation.

Data management and knowledge sharing through a database and a web-based platform that contains baseline information on species, new knowledge, and comprehensive species information and assessment can be utilized to show more accurate biodiversity trends. The Clearing-House Mechanism (CHM), established by CBD to facilitate information sharing (Laihonen et al. 2004), is an internet portal that can be expanded by the BMB. An example is Malaysia's Biodiversity Clearing House Mechanism website (http://chm-malaysia.org/) which contains an impressive catalogue of the country's flora and fauna (Napis et al. 2001). Balmford et al. (2005) further suggested the improvement on the use of local calibration and ground-truthing of remotely-sensed data, development of volunteer networks for data gathering, and exploration of ways in which locally collected data translate into higher analysis as some of the routes towards reaching the intended goal of the CBD.

The proposed updated National List of Threatened Terrestrial Fauna is a product of a collaborative undertaking among various experts and practitioners from various sectors in the Philippines' biodiversity and conservation fields. It is envisioned that, through the PRLC and with continued inputs from the TWGs, the list is updated periodically as stipulated in the Wildlife Act.

The updated list can contribute to conservation planning and species management. As a policy instrument, it can serve its purpose in managing biodiversity by boosting funding and research in species and habitats that need attention, while curbing species decline by controlling the drivers of biodiversity loss. As a conservation tool, the list can contribute to planning of protected areas and critical habitats, priority setting for species conservation efforts, and biodiversity awareness among stakeholders and the general public.

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Literature cited

An act providing for the conservation and protection of wildlife resources and their habitats, appropriating funds therefore and for other Purposes, Republic Act 9147. 2001. Philippine laws and jurisprudence databank. [accessed 2018 February 13]. http://www.lawphil.net/statutes/repacts/ra2001/ra_9147_2001.html.

Baillie JEM, Collen B, Amin R, Akcakaya HR, Butchart SHM, Brummit N, Meagher TR, Ram M, Hilton-Taylor C, Mace GM. 2008. Toward monitoring global biodiversity. Conserv Lett. 1:18–26.

Balmford A, Crane P, Dobson A, Green RE, Mace GM. 2005. The 2010 challenge: data availability, information needs and extraterrestrial insights. Phil Trans R Soc B. 360:221–228.

BirdLife International. 2015. IUCN Red List for Birds. [Accessed 2015 September]. http://www.birdlife.org.

Brito D, Ambal RG, Brooks T, De Silva N, Foster M, Hao W, Hilton-Taylor C, Paglia A, Rodríguez JP, Rodríguez JV. 2010. How similar are national red lists and the IUCN red list? Biol Conserv. 143:1154–1158.

Butchart SHM, Akcakaya HR, Kennedy E, Hilton-Taylor C. 2006. Biodiversity indicators based on trends in conservation status: strengths of the IUCN Red List Index. Conserv Biol. 20(2):579–581.

De Chavez. 2018. Correspondence with author, February 2018.

Gärdenfors U. 2001. Classifying threatened species at national versus global levels. Trends Ecol Evol. 16(9):511–516.

Gill F, Donsker D (Eds.). 2016. International Ornithological Congress (IOC) world bird list v. 6.1. IOC, Washington, D.C. [Accessed January 2016]. www.worldbirdnames.org.

Gomez L, Sy EY. 2018. Illegal pangolin trade in the Philippines. TRAFFIC Bulletin 30(1): 37–40.

Groves CP. 2001. Taxonomy of wild pigs of Southeast Asia. Asian Wild Pig News. 1:2–3.

Grubb P. 2005. Artiodactyla. In: Wilson DE, Reeder DM, editors. Mammal Species World A Taxon Geogr Ref. 3rd ed. Baltimore: John Hopkins University Press; p. 637–722.

Heaney LR, Balete DS, Rickart EA. 2016. The mammals of Luzon island: biogeography and natural history of a Philippine fauna. Baltimore, Maryland (USA): Johns Hopkins University Press.

