ABUNDANCE AND DISTRIBUTION OF SEAGRASSES IN ANDA, PANGASINAN

by

Shella C. Parreño
Pangasinan State University
Binmaley Campus
Binmaley, Pangasinan
Telefax (075) 543-3012)

Introduction

The marine waters are so vast and immensely stable. It measures 1,666,340 km^2 with a coastline of 34,600 km. It spells life of various forms, from minute organisms to gigantic ones, autotrophs to heterotrophs, benthic to pelagic, etc. These includes more than 2,500 species of fish, more than 600 species of seaweed and 16 species of seagrasses (BFAR undated). All these organisms interact with one another to balance the marine ecosystem and continuously provide food and raw materials for the manufacture of goods essential for human existence. The marginal ocean environments – coasts, bays, and estuaries are the richest portion of the marine complex. The coasts are in fact one of the richest biomes in the planet earth due to the presence of various kinds of producers including epiphytic organisms and high organic loading from within and nearby environment. One of the conspicuous component of the coastal biomes is the seagrass. It is the only submerge marine flowering plant. Though considered grass, they play an important role in the marine ecosystem: trap and stabilize sediments which consequently reduce sediment load and prevent soil erosion , serve as nursery, shelter and food for fish invertebrates and "dugong" or sea cow. Seagrass biomass is a primary factor in determining the organization of marine macrofaunal communities as it controls the habitat complexity, species diversity, and abundance of associated invertebrates. It is this ecological role of seagrass that links them directly to the improvement of livelihood of many coastal inhabitants (Fortes, 1990). Various organisms (fishes, shellfishes, algae echinoderms, coelenterates bivalves, mollusks, reptiles, mammals etc.) essential to humans as source of food and income are present in the seagrass beds. This marine plant, though great in quantity are now threatened and some are becoming extinct due to overfishing not only through the use of sophisticated gear like trawl and electrofishing gadgets but the blast fishing and cyanide fishing caused much decline on fish catch and destruction of these habitat. Overexploitation is compounded by the development in the coastal areas. Tourism for instance, though it is bringing dollars to the country is putting much pressure to the coastal zone. The coastal areas are decreasing in size as they are converted to hotels, restaurants, resorts, and the like. The motile organisms that have eluded the plunderous threat have found their way to other areas and perpetuate but, the non-motile ones especially the seagrasses are greatly affected.

Seagrasses are considered by many as a mere grass and worst a menace to the sea and disturbance for pleasure seekers hence, are removed in resorts and tourism areas and are undermined in less developed ones. Far from the knowledge of many, seagrass beds, yielded faunal densities three times higher than non seagrass areas. The monetary value have been assigned to seagrass beds based on the fisheries they support. In Puget Sound Washington, a 0.4 hectare of ell grass bed has a value of approximately US$ 412,325 annually, estimated from the amount of energy derived from the system as well as the nutrition it generated for oyster culture, community and sport fisheries, sport charters and water fowls (Fortes, 1997).

The human impact on the destruction of the seagrasses wrought havoc in the lives of organisms inhabiting in them and consequently reduce catch and deprive the fisherfolks of their source of livelihood and income. Most of the impacts however, were not properly measured and documented to present a concrete evidence to the planners as well as end users for proper management approaches.

It is encouraging to note that national governments have at least began actively implementing means to conserve and integrate management of marine resources. This is borne out of an awareness of the need to preserve biological diversity and ecological balance. In 1993, the former Philippine President Fidel V. Ramos issued Proclamation No. 156 declaring Lingayen Gulf as environmental critical area and to facilitate the Lingayen Gulf Plan, the Lingayen Gulf Coastal Area Management Commission (LGCAMC) was created by virtue of Executive Order No. 141 in 1994 with a mandate to formulate the short and long-term plans for the area covered as well as to address certain policy, planning and implementation issues, and to effectively and efficiently implement the plan and the coordinate and integrate all environment and natural resources management of related government activities in the Lingayen Gulf area (LGCAMC, 1999). Prior to its dissolution in 2002, the Commission in cooperation with the Inter-Agency Task Force for Coastal environmental protection (ATFCEP)

Region 1, 257 persons were apprehended for illegal fishing which includes blast fishers, 20 fish dealers/vendors 185 commercial fishing boat crew and 18 municipal fishers using fine meshed nets. Studies on the Development Criteria for the Coastal Zoning of Lingayen Gulf was jointly undertaken by the University of the Philippines, Marine Science Institute (UPMSI), Pangasinan State University, College of Fisheries (PSU-CF) and Don Mariano Marcos Memorial State University, Institute of Fisheries (DMMMSU-IF) in 1998 shortly after the issuance of the Republic Act 8550 or otherwise known as Philippine Fisheries Code of 1998, an act providing for the development, management and conservation of the Fisheries and aquatic resources, integrating all laws pertinent thereto and for other purposes.

These efforts addresses the immediate need to stop illegal fishing and to effective conserve the marine resources. However, because environmental policies are not effectively enforced, pollution control and proper use and protection of marine resources are all compromised. Related government projects also miserably fail due to misdirected and highly unscientific priorities. As a result, the people have become skeptical of the bureaucracy and now participate less in information exchange among scientists, environmental planners and resource managers. In order to effectively manage the seagrass resources, political commitment and active participation of the public are necessary. Likewise better understanding of the seagrass ecology, their frailties and strengths, in the face of the rapidly deteriorating marine environment are also important. These would require: 1) creating public awareness on the qualities and economic value of seagrass system through formulation and implementation of national seagrass management programs; 2) monitoring seagrass beds expansion, changes in standing stocks, impact and disturbances; 3) studying the totally unaffected areas to yield baseline data on the inherent biological and ecological capabilities of the plant populations and communities; 4) incorporating a holistic approach in planning for both scientific research and environmentally related decisions; and 5) developing programs to intensify application of the most practical and proven means of rehabilitating or restoring degraded seagrass habitats. However, non of these management practices could be effectively implemented without a knowledge of where the seagrass beds are located. Mapping of seagrass areas for coastal management purposes has been implemented successfully in some parts of the Philippines. Initial report of the Fisheries Resource Management Project conducted in Lingayen Gulf revealed that the seagrass beds are located at identified and existing aquaculture and tourism areas in the gulf (FRMP, 2000). In Santiago islands alone the proposed Marine Reserve and Park System includes a very dense (approximately 5 km2) seagrass beds at the right side off Malilnep Channel and the rest (about 20 km2) are suitable for conservation. In this area and the rest of Cape Bolinao, there abounds 126 species of fish from 47 families (Fortes, 1994, cited by FRMP, 2000). An earlier study (SARCS/WOTRO/LOICZ , 1996) yielded the following relationship : seagrass biomass required (metric tons/m2) = 81.6 *Siganus* biomass indicating large volume of catch in dense seagrass beds. However, initial estimates by the SARCS/WOTRO/LOICZ indicated a decreasing seagrass area from 9.9 km in 1978 to 5.7 km2 in 1992 in the Bolinao reef system and this has not been remedied as tourism and aquaculture and illegal fishing activities keeps on increasing in the gulf. A continuous and thorough assessment of the seagrass resources has to be done and consequently measure effectively the impact of every human activity in the seagrass community, not only in Bolinao but also in other parts of the Philippine marine waters, and create a more effective management measures to conserve the marine resources.

Objectives of the study

The study aimed to evaluate the status of seagrasses in terms of distribution (horizontal and vertical) and abundance in terms of frequency of occurrence, relative frequency of occurrence, density relative density, and diversity along the three coastal barangays in Anda, Pangasinan namely: Cabungan, Imbo, and Tondol. The basic information that could be derived through this study will be of potent contribution for the effective management of the marine resources in the said three barangays.

Specifically, the study sought to :

1. determine the prevailing environmental condition of the seagrass beds the three (3) barangays of Anda, Pangasinan in terms of:
   a. Soil properties (substrate type), and
   b. Water quality (salinity, temperature, pH, depth and visibility)
2. evaluate the status of seagrasses in the identified coastal barangays in terms of :
   a. Distribution (horizontal and vertical)
   b. Abundance
      b.1. frequency of occurrence
      b.2. relative frequency of occurrence
      b.3. density
      b.4. relative density, and
      b.5. diversity
3. determine the relationship between the prevailing soil and water conditions with the abundance of seagrasses along the northeastern barangays of Anda, Pangasinan?

Significance of the Study

Seagrasses form the basis of many marine ecosystem and there is a diversity of marine plant and animal life associated with it. Many studies mentioned organisms attached to the plant surfaces (epiphytes), those that dwell in sediment surfaces (epibenthos), those living buried in the sediments epifauna), those that live in or above the plant canopy (nektons) fishes, birds, reptiles, and mammals. Fishes are the most abundant and important in the group. Since their habitat (the seagrasses) are threatened, disturbed and have declined (biomass and density) due to increasing population, and its diverse demand upon the coastal marine ecosystem (food, avenues of transportation, receptacle of wastes, living space, sources of recreational and aesthetic pleasures), there is a great possibility that the link in the productivity chain will be broken and the whole ecosystem will collapse. In view of this, experts in every country bordering the South China Sea and the Gulf of Thailand convened and formed committees to implement a programme on **Reversing Environmental Degradation Trends** in their respective areas of coverage wherein one among the habitat of great concern is the seagrass. One of the priorities is the development of criteria for seagrass area of regional and global significance for protection and sustainable management. To achieve this, initially, the committee in each country have formulate its own programme, metadata bases containing information on biodiversity, environmental conditions, threats, current use and economic valuation and research studies on local ecology, systematics and management potentials have to be urgently implemented. This present study is an answer to their call.

The study was also conducted to assist the coastal area planners and managers to attain their goal of conserving our marine resources to sustain the needs for fish and other fishery products of the growing population.

Results of this study will help them in defining the resources within the area covered, their bounds that appropriate management measures could be done. The baseline information gathered in this study will be of reference to them to forecast future fish production.

The conduct and results of the study would increase the awareness of the local coastal inhabitants on seagrasses and the benefits that could be derived from this resource, this way, they will be encouraged to participate in the management of this resource and would be effective steward of them.

Results of the study will also serve as a leeway for the evaluation and management of other unspoiled or untapped areas of the country by other researchers and government planners.

Through the results of this study, the study areas in Anda will have an increased publicity or will be known to students, faculty and other readers, this way, greater appreciation and attention will somehow be afforded to them.

This study will serve as reference material for faculty and students handling and taking up, respectively Bachelor of Science in Marine Biology (BSMB), Bachelor of Science in Environmental Studies (BSES), Bachelor of Science in Fisheries and even Bachelor of Science in Biology (BSBio) and other related sciences.

RESEARCH METHODOLOGY

The study was conducted in the northeastern coast of the only island town of Anda, Pangasinan. Being an island, it is surrounded by marine waters and believed to be still untapped, prestine and a good pilot site for baseline data gathering and management studies. The coastal waters of the three adjacent coastal barangays: Tondol, Imbo, and Cabungan was used as the sampling sites. The coastal waters of Anda is still teemed with marine resources like corals, seagrasses, seaweeds and variety of fishes and invertebrates.

A reconnaissance survey of the three areas was conducted prior to the establishment of transects to determine the extent of seagrass beds. Each area was divided into 4 transect, with a distance of 200m apart, which was established perpendicular to the shoreline.

An improvised line transect and a quadrat measuring 0.5 x 0.5 m was used in the collection of data on the species composition, frequency of occurrence, relative frequency of occurrence, density, relative density and species diversity. Sampling was done simultaneously in the three barangays, Sampling days and time coincide with the lowest low tide. Four transects were established perpendicular to the shore. The quadrats of every transect was laid in the bottom soil in the side of the transect starting from 200 meter mark from the shore to 380 meters offshore. All species of seagrass in each quadrat were counted and recorded. In turbid and densely populated areas, seagrasses were uprooted for ease in counting and identification. Uprooted specimen were placed in labeled plastic bags and brought in the shaded area for identification, counting and recording. Identification was aided by references from PSU and UPMSI.

Water parameters such as salinity, temperature, pH, visibility, and depth were monitored using refractometer, thermometer, pH meter, and secchi disc, respectively. This was done ahead of data collection to avoid disturbance of the water and to have a more or less accurate measurement of water depth as water level fluctuates with tide. Soil grain size from each quadrat was determined using the grade scale of Wentworth (in English et al. eds., 1994).

The abundance of the seagrasses in the three barangays were determined using the following formula adapted from Asito and atobe (1970):

1. Frequency of occurrence (f_i)

$$f_i = \frac{j_i}{k}$$

Where:

f_i = frequency of occurrence of species i

j_i = number of quadrats in which specie i occurs

k = total number of quadrats laid

2. Relative frequency of occurrence (Rf_i)

$$Rf_i = \frac{f_i}{T_i} \times 100$$

Where:

Rf_i = relative frequency of occurrence of species i

f_i = frequency of occurrence of species i

T_i = total frequency of occurrence of all species

3. Density of a species (D_i)

$$D_i = \frac{n_i}{A}$$

Where:

D_i = density of species i

n_i = total number of individuals of species i

A = total area sampled

4. Relative Density (RD_i)

$$RD_i = \frac{D_i}{TD} \times 100$$

Where:

RD_i = relative density of species i

D_i = density of species i

TD = sum of the densities of all the species

5. Shannon Weiner Species Diversity Index ($\bar{H}$)

$$\bar{H} = \left(\frac{n_i}{N}\right) \log \left(\frac{n_i}{N}\right)$$

Where:

$\bar{H}$ = species diversity

n_i = number of individuals of species i

N = total number of individuals in all species

RESULTS AND DISCUSSION

This chapter presents the results of the study, which include the environmental conditions, frequency of occurrence, density as well as diversity of seagrasses in the three study areas. Statistical analysis and interpretations are also presented in this chapter. Data gathered were also compared with other studies to support the interpretation summary data.

Environmental Conditions

A number of general parameters are critical to whether seagrass will grow and persist. These include physical parameters that regulate the physiological activity of seagrasses soil property (substrate type) and water quality (salinity, temperature, pH, water depth and visibility).

Soil Properties (substrate type)

Cabungan

The coastal area of Cabungan is generally characterized by a very wide intertidal zone. The bottom soil is compose of 11% mud/silt, 32% sand and mud, 29% pure sand, 20% sand and granules and 9% mixture of sand, cobble and boulder (Table 1).

Imbo

Imbo has a narrow coastline, approximately 720 m. Like Cabungan coast, its coastal area is characterized by a very wide intertidal zones. The bottom soil is composed of 9% mud/silt, %26 sand and mud, 17% pure sand, 41% sand and granules and 7% mixture of sand, cobble and boulder (Table 1; Appendix Table 5-8).

The area has plenty of live corals and seagrasses are interspersed by corals and seaweeds.

Table 1. Grain size, number of quadrats where they were observed and their corresponding percentages in the three barangays in the northeastern coast of Anda, Pangasinan

Grain size (mm)	Cabungan		Imbo		Tondol		Mean	
	No. of Q.	%	No. of Q.	%	No. of Q.	%	No. of Q.	%
Silty/muddy (0.0039- 0.125)	17	11	14	9	0	0	10.33	6.67
Sandy muddy (0.126 – 0.5)	48	32	40	26	14	9	34	22.33
Pure Sand (0.51 – 2)	44	29	26	17	60	39	43.33	28.33
Granules (2.1 – 64)	30	20	62	41	70	46	54	35.67
Cobble & boulder (64.1 - > 256)	13	9	10	7	9	6	10.63	7.33

Tondol

Tondol has also extensive intertidal areas. It is noted for its white sand making it more attractive to beach goers. The bottom soil is composed of 9% sand and mud, 39% pure sand, 46% sand and granules and 6% mixture of sand, cobble and boulder (Table 1 and Appendix Table 9-12). These substrate type contributes to the very clear water in Tondol.

Table 2 shows the substrate preference of some seagrass species.

Table 2. Subsrate preference of some seagrass species

Species	Substrate Preference
Enhalus acoroides	Sandy-muddy
Thalassia hemprichii	Coral sand
Halophila minor	Sandy-muddy
Cymodocea serrulata	muddy-sandy to coralline
Cymodocea rotundata	muddy- sandy to coralline
Halodule uninervis	muddy- sandy to coralline
Halodule pinifolia	muddy-sandy to coralline
Syringodium isoetifolium	muddy
Thalassodendron ciliatum	rocky or reef or sand-covered rocks

Water Quality

Cabungan

Water salinity in this area ranged of 28 ppt to 33 ppt while water temperature ranged from 26^{o}C to 32^{o}C. Water pH on the other hand ranged from 7.2 to 7.8 and water depth where seagrasses can be found ranged from 12-254 cm. The water visibility in the area was almost crystal clear (Table 3) except when the bottom of the intertidal water is disturbed by boats or gleaning fishermen. The seagrass bed is very near coral reefs and some seagrasses are interspersed with seaweeds and corals in the upper subtidal areas. Mangroves naturally grow in the shore.

