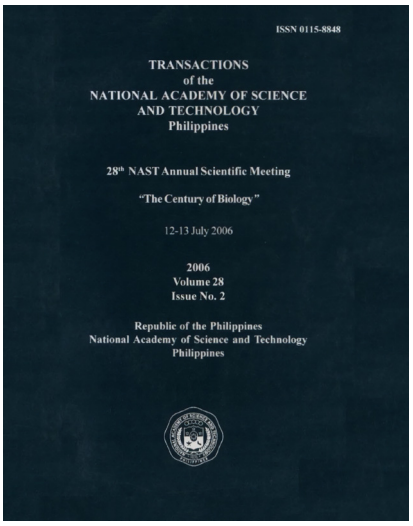
TRANSACTIONSNASTPHL
ISSN 0115-8848 (print)
ISSN 2815-2042 (online)
https://transactions.nast.ph
Vol. 28 Issue No. 2 (2006)
doi.org/10.57043/transnastphl.2006.4589

Transactions NAST PHL, is the official journal of the National Academy of Science and Technology Philippines. It has traditionally published papers presented during the Academy's Annual Scientific Meeting since 1979 to promote science-based policy discussions of and recommendations on timely and relevant national issues as part of its functions as a national science academy. Starting in 2021, this journal has been open to contributions from the global scientific community in all fields of science and technology.



Philippine Biodiversity: Ecological Roles, Uses, and Conservation Status

A.C. Alcala[1*], E.L.Alcala[1], I.E. Buot Jr.[2], A. Diesmos[3], M.L. Dolar[4], E.S. Fernando[5], J.C. Gonzalez[6] and B. Tabaranza[7]

[1] Siliman University-Angelo King Center for Research and Environmental Management, 2/F SU Marine Lab., Siliman Beach, Dumaguete City, 6200
[2] Institute of Biological Sciences, College of Arts and Sciences, Uiversity of the Philippines - Los Baños, College, 4031 Laguna
[3] National Museum ofthe Philippines, Padre Burgos Ave., Ermita, Manila
[4] Tropical Marine Research for Conservation, 6363 Lakewood St., San Diego, CA 92122, USA
[5] Department of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines Los Baños, College, 4031 Laguna
[6] Animal Biology Division, Institute of Biological Sciences, College of Arts and Sciences, and Museum of Natural History, University of the Philippines Los Baños, College, 4031 Laguna
[7] Haribon Foundation, 140 Kalayaan Ave., Diliman, Quezon City

Citation
Alcala AC et al. 2006. Philippine biodiversity: ecological roles, uses, and conservation status. Transactions NAST PHL 28(2): 203-214. doi.org/10.57043/transnastphl.2006.4589

Trans. Natl. Acad. Sci. Tech. Philippines 28:203–214 (2006)
ISSN 0115-8848

PHILIPPINE BIODIVERSITY: ECOLOGICAL ROLES, USES, AND CONSERVATION STATUS

A.C. Alcala[1*], E.L. Alcala[1], I.E. Buot Jr.[2], A. Diesmos[3], M.L. Dolar [4], E.S. Fernando[5], J.C. Gonzalez[6] and B. Tabaranza[7]

[1]Siliman University-Angelo King Center for Research and Environmental Management, 2/F SU Marine Lab., Siliman B each, Dumaguete City, 6200

[2]Institute of Biological Sciences, College of Arts and Sciences, Uiversity of the Philippines - Los Baños, College, 4031 Laguna

[3]National Museum of the Philippines, Padre Burgos Ave., Ermita, Manila

[4]Tropical Marine Research for Conservation, 6363 Lakewood St., San Diego, CA 92122, USA

[5]Department of of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines Los Baños, College, 4031 Laguna

[6]Animal Biology Division, Institute of Biological Sciences, College of Arts and Sciences, and Museum of Natural History, University of the Philippines Los Baños, College, 4031 Laguna.

