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Philippine mangroves: Species composition, characteristics, diversity, and present status

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ABSTRACT. Through the years mangrove areas in the Philippines continued to decline due to human activities. This paper aims to present the status of the Philippine mangroves based on species composition, diversity, and mangrove forest area through manuals, books, and other local and international online resources. Results showed that there were 35 species of mangroves described in terms of their external features, substrate, and zone preference. Bohol had the most diverse mangrove ecosystem with 26–34 species. The most prevalent species were *Avicennia, Sonneratia,* and *Rhizophora* that grew in muddy substrates. Among the provinces, 18.52% had mangrove areas recognized as protected areas. Mangrove decline is attributed to the increase of brackish water culture ponds and the greatest decline occurred when shrimp culture boomed in the 1980s. Other causes are over exploitation, weak law enforcement, lack of manpower and resources, corruption, and poor management of mangrove areas and brackish water ponds. Along with this is the loss of flood control and coastal protection indicating increased susceptibility to climate change. Thus, reforestation and reversion of abandoned brackish water ponds are needed. Reforestation must ensure the suitability of mangrove species to the physical characteristics of the environment. Also, the government must actively spearhead the sustainable use of mangrove ecosystems.

Keywords: *Aquaculture, brackish water ponds, diversity, marine protected area, Philippines*

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INTRODUCTION

Globally, mangrove forests comprise 18 million ha, 35% of which are found in the Southeast Asian countries, including the Philippines (Honcluda-Primavera, 2000). Southeast Asia also has the most diverse mangrove forests, with more than 50 species (Richards and Friess, 2016). Initially, mangrove forests in Southeast Asia spread up to more than 6.8 million ha. Of these, Indonesia had the most significant mangrove cover with 59.8% (4,066,400 ha), whereas the Philippines only had 2.2% (149,600 ha) (Figure 1) (Giesen et al., 2007).

Mangrove ecosystems have decreased over the last 50 years, diminishing to about one-third of mangrove forests worldwide (Alongi, 2002). This degradation is frequently attributed to the continued growth of the human population. Human activities that contribute to mangrove degradation include aquaculture, mining, over-exploitation of mangrove economic services, and urban development (Alongi, 2002) such as conversion to salt ponds, settlements, agriculture like rice and coconut fields, and tourist resorts (Primavera, 2005; Primavera et al., 2014). From these, aquaculture remains the topmost basis of declining mangrove forests (Primavera et al., 2014; Richards and Friess, 2016). In Southeast Asia, Myanmar is the chief hotspot for mangrove loss followed by the Philippines (Richards and Friess, 2016). In 1918, mangrove forest cover in the Philippines was estimated to reach 500,000 ha (Brown, 1920), but it continued to decline by 51.8% as of 2010 (Long et al., 2014). Only 5% of the remaining mangroves are considered old, while others are already secondary growth. Most old mangroves are located in Palawan (White and Cruz-Trinidad, 1998). The decline is mainly attributed to the logging activities prevalent from 1920 to 1970 (Calumpong and Meñez, 1997) and to the development of brackish water culture ponds that peaked in the 1950s and 1960s. During that period 5,000 ha of mangrove forests per year were converted to brackish water ponds (Primavera, 1995; Long et al., 2014), and the government even supported its conversion since the issuance of P.D. 704 in 1975 (Agbayani, 2000). Other anthropogenic activities contributing to mangrove decline are over-exploitation and conversion to rice farmlands and coconut plantations, salt beds, and industrial areas (Primavera, 2005). Pollution is another factor (Rahman et., 2009). Frequently occurring pollution in the mangrove forests include oil pollution, heavy metals, and wastes (includes plastics, and biodegradable materials) from residential areas, aquaculture, agriculture, roads, industry, and mining. These can reduce and damage mangrove ecosystems and can lead to loss of numerous species of flora and fauna and disruption or cessation of fish and shrimp life cycle (Rahman et al., 2009).

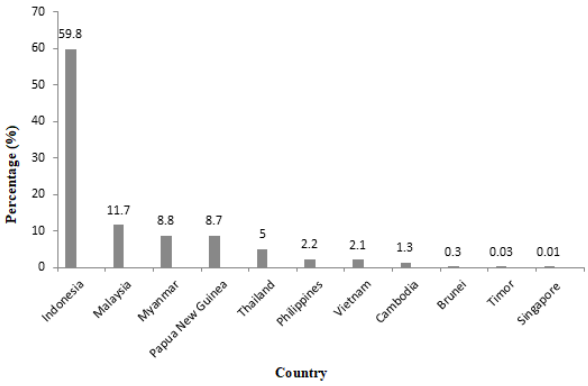

Figure 1. Mangrove forest cover in Southeast Asian countries: Indonesia, Malaysia, Myanmar, Papua New Guinea, Thailand, Philippines, Vietnam, Cambodia, Brunei, Timor, and Singapore.

Mangrove ecosystems provide various ecosystem services (Barbier, 2012) that are important for human well-being (Millennium et al., 2005). These services are sets of benefits that ecosystems produce for the society, and these come in to four classes, the provisioning, regulating, cultural, and supporting services (Millennium et al., 2005; Turner et al., 2009). According to Buncag et al. (2019), mangroves help various forms of life, including animals on land, in the sea, and people. They

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provide direct benefits like food and indirect benefits like protecting against disasters and coastal damage. Mangroves provide products to humans such as timber, fuel wood, charcoal (Brander et al., 2012). Regulating services include coastal protection, flood prevention, water quality (Grizzetti et al., 2019), erosion control, prevention of salt-water intrusion (Brander et al., 2012), and carbon sequestration (Millennium et al., 2005). Supporting services are those that are essential for the production of all other ecosystem services (Kremen, 2005) like the provision of habitats for spawning, breeding, and nursery (Brander et al., 2012). Cultural services, on the other hand, are the non-material benefits that we get from ecosystems such as tourism and recreation, education and learning, and aesthetics (Langemeyer et al., 2015). Thus, such ecosystems must be sustainably used. This paper aims to present the status of the Philippine mangroves in terms of mangrove species composition, diversity, and mangrove forest area in different locations in the Philippines. This is essential to provide an idea of the extent of reforestation and reversion programs needed in the country. According to the DENR (2013), a nationwide assessment of the general conditions of mangrove areas has yet to be done despite its continued degradation. Also, data gathered on the current state of our mangrove forests has been limited.

MATERIALS AND METHODS

In this paper, we mainly used the book of Calumpong and Meñez (1997) to reference the different mangrove species in the Philippines and their characteristics. We used the words "status of mangroves," "Philippine mangroves," and "aquaculture" in the Philippines as search terms from online resources such as Google Scholar and e-journals. Ph, iamure.com, and the Philippine Council for Agriculture Aquatic Research and Development (PCAARD) and Natural ResourcesResearch and Development (NRRD). Other sources on mangrove forest area, species diversity or composition in the Philippines, and the factors that caused its decline were taken from various journal articles, books, and manuals of DENR on mangrove management. The journal articles were taken from Springer, Elsevier, jcr-online, academia.edu, iamure.com, and the National Center for Ecological Analysis and Synthesis. The Bureau of Fisheries and Aquatic Resources (BFAR) obtained data on brackish water ponds.

RESULTS AND DISCUSSION

A. Mangrove species characteristics

Mangrove species in the Philippines that were described in detail belong to 19 families, 24 genera, and 35 species (Table 1). The most prevalent in the country are the *Rhizophora, Avicennia, Bruguiera, Sonneratia,* and *Nypa* (Calumpong and Meñez, 1997), which are comparable to the main mangrove species of Indonesia (Spalding et al., 1997). Such species were reflected in the six Philippine provinces observed, by adding *Ceriops* and *Aegiceras*. Thailand also has a similar dominant species with the replacement of Combretaceae for *Bruguiera* (Thammarat et al., 2009). *Avicennia, Sonneratia,* and *Rhizophora* are among those species found in copious amounts in Vietnam (Hong and San, 1993) and in prevalence in some of the mangrove forests in Kemaman District, Malaysia (Sulong et al., 2002). Two of its four dominant species in Florida are the *Rhizophora mangle* and *Avicennia germinans* (Chapman, 2013).

