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Tanintharyi Conservation Programme

SURVEY OF MANGROVES IN AUCKLAN BAY AND ADJACENT AREAS, KYUN-SU AND BOKE-PYIN TOWNSHIPS, TANINTHAYI REGION

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The program

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Cover image

Rhizophora mucronata, Aucklan Bay, Myanmar (Credit: San Tha Tun)

Introduction

Mangroves are the trees and bushes growing within the intertidal zone, especially between mean sea level and high tide mark reached in spring tide. Palms, ferns and some climbers are also associated in this community. The term 'mangrove' is also used more generally to describe both the plant communities they form and the habitat itself (Clough, 2013). The most extensive mangroves are found in rivers, deltas, where rivers flow directly into the ocean and have created new expanses of land through the active deposition of new sediments (Spalding et al., 2010).

Among 18 million ha of the mangroves cover at global scale (Spalding et al., 1997), focal area can be determined throughout South East Asia, from Myanmar in the northwest through the scattered islands of Indonesia to the Philippines archipelagos. There are approximately 70 species of true mangroves, of which some 65 contribute significantly to the structure of mangrove forests.

Myanmar abound a long coastline, three coastal regions as Rakhine Coast, Ayeyarwady Delta and Taninthayi Coast (Figure 1), measuring about 2400 km from the Naaf River mouth to the Pakchan River mouth with a large number of estuaries, rivers, creeks and islands (Capt. San Myint, 1995), with mangrove areas of 502,911 ha. (Spalding et al., 2010)). In these mangroves, 46% are included in Ayeyarwady, 37% in Tanintharyi and 17% in Rakhine. Mangrove areas of Myanmar stand at about 7th position in the world and 3rd position in Southeast Asia. On the other hand, Myanmar possesses 4% of world mangroves, and 8.8% of Southeast Asia mangroves (Giesen *et al*. 2006). Myanmar also comprises over eighty species of mangroves and its' associates. In this study area, 46 species of trees, shrubs, herbs, climbers, palms and fern also contribute to the structure of mangroves although there is no clear dividing line between major and minor mangroves.

Mangroves forests are never homogenous and the species within them are never evenly distributed. Individual species show distinct niche preferences, while the ecosystems themselves are dynamic, influenced by local patterns of the physical and chemical environment. Mangrove ecosystems not only produce goods but they also provide services.

Linked to mangroves are thousands of other species of plants and animals, fungi and bacteria, which together make up a complex ecosystem. Mangrove plants are the ecosystem engineers, building and maintaining the physical structure of the habitat; they also key primary producers in the estuarine and marine environment.

Human has used mangroves for a long time. Timber and fisheries benefits from the mangroves are probably as old as the history of human settlement in mangrove areas; but as societies became more structured, so larger-scale and industrial uses of mangroves spread. One of the best-known early 'industrial uses' of mangroves was the large trade in mangrove poles from East Africa to various Arab States. This dates back to 200 BC and continued throughout the 1980s. Human uses of mangrove ecosystem today are considerable. The most important of these are derived from three critical ecosystem services, the provision of wood, the support of fisheries, and the protection of coastlines from storms and erosion (Spalding *et al*., 2010).

The aims of this study are: 1) to know the mangrove species growing around Aucklan Bay and Whale Bay areas; 2) to visualize and evaluate the current status of economically important species of mangroves from both bays coastal areas; and 3) Identify key mangrove forests for protection.

Study Areas and Methods

Study Areas

Aucklan Bay is situated in eastern part of Andaman Sea and it is included in Kyun Su Township. Whale Bay is also located in this region and shared by Kyun Su and Boke Pyin Thowships. Many rivers, creeks and tributaries have been formed in this region. Many rivers and creeks that originated from Taninthayi mountain ranges and flowing into Andaman Sea. The rivers and creeks' water carry sediments from mountain ranges and deposits in this area and creating deltaic formation. The both banks of the rivers and creeks and river mouth create an establishment of mud flats with mangrove vegetation. The present study was conducted around Aucklan Bay and Whale Bay regions. The map of the study area was shown in Figure 1.

Identification of Mangroves

Identification of the mangrove species in the present study was used by Tomlinson (1986), Aksornkoae *et al*. (1992), Kitamura *et al*. (1997), Naskar and Mandal (1999) and Giesen *et al*. (2006).

Methods for Relative Density and Relative Frequency

Relative density and relative frequency of mangrove species and plant cover data were collected during April and May 2014. To access the relative density and frequency of plant species, sixteen random sample plots were established through the study areas. The measurement of each sample plot is $30m^2$. The location of each plot was marked by GPS. All the plants within the sample plots were recorded for tree ≥ 2.5 cm diameter at breast height (DBH). Shrubs and climbers in the sample plots were also recorded.

Relative density and relative frequency were calculated according to Snedaker and Snedaker, 1984 and English *et al.,* 1994. Quantitative parameters such as percentage of density and frequency of each species present in sample plots were recorded and analysed.

The density of a species is the numerical representation of its individual in a plot (unit area). The density of a species refers to the adequacy of its different requirements and the availability of space. Density is determined by-

$$\text{Density (D)} = \frac{\text{No. of individuals of the species in all the sample plots}}{\text{Total no. of sample plot studied}}$$

$$\text{Relative Density (R.D)} = \frac{\text{No. of individuals of the species in all the sample plots}}{\text{No. of individuals of all the species}} \times 100$$

The frequency of a species is expressed as the percentage of occurrence of its individuals in a number of observations. In order to obtain the frequency of different species growing in a community, it is determined by

$$\text{Frequency (F)} = \frac{\text{No. of sample plots in which the species occur}}{\text{Total no. of plots samples}}$$

$$\text{Relative Frequency (F)} = \frac{\text{No. of occurrences of the species}}{\text{No. of occurrences of all the species}} \times 100$$