[7]Haribon Foundation, 140 Kalayaan Ave., Diliman, Quezon City

Abstract

The Philippines has been recognized as having one of the world's megabiodiversity centers for terrestrial and near-shore marine fish fauna. This is due to a number of factors: insular condition providing barriers to faunal and floral dispersal, isolated high mountain areas promoting high levels of endemism as a result of geographic isolation, tropical rain forests providing equable climatic conditions year round, and unique geological origin of islands. The paper deals with species of seed-bearing and non-seed-bearing flowering plants, freshwater and top carnivorous fish, amphibians and reptiles, birds, and terrestrial and marine mammals. The main topics discussed are conservation status at the species level, values and uses of biodiversity, threatened and endangered species, recommendations on their conservation.

Keywords: Biodiversity, endemism, conservation, endangered species

Authors' names are arranged alphabetically; corresponding author

Introduction

The Philippines is one of the biodiversity mega-centers of the world, with many species per unit area of land and sea. But it is also considered as one of the world's biodiversity "hot spots," "which are areas featuring exceptional concentrations of endemic species and experiencing exceptional loss of habitat," according to Myers et al. (2000).

The high species richness of the Philippines is due to a number of factors that together have combined to produce conditions favorable for the evolution of plant and animal species. These factors include the country's location in the humid tropics, the equable climatic conditions year round, the diverse microhabitats for plants, animals and other forms of life, the insular conditions in an archipelagic setting resulting in geographic isolation due to marine barriers, the high tropical mountain areas where high levels of endemism at the species level are to be found the movements of land masses during the past geological ages, and the changes in sea levels during the Pleistocene era. The country is close to a large Asian landmass serving as source for the ancestors of some of its fauna and flora.

Despite the rapid destruction of tropical rain forests in the Philippines during the past 50-60 years, many new species of plants and vertebrates (primarily amphibians and mammals), are still being discovered today, an indication of the limitation in the methods used in distinguishing species as well as inadequate fieldwork in the past.

The number of terrestrial species reported in this paper therefore represents the lower end of the estimates as the numbers of endemic species tend to increase with more fieldwork and wider use of new genetic tools for biological systematics studies. Marine species, because of oceanographic connectivity among marine areas, show low levels of endemism, but this is offset by the sheer large numbers of marine species, such as corals, mollusks, and fishes adapted to various marine microhabitats

This report deals only with flowering plants, land vertebrates (amphibians, reptiles, birds, and mammals), one Family of truly freshwater fish and four Families of top carnivorous fish to demonstrate some aspects of evolution and conservation of these two vertebrate groups. A main gap in this paper is that not one group of invertebrates has been included.

In this paper, we have limited our coverage of Philippine biodiversity mainly to a discussion at the species level and the ecological roles, uses and conservation status of these species.

Each of the seven authors contributed to the paper, but it was the first author's responsibility to select parts of each author's contributions for inclusion in the present paper. However, for purposes of publication, each author was requested to review and revise, as needed, the draft on the taxonomic group he was responsible for.

Philippine Flowering Plants (Gymnosperms and Angiosperms)

Plants are the primary producers and provide the habitat infrastructure for many natural and man-made ecosystems. They are an important source of food for humankind and wildlife species. Plants provide ecosystem stability, ecological goods and services such as clean air, potable water, fertile soils, medical and industrial chemicals, genetic material for biotechnology, etc.

The flowering plants or seed-producing plants are composed of the Gymnosperms (with naked seeds) and the Angiosperms (with seeds in closed vessels or fruits). The first group is the more primitive, consisting of 33 species, of which 6 (18%) are endemic to the Philippines. The Angiosperms consist of about 8,120 species of which 5,800 (71%) are endemic.

There are 18 centers of plant diversity in the country. These are areas of high species richness, of diverse microhabitats for plants, and of high endemism. These centers are found on 10 generally larger islands except for Batan Island and Sibuyan Island. About 88 Conservation Priority Areas for Plants have been identified on the basis of endemism, presence of Endangered species, habitat diversity and degree of exploration.