Table 3. Water quality of the three barangays in the northeastern coast of Anda, Pangasinan.

Water Parameters	Barangays		
	Cabungan	Imbo	Tondol
Salinity (ppt)	28 – 33	28 – 33	28 – 34
Temperature (^oC)	26 - 32	24 - 32	26 - 34
pH	7.2 – 7.8	7.2 – 7.8	7.2 – 7.8
Visibility	80 – 100%	75 - 100	100%

Imbo

Water salinity and pH range in this area was the same as that of Cabungan (28 to 33 ppt; 7.2 – 7.8). Water temperature range, however, is a little wider in this area (24^oC to 32^oC) probably due to the effect of time of sampling. Water depth where seagrasses can be found ranged from 14.5 -228 cm, while water visibility is 100% (Table 3) except in area disturbed by gleaners and fishermen. The seagrasses are also interspersed with seaweeds and aquatic fauna like snails starfishes, sea urchins and few sea cucumbers.

Tondol

The area has a narrow range of salinity and temperature (26 to 34 ppt and 24^oC to 34^oC, respectively) the same pH range with that of the other two areas (7.2-7.8) was obtained in this area. Water depth on the other hand was a little bit deeper with a range of 14-310 cm. Water visibility is also crystal clear but more clearer than Cabungan and Imbo where aquatic flora and fauna like seaweeds, sea cucumber, sea urchins and starfishes are more visible. The much clearer water in Tondol slightly affected the water salinity and temperature. Water easily cools down early in the morning and easily warms up in the afternoon when there are no particulate matter within the water column. Salinity also increases as water evaporates. Salinity changes, however is not pronounced as the sea is vast and wide. This often occurs in the shallow portion of the sea as temperature changes.

The presence of seagrasses in all the three areas also made the water clear as they inhibit resuspension of organic and inorganic matter through leaf action (Calumpong and Meñez, 1997).

Seagrass Species and Their Distribution

Seagrass Species

Table 3 presents the different species of seagrass identified in the Northeastern coast of Anda, Pangasinan. Nine (9) seagrass species from two (2) families and seven genera were found in the coasts of Cabungan, Imbo and Tondol. Under Family *Hydrocharitaceae* three species were identified namely: ***Enhalus acoroides*** (Tropical eelgrass), ***Halophila minor*** (small spoon grass) and ***Thalassia hemprichii*** (Dugong grass). Under the Family *Potamogenotaceae* the following six species were identified: ***Cymodocea rotundata*** (round-tipped seagrass), ***Cymodocea serrulata*** (toothed seagrass), ***Halodule pinifolia*** and ***Halophila uninervis*** (fiber-strand seagrass), ***Syringodium isoetifolium*** (Syringe-grass),and ***Thalassodendron ciliatum*** (woody seagrass).

As shown in Table 4, only four (4) seagrass species identified in Transect 1 of Cabungan coast. Two species falls under Family *Hydrocharitaceae* (***C. rotundata*** and ***C. serrulata***) and two under Family *Potamogenotaceae* (***E. acoroides*** and ***T. himprichii***). In Transect 2, the two families are well represented as all the nine species shown in Table 1 (***E. acoroides, H. minor***, ***T. hemprichii, C. rotundata***, ***C. serrulata***, ***Halodule pinifolia***, ***Halophila uninervis***, ***Syringodium isoetifolium,*** and ***Thalassodendron ciliatum***) are present. In Transects 3 and 4, eight (8) species were observed these exclude ***S. isoetifolium*** in the former and

H. minor in the latter. The nine species were also found in Imbo, however, only Transect 4 was observed to have the complete list of the nine species. In Transect 1, seven (7) species were observed (***E. acoroides, H. minor***, ***T. hemprichii, C. rotundata***, ***C. serrulata, Halodule pinifolia***, and ***Halophila uninervis***,). Transects 2 and 3 has eight (8) species. ***Syringodium isoetifolium*** is the common species which was not observed in the said two transects (2 and 3). In Tondol, Transects 1, 2 and 4 has eight (8) species. ***Syringodium isoetifolium*** is absent in Transect 1, *T. ciliatum* in Transect 2 and *T. uninervis*

Table 4. Species of seagrasses in the three barangays in the northeastern coast of Anda, Pangasinan

Family/Species	Cabungan				Imbo				Tondol			
Hydrocharitaceae	1	2	3	4	1	2	3	4	1	2	3	4
Enhalus acoroides	/	/	/	/	/	/	/	/	/	/	/	/
Halophila minor	/	/	/	X	/	/	/	/	/	/	/	/
Thalassia hemprichii	X	/	/	/	/	/	/	/	/	/	/	/
Potamogenotaceae												
Cymodocea rotundata	X	/	/	/	/	/	/	/	/	/	/	/
Cymodocea serrulata	X	/	/	/	/	/	/	/	/	/	/	/
Halophila pinifolia	X	/	/	/	/	/	/	/	/	/	/	/
Halophila uninervis	X	/	/	/	/	/	/	/	/	/	X	X
Syringodium Isoetifolium	/	/	x	/	x	/	/	/	x	/	/	/
Thalassodendron ciliatum	/	/	/	/	X	X	X	/	/	X	X	/

/ - present
x - absent

in Transect 4. Transect 3 has only seven (7) species (***E. acoroides, H. minor***, ***T. hemprichii, C. rotundata***, ***C. serrulata, H. pinifolia*** and ***Syringodium isoetifolium***).

In terms of the number of species present, the Northeastern coasts of Anda, Pangasinan has more compared to Bolinao and Puerto Galera with only eight (8) species (***E. acoroides, H. minor***, ***H. ovalis***, ***T. hemprichii, C. rotundata***, ***C. serrulata, H. univervis*** and ***S. isoetifolium***). under six (6) genera; Ulugan Bay with only seven (7) species under 6 (6) genera (***E. acoroides, H. ovalis***, ***T. hemprichii, C. rotundata***, ***C. serrulata, H. uninervis*** and ***S. isoetifolium***); Pagbilao Bay, Banacon and Guimaras Island with only six (6) species under five (5) genera. The species composition in these three areas however, differ from each other. In Pagbilao Bay, the two Cymodocea species (***C. rotundata*** and ***C. serrulata***) are present along with ***E. acoroides, H. ovalis***, ***T. hemprichii,*** and ***S. isoetifolium***. In Banacon Bay, seagrass species is composed of ***E. acoroides, H. minor***, ***T. hemprichii, C. serrulata, H. pinifolia*** and ***H. uninervis*** (Rollon and Fortes, 1991) whereas, in Guimaras island, (***E. acoroides, H. minor***, ***T. hemprichii,C. rotundata***, ***C. serrulata, H. pinifolia*** and ***S. isoetifolium*** are present (Babaran et al. 1997). The variation in the number of species could be attributed to the type of substratum (silty muddy, sandy muddy, sandy, granular and cobble to boulder compared to a muddy and very coarse sand in other areas mentioned).

Horizontal and Vertical Distribution of Seagrasses

Cabungan

Four (4) transects were established in Cabungan at an interval of 200 meters apart. Results of the study (Fig. 3a-d) showed only four species in Transect 1: T***. hemprichii, C. serrulata, C. rotundata,*** and ***E. acoroides. Thalassia hemprichii*** dominated almost entirely the whole stretch of the transect. Horizontal distribution covers the first 10 meter to 370 meter zones and were found in 371 out of the 380 quadrats laid. The frequencies where they exist even reached 154 shoots/quadrat. Vertical distribution of this species starts from 35 cm to 262 cm deep during low-low tide. ***Enhalus acoroides*** are also widely spread but they occur in patches only in the first50 m (35-48 cm deep) and within 110, 150 and 190-meter zones and reappear along with ***T. hemprichii*** and sometimes singly offshore between 230 and 380-meter zones to a depth of 262 cm. ***Cymodocea serrulata*** is present only in 10 quadrats between 80 and 190-meter zones or 35 cm to 175 cm deep while ***C. rotundata*** only in 9 quadrats within the same horizontal and vertical zones as that of ***C. serrulata.*** In Transect 2, there exists nine species. The trend of the horizontal distribution of the four species is almost the same as Transect 1 except that all of them extends to the entire stretch of the transect (380 m). However, considering the occurrence and frequencies, they are distributed in descending order as follows: ***T. hemprichii. C. serrulata, c. rotundata*** and ***E. acoroides***. Vertical distribution of these four species start from 22 cm to 187 cm deep. Though ***H. uninervis*** is the third highest in terms of frequency in this transect, its occurrence in only 10 quadrats between 60 and 360-meter zones and its being small accounts for its lesser/narrower distribution compared to ***C. rotundata*** and ***E. acoroides***. It extends from 26 to 193 cm deep. The other 4 species***: T. ciliatum, S. isoetifolium, H. pinfolia*** and ***H. minor*** occur in patches and were distributed in less than 10 quadrats in the nearshore areas (22 to 26 cm deep) up to 150-meter zone (59 cm deep), except for ***H. pinifolia*** which reappear in the middle 250-meter zone (173 cm deep).

In Transect 3, nine species were observed. ***Cymodocea. serrulata*** is the most widely distributed as they were present in 27 quadrats between the 10 to 380-meter zones. (16 cm to 254 cm deep). They likewise occur in dense mats compared to other species. ***Thalassia hemprichii*** is also widely spread between 10 to 380-meter zones (16 cm to 254 cm deep) however, they exist only in 25 quadrats. ***Cymdocea rotundata*** on the other hand exists in almost the same horizontal and vertical zones as that of ***C. serrulata*** but only found in 24 quadrats between 20 to 380-m zones , or 18 cm to 254 cm deep, and in lesser frequency. Surprisingly, ***E. acoroides*** is only noted in 5 quadrats nearshore between 20 and 150-meter zones or 18 cm to 48 cm deep. Almost all ***H. uninervis*** were found in the lower quadrats between 150 to 350-meter zones (48 m to 178 m deep) except for a dense mat which were found in the 60-meter zone (16 m deep). The other 4 species (***H. minor, H. pinifolia,***

S. isoetifolium and ***T. ciliatum*** have the least distribution as they exists only in 150-meter zone (48 m deep) except for ***H. pinifolia*** which was also found in 130-meter

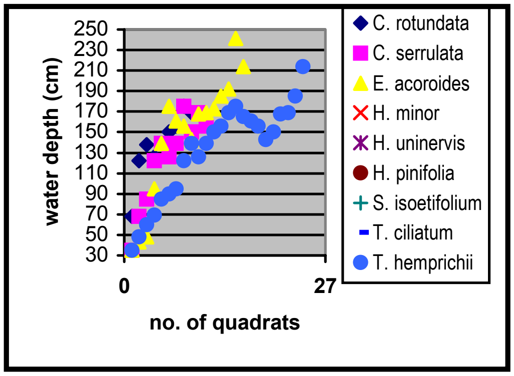

Figure 3a. Transect 1

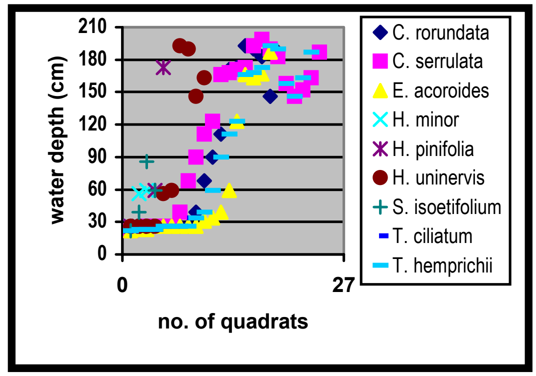

Figure 3b. Transect 2

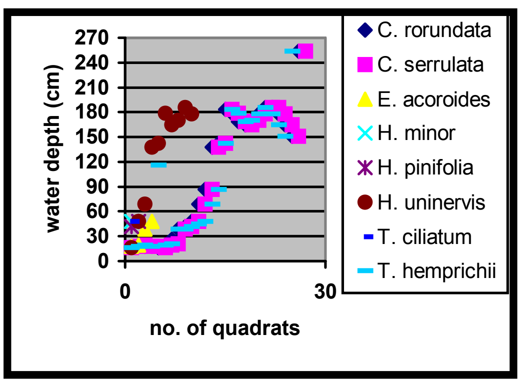

Figure 3c. Transect 3

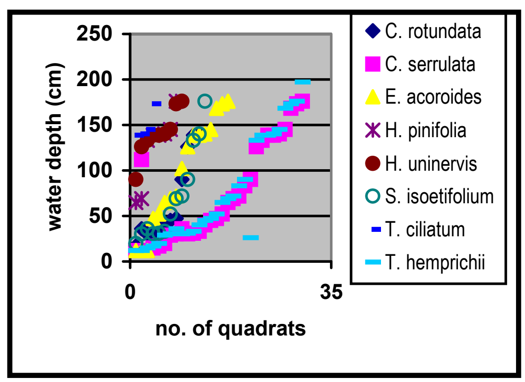

Figure 3d. Transect 4

Figure 3a-d. Distribution of seagrasses per transect in Cabungan

zone (42 m deep).

In Transect 4, eight species were noted. ***T. hemprichii*** have extensive coverage , 20 to 380-m zones (12 to 197 cm deep), though it is not noted in 7 quadrats within the whole stretch of the transect (380m). ***Cymodocea serrulata*** and ***E. acoroides*** are spread until the 360-meter zone (176 cm deep). The former however, are well scattered as they were observed in 29 quadrats between 20 to 360-m zones (12 to 187 m deep) compared to only 17 for the latter, though it could be found from 10 to 360-m zones (12 to 187 cm deep). ***Syringodium isoetifolium*** is scattered in 14 quadrats between 70 to 350-meter zones (29 to 176 cm deep) while ***C. rotundata*** exists in 9 quadrats between 100 and 360 zones (30 to 187 cm deep) In this transect, the *Halodule* species were noted in 8 quadrats between 190 and 360-meter zones and 240 to 350-meter zones, respectively (69 to 176 cm deep). In the much lower zones, between 310 and 350-meter zones (140 to 176 cm) the ***T. ciliatum*** emerges. This transect is devoid of ***H. minor***.

Horizontally, the nine species are well distributed in between 140 and 150-meter zones of the four transects. Though they are all present also in the 80-meter zone the number of shoots are just within the average. The 60-meter zone is even denser compared to the 80-meter zone. Generally, the full stretch of the three transect is filled with seagrasses, however, aside from the 60; 140 and 150-meter zones, seagrasses abounds in the 70, 90, 130, 160,170, 260 and 290-meter zones with frequency range of 491 to 722 shoots. Beyond the 290-meter zones, mostly 3 to 4 species exist in lesser frequencies.

Vertically , seagrasses in Cabungan are concentrated in the upper intertidal to the lower subtidal waters to a mean water depth of 133 cm. Beyond this depth, the number of species reduced to three to four except for Transect 4 where there still remains seven species but in very few frequencies.

Imbo

The seagrass beds in Imbo is approximately 640,000 m2. There were alsofour (4) transects laid offshore, from 200 meter mark from the coastline, with a distance of 200meters apart, considering the small coastline of approximately 800 meters.