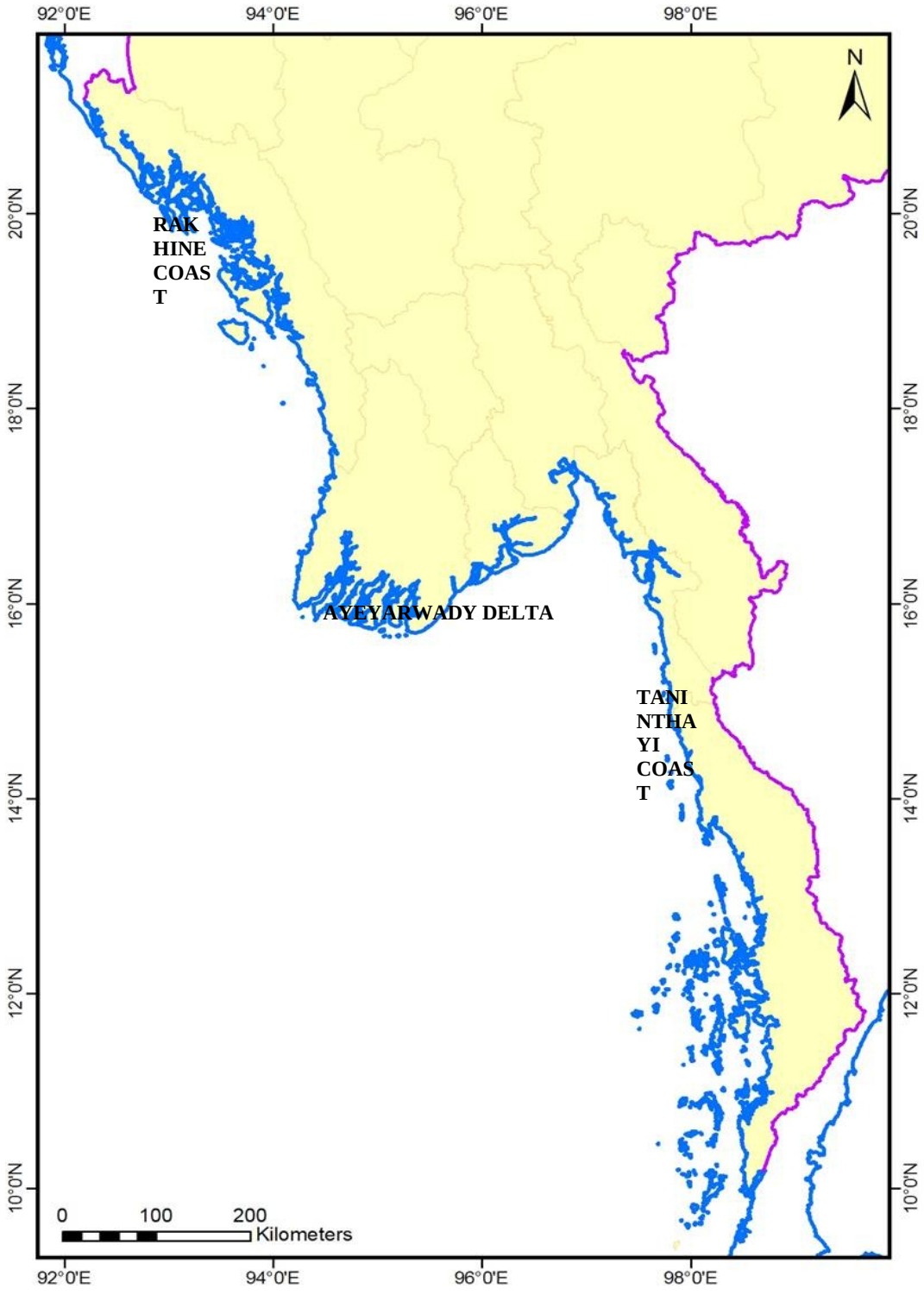

Fig.1. Map showing the three coastal regions of Myanmar

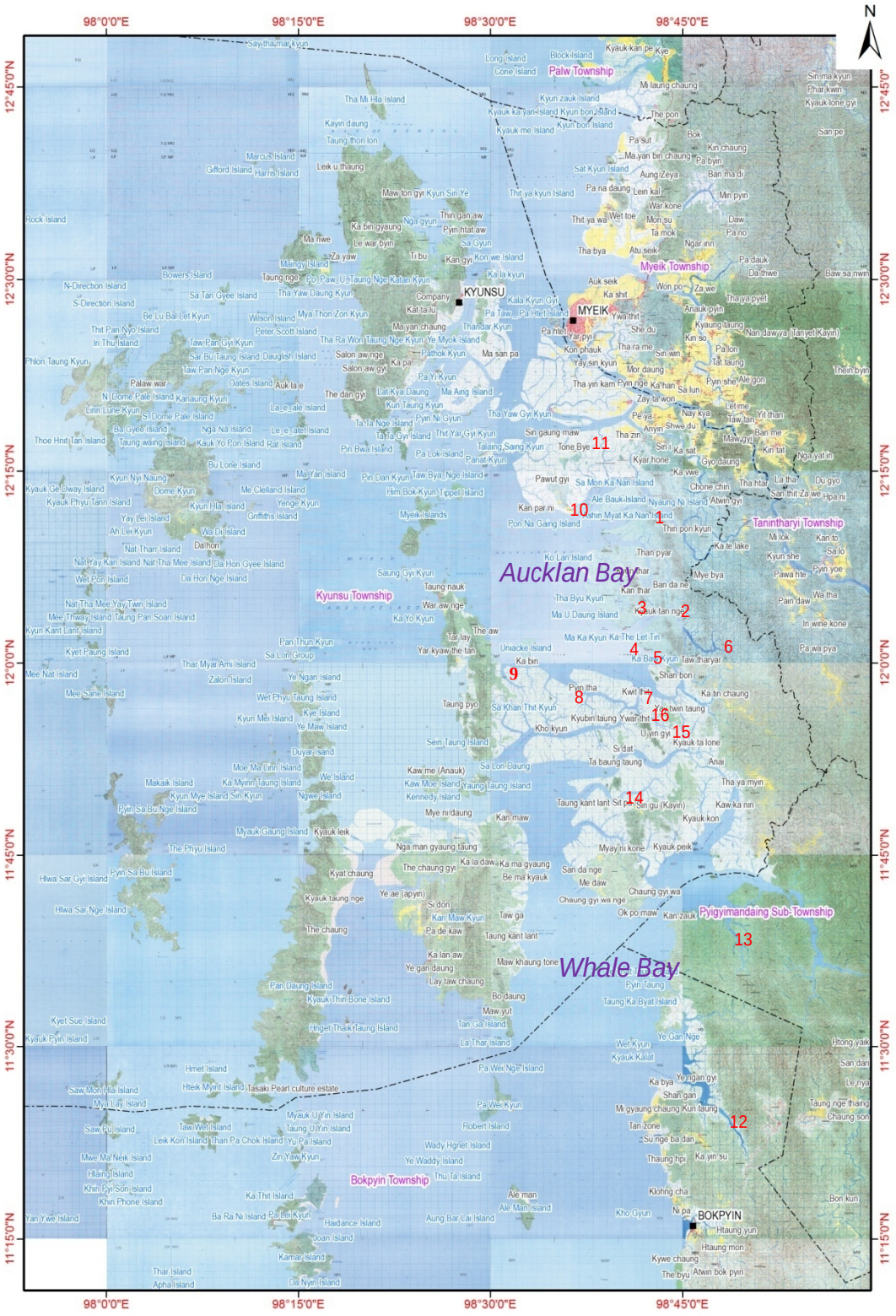

Fig.2. Map showing the random sample plots and survey areas

Results

Identification and Species Composition

Identified list of mangroves in Aucklan Bay and adjacent areas have been described in table 1. In the present study area, a total of 4609 individuals, representing 46 species belonging to 32 genera from 20 families were recorded.

In study area, the most abundant family was the Rhizophoraceae with eight species followed by Avicenniaceae with three species, Meliaceae with two species, Sonneratiaceae, Plumbaginaceae, Myrsinaceae, Sterculiaceae, Rutaceae, Fabaceae, Tiliaceae, Arecaceae and Euphorbaceae with one species each respectively (Table 2).

Table1. Identified list of mangroves in Aucklan Bay and adjacent areas

No.	Family	Genus/Species	Habit
1.	Acanthaceae	*Acanthus ilicifolius*	Herb/Shrub
2.		*Acanthus volubilis*	Climber
3.	Arecaceae	*Nypa fruticans*	Palm
4.		*Oncosperma tigillarium*	Palm
5.		*Phoenix paludosa*	Palm
6.	Asclepiadaceae	*Finlaysonia maritima*	Climber
7.		*Sarcolobus carinatus*	Climber
8.		*Pentatropis capensis*	Climber
9.	Asteraceae	*Pluchea indica*	Shrub
10.	Avicenniaceae	*Avicennia alba*	Tree
11.		*Avicennia marina*	Tree
12.		*Avicennia officinalis*	Tree
13.	Bignoniaceae	*Dolichandrone spathacea*	Tree
No.	**Family**	**Genus/Species**	**Habit**
14.	Euphorbiaceae	*Excoecaria agallocha*	Tree
15.	Fabaceae	*Caesalpinia crista*	Shrub
16.		*Cynometra ramiflora*	Small tree
17.		*Dalbergia spinosa*	Spiny shrub
18.		*Derris scandens*	Climber
19.		*Derris trifoliata*	Climber

20.		*Intsia bijuga*	Tree
21.		*Pongamia pinnata*	Tree
22.	Flagellariaceae	*Flagellaria indica*	Climber
