Journal of Ecosystem Science and Eco-Governance (JESEG)

Vol. 6, No. 2 | December 2024
PRINT ISSN 2704 4394 | ONLINE ISSN 2782 8522
DOI: https://doi.org/10.54610/jeseg.v6i2.131

Diet analysis of Philippine Crocodile *Crocodylus mindorensis* (Schmidt 1935) in Paghungawan Marsh, Barangay Jaboy Pilar, Surigao del Norte, Philippines

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Received: September 9, 2024
Revised: October 28, 2024
Accepted: December 2, 2024
Available Online: December 12, 2024

Cite this article: Baltazar, C.J.N., Gamalinda, E.F., Galolo, A.R.V., Ombat, L.A., Baltazar, P.C., Magallanes, F.P., & Manalo, R.I. (2024). Diet analysis of Philippine Crocodile *Crocodylus mindorensis* (Schmidt 1935) in Paghungawan Marsh, Barangay Jaboy Pilar, Surigao del Norte, Philippines, *Journal of Ecosystem Science and Eco-Governance*, **6**(2):12-21.

A B S T R A C T

Siargao Islands in Surigao del Norte have not been part of the historical range of the Philippine Crocodile (*Crocodylus mindorensis*). However, 36 juvenile F2 progeny of this species were successfully introduced in Paghungawan Marsh in 2013, with a supplemental release of eight yearlings and 21 juvenile crocodiles in 2017. To supplement the current knowledge of this species' biology with essential information on its success in thriving Paghungawan Marsh since its introduction, a study on the diet analysis of this crocodile species was conducted in the area. Through stomach flushing of three *C. mindorensis* individuals captured in the study area, the stomach contents were collected and grouped into four categories: vertebrates (50%), invertebrates (33.33%), inorganic and organic materials (12%), and plant materials (5%). Diet of the three *C. mindorensis* individuals showed food items that vary from Cichliformes (40%), Architaenioglossa (11.67%), Chiroptera (10%), Coleoptera (5%), Decapoda (8.33%), and Hymenoptera (8.33%) which indicates that fishes are their dominant prey. These findings suggest that *C. mindorensis* is a generalist species and seemingly opportunistic. Their diet reflects habitat variability and the available prey items of the established stations. This study highlighted the adaptive capacities of *C. mindorensis* and suggests that if protected and with sufficient prey availability, the population of this endangered species will recover. More dietary composition studies should be done to understand better how this species participates in varied communities.

Keywords: *food items, stomach flushing, carnivorous predator, endemic crocodile*

1 Introduction

Two crocodilian species are found in the Philippines: the Estuarine Crocodile, *Crocodylus porosus*, and the Philippine Crocodile, *Crocodylus mindorensis*. Endemic to the Philippine Islands, *C. mindorensis* was historically distributed in the Visayan Islands and southern and central Luzon but has been locally extinct (Ross and Alcala 1983). Remnant populations are found in inland freshwater habitats in northeastern Luzon and central to southern Mindanao (Pontillas 2000, van Weerd 2010, and Pomares et al. 2008). These records indicate that the species exist in isolated populations on small islands with minimal habitats (Manalo 2008).

Historically, the Philippine crocodile has not been known to occur in the Siargao Islands, Surigao del Norte. In March 2013, 36 juvenile F2 progeny from the Pag-asa Farm semi-wild facility of J.K. Mercado & Sons Agricultural Enterprises Inc. (JKMSAEI) in Kapalong, Davao del Norte, were successfully introduced in Paghungawan Marsh in Siargao Islands initiated by the Philippine Government in partnership with the Non-Government Organization, Crocodylus Porosus Philippines Inc. (CPPI) (Manalo et al. 2013). This semi-wild facility was conceived as part of a tripartite crocodile conservation partnership among DENR, Siliman University, and JKMSAEI. The habitat suitability survey on the release site indicated that Paghungawan Marsh was ideal for Philippine crocodiles. Critical resources such as food and microhabitats are naturally available (Bucol et al. 2013). The release aims to repopulate the species in the wild, enhance the current knowledge of the species biology, and contribute to the island's tourism industry, making it a Community-based Sustainable Tourism (CBST) site featuring the natural and rich biodiversity of Paghungawan Marsh and Crocodile Night Watch as a significant attraction. After the release, monitoring showed a decrease in the number of crocodile sightings, primarily attributed to the natural dispersal movement of the crocodiles to areas inaccessible to humans and the presence of heavy infrastructure development, such as the upgrading of provincial roads, caused the juvenile crocodiles to move away to adjacent waterlogged areas. With this, the local government of Pilar requested a supplemental release of eight yearlings and 21 juvenile crocodiles in 2017 to enhance their community-based sustainable ecotourism and continuously increase the wild population in the southern Philippines (Manolis 2017).

