COMMUNITY STRUCTURE OF SEAGRASSES

ALONG SELECTED COASTAL AREAS IN THE PHILIPPINES

A Research Paper
Presented to
The Faculty of Philippine Science High School Western Visayas
Bito-on, Jaro, Iloilo City

In Partial Fulfillment
of the Requirements for
SCIENCE RESEARCH 2

by

Melchor A. Altillero Jr.
Celaida Gayle D. Gumban
Jewel V. Vijar
Fourth Year – Photon

February 2006

APPROVAL SHEET

This research proposal hereto entitled:

"Community structure of seagrasses along selected coastal areas in the Philippines"

prepared and presented by Melchor A. Altillero Jr., Celaida Gayle D. Gumban, and Jewel V. Vijar in partial fulfillment of the requirements in Science Research 2, has been examined and is recommended for acceptance and approval.

JOSETTE T. BIYO
Adviser

Approved by the Committee on Oral Examination with a grade of PASSED on February____, 2006.

ZENNIFER OBERIO
Chairman

HAROLD MEDIODIA
Member

JOSETTE BIYO
Member

Accepted in partial fulfillment of the requirements in Science Research 2.

DR. JOSETTE T. BIYO
OIC, Office of the Director

ACKNOWLEDGEMENT .

First and foremost, we would like to thank our Lord, God for without His help and guidance, we could not have accomplished this research paper.

We would also like to thank the following:

Dr. Josette T. Biyo for sharing her invaluable time and expertise regarding the study. We are very honored for having her as an adviser.

Our co- adviser. Mr. Harold Mediodia for ceaselessly accompanying us in our trips and supervising us in our filed work.

Pfizer Philippines for giving us the grant which helped us cover all the expenses of the study.

The research committee headed by Ms. Zennifer Oberio for helping us improve the quality of our paper through their suggestions and critiques.

Our parents and family for not only supporting us but taking first hand roles doing the study.

To all the people we have met and new friends we made along the way while doing the study.

To our friends and classmates for the support.

To the whole Philippine Science High school Community for helping us make this research paper as success.

And to each other for doing our part in the best way we could in accomplishing not only this thesis but surviving the test of patience, will, determination and friendship.

Altillero, Melchor A., Gumban, Celaida Gayle D., Vijar, Jewel V. "Community structure of seagrasses along selected coastal areas in the Philippines". Unpublished Research. Philippine Science High School Western Visayas. Bito-on Jaro, Iloilo City. February 2006.

ABSTRACT

The community structure of seagrasses in Tando, Guimaras; Odiongan, Romblon; Looc, Romblon and Concepcion, Iloilo was described in terms of: a.) species composition, b.) density, c.) biomass, d.) demographic characteristics, e.) vegetative and reproductive dynamics.

Six species were observed in Tando, Guimaras, namely: *Thalassia hemprichii, Cymodocea rotundata, Enhalus acoroides, Halodule uninervis*, *Syringodium isoetifolium* and *Halophila ovalis.* Five species were found in Odiongan, Romblon; two in Concepcion, Iloilo; while Looc, Romblon is monospecific.

Seagrass density in the four sites ranged from 1477 to 1886 shoots/sq m, while biomass ranged from 177 to 447.3 g DW/sq m.

The age reconstruction technique showed that mean and median ages were highest for *T. hemprichii* in Odiongan, Romblon. Net recruitment is positive in Guimaras, Romblon and Iloilo. Results revealed that the length of the vertical internodes in *T. hemprichii* and *C. rotundata* showed definite annual cycles from January-March and July-August and higher vertical growth rate during the months of March-April.

Results showed that *T. hemprichii* flowers 10.67 % in Tando, Guimaras and 15.58 % in Odiongan, Romblon. In Concepcion, Iloilo, flowering frequency for *C. rotundata* was 15.94 %. Results revealed that *C. rotundata* flowers the whole year round and shows a unimodal trend which peaks in August while *T. hemprichii* in Guimaras and Romblon peaks in January.