Hoffmann M, Brooks TM, da Fonseca GAB, Gascon C, Hawkins AFA, James RE, Langhammer P, Mittermeier RA, Pilgrim JD, Rodrigues ASL, Silva JMC. 2008. Conservation planning and the IUCN Red List. Endanger Species Res. 6:113–125.

[IUCN] International Union for the Conservation of Nature. 2015. The IUCN Red List of Threatened Species. Version 2015. [Accessed 2015 September]. www.iucnredlist.org.

Joint implementing rules and regulations pursuant to Republic Act No. 9147: an act providing for the conservation and protection of wildlife resources and their habitats, appropriating funds therefore and for other purposes (Joint DENR-DA-PCSD Administrative Order 01-2004). 2004. Philippine Clearing House Mechanism for Biodiversity. [accessed 13 February 2018]. http://www.chm.ph/index.php?option=com_docman&task=doc_details&gid=36&Itemid=74&el_mcal_month=7&el_mcal_year=2009.

Kennedy RS, Gonzales PC, Dickinson EC, Miranda HC Jr, Fisher TH. 2000. A guide to the birds of the Philippines. New York (USA): Oxford University Press.

Koch A, Gaulke M, Böhme W, 2010. Unravelling the underestimated diversity of Philippine water monitor lizards (Squamata: *Varanus salvator* complex), with the description of two new species and a new subspecies. Zootaxa. 2446:1–54.

Lagrada L, Schoppe S, Challender D. 2014. *Manis culionensis*. The IUCN Red List of Threatened Species 2014: e.T136497A45223365. [accessed 8 May 2018]. http://dx.doi.org/10.2305/IUCN.UK.2014-2.RLTS.T136497A45223365.en.

Laihonen P, Kalliola R, Salo J. 2004. The Biodiversity Information Clearing-House Mechanism (CHM) as a Global Effort. Environ Sci Policy. 7:99–108.

Lucchini V, Meijaard E, Diong CH, Groves CP, Randi E. 2005. New phylogenetic perspectives among species of Southeast Asian wild pig (Sus sp.) based on mtDNA sequences and morphometric data. J Zool. 266:25–35.

Martın-Lopez M, Gonzalez JA, Montes C. 2011. The pitfall-trap of species conservation priority setting. Biodiversity Conservation. 20:663–682.

Miller RM, Rodríguez JP, Aniskowicz-Fowler T, Bambaradeniya C, Boles R, Eaton MA, Gärdenfors U, Keller V, Molur S, Walker S, Pollock C. 2007. National threatened species listing based on IUCN criteria and regional guidelines: current status and future perspectives. Conserv Biol. 21:684–696.

Napis S, Salleh KM, Itam K, Latiff A. 2001. Biodiversity databases for Malaysian flora and fauna: an update. Proceedings of Internet Workshop 2001 (IWS2001), National Institute of Informatics, Tokyo, Japan; organized by Internet Research Committee of Institute of Electronics, Information and Communication Engineers, Japan and High Quality Internet Study Group of Information Processing Society of Japan; 21-23 February, 2001; Tokyo Japan.

Philippine Clearing House Mechanism for Biodiversity. 2009. [accessed 2018 February 13]. http://www.chm.ph.

Posa MRC, Diesmos AC, Sodhi NS, Brooks TM. 2008. Hope for threatened tropical biodiversity: lessons from the Philippines. BioScience. 58(3):231–240.

Quayle JF, Ramsay LR. 2005. Conservation status as a biodiversity trend indicator: recommendations from a decade of listing species at risk in British Columbia. Conserv Biol. 19(4):1306–1311.

Rodriguez JP. 2008. National Red Lists: The largest global market for IUCN Red List categories and criteria. Endangered Species Research, Preprint, 2008.

Sachs JD, Baillie JE, Sutherland WJ, Armsworth PR, Ash N, Beddington J, Blackburn TM, Collen, B, Gardiner B, Gaston KJ and Godfray HCJ. 2009. Biodiversity conservation and the millennium development goals. Science, 325(5947), pp.1502-1503

Szabo JK, Butchart SHM, Possingham HP, Garnett ST. 2012. Adapting global biodiversity indicators to the national scale: a Red List Index for Australian Birds. Biol Conserv. 148:61–68.