Crocodiles are carnivorous predators that prey on small fishes, frogs, crustaceans, insects, and small aquatic invertebrates (Fergusson 2010). They are ambush hunters, waiting for fish or land animals to come close, then rushing out to attack (Gurjwar and Rao 2018). Nile crocodiles prey on waterfowl and kingfishers by snatching and consuming dead animals that would otherwise pollute the waters (Wallace and Leslie 2008). Crocodiles cannot masticate, and their inflexible tongues cannot assist swallowing. Instead, they rely on mechanical and chemical breakdown further along the digestive tract for food digestion (Avila-Cervantes et al. 2017). According to Gurjwar and Rao (2018), crocodiles have a very slow metabolism and can survive long periods without food. Despite their appearance of being slow, these cold-blooded predators are on top of their environment, and various species have been observed attacking and killing animals.

Based on the study conducted by Isberg (2007), crocodilians are carnivorous reptiles, and their diets consist mainly of proteins and fats. The fat composition in the crocodile's tail is essential because it is a source of energy during low food availability or hibernation periods. Therefore, the tail of a crocodile is adapted for fat storage and plays a vital role in providing energy for the crocodile during times of scarcity (Isberg 2007). The study of Luthada-Rawiswi et al. (2019) on Nile crocodiles revealed that fats are high-energy nutrients that can be utilized to partially spare protein, and fats supply about twice the energy of proteins and carbohydrates.

Studies have shown that the composition of crocodile diet changes distinctly through different life stages (Isberg 2007). As crocodiles grow, they develop strategies to hunt in deeper water (e.g., fish, turtles, and mud crabs) and along the shore (e.g., dingoes, wallabies, and birds). Previous dietary studies reported aquatic and terrestrial insects, arachnids, aquatic gastropods, crustaceans, fish, amphibians, reptiles, birds, and terrestrial mammals (Cedeño-Vazquez et al. 2014). The ontogenetic trends of the crocodilian diet are similar for the different species, although different to compare statistically because of seasons, size classes, and types of analyses (Wallace and Leslie 2008).

More information on the ecology, feeding behavior, and life history of *C. mindorensis* needs to be provided. Most of the early works, mainly on breeding factors and behavior in captivity, were gathered from captive populations at the Crocodile Farming Institute (CFI), which was later renamed to Palawan Wildlife Rescue and Conservation Center (PWRCC) (Ortega 1998), and at a small captive breeding center at Silliman University in Negros Island (Alcala et al. 1987). On the feeding biology of *C. mindorensis,* the only available data is the study of Brown et al. (2021), which reflected the dominance of snails in the food prey items, suggesting its association in rice paddies being their microhabitat. Hence, this study analyzed the stomach contents of

C. mindorensis in Paghungawan Marsh and determined the patterns of prey availability to know the foraging behavior and diet of the said species in the wild. With a better understanding of the feeding biology of *C. mindorensis*, conservation planners can identify more suitable release sites with suitable prey items.

2 Materials and Methods

Study site

The Paghungawan Marsh, covering an area of 18.5 ha, is in the north-central region on the island of Siargao. It is included in the Siargao and Bucas Grande group of islands that were formally gazette as part of the protected area under Presidential Proclamation No. 902 on 10 Oct 1996, under the Republic Act 7586, otherwise known as the National Integrated Protected Areas System (NIPAS) Act of 1992. Formed by a geological limestone depression, the Paghungawan Marsh – a freshwater marsh, lies within the jurisdictional boundaries of Barangay Jaboy in the Municipality of Pilar. The marsh is dominantly covered by typical swamp-associated species such as the cheesewood tree *Nauclea orientalis* (locally called "bangkal") and the herbaceous *Hypolytrum nemorum*. Mudfish, tilapia, and carp are fish species thriving in the area. This habitat maintains its resiliency to changing climate and is known to host diverse terrestrial species.

The sampling site has several natural limestone depressions and shallow caves. These limestone caves become partly submerged underwater during the wetter months. They also serve as the habitat for several fruit-eating bats, swiftlets, and other invertebrate species vital in maintaining ecological processes in the adjacent forest ecosystem. Figure 1 shows the stations where the three crocodiles were captured.

This study was granted with the gratuitous permit number R13-2021-08 issued by DENR Region XIII Butuan City. The study was also presented in the Protected Area Management Board (PAMB) with a resolution number 2021-90.

Crocodiles were captured during the dry season in June 2021 and April 2022. The locations where the traps were set were determined based on previous reports from the quarterly spotlight surveys conducted by CPPI. Baited snare traps were deployed overnight in three sampling stations (Table 1).