23.	Malvaceae	*Hibiscus tiliaceus*	Shrub
24.	Meliaceae	*Xylocarpus granatum*	Tree
25.		*Xylocarpus moluccensis*	Tree
26.	Myrsinaceae	*Aegiceras corniculatum*	Small tree/Shrub
27.	Plumbaginaceae	*Aegialitis rotundifolia*	Small tree
28.	Pteridaceae	*Acrostichum aureum*	Fern
29.		*Acrostichum speciosum*	Fern
30.	Rhizophoraceae	*Bruguiera cylindrica*	Tree
31.		*Bruguiera gymnorhiza*	Tree
32.		*Bruguiera parviflora*	Tree
33.		*Bruguiera sexangula*	Tree
34.		*Ceriops decandra*	Small tree/Shrub
35.		*Ceriops tagal*	tree
36.		*Kandelia candel*	Small tree
37.		*Rhizophora apiculata*	Tree
38.		*Rhizophora mucronata*	Tree
39.	Rutaceae	*Merope angulata*	Shrub
40.	Sonneratiaceae	*Sonneratia alba*	Tree
41.		*Sonneratia apetala*	Tree
42.		*Sonneratia griffithii*	Tree
No.	**Family**	**Genus/Species**	**Habit**
43.	Sterculiaceae	*Heritiera fomes*	Tree
44.		*Heritiera littoralis*	Tree
45.	Tiliaceae	*Brownlowia tersa*	Shrub
46.	Verbenaceae	*Clerodendrum inerme*	Shrub

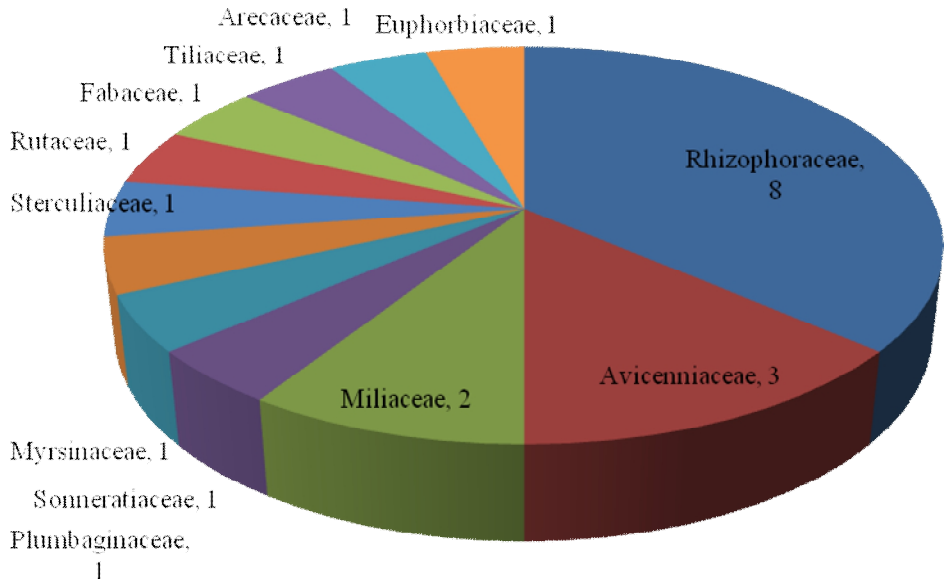

Fig.3. Ranking of family by number of tree species composition in study area

Table 2. Ranking of family by number of tree species composition in study area

No.	Family	No. of Species	No. of Plants
1	Rhizophoraceae	8	3453
2	Avicenniaceae	3	102
3	Miliaceae	2	151
4	Sonneratiaceae	1	191
5	Plumbaginaceae	1	61
6	Myrsinaceae	1	307
7	Sterculiaceae	1	161
8	Rutaceae	1	42
9	Fabaceae	1	21
10	Tiliaceae	1	3
11	Arecaceae	1	26
12	Euphorbiaceae	1	91
	Total		4609

Relative Density and Relative Frequency

Relative density of mangrove species in study area is shown in Figure 3. As a result, relative density for *R. mucronata* was 24.97% followed by *C. decandra* 24.23%, *R. apiculata* 9.52%. *B. sexangula* and *C. tagal* show low relative density in this study.