About 491 (6%) species of gymnosperms and angiosperms are threatened (Vulnerable to Critically Endangered). Of the 45 species of Philippine dipterocarps (Family Dipterocarpaceae) 11 are Critically Endangered, five are Endangered and 12 are Vulnerable (DENR Administrative Order No. 2007-01). Our recent survey of southwestern Negros, where the rain forest has been degraded and fragmented, as in other parts of the country, indicates that of the 17 species of dipterocarps reported from the island, five (29%) may have been lost during the past 50-60 years (Paalan et al. in manuscript).

An exciting area for exploration is the search for plant species for specific purposes. Medical products from some medicinal plants are now being sold as food supplements. Maybe, a search for plant species with potential for bio-fuels is in order.

Philippine Ferns (Pteridophytes)

Ferns or non-seed-bearing vascular plants number about 1,100 species, in 144 genera and 39 families, of which 285 (26%) species are endemic to the Philippines (Barcelona, 2002). These plants are important as food, ornamentals, source of medicinal chemicals, and as materials for handicrafts. Some fern species provide raw materials for attractive handicrafts sold to tourists. The Mangyans of Mindoro, for example, use some species of ferns for their body adornment. For these reasons, it is to our interest to conserve them.

About 49 species of ferns are threatened (Tan et al, 1986; Madulid, 2000). The major causes for this are forest destruction and over-collection (Zamora and Co, 1986; Amoroso et al, 1996). These are very evident in mountain forests with surrounding villages frequently visited by tourists as Mt. Mayon and similar

places. Among the fern species that are vulnerable to potentially endangered are the 26 endemic species of tree ferns of the genus *Cyathea* (Madulid, 2000). This fern group is over-harvested for ornamental use; the trunks are used as substrate for growing orchids. *Cyathea* crosiers are collected from Mt. Mayon as Teddy Bears. The other fern species that are over-collected are *Lycopodium* spp. and *Platycerium coronarium* from forests of Quezon province. It is suggested to the users of *Cyathea* trunks to cultivate tree ferns, which thrive at mid-mountain elevations (Buot, 1999; Banaticla and Buot, 2003, 2004, 2005, 2006).

Philippine Freshwater and Marine Fishes

There is only one family of truly freshwater fish in the Philippines—the Family Cyprinidae. George S. Myers wrote a paper titled "The endemic fish-fauna of Lake Lanao and the evolution of higher categories" in 1959. In this paper, Myers discussed what he believed to be an explosive species evolution in four of the five genera of the freshwater fish Family Cyprinidae in the volcanic Lake Lanao, Mindanao Island some 10,000 years ago, an estimate disputed by other scientists. Within the four endemic genera 17 endemic species evolved. The total number of cyprinid species in Lake Lanao was 18. When American and German scientists explored the lake several years later, only few (3-4?) of this species flock of 18 were found. The conclusion was that most of the endemic species had become extinct.

Santos-Borja (in the internet), quoting information from certain authors, stated that the eleotrid *Hypseleotris agilis* and the goby *Ophieleotris agilis* have been introduced into the lake and may have caused the extinction of most of the endemic cyprinid species. Earlier it was suspected that the introduction of a species of goby, *Glossogobius giurus* (along with bangus) have something to do with the disappearance of the cyprinid species (information from Professor D.S. Rabor). Professor Pedro Escudero at Mindanao State University thinks that three species, *Hypseleotris agilis, Glossogobius giurus*, and *Glossogobius celebius* are the culprits in the disappearance of most endemic cyprinids based on anecdotal reports of Lake Lanao fishermen. It is possible that the introduction of invasive marine species was one of the reasons for the extinctions, but other factors cannot be discounted as no thorough investigations have been conducted.