Mangrove species are dispersed differently in mangrove ecosystems based on the tidal level (low, mid, high) they are exposed to, on the elevation (downstream, intermediate, and upstream), on the type of substrate from which they grow (Primavera et al. 2012, 2014), and on salinity regime (Cuenca et al., 2015; Barik et al., 2018). Mangroves usually

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cultivate well in muddy substrates (Tomlinson, 1994; Chapman, 2013), though other species occur in sandy, peat, and coral cays (Chapman, 2013). Most of the species occupy the middle (seaward) to landward area (Primavera et al., 2012,), and *Avicennia* and *Sonneratia* occur as front liners in the seaward, while Rhizophora grows behind the two front liners (Tomlinson, 1994; Calumpong and Meñez, 1997). As shown in Table 1, *Avicennia* and *Sonneratia* prefer the seaward area, while others occupy along streams and in the landward zone. Individual mangrove species has optimum range of salinity for its desired habitat (Barik et al., 2018). Salinity differs from the downstream (27% to 28%), intermediate (1% to 17%), and upstream (0% to 4%), and it impacts the growth rates of mangroves thereby affecting its distribution. Mangrove species have optimal growth rates in elevation with low salinity (Cuenca et al., 2015). *Ceriops* and *Avicennia* have been found to tolerate high salinity areas (Barik et al., 2018), with *Avicennia* seedlings achieving an optimal growth in 5% to 30% salinity (Cuenca et al., 2015), while *Nypa* and *Heritiera* are distinguished in low salinity areas (Barik et al., 2018).

Table 1. Characteristics of different mangrove genera in the Philippines.

Family	Genus	Zone/Substrate	Physical Characteristics
Acanthaceae	*Acanthus*		Low shrub; small and spiny leaves; white or blue flower
Apocynaceae	*Cerbera manghas*	Sandy	Small to large tree; simple and alternate or spiral or whorled leaves; bark exudes yellow sap; terminal and tubular flower
Avicenniaceae	*Avicennia*	Seaward; muddy	Simple, opposite, and lanceolate to ovate leaves; erect and pointed pneumatophores; small and orange flowers
Bignoniaceae	*Dolichandrone spathacea*		Small to large tree; even numbered compound leaves; cylindrical, long, pendulous pod or capsule fruit
Combretaceae	*Lumnitzera*	Inner edges or sandy	Small to large tree; simple and alternate or spiral or whorled leaves; cylindrical or elongated smooth fruit
	Terminalia catappa	Along exposed coasts	Small to large tree; simple, alternate or spiral or whorled, and yellowish green leaves w/ wooly underneath; hard nut and heart-shaped fruit;
Euphorbia-ceae	*Excoecaria agallocha*	Landward	nuts in spikes Small to large tree; simple and alternate or spiral or whorled leaves; bark exudes white sap; axilliary flower that are not
Fabaceae/ Leguminosae	*Aganope heptaphylla*	Landward fringes	tubular Small to large tree; odd numbered compound leaves; monoliform fruit
	Pongamia pinnata		Small to large tree; odd

			numbered compound leaves;
	Derris trifoliata		pod fruit that is beaked Small to large tree; odd numbered compound leaves;
Lecythidaceae	*Barrington asiatica*	Landward of exposed coasts	pod fruit that is not beaked Small to large tree; simple and alternate or spiral or whorled
Lythraceae	*Pemphis*	Exposed coasts, sandy	leaves; cubical and large fruit Small to large tree; simple, lanceolate, and opposite leaves
Malvaceae	*Hibiscus tiliaceaus*	Exposed coasts, inland	w/ acute tip; turbinate fruit Small to large tree; simple and alternate or spiral or whorled
Meliaceae	*Xylocarpus*	Along streams	leaves; cylindrical or elongated, ridged, and torpedo-like fruit Small to large tree; even
Myrsinaceae	*Aegiceras*	Sandy	numbered compound leaves; globose and orange-shaped fruit Small to large tree; simple and
Myrtaceae	*Osbornia*	Understory growth in zones inundated by highest tides	alternate or spiral or whorled leaves; cylindrical or elongated banana-shaped fruit Small to large tree; simple and
Palmae	*Nypa*	Along streams and estuaries	opposite leaves; globose and smooth fruit
Pteridaceae	*Acrostichum*		Palm w/ creeping stem True fern; compound and not
	Rhizophora	Deep, soft mud, tidally inundated	spiny leaves; young leaves are crimson or green Simple and opposite leaves; viviparous; prominent prop
Rhizophoraceae	*Bruguiera*	Landward; muddy	roots; pear-shaped fruit; calyx w/ 4 lobes Simple and opposite leaves; viviparous; prominent prop
	Ceriops	Tidal streams	roots; turbinate fruit; calyx w/ 8-15 lobes
Rubiaceae	*Scyphiphora*	Along river banks, firm muddy or sandy , on exposed coasts	Simple and opposite leaves; viviparous; calyx w/ 5-6 lobes Small to large tree; simple, obovate and opposite leaves
Sonneratiaceae	*Sonneratia*	Mouths of tidal streams, rocky or sandy to muddy substrate at the seaward fringe	w/ rounded tip; elongated, grooved fruit Simple, opposite, elliptical to orbicular leaves; tall and coni-
Sterculiaceae	*Heritiera littoralis*	Inland	cal pneumatophores; large and green to reddish flowers Small to large tree; simple, alternate or spiral or whorled, and white leaves w/ scaly un-

Source: Calumpong and Meñez 1997

Mangrove species have distinct characteristics that allow them to grow tidally inundated (Rezende et al., 2013) and low-nutrient soil due to low oxygen and waterlogging (Reef et al., 2010). Pneumatophores, for example, are above-ground roots essential for aeration. Prop roots, on the other hand, are used as support to decrease tidal currents (Calumpong and Meñez, 1997). Only *Avicennia* and *Sonneratia* have prominent pneumatophores among the mangrove species, while *Rhizophora* and *Bruguiera* have prop roots (Table 2). In addition, nearly all mangrove species are evergreen, which is essential to reduce nutrient loss (Aerts, 1995). Various leaf shapes and arrangements of mangroves are shown in Figure 2.

Table 2. Distinct characteristics of mangrove species in the Philippines.

Species (local name)	Leaves	Stem / root	Fruit/hypocotyl	Flower
Nypa fruticans (nipa)	Palm-like, lanceolate leaflets, oppositely pinnate	Creeping and thick, mostly underground	Angular, one seeded, w/ smooth dark brown covering	Enclosed by gold bracts (female), club-shaped spikes at the tip of lateral axis
Avicennia lanata (bungalon)	Obovate or broadly oblong, wooly undersides, yellow-brown	Large, smooth to grid-cracked, dark brown to dark gray bark		Yellow, terminal, compact nutlets
Avicennia officinalis (Api-api; bungalon)	Obovate or broadly oblong leaves w/ rounded tip and green underside	Medium sized, smooth to grid-cracked, dark brow to dark gray bark	Characteristically russet, about 3 cm long, slightly elongated w/ short apical beak	Globose clusters; yellow petals folding in a distinctive manner, subtended by grayish leaves w/ bracts and bracteoles
Avicennia alba (Bunglon-puti)	Simple, opposite, silvery underneath, oblong to oblong-elliptical shape, acute apex	Large tree w/ pneumatophores, dark brown and minutely scaly bark	Obliquely conic or narrowly oblong in shape, compressed laterally, not beaked	Elongated inflorescence w/ yellow to orange color
Avicennia marina (bungalon; piapi)	Simple, opposite, ovate or lanceolate leaves w/ abruptly acute tips	Small tree w/ pneumatophores, smooth, slightly flaky, and light gray to brown black bark	Cordate and beaked	
Sonneratia alba (firefly mangrove; pedada)	Simple, opposite, fleshy, simple and broadly ovate to suborbicular in shape	Medium sized w/ conical pneumatophores		Greenish or yellowish petioles and in inner sides of sepals, cup-shaped calyx
Sonneratia caseolaris (firefly mangrove; pagatpat; pedada)		Smaller than *S. alba*		Reddish petioles and in inner sides of sepals, flat calyx