This study demonstrates the use of the age reconstruction technique based on Leaf Plastochrone Interval (PI) estimate as a useful tool in assessing seagrass condition in the country's coastal areas.

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE PAGE

LIST OF TABLES

LIST OF PLATES

LIST OF APPENDIX

APPENDIX

CHAPTER I

INTRODUCTION

A. Background of the Study

Seagrasses are marine plants with the same basic strueture as terrestrial (land) plants, and form meadows in estuaries and shallow coastal waters with sandy or muddy bottoms (The State of Queensland and Environmental Protection Agency, 2004). They are neither true grasses nor algae (Lloyd, 1999). Seagrasses are the only marine flowering flowering plants, complete with leaves, rhizomes (underground, usually horizontally-oriented stems) and root systems. Reproduction is usually by producing flowers through pollination, the seagrasses , having the capacity of hydrophilous pollination (www.botany.hawaii.edu).

There are approximately 60 known species of seagrasses in the world (World Seagrass Association, 2004). Twenty-five species are found in Australia (Fortes, 1989) while the Philippines ranked second in species diversity, with 16 reported species (Fortes, 1995).

Some factors that affect the distribution of seagrasses are sunlight, nutrient levels, water depth, turbidity, salinity, temperature, current and wave action (World Seagrass Association, 2004)

Seagrass communities are among the most productive and dynamic ecosystems. Seagrasses are central to a web of life (The State of Queensland Environmental Protection Agency, 2004) as they provide food habitats and nursery grounds for many marine animals. They also act as substrate stabilizers, thereby increasing light penetration needed by autotrophs in the oceans, as well as create a calm habitat for many species (World Seagrass Association, 2004).

Despite the economic and ecological importance of seagrasses, reports of their physical losses are growing (Rollon, 1998; Short and Wyllie-Echeveria, 1996). Seagrass beds are being diked, filled, dredged and converted to other coastal uses (Fortes, 1990).

Other natural and human-induced perturbations, which continuously threaten seagrasses, include excessive pollution from sewage discharge, oil run-off, and human activities like physical destruction from dredging, uncontrolled bait digging, boat propellers and anchors, and inappropriate fishing methods (World Seagrass Association, 2004; Short et al., 1998; Rollon, 1988; Short and Wyllie-Echeveria, 1996).

Data on the taxonomy, distribution and ecology of seagrasses in the ASEAN region are few (Kiswara, 1992). This is due to the fact that there are a few numbers of investigations involved in seagrass research (Fortes, 1990).

In the Philippines, several reports on the community structure of seagrasses have been published (Fortes, 1986, 1989; Terrades, 1997; Duarte et al., 1997). Most of these studies, however, were conducted in Bolinao, Pangasinan where the Marine Research Station of the University of Philippines in Diliman is located. Considering the great economic and ecological value of seagrasses, it is important to generate information about their condition in the different coastal areas of the country.

In this study, the community structure of seagrasses along selected coastal areas in the Philippines such as Tando Island, Nueva Valencia, Guimaras; Odiongan, Tablas Island, Romblon; Looc, Tablas Island, Romblon; and Sitio Looc, Concepcion, Northern Iloilo, was studied. The community structure was described in terms of species composition, shoot density and aboveground biomass of seagrasses. Community structure of dominant species *Thalassia hemprichii* and *Cymodocea rotundata* was described in terms of their demographic characteristics and reproductive and vegetative dynamics of these marine plants.

The study also described the physico-chemical conditions of the study sites in terms of water temperature, water salinity, and the level of dissolved oxygen in water.

Results obtained from the different study sites were compared.

B. Objectives of the Study

This study described the community structure of seagrasses in the coastal areas of Tando Island, Nueva Valencia, Guimaras; Odiongan, Tablas Island, Romblon; Looc, Tablas Island, Romblon; and Sitio Looc, Concepcion, Northern Iloilo.