Coral reef and reef-associated fishes show a high species richness in the Philippines. Marine biologists estimate that 3,000-4,000 species are found on coral reefs in the Indo-West Pacific region. The Philippines is at the center of marine biodiversity in terms of near-shore fishes Carpenter and Springer (2005). Our studies in central Philippines indicate some 200 conspicuous species on reef transects, of which about 125 species in 34 families are used as food (Alcala and Russ 2002). However, only about a dozen families supply some 90-95% of the biomass of the food fishes caught. Among the highly desired species are those belonging to the 4-5 carnivorous families occupying the top of the food webs on coral reefs. In this paper, we deal only with the top carnivores found on reefs.

The numbers of species in these 4-5 families of reef fish found in pristine reefs prior to our regular monitoring of marine protected areas (MPAs) since the early 1980s are not known. But we can have an idea by looking at the underwater survey results in the Visayan waters for a period of 30 years. A total of 69 species of top carnivores in the four Families (Serranidae, Lutjanidae, Lethrinidae and Carangidae) were recorded in our surveys of protected and unprotected coral reefs in the Visayan waters (SUAKCREM unpubl data). Some of these species are no longer found in some reefs. In several regularly monitored MPAs in the Bohol (Mindanao) Sea about 23 species in the four top carnivore Families have been recorded in marine reserves that were fully protected for 22 years (SUAKCREM unpubl data). In terms of the biomass of these 23 species the trend is exponential, indicating that biomass continues to rise with years of protection. From our monitoring data, top carnivorous fish are the first to disappear under heavy exploitation and the last to recover, requiring decades, not few years.

Philippine Amphibians and Reptiles

Philippine amphibians presently number about 102 species, but will increase in number with the application of the genetic and lineage approaches to systematics. This group comprises the tailless amphibians (frogs and toads) and the legless amphibians (caecilians) but lacks the tailed amphibians (salamanders and newts). The latter are temperate forms that were not able to migrate southward in the course of their evolution. A noteworthy example of the latter is the largest species, the Japanese salamander. In size, Philippine frogs and toads range from several cm to ca 1.5 cm in total length. The smallest species has just been described (see Alcala and Brown 1998) from northern Luzon, *Platymantis pygmaeus*, which is a little larger than the smallest frog in Cuba, with a length of 1.0 cm. Many species of Philippine are colorful, ranging in color from green to brown, to reddish, some with colorful spots.

Philippine amphibians are closely associated with close-canopy tropical rain forests. About 85% are associated with wet forests, being highly dependent on and sensitive to moisture (liquid water, high humidity) and relatively low ambient temperatures. Many frog species are dependent on water bodies for reproduction, but a large proportion reproduces directly from eggs to miniature frogs under wet to moist situations in their microhabitats. These characteristics make amphibians good indicators of climate change. Where they no longer occur indicates lack of moisture, which in turn could be due to climate change.

Estimates of Threatened to Critically Endangered amphibian species range from 28 to 63%, depending on who makes the assessment. This difference in opinion is accounted by the fact that many forest species are Data Deficient (which includes deficient knowledge of their systematics and ecology), making judgment of conservation status difficult. However, one fact stands out: all forest-dwelling species are at least Threatened because of the continuing destruction

and degradation of close canopy tropical rain forest, the only type of forest that maintains sufficient moisture essential to the life of amphibians and the existence of their microhabitats. Local communities consume common species of ranid frogs in ricefields and forest streams, and if not regulated exploitation could be a threat to these species. Still another threat is introduction of exotic species like the American bullfrog and the Taiwan frog. The former, a predator on other species of frogs, was introduced in central and northern Luzon in the 1980s and the latter in Los Baños in the 1990s (A. Diesmos, pers comm.).

The reptiles of the Philippines are composed of representatives of all four main reptilian groups, namely, lizards, snakes, turtles, and crocodiles. Exclusive of some 15 species of hydrophiid sea snakes and five species of marine turtles, there are 107 species of lizards, 85 species of snakes, three species of turtles, and two species of crocodiles, a total of 197 species, the majority of which are lizards and snakes. About 75% of the reptile species are tropical rain forest-associated species and, like the amphibians, are highly dependent on forest microhabitats. Therefore their future survival greatly depends on the presence of forests. Reptiles differ somewhat from amphibians in that many species can survive in man-made microhabitats and they can withstand drier areas better than amphibians.