The snares were not used in the area for wildlife hunting but were only deployed solely for

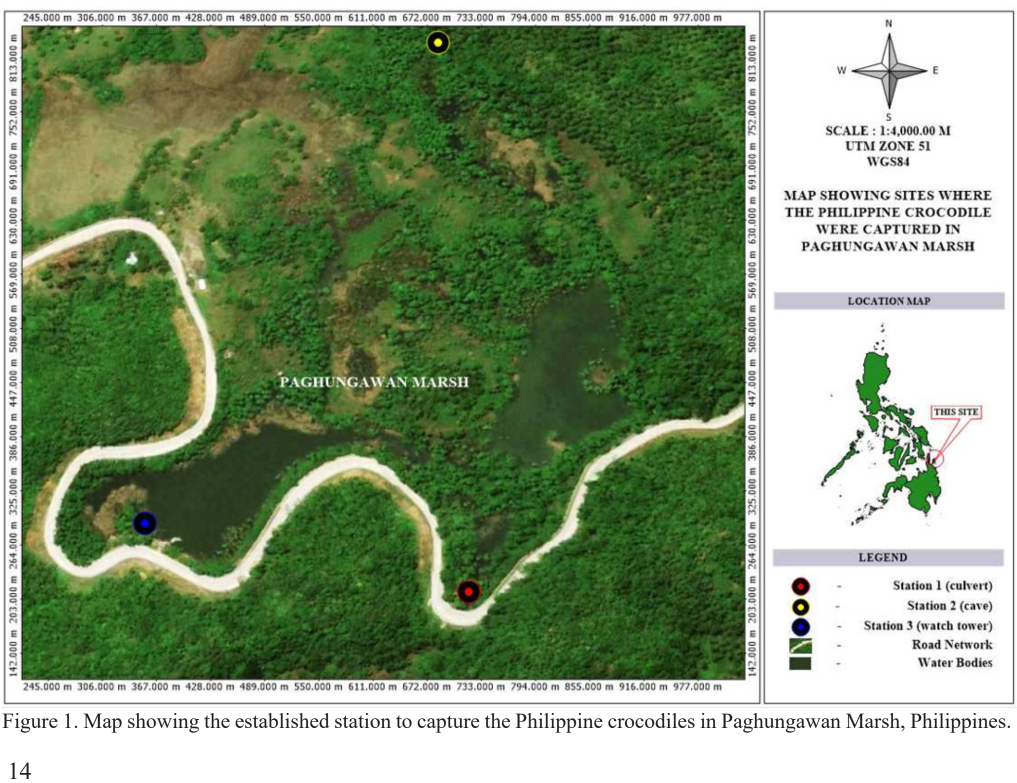

Figure 1. Map showing the established station to capture the Philippine crocodiles in Paghungawan Marsh, Philippines.

Table 1. The coordinates of the three sampling stations that were established overnight in Paghungawan Marsh, Philippines.

Stations	Coordinates	Description of Habitat
1	9°53’39.12”N; 126°4’51.6”E	near the access drainage culvert along the edge of marsh dominated with herbaceous plant Hypolytrum nemorum
2	9°53’52.8”N; 126°4’43.32”E	inside a slightly elevated limestone cave
3	9°53’39.12”N; 126°4’51.6”E	near the watch tower within the rock crevices

the study and removed upon sampling completion. Before collecting samples, physicochemical parameters were determined using Onset® HOBO® Data Loggers U-12 for temperature, humidity, and light intensity, together with Horiba Portable meter for pH and dissolved oxygen deployed in the three identified sampling stations.

Capture Method and Stomach Flushing

The three adult Philippine crocodiles that were captured using the baited funnel-type fence snare trap were securely immobilized to measure their SVL and determine sex through cloacal sexing. Stomach contents were obtained within a few hours from the time of capture by stomach flushing with brine solution using the “scoop and pump” method (Taylor et al. 1977) as modified by Webb et al. (1982) until further flushes consisting of water only. Stomach flushing is a non-destructive technique that is demonstrated to recover >95% of contents in crocodilian stomachs (Rice et al. 2005). In performing the procedure, it was made sure that no crocodile was harmed. The subject species was put aside to rest before releasing it carefully back into the wild. Likewise, it was ensured that there was minimum disturbance to the habitat and wildlife resources during the collection process.

Dietary analysis

Stomach samples were sorted and preserved using 70% denatured alcohol for transport to the Caraga State University (CSU) laboratory for further analysis. Each prey item was examined under a stereomicroscope to identify up to the lowest possible taxon. Food items were classified based on existing taxonomic guides (Brown et al. 2021), and the stomach contents were categorized into the following: invertebrate, vertebrate, plant materials, and organic and inorganic materials (Solania et al. 2019). To assess the importance of each prey item in the diet of the three crocodiles, the frequency of occurrence (FOO) was calculated, which is the number of times a category is present in one or more stomachs expressed as a percentage of the total number of stomachs contents (Torralba et al. 2022).