Ceriops decandra (malatangal; hangalay)	Simple, opposite, broadly obovate, and yellowish-green leaves	Small tree w/ slightly swollen base		
Ceriops tagal (tangal; tungog)	Narrow obovate leaves w/ slightly notched tip		Hypocotyls are cylindrical, slightly ridged, warty, and 16-25 cm long	Sessile flowers w/ calyx reflexed in fruit
Rhizophora apiculata (bakauan-lalake)	Simple, opposite, elliptic-oblong to sub-lanceolate shape, wedge-shaped base and pointed tip, purple stipules, petioles, and the midrib at times	Medium to large trees w/ prop roots, Dark brown, externally ridged bark, red and fibrous internally		Occur in pairs on short and stout stalk
Rhizophora stylosa (bakauan; bakhawan-tigrihon)	Similar leaves w/ *Rhizophora mucronata*	Smaller than *Rhizophora apiculata* and *Rhizophora mucronata*		Similar inflores-cence w/ *Rhizo-phora mucronata* but styles are long upto 5 mm
Rhizophora mucronata (bakauan babae)	Mucronate apex, yellow stipules, petioles and midrib at times,			Attached to slen-der stalks, form clusters of 3-7 yellow flowers
Bruguiera gymnorrhiza (busain)	White wax in twigs and petioles, opposite, oblong, acute apex, reddish stipule, 9-10 pairs of lateral nerves	Medium sized w/ short prop roots, black and fissured bark	Calyx lobes are persistent and erect, turbinate shape, about 1 m or more in width; thick and cylindrical hypocotyl	Red, solitary, w/ 12-14 calyx lobes
Bruguiera parviflora (langaral)	Simple, opposite, elliptical, pointed apex, light green stipules	Small tree; smooth and gray bark	Calyx lobes are ridged and erect; smooth, slender, and pendulous hypocotyls	Yellowish-green, in clusters of 3-4, 8 calyx lobes
Bruguiera sexangula (pototan)	Green or yellowish stipules, leaves w/ 6-7 pairs of lateral, thinner nerves			Yellowish or brown
Osbornia octodonta (taualis)	Simple, opposite, obovate, reddish petioles	Small tree, dark red bark that are easily peeled off	Globose, smooth, w/o persistent calyx parts	Sessile, white, and axilliary
Scyphiphora hydrophylla-cea (nilad)	Simple, obovate, opposite, in 2 ranks, visibly shiny on the surface, flat and sticky leaf buds	Small tree	Green, crowned w/ persistent calyx, up to 1 cm long, grooved or ribbed	White, axilliary, in cymose clusters

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Pemphis acidula (bantigi)	Simple, opposite, small to 3 cm long, tongue-like, w/ white hair covering	Small tree, light gray to brown bark that are shred into strips	Flower persists, capsule that opens at the apex	White, solitary in axils, bell-shaped
Excoecaria agallocha (buta-buta; alipata)	Simple, spiral, shiny surface, petiolate, obovate, pointed apex	Small tree, w/ poisonous milky sap in the bark and twigs		Spike (male), raceme (female)
Cerbera manghas (baraibai)	Simple, spiral, large, elliptical	Small tree, exudes yellowish latex	Globose, pendulous	White, terminal, tubular
Aegiceras corniculatum (saging-saging)	Simple, alternate, leathery, obovate	Small tree	Green (immature), red (mature), banana-like	In single whorl
Aegiceras floridum (tinduk-tindukan)	Smaller leaves w/ darker underneath from *A. corniculatum*		Not curved, in unbranched cluster	
Lumnitzera littorea (sagasa)		Pneumatophores w/ looped laterals		Red w/ conspicuous yellow stamen, terminal spike
Lumnitzera racemosa (kulasi; mayoro)	Simple, spiral, elliptical, notched apex	Small tree, fissured bark, pneumatophores not well developed	Smooth and cylindrical	White, sessile flowers in axilliary inflorescence
Hibiscus tiliaceus (malubago)	Large, semi-orbicular, stipules surround the leaf base, w/ glands and hairs	Small tree	Torpedo-like, nearly triangular	Large; overlapping, showy petals; maroon internally; fused stamens;
Barringtonia asiatica (bitobitoon; botong)	Simple, large up to 30 cm, obovate, clustered at tip of branches	Medium-sized, dense crown	Large, cube shape	White, large, numerous stamens
Heritiera littoralis (dungon; dungon-late)	Simple, large up to 20 cm long, spiral, stiff, leathery, scaly white underside	Medium-sized, gray to dark brown bark	Brown ridged nut	Subterminal, in panicles, calyx is hairy, cup-shaped, green externally, and red internally
Terminalia catappa (talisay)	Large up to 30 cm long, obovate	Large tree	Almond-shaped, 7 cm long, compressed laterally and ridged	Terminal spikes (male), perfect and axilliary spikes (female)
Xylocarpus granatum (tabigi)	Compound, w/ 4 leaflets that are thick, elliptical, and w/ rounded apex	Medium-sized, fissured bark that flakes off	Large, globose, greenish yellow (ripe)	Lateral panicle inflorescence, less than 8 cm long

Xylocarpus moluccensis (piagau)	Compound w/ four leaflets that are thin, broadly ovate, pointed apex	Small tree, gray, longitudinal, fissured bark that peels off	Large, globose, greenish brown (ripe)	Inflorescence as lateral branch cluster, greater than 8 cm long
Dolichandrone spathacea (balok-balok; tui)	Compound, petiolate, w/ odd-numbered, 3-11 leaflets, opposite leaflets in two ranks, ovate-lanceolate, pointed apex, entire margin	Large tree, gray to dark brown trunks w/ prominent lenticels and leaf scars	Flat, elongated capsule up to 0.5 m long, w/ many seeds	Large, 8 cm long, 12 cm width, tubular, w/ inflated and fringed lobes, solitary, axilliary, w/ minute scale-like bracts, green calyx, white at maturity
Pongamia pinnata (bani)	Compound w/ 5-7 ovate-elliptical leaflets	Spreading tree	Legume, compressed, ellipsoid, pea-shaped and beaked to a point	Panicle inflorescence, 20-25 cm long, axilliary
Aganope heptaphylla	Light green, elliptical leaflets	Small tree	Flat, limited between 2-6 seeds	Green w/ white wings in long spikes, in twining branches
Derris trifoliate (tuble)	Light green and elliptical leaflets	Liana to small tree	Green, flat, and elliptical	Pink, in long spikes on twining branches

Source: Calumpong and Meñez 1997

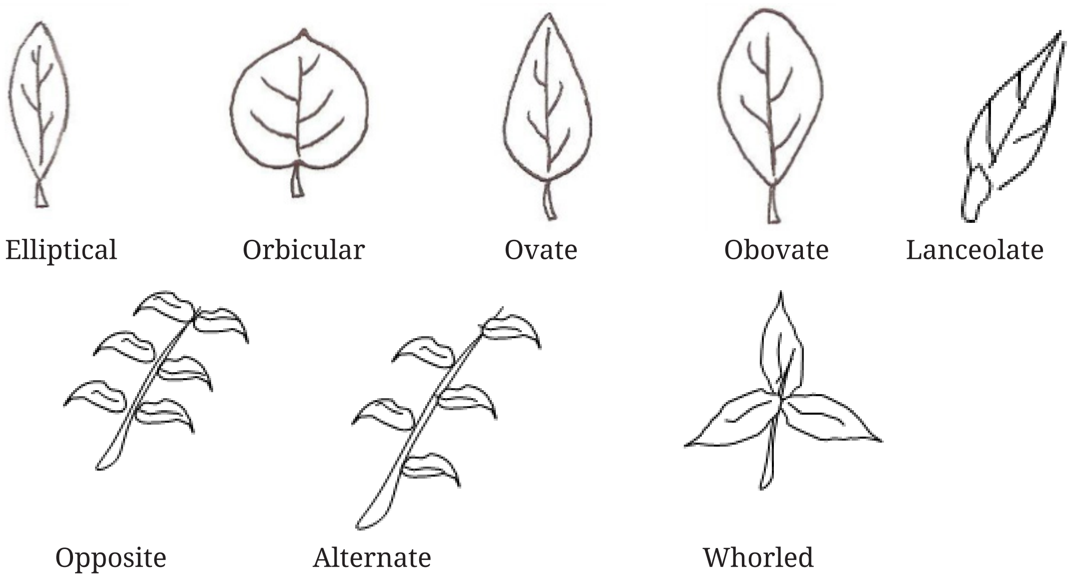

Figure 2. Common leaf shapes and leaf arrangement of mangrove plants.