The 1987 Constitution of the Republic of the Philippines. 1987. Official Gazette [accessed 2013 January 14]. http://www.gov.ph/the-philippine-constitutions/the-1987-constitution-of-the-republic-of-the-philippines/.

Vié JC, Hilton-Taylor C, Stuart, SN. (eds.) 2009. Wildlife in a changing world—an analysis of the 2008 IUCN Red List of Threatened Species. Gland (Switzerland): IUCN. 180 pp.

Walsh JC, Watson JEM, Bottrill MC, Joseph LN, Possingham HP. 2012. Trends and biases in the listing and recovery planning for threatened species: an Australian case study. Oryx, 47(1):134–143.

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.

Zamin TJ, Baillie JEM, Miller RM, Rodriguez JP, Ardid A, Collen B. 2010. National Red listing beyond the 2010 target. Conserv Biol. 24(4):1012–1020. https://doi.org/10.1111/j.1523-1739.2010.01492.x

Annex 1 List of threatened Critically Endangered, Endangered, and Vulnerable invertebrate species and their status in the proposed amendments to DAO 2004-15

Family	Scientific name	Common name	Proposed status	Justification*	
Nocticolidae	*Nocticola caeca*	Antipolo blind cave cockroach	EN	3, 5, 12	Known only from original collection (1892); known only from and probably restricted to Cueva de Antipolo, Rizal
	Nocticola simoni	Simon's cave cockroach	EN	3, 5, 12	Known only from original collection (1890); known only from and probably restricted to Cueva de Talbac, San Mateo, Rizal
Blaberidae	*Opistoplatia beybienkoi*	Bey-bienko apterous cockroach	VU	5, 15, 17, 24	Known only from Coron, Busuanga, and Puerto Galera, Mindoro; Similar looking species are used in pet trade and Chinese medicine.
	Perisphaerus flavicornis	Yellow-banded pill cockroach	VU	5, 15, 13	Recorded only from Palawan but present also in nearby countries
	Perisphaerus glomeriformis	Black-head pill cockroach	VU	5, 15, 13	Recorded only from Catarman, Samar
Blattidae	*Homalosilpha ustulata*	Silphid cockroach	VU	9, 15, 17, 13	Similar looking species are used in pet trade.
	Periplaneta banksi	cockroach	VU	5, 15	Known only from caves in Polillo Island, Quezon and Samal Island, Davao
Buprestidae	*Chrysodema dalmanni*	Jewel beetles	VU	5, 13, 15, 16	
	Chrysodema eximia	Jewel beetles	VU	5, 13, 15, 16	
	Chrysodema jucunda	Jewel beetles	VU	5, 13, 15, 16	
	Chrysodema manillarum	Jewel beetles	VU	5, 13, 15, 16	
	Chrysodema smaragdula	Jewel beetles	VU	5, 13, 15, 16	