Figure 4a-d presents the distribution of seagrasses per Transect in Imbo, Pangasinan. In Transect 1, seven species were observed: ***Thalasia hemprichii, Enhalus acoroides, Halophla minor, Cymodocea rotundata, Cymodocea serrulata, Halodule pinifolia, and Halodule uninervis . Cymodocea rotundata, Cymodocea serrulata,*** and ***Thalasia hemprichii*** extends up to 200 meter offshore and up to a depth of 113 cm, but they no longer exist beyond this zone. ***Enhalus***

acoroides extends up to 190 meters and thrives in the same water depth as that of the first four species, and this disappears beyond this zone. The two ***Halodule*** species (***H. pinifolia and H. uninervis***) have a narrow distribution. They were observed between 10 to 120 meters zone or 25 cm to 34 cm deep. ***Halophila. minor*** is limited only in the 70 meters zone or 29 cm deep. Generally, seagrasses in Transect 1 is widely spread from nearshore to the 120-meter zone (34 cm deep). The

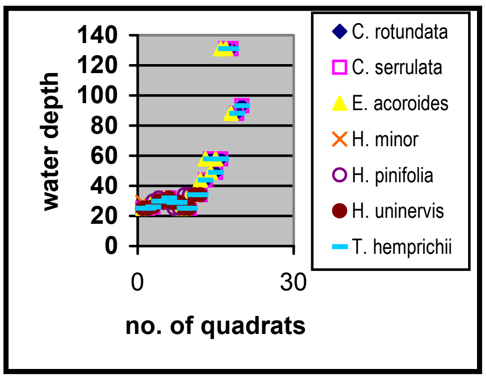

Figure 4a. Transect 1

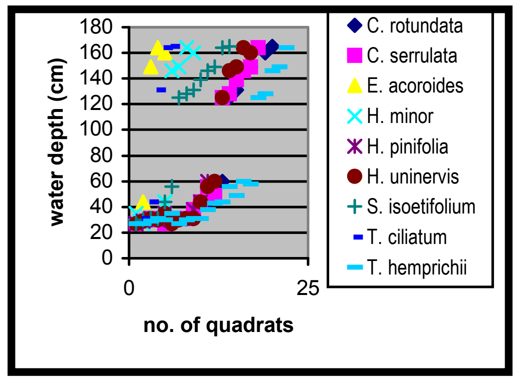

Figure 4b. Transect 2

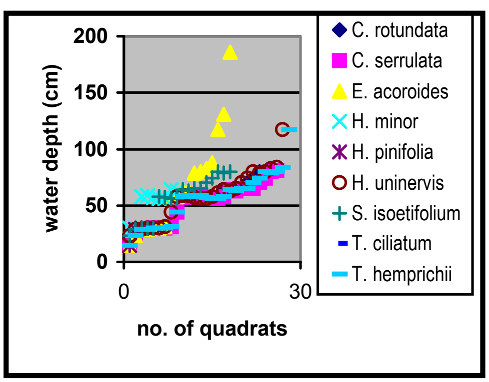

Figure 4c. Transect 3

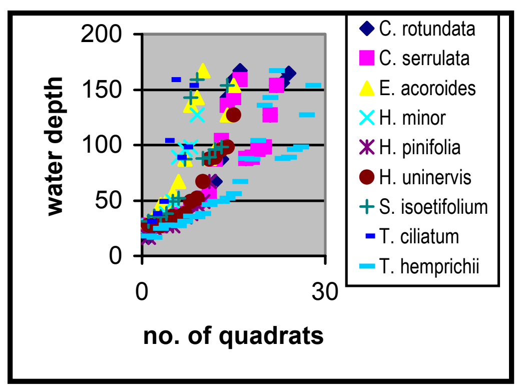

Figure 4d. Transect 4

Figures 4a-d. Distribution of seagrasses per transect in Imbo

presence of the two *Halodule* species (***H. pinifolia and H. uninervis***) is a contributory factor aside from the denser population of ***T. hemprichii*** in the first few quadrats and ***C. rotundata*** in between 50 and 120-meter zones (30 to 34 cm deep). Beyond this zone, the distribution becomes narrow as the number of species as well as density decreases.

In Transect 2, the nine species were present. ***Thalassia hemprichii*** is the most spread species. It is present densely from the first quadrat to 290 meters zone (165 cm deep) except between 190 and 200 m, 230 and 280 m zones (between 128 to 160 cm deep). ***Cymodocea rotundata*** spreads up to 290 meters zone however, they exist, almost in patches, only in 21 quadrats. ***Cymodocea serrulata*** on the other hand extends up to 270 meter zone (164 cm deep) but is present only in 18 quadrats laid. ***Halodule uninervis*** occurred 17 quadrats, in almost in the same zone as that of ***C. serrulata*** (20-280m). They even dominated three zones: 70, 90, and 140 m or 27, 31 and 139 cm deep, however because of its being small in nature, they are overshadowed by the three aforementioned species. ***Syringodium isoetifolium*** spreads in 14 quadrats between 80 to 290 meter zones (30 to 165 cm deep). They are present in moderate frequencies in 9 quadrats between 80 to 220 meters zones (30 to 131 cm deep) but dominates the 240 to 270 meters zones (139 to 164 cm deep). ***Halodule pinifolia*** is limited only in 11 quadrats, between 20 to 130 meters zones (27 to 44 cm deep). ***Halophila minor*** exists in 9 quadrats between 60 and 280 meters zones ((35 to 160 cm deep). ***Thalassodenron cilatum*** is found in patches in 6 quadtrats of this transect between 70 and 280 m zones (27 to 160 m) and ***E. acoroides*** occurred only in 5 quadrats between 90 to130 meters (31 to 44 cm deep) and 260 to 280 meters zones (149 to 160 cm deep).

Considering the number of species and density per species, seagrasses in Transect 2, are widely distributed in the middle and lower portion of the transect (70 to 140-meter zones and 240 to 270-meter zones (within 29 to 49 cm and 106 to 131 cm deep). Beyond this, only in between 280 and 290-meter zones (138 to 148 cm deep) do few seagrass species exist.

In Transect 3, the presence of ***H. pinifolia*** in the first 60 - meters zone (15 to 30 cm deep), and ***H. minor*** on the 50 to 200-meter zones (30 to 63 cm deep) makes the distribution wider from the 10 to 200-meter zones (15 to 63 cm deep). The continuous occurrence of ***T. hemprichii*** in high frequency, however, in the lower 240 to 270-meter zones (65 to 80 cm deep) does not greatly influence the frequency of the populations. In the lower most zones (300 to 380-meter; 81 to 186 cm deep) some species disappear and those that exist are in lower frequencies. In this transect, though ***E. acoroides*** extends to the full length of the transect (380m; 186 cm deep), they do not exist in many (19) of the quadrats especially in the middle zones and they are only in patches***.*** ***Thalassia hemprichii*** is the most widely spread species. It is present almost always in great frequencies from the 10 meter to 340 meter zones (15 to 117 cm deep) except in between 180, 220 and 230 ; 280, 300, 310 and 330 meters zones (between 61 to 88 cm deep). The two species of ***Cymodocea (C. rotundata*** and ***C. serrulata***) are also widely spread. They extends from the 10 to 270 and 300 meters zones (within 15 to 81 cm deep), respectively and not exist only in few zones in the middle of the transect. ***Halodule univervis*** is a species of equally wider distribution, from the 20 to the 340 meters zones (15 to 117 cm deep), though not exist in the first and 7 quadrats in between the boundaries. ***Syringodium isoetifolium***, though widely spread from the 20 to 290 meters zones (15 to 80 cm deep), they are present only in 20 quadrats out of the 38 quadrats laid. They do not exist in 18 quadrats (1, in between 3 and 22 and beyond 290 meters)***.*** ***Halophila minor*** is present only in 9 quadrats within 50 to 200 meters zones (30 to 63 cm deep). Of the eight species found in this transect ***H. pinfolia*** has the narrow distribution as they only exist in 4 quadrats within 10 to 60-meter zones (15 to 30 cm deep). ***Thalassodendron ciliatum*** is absent in this transect.

In Transect 4, ***T hemprichii*** spreads in mats from the first 10-meter zone up to 310-meter zone (18 to 165 cm deep). It is widely distributed in 31 out of 38 quadrats laid. The two ***Cymodocea*** *species* (***C. rotundata*** and ***C. serrulata***) have also wider distribution but are only found in 24 and 22 quadrats, respectively. The former covers the first 10 to 310-meter zones (18 to 165 cm deep) while the latter stretches from 40 to 290-meter zones (28 to 154 cm deep). ***Halodule uninervis*** and ***E. acoroides*** occurred in the same number of quadrats (15) however, the former spreads from 40 to 280-meter zones (28 to 127 cm deep) whereas the latter stretches only from 70 to 290- meter zones (31 to 154 cm deep). ***Syringodium isoetifolium*** have the same horizontal distribution as that of ***E. acoroides*** (70-290 m) however it was found only in 14 quadrats. *H. minor* and ***T. ciliatum*** is sparsely distributed in 9 and 8 quadrats, respectively in the middle 60 to 290-meter zones (27 to 154 cm deep).

Aside from the dense population of ***T. hemprichii*** in this transect, the presence of *H. uninervis* in great quantities in the upper zones (70 and 140 m; 31 to 52 cm deep) and of ***S. isoetifolium*** in the lower zones (240-270 m; 88 to 98 cm deep) widened the distribution of the seagrasses in this transect. They are concentrated on the first 20 to 290-meter zones (17 to 154 cm deep) with the highest frequency of 376 shoots. Only three zones in between have frequencies lower than 50 shoots.

Generally, in all the four (4) transects, only the 130-meter zones (49 and 44 cm deep) of Transects 2 and 4 has the most number of species (9). The density of seagrasses in Imbo is greater on the first half of the area (10-200 meters). Beyond this zone, the distribution becomes narrow, except in Transect 2 and 4 where mats of ***S. isoetifolium*** exist from 240 to 270-meter zones (39 to 164 cm deep).

Tondol

There were eight (8) species observed in Transect 1 of Tondol, Anda, Pangasinan. Like in other areas, ***T. hemprichi*** has the widest distribution. It extends from the first 10 – 260 meter zones (29 to 210 cm). The two (2) Cymodocea species also extends to the same length but were first observed horizontally in the 30 m in a water depth of 42 cm (***C. rotundata***) and 60m or 66 cm deep (***C. serrulata***) zones, with few empty quadrats in between. *E. acoroides* on the other hand, reaches up to 240-meter zone (200 cm deep) and was first observed in the 30 m zone (42 cm deep) like ***C. rotundata*** but is distributed only in fewer (15) quadrats. ***Halophila minor*** and ***Halodule uninervis*** are confined only six (6) quadrats in the upper 20 to 120-

meter zones (32 to 106 cm deep) while ***Halodule pinifolia*** and ***Thalssodendron ciliatum*** are spread in the lower 80 to 180-meter zones (86 to 149 m deep) and 140 to 210-meter zones (132 to 186 cm deep), respectively. ***Syringodium isoetifoilium*** is absent in this transect (Figure 5a).

Figure 5b presents the distribution of seagrasses in Transect 2. ***Thalassia himprichii*** and ***C. rotundata*** have the same area of distribution, 10 to 260m zones (15 to 38 cm deep), but the former were observed in 25 quadrats whereas the latter, only in 15 quadrats. ***Syringodium isoetiffoilium*** and ***C. serrulata*** were observed in the same number of quadrats but the former extends from the 10 to 250m zones (15 to 38 cm deep) and the latter only from 40 to 260 m zones (13 to 39 cm deep). ***Enhalus acoroides*** and ***H. pinifolia*** are spread in the same zones (40m to 250m; 13 to 38 cm deep) however, the former though in patches, are spread in 12 quadrats compared to only 9 in the latter. The six aforementioned seagrass species also exists in quite deeper water (up to 80 cm) as the seagrass bed has an irregular bottom slope with the middle as the deeper portion As expected, ***H. minor*** are observed in the intertidal zone (10m -80m zones; 13 to 29 cm deep) of this transect and reappear in the upper subtidal (120m, 170m and 180m; within 49 to 80 cm deep) zones***. Halodule uninervis*** on the other hand, is confined only in the upper subtidal zones (180m to 210m; within 66 to 80 cm deep),

In Transect 3 (Fig. 5c), only ***T. hemprichii*** extends to much longer stretch of the transect (10m-290m) with a much deeper water (23 to 216 cm deep)***. Enhalus acoroides*** spreads widely than ***H. minor*** as it stretches from 20 to 280 m zones (23 to 197 cm deep) while the latter spreads from 40 to 200-meter zones (37 to 57 cm deep). The two ***Cymodocea*** species are observed in the same number of quadrats (11) and the same length of the transect but ***C. rotundata*** was first observed in the 70-meter zone whereas ***C. serrulata*** only in the 90-meter zones but with the same water depth (43 cm) with . ***Syringodium isoetifolium*** has a very narrow distribution in this transect. It was observed in the intertidal (10m-180m) zones (25 to 52 cm), however, it was not observed in many of the quadrats in between. ***Halodule pinifolia*** has the most narrow distribution. It is confined only between 150 to 170-m zones and 200 to

220-meter zones (within 36 to 136 cm deep), beyond this, could no longer be observed.

Like in the other three transects, ***T. himprichii*** spreads widely than the other species in Transect 4. It stretches from the 10m to 310-meter zones (18 to 251 cm deep). ***Cymodocea rotundata*** and ***E. acoroides*** extends to the same length as that

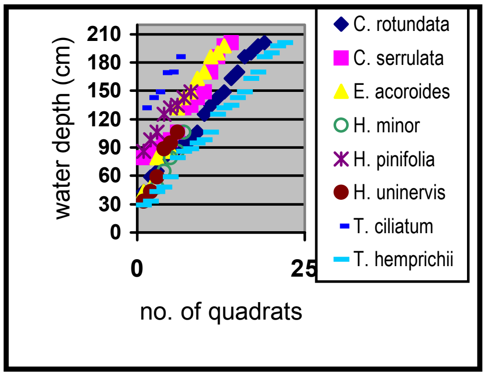

Figure 5a Transect 1

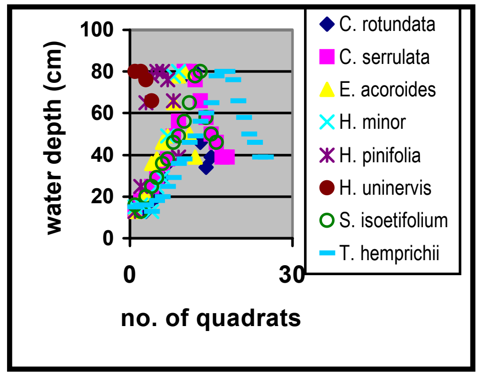

Figure 5b. Transect 2

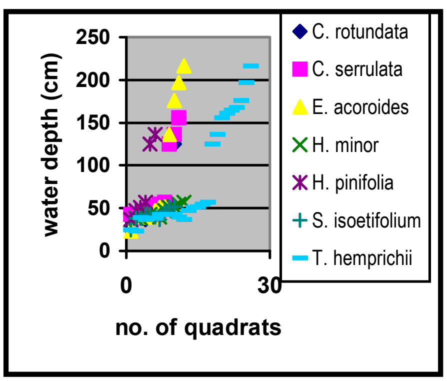

Figure 5c Transect 3

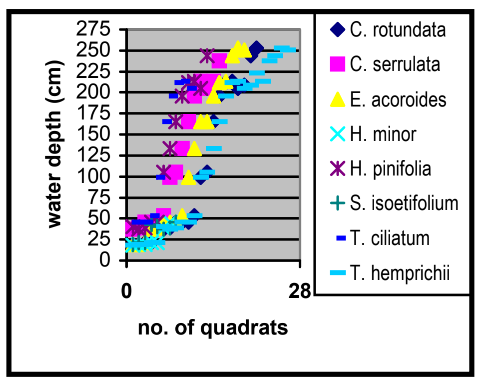

Figure 5d. Transect 4

Figures 5a-d. Distribution of seagrasses per transect in Tondo

of ***T. himprichii*** however, they were first observed in the next 10-meter zones (20 m: 19 cm deep). ***Cymodocea serrulata*** is confined in the lower intertidal (100m) to the upper subtidal (280m) zones of this station, within a depth of 36 to 238 cm. ***Halodule pinifolia*** on the other hand is distributed between the 90 to 240-meter zones or 40 to 205 cm deep (Fig.5d). ***Thalassodendron ciliatum*** extends to the same length but first appeared in the lower intertidal (120m; 46 cm deep) zones***.*** ***Halodule uninervis*** and ***S. isoetifolium*** are both confined in the intertidal zones They extends to a transect length of 120m (46 cm deep) but the former has a wider distribution than the latter as it is first observed in the 10m zone (18 cm deep) and the latter in the 30-meter zone 19 cm deep).

Frequency of Occurrence

The frequency of occurrence is determined by the number of quadrats where each species occurred over the total number of quadrats (38) laid in each transect.

Cabungan

In Cabungan coast, ***T. hemprichii*** occurred most frequently with a mean value of 0.70. Out of a total of 152 quadrats laid, it was observed in 106 quadrats. This indicates that this species is widely spread compared to other species. ***Cymodocea serrulata*** has a mean frequency of occurrence value of 0.60. It was also observed in four (4) transects however, the number of quadrats where it was observed is lesser (91) compared to ***T. hemprichii***, this ranked only second in terms of frequency of occurrence. ***Cymodocea rotundata*** ranked third with a mean value of 0.43. It occurred only in 66 quadrats. ***Enhalus acoroides*** ranked fourth with a mean value of 0.39 and was observed only in 60 quadrats. The rest of the species (***H. uninervis, Syringodium isoetifolium, H. pinifolia, T. ciliatum*** and ***H. minor)*** occurred less frequently. Computed mean values are: 0.20, 0.12, 0.10 0.09 and 0.03, respectively. The value of these five species are greatly affected by their non-occurrence in Transect 1 and in Transects 3 and 4 in the case of ***S. isoetifolium*** and ***H. minor,*** respectively. ***Halophila minor*** has the least mean frequency of occurrence value (0.03) for it was observed only thrice in Transect 2 and once in Transect 3 (Table 5).