There are no estimates of the numbers of Threatened to Critically Endangered reptiles in the various families except in the crocodile group. The Philippine Crocodile is Critically Endangered, and the only extant populations in the wild are in northern Luzon and the Ligawasan Marsh on Mindanao. Both the Salt-water Crocodile and the Philippine Crocodile are found in private farms and in the crocodile-breeding center in Puerto Princesa, Palawan. The Department of Environment and Natural Resources has failed to accomplish the goal of the breeding program on crocodiles, which is to release to the wild, captive-bred individuals of the Philippine Crocodile and to offer captive-bred individuals of the Salt-water Crocodile to the private sector for commercial purposes. Crocodile conservation and utilization are largely in the hands of the private sector.

The three species of monitor lizards are in need of conservation. The common species, *Varanus salvator*, needs a taxonomic review to determine the species limits of the various populations. The other two are distinct: *Varanus grayi*, a vegetarian, is found on Luzon, and its survival in the future depends on the conservation of the rain forest, where it inhabits large trees. The third species, just described, *Varanus mabitang,* a frugivore, is found only in northwestern Panay and needs more ecological study.

Among the skinks, geckos and snakes, the arboreal and burrowing species, being highly dependent on moisture, would most likely become threatened if forests disappear. Forest degradation and fragmentation in southwestern Negros caused the disappearance of about 20% of the species of amphibians and reptiles during the past 50-60 years (Alcala et al. 2004).

The larger snakes, including the python and the rat snakes, are useful to man because of their food and feeding habits being predators of rodents. Even the cobras and their relations, the sea snakes, are useful in the production of antivenins.

In general, snakes and crocodiles, which are top predators on land, perform important ecosystem functions such as keeping the predator-prey relations balanced, recycling of nutrients between land and freshwaters, etc.

Philippine Birds

There are 576 species of birds reported from the Philippines based on BirdLife International. Of this number, 192 (33%) are endemic. More species are slowly added to the list. For example, seven species have recently been added, including the Calayan rail (*Gallirallus calayensis*). Birds have the lowest endemism among the vertebrate classes in the Philippines. This is not surprising, as birds in general are highly mobile exchanging genetic material among adjacent populations.

Of the 576 species, 124 (21.5%) are considered Near Threatened to Critically Endangered. Two subspecies, the Ticao Tarictic and the Siquijor Hanging Parakeet, are extinct. Two more species, the Sulu Bleeding Heart Pigeon and the Negros Fruit Dove, have not been seen since 1891 and 1953, respectively, and are presumed extinct. With regard to the Negros species, one of us (ACA) was with Professor D.S. Rabor at Pula, Canlaon City (2500 feet above sea level) when the only specimen of that species was collected. There were two individuals of the species seen; one was shot with a 12-gauge shotgun but a second shot missed the other. No other specimen of this species has been seen or collected since 1953. However, a negative finding always needs confirmation, as shown by the case of the Cebu Flowerpecker, which was missing between 1901 and 1991, but was rediscovered in 1992.

The major threats to birds are loss of forest habitats and hunting. Some birds require different habitats for specific functions. These habitats are needed to ensure survival. For example, the incubator bird requires forest and beaches to complete their life cycle. Other species such as the top predator, Philippine Eagle, requires large areas of rain forest for foraging in order to maintain its population. Still other species such as hornbills require large trees provided only by intact rain forests in order to breed successfully. Strategies to counter these threats are needed to ensure successful conservation. Some of these strategies are information and educational campaigns and participation of local communities and local government units in the conservation effort.