Family	Scientific name	Common name	Proposed status	Justification*
Cerambycidae	*Stenoleptura apoensis*	Longhorn beetles	VU	3, 5, 6, 15
	Metapocyrtus similis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus chrysomelas	Easter egg beetles	VU	3, 5, 6, 15
Curculionidae	*Eupachyrrhynchus superbus*	Easter egg beetles	VU	3, 5, 6, 15
	Homalocyrtus maculatus	Easter egg beetles	VU	3, 5, 6, 15
	Macrocyrtus contractus	Easter egg beetles	VU	3, 5, 6, 15
	Macrocyrtus erosus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus bifasciatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus bucasanus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus derasocobaltimus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus diffusisquamosus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus geniculatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus humeralis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus longipenis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus octomaculatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus pardalis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus quadriplagiatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus samarensis	Samar Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus sexmaculatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus subfasciatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus violaceous	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus chloromaculatus	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Metapocyrtus clemensi	Clemens' Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus frosti	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus lineaticollis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus mindanaoensis	Mindanao Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus negrosensis	Negros Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus ruficollis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus subdolosus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus ticaoensis	Ticao Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus trifaciatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus univerrucosus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus abbrevilineatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus acutipennis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus annulatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus batanensis	Batan Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus bifoveatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus brevicollis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus bukidnonensis	Bukidnon Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus caeruleomaculatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus camarinensis	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Metapocyrtus chlamydatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus congestus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus derasus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus difficilis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus elegans	Elegant Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus elongatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus erichsoni	Erichnsoni's Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus figuratus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus gibbirostris	Round-snout Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus gregarius	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus imitatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus impius	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus interruptolineatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus interruptostriatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus interruptus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus lepantoensis	Lepanto Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus limayensis	Limay Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus lindabonus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus lumutanus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus macgregori	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus magnigibbicollis	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Metapocyrtus mindorensis	Mindoro Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus monticola	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus multisquamosus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus niger	Black Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus panayensis	Panay Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus perpulcheroides	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus picipennis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus picticollis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus pilositibialis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus polilloensis	Polillo Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus politissimus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus politus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus proteus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus pseudomandarinus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus pseudomonilifer	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus reyesi	Reyes Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus rugicollis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus schicki	Schick's Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus sibuyanensis	Sibuyan Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus striatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus subdiffusus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus subfaciatus	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Metapocyrtus subvirgatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus sumptuosus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus tenuipes	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus virgatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus visayaensis	Visayan Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus whiteheadi	Whitehead's Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus worcesteri	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus bifoveatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus boholensis	Bohol Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus consobrinus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus helleri	Heller's Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus ilocanus	Ilocano Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus insulanus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus lanusinus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus monstrosus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus moorei	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus ornatus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus ostentator	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus propolitus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus quadrilifer	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus schoenherri	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus subquadrilifer	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Metapocyrtus triangularis	Triangle Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus tumoridorsum	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus virens	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus asper	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus celestinoi	Celestino's Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus laevicollis	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus metallicus	Metallic Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus transversarius	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus acutispinosus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus apoensis	Apo Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus banahaoensis	Banahaw Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus confusus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus joloensis	Jolo Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus profanes	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus pseudoviridans	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus rostrogibbous	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus smaragdinus	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus socius	Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus tawiensis	Tawi-tawi Easter egg beetles	VU	3, 5, 6, 15
	Metapocyrtus vestitus	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Metapocyrtus viridans	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus absurdus	Absurd Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus amabilis	Friendly Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus anellifer	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus apicatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus apocyrtoides	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus apoensis	Apo pachyrhynchid	VU	3, 5, 6, 15
	Pachyrrhynchus ardentius	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus argus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus atrocyaneus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus baluganus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus basilanus	Basilan Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus bengetanus	Benguet Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus bucasanus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus caeruleovittatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus chamissoi	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus chlorites	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus circulatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus congestus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus consobrinus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus corpulentus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus croesus	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Pachyrrhynchus cumingi	Cuming's Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus davaoensis	Davao Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus decussatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus dohrni	Dohrn's Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus dubiosus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus elegans	Elegant pachyrhynchid	VU	3, 5, 6, 15
	Pachyrrhynchus eos	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus eques	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus erichsoni	Erichson's Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus erosus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus forsteni	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus galerensis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus gemmatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus gloriosus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus halconensis	Halcon Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus helleri	Heller's pachyrhynchid	VU	3, 5, 6, 15
	Pachyrrhynchus hirokii	Hiroki's Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus igorota	Igorot Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus inclytus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus infernalis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus jugifer	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus lacunosus	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Pachyrrhynchus latifasciatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus libucanus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus loheri	Loher's Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus lorquini	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus lubanganus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus moniliferus	Cacao weevil	VU	3, 5, 6, 15
	Pachyrrhynchus morio	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus multipunctatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus naokii	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus negrosensis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus nobilis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus nobiliyamianus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus ochroplagiatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus orbifer	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus pelpulcher	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus phaleratus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus pinorum	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus postpubescens	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus pseudomabilis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus pseudoproteus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus psittacinus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus pulchellus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus regius	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus reticulatus	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*
	Pachyrrhynchus rizali	Rizal's Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus roseomaculatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus rufopunctatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus rugicollis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus samarensis	Samar pachyrhynchid	VU	3, 5, 6, 15
	Pachyrrhynchus sanchezi	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus sarcitis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus scheonherri	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus schuetzei	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus semiignitus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus semperi	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus signaticollis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus signatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus smaragdinus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus sonani	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus speciosus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus sphaericollaris	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus sphenomorphoides	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus stello	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus striatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus subamabilis	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus sulphureomaculatus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus sumptuosus	Easter egg beetles	VU	3, 5, 6, 15
	Pachyrrhynchus tadaochii	Easter egg beetles	VU	3, 5, 6, 15