Relative frequency of mangrove species in study area is shown in Figure 4. Relative frequency for *R. mucronata* was 87.5% and *B. parviflora* was 75% followed by *R. apiculata* 68.75% and *X. granatum* 68.75%. *B. sexangula* shows low relative frequency in this study.

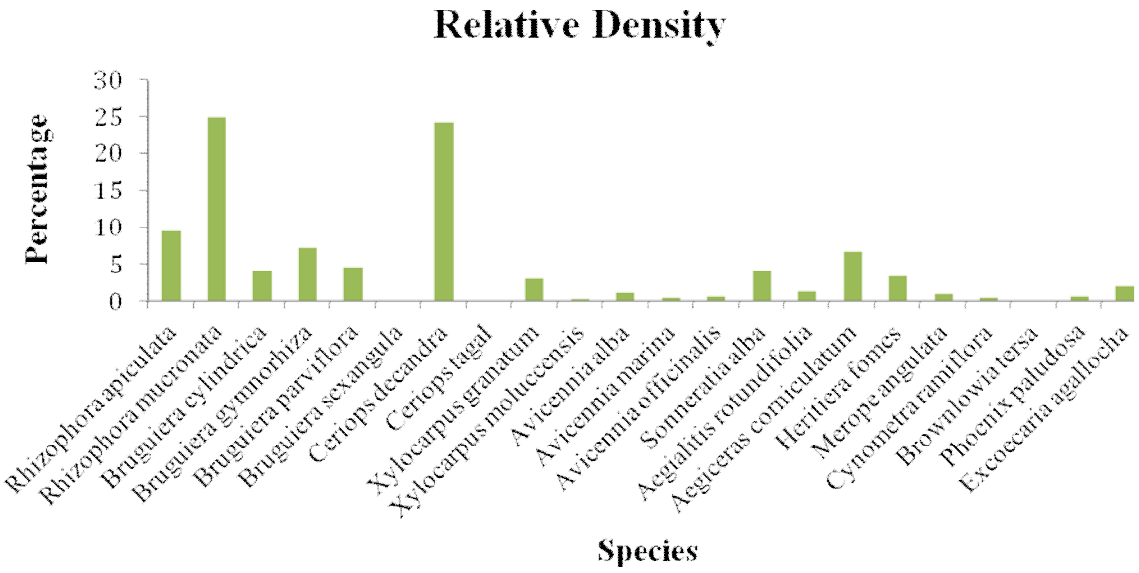

Fig.4. Relative density of mangrove species based on the random sample plots

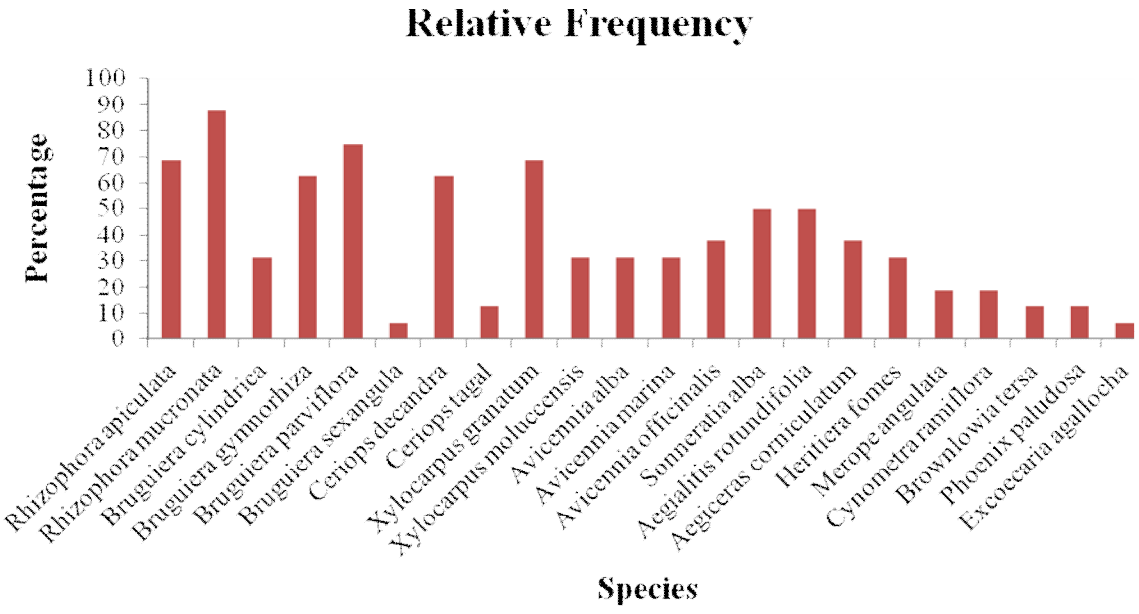

Fig.5. Relative frequency of mangrove species based on the random sample plots

Tree species distribution by Frequency classes

According to the Raunkiaer (1934), five frequency class of species frequency distribution found in the study area were shown in table 2 and Figure 5. The frequency gives an approximate indication of the homogeneity of the species/stands.