B. Mangrove species diversity in the Philippine provinces

Based on the studies of several researchers, Bohol had the most diverse mangrove ecosystem with 26 to 34 species followed by Panay Island with 33 species (Table 3). Mangrove diversity in Bohol is most likely promoted by the presence of large freshwater discharge and tidal inundation that carries sediments (Middeljans, 2014). Nevertheless, its high species diversity as compared to other Philippine provinces is significantly influenced by the active management efforts of the Abatan Lincod Mangrove Growers Organization (ALIMANGO) particularly on the protection of mangroves against illegal logging and fishpond conversion. This organization is under a Community-Based Forest Management Agreement (CBFMA) No. 42859-43573, which was issued by the DENR in 1995 and was approved on July 7, 1998 advocated to achieve its main goal of sustainable forestry by putting the community first and enhancing the people's well-being (Melana et al., 2005). Community participation in decision-making and resource management is the key element in attaining institutional sustainability (Datta et al., 2012). This mangrove management strategy is supported in many areas such as in St. Lucia (Smith and Berkes, 1993), Indonesia (Brown et al., 2014), East Africa (Zorini et al., 2004), and India (Selvam et al., 2003). This reveals the importance of community involvement in actualizing effective conservation, protec7tion, rehabilitation, and management strategies of mangrove ecosystems towards sustainability.

The most common type of genus observed in 6 provinces were *Avicennia, Rhizophora,* and *Sonneratia,* though *Ceriops, Nypa,* and *Aegiceras* also showed dominance in at least one of the provinces (Figure 3). The substrate of the mangrove areas in most of the provinces was observed to be muddy (Juario and Ontoy, 2005; Becira 2006; Picardal et al., 2011; Lunar and Laguardia, 2013; Valenzuela et al., 2013) in which mangroves in general nurture well (Tomlinson, 1994; Chapman, 2013), hence the probable reason for the dominance of *Rhizophora, Avicennia,* and *Sonneratia.* This indicates the importance of suitability of mangrove species to its environment which must be considered in mangrove reforestation programs. Based on the study of Elster (2000) site selection and preparation are the primary factors to achieve success in reforestation. Many of the reforestation projects in Visayas and Mindanao resulted to low survival rate and one of the reasons behind it is poor site selection (Melana et al., 2005). This is also the reason why most of the mangrove rehabilitation programs in Indonesia have failed (Brown et al., 2014). A poor survival rate of mangroves at 10-20% can be attributed to the mismatching of species and site selection (Primavera and Esteban, 2008).

Among 81 provinces in the Philippines only 15 have mangrove forest areas recognized as protected areas or parks (Figure 4), which comprises 18.52%. It includes the Calatagan Mangrove Forest Conservation Park with 9 mangrove species, Olango Island, Cebu with 23 species, and Pagbilao, Quezon with 24 species (Table 3). The development of Marine Protected Areas (MPAs) has been somewhat gradual in terms of its selection, designation and management (Jones 2001). It was only in 1984 that the first guidelines on establishing MPA was published by the IUCN (Salm and Clark, 1984) and in 1992 when they made available in print more extensive applicable guidelines (Kelleher and Kenchington, 1992). Few of the reasons for its slowed development are the limited scientific knowledge (Mascia, 2001), wide spatial scale, and complexity of marine ecosystems (Jones, 2001). In the Philippines, many MPAs are minor and are managed inefficiently (Arceo et al., 2008; Cabral et al., 2014) due to lack of national agency to oversee the development of all MPAs (Maypa et al., 2012), poor documentation, and scanty reports that are generally unpublished and are usually misplaced or lost (Cabral et al., 2014).

Table 3. Mangrove species diversity in different provinces of the Philippines.

Province/Location	Number of species	Reference
LUZON	22	DENR, 2013
Aklan (Ibajay) Aurora Batangas	23	DENR, 2013
Calatagan Mangrove Forest • Conservation Park	9	Lunar and Laguardia, 2013

• Mangrove Rehabilitation Area, Balibago, Calatagan	7	Lunar and Laguardia, 2013
Catanduanes	23	Masagca, 2008
Mindoro (Puerto Galera)	18	DENR, 2013
Palawan (Puerto Princesa Bay)	14	Becira, 2006
Quezon (Pagbilao)	24	DENR, 2009
Romblon	4	Sabigan et al., 2013
VISAYAS		
Bohol	34; 26	Juario and Ontoy, 2005; DENR,
• Maribojoc	29	2013 Middeljans, 2014
Cebu		
• Balamban	19	Bagalihog et al., 2003; Juario and Ontoy, 2005
• Malhiao, Badian	12	Valenzuela et al., 2013
• San Remigio	18	DENR, 2013
• Olango Island	23	Magsalay et al., 1989; Juario and Ontoy, 2005
Leyte	5	Picardal et al., 2011
• Ormoc Bay	18	Juario and Ontoy, 2005
Negros Island (Bais Bay)	14	Calumpong, 1992; Masagca, 2008
Negros Oriental (Guihulugan)	18	Bagalihog, 2000; Juario and Ontoy, 2005
Panay Island	33	Primavera et al., 2004; Juario and Ontoy, 2005
MINDANAO		
Misamis Occidental (Misom in Baliangao)	21	Cadiz and de Leon, 1994; Masagca, 2008
Panguil Bay	21	Philippine Council for Agriculture Aquatic and Natural Resources Research and Development 2009

C. Mangrove forest area

The total mangrove forest area in the Philippines in 1951 was recorded to reach 428,382 ha (Table 4). From that year on to 2010, it declined by 43.78% and the greatest decline occurred within 1980 to 1988. Each region in the Philippines revealed at least 31% loss of mangrove forests from 1951 to 1988 and the biggest loss occurred in Central Luzon (99.12%) followed by the Western Visayas (94.24%) (Table 5 and Figure 5). In 2000, mangrove forest areas increased by 113.02% (256,185 ha) from 1994 but decreased again by 2.84% in 2003. During this time, Region IV-B had the biggest mangrove forest area from both natural and plantation (reforestation) sources (Table 6 and Figure 6). The change in mangrove forest areas from 1951 to 2010 is shown in (Figure 7).

On the other hand, brackish water ponds increased from 1950 (72,753 ha) to 1994 (239,323 ha) by 69.6% and the greatest increase took place within 1951 to 1960 with 49.89% of increase (Table 7).

Mangrove forests have been used by humans for consumption and economic profits that led to its over exploitation and destruction (Juario and Ontoy 2005). It was used for fuel wood and was converted to agricultural and industrial purposes, salt beds, and human settlements (Primavera, 2000). In Lingayen Gulf, for example, mangrove woods