The specific objectives are:

1. Determine the species composition, shoot density and aboveground biomass of seagrasses at the different study sites;
2. Describe the demographic characteristics of seagrasses at the different study sites in terms of a) mean age of shoots, b) median age of shoots, c) gross recruitment rate, d) mortality rate, and e) net recruitment rate;
3. Describe the reproductive dynamics in terms of a) frequency of flowering, and b) seasonality in flowering;
4. Describe the reproductive dynamics of seagrasses at the different study sites in terms of a) vertical growth rate of shoots, b) horizontal elongation rate of rhizomes, and c) seasonality in growth of vertical internodes;

5. Describe the physico-chemical factors present in the study-sites in terms of a) water temperature, b) water salinity, and c) dissolved oxygen; and

6. Compare results obtained from the different study sites.

C. Significance of the Study

Seagrasses are essential components of the marine environment and are among the most productive and dynamic communities. They provide habitats and nursery grounds for many marine animals, and act as substrate stabilizers. Seagrasses bind the ocean floor to prevent erosion and keep water clear, increasing the amount of light reaching the seagrass beds. They also work as filters in run-off that comes from rivers before it is washed out to sea and to coral reefs.

A number of problems face the long-term survival and health of seagrass populations in out coastal zone. Despite their economic and ecological importance, seagrass beds are disturbingly disappearing worldwide (Fortes, 1989; Rollon; Biyo, 2001). They are affected by pollution and other human activities in the environment. They are being dredged, diked, and converted to other coastal uses (Fortes, 1990). In order to manage and protect our seagrass beds, it is important to know what species of seagrass are in the Philippines, where they are found, and what is their condition in the coastal areas of the country.

D. Scope and Limitation of the Study

This study described the community structure of seagrasses along selected coastal areas in the Philippines in terms of species composition, shoot density and aboveground biomass.

The Leaf Plastochrone Intervals of species *Thalassia hemprichii* and *Cymodocea rotundata* were used to further describe the community structure of the two species in terms of demographic characteristics and reproductive and vegetative dynamics.

Demographic characteristics were determined in terms of mean shoot age, median shoot age, gross recruitment rate, shoot mortality rate and net recruitment rate. Reproductive dynamics was described in terms of frequency of flowering and seasonality in flowering. Vegetative dynamics was described in terms of vertical growth rate of shoots, horizontal elongation rate of rhizomes, and seasonality in growth of vertical internodes.

Physico-chemical conditions of the sampling sites were determined in terms of water temperature, water salinity, and the level of dissolved oxygen in water.

The study sited were: Tando Island, Nueva Valencia, Guimaras; Odiongan, Tablas Island, Romblon; Looc, Tablas Island, Romblon; and Sitio Looc, Concepcion, Northern Iloilo. Results obtained from the different study sited were compared.

E. Definition of Terms

Aboveground biomass – in this study, it refers to the amount of organic matter in leaves and stems of seagrasses usually its dry weight.

Autotrophic – capable of utilizing inorganic carbon as the main source of carbon and of obtaining energy for life processes from the oxidation of inorganic elements (chemotrophic) or from radiant energy (phototrophic) (Research Branch, 1976).

Community structure – refers to the temporal changes in species composition, shoot density, distribution, growth, and productivity of the different seagrass species in relation to some environmental parameters in the area. In this study, community structure was described in terms of species composition, shoot density, aboveground biomass, demographic characteristics, and vegetative and reproductive dynamics of seagrasses in the study sites.

Core sampling technique – technique used in underground or undersea exploration and prospecting. A core sample is roughly cylindrical piece of subsurface material removed by a special drill and brought to the surface for examination (Encyclopedia Britannica, 2004).

Corer – a device having a hollow cylindrical drill or tube, used for taking samples of earth, rock, etc., from below the surface of the ground or ocean bottom (Pearson Education, 2004).