Family	Scientific name	Common name	Proposed status	Justification*	
	Pachyrrhynchus taylori	Easter egg beetles	VU	3, 5, 6, 15	
	Pachyrrhynchus tilikensis	Easter egg beetles	VU	3, 5, 6, 15	
	Pachyrrhynchus tobafolius	Easter egg beetles	VU	3, 5, 6, 15	
	Pachyrrhynchus tristis	Easter egg beetles	VU	3, 5, 6, 15	
Papilionidae	*Chilasa carolinensis*	Mindanao swallowtail	CR	2, 5, 14, 15	Collected for international trade
	Pachyrrhynchus venustus	Easter egg beetles	VU	3, 5, 6, 15	
	Pachyrrhynchus viridans	Easter egg beetles	VU	3, 5, 6, 15	
	Pachyrrhynchus yamianus	Easter egg beetles	VU	3, 5, 6, 15	
	Pachyrrhynchus zamboanganus	Zamboanga Easter egg beetles	VU	3, 5, 6, 15	
	Pachyrrhynchus zebra	Zebra Easter egg beetles	VU	3, 5, 6, 15	
Lucanidae	*Dorcus parryi*	Stag beetles	VU	5, 13, 15, 17	
	Dorcus taurus	Stag beetles	VU	5, 13, 15, 17	
	Dorcus titanus	Stag beetles	VU	5, 13, 15, 17	
	Metallactulus parvulus	Stag beetles	VU	5, 13, 15, 17	
	Odontolabis alces	Stag beetles	VU	5, 13, 15, 17	
	Odontolabis intermedia	Stag beetles	VU	5, 13, 15, 17	
	Odontolabis latipennis	Stag beetles	VU	5, 13, 15, 17	
Cicadidae	*Psithyristria ridibunda*	Laughing cicada	VU	5, 6	
Gerridae	*Amemboa (s.str.) philippinensis*	-	EN	3, 5, 6	
	Aquarius philippinensis	-	VU	5, 6	

Family	Scientific name	Common name	Proposed status	Justification*	
Helotrephidae	*Hydrotrephes busuanganus*	Busuanga helotrephid backswimmer	VU	5, 6	
	Hydrotrephes minutus	Minute helotrephid back-swimmer	VU	5, 6	
	Hydrotrephes stereoides	-	VU	5, 6	Subspecies *H. s. montanus* is known only from extremely limited range and habitat
Hermatobatidae	*Hermatobates marchei*	-	VU	5, 6	
Nepidae	*Borborophyes mayri*	-	VU	5, 6	
Ochteridae	*Ochterus baltazarae*	Baltazar's ochterid	VU	5, 6	
	Ochterus magnificus	Magnificent ochterid	VU	5, 6	
	Ochterus magnus	Big ochterid	VU	5, 6	
Pseudococcidae	*Trionymus summus*	Apo summit grass root mealybug	VU	5, 6	Known only from roots of grasses growing in the peak area of Mount Apo (2950 masl); grass host not protected
Saldidae	*Chartoscirta mayona*	-	VU	5, 6	
	Orthosaldula rubroalata	-	VU	5, 6	
Sphecidae	*Chalybion magnum*	Great blue mud-dauber	VU	4, 10	
	Chalybion polyphemus	Polyphemus/Cyclops blue mud dauber	VU	4, 10	
	Sceliphron fervens	Fiery yellow and black mud dauber	VU	5, 4, 10	In the Philippines, this can only be found in Palawan.
	Sceliphron javanum	Handsome yellow and black mud dauber	VU	-	Last recorded in 1991 and recollected in 2016; with low progeny (3–5 cells) and only 34 museum specimens (UPLB-MNH)