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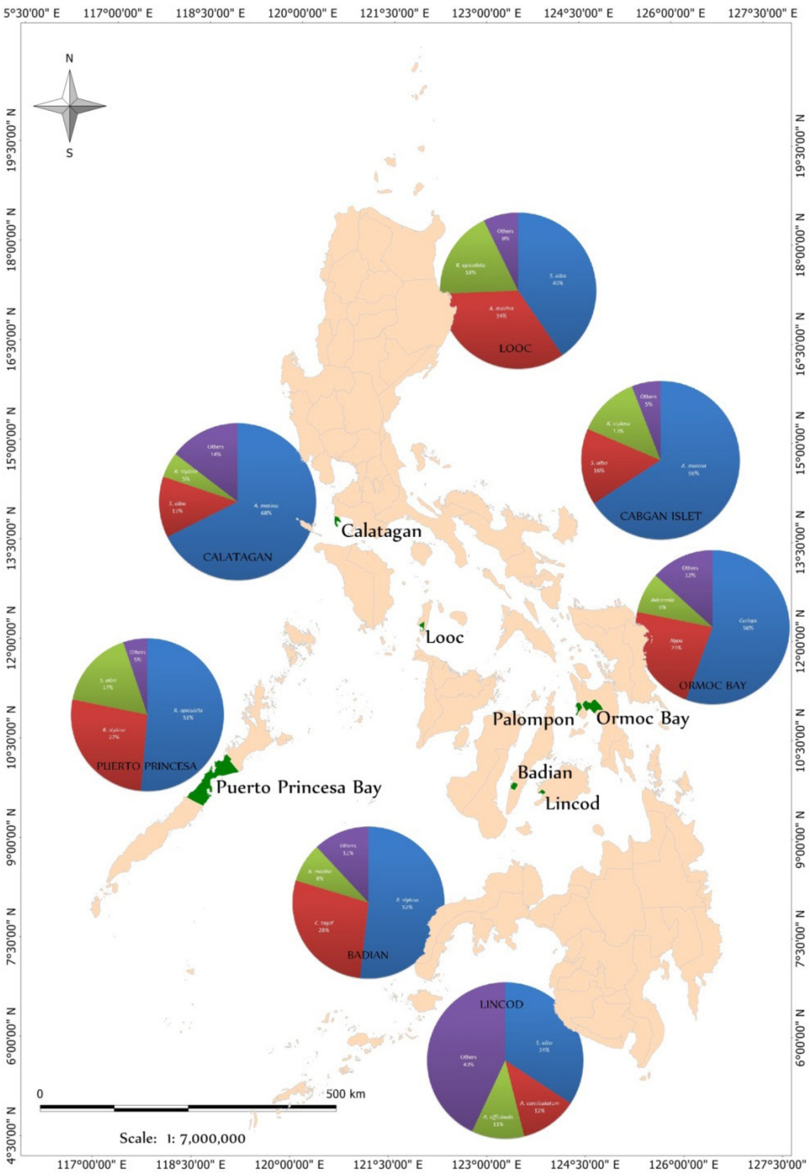
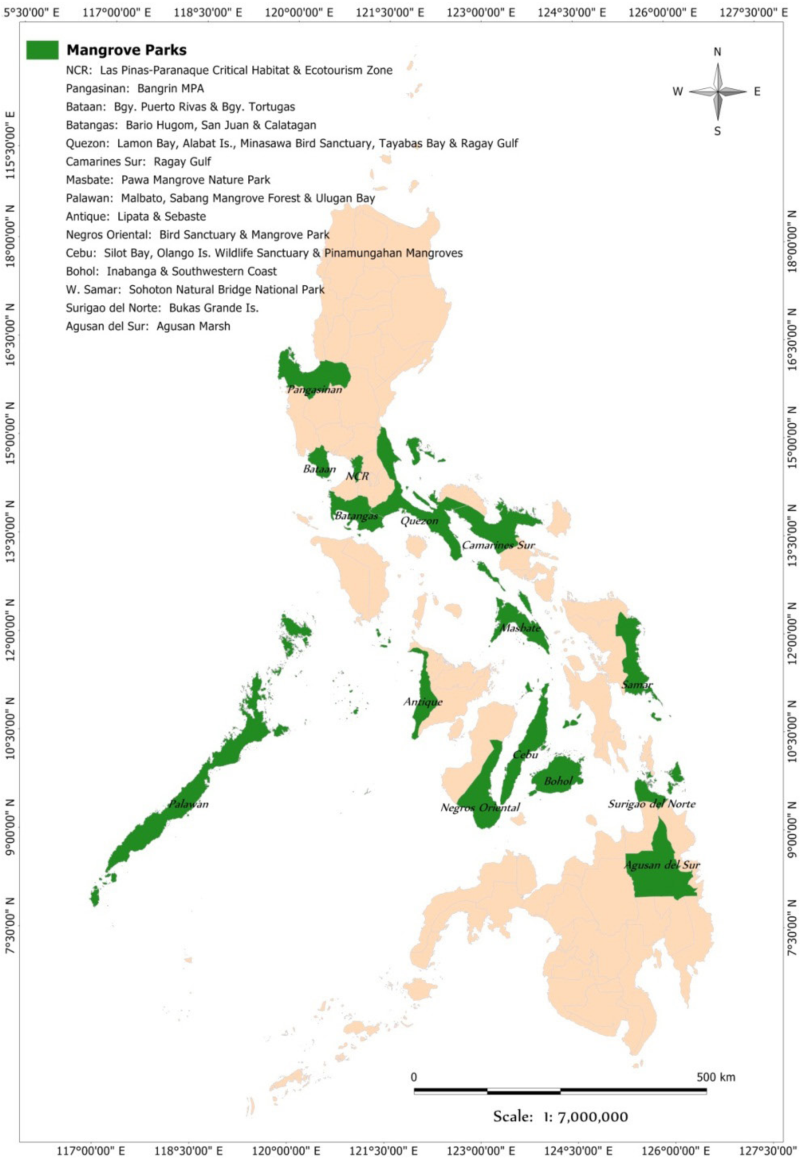


Sources: Calatagan, Batangas (Lunar and Laguardia, 2013); Puerto Princesa Bay, Plawan (Becira, 2006); Badian, Cebu (Valenzuela et al., 2013); Lincod, Bohol (Middeljans, 2014); Palompon, Leyte (Picardal et al., 2011); Ormoc Bay, Leyte (Juario and Ontoy, 2005); Looc, Romblon (Sabigan et al., 2013)

Figure 3. Dominant mangrove species in various Philippine provinces

were extremely over harvested for its many uses (White and Cruz-Trinidad, 1998). However, the leading cause of mangrove decline is its conversion to brackish water aquaculture ponds (Primavera, 2000), which is parallel to the mangrove decline in other Southeast Asian countries with large-scale fishing industries like Indonesia, Thailand, and Vietnam (Giesen et al., 2007). In Bangladesh majority of the mangroves are degraded for shrimp farming, while in China and Taiwan mangrove degradation is influenced by a number of factors including shrimp farming, charcoal production, firewood, and conversion to agricultural use (Spalding et al., 1997). In Singapore, conversion of mangrove areas to housing is the major cause (Giesen et al., 2007). In the Philippines, 95% of the brackish water ponds were originated from mangrove areas from 1952 to 1987 (PCAFNRRD, 1991; Primavera, 1995). Mangrove roots like those in *Rhizophora* collect sediments that increase land elevation, hence mangrove areas are commonly converted to fishponds after



Source: DENR 2013

Figure 4. Mangrove areas recognized as protected areas or parks in different Philippine provinces

1930 and 1980 (Walters, 2003; Walters, 2004).

Fishing industry in the Philippines is very essential (Yap, 1999) as fishes ranked second in the most important food for Filipinos after rice (White and Cruz-Trinidad, 1998). The country is in the 12th place in the largest fish producers worldwide in 1995 and in terms of aquaculture production, Philippines ranked 4th based on the FAO Yearbook 1995 (Yap, 1999). The first ponds in the Philippines were recorded as early as 1863 (Primavera, 1995). It was assumed that brackish water ponds originated either in Madura or in East Java, Indonesia with milkfish (*Chanos chanos*) as the first pond species (Yap, 1999). In 1940 brackish water culture ponds already reached a total area of 60, 998 ha with a rate of 1,176 ha (Primavera, 1995). In Kerala, Southwest India the construction of brackish water ponds for aquaculture was also initiated centuries ago (Spalding et al., 1997).

From 1950 to 1960, mangrove conversion to ponds peaked at a rate of 5,000 ha (Primavera, 1995). The ponds were constructed in the middle to upper intertidal zones (Primavera et al., 2014), and were either monocultures of milkfish or polycultures of milkfish with shrimps,

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mud crabs, seaweeds, mollusks, and fishes like rabbitfish, seabass, and tilapia; but the most profitable and prominent is with shrimps and crabs (Yap et al., 2007). This increase is attributed to the loan assistance of U$23.6 million provided by the International Bank for Reconstruction and Development (IBRD) for the development of fishponds when the Fisheries and Aquatic Resources (BFAR) was established in 1947 (Siddall et al., 1985; Primavera, 2000). From the country's total area of brackish water culture ponds (82,228 ha) in 1951, NCR (Central Luzon) had the greatest number of such ponds (34,172 ha) followed by the Western Visayas with 27, 741 ha (Fisheries Gazette of the Philippines, 1952; Primavera, 1995), which most likely is the reason behind their high percentage (more than 94%) of mangrove loss from 1951 to 1988. This indicates a greater risk for cyclones, tsunamis, storm surges, and floods in the said regions. Without the support of the government, pond construction progressed gradually (Primavera, 1995), and so mangrove degradation would be at a slower rate.