Dissolved oxygen – oxygen that is dissolved in water and therefore available for use by plants (phytoplankton), shellfish, fish, and other animals. If the amount of oxygen is too low, aquatic plants and animals may die. In addition, aquatic population exposed to low dissolved oxygen concentration may be more susceptible to adverse effects of other stressors (e.g., disease, toxic substances). Wastewater and naturally occurring organic matter contain oxygen-demanding substances that when decomposing, consume dissolved oxygen (www.epa.gov/maia/html/glossary.html).

Estuary – refers to a semi-enclosed coastal body of water, which has a free connection with the open sea and within which seawater mixes with fresh water. The key feature of an estuary is that it is an interface between seawater and freshwater and there is an influence of the ocean tide creating a dynamic relationship between the two waters (Pritchard, 1967).

Juvenile – is an individual organism that has not yet reached its adult form, maturity or size; for humans this is called a child (http://en.wikepedia.org/wiki/Juvenile).

Leaf plastochrone (PI) interval – it is the amount of time it takes for a plant to repeat an iterated module such as a leaf (Erickson and Machilini, 1957).

Physico-chemical factors – are environmental parameters affecting the being and/or growth of organisms in an area. In this study, physico-chemical factors were described in terms of water temperature, water salinity, and the level of dissolved oxygen containing seagrasses.

Quadrat sampling – sampling where a shape, usually a square, area is used as a sample unit. In sampling using quadrats, small, manageable areas of known dimension are designated as the sample unit. A number of quadrats will be selected to provide the data needed to estimate the population parameters of interest (http://www.ifasstat.ufl.edu/nrs98/Quad2.htm).

Recruitment – refers to births of seagrasses in this study.

Refractometer – an instrument which measures the bending (refraction) of light through a liquid. It can be used to measure the salinity of water (www.csc.noaa.gov/scoysters/html/glossary.htm).

Reproductive dynamics – the sexual reproductive patterns of plants (Rollon, 1998).

Rhizome – is a horizontal, usually underground stem of a plant that often sends out roots and shoots from its nodes. It is also called a creeping rootstalk or rootstock. Many plants have rhizomes that serve to spread the plant by vegetative reproduction (Wikipedia, 2004).

Seagrasses – are marine intertidal angiosperms with the same basic structure as terrestrial (land) plants, and form meadows in estuaries and shallow coastal waters with sandy or muddy bottoms (The State of Queensland Environmental Protection Agency, 2004).

Seagrass population demographics – this includes mortality and recruitment rates used to evaluate potential population decline or increase as indicator of seagrass condition in an area.

Seagrass reconstructive technique – a technique which utilizes patterns of leaf scars on the seagrass shoots as estimator of the plastochrone intervals over time such that a one time, destructive event can be used to estimate historical seagrass productivity.

Shoot density – in this study, it refers to the number of shoots per square meter, which was determined from each study site.

Species composition – a term relating the relative abundance of one plant species to another using a common measurement; the proportion (percentage) of various species in relation to the total on a given area (fire.r9.fws.gov/ifcc/monitor/EFGuide/glossary.htm).

Taxonomy – is a tree structure of classifications for a given set of objects. At the top of this structure is a single classification - the root node – that applies to all objects. Nodes below this root are more specific classification that apply to subsets of the total set of classified objects. So for instance in Carolus Linnaeus's Scientific classification of organisms, the root is the Organism (as this applies to all living things, it is implied rather than stated explicitly). Below this are the Kingdom, Phylum, Class, Order, Family, Genus, and Species, with various other ranks sometimes inserted (Wikipedia, 2004).

Vegetative dynamics – the shoot growth pattern of plants (Rollon, 1998).

Water salinity– is the total concentration of the ions present in water and is usually computed from the sodium, potassium, magnesium, calcium, carbonate, silicate, and halide concentrations. Several important bodies of inland waters, often called inland seas, have very high salinities (Encyclopedia Britannica, 2004).