Table 5. Number of quadrats where each species occur and the frequency of occurrence of seagrasses in Cabungan, Anda, Pangasinan

Species	Transects								Total		Mean	
	1		2		3		4					
	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo
E. acoroides	20	0.53	19	0.50	4	0.11	17	0.45	60	1.58	15	0.39
H. minor	0	0.00	3	0.08	1	0.03	0	0.00	4	0.11	1	0.03
T hemprichii	26	0.68	24	0.63	25	0.66	31	0.82	106	2.79	26.5	0.70
C. rotundata	9	0.24	19	0.50	26	0.68	12	0.32	66	1.74	16.5	0.43
C. serrulata	10	0.26	24	0.63	27	0.71	30	0.79	91	2.39	22.8	0.60
H. pinifolia	0	0.00	5	0.13	2	0.05	8	0.21	15	0.39	3.75	0.10
H. uninervis	0	0.00	10	0.26	11	0.29	9	0.24	30	0.79	7.50	0.20
S. isoeifolium	0	0.00	5	0.13	0	0.00	13	0.34	18	0.47	4.50	0.12
T. ciliatum	0	0.00	9	0.24	1	0.03	4	0.11	14	0.37	3.50	0.09
Total Q laid	38		38		38		38		152		38	
Total fo		1.71		3.11		2.55		3.26		10.6		2.66
Grand Mean		0.19		0.34		0.28		0.36		1.81		0.45

Q quadrat

fo frequency of occurrence

Imbo

The first to third order of the frequency of occurrence of seagrass species in Imbo coast is similar to that of Cabungan however, the values are much smaller due to the smaller area of seagrass beds in this coast (640,000 m^2)in this area**.** ***Thalassia hemprichii*** is the most frequently occurring species with a mean value of 0.65. It occurred in 99 quadrats out of 152 total quadrats laid. The two ***Cymodocea*** *species* (***C. rotundata*** and ***C. serrulata***) followed with a frequency of occurrence value of 0.59 and 0.57, respectively. They occurred in 89 and 86 quadrats, respectively.

Halodule uninervis ranked fourth with a mean value of 0.47 and observed in 71 quadrats. ***Enhalus acoroides*** ranked only fifth in this coast with a mean value of 0.37 and occurred only in 56 quadrats. The rest of the four (4) species (***S. isoetifolium, H. pinifolia H. minor***, and ***T. ciliatum***) have lesser values of 0.30, 0.24, 0.18, and 0.09, respectively. Though ***S. isoetifolium***, did not occur in Transect 1, its frequency of occurrence value is the same as that of ***E. acoroides*** in Transect 3 (0.47) which ranked fifth in this area. ***S.yringodium isoetifolium*** occurred in 46 quadrats, while ***H. pinifolia*** and ***H. minor*** occurred only in 36 and 28 quadrats, respectively. ***Thalassodendron ciliatum*** has the least frequency of occurrence value as it occurred only in 14 out of 152 quadrats laid, particularly in Transects 2 and 4. It is totally absent in all the quadrats laid in Transect 1 and 3 (Table 6).

Table 6. Number of quadrats where each species occurred and their frequency of occurrence in Imbo, Anda, Pangasinan

Species	Transects								Total		Mean	
	1		2		3		4					
	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo
E. acoroides	18	0.47	5	0.13	18	0.47	15	0.39	56	1.47	14	0.37
H. minor	1	0.03	9	0.24	9	0.24	9	0.24	28	0.74	7	0.18
T hemprichii	20	0.53	23	0.61	28	0.74	28	0.74	99	2.61	25	0.65
C. rotundata	20	0.53	20	0.5	23	0.61	26	0.68	89	2.34	22	0.59
C. serrulata	20	0.53	18	0.47	26	0.68	22	0.58	86	2.26	22	0.57
H. pinifolia	10	0.26	11	0.29	4	0.11	11	0.29	36	0.95	9	0.24
H. uninervis	12	0.32	17	0.45	27	0.71	15	0.39	71	1.87	18	0.47
S. isoeifolium	0	0.00	14	0.37	18	0.47	14	0.37	46	1.21	12	0.30
T. ciliatum	0	0.00	6	0.16	0	0.00	8	0.21	14	0.37	4	0.09
Total Q laid	38		38		38		38		152		38	
Total fo		2.66		3.24		4.03		3.89		13.82		3.45
Grand Mean		**0.30**		**0.36**		**0.45**		**0.43**		**1.54**		**0.38**

Q quadrat
fo frequency of occurrence

Tondol

Table 7 presents the number of quadrats and frequency of occurrence of seagrass species in Tondol, Anda, Pangasinan. A shown in the table, the most frequently occurring species in this area is still ***T. hemprichii*** with a mean value of 0.65. It was noted in ninety nine (99) quadrats. The frequency of occurrence of ***T. hemprichii*** is 47.76% higher than the second frequently occurring species, ***C. rotundata*** with a mean value of only 0.44 which was noted in only 67 quadrats. ***Enhalus acoroides and C. serrulata*** have nearly the same frequency of occurrence values of 0.39 and 0.38, respectively. The former was noted in 60 and 59 quadrats, respectively. The above four species have above the median (0.30) frequency of

Table 7. Number of quadrats where each species occurred and their frequency of occurrence in Tondol, Anda, Pangasinan

Species	Transects								Total		Mean	
	1		2		3		4					
	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo	No.of Q	fo
E. acoroides	13	0.34	12	0.32	16	0.42	19	0.50	60	1.58	15.0	0.39
H. minor	7	0.18	9	0.24	12	0.32	7	0.18	35	0.92	8.75	0.23
T hemprichii	23	0.61	25	0.66	25	0.66	26	0.68	99	2.61	24.8	0.65
C. rotundata	19	0.50	15	0.39	11	0.29	22	0.58	67	1.76	168	0.44
C. serrulata	14	0.37	18	0.47	11	0.29	15	0.39	58	1.53	14.5	0.38
H. pinifolia	8	0.21	9	0.24	6	0.16	13	0.34	36	0.95	9.0	0.24
H. uninervis	6	0.16	4	0.11	0	0.00	0	0.00	10	0.26	2.5	0.07
S. isoeifolium	0	0.00	17	0.45	10	0.26	8	0.21	35	0.92	8.8	0.23
T. ciliatum	6	0.16	0	0.00	0	0.00	10	0.26	16	0.42	4.0	0.11
Total Q laid	38		38		38		38		152		38.0	
Total fo		2.53		2.87		2.39		3.16		11.0		
Grand Mean		**0.28**		**0.32**		**0.15**		**.035**		**1.10**		**0.30**

Q - quadrat
fo - frequency of occurrence

occurrence values. The values of the other five species, (***H. pinifolia, Syringodium isoetifolium, H. minor, T. ciliatum*** and ***H. uninervis***) have below median frequency of occurrence values to wit: 0.24, 0.23, 0.11 and 0.07, respectively as they were found in 36, 35, 16 and 10 quadrats, respectively. Aside from the fact that ***T. ciliatum*** and ***H. uninervis*** were found in very few quadrats/transects, their absence in two transect have greatly reduced their frequency of occurrence values.

Mean Frequency of Occurrence of Seagrasses

Table 8 presents the mean frequency of occurrence of seeagrasses in the northeastern barangays of Anda, Pangasinan. ***Thalasssia hemprichii*** occurred most frequently with a mean value of 0.66. ***Cymodocea serrulata, C. rotundata*** and

Table 8. Mean frequency of occurrence of seagrasses in the northeastern brangays of Anda, Pangasinan

Species	*Cabungan*	*Imbo*	*Tondol*	*Total*	*Mean*
E. acoroides	0.39	0.37	0.39	***1.14***	***0.38***
H. minor	0.03	0.18	0.23	***0.43***	***0.14***
T. hemprichii	0.70	0.65	0.65	***1.97***	***0.66***
C. rotundata	0.43	0.59	0.44	***1.42***	***0.47***
C. serrulata	0.60	0.57	0.38	***1.54***	***0.51***
H. pinifolia	0.10	0.24	0.24	***0.56***	***0.19***
H. uninervis	0.20	0.47	0.07	***0.76***	***0.25***
S. isoeifolium	0.12	0.30	0.23	***0.63***	***0.21***
T. ciliatum	0.09	0.09	0.11	***0.25***	***0.08***
Total	2.66	3.45	2.74	***8.71***	***2..90***
Grand Mean	0.30	0.38	0.30	***0.97***	***0.32***

Q - quadrat

fo - frequency of occurrence

E. acoroides *followed in descending order with mean values of 0.51, 0.47 and 0.38, respectively. They are the four species whose mean values are above the grand mean value of 0.32. The rest of the five species (****H. pinifolia, S. isoetifolium, H. minor, T. ciliatum and H. uninervis****) have mean values of 0.19, 0.21, 0.14, 0.25 and 0.08, respectively. These values are 22% to 75% lower than the mean. Based on the mean frequency*per area, Cabungan has the highest mean frequency of occurrence with a mean value of 0.45 followed by Imbo with the lowest mean value of 0. 30.

Relative Frequency of Occurrence

Cabungan

The relative frequency of occurrence of seagrass species in Cabungan is presented in Figure 6. As can be gleaned from the Figure, ***T. hemprichii*** has the

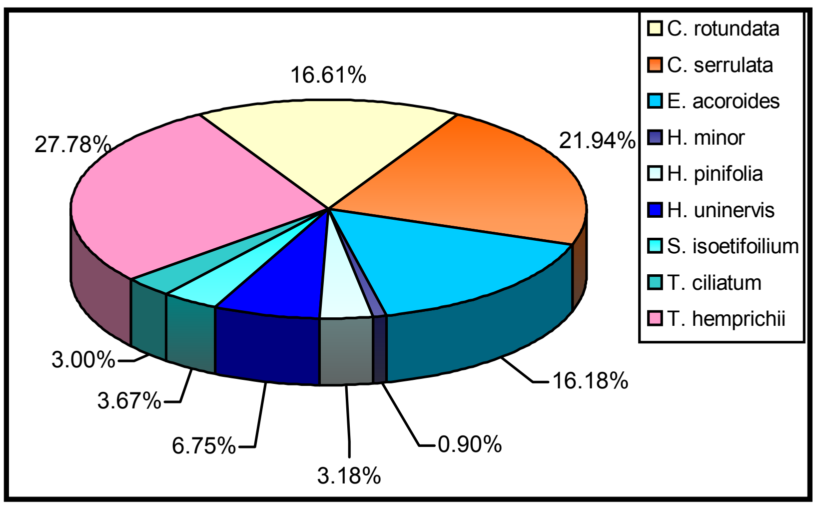

Figure 6. Relative frequency of occurrence of seagrass species in Cabungan

highest of 27. 78%. C***ymodocea serrulata*** followed closely with a share of 21.94%, 5.84% lower than ***T. himprichii***. ***Cymodocea*** an ***E. acoroides*** have almost the same share of 16.61% and 16.18%, respectively. The other five species have less than 10% share. ***Halodule uninervis*** shared 6.75%, ***S. isoetifolium***, 3.67%, ***H. pinifolia***, 3.18%, ***T. ciliatum***, 3.0%, and ***T. minor*** with only 0.90% share.

Imbo

Like in Cabungan coast, ***T. hemprichii*** occupied the largest portion of the area surveyed as evidenced by its relative frequency of occurrence value of 18.94%. The two **Cymodocea** species (***C. serrulata*** and ***C. rotundata***) occupied almost the same portion with mean values of 17.17% and 16.58%, respectively. ***Halodule uninervis*** and ***E. acoroides*** followed, the former covering 13.37% and the latter covering 10.95%. Four species occupied less than 10% of the area. ***Syringodium isoetifolium*** and ***H. pinifolia*** shared 8.15% and 7.22%, respectively. ***Halophila minor*** only occupied 5.07% and only a negligible portion (2.57%) was occupied by ***T. ciliatum*** (Figure 7).

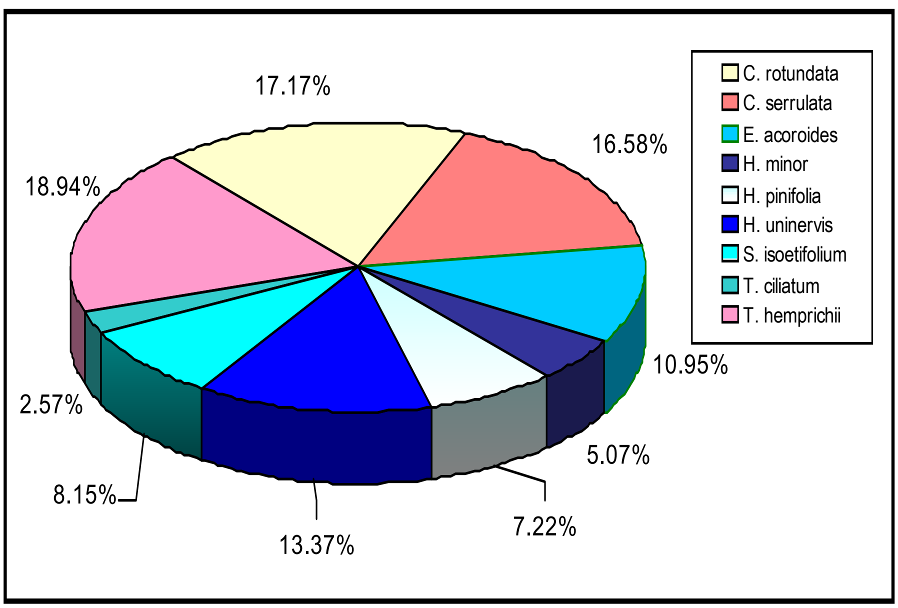

Figure 7. Relative frequency of occurrence of seagrass species in Imbo

Tondol

Relative of the other species in Tondol, ***Thalassia hemprichii*** still shared the highest percentage (24.01%). ***Cymodocea rotundata*** followed with a mean value of 15.99%. Surprisingly, ***E. acoroides,*** ranked third with a mean value of 14.49% a little bit higher than ***C. serrulata*** (13.92%). This is due to the fact that it is well distributed in the area sampled compared to ***C. serrulata*** which often ranked either second or third in other stations whereas in Tondol it only ranked fourth (4.10% lower than ***E. acoroides***). The rest of the species has a relative frequency of occurrence of below 10.0%.

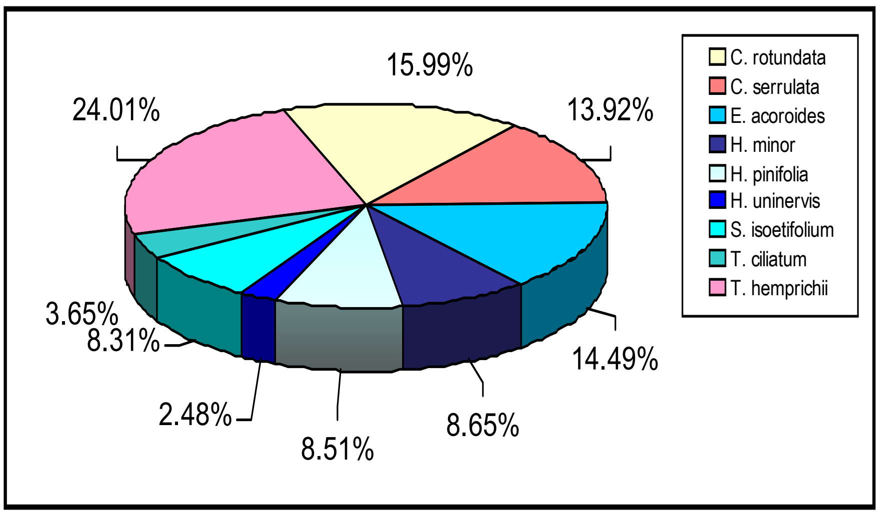

Figure 8. Relative frequency of occurrence of seagrass species in Tondol

Arranged in descending order they are as follows: ***H. minor***, 8.65%; ***H. pinifolia***, 8.51%; ***S. isoetifolium*** 8.31%; ***T. ciliatum*** 3.64%; and ***H. uninervis*** 2.48% (Figure 8).

Mean Relative Frequency of Occurrence

As can be observed in the three Figures (Figures 6, 7 & 8) the ***T. hemprichii, C. serrulata*** *and* ***C. rotundata*** is stable in its position as the three most frequently occurring species relative of the other nine species in the Northeastern coast of Anda, Pangasinan. ***Enhalus acoroides*** ranked fourth despite the drop in its percent share in Imbo (Figure7). Mean values of the four species in descending order are as follows: 23.59% (***T. hemprichii***), 17.48% (***C. serrulata***), 16.59 % (***C. rotundata***), and 13.88% (***E. acoroides***). The ranking of other species is unstable. Figure 9 however, further shows their mean relative frequency of occurrence in the following descending order: ***H. uninervis*** (7.89%), ***S. isoetifolium*** (6.56%), ***H. pinifolia*** (6.28%), ***H. minor*** (4.76%) and ***T. ciliatum*** (2.76%).