Philippine Marine and Land Mammals

Philippine marine mammals belong to two orders, Cetacea (whales and dolphins) and Sirenia (dugongs). There are 26 whales and dolphins and one dugong, a total of 27, reported from Philippine marine waters (Dolar and Perrin 1996; Perrin et al. 2002; Dolar 1999; Dolar, pers comm). The toothed whales and dolphins are the most common and abundant species numbering 21. There are five species of baleen whales in Philippine marine waters.

Whales and dolphins as well as dugongs undertake long distance journeys in seas that could be under the jurisdiction of several neighboring countries. Their conservation often requires international agreements. The Philippines through

BFAR prohibits killing of marine mammals under the provisions of Fishery Administrative Orders (e.g. DAO 55 of 1991, which protects dugongs in Philippine waters). However, we all know that implementation is often difficult, and marine mammals, particularly dugongs, are often the victims of blast fishers.

The Irrawaddy Dolphin in Malampaya Sound (a 231 km^2 Protected Seascape since 2000) is the rarest and the most Endangered with only 77 animals remaining (L. Dolar, pers comm). The major threat comes from many kinds of fishing gear (gill nets, liftnets, ring nets, crab traps, shrimp corrals etc.) of fishers in the Sound, who form about 70% of the population of 23,000 people (growth rate 6.67% per annum) living in the vicinity of this body of water. Conservation of this species is extremely difficult, but must be done to allow this species to survive in the future. Aside from this species, all other dolphins are threatened by fishing using various kinds of nets.

The best use of marine mammals is for tourism. This non-consumptive use of marine mammals has proven profitable at Tañon Strait near Bais City, Negros Oriental, Philippines. This way, marine mammals contribute to the economy and are preserved for the future.

Some countries intentionally hunt whales for food, claiming that this fishing activity is part of their culture. Such claims are often difficult to resolve in relation to biodiversity conservation. Apparently, the often-cited case of dugong hunting by Australian aborigines has been resolved to the satisfaction of the aborigines and the Australian government.

Land mammals of the Philippines number 179 species, of which 111 (67.4%) are endemic (Heaney et al. 1998). Among the vertebrate groups discussed here, mammals would seem to rank the highest in terms of new species being discovered. New species of rodents have recently been discovered in sub-montane (mid-mountain) and mossy forests. Lawrence Heaney and his collaborators have documented an interesting food habit of this group, their dependence on earthworms as food.

The IUCN Red List of Threatened Animals shows 22 Endangered and Critically Endangered Species and 27 Vulnerable species. These 49 threatened species represent 27% of the total number of the Philippine land mammal species.

Some species listed under Critically Endangered may be virtually Extinct or almost Extinct. One example is the Visayan Warty Pig, which no longer exists as a distinct species because of hybridization with domestic pigs. Another example is the Negros Bare-backed Fruit Bat, which apparently is represented by only few individuals living in marginal microhabitats (aerial ferns) in small forest fragments in southwestern Negros Island (E. Alcala et al. in manuscript).

Like the rest of the land vertebrates, mammals stand to lose more species with the demise of tropical rain forests because a large proportion of them including the larger ones are closely bound to the forest ecosystem. Large species such as the Spotted Deer, Philippine Crocodile, and Philippine Eagle require large areas of appropriate habitats.

Summary of the Conservation Status of Philippine Biodiversity

The numbers of species shown in Table 1 below are approximate. The total number of land vertebrates is 1,054 distributed in 30 million hectares of land area, but the new systematics using genetic tools would most likely reveal additional new species to total approximately 1,100 species. A similar statement can be made for higher plants. As more fieldwork is conducted, more new species are likely to emerge. The number of Threatened to Critically Endangered species indicated in the table below are rough approximations because of lack of precise information.