3 Results and Discussion

Prey Preferences of Philippine Crocodiles

Each crocodile captured in Paghungawan Marsh, Siargao Islands, was identified by a unique tail cut number and its sex and snout-to-vent length (SVL) in centimeters. The female had SVL measurements of 95 cm, and the two males had 105 cm and 110 cm, respectively. The stomach content of these three crocodiles was examined, revealing prey items that included fish, snails, ants, bees, wasps, beetles, crustaceans, and plant material, all of which were consistently present across individuals (Table 2). The two male crocodiles’ stomachs contained bats, gastroliths, and wood, suggesting a broader ingestion of materials possibly linked to dietary or digestive behaviors.

As observed, crocodiles 3/1/1 and 2/0/37 captured inside the cave have similar food intake with more diverse prey items compared to crocodile number 3/0/36, captured in Station 1. These findings indicate that crocodiles are opportunistic predators in the habitats they thrive in.

Categorization of food consumed by each individual

The stomach contents found in the three individuals of crocodiles captured in the sampling site were grouped according to their categories based on the previous studies of Torralba et al. (2022) and Solania et al. (2019). As shown in Figure 2, the contents were categorized as invertebrate, like beetles, snails, and crustaceans, and vertebrate prey, which includes its bones and other remnants of its body parts. Plant fragments such as leaves, fruits, and twigs were plant matter. Stones and wood debris were categorized as inorganic and organic materials. Intricate structures from both invertebrates and vertebrates, like shells, chitinous covering of crustaceans, fish scales, and bones, were frequently observed and

Table 2. The stomach contents retrieved from the three captured crocodiles in Paghungawan Marsh, Siargao Islands, Philippines.

Tail Cut Number	Sex	Snout-to-vent Length (SVL) in cm	Stomach Contents
3/0/36	Female	95	fish, snails, ants, bees, wasps, beetle, crustaceans, and plant material
3/1/1	Male	105	fish, snails, ants, bees, wasps, beetle, crustaceans, bats, gastroliths, wood and plant material
2/0/37	Male	110	fish, snails, ants, bees, wasps, beetle, crustaceans, bats, gastroliths, wood and plant material

Figure 2. Stomach contents retrieved from the captured crocodiles: (A) invertebrates; (B) vertebrates; (C) plant material; (D) organic and inorganic material.

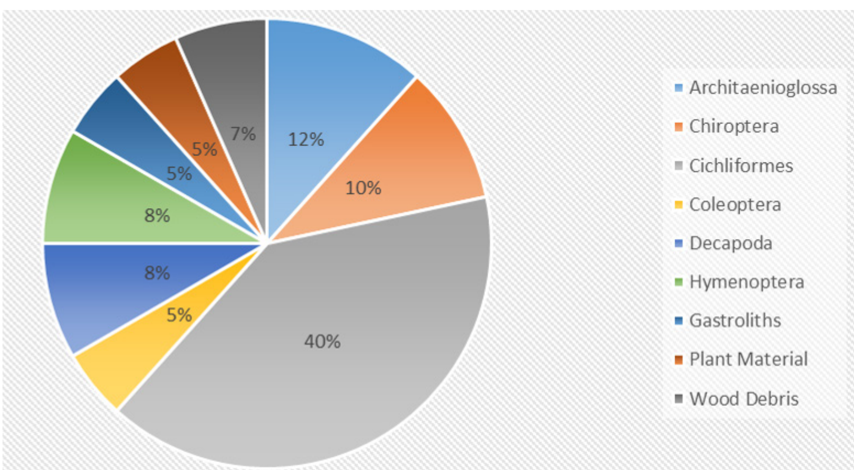

Figure 3. Comparison of percentage composition of each stomach content observed from all sampled individuals of *Crocodylus mindorensis.*

could be overrepresented due to slower digestion and gut retention in crocodiles (Platt et al. 2013).

Figure 3 shows the percentage composition of the different stomach contents in every individual of *C. mindorensis*. Of the stomach contents, Cichliformes had the highest percentage occurrence (Mean=40%) in the three crocodiles followed by Architaenioglossa (Mean=12%). The samples could only be identified up to the Order level and could not be classified to the lowest taxonomic rank.