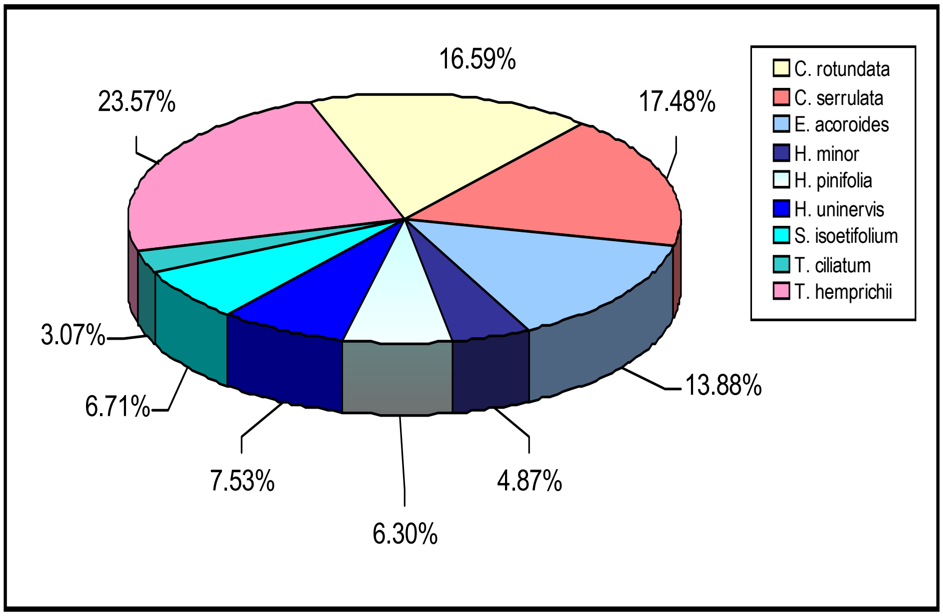

Figure 9. Mean relative frequency of occurrence of seagrasses in the Northeastern barangays of Anda, Pangasinan

DENSITY

Cabungan

Figure 10 presents the density of seagrass species in Cabungan. The mean species density in this area ranged from 5.0 shoots/m^2 (***T. ciliatum***) to 136.21 shoots/m^2 (***T. hemprichii***). In decreasing order of density, the following three species falls above the mean (43.27shoots/m^2): ***T. hemprichii***, 383.45 shoots/m^2; ***C. serrulata***, 86.11 shoots/m^2 and ***C. rotundata*** 56.66 shoots/m^2. Six species have densities falling below the mean average to wit: ***H. uninervis***, 36.29 shoots/m^2, ***E. acoroides***, 22.97 shoots/m^2; ***H. pinifolia***, 20. 05 shoots/m^2; ***S. isoetifolium***, 15.63 shoots/m^2; ***H. minor***, 8.52 shoots/m^2 and ***T. ciliatum***, 5.0 shoots/m^2 (Appendix Table 13). The contributory factor for the higher density of the three specie that fall above the mean is the non-existence of the other six species in Transect 1.

As per transect basis, the highest density of seagrasses was observed in Transect 2 with a mean value of 60.48 shoots/m^2, followed by Transects 3, 4, and 1 in descending order with mean values of: 43.50 shoots/m^2, 37.54 shoots/m^2, and 31.57 shoots/m^2, respectively (Figure 11). The higher density in station 2 is attributed to the presence of the nine species and the higher number of shoots of almost all the species, excluding ***C. serrulata***, and ***C. rotundata***. Despite the absence of ***S. isoetifolium*** in Transect 3, it still ranked second in terms of density due to the higher density of the two *Cymodocea* species (***C. serrulata***, and ***C. rotundata***) in this station compared to the other stations.

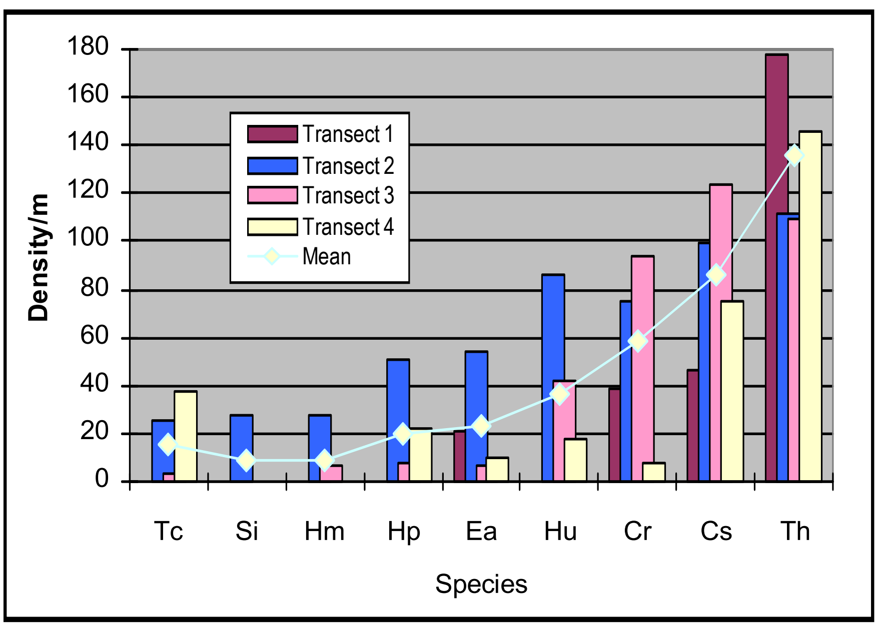

Figure 10. Density of Seagrass species per transect in Cabungan

The lesser density of the six species (***C. serrulata***, ***C. rotundata, E. acoroides, H. pinifolia***: ***H. uninervis*** and ***T. ciliatum***) and the absence of ***H. minor*** in Transect 4 have affected its mean density, placing it in the third rank.

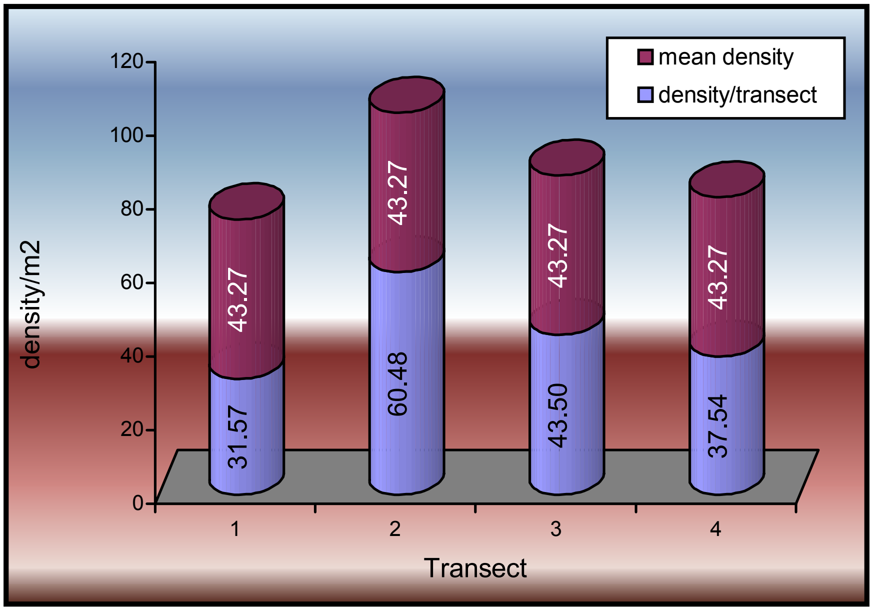

Figure 11. Mean density and density of seagrasses per transect in Cabungan

Thallasia. himprichii's higher density (177.89) in Transect 1 made its mean density just a little higher (15.90%) than Transect 4 despite the existence of only four (4) species ***C. serrulata***, ***C. rotundata, E. acoroides,*** and ***T. hemprichii.***

Imbo

The mean shoot density of seagrasses in this area (57.19 shoots/m^2) is higher than that of Cabungan (43.27 shoots/m^2). Species density ranges from 1.79 shoots/m^2 (***T. ciliatum***) to 223.34 shoots/m^2 (***T. hemprichii***). The range (221.55) is 40.77% higher than that of Cabungan (131.21). In the species level, ***T. hemprichii*** still has the highest density of 223.34 shoots/m^2. ***Syringodium isoetifolium*** followed with a mean value of 101.92 shoots/m^2 and then by ***H. uninervis*** with mean a shoot density of 84.47 shoots/m^2. The density of the aforementioned three species falls above the mean density whereas, the rest of the six species (***C. serrulata, C. rotundata, H. pinifolia, E. acoroides, H. minor*** and ***T. ciliatum***) fall below the mean density. Mean values for each species are 39.61, 31.24, 16.53, 8.45, 7.37 and 1.79 shoots/m^2, respectively (Figure 12).

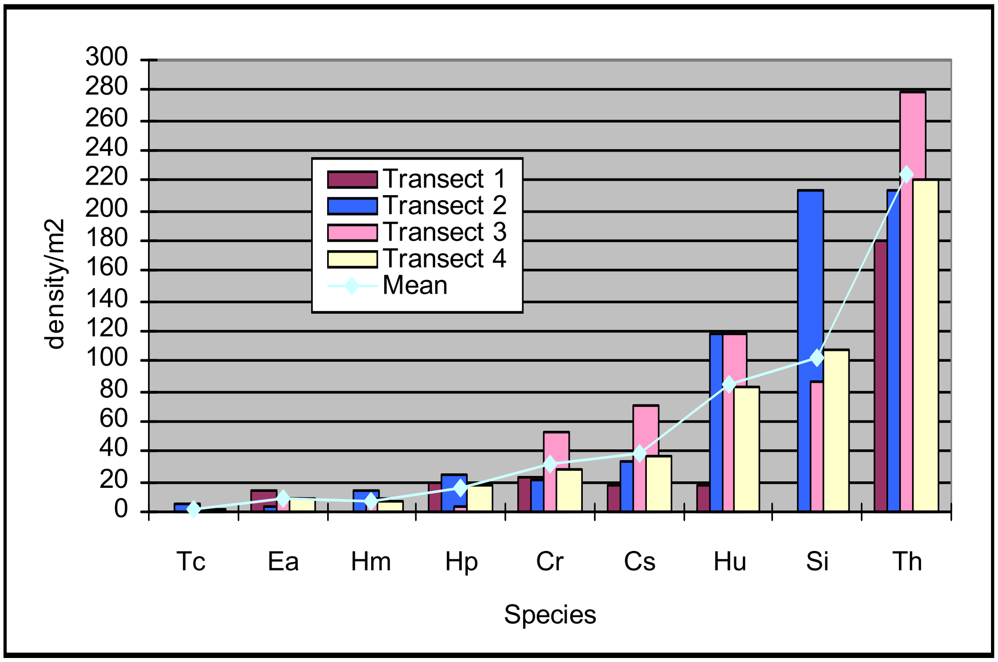

Figure 12 . Density of seagrasses species per transect in Imbo

Per transect density is higher than that of Cabungan with Transect 2 having the highest mean seagrass density of 72.02 shoots/m^2 followed by Station 3 with a mean value of 69.74. The least was observed Transect 1 with a mean value of 30.12 shoots/m^2. Though the seagrasses extends to the last quadrat (380) laid in Transect 3 (Appendix Table 7), Transect 2 obtained the highest density due to the presence of all the species in greater quantities (number of shoots). The absence two species (***S. isoetifolium*** and ***T. ciliatum***) and the very few number of shoots of ***H. minor*** (2) an ***H. uninervis*** (161) in Transect 1 greatly reduced its density (Figure 13).

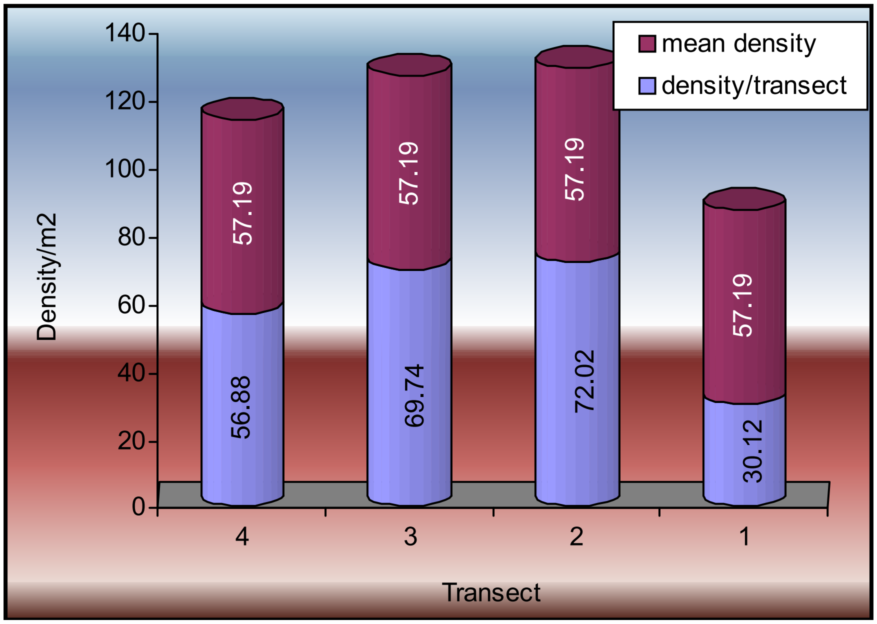

Figure 13. Mean density and density of seagrasses per transect in Imbo

Tondol

Figure 14 shows the density of each seagrass species per transect. Comparing its density with the other two areas, it has the least variable density considering the range of 142.11shoots/m^2 against 222.38 shoots/m^2 and 378.45shoots/m^2, respectively. Of the nine species, only two (2) have densities greater than the mean: ***S. isoetifolium*** (42.16) and ***T. hemprichii*** (146.95) and seven (7) species have density values falling below the mean: ***C. rotundata*** (29.53 shoots/m^2),***C. serrulata*** (22.66 shoots/m^2), ***H. minor*** (21.18 shoots/m^2), ***H. pinifolia*** (18.92 shoots/m^2),

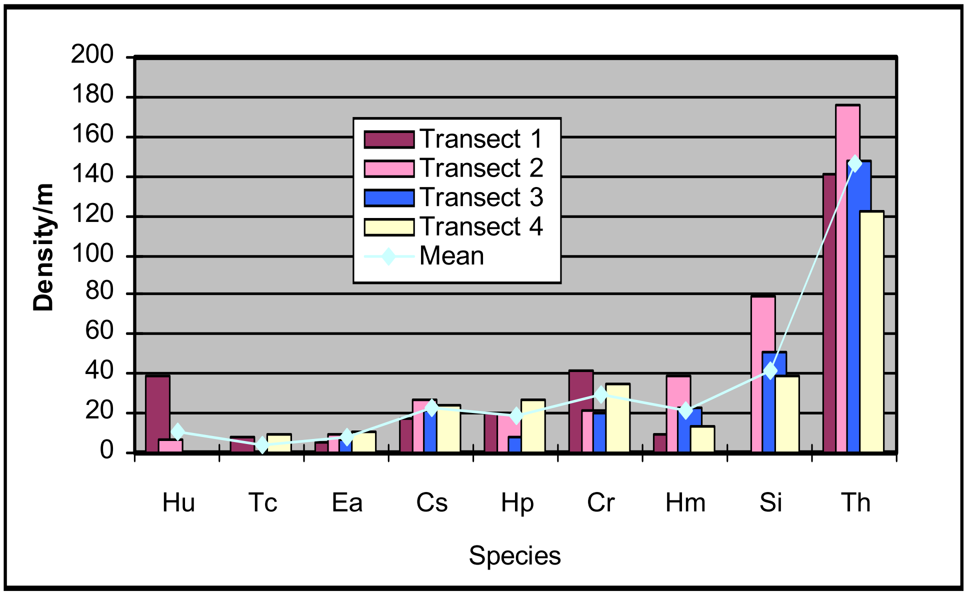

Figure 14. Density of seagrass species per transect in Tondol

(11.26 shoots/m^2), ***E. acoroides*** (8.29 shoots/m^2), and ***T. ciliatum*** (4.39 shoots/m^2).

Figure 15, shows the density per Transect in Tondol, Anda, Pangasinan. As can be gleaned from the Figure, Transect 2 has the highest density with a mean value of 42.11 shoots/m^2 compared to the other three transects with almost the same density of 31.43 shoots/m^2 (Transect 4), 32.32 shoots/m^2 (Transect 1), and 30.85 shoots/m^2 (Transect 3).