Table 1. Summary of the conservation status of Philippine biodiversity

Taxonomic Group	Species Richness	Endemic Species		Threatened to Critically Endangered as of 2006	
		Number of Species	% of Total Number	Number of Species	% of Total Number
Seed Plants	10,524	6,286	59.73	696	16.6
Ferns	1,100	285	26	49	4.5
Fish (cyprinids)	18, ca 4 still existing (?)	17	94.1	4	100
Amphibians	102	76(?)	ca 75	29(?)	Ca 28-63
Reptiles	197	138(?)	ca 70	40(?)	ca 20 (?)
Birds	576	192	33	128	22
Marine Mammals	26	-	-	1	4
Land Mammals	179	111	ca 64	49	27

Strategies for Sustainable Conservation of Philippine Biodiversity

The following strategies are suggested to conserve Philippine biodiversity:

1. Establishment of protected areas
2. Prevention of alien invasive species introductions as well as introductions from one habitat type to another
3. Re-introduction of lost species with adequate safeguards
4. Preservation of remnants of original vegetation such as tropical rain forest, mangroves and beach forests
5. Captive breeding of Critically Endangered species and release to the wild with adequate safeguards
6. Use with adequate controls of wildlife species to earn incomes for local communities
7. Collaboration of local government units and local communities, local people's organizations in management
8. Conduct of information and education on biodiversity conservation
9. Encouragement of local government issuances as policy framework for local participation in conservation

Summary and Conclusions

The Philippines is indeed a country with high species biodiversity and high endemism. But it is also a biodiversity hotspot because of the rapid rate of habitat destruction that would hasten extinction. There is reason to believe that extinction rate is about 20% species loss for every 50-60 years. This figure based on limited data on amphibians and reptiles is slightly lower than that predicted (30+%) for Southeast Asia.

The causes of species extinction are mainly habitat destruction and over-exploitation. Another cause is hybridization with domestic species. This is shown in the case of the Visayan warty pig. Still another cause is competition with alien, invasive species as in the case of the cyprinids of Lake Lanao. Among plants, over-exploitation appears to explain local extinctions of some species of dipterocarps (eg., "lauan").

Because loss of biodiversity has many undesirable socioeconomic and ecological or environmental effects that could lead to ecosystem instability and decreased productivity, it is in the country's interest to conserve its biodiversity. Some strategies to do this are given in this paper.

References

Alcala, AC and WC Brown 1998. Philippine Amphibians: An Illustrated Guide. Bookmark, Manila. 113 pp.

Alcala, AC and GR Russ 2002. Status of Philippine coral reef fisheries. Asian Fisheries Science 15: 177-192

Alcala, EL, AC Alcala and CN, Dolino 2004 . Amphibians and reptiles in tropical rain forest fragments on Negros Island, the Philippines. Environmental Conservation 31:254-261.

Amoroso, VB, Acma, FM, Pava, HP. 1996. Diversity status and ecology of pteridophytes in three forests in Mindanao, Philippines. In: Camus JM and Johns RJ. (eds.). Pteridology in Perspective, pp. 53 - 60, Royal Botanic Gardens, Kew.

Banaticla, MCN and Buot, IE Jr. 2003. Dominant pteridophyte species of Mount Banahaw de Lucban, Luzon Island, Philippines. Flora Malesiana Bulletin 13:281-283.

Banaticla, MCN and Buot, IE Jr. 2004. Fern patch structure and species diversity along the altitudinal gradient on Mount Banahaw de Lucban, Luzon Island, Philippines. Philippine Agricultural Scientist 87: 49-60.

Banaticla, MCN and Buot IE Jr. 2005. Altitudinal zonation of pteridophytes on Mount Banahaw de Lucban, Luzon Island, Philippines. Plant Ecology 180: 135-151.

Banaticla MCN and Buot IE, Jr. 2006. Endemic ferns on the northeastern slopes of Mt. Banahaw de Lucban, Sierra Madre mountain range, Southern Luzon, Philippines: Potentials for domestication and landscaping. Journal of Nature Studies 5: 13-22.

Barcelona, JF. 2002. Philippine pteridophyte collections as a resource for conservation planning. Fern Gazette 16 (6-8): 307 -312.

Brown, WC and AC Alcala 1978. Philippine Lizards of the Family Gekkonidae. Silliman University Natural Science Monograph Series No. 1, 146 pp.