Table3. Tree species distribution by Frequency classes in study area

Frequency range	Frequency class	No. of species	Total individual	% of total species frequency distribution
1-20%	A	7	189	31.81818
21-40%	B	7	773	31.81818
41-60%	C	2	252	9.09091
61-80%	D	5	2244	22.72727
81-100%	E	1	1151	4.54545
	Total	22	4609	100

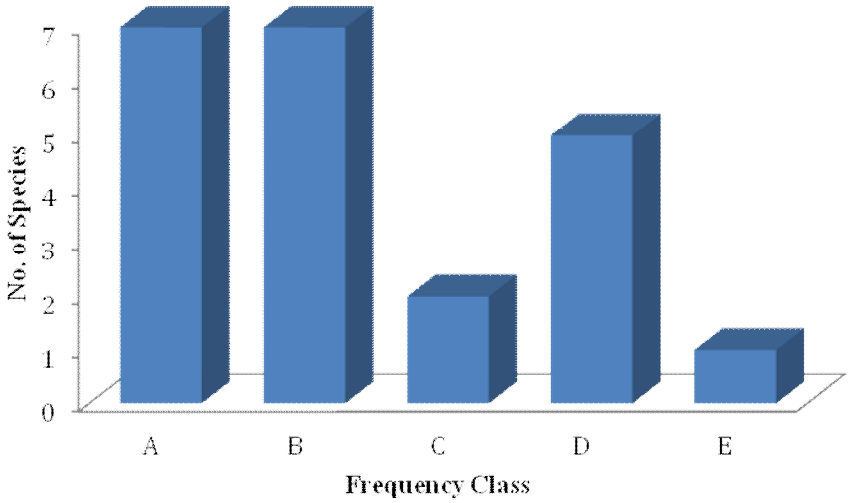

Fig.6. Tree species distribution by Frequency classes in study area

Phenology

Mangrove plants show periodicity and seasonality in leaf, flower and fruit production. The leaves of *Excoecaria agallocha* turn to red color before shedding. No seasonal shedding of the leaves was observed in *Aegialitis rotundifolia*, *Aegiceras corniculatum*, *Avicennia* spp. and *Bruguiera* spp.

Members of the Family Avicenniaceae show a flowering pulse and which occurs during the months of March and April. Flowering and fruiting of the members of Family Rhizophoraceae especially *R. apiculata*, *R. mucronata*, *B. gymnorhiza*, *B. parviflora* have been observed in this study period. Buds formation, flowering and fruiting of some mangrove species of Aucklan Bay and adjacent areas in April and early May have been shown in Table 3.

Natural Regeneration

Many mangrove species regenerate naturally within the forests. Viviparous species in this study area such as *R. apiculata*, *R. mucronata*, *B. cylindrica*, *B. gymnorhiza*, *B. parviflora* and *C. decandra* regenerate under/near the parent plants and other convenient places (Appendix I, Figure 1, 2, 3, 4). Seedlings of *S. alba* and *A. alba* grow its' parent plants and some soft mud banks (Appendix I, Figure 10, 11).

Table4. Phenology of some mangrove species of study areas in April and early May

No.	Family	Genus/Species	Buds Formation	Flowering	Fruiting
1.	Acanthaceae	*Acanthus ilicifolius*		Â	Â
2.		*Acanthus volubilis*		Â	Â
3.	Avicenniaceae	*Avicennia alba*		Â	
4.		*Avicennia marina*		Â	
5.		*Avicennia officinalis*		Â	
6.	Euphorbiaceae	*Excoecaria agallocha*		Â	
7.	Fabaceae	*Caesalpinia crista*		Â	Â
No.	**Family**	**Genus/Species**	**Buds Formation**	**Flowering**	**Fruiting**
8.		*Cynometra ramiflora*			Â
9.		*Dalbergia spinosa*	Â	Â	
10.		*Derris scandens*		Â	
11.		*Derris trifoliata*		Â	
12.	Fabaceae	*Intsia bijuga*			Â
13.		*Pongamia pinnata*		Â	Â
14.	Flagellariaceae	*Flagellaria indica*		Â	
15.	Malvaceae	*Hibiscus tiliaceus*		Â	Â
16.	Meliaceae	*Xylocarpus granatum*		Â	Â
17.		*Xylocarpus moluccensis*		Â	
18.	Myrsinaceae	*Aegiceras corniculatum*	Â	Â	Â

19.	Plumbaginaceae	*Aegialitis rotundifolia*		Â	
20.	Rhizophoraceae	*Bruguiera cylindrica*		Â	Â
21.		*Bruguiera gymnorhiza*	Â	Â	Â
22.		*Bruguiera parviflora*	Â	Â	Â
23.		*Bruguiera sexangula*		Â	
24.		*Ceriops decandra*		Â	Â
25.		*Ceriops tagal*		Â	
26.		*Kandelia candel*	Â	Â	Â
27.		*Rhizophora apiculata*	Â	Â	Â
28.		*Rhizophora mucronata*		Â	Â
29.	Rutaceae	*Merope angulata*			Â
30.	Sonneratiaceae	*Sonneratia alba*	Â	Â	Â
31.		*Sonneratia apetala*	Â	Â	
32.		*Sonneratia griffithii*	Â	Â	Â
33.	Sterculiaceae	*Heritiera fomes*		Â	
34.		*Heritiera littoralis*		Â	
35.	Tiliaceae	*Brownlowia tersa*		Â	
36.	Verbenaceae	*Clerodendrum inerme*		Â	Â

Utilization

In traditional societies in this study area rural people utilize and live within the mangrove ecosystems (Appendix II, Figure 1). The two most widespread uses of mangrove wood are for fuel and construction. Different mangrove species have different wood properties, making some more suitable for specific uses.

Firewood

Firewood is usually obtained from trees and branches. *Rhizophora* spp., *Bruguiera* spp., *Ceriops* spp., *H. fomes* and *Xylocarpus* spp. are the main uses for firewood. Although the volume is not estimated, all mangrove dwellers use good quality firewood especially for cooking. Elsewhere in this study area, the billets are split into sections and sold as firewood (Appendix II, Figure 2).

Charcoal

Charcoal production has been started about 1995. Charcoal kilns were located on the hillside along the river banks and creeks and close to rivers and creeks where transport boats (Appendix II, Figure 3, 4) can dock. At the present time, kilns were made by carving hillside (Appendix II, Figure 5, 6). Charcoal kilns of this study area are not as dome shape, and it is rectangular. The measurement of kiln was mentioned as diagonally across the corner. The large kiln is about 6.4-7.3m, medium kiln is about 4.1-4.5m and the small one is about 1.8m.