Family	Scientific name	Common name	Proposed status	Justification*	
Geometridae	*Milionia coronifera*	Pine looper moth	VU	2, 5, 9, 6	
	Milionia philippinensis	Philippine day flying moth	VU	2, 5, 9, 6	
Lycaenidae	*Poritia solitaria*	Angat common gem	CR	2, 5, 8, 14	Only one record since 1988
	Arhopala tindongani	Tindongan's oakblue	EN	2, 5, 14, 7, 6	
	Arhopala luzonensis	Luzon oakblue	VU	2, 14, 7	
	Arhopala simoni	Tawitawi oakblue	VU	2, 14, 8	
	Dacalana halconensis	Halcon royal	VU	2, 5, 14, 7, 6	
	Deramas mindanensis	Mindanao bluejohn	VU	2, 14, 8	
	Deramas sumikat	Negros bluejohn	VU	2, 14, 8	
	Miletus takanamii	Takanami's brownie	VU	2, 14, 8	
	Una philippensis	Philippine una	VU	2, 14, 5, 7	
Nymphalidae	*Helcyra miyazakii*	Miyazaki's nymphalid	CR	2, 5, 14, 7, 6	Last recorded in 1984
	Tanaecia dodong	Masbate brush-footed butterfly	CR	2, 5, 14, 8, 6	
	Tanaecia lupina	Jolo brush-footed butterfly	CR	2, 5, 14, 8, 6	
	Tanaecia susoni	Cebu brush-footed butterfly	CR	2, 5, 14, 8, 6	
	Charaxes sangana	Sanga emperor	VU	2, 14, 8	
	Elymnias luteofasciata	Mindanao palmfly	VU	2, 7, 14	
	Euthalia mindanaensis	Mindanao baron butterfly	VU	2, 14, 8	
	Parantica davidi	David's tiger	VU	2, 5, 7, 14, 15	There is demand in international trade.
	Parantica noeli	Noel's tiger	VU	2, 5, 8, 14, 15	There is demand in international trade.

Family	Scientific name	Common name	Proposed status	Justification*	
	Terinos romeo	Romeo's assyrian	VU	2, 14, 8	
	Chilasa osmana	Leyte swallowtail	CR	2, 5, 14, 15	Collected for international trade
	Menelaides luzviae	Marinduque swallowtail	CR	2, 5, 14, 15	Collected for international trade
	Pathysa euphratoides	Mindanao swordtail	CR	2, 5, 14, 8, 6	
	Achillides chikae	Luzon peacock swallowtail	VU	2, 5, 15	High demand in international trade
	Pachliopta strandi	Philippine crimson rose	VU	2, 5, 14	
Saturniidae	*Actias philippinica*	Philippine moon moth	VU	2, 13, 15	High demand for trade
Aeshnidae	*Gynacantha constricta*	Constricted darner	VU	11, 5, 20	Known from Laguna
Amphipterygi-dae	*Devadatta basilanensis*	Basilan damselfly	VU	5	
Argiolestidae	*Luzonargiolestes realensis*	Real Quezon damselfly	VU	11, 4, 5, 13, 21	Known only from type locality (National Botanical Garden)
	Luzonargiolestes baltazarae	Baltazar's damselfly	VU	11, 5, 13, 21	
Chlorocyphidae	*Rhinocypha hageni*	Hagen's damselfly	EN	11, 4, 5, 13, 21	
	Rhinocypha dorsosanguinea	Red-backed damselfly	VU	11, 5, 13, 18, 21, 23	Known only from Basilan; also with unconfirmed record in Mindanao
	Rhinocypha latimacula	Bongo damselfly	VU	11, 4, 5, 13, 21	Known only from Tawi-tawi and Bongao Island
Coenagrionidae	*Luzonobasis glauca*	Damselfly	VU	5, 13, 21	Known only from northern and Central Luzon
	Pandanobasis cantuga	Damselfly	VU	5	
	Pandanobasis daku	Damselfly	VU	5, 13, 21	Known only from Leyte