Percentage of Diet Categories of C. mindorensis

Vertebrates were frequently found in the guts of the examined crocodiles, which comprised 50% of the gut content. *C. mindorensis* consumed food items varying from Chiroptera (FOO=10%) and Cichliformes (FOO=40%) followed by the invertebrates (33.33%) that consisted of Architaenioglossa (FOO=11.67%), Coleoptera (FOO=5%), Decapoda (FOO=8.33%), and Hymenoptera (FOO=8.33%). Inorganic and organic materials ranked third, comprising 12% of the total, while plant material was the least food group recorded (5%). Crocodiles are expected to be known as carnivorous predators (Fergusson 2010).

Environmental parameters were also obtained to discuss its potential effect on prey item availability. As observed in the different sampling plots, the average water temperature and light intensity were highest at Station 3, which is more exposed to the sun (near the watchtower), and lowest at Station 2 (near the cave). Humidity, pH, and dissolved oxygen were highest in Station 2 and lowest in Station 3. These parameters are inversely proportional to temperature.

According to Horne and Goldman (1994), as water temperature increases, the solubility of oxygen decreases, increasing water pollution and negatively affecting aquatic organisms. Low dissolved oxygen levels from increased water temperatures also affect the solubility and availability of essential nutrients. Healthy water should generally have dissolved oxygen concentrations above 6.5-8 mg/L. The occurrence of *C. mindorensis* in cliffs and caves is likely due to the decreasing water level and temperature change in the marsh. Crocodilians have a preferred body temperature of around 30-33℃, and to achieve such temperatures, they move back and forth between warm and remarkable parts of their environment. In cold weather, they bask in the sun to heat; in hot weather, they seek shaded, cool areas to avoid overheating (Webb 2014). During the dry season and the water level in the marsh is shallower, *C. mindorensis* was observed to hide in caves, grottos, and crevices within the secondary-growth karst forest on the eastern side of the marsh as seasonal shelter (Binaday et al. 2020).

Cedeño-Vazquez et al. (2014) reported that it is the first time they observed near the shore of a freshwater wetland in Rio Hondo that a bat is part of the diet of *C. moreletii*. Crocodiles 3/1/1 and 2/0/37 were captured inside the cave; bats represent 10% and 20% of their total stomach contents. Binaday et al. (2020) revealed that three sub-adult crocodiles were found in cliff crevices across a road bordering the marsh. Although several species of crocodiles are known to utilize crevices and caves, like Nile crocodiles (*C. niloticus*) (Fergusson 2010), Australian freshwater crocodiles (*C. johnstoni*) (Somaweera et al. 2014) and African dwarf crocodiles (*O. tetraspis*) (Shirley et al. 2017). According to Binaday et al. (2020), this is the first observation of *C. mindorensis* utilizing elevated limestone crevices and caverns on steep slopes, suggesting that more work is needed to understand its movement patterns and the duration of cave utilization. The findings of this study in Paghungawan Marsh indicate that Philippine crocodiles in the marsh may be exploiting the abundant fish population opportunistically compared to other prey types that are less available in the area.

Since crocodiles are carnivores, gastroliths (stones), wood, plant material, and seeds can be considered accidental ingestion during prey capture (Eaton and Barr 2005). However, Huchzermeyer (2003) mentioned that crocodilians are known to swallow stones as gastroliths, which help digest their prey. Most gastroliths, especially intentionally ingested stones, are generally restricted to the stomach, and the entire digestive tract of vertebrates can contain gastroliths (Wings 2007). Hardwood sticks and seeds could also serve as gastroliths (Eaton and Barr 2005).

Even though percent occurrence has proven to be an efficient method to examine prey items (Platt et al. 2013), digestion rates can produce biased stomach content data and have been shown to inflate the observation of hard chitinous remains due to longer digestion time (e.g., fish scales and bones, snail opercula, and hair) which emphasizes the need for a standardized method to quantify crocodile prey items, allowing for a better understanding of dietary dynamics and inter-individual diet variation.

Comprehensive dietary analyses in crocodiles are difficult to achieve mainly because of the need for methods to determine the lowest taxonomic level and the number of prey consumed with high certainty (Balaguera-Reina et al. 2018). In the study of Wallace and Leslie (2008) involving *C. niloticus*, fishes were found more frequently with increased crocodile size and constituted a higher percentage of the total dietary mass. There was no observed difference between the frequencies of stomach contents between the sexes. In the fishery assessment conducted by Manalo et al. (2015) in Paghungawan Marsh, six fish species were in the marsh. Of a total of 245 fishes sampled, 81% were Nile Tilapia (*Oreochromis niloticus*). The highest total catch (in one hour of fishing) was recorded in the release site in Paghungawan Marsh with a mean catch-per-unit effort (CPUE) of 9.44±7.62 kg/net/hour. The abundance of fish in the marsh could be attributed to its dominance in the observed prey samples.