If the wood (billets) cannot transform into fully charcoal (Appendix III, Figure 1), the brown-black billets have also been used as firewood, and these are called 'Htin-Khaung' by local people (Appendix III, Figure 2).

Construction and other uses

The extraction of poles from *R. apiculata*, *R. mucronata*, *B. gymnorhiza* and *S. alba* is mostly from the construction of houses, walkway and fishing stakes. Timber planks from *S. alba* is the most obvious and significant mangrove forest product for the construction of walkway flooring and jetty in this study area (Appendix III, Figure 3, 4 and 5). Villagers sawed *S. alba* wood up into logs (Appendix III, Figure 6). *S. alba* is also used for keels and flooring of vessel and *H. fomes* and *X. moluccensis* have been used for paddles and oars. And, simple dug-out container is curved from large trunks of *S. alba*. to put shrimp paste (Appendix IV, Figure 1). Moreover, timber planks from *X*. *moluccensis* have been used for house flooring. The long and strong poles of *B. parviflora* are used for the rooftop.

Big billets of *R. mucronata* were used for the seats of coffee shop (Appendix IV, Figure 2). The drying racks (Appendix IV, Figure 3) and interweaving network for the walls have been derived from Rhizophoraceae plants and *S. alba* (Appendix IV, Figure 4). *Nypa* palms are widely used as form of thatch for traditional housing throughout this study area. Utilization of some mangrove species is summarized in Table 4.

Table 5. Utilization of some mangrove species in study areas.

	Species	Firewood	Charcoal	Timber	Poles	Fence Posts	Construction	Fishing Stakes	Boat Building	Furniture	Flooring
1	*Avicennia alba*	Â	Â		Â	Â		Â			Â
2	*Avicennia marina*	Â	Â		Â	Â		Â			Â
3	*Avicennia officinalis*	Â	Â		Â	Â		Â			Â
4	*Excoecaria agallocha*				Â	Â					
5	*Xylocarpus granatum*	Â	Â						Â	Â	
6	*Xylocarpus moluccensis*	Â	Â	Â			Â		Â		Â
7	*Aegiceras corniculatum*	Â			Â	Â					
8	*Bruguiera cylindrica*	Â	Â		Â	Â	Â	Â			Â
9	*Bruguiera gymnorhiza*	Â	Â		Â	Â	Â	Â			Â
10	*Bruguiera parviflora*	Â	Â		Â	Â		Â			Â
11	*Ceriops decandra*	Â			Â	Â		Â			
12	*Ceriops tagal*	Â	Â		Â	Â		Â			Â
13	*Rhizophora apiculata*	Â	Â		Â	Â	Â	Â			Â
14	*Rhizophora mucronata*	Â	Â		Â	Â	Â	Â			Â
15	*Sonneratia alba*			Â	Â		Â	Â	Â		Â
16	*Sonneratia apetala*				Â			Â			
17	*Sonneratia griffithii*			Â							
18	*Heritiera fomes*	Â	Â	Â	Â		Â				

Conservation Needs

Although the whole/entire Aucklan Bay areas would be conserved, prioritization will be chosen. A summary of all results and levels of degradation at each site are given in Table 5. Prioritization (eg. first, second and third) for conservation needs of studied sample plot areas have been categorized and described in Table 5.

There are no shrimp farming in this area because it is possible that the local people could survive on various kinds of forestry activities and artisanal fisheries. On the other hand, some conservation activities have been undertaken by private enterprises (private sector) in Kyun-Su Township (Appendix IV, Figure 5, 6).

Table 5. Summary of results and levels of degradation at each site

Site	GPS Location	# of Mangrove Species	Top 5 species densities (in order highest to lowest)	Quantitative Description (3heavily degraded; 2 degraded; 1 intact)	Main threat/s	Qualitative description (include potential for protection, any distinguishing notes)
1	12° 11´ 33´´ N, 98° 40´ 42´´ E	12	*Ceriops decandra, Bruguiera gymnorhiza, Bruguiera cylindrica, Rhizophora apiculata, Rhizophora mucronata*	*R. apiculata*, *R. mucronata* & *B. gymnorhiza* **= 3**; *B. cylindrica* & *B. parviflora* **= 1**	Exploit for charcoal, firewood and household items	Natural regeneration - *C. decandra* & *B. cylindrica; C. tagal* is rare and need to protect
2	12° 02´ 02´´ N, 98° 47´ 08´´ E	7	*R. apiculata, Xylocarpus granatum, Bruguiera parviflora, R. mucronata, Aegiceras corniculatum*	*R. apiculata*, *R. mucronata* & *X. granatum* **= 2**	Exploit for charcoal	Most *Rhizophora* stands have been cut; *S. griffithii* and *X. mekongensis* rare and need to protect
3	12° 03´ 50´´ N, 98° 44´ 14´´ E	12	*C. decandra, R. mucronata, R. apiculata, B. parviflora, X. granatum*	*R. apiculata*, *R. mucronata* & *B. parviflora* **= 2**	Exploit for charcoal, firewood	Natural regeneration - *B. parviflora*
4	12° 03´ 01´´ N, 98° 40´ 43´´ E	10	*R. mucronata, R. apiculata, Avicennia alba, B. gymnorhiza, Avicennia marina*	*R. apiculata*, *R. mucronata, B. gymnorhiza* & *B. parviflora* **= 2**	Exploit for charcoal, firewood and construction	National regeneration - *A. corniculatum*, *A. alba* & *A. rotundifolia*
5	12° 01´ 17´´ N, 98° 41´ 40´´ E	7	*Aegiceras corniculatum, Sonneratia alba, A. alba, Aegialites rotundifolia, R. apiculata*	*S. alba* **= 2**	Exploit for household items	*S. alba* and *A. alba* dominant; Natural regeneration - *A. corniculatum*, *A. rotundifolia; A. alba* stands dbh (21.00-46.45 cm)
6	11° 52´ 53´´ N, 98° 45´ 20´´ E	19	*C. decandra, Heritiera fomes, Merope angulata, B. gymnorhiza, X. granatum*	*B. gymnorhiza* & *B. parviflora* **= 2**	Exploit for household items	*B. sexangula* is rare and need to protect; shrubs and climbers also invaded
7	11° 57´ 22´´ N, 98° 41´ 11´´ E	12	*R. mucronata, R. apiculata, B. parviflora, X. granatum, A. alba*	*R. mucronata, B. gymnorhiza* **= 3**; *X. granatum* **= 2**	Exploit for charcoal, firewood and household items	*C. tagal* is rare and need to protect; *X. granatum* has been cut; *R. mucronata* has small dbh (2.86-8.9 cm), one stand dbh (18.1 cm); *R. apiculata* dbh (8.27-18.1 cm)