Family	Scientific name	Common name	Proposed status	Justification*	
Corduliidae	*Hemicordulia apoensis*	Emerald dragonfly	VU	11, 5, 13, 18	Known only from Mount Apo
Euphaeidae	*Heterophaea barbata*	Damselfly	VU	11, 5, 13, 21, 18	Known from northern and Central Luzon
Platycnemididae	*Risiocnemis seidenschwarzi*	Damselfly	CR	1	
	Coeliccia exoleta	Damselfly	VU	5, 13, 22, 18	Known from Mindanao and Camiguin
	Risiocnemis antoniae	Antonia's damselfly	VU	11, 5, 13, 21, 18, 19	Known from eastern Mindanao
	Risiocnemis odobeni	Odoben's damselfly	VU	5, 13, 21	Known only from Bicol Peninsula
	Risiocnemis pulchra	Damselfly	VU	11, 4, 5, 13, 20	Known only from Bataan
Platystictidae	*Protosticta plicata*	Damselfly	CR	11, 5, 13, 18, 21, 23	Known only from Kawasan Falls
	Sulcosticta striata	Damselfly	EN	11, 5, 13, 21, 18	Known from northern Luzon
	Drepanosticta acuta	Damselfly	VU	5, 13, 21	Known only from Camarines Sur
	Drepanosticta aries	Damselfly	VU	5, 13, 21	Known only from Mount Apo, Lake Sebu
	Drepanosticta aurita	Damselfly	VU	5, 13, 21	Known only from Mindoro; Lubang Island
	Drepanosticta centrosaurus	Damselfly	VU	11, 5, 21, 19	Known only from Surigao del Sur and Davao Oriental
	Drepanosticta ceratophora	Damselfly	VU	11, 5, 22	Known from Palawan mainland and Balabac Island
	Drepanosticta furcata	Damselfly	VU	5, 13, 21	Known only from Siquijor

Family	Scientific name	Common name	Proposed status	Justification*	
	Drepanosticta myzouris	Damselfly	VU	5, 13, 21	Known only from Mount Isarog
	Drepanosticta quadricornu	Damselfly	VU	5, 13, 21	Known only from Palawan and Busuanga
	Drepanosticta rhamphis	Damselfly	VU	5, 13, 21	Known only from Catanduanes
Phasmatidae	*Mithrenes asperulus*	Stick insect	VU	9, 15, 13	
Phylliidae	*Microphyllium pusillulum*	Leaf insect	VU	5, 6	Known only from Luzon, Nueva Vizcaya
	Microphyllium spinithorax	Leaf insect	VU	5, 15, 6	Known only from Luzon, St. Thomas
	Phyllium bilobatum	Leaf insect	VU	9, 15, 13	
	Phyllium bonifacioi	Bonifacio's leaf insect	VU	5, 15, 6	Known only from northern Luzon
	Phyllium ericoriai	Leaf insect	VU	2, 15, 6	Endemic to Luzon
	Phyllium gantungense	Leaf insect	VU	2, 15, 5, 6	Endemic to Palawan
	Phyllium geryon	Leaf insect	VU	5, 6,	
	Phyllium mabantai	Leaf insect	VU	5, 15, 6	Known from Mindanao, Mount Apo, Agco, 2008
	Phyllium mindorense	Leaf insect	VU	5, 15, 6	Known from Mindoro Island, Mount Halcon, 1996
	Phyllium palawanense	Leaf insect	VU	5, 15, 6	Known from Palawan
	Phyllium woodi	Leaf insect	VU	5, 15	Known from Sibuyan and Dapitan, Mindanao
Diapheromeridae	*Conlephasma enigma*	Enigmatic stick insect	VU	5, 15, 6	Known only from Mindoro, Mount Halcon, 2006; phylogenetic position *incertae sedis* within order of Phasmatodea