In 1970s, pond construction was reduced to 800 ha from 5, 000 ha due to the declaration of Forestry Reform Code (PD 705 in 1975; Primavera, 1995) and the 1975 Fisheries Code (Primavera, 1992). The Forestry Reform Code provided various rules and regulations on the protection and conservation of mangrove areas that function as coastal protection or buffer zones from alienation and deforestation activities. Buffer zones are those areas that contain at least 20 m of mangroves that stand along the coastline fronting the bodies of water, and those with bands of mangrove trees that line various islands, seaside roads, and coastal settlements (DENR, 2013). Southeast Asian countries essentially need coastal buffer zones with a breadth of 20 to 100 m (Philippines), 100 m (Malaysia), and 200 to 540 m (Indonesia) that should be maintained along coastlines, riverbanks, and between ponds and agricultural lands like rice fields (Primavera, 2005). Other rules of the declaration are the release of mangrove areas that do not function as buffer zones and are fit for fishpond conversion to the management of BFAR, and the reversion of such mangrove areas to forest land category after they are abandoned for 5 years from the time of release for fishpond purposes (DENR, 2013). However, mangrove forests remained listed as areas open for development in the annual statistics of BFAR until 1984 (Primavera, 1995). Thus, the construction of brackish water ponds continued to increase but at a slower rate from 1970s to 1980. Related to this is the lower percent loss in mangrove areas during the said years. This signifies the lack of protection and conservation strategies from the government itself, which is imperative to prevent further degradation of our mangrove ecosystems. Despite the continued decline of mangrove ecosystems in the country, the government funded mangrove reforestation program was only initiated during the 1980s in Marungas, Sulu (Agaloos, 1994; Primavera and Esteban, 2008). Although, mangrove reforestation projects began as early as 1930s to 1960s through the efforts of local communities from various provinces such as Negros (1930s–1940s), Bohol (1950s–1960s) (Agaloos, 1994; Primavera, 2000; Walters, 2000, 2003; Primavera and Esteban, 2008), Cebu, and Negros Oriental (Yao, 1986; Primavera, 1995). Reforestation projects were focused in Central Visayas, which is a typhoon prone region (Primavera and Esteban, 2008). Record showed that *Rhizophora* species and *Nypa fruticans* were the earliest mangroves planted surrounding Manila Bay (Brown, 1920). The first foreign funded project was the World Bank-funded Central Visayas Regional Project that took place in 1984 (Primavera and Esteban, 2008). Another reforestation project of the government is situated in Kalibo, Aklan from which 50 ha of foreshore were planted with *Rhizophora* and nipa palm (Primavera, 1995). In other countries like Bangladesh and Vietnam, wide afforestation and re-afforestation activities of mangroves are conducted for at least 15 years already. As early as 1966, Bangladesh have cultivated more than 1,200 km^2 of mangroves (Spalding et al., 1997). Moreover, Executive Order 192 was created in 1986 that required the Forest Management Bureau to prescribe policies and projects directed towards efficient protection, conservation, development, management, and use of forest lands and watersheds, which include the mangrove forests (DENR, 2013).

Nevertheless, mangrove decline was never halted. During the 1980s onwards, shrimp industry particularly on *Penaeus monodon* (giant tiger prawn) increased from 1 400 metric tons to 47,600 metric tons (1990) because of the availability of seeds and imported feeds (Primavera, 1992) that were financially aided by the government and private sectors. Examples of these sectors are the Asian Development Bank that granted U$21.8 million of loans for its Aquaculture Development Project in 1984 (Primavera 1993) and the International Bank for Reconstruction and Development (IBRD) that gave economic assistance (Primavera, 1995). In Bangladesh, *P. monodon* culture also contributed to the country's aquaculture industry (Debnath et al., 2016). Shrimp pond construction in Southeast Asia is supported by both the government and private sectors due to the export demands of shrimps (Agbayani, 2000). In the Philippines alone, an estimated 80% of prawns and shrimps were exported to Japan and 13.6% to the U.S. in 1987 (Primavera, 1992). Pond development have grown to 4,700 ha (Primavera,1995) with Central Luzon and Western Visayas having the widest area of brackish water ponds (BFAR, 1988; Primavera, 1992) that resulted to a higher rate of increase compared to the 1970s. This most likely explains the higher percent loss of mangroves from 1980 to 1988 with Central Luzon and Western Visayas having the hugest percent loss. In Thailand shrimp farming has caused the largest impact on mangrove ecosystems resulting to its decline from 1961 to 1996 (Thammarat et al., 2009). In addition to mangrove degradation, aquaculture has several environmental impacts affecting the natural habitat, wildlife, genetic traits, soil and water characteristics, and landscape. Examples are water and soil salinization, dispersion of diseases and parasites, entry of exotic species, dislocation of wildlife, and pollution (Primavera, 1994, 2005). This clearly signifies that aquaculture threatens other marine ecosystems as well. Hence, environmentally friendly aquaculture must be actively undertaken. In Thailand, for example, small-scale shrimp farmers practice farming techniques that have decreased the occurrence of diseases such as farming in supra-tidal areas, which prevent or lower the cases of water exchange unlike in mangrove areas, and the use of either concentrated seawater or freshwater as medium on cultured shrimps, which aided in reducing viral infections (Thammarat et al., 2009). Also, evidence showed that mangroves are capable of eliminating considerable amounts of nitrogen and solid wastes from shrimp ponds (Platon, 2005) signifying the important role of mangroves in treating aquaculture disposals. This further implies the need for reforestation of mangroves in pond areas.

Brackish water ponds continued to increase at a mean annual rate of 5.4% (Yap, 1999) due to its high production reaching 267 814 metric tons in 1990 (BFAR, 1990). In addition, large mangrove trees were harvested excessively since 1992 that further degraded the mangrove forests in the country (Juario and Ontoy, 2005). However, fish yields declined by 4.1% and shrimp production dropped by 14.6% in 1996. Moreso, the environmental impact of aquaculture led to its negative growth in 1997. Shrimps were infected with disease resulting to a decrease in *P. monodon* production by 47.4% yielding only 40, 102 metric tons in the said year from 76, 220 metric tons in 1996 and pollution affected the mussel beds. This has caused a slight

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decrease in the gross value of fisheries (Yap, 1999).

Besides, more laws were established in the 1990s. The Local Government Code (RA 7160) was mandated in 1991, which gives autonomy to the Local Government Unit (LGU) in the fulfillment of the national goals in their territories that include the conservation of mangroves. Among the responsibilities of the LGUs within the policies of the law are the enforcement of community-based forestry projects, implementation of environmental protection laws, fishery development, and planting trees (DENR, 2013). One example of conservation activities of the LGUs is the reforestation programs of *A. marina* in Tabuk Islet Palompon, Leyte and the protection of its remaining mangrove trees from illegal logging, which made the area a bird and marine sanctuary in 1996 (Picardal et al., 2011). In 1998, the NIPAS Law and The Fishery Code were promulgated. The NIPAS Law indicated the creation of National Integrated Protected Areas System, which specifies biologically significant ecosystems as protected areas. Such ecosystems house different forms of species that are rare or endangered like the watersheds, wildlife sanctuary, and mangrove reserve (DENR, 2013). The whole of Palawan has at least 55,000 ha of mangrove forest reserves (Primavera and Esteban, 2008) that are all recognized as protected areas (DENR, 2013). This could have contributed to the larger mangrove areas found in Region IV-B, unlike in other provinces, in which not all mangrove reserves and natural parks were recognized as protected areas. This is due to the lack of national legislation that can support and protect the LGUs, DENR, and coastal communities who made initial efforts for the actualization of the NIPAS Law from the probable actions of influential individuals with vested interests (DENR, 2013). In contrast, Malaysia recorded approximately 14.50 million ha of forest as Permanent Reserve Forests (PRF) and 3.39 million of these are designated as national parks, wildlife, sanctuaries, and nature reserves. Most importantly, their forested PRFs are sustainably managed for their ecological and economic services. Hence, Malaysia is ranked 6th in the extent of their mangrove areas worldwide (Hamdan, 2012). This indicates the importance of proper management of mangrove reserves towards its sustainable use. Brunei Darussalam, for instance, allocated only 2 km^2 of their mangrove area for urbanization and conversion to other uses, and allotted 75 km^2 for timber use, while more than 50% is designated for preservation, conservation, and protection (Spalding et al., 1997).