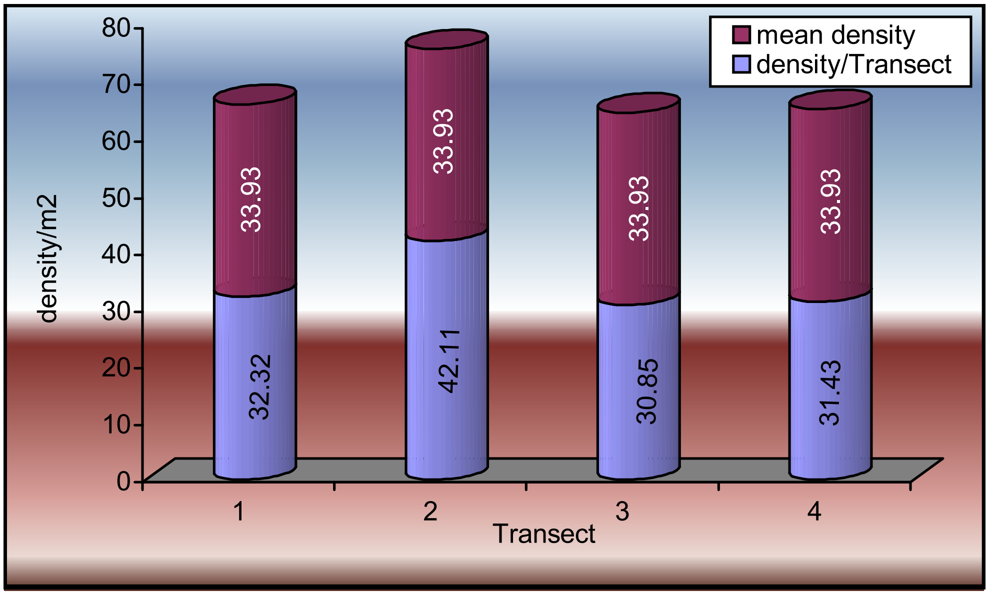

Figure 15. Mean density and density of seagrasses per transect in Tondol mean seagrass density per species

The mean density of the dominant species, ***T. hemprichii*** (168.8 shoots/m^2), in the Northeastern coast of Anda, Pangasinan (Figure 16) is higher than the density of this species in Bolinao (89.23 shoots/m^2), Puerto Galera (99.32 shoots/m^2), Guimaras Island (1.48 shoots/m^2), Pagbilao Bay (1.24 shoots/m^2), Ulugan Bay (0.67 shoots/m^2) and Banacon, Bohol (17.36 shoots/m^2), but lower compared to that of Seribu Island in Indonesia (198.75 shoots/m^2). Among the aforementioned mentioned places in the Philippines, ***T. hemprichii*** dominates only in Puerto Galera. In Guimaras Island it is outnumbered by ***H. pinifolia, H. minor, E. acoroides*** and ***H. ovalis*** with mean densities of 133.6 , 27.4, 12.7 and 12.6 shoots/m^2, respectively. Meanwhile, in Bolinao, ***H. minor*** and ***H. uninervis*** are denser that ***T. hemprichii*** as evidenced by there computed density of 117.96 and 115.6 shoots/m^2, respectively. In Pagbilao Bay, ***E. acoroides*** dominates the area with a mean density of 20.06 shoots/m^2. It is 1518% denser than ***T. hemprichii*** with a mean density of only 1.24 shoots/m^2. The same species (***E. acoroides***) dominates Banacon, Bohol with a quite higher density

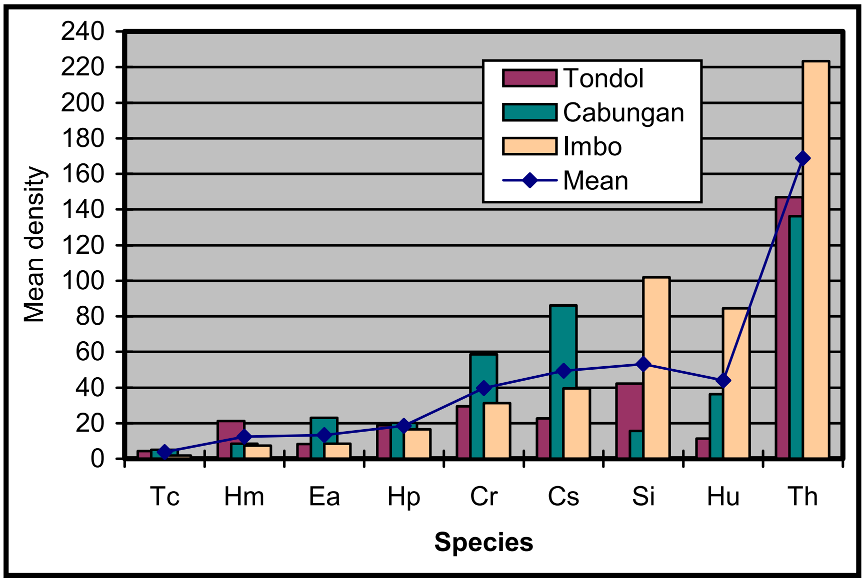

Figure 16. Mean seagrass density per species in the northeastern barangays of Anda, Pangasinan

of 31.52 shoots/m^2. ***Thalassia hemprichii*** only ranked second in terms of density in this area. In Ulugan Bay, on the other hand, ***T. hemprichii*** is the least abundant species. ***Halodule uninervis*** dominates the area with a mean density of 43.09 shoots/m^2.

Relationship Between Seagrass Density and Soil Grain Size

A Pearson correlation revealed a correlation between seagrass density and soil grain size . The correlation, however, is small or weak and is negative (Table 14), and signifies an inverse relationship which means the finer the grain size of the substrate the higher is the density or the coarser the grain size, the lower is the density . This is just natural for like the natural grasses, most seagrasses need finer sediment to anchor their roots so that they will not be drifted by the waves or current in areas where they could not or hardly survive. Furthermore, like other plants, seagrasses need to draw nutrients from the soil and these nutrients are abundant in finer substrates than coarser ones.

Relationship Between Seagrass Density and Water Depth

A weak, small or negligible negative correlation between the water depth and density was also observed. This is evidenced by the negative value of -0.073 (Table 9)

Table 9. Pearson correlation between density of seagrasses and soil grain size

		Water depth
Density	Pearson Correlation	-.073
	Sig. (2-tailed)	.374
	N	152

** Correlation is significant at the 0.01 level (2-tailed).

Paguso et al., 1992 stated that a correlation coefficient less than zero to –0.5, signifies a weak or small negative correlation between the two variables. Values lesser than -0.5 signifies high or strong negative correlation. He further showed that correlation coefficient greater than zero but less than 0.5 signifies small or weak correlation whereas values greater than 0,5 signifies high or strong correlation. This means that the density of seagrasses decreases as the water depth increases. The relationship is expected because as the water grows deeper, the intensity of light also decreases and seagrases will not grow luxuriantly and reproduce rapidly in areas with low light intensity as like all photosynthetic plants, seagrass require light as source of energy for the synthesis of organic products needed for their normal growth and development (Short et al, 2004).

Relationship Between Seagrass Density and Soil Grain Size

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Table 10. Pearson correlation between grain size and mean density of seagrasses

		Grain size
Density	Pearson Correlation	-.246
	Sig. (2-tailed)	.002
	N	152

Mean Density of Seagrasses in the Three Coastal Barangays

Figure 17 presents the mean density of seagrasses in the three barangays in the northeastern coast of Anda, Pangasinan. As shown in the Figure, Imbo has the highest mean density of 57.19 shoots/m2. The value is 40.67% and 47.79% higher than the

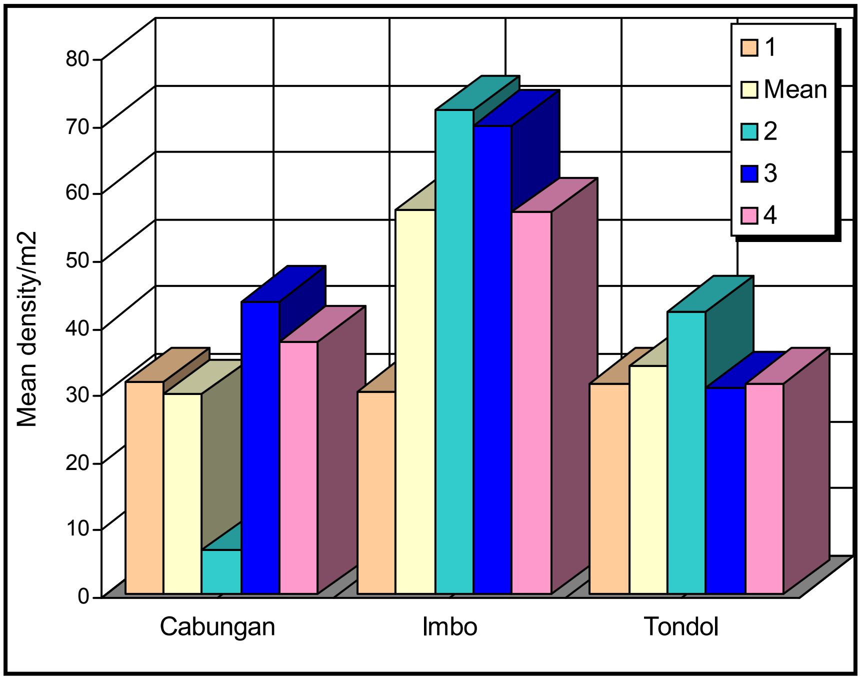

Figure 17. Mean density and density per transect of seagrasses in the three coastal barangays

mean density of seagrasses in Tondol and Cabungan, respectively. The mean value in Cabungan is greatly affected by the absence of the five species in Transect 1.

Cabungan

Figure 18 presents the relative density of seagrass species in Cabungan, Anda, Pangasinan. The Figure shows that ***T. hemprichii*** contributed the highest bulk of seagrasses in the area with a relative density of 38.54%. ***Cymodocea serrulata*** shared 22.11%, and ***C. rotundata***, 14.84%. The rest of the species shared less than 10%. ***Halodule uninervis*** contributed 7.91; ***E. acoroides***, 5.53%; ***H. pinifolia*** 4.43% ; ***S. isoetifolium*** 3.92%; ***H. minor***, 1.69% and ***T. ciliatum***, 1.05% (Figure 18).

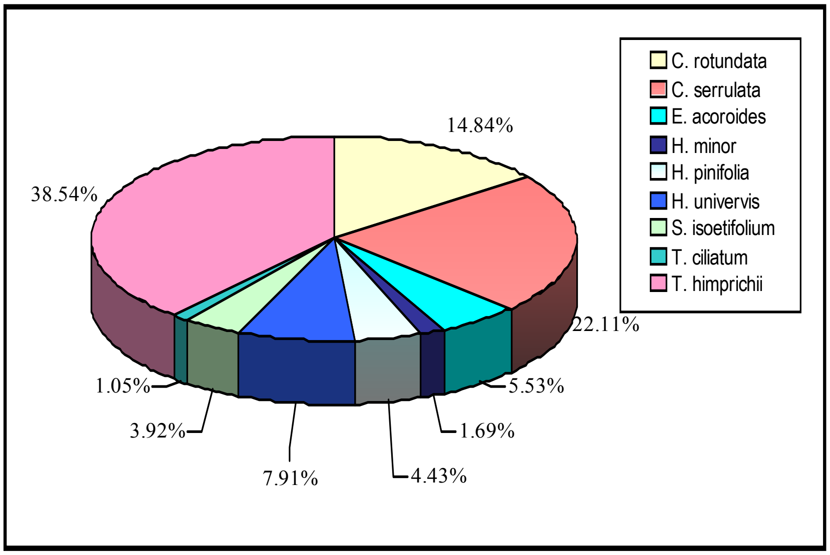

Figure 18. Relative Density of Seagrass Species in Cabungan

Imbo

Thalassia hemprichii shared the highest value of almost 50% (46.71%) of the mean density of the seagrasses in the area. ***Syringodium isoetifolium*** ranked second. It contributed 16.93%, which is 29.79% lower than ***T. hemprichii***. ***Halodule uninervis*** ranked third with a mean value of 14.95% Five species (***C. serrulata, C. rotundata, H. pinifolia, E. acoroides*** and ***H. minor***) contributed less than 10%. Mean values are as follows: 7.54%, 6.41%, 3.76%, 2.17%, and 1.23%, respectively. ***Thalassodendron ciliatum*** have even less than 1% share (0.30%) as evidenced by its negligible share in the pie graph (Figure 19).

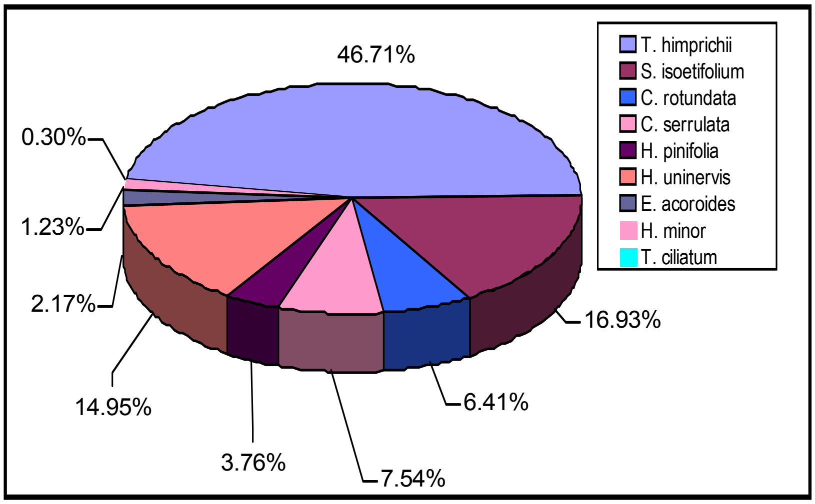

Figure 19 . Relative density of seagrass species in Imbo

Tondol

Thallassia hemprichii's share of 48.26% is the highest relative of all the other species in this area. The second in rank is ***S. isoetifolium with a share of only*** 13.23%, which is 35.05% lower than that of ***T. hemprichii***. The third in rank is ***C. rotundata*** with a share of only 10.00%. The rest of the species has a relative density lower than 10.00%. ***Cymodocea serrulata*** has 7.44%; ***H. minor***, 6.66%; ***H. pinoflia***, 6.26%; ***H. uninervis***, 3.84; ***E. acoroides***, 2.73 and ***T. ciliatum***, 1.56% (Figure 20).

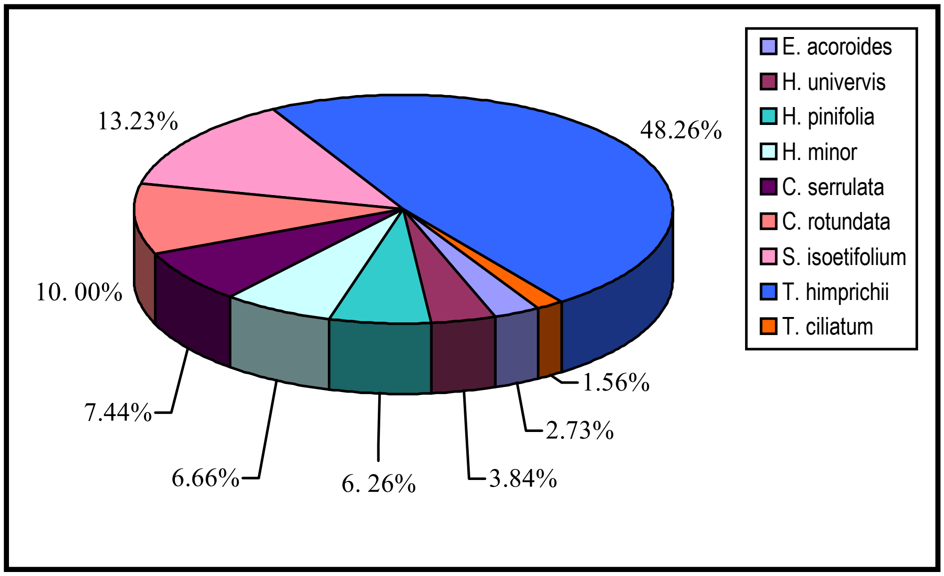

Figure 20 . Relative density of seagrass species in Tondol

Mean Relative Density of the Different Seagrass Species

Based on the relative density presented in the three figures above, the mean relative density of each species varies in different areas, except for that of ***T. hemprichii***, which consistently shared the highest percentage. The two Cymodocea species ,***C. serrulata and C. rotundata***, ranked second and third with mean values of 12.40% and 10.53%, respectively***.*** ***Halodule uninervis*** and ***S. isoetifolium*** ranked fourth an 5th with mean values of 8.77% and 7.02% due to the higher values they incurred in Cabungan. ***Halodule pinifolia*** and ***T. ciliatum*** have almost the same mean values of 4.84% and 4.83%, respectively. The higher percentage share of ***T. ciliatum*** in Tondol push it up of ***E. acoroides*** by a matter of 1.29%. ***Halophila minor*** has the lowest mean share of only 3.18% due to its very low share (1.2%) in Imbo. (Figure 21).