8	11° 57´ 41´´ N, 98° 36´ 52´´ E	11	*R. mucronata, R. apiculata, Bruguiera cylindrica, B. gymnorhiza, B. parviflora*	*R. mucronata* **= 3**; *B. gymnorhiza* & *B. parviflora* **= 2**	Exploit for charcoal, firewood and construction	Big stands of *Rhizophora* and *Bruguiera* have been cut; Natural regeneration - *B. Cylindrica*, *B. gymnorhiza* and *B. parviflora*; *R. apiculata* dbh (25.45 cm) - very rare as this size in this area
9	11° 59´ 35´´ N, 98° 32´ 35´´ E	14	*R. mucronata, B. parviflora, B. cylindrica, R. apiculata, B. gymnorhiza*	*R. mucronata*, *B. gymnorhiza* & *B. parviflora* **= 2**	Exploit for charcoal, firewood and construction	Most big stands have been cut; Natural regeneration - *A. rotundifolia*, *B. gymnorhiza*, *B. parviflora*, *C. decandra*, *R. mucronata*, *S. alba*; *X. mekongensis* is rare and need to protect
10	12° 12´ 26´´ N, 98° 36´ 26´´ E	8	*A. corniculatum, S. alba, A. rotundifolia, R. mucronata, R. apiculata*	Big stands of *S. alba* **= 3**; *R. apiculata*, *R. mucronata* **= 2**	Exploit for charcoal, firewood and construction	Most *S. alba* stands were small (some stands in the past were about 80-100 cm dbh according to villagers); natural regeneration - a few of *R. apiculata*, *R. mucronata* and some extent of *A. corniculatum, A. rotundifolia* and *A. alba*
11	12° 18´ 09´´ N, 98° 38° 11´´ E	20	*C. decandra, Excoecaria agallocha, H. fomes, Cynometra ramiflora, Merope angulata*	*R. apiculata* and *R. mucronata* **= 3**; *H. fomes* **= 2**	firewood and household items	Natural regeneration - *C. decandra* & *H. fomes*; Most mangroves were degraded more near to Myeik
12	11° 24´ 36´´ N, 98° 46´ 31´´ E	11	*C. decandra, B. parviflora, B. gymnorhiza, R. mucronata, R. apiculata*	*R. apiculata* and *R. mucronata* **= 3**; *B. gymnorhiza* & *B. parviflora* **= 2**	Exploit for charcoal, firewood and construction	Mangroves belonging to family Rhizophoraceae have mostly been cut and need to protect; Natural regeneration - *B. gymnorhiza*, *B. parviflora*, *C. decandra* and *R. apiculata*; *X. mekongensis* is rare (one big stand - 30.22 dbh) and need to protect
13	11° 39´ 05´´ N, 98° 48´ 48´´ E	5	*R. mucronata, S. alba, A. alba, A. rotundifolia, A. marina*	*R. mucronata* **= 3**; *S. alba* **= 2**	Exploit for charcoal, firewood and construction	Natural regeneration - *R. mucronata*, *S. alba*; *R. mucronata* small dbh (6.04-10.81 cm), *A. alba* dbh (12.72 cm), *A. alba* a little big dbh (14.95-24.81 cm)
14	11° 50´ 44´´ N, 98° 43´ 01´´ E	12	*B. gymnorhiza, R. mucronata, B. parviflora, C. decandra, B. cylindrica*	*R. mucronata* **= 3**	Exploit for charcoal, firewood and construction	Most of the *Rhizophora* stands are small in this area; Natural regeneration - *B. gymnorhiza*, *B. parviflora*, *C. decandra* and *R. mucronata;* some shrubs and climbers invaded

15	11° 54´ 54´´ N, 98° 41´ 29´´ E	15	*C. decandra, Phoenix paludosa, H. fomes, B. gymnorhiza, Merope angulata*	*R. mucronata*, *B. gymnorhiza* & *B. parviflora* **= 2**	household items	This area is nearer to landward and *C. decandra* is dominant; Natural regeneration - *B. gymnorhiza*, *C. decandra* and *H. fomes*
16	11° 55´ 29´´ N, 98° 40´ 18´´ E	13	*R. mucronata, C. decandra, B. gymnorhiza, X. granatum, R. apiculata*	*R. apiculata*, *R. mucronata*, *B. gymnorhiza* & *B. parviflora* **= 2**	Exploit for charcoal, firewood and construction	Most *R. mucronata* stands were small; Natural regeneration - *B. cylindrica*, *B. gymnorhiza*, *C. decandra* and *H. fomes*

Table 6. Prioritization of plot areas for conservation needs.

No.	Priority	Plot No. & Adjacent areas
1	First	2, 3, 4, 5, 7, 8
2	Second	1, 6, 9, 10, 11, 14, 15, 16
3	Third	12, 13

Discussion and Conclusion

Identification of mangrove species from this study area was undertaken with available literatures. More detail taxonomic works may be required for some species due to distinct characters different from its sister species. Overall the condition of the mangrove forests across all sites is considered degraded to heavily degraded, with only one area within Site 1 considered intact. Encouragingly however many of the sites are undergoing natural regeneration. Although it is important that efforts are made to try and protect all these sites, several areas stand out due to the rarity of the species, including Site 1, 6, 7, 8, and 12.

According to the Raunkiaer (1934), five frequency classes of species frequency distribution was found in the study area. The frequency showed an approximate indication of the heterogeneity of a stand. In this result, high value of tree species distribution was found in lower frequency class (A) and (B) of in this area. Low value of tree species distribution was found in frequency class (C) and (E). These results showed a degree of floristic composition heterogeneity. Because of many different species growing together within the same ecological condition in a tropical mangrove forest, floristic heterogeneity can be observed in this area.