As shown in Table 3, crocodiles prey on various species. These existing studies on diets subjected three different crocodilian species: 49 American crocodiles (*Crocodylus acutus*) in 10 months (Balaguera-Reina et al. 2018); 286 Nile crocodiles (*Crocodylus niloticus*) in two year-period (Wallace and Leslie 2008); and 30 Philippine crocodiles (*Crocodylus mindorensis*) in nine months (Brown et al. 2021). Considering that more crocodiles were sampled in the previous studies for a longer duration of their studies, they were able to discover a diverse selection of prey items. However, this study in Paghungawan Marsh examined only three crocodiles, revealing five prey groups from six different taxonomic Orders in their stomach contents. Because of the observed low abundance of other potential prey items of Philippine crocodiles in Paghungawan Marsh, such as wading birds, reptiles, and frogs, compared with the high abundance of fish in the marsh (Bucol et al. 2013), the captured individuals showed a dominance of fish in their food intake and less diverse prey items. The low occurrence of some food items could also indicate the low or non-availability of these prey items in certain stations (Balaguera-Reina et al. 2018).

Dietary differences among locations, sex, and size may be related to differences in foraging behavior and variation in prey species encountered in different habitat types (Platt and Brantly 1991). The variety of prey consumed by crocodiles and the transition from invertebrate to vertebrate foods with an increase in size was consistent with other studies. It showed that the composition of their diets changed distinctly through different life stages (Wallace and Leslie 2008, Balaguera-Reina et al. 2018, Platt et al. 2013, and Brown et al. 2021). Crocodiles are considered generalists with a broad spectrum of prey inhabiting all habitats (e.g., terrestrial, aquatic, and aerial) (Balaguera-Reina et al. 2018). There are several similarities in the food preference of the three species of crocodiles, only that Annelida was only

Table 3. Comparison of prey groups observed in the stomach contents of crocodiles based on existing diet studies on different species of crocodiles.

Prey group	***C. niloticus***	***C. acutus***	***C. mindorensis***	***C. mindorensis***
	Balaguera-Reina et al., 2018 (Central America)	**Wallace & Leslie, 2008 (Botswana)**	**Brown et al., 2021 (Philippines)**	**This study**
Amphibians	/	/	/	
Annelida	/			
Arachnids	/	/		
Birds	/		/	
Crustaceans	/	/	/	/
Fish	/	/	/	/
Insects	/	/	/	/
Mammals	/	/	/	/
Reptiles	/	/	/	
Snails			/	/

found in American crocodiles, and snails are only present in Philippine crocodiles, based on the existing dietary studies on crocodiles.

Cichliformes were the most frequently recovered prey, consistent with other crocodilians (Rice et al. 2005 and Wallace and Leslie 2008). Our data showed similarities in prey composition with the study of Brown et al. (2021) in the municipalities within Isabela Province on *C. mindorensis* diet. However, in their study, the dominant prey is a snail, greatly influenced by its study site, whose landscape is intensely dominated by agriculture, interspersed corn and rice fields in the foothills of the Sierra Madre, to networks of small creeks and canals running between agricultural plots with high presence of snails. Despite general expectations of crocodilian ontogenetic dietary trends, snails were prominent in their study's diet of *C. mindorensis*. Reliance on the invertebrate prey base has been previously hypothesized to result from their high abundance and diversity in the environment and net energetic value (Balaguera-Reina et al. 2018).

4 Conclusion and Recommendations

This study found that *C. mindorensis* is a generalist species, as reflected by their diet, the available prey items, and the habitat variability of the established stations. The dietary data showed that it has a varied and seemingly opportunistic diet, and though it is highly dependent on aquatic prey, it still hunts on land as well. It may have similarities with other crocodilians, but there is a local variation within the diet of the said species. This finding highlights the importance of using the context of predator population and prey abundance. Since the present study identified the prey items only up to the Order level, this emphasizes the need for a standardized method to quantify crocodiles' prey items accurately.

Owing to the limited sample size of *C.mindorensis*, it is necessary to allocate a longer sampling duration to capture more individuals of crocodiles to be subjected to stomach lavage, which could result in the observation of a wider variety of prey items. There is a need for additional field observations of foraging crocodiles to complement dietary studies based on the analysis of stomach contents. Further studies should be conducted for greater insight into the confounding factors potentially influencing its diet. This study highlights the adaptive capacities of crocodilians. It suggests that if protected from hunting and with sufficient prey availability, *C. mindorensis* can survive in heavily degraded habitats. Therefore, conservation efforts must be directed to maintain habitats in good conditions with minimum human intervention that allows the population of this endangered species to recover. Also, more studies that quantify dietary composition should be done to understand better how this species fits and participates in the varied communities in which it is found.