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter consists of seven parts, namely, (1) Seagrass description, (2) Evolution of Seagrasses, (3) Seagrass community, (4) Seagrass Habitat, (5) Factors Affecting the Growth, Distribution and Productivity of Seagrasses, (6) Importance of Seagrasses, and the (7) Present Conditions of Seagrasses.

A. Description

Seagrass is a marine plant with the same basic structure as terrestrial plants. They have tiny flowers and strap like or oval leaves. They form meadows in estuaries and shallow coastal waters with sandy or muddy bottoms (Tropical topics, 1993).

There are 60 species of seagrasses worldwide (Kuo and McComb, 1995). Sixteen species of seagrasses have been reported for the Philippines (Fortes, 1995), twelve species for Indonesia (Fortes 1989), eleven for Thailand (Leuwmanomont et al., 1996) and Singapore (Fortes, 1989), and ten for Malaysia (Fortes, 1989). In terms of seagrass species diversity, Australia ranks first with 25 reported species (Fortes, 1989), while the Philippines, with 16 reported species in which seven are common, ranks second worldwide (Bayona et al., 2003).

A remarkable similarity of vegetative appearance, growth, and morphology exists among the seagrasses. They have a linear form exhibited by a root system (rhizomes and roots) below ground and leaf structure (short shoots and leaf blades) above ground.

The flat blades are either broad (*i.e.*, turtle grass) or narrow. The *Halophila* species differ from the other seagrasses in that the leaf structure is shorter with the blades resembling tufts or whorls.

As seagrass blades break off, they are exported from the immediate area by winds and currents. From the rhizomes, which are just under the sediment surface, emerge the roots and root hairs into the surrounding substrate. Seagrass rhizomes range in diameter from 1 mm (0.04 in) for the *Halophila* group to 1 cm (0.4 in) for Thalassia species. These plant components form a well-developed anchoring system and constitute the belowground biomass of the plant. The leaf structure consists of short shoots from which leaf blades emerge into the water column. Leaf blades from these species range in width from 1 mm to 1 cm (0.04 to 0.4 in) and in length from 5 mm to 1 m (0.2 to 40 in). The leaf varies in shape for the *Halophila* group from oval to linear while the other species are essentially elongate. These components represent the aboveground biomass or standing crop of the plant (www.southeast.fws.gov).

B. Evolution

Seagrasses are believed to be derived from terrestrial·plants which returned to the sea by gradual progressive steps of acclimation to shallow fresh water, to shallow brackish water, and finally to the submersion in marine water. The adaptation to a submerged life in marine waters involves a complex set of anatomical, morphological and physiological changes.

Some of the changes that took place include:

Blade is strap like and has either no continuous layer or just a thin one. There is a single chlorophyllous cell layer below, which is a thick colorless aerenchyma layer with large air canals running the length of the blade. The rhizome often serves as storage area for the starch and includes a continuation of the air canals. Roots include root hairs and a continuation of the air canals (www.botany.hawaii.edu).

C. Seagrass Communities

One of the most productive communities on earth, the seagrass community is found in estuaries, lagoons, and shallow open shelves off the coast. These vast meadows are habitat for large populations of invertebrates and fishes and provide the richest nursery and feeding ground in coastal waters (www.dep.state.fl.us).

Seagrasses are the sole marine representative of the angiospermae. They all belong to the order Helobiaein two families, Potamogetonaceae and Hydrocharitaceae (wwwscience.murdoch.edu).

Thalassia hemprichii, one common seagrass species in South East Asia, exhibits some variation in leaf width and length. The rhizome is thick (up to 5 mm thick), and distinctive, since the nodes, where the old shoots joined the leaf-bearing branch, are plainly visible with a prominent scale at each. The pale basal leaf sheath is 3-7 cm long and well developed. Leaves are generally 10- 40 cm long, ribbon-like and often slightly curved laterally. Leaf width is generally in the range of 0.4-1.0 cm. There are 10-17 longitudinal leaf veins. The leaves have numerous large tannin cells grouped in short black bars running parallel to the long axis of the leaf. These 'bars' are clearly visible to the naked eye and are one of the diagnostic features of this species. The leaf tip is rounded and sometimes slightly serrated and no ligule is present (Lanyon, 1986).