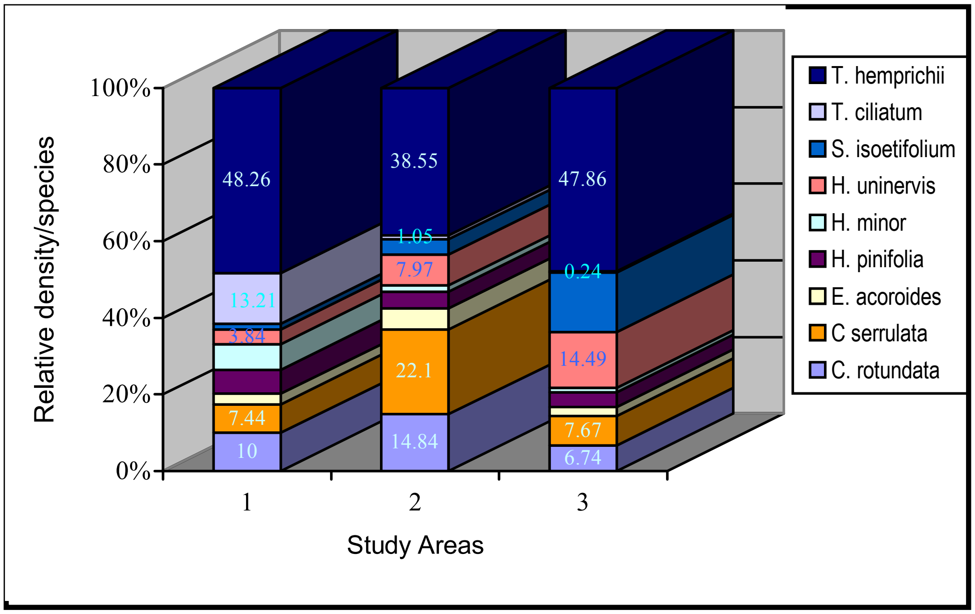

Figure 21. Mean relative density of the different species of seagrasses in the northeastern coast of Anda, Pangasinan

Diversity

Cabungan

Diversity is a measure, normally expressed as an index of a number of species in a particular area. However, it is often affected by the number of individuals of a species or species frequency. A calculation of the Shannon-Weaver's Diversity Index (H) yields values ranging from 1.05418 in Transect 1 to 2.04071 in Transect 2. It is in the latter where higher number of species where observed. In contrast, there are only four (4) species identified in Transect 1. The influence of the species number in diversity can be observed in Transect 3 and 4 (Figure 22). They have the same number of species (8) however, there are more number of shoots in Transect 4 and disregarding the non- existence of ***S. isoetifolium*** (Transect 3) and ***H. minor*** (Transect 4), the difference in the number of shoots/species is quite great in favor of the latter Transect (Figure 22).

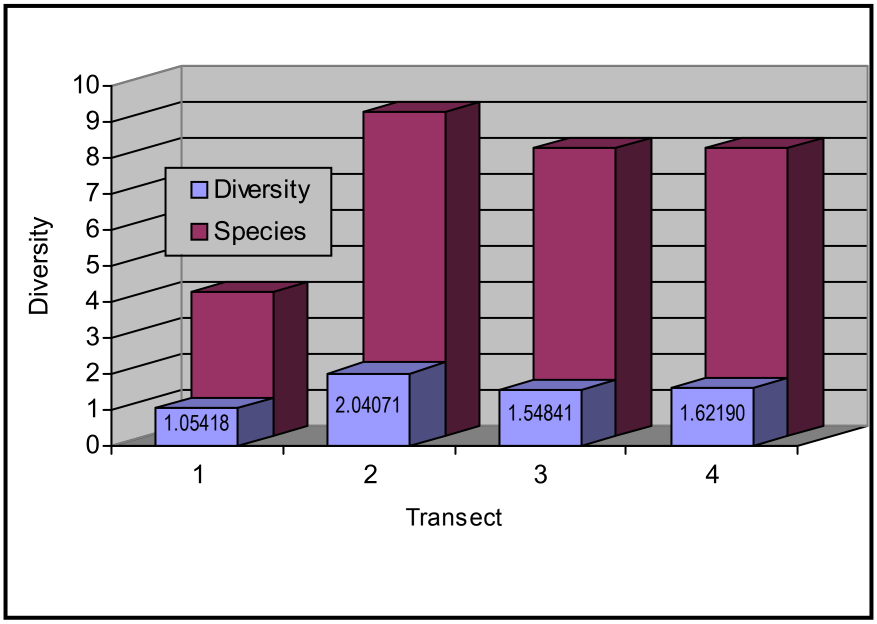

Figure 22. Number of species and diversity of seagrasses per Transect in Cabungan, Anda, Pangasinan

Imbo

Figure 23 presents the number of species as well as the calculated diversity index per transect in Imbo, Pangasinan. As can be gleaned from the Figure, Transect 2 has the higher number of species as well as diversity index than in two other transects (Transects 1 and 3). In descending order, number of species and diversity index are as follows: 1.18391 and 7 in Transect 1; 1.54748 and 8 in Transect 3; and 1.58196 and 9 in Transect 2.

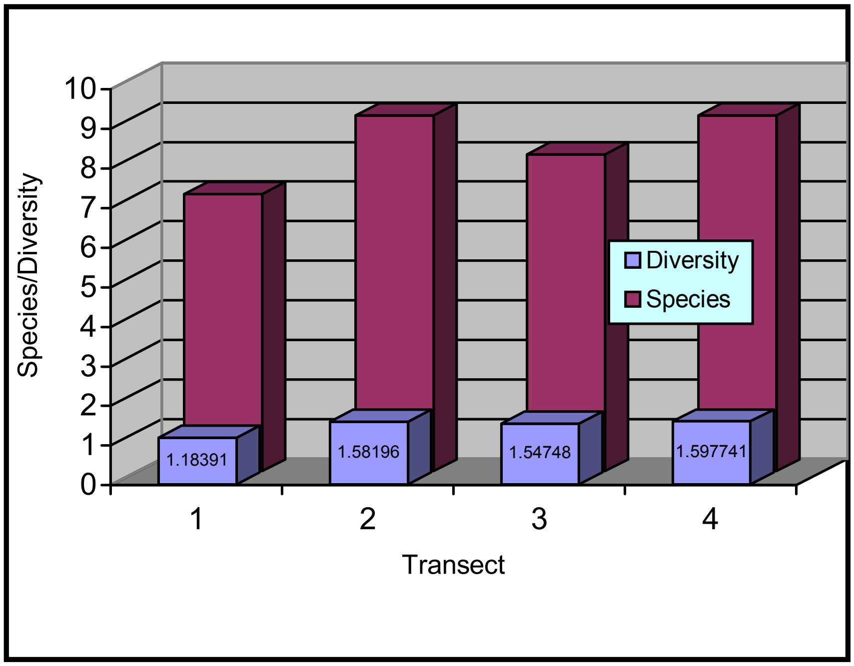

Figure 23. Number of species and diversity of seagrasses per transect in Imbo

Tondol

As shown in Figure 24, the four transects have the same the number of species (8). Their diversity values however are affected not only by the species richness (number of species) but also by equitability, which refers to the evenness with which individuals are distributed amongst species (Pielou, 1966 cited in English et al. eds., 1994). The lower frequency/number of shoots (ni) of ***H. uninervis*** in Transect 2 (Appendix Tables 18 and 30) greatly affected the diversity value of this transect (1.5869). It is 7.68% lower than the value of Transect 4 and only 1.73% higher than the value of Transect 1 when in fact it has the higher total frequency/number of shoots (ni) 0f 3600 shoots compared to only 2687 shoots and 2678 shoots in Transect 4 and 1 respectively (Appendix Tables 18 32 and 29). Despite the higher frequency/number of shoots (ni) in Transect 3 is the least diverse among the four Transect due to its having the lowest number of species (7).

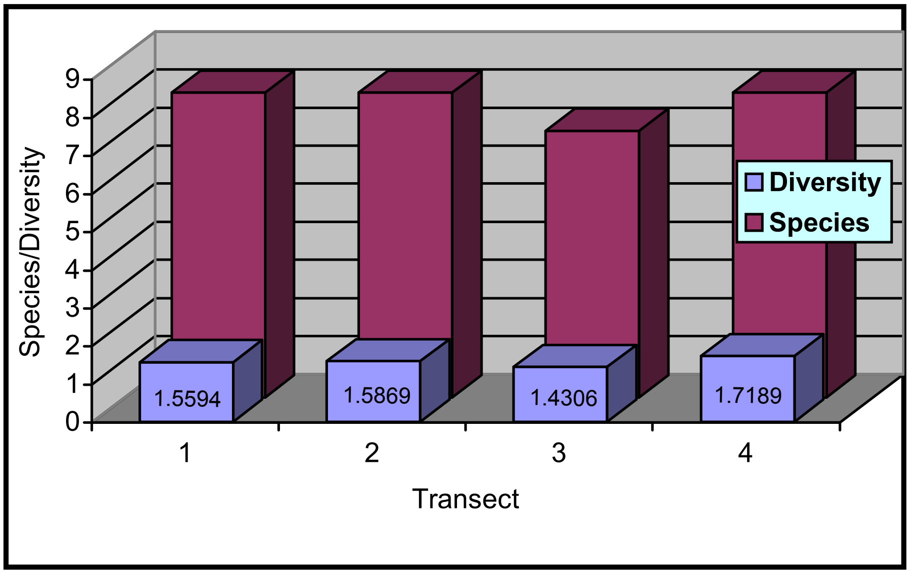

Figure 24. Number of species and diversity of seagrasses per transect in Tondol

Mean Diversity of Seagrasses in the Three Coastal Barangays

Generally the nine species of seagrasses are present in the three barangays. Despite having the highest total frequency/number of shoots (ni), the uneven distribution of individuals in Imbo (with 2 being the lowest frequency) contributed to its having the least diversity value of (1.477772) compared to the values in the other two barangays 1.566289 (Cabungan); and 1.573934 (Tondol). Although There are only four (4) species found in Transect 1 of Cabungan, the distribution of the individuals in every transect is less varied compared to that of Imbo. Computing the range (highest-lowest value), Imbo has the largest range, which signifies highly dispersed values. The frequencies per species/Transect in Tondol, on the other hand, are less varied than that of Cabungan, hence, considered to have more diverse seagrasses among three areas surveyed.

The values obtained in the three barangays (Figure 25) as well as mean value (1.539335) is slightly lower than that of Puerto Galera in Palawan (1.257157), Bolinao

(1.03955), Ulugan Bay (1.0367), Banacon, Bohol (0.7631) and Pagbilao, Quezon (0.473).

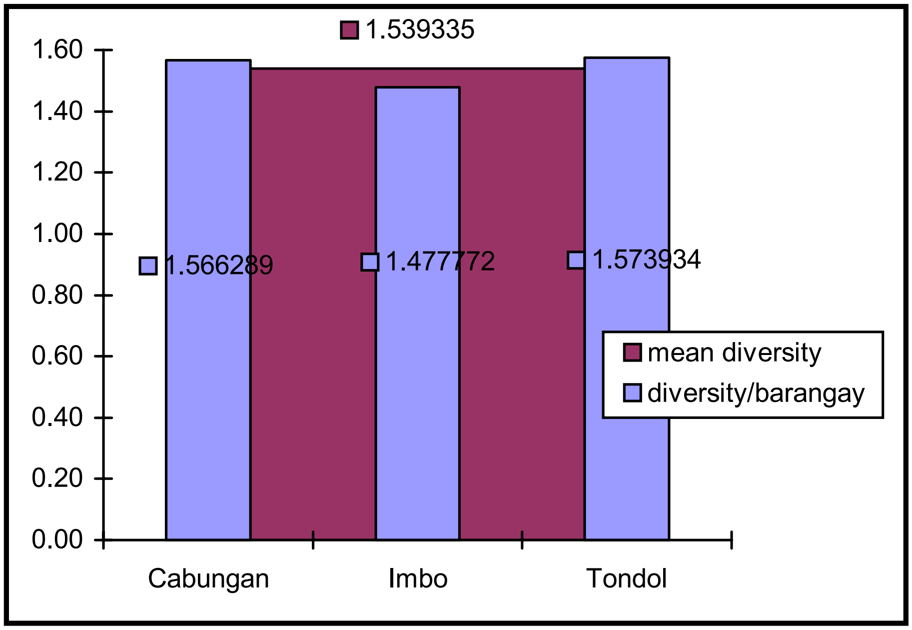

Figure 25. Mean species diversity of seagrasses in the three barangays in Anda, Pangsinan

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

This chapter the summary of findings, conclusions and recommendations of the study. This unveils the purpose the study, concise methodology and results of the survey. Conclusions were based on the objectives of the study and possible actions/interventions were included in the recommendation with a hope seeing a properly managed seagrass resources in the near future.

Summary

A resource survey was conducted in the three barangays of the northeastern Coast of Anda, Pangasinan (Tondol, Imbo, and Cabungan) to determine the status of seagrasses in terms of: distribution along transect length and depth gradient and abundance in terms of a) frequency of occurrence b) relative frequency of occurrence c) density d) relative density and e) diversity. Soil (grain size) and water quality in the three coastal barangays were also monitored to determine their relationship with the abundance of seagrasses specifically with density.

To accomplish the objectives of the study, four transect lines were established in upper intertidal waters of each barangay offshore to a transect length of 380 meters. In each transect two (2) quadrats were laid adjacent to each other at a distance of one meter. To cover the whole stretch of each transect, the first two quadrats were replicated thirty eight (38) times at a 10-meter interval. Before the collection and counting of samples in each interval, water salinity, pH, temperature ass well as depth were taken. Seagrasses in each quadrat were pulled with the aid of a pointed stick and simultaneously soil grain sizes were recorded as adapted from Wentworth (in English et al.,1994). All seagrasses collected in each quadrat were placed in a labeled plastic bag and brought to a small nipa hut for identification and counting. In quadrats with few numbers of seagrasses, on-site counting and identification with the aid of a mask were done. This was made possible and easier through familiarization of the species before the survey proper.

Collected data were tabulated and the frequency of occurrence, relative frequency of occurrence, density relative density and diversity were computed and plotted using a pie and/or bar graph. Relationships between water depth and density and soil grain size and density were determined through Pearson correlation coefficient and differences between the frequency of occurrence, relative frequency of occurrence, density, relative density per species, per transect and per barangay were analyzed using Analysis of Variance (ANOVA) through the aid of SPSS 10.0. The same statistical tool was used to determine significant differences on the diversity of seagrasses per barangay.

Results of the study revealed the following environmental conditions that exist in the study areas: In Cabungan, soil grain size is compose of 9% mud/silt, 32% sand and mud, 29% pure sand, 20% sand and granules and 9% mixture of sand, cobble and boulder. In Imbo, higher percentage of the bottom soil is compose of a mixture of sand and granules (41%) followed by sand and mud (26%) pure sand (17%), mud and silt (9%), and mixture of sand, cobble and boulder (7%). In Tondol bottom soil is composed mostly of sand and granules (46%), followed by pure sand (39%), sand and mud (9%), and mixture of sand, cobble and boulder (6%). Generally bottom soil in the whole study area is composed of silt/mud (6.67%), sand and mud (22.37%), pure sand (28.33 %), granules (35.67%), cobble and boulder (7.33%).

Water salinity in the three barangays ranges from 28 to 34 ppt. Salinity in Tondol is 1 ppt higher than that of Cabungan and Imbo, which registered a highest refractometer reading of 33 ppt. Lowest temperature was recorded in the study registered at 24^{o}C in Imbo compared to only 26 in Cabungan and Tondol but the difference is probably due to time of monitoring. The nearness of the boarding house to the study area in Imbo made the monitoring faster and earlier than the other two areas. Hottest temperature was recorded in Tondol where the water is so clear and transparent enabling the sun's rays to penetrate up to the deepest portion of the water in the area surveyed. Water pH, on the other hand, is the same in all the three barangay (7.2 to 7.8). The values are a little above neutral or slightly alkaline.