5 Acknowledgement

The authors would like to express their deepest gratitude to Crocodylus Porosus Philippines, Inc. for their professional and financial support involving fieldwork logistics, most especially to Mr. Jake Wilson Binaday for the critical review of the manuscript. We would also like to thank Department of Environment and Natural Resources Caraga Region, Regional Executive Dir. Nonito M. Tamayo and Hon. Mayor Maria Liza G. Resurreccion for facilitating research permit acquisition. Most importantly, we thank the numerous families in Barangay Jaboy, Pilar, Surigao del Norte for their exceptional support in the completion of the fieldworks.

Statement of Conflict of Interest

To ensure impartiality, EF Gamalinda, a member of the JESEG Editorial Board, was excluded from the review process of this article. The authors confirm that there are no conflicts of interest related to the publication of this paper.

Author Contribution

Conceptualization: CJ Baltazar, LA Ombat, ARV Galolo, EF Gamalinda, P Baltazar, and RI Manalo; *Data Collection:* CJ Baltazar, P Baltazar, RI Manalo, and F Magallanes; *Interpretation of Data:* CJ Baltazar; *Manuscript Writing and Revision:* CJ Baltazar, LA Ombat, ARV Galolo, EF Gamalinda, and RI Manalo.

6 Literature Cited

Alcala, A. C., Ross, C. A., & Alcala, E. L. (1987).

Observations and behaviour of captive Philippine crocodiles (*Crocodylus mindorensis* Schmidt). *Siliman Journal*, **34**:18-28

Avila-Cervantes, J., Charruau, P., Cedeño-Edeño-Vázquez R., Varela B.J, & Larsson H.C.E. (2017). *Crocodylus acutus* (American crocodile) diet. *Herpetological Review,* **48**(4): 839-840.

Balaguera-Reina, S.A., Venegas-Anaya, M., Beltrán-López, V., Cristancho, A., & Densmore III, L.D. (2018). Food habits and ontogenetic dietary partitioning of American crocodiles in a tropical Pacific Island in Central America. *Ecosphere*, **9**(9): e02393.

Binaday, J.W.B., Manalo, R.I., Baltazar, P.C., & Magallanes F.P. (2020). *Crocodylus mindorensis* (Philippine Crocodile): habitat use. *Herpetological Review*, **51**(2): 319-321.

Brown, J.C., Shirley, M.H., Yog-Yog, A., Van Weerd, M., Balbas, M.G., Tarun, B.A., & Siler, C.D. (2021). Use of diet and body condition assessments as intermediate indicators of translocation success in the Critically Endangered Philippine crocodile (*Crocodylus mindorensis*). *Aquatic Conservation: Marine and Freshwater Ecosystems*, **31**(10): 2817-2829.

Bucol, A.A., Aspilla, P.S., Dipaling, C.P., Manalo, R.I, Baltazar, P.C., Alcala, A.C., Mercado, V.P, Belo, W.T., & Chan, S.S. (2013). Status of the introduced Philippine crocodiles (*Crocodylus mindorensis*) in Paghongawan Marsh, Siargao Island, Philippines. *Crocodile Specialist Group Newsletter,* **32**(3): 20–22.

Cedeño-Vazquez, J.R., Gonzalez-Avila, F., Ramirez, R.M., Buenfil-Rojas, A.M. 2014. *Crocodylus moreletii* (Morelet's Crocodile) Diet. *Herpetological Review*, **45**(2): 322

Eaton, M.J., & Barr, B. (2005). Regional Africa report: Lac Tele, Rep. of Congo. *Crocodile Specialist Group Bull,* **24**: 18-20.

Fergusson, R.A. (2010). Nile crocodile *Crocodylus niloticus*. Crocodiles. Status Survey and Conservation Action Plan 3rd edn (eds Manolis SC, Stevenson C): 84-89.

Gurjwar, R.K., Rao, R.J. (2018). Assessment of Human-Crocodile Conflict. Lambert Academic Publishing. pp. 1-5

Horne, A.J., Goldman, C.R. (1994). Limnology 2nd ed. McGraw-Hill, Inc. pp. 576

Huchzermeyer, F.W. (2003). Crocodiles: biology, husbandry and diseases. CABI Publishing, Wallingford. pp. 352

Isberg, S.R. (2007). Nutrition of juvenile saltwater crocodiles (*Crocodylus porosus*) in commercial production systems. CABI Reviews: **11**.

Luthada-Rawiswi, R.L., Mukaratirwa, S., & O'Brien, G. (2019). Nutritional Value of the Nile Crocodile (*Crocodylus niloticus*) Meal for Aquaculture Feeds in South Africa. *Journal of Fisheries Sciences,* **13**(2): 020-025.