Phenology is one of the important aspects for the restoration of mangrove forests. Some species revealed a flowering and fruiting periodicity more than once a year (personal observation). Some plants may flower and produce fruits in an irregular manner. However, it is observed that not all the individuals of any population in this area show the same manner.

Mangrove plants regenerate naturally especially for the enhancement of vivipary. Although seedling recruitment and subsequent survival rate in different species could not be recorded, natural regeneration of most mangrove species in this area is good at the moment. Therefore, in the present situation conservation of relevant selected areas is more suitable than any other plantation works.

Ong and Gong (2013) mentioned that an aerial survey provides a quick overview of the nature and condition of mangroves that are not easily visible from the ground. It is not sure that there is no aerial survey on the mangroves of this study area.

Mangroves of study area are subjected to strong biotic pressures, viz. exploitation of wood for fuel and construction. Traditional coastal dwellers and communities have long understood the value and benefits of the mangroves on which they depend for food, shelter, fuel and other necessities of life. Spalding et al.

(2010) noted that timber and fisheries benefits from the mangroves are probably as old as the history of human settlement in mangrove areas. One of the large villages from Aucklan Bay, 'Ye-Gan-Aw' has been established for sixty years ago. Most of the villages in this area were established since 20th half-century. Charcoal making was started probably last twenty years ago.

The extraction of poles is mostly for the construction of houses, and these are in great demand as piles for building and walkway construction. Baba et al. (2013) mentioned that when mangrove poles were piled into the ground, they are resistant to rot under subterranean anaerobic soil condition. Mangrove dwellers from Aucklan Bay area choose *S*. *alba* poles for piles of houses and walkway construction. Timber planks from *S. alba* is also used for flooring of the walkway. The villagers said depend on their experience; it lasts long about twenty years resistant to different seasons. *R. apiculata, R. mucronata* and *B. gymnorhiza* poles were also used for piling. Therefore, villagers cut selectively *S. alb* and Rhizophoraceae plants for many years in this area. Spalding et al. (2010) described that many remaining mangrove areas are no longer pristine, with most showing some level of ecosystem alteration as a result of selective cutting and utilization. It is agreed with Spalding et al. (2010) and there is no pristine mangrove area and probably forest structure alteration in Aucklan Bay.

R. apiculata and *R. mucronata* are the two main species used for charcoal production. Later, *B. gymnorhiza*, *B. cylindrica*, *B. parviflora* and *H. fomes* have also been used for charcoal production. Selected good quality charcoal has been exported to Thailand, and small charcoal which was locally called 'packing' has been exported to Yangon and Myeik region. The following procedures as wood cutting, carbonization and charcoal production, exporting to local market and oversea, are illegal. There are no registered charcoal contractors, and no licenses have been issued in this study area. Therefore, it is difficult to obtain detail or confirm data or information on the charcoal making process and production because of these works are illegal. However, charcoal production from this region is one of the main causes for deforestation of mangroves and forest degradation. On the other hand, Introduction/use of chain-saw is much worse than manual cutting and quick aspect for the deforestation of mangroves.

First, the workers cut the tree and sending the billets to the wood carrying boat for charcoal production. Last ten years, they strode across the mangrove forests with 5-10 long steps to arrive carrying boat. But at the moment it takes about 100-200 long steps to meet carrying boat. It means woody vegetation for good quality

charcoal (especially *Rhizophora*) is rare in the front line of mangrove forests, and across the forests more inside they have to seek good timbers. Felling operation is done by rural peoples in relevant and appropriate areas where good quality plants/timber are abundant. For that reason mangrove forests in this area are degraded daily, monthly and yearly respectively.

There is a need for a paradigm shift, and towards this, there is urgent need for ecologists to work very much more closely with economists-not merely to put values on goods and services but to evolve ecologic-economic system that is more socially just and that will result in the sustainable use of ecosystems. This is indeed the challenge of the new millennium; if it is not met, humankind may not survive to the next (Ong and Gong, 2013). Therefore, it is necessary to conserve or sustainable uses of valuable greener resource together with local community participation. If you want to conserve or manage sustainably our mangrove forests today, it is too late because of daily and gradually degradation of mangrove forests occur in Aucklan Bay and Whale Bay areas.

Utilization of mangroves (as well as timber) has been far less sustainable and some kinds of mangrove stands have been cut for various uses in Aucklan Bay and adjacent areas. Moreover, intensive uses of remaining mangrove forests have led to widespread degradation, with impacts both upon structure and function. So, conservation and maintenance of mangrove ecosystems is necessary for the long term benefits of the communities and to eradicate poverty and hunger. For that reason, community based restoration and management of mangroves should be implemented for the valuable coastal resource conservation as well as the livelihood of the local communities.

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APPENDIX I

Fig.1. Natural regeneration of *R. apiculata.*

Fig.2. Natural regeneration of *R. mucronata* under mother tree.

Fig.3. Newly dense regenerate seedlings of *B. parviflora.*

Fig.4. Natural regeneration of small pure stands of *C. decandra.*

Fig.5. Regeneration of small pure stands of *S. alba.*

Fig.6.Natural regeneration of *Avicennia* (front) and old trees of *Avicennia.* (back).

APPENDIX II

Fig.1. House construction within mangrove. forests.

Fig.2. Firewood selling in a village.

Fig.3. Carrying boat with full of Rhizophoraceae billets.

Fig.4. Carrying boat with full of Rhizophoraceae billets.

Fig.5. Charcoal kiln.

Fig.6. Charcoal kiln.

APPENDIX III

Fig.1. Charcoal packing ready to export.

Fig.2. Wood not fully charcoal 'Htin-Khaung'.

Fig.3. Walkway flooring constructed with Rhizophoraceae poles.

Fig.4. Walkway flooring constructed with small planks *of S. alba.*

Fig.5. Jetty and house construction by poles of *S. alba* and *Rhizophora.*

Fig.6.Villagers sawed *S. alba* trunk up into wood.

APPENDIX IV

Fig.1. Dug-out container curved from trunk of *S. alba.*

Fig.2. Seats made from *R. mucronata.*

Fig.3. Drying rack making with Rhizophoraceae poles.

Fig.4. Walls making with small planks of *S. alba.*

Fig.5. Conservation of mangrove forest by private enterprise.

Fig.6. Conservation of mangrove forest by private enterprise.