The nine species of seagrasses are distributed from the first 10-meter zone to the whole stretch of the transect (380 m) in Cabungan with ***T. hemprichii*** as the most widely distributed species. It is found in the whole stretch of the four (4) transect. It is followed by ***C. serrulata, C. rotundata*** and ***E. acoroides**, which* extend to 380 m but in lesser number of quadrats than ***T. hemprichii*****.** Generally, the nine species are well distributed in between 140 and 150-meter zones of the four transects. Though they are all present also in the 80-meter zone the number of shoots are just within the average. The 60-meter zone is even denser compared to the 80-meter zone. Seagrasses abounds in the 70, 90, 130, 160,170, 260 and 290-meter zones. Beyond the 290-meter zones, mostly 3 to 4 species exist in lesser frequencies.

As to depth gradient, seagrasses in Cabungan are concentrated in the upper intertidal to the lower subtidal waters to a mean water depth of 133 cm. Beyond this depth, the number of species reduced to three to four except four Transect 4 where there still remains seven species but in very few frequencies.

Like in Cabungan, seagrasses in Imbo extends up to the 380 – meter zones particularly in Transect 3. However, in the other three transect they can only be observed up to 200 to 290 – meter zones, in Transects 1, 3 & 4, respectively. Generally, in all the four (4) transects, only the 130-meter zones (49 and 44 cm deep) of Transects 2 and 4 have the most number of species (9). The density of seagrasses in Imbo is greater on the first half of the area (10-200 meters). Beyond this zone, the distribution becomes narrow, except in Transect 2 and 4 where mats of ***S. isoetifolium*** exist from 240 to 270-meter zones (139 to 164 cm deep). Species wise, Still ***T. hemprichii*** is the most widely distributed species followed ***E., acoroides*** but the latter though found up to 380 – meter zone (Transect 3), are present only in patches and in lesser number of quadrats than ***T. hemprichii*** and the two ***Cymodocea*** species (***C. rotundata and C. serrulata***). ***Thalassodendron ciliatum*** is the least distributed species in this area.

In Tondol, seagrasses extends only up to 310-meter zone (250 cm deep) with ***T. hemprichii*** as the most widely spread species followed by ***E. acoroides***. Which spreads from 20-meter zone to 310- meter zones but found in lesser number of quadrats like in Cabungan. The two (2) ***Cymodocea*** species (***C. rotundata and C. serrulata***) followed closely . They extend from 10 to 300 meter zone for the former and 40 to 300 meter zones in the latter. ***H. uninervis*** has a very narrow distribution in these areas for it spread only from 20 to 200 in Transects 1 and 2 and is absent in Transects 3 & 4. Horizontally, the nine species of seagrasses occupied the 90 to 120 – meter zones and 160 to 240 – meter zones.

Vertical distribution of seagrasses in this area extends from 13 to 345 cm deep but the nine species are concentrated in 36 to 60 cm deep and 86 to 153 cm deep.

In terms of frequency of occurrence of seagrasses in the three barangays, ***Thalasssia hemprichii*** occurred most frequently with a mean value of 0.66. ***Cymodocea serrulata, C. rotundata*** and ***E. acoroides*** followed in descending order with mean values of 0.51, 0.47 and 0.38, respectively. They are the four species whose mean values are above the grand mean value of 0.32. The rest of the five species (***H. pinifolia, Syringodium isoetifolium, H. minor, T. ciliatum*** and ***H. uninervis***) have mean values of 0.19, 0.21, 0.14, 0.25 and 0.08, respectively. These values are 22% to 75% lower than the mean. Based on the mean frequency per area, Cabungan has the highest mean frequency of occurrence with a mean value of 0.45 followed by Imbo with the lowest mean value of 0. 30.

The trend on the relative frequency of occurrence of seagrasses in the three barangays naturally followed its non-relative counterpart. Mean values of the nine species in descending order are as follows: 23.59% (***T. hemprichii*)**, 17.48% (***C. serrulata***), 16.59 % (***C. rotundata***), and 13.88% (***E. acoroides***) ***H. uninervis*** (7.89%), ***S. isoetifolium*** **(**6.56%), ***H. pinifolia*** (6.28%), ***H. minor*** (4.76%) and ***T. ciliatum*** (2.76%).

Of the nine species, only one (1) has density greater than the mean of 44.79 shoots/m^2 (***T. hemprichii,*** 146.95) and seven (8) species have density values falling below the mean: *S. isoetifolium* (42.16), ***C. rotundata*** (29.53 shoots/m^2), ***C. serrulata*** (22.66 shoots/m^2), ***H. minor*** (21.18 shoots/m^2), ***H. pinifolia*** (18.92 shoots/m^2), ***H. uninervis*** (11.26 shoots/m^2), ***E. acoroides*** (8.29 shoots/m^2), and ***T. ciliatum*** (4.39 shoots/m^2).

Considering the mean density of seagrasses in the three barangays in the northeastern coast of Anda, Pangasinan, Imbo has the highest mean density of 57.19 shoots/m2. The mean value is 40.67% and 47.79% higher than the mean density of seagrasses in Tondol and Cabungan, respectively. The mean value in Tondol was 33.93 shoots /m^2. It has also the least variable density compared to that of Cabungan and Imbo considering the range of 142.11shoots/m^2 against 222.38 shoots/m^2 and 378.45shoots/m^2, respectively. Cabungan has the lowest with a mean value of 29.77 shoots/m^2 . It is greatly affected by the absence of the five species in Transect 1.

The mean relative density of each species varies in different barangays, except for that of ***T. hemprichii***, which consistently shared the highest percentage. The two *Cymodocea* species ,***C. serrulata and C. rotundata***, ranked second and third with mean values of 12.40% and 10.53%, respectively***.*** ***Halodule uninervis*** and ***S. isoetifolium*** ranked fourth an 5th with mean values of 8.77% and 7.02% due to the higher values they incurred in Cabungan. ***Halodule pinifolia*** and ***T. ciliatum*** have almost the same mean values of 4.84% and 4.83%, respectively. The higher percentage share of ***T. ciliatum*** in Tondol push it up of ***E. acoroides*** by a matter of 1.29%. ***Halophila minor*** has the lowest mean share of only 3.18% due to its very low share (1.2%) in Imbo.

The diversity of seagrasses in the northeastern coast of Anda, Pangasinan varies in the three barabgays with Tondol as the most diverse followed by Cabungan and Imbo as the least diverse. The nine species of seagrasses are present in the three barangays, however, the uneven distribution of individuals in Imbo (with 2 being the lowest frequency) contributed to its having the least diversity value of (1.477772) compared to the values in the other two barangays 1.566289 (Cabungan); and 1.573934 (Tondol). Although there are only four (4) species found in Transect 1 of Cabungan, the distribution of the individuals in every transect is less varied compared to that of Imbo. Computing the range (highest- lowest value), Imbo has the largest range, which signifies highly dispersed values. The frequencies per species/Transect in Tondol, on the other hand, are less varied than that of Cabungan, hence, considered to have more diverse seagrasses among three areas surveyed.

A Pearson correlation analysis on the relationship of grain size and density revealed a small or weak negative correlation (-246). This signifies an inverse relationship, which means that the finer the grain size of the substrate the higher is the density or the coarser the grain size, the lower is the density.

Likewise the same inverse relationship was observed between water depth and density. This is evidenced by the negative value of -0.073. This means that the density of seagrasses decreases as the water depth increases.

Conclusion

Based on the results of the study, the following conclusions were drawn:

1. The environmental conditions (soil grain size and water quality) are within the standard measurements for the growth of seagrasses.
2. Seagrasses in the northeastern barangays of Anda are widely spread, abundant, and diverse.
3. The density of seagrasses decreases with increasing soil grain size and increases with decreasing water depth.

Recommendations

Seagrass beds in three barangays in the northeastern coast of Anda, Pangasinan are rich not just in nutrients but also in aquatic flora and fauna. As mentioned earlier, the seagrass beds are interspersed with seaweeds, sea urchins, sea cucumber, snails, starfishes and variety of fishes also abounds. It is not surprising to know that the seagrass beds in these areas are highly disturbed because of the inhabitants even the fisherfolks are unaware of the benefits they could derive from seagrasses hence, destructions caused boats and their anchors even by gleaners who are using either push nets to gather shells and shellfishes like shrimps (particularly in Cabungan) or bare hands (Imbo and some parts Tondol) are undermined. To properly manage the seagrass beds in the area, the following strategies are necessary:

1. **Development of municipal coastal development plan incorporating seagrasses.** - Every municipalities are to formulate a development plan covering every area within their jurisdiction including coastal waters. A multi-sectoral participation (LGU's, NGO's, PO's, fisherfolks, SUC's and other government agencies) would enable the officials to gather ample theoretical information and experiences as well as to identify the problems and needs to properly manage the coastal resources.
2. **Orientation seminar** - Lack awareness of the coastal inhabitants on the nature, usefulness as well as the causes and effects of the destruction of their resources is one of the major problems confronting coastal managers. The orientation seminar will widen their knowledge that they would learn to value other resources like seagrasses the way they value fishes and other high valued species. A slide or CD viewing for visitors depicting the resources and their benefits is a must for Tondol and Cabungan where they are frequently visited by swimmers, students and other visitors not just because of the white beach in Tondol but also because of the sanctuaries in the areas mentioned.
3. **Develop coastal resources linked livelihood projects.** through identification of the needs of the fisherfolks through focus group discussion and /or consultation; conduct of training-seminars on appropriate fisherery/aquaculture technologies for fisherfolks, housewives and out of school youths prior to project implementation - to provide alternative source of income thus, lessening stress on seagrass beds and other coastal habitat. The projects should be financed at the start to divert the attention of the fishermen and shell collectors to a more worthwhile endeavor.

   Technology trainings on the how to make use of the seagrass leaves especially of the fallen ones drifted along the shores (compost making, paper making, bag making etc.) should also be done. This will serve as additional livelihood for the families along the shores of these three barangays. A ready market for the product should be ensured that sustainability of the project would also be ensured.

4. **Organize/ reactivate the fisherfolks organizations including housewives and out-of-school youths.** The fisherfolks and their families play a vital role in the management of the coastal resources. They are the end users and once properly guided, they could protect and conserve it effectively like the way they protect their precious properties.
5. **Strengthening of the BANTAY DAGAT, community leaders and other fishery law enforcers through trainings/seminars on environmental laws and provision of with communication and transportation equipment (EG-ICOM, speed boats and licensed firearms) and incentives.** The BANTAY DAGAT members in the tree study sites are not fully compensated and not fully equipped and armed. The lack of awareness and incentives discouraged them to guard their resources from intruders and illegal fishers. The lack of communication and transportation equipment allows the entrance of these violators of the law. The conduct of trainings/seminars and provisions of necessary equipment would encourage them to participate actively in any conservation and management activities.
6. **Implement stock enhancement projects (e.g. seagrass transplantation sea ranching**). Areas which was previously been destroyed by explosives and less productive seagrass beds could be seeded by fish and other marine organisms like abalone, top shell sea cucumber and even corals and seaweeds to increase fish production for sustainable use of the coastal waters.
7. **Continuous assessment of the seagrass beds in the study area and other areas in Anda.** Resource assessment be a continuous activity. It should be done in each area at least every two to five years to monitor the status of seagrasses and other resources and determine which area should be developed and preserved as sanctuary/park or marine protected area (MPA). Assessment should include other associated flora and fauna as well as the other factors that would affect effective conservation and management.

Along with the possible interventions for the proper management of seagrass beds in the study areas, the following are highly recommended for future studies in the area:

a. Assessment of the whole coastal waters of Anda should be conducted to have a complete data of the status of seagrasses in the area considering other associated flora and fauna.
b. A compass or GPS should be used to determine the exact location of the study areas so as not to duplicate the study or if a verification study is needed, exact location will be identified.
c. Skills in identifying and counting species underwater is needed so as not to uproots seagrasses during sampling.

BIBLIOGRAPHY

Alcala, A. C. 1990. Management of Nearshore Resources: Proceedings to the Seminar-Workshop on Management of Nearshore Resources. Ecotech Center, Cebu City, Philippines.

Azkab, M.H. 1991. Study on Seagrass Community Structure and Biomass in the Southern Part of Seribu Islands. In Alcala et al. (eds.) Proceeding of the Regional Symposium in living Resources in Coastal areas, 30 January 1 February, 1989 p. 353-362.

Brewer, R. 1979. Ecological Diversity. In Principle of Ecology. W.B. Saunders Co. Philadelphia, London, Toronto, p. 164-168.

Calumpong, H. P. and E. G. Meñez. 1997. Seagrasses. In Field Guide to the Common Mangroves, Seagrasses, and Algae of the Philippines. Bookmark & CO. Phil. p 58-83.

English, S. C., C. Wilkinson, and B. Beker (Eds). 1984. Survey Manual for Tropical Marine Resources. Australian Institute of Marine Sciences. PMB No. 3. Australia.

Fortes, M. D. 1990. Seagrasses: A Resource Unknown in the ASEAN Region. ASEAN/US CRMP Education. Series No. 6, 45 p. ICLARM/ASEAN CRMP Manila , Phil.

Fortes, M.D. 1991. Scientific Design and Field Monitoring of Ecological Parameters. In Trono, C. G. Jr, C. R. Pagdilao and M. M. Acedera (eds). Training on Seaweed Research. Proceedings on the Seaweed Research Training and Workshop for Project Leaders. Book Series No. 11/1991. UPMSI, Diliman, Quezon City 23 November- 10 December , 1987. PCAMRD/DOST 175 p.

Fortes, M.D. 2003. Seagrasses: Their Role in the marine Environment: A Paper delivered during the 1st National Seagrass Networking Conference at Legend Hotel, Puerto Princesa, Palawan o September 02-05, 2003.

Fortes, M. D. 2001. Management of Seagrass and Mangrove Ecosystem in the Philippines. In Alcala A. C. and M.C. Balgos (eds) Proceeding of the Seminar Workshop on the Management of Nearshore Fishery Resources. ECOTECH Center, Cebu City 23-25 January 1990. PCAMRD/DOST. 218 p – Book series No. 10/1991.

Gomez, K. A and A.A. Gomez. 1984. Statistical procedures fo4r Agricultural Research (2nd ed.) An International Rice Research Institute Book. Wiley-Interscience Pub.John Wiley & Sons New York, Toronto, Singapore.

Meñez E. G., R.C. Philips and H. P. Calumpong. 1983. Seagrasses From the Philippines Smithsonian Contribution to the Marine Science No. 21, 36 p. Smithsonian Institution, Washington.

Nateckanjanalarp, S.S. and W. Chidonnirat. 1991. Observations of the Spatial Distribution of Coral Reefs and Seagrass Beds in the Gulf of Thailand. In Alcala et al. (eds). Proceedings of the Regional Symposium in Living Resources in Coastal Areas, 30 January – 01 February, 1989 p 363-366.

Odum, E. P. 1971. Species Diversity in Communities. In Fundamentals of Ecology 3rd Edition. W.B. Saunders Co. London.

Ornate, J. A., J. S. Estacion and J. Puique. 1991. Survey of Seagrasses and Their Economically Important Invertebrates in North Bais Bay and \Sequijor Island Philippines. In Alcala et al. (eds) Proceeding of the Regional Symposium in Living Resources in Coastal Areas, 30 January – 01 February, 1989. p 379-383.

Pagoso, C.M. and R.A. Montaña. 1997. Introductory Statistics. Manila: Rex Bookstore 391 p.

Philips, R.C. and E. G. Meñez. 1988. Seagrasses: Smithsonian Contribution to the Marine Science No. 21, 104 p. Smithsonian Institution Press, Washington.

Rollon, R.N. and M. D. Forrtes. 1991. In Structural Affinities of Seagrass Communities in the Philippines. In Alcala et al. (eds) Proceedings of the Regional Symposium in Living Resources in Coastal Areas, 30 January – 01 February, 1989. p 333-346.

Sanares, R.C. and V.T. Balinas. 2002. Introduction to Data Analysis. A paper presented during the training on "Experimental Design and Analysis of Data in Fisheries Research. UP in the Visayas on May 8-10, 2002.

Short, F. T. , R. G. Cole, E. Koch and M.D. Fortes. 2004. Global Monitoring Network of Seagrass Resources. http://www.SeagrassNet.org

Sumich, J. L. 1976. Marine Plants. In Introduction to the Biology of Marine Life. Wm. C. Brown Co. Pub. USA. p 101.

UNESCO, 2002. An Ecological Assessment of Ulugan Bay, Palawan, Philippines CSI Info N^{o} 12, UNESCO, Paris, 46 pp.

Zeiman, J. C. 1975. Tropical Seagrass Ecology and Pollution. Amsterdam Elsevier Pub. Co. Washington DC.

FRMP. 2000. Fisheries Management Project. Seagrass and Mangrove Componenet: A Situationer.