Manalo, R., Alcala, A., Mercado, V., & Belo, W. (2013). Conservation Introduction of the Philippine crocodile in Paghungawan Marsh, Siargao Island Protected Landscape and Seascape (SIPLAS), Surigao Del Norte, Philippines. Global Re-Introduction Perspectives. Case-studies from around the globe: **51**.

Manalo, R. (2008). Occurrence of *Crocodylus mindorensis* in the Cordillera Central. Abra Province, Luzon Island. *National Museum Papers,* **14**: 109-115.

Manolis, C. (2017). 2nd Siamese Crocodile Meeting on Husbandry and Conservation" and "Siamese Crocodile Task Force Meeting" (1-2 June 2017). *Crocodile Specialist Group Newsletter.* **36**(2): 5-9.

Ortega, G.V. (1998). Philippine crocodile conservation. *Crocodile specialist group newsletter*, **14**(4):101-134.

Platt, S.G., & Brantley, C.G. (1991). Observations of foraging behavior in captive juvenile *Alligator mississippiensis*. *Herpetological Review*, **22**: 83–84.

Platt, S.G., Elsey, R.M., Liu, H., Rainwater, T.R., Nifong, J.C., Rosenblatt, A.E, Heithaus, M.R., & Mazzotti, F.J. (2013). Frugivory and seed dispersal by crocodilians: an overlooked form of saurochory? *Journal of Zoology,* **291**(2): 87-99.

Pomares, C.C., Pomares, M.P., & Escalera, C.M.R. (2008). The existence of wild crocodile populations in Ligawasan Marsh and its tributaries. *National Museum Papers,* **14**: 116-122.

Pontillas, F. (2000). New breeding sites for the Philippine crocodile. *Crocodile specialist group newsletter,* **19**(2): 7-12.

Rice, K.G., Mazzotti, F.J., & Brandt, L.A. (2005). Status of the American alligator (*Alligator mississippiensis*) in southern Florida and its role in measuring restoration success in the Everglades. *Status and Conservation of Florida Amphibians and Reptiles:* 145-453.

Ross, C.A., & Alcala, A.C. (1983). Distribution and status of the Philippine crocodile (*Crocodylus mindorensis*). *Kalikasan,* **12**(1): 169-173.

Shirley, M.H., Burtner, B., Oslisly, R., Sebag, D., & Testa, O. (2017). Diet and body condition of cave-dwelling dwarf crocodiles (*Osteolaemus tetraspis*, Cope 1861) in Gabon. *African Journal of Ecology*, **55**(4):411-422.

Solania, C., Penaso, P.J., Samosino, J., & Lasco, E.M. (2019). Diet composition and endoparasitic load of the cane toad, *Rhinella marina* (Linnaeus 1758) from select localities of Butuan City, Philippines. *Journal of Ecosystem Science and Eco-Governance* **1**(1): 33- 42.

Somaweera, R., Nifong, J., Rosenblatt, A., Brien, M.l., Combrink, X., Elsey, R.M., Grigg, G., Magnusson, W.E., Mazzotti, F.J., Pearcy, A., & Platt, S. (2020). The ecological importance of crocodylians: towards evidence-based justification for their conservation. *Biological Reviews*, **95**(4): 936-959.

Taylor, J.A., Webb, G.J.W., & Magnusson, W.E. (1978). Methods of obtaining stomach contents from live crocodilians (Reptilia, Crocodilidae). *Journal of Herpetology*, **12**(3): 415-417.

Torralba, C.A.V., Gamalinda, E.F., & Estaño, L.A. (2022). Dietary preference of Alien Invasive Anurans (*Rhinella marina, Hoplobatrachus rugulosus,* and *Kaloula pulchra*) in Butuan City, Northeastern Mindanao, Philippines. *Journal of Ecosystem Science and Eco-Governance*, **4**(2): 20-28.

Van Weerd, M. (2010). Philippine crocodile *Crocodylus mindorensis.* Crocodiles: status, survey and conservation action plan. Third edition. Darwin: Crocodile Specialist Group: 71-78.

Wallace, K.M., & Leslie, A.J. (2008). Diet of the Nile crocodile (*Crocodylus niloticus*) in the Okavango Delta, Botswana. *Journal of Herpetology,* **42**(2): 361-368.

Webb, G. J. W. (2014). Wildlife Conservation: In the Belly of the Beast. pp. 342

Webb, G.J.W., Manolis, S.C., & Buckworth, R. (1982). *Crocodylus johnstoni* in the McKinlay River Area, NTI Variation in the diet, and a new method of assessing the relative importance of prey. *Australian Journal of Zoology*, **30**(6): 877-899.

Wings, O. (2007). A review of gastrolith function with implications for fossil vertebrates and a revised classification. *Acta Palaeontologica Polonica,* **52**(1).