Family	Scientific name	Common name	Proposed status	Justification*
Bradybaenidae	*Helicostyla smargadina*	Tree snail	CR	1
	Helicostyla daphnis	Tree snail	VU	5, 15, 6
	Helicostyla portei	Tree snail	VU	5, 15, 6
	Mesanella monochroa palawanica	-	VU	5, 15
Helicarionidae	*Coneuplecta turrita*	-	CR	1
	Ryssota otaheitana	Helical snail	VU	15, 6
	Ryssota sagittifera batanica	Helical snail	VU	5, 15, 6

*Justification

1 Adopt IUCN Status
2 Endemic species
3 Known only from original collection
4 Known only from type series / type locality
5 Known only from extremely limited range and habitat; known from limited distribution
6 Known from localities that are under severe threat / with high human disturbance
7 Occurs within priority areas of conservation
8 Occurs outside priority conservation sites
9 No specific locality recorded
10 Not seen in museum collections and through active collection
11 Forest specialist
12 Strictly cave-dwelling
13 Data deficient
14 Population is unstable
15 Prone to poaching and illegal trade
16 Used as ornaments
17 Pet trade; pet game/animals
18 Habitat alteration; habitat conversion
19 Mining
20 Habitat degradation
21 Deforestation; illegal logging
22 Habitat fragmentation
23 Ecotourism
24 Used in Chinese medicine

Annex 2 List of meetings and workshops

	Date	Venue	Number of Attendees	
1st	08 April 2015	Biodiversity Management Bureau (BMB), Quezon City	PRLC only	Philippine Red List Committee Meeting
2nd	03 June 2015	BMB, Quezon City	PRLC only	Philippine Red List Committee Meeting
3rd	03 July 2015	BMB, Quezon City	PRLC and TWG 13 attendees	Philippine Red List Committee Meeting
4th	11 February 2016	BMB, Quezon City	PRLC and TWG 13 attendees	Philippine Red List Committee Meeting
5th	29 March 2016	BMB, Quezon City	PRLC and TWG 12 attendees	Philippine Red List Committee Meeting
6th	26 July 2016	BMB, Quezon City	PRLC and TWG 12 attendees	Philippine Red List Committee Meeting
7th	19 October 2016	ICON Hotel North Edsa, Quezon City	PRLC and TWG 20 attendees	Philippine Red List Committee Meeting
8th	30 May 2017	BMB, Quezon City	PRLC and TWG 11 attendees	Philippine Red List Committee Meeting
9th	22 August 2017	BMB, Quezon City	PRLC and TWG 13 attendees	Philippine Red List Committee Meeting
10th	13–14 December 2017	B Hotel, Quezon City	PRLC and TWG 16 attendees	Philippine Red List Committee Meeting
11th	1–2 February 2018	Cocoon Boutique Hotel, Quezon City	PRLC and TWG 22 attendees	Philippine Red List Committee Meeting
12th	24-25 May 2018	Sulo Hotel, Quezon City	PRCC and TWG 17 atendees	Philippine Red List Committee Meeting
Workshops:				
	18–19 April 2015	University of Eastern Philippines, Catarman, Northern Samar	30 participants	Philippine Threatened Species Assessment Workshop
	1–3 September 2015	Clark, Angeles, Pampanga	30 participants	Threatened Species TWG Assessment Workshop
	6–7 April 2016	Filipiniana Hotel, Calapan City, Oriental Mindoro	280 participants	Constituency Consultation / Workshop at the 25th Philippine Biodiversity Symposium
	2 November 2016	Los Baños, Laguna	TWG on Invertebrates only	Invertebrate TWG Meeting
	19 July 2017	Ateneo de Manila University, Quezon City	280 participants	Public Presentation at the 26th Philippine Biodiversity Symposium

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