The Fishery Code, on the other hand, specifies policies related to all fishery operations. Few of these include the prohibition of disposal and alienation of public lands fit for fishery purposes like mangrove areas, the issuance of Foreshore Lease Agreement (FLA) for public lands that can be used for fishpond purposes only to certified fisher folks, and the responsibility of the DENR to identify underdeveloped fishponds under the FLAs that can be reverted and restored to mangrove area (DENR, 2013). When a 239,000 ha of underutilized fishponds are reverted to mangrove areas it can yield U$14, 000 to U$16,000 ha from fish catch and other ecosystem services, plus it retrieves coastal protection (Primavera et al., 2014).

The establishment of these laws and the negative growth of aquaculture could be the factors that increased the mangrove areas from 1994 to 2000. At the present time, the Local Government Code, Fishery Code of 1998, EO 192, and PD 705 remain enforced by the Philippine government to direct activities that classify, develop, and manage the environment and natural resources (DENR, 2013). Yet, the total mangrove area as of 2010 is still far from its original area in 1951. Though reforestation programs spread throughout the Philippines and gained more support from the national government and international institutions including the World Bank, Asian Development Bank, and Overseas Economic Cooperation Fund of Japan, re-plantation remains meager. It only reached an area of 8,705 ha, which is insufficient to compensate with the total mangrove loss from the accumulated years (PCAFNRRD 1991; Primavera, 1995). Other factors are inefficient implementation of laws, entry of influential authorities and business sectors that support pond industries (Primavera, 1995), lack of manpower and resources (Primavera et al., 2014), and corruption within the government agencies directly involved in the management of mangroves (Primavera 1995, 2000a).

Gaps in fishpond monitoring and management observed include the conversion of leased mangrove areas for fishpond purposes under FLA into titled fishpond beyond the knowledge of DA and DENR; illegal construction of ponds; lack of evaluation, assessment, and inventory of titled fishponds; and failure to revert abandoned or underdeveloped ponds to mangrove areas (DENR, 2013). There are 131,471 ha of brackish water ponds that are privately owned and 78 969 ha that are government owned for lease (FLA). The privately owned ponds were not described based on its location or category (Alienable or Disposable or Classified Forestland), while from all leased ponds only 45% were productive. However, only 4,758 ha were returned for reversion to mangrove areas (DENR, 2013). Another case would be the illegal conversion of mangrove area to ponds in Dasol, Pangasinan that was initiated by the municipal mayor and the secretary in 1998 (Fuertes, 1997; Primavera, 2000). In addition, there is an occurrence of mangrove forests in Alienable and Disposable Lands, which clearly implies the absence of assessment and proper evaluation of lands; lack of surveys and zoning of mangrove areas (DENR, 2013). This reveals inefficient governance of the individuals in higher positions who are t asked to implement mangrove laws, codes, and policies.

According to DENR (2013) stated that most of the mangrove areas in the country have already been degraded based on flora, subsoil, and both terrestrial and marine organisms, yet until now there has been no assessment of the general condition of mangrove ecosystems in relation to its many concerns including its protection, food security, and its threat from climate change and economic development. Alongside mangrove

Table 4. Percent loss in mangrove forest area of the Philippines from 1951 to 2010.

Year	Mangrove Area (ha)	Percent Loss /Increase	Percent Loss from 1951 (428,382 ha)
1960	365,324	14.72% (loss from 1951)	14.72%
1970	288,000	21.17% (loss from 1960)	32.77%
1980	242,000	15.97% (loss from 1970)	43.51%
1988	139,725	42.26% (loss from 1980)	69.72%
1990[a]	132,500	5.17% (loss from 1988)	69.07%
1994	120,500	9.06 % (loss from 1990)	71.87%
2000[b]	256,185	113.02 % (increase from 1994)	40.20%
2003[c]	248,907	2.84% (loss from 2000)	41.90%
2010[d]	240,824	3.25% (loss from 2003)	43.78%

Sources: (1951) Villaluz 1953, (1988) National Mapping and Resource Information Authority 1988, (1994) DENR 1996 as cited by Primavera 2000, [a] Primavera 1995, [b] Long and Giri 2011, [c] DENR 2013, [d] Long et al. 2014

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degradation is the ecosystem's vulnerability to climate change (Cuenca et al., 2015). An important impact of climate change to mangrove ecosystems is the rising of sea levels, which may have the greatest threat to mangrove areas that are having reduction in sediment elevation and with limited landward migration (Gilman et al. 2008). Mangroves are responsible for substrate elevation at a rate of about 0•1 cm year by trapping suspended sediments (brought by tidal inundation) to nearly 80% or equal to roughly 10–12 kg of sediment m−1creek length/ spring tides (Furukawa et al., 1997).

To sum it up, mangrove ecosystems in the Philippines are still declining. Though efforts were made by both the private and public sectors in reforesting mangrove ecosystems, it is not enough to make up for the losses made through the years. Fisheries remain an important economic aspect in the Philippines, hence its continued mangrove degradation. It is evident that the construction of brackish water culture ponds is inversely proportional to the status of mangrove ecosystems. Even though the economic and ecological importance of mangroves and their main cause of degradation have already been identified in the past years, the government only showed minor efforts to address the seriousness of the problem.

Table 5. Percent loss of mangrove forest cover in the Philippines per region from 1951 to 1994.

Region Number	Region Name	1951[a] (ha)	1988[b] (ha)	% Loss (1951-1988)	1994[c] (ha)	% Loss (1988-1994)	Total % Loss (1951-1994)
I	Ilocos Region	771	200	74.05	100	50.00	87.03
II	Cagayan Valley	7,322	3,400	53.56	3,800	No loss	48.10
III	Central Luzon	56,799	500	99.12	100	80.00	99.82
IV	Southern Tagalog	77,997	51,000	34.61	29,400	42.35	62.31
V	Bicol Region	42,234	9,900	76.56	600	93.94	98.58
VI	Western Visayas	49,035	2,825	94.24	3,000	No loss	93.88
VII	Central Visayas	24,213	9,650	60.10	2,500	74.10	89.68
VIII	Eastern Visayas	36,501	24,850	31.92	600	97.59	98.36
IX	Western Mindanao	91,072	19,300	78.81	54,100	No loss	40.60
X	Northern Mindanao	18,273	8,600	52.94	20,300	No loss	No loss
XI	Southern Mindanao	17,518	7,100	59.47	5,800	18.31	66.89
XII	Central Mindanao	6,647	2,400	63.89	200	91.67	96.99
	Total	428,382	139,725	67.38	120,500	13.76	71.87

Sources: [a] Villaluz, 1953 as cited by Primavera, 2000, [b] National Mapping and Resource Information Authority, 1988 as cited by Primavera, 1995, [c] DENR, 1996 as cited by Primavera, 2000a

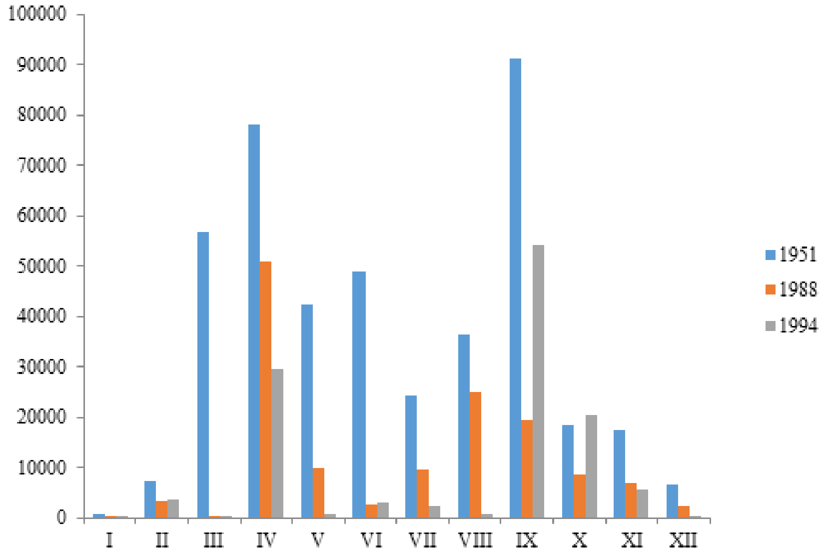

Figure 5. Change in mangrove forest area in different regions of the Philippines from 1951 to 1994.