Brown, WC and AC Alcala 1980. Philippine Lizards of the Family Scincidae. Silliman University Natural Sciences Monograph Series No. 2, 264 pp.

Brown, RM, AC Diesmos and AC Alcala 2001. The state of Philippine herpetology and the challenges for the next decade. Silliman Journal, 42: 18-87.

Buot IE Jr. 1999. Pteridophytes frequently sold at Carbon Market, Cebu: Implications to urban horticulture and nature conservation. Philippine Scientist 36: 148-153.

Carpenter, KE and VG Springer 2005. The center of the center of marine shore fish biodiversity: the Philippine Islands. Environmental Biology of Fishes 72: 467-480.

Collar, NA, D. Mallari and B Tabaranza. 1999. Philippine Red Data Book for Birds of the Philippines, Bird Life International-Haribon Foundation, Bookmark Inc., Manila.

DENR-UNEP. 1997. Philippine Biodiversity: An Assessment and Action Plan. 298p. Department of Environment and Natural Resources and the United Nations Environment Programme. Bookmark, Inc., Makati, Philippines.

DENR-PAWB, CI, and UP-CIDS. 2003. Philippine Biodiversity Conservation Priorities: A Second Iteration of the National Biodiversity Strategy and Action Plan. 113p. Department of Environment and Natural Resources, Conservation International -Philippines, and U.P. Center for Integrated Development Studies, Quezon City, Philippines.

Dolar, MLL and WF Perrin. 1996. Preliminary results on the distribution and abundance of cetaceans in the Philippines. IBI Reports No. 6, 1996: 9-23.

Dolar, ML 1999. Abundance, Distribution and Feeding Ecology of Small Cetaceans in the Eastern Sulu Sea and Tañon Strait, Philippines. Ph.D. dissertation, University of California, San Diego.

Heaney, LR, ML Dolar, AC Alcala, ATL Dans, PC Gonzales, NR Ingle, MV Lepiten, WLR Oliver, PS Ong, EA Rickart, BR Tabaranza, Jr. and RCB Utzurrum. 1998. A Synopsis of the Mammalian Fauna of the Philippine Islands. Fieldiana: Zoology New Series, No. 88: 5+61 pp.

Madulid, DA. 2000. Philippine Plants Endangered Plants. Pundasyon sa Pagpapaunlad ng Kaalaman sa Pagtuturo ng Agham Ink. Manila. 50p.

Mallari, NAD, MJ Crosby and B Tabaranza. 2001. Key Biodiversity Conservation Sites in the Philippines: A Haribon-BirdLife International List of Important Bird Areas of the Philippines. Birdlife International-Haribon Foundation, Bookmark, Inc., Manila.

Myers, GS. 1960. The endemic fish fauna of Lake Lanao, and the evolution of higher taxonomic categories. Evolution 14 (3): 323-333.

Myers, N, RA Mittermeler, CG Mittermeler, GAB da Fonseca, and J Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853-858.

Perrin, WF, RR Reeves, MLL Dolar, TA Jefferson, H Marsh, JY Wang and J Estacion (eds.). 2002. Report of the Second Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia. CMS Technical Series Publication No. 9.

Philippine Plant Conservation Committee. 2007. Framework for Philippine Plant Conservation Strategy and Action Plan. 44p. Protected Areas and Wildlife Bureau-Department of Environment and Natural Resources, Quezon City, Philippines.

Tan BC, Fernando ES, Rojo JP. 1986. An updated list of endangered Philippine plants. Yushania 3: 1-5.

Utzurrum, RCB. 1992. Conservation status of Philippine fruit bats (Pteropodidae). Silliman Journal 36: 27-45.

Wildlife Conservation Society of the Philippines. 1997. Philippine Red Data Book, Bookmark. 262 pp.

Zamora PM, Co LL. 1986. Guide to Philippine Flora and Fauna. Vol 2. Quezon City: Ministry of Natural Resources and UP.