Table 6. Mangrove forest area of the Philippines in classified forestland and in alienable and disposable lands from both natural and plantation sources per region in 2003.

Region	**Mangroves (ha) (Natural)**		**Total (ha)**	**Mangroves (ha) (Natural)**		**Total (ha)**
	Classified Forestland	**Alienable and Disposable Lands**		**Classified Forestland**	**Alienable and Disposable Lands**	
I	85	66	151			
II	3,069	5,533	8, 602			
III	137	231	368			
NCR		30	30			
IV-A: Calabarzon	5,237	6,109	11,346			
IV-B: Mimaropa	43,908	13,659	57,567	465		465
V	6,698	6,801	13,499			
VI	2,306	2,294	4,600			
VII	5,949	5,821	11,770			
VIII	23,000	15,781	38,781	287	226	513
IX	14,931	7,348	22,279	46	3	49
X	1,297	1,195	2,492			
XI	799	1,211	2,010			
XII	418	932	1,350	86		86
CARAGA	13,808	12,923	26,731			
ARMM	31,935	13,851	45,786	432		432
Total	153,577	93,785	247,362	1,316	229	1,545

Source: DENR, 2013

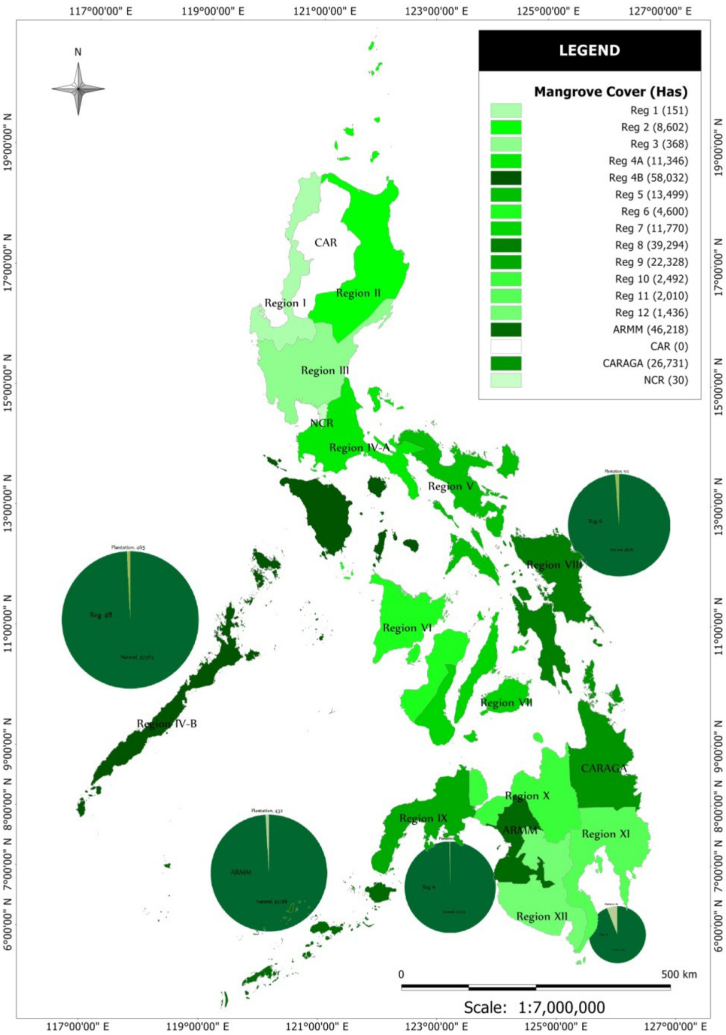

Figure 6. Mangrove forest cover in different regions of the Philippines from both natural and plantation sources in 2003 (DENR, 2013).

Table 7. Change in area of brackish water ponds from 1950 to 2010.

Year	Area (ha)[a]	Area Increased (ha)	Percent Increase (%)
1950	72,753[b]		
1951	82,228[b]	9,475 (from 1950)	13. 02%
1960	123,252[b]	41,024 (from 1951)	49.89%
1970	168,118[b]	44,866 (from 1960)	36.40%
1980	176,231	8,113 (from 1970)	4.83%
1988	210,680	34,449 (from 1980)	19.55%
1990	222,907	12,227 (from 1988)	5.80%
1994	239,323	16,416 (from 1990)	7.36%
2000	239,323	No increase	
2003	239,323	No increase	
2010	239,323	No increase	

Sources: [a] *BFAR 1980, 1988, 1990, 1994, 2000, 2003, 2010,* [b] *Primavera 1995*

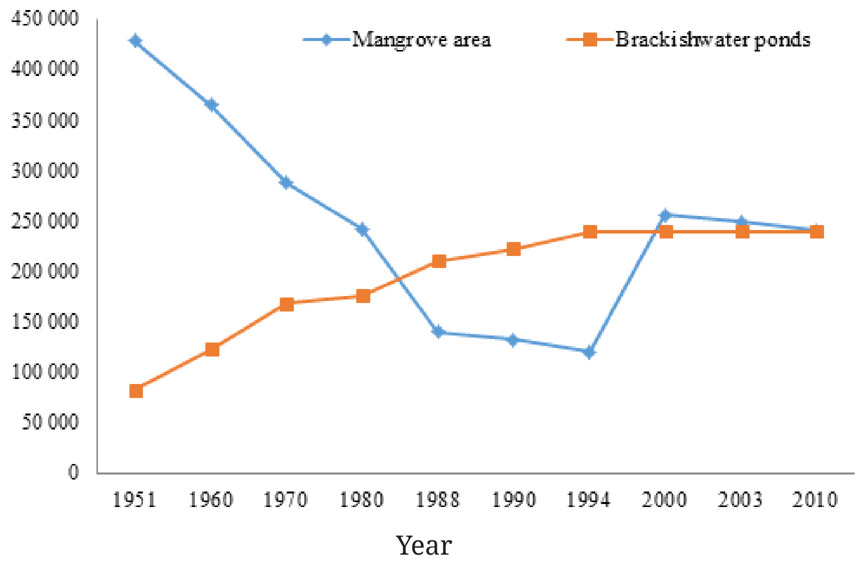

Figure 7. Changes in mangrove forest and brackish water pond areas from 1950 to 2010 Mangrove area:1951 (Villaluz, 1953; Primavera, 2000), 1960-1990 (Primavera, 1995), 1988 (National Mapping and Resource Information Authority, 1988; Primavera, 2000), 1994 (DENR, 1996; Primavera, 2000), 2000 (Long and Giri, 2011), 2003 (DENR, 2013), 2010 (Long et al., 2014); Brackish water ponds area: 1950-1990 (Primavera 1995), 1988-2010 (BFAR, 1988, 2000, 2003, 2010).

CONCLUSION AND RECOMMENDATIONS

The most dominant mangrove species in the Philippines are the *Avicennia, Sonneratia,* and *Rhizophora* that commonly grow in a muddy substrate and Bohol has the most diverse in terms of the number of species of mangroves. Though, status of mangroves in the municipal and provincial levels is limited since thorough assessment was not yet conducted by appropriate government agencies at this level nationwide. Through the years, the country's mangrove ecosystems declined primarily because of the growth of brackish water aquaculture ponds and partly due to unsustainable use and harvesting for fuel food, housing needs, and opening for tourism and residential areas. The continued degradation of mangrove ecosystems signifies greater impacts of climate change, higher risk to cyclones, tsunamis, and the like, and declining fisheries products. Since both fisheries and mangroves are important aspects in the country, the government must promote the sustainable use of mangrove ecosystems. Laws must be properly and actively enforced most especially on the protection, restoration, and conservation of mangroves, and on the regulation of aquaculture ponds. Mangrove reforestation programs should consider the suitability of mangrove species to its environment to achieve a higher rate of success. In addition, environment-friendly aquaculture must be applied in all forms of aquaculture to prevent its impacts on coastal waters, habitats, and wildlife. Hence, it is important that more studies must be conducted with regards to the status of mangrove species in every province in the country and appropriate management of our mangroves and fishponds must be undertaken by the designated authorities.

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