Thalassia hemprichii is common on mud and coral sand or coarse coral-sand substrates found in sheltered habitats. The plant has been observed growing from the base and through fingers of corals at 6 meters deep (Pascasio and Santos, 1930).

Other seagrass species in South East Asia includes: *Enhalus acoroides* (Very thick rhizome at least 1cm with black, fibrous bristles and cord-like roots); *Cymodocea rotuntada and Cymodocea serrulata* (Flat, linear, strap-like leaves);

Halodule uninervis (Trident leaf tip with three points); *Halophila ovalis (*Small oval leaves, 5-20mm long) and *Syringodium isoetifolium* (Narrow, spaghetti-like leaves, 1-2mm diameter)(Coles et al, 2004).

Seagrass have been recorded up to 42m deep but is usually found 10-15m. Seagrass root systems stabilize the sediment and prevent erosion. The leaves retard current flow to reduce water velocity, which allows particles to settle into the system (Scholander, 1968).

Seagrasses inhabit all types of ground, from mud to rock. The most extensive seagrass beds occur on soft substrates like sand and mud. Seagrasses cover areas in coastal waters from tropical to temperate regions (www.physiol.arizona.edu).

Seagrasses are common on coral reefs. Most inhabit the sandy bottoms of lagoons, and some grow in sand at the base of the outer reef crest. Seagrasses are not generally able to withstand high wave-action and therefore are more common on sheltered parts of reefs (www.dep.fl.us).

D. Factors Affecting Growth, Distribution, Productivity of Seagrasses

River estuaries are dominated by run-off from the land that carries freshwater, sediment and nutrient into the ocean. Coastal seagrass habitats are dominated by physical disturbance caused by periodic events such as cyclones, storms and floods. Deepwater seagrass meadows are limited in their growth by the availability of light. Sunlight is filtered by the water column with less light reaching the bottom in deeper water. As a result, seagrass growth is limited by the clarity of the seawater above it. Reef seagrasses are limited by substrate type and shelter from waves. Most coral reef waters and sediments also have very limited nutrients available for seagrass growth (Coles et al, 2004).

Seagrasses are photosynthetic and autotrophic. Slight increases in the levels of nutrients in the water can increase the rate of growth of seagrasses, but excess nutrients favor the growth of epiphytes, which decrease the amount of light available for photosynthesis, and hence decreases the growth rate of the seagrass (Tropical topics, 1993).

The roots and horizontal stems (rhizomes), often buried in sand or mud, anchor the grasses and absorb nutrients. Leaves, usually green, are produced on vertical branches and also absorb nutrients. The stems and leaves of seagrasses contain veins and air channels so they can carry fluid and absorb gases. Seagrasses rely on light to convert carbon dioxide into oxygen. The oxygen is then available for use by other living organisms (www.physiol.arizona.edu).

The primary constituents of plant material are carbon, nitrogen, and phosphorus. The accessibility of these components as dissolved nutrients is an important factor governing the production of seagrass. In general, seagrasses acquire most of their required inorganic carbon from free CO_2 and assimilate nitrogen and phosphorus from the sediments via their roots and rhizomes and from the water column via their leaves.

Seagrasses prefer temperatures between 20 and 30°C (68 and 86°F). Seagrasses in deeper water are buffered from cold temperatures because the overlying water has a greater mass to be cooled.

While each of the seagrasses can tolerate considerable short-term salinity fluctuations, they all have an optimum salinity range from 24 to 35 parts per thousand.

Seagrasses grow in a wide variety of sediments from fine mud to coarse sandy material. As rooted plants, seagrasses require a sufficient depth of sediment for proper development. Sediments anchor the seagrass against the effects of water surge and currents, and provide the matrix for growth and nutrient supply. Sufficient sediment depth and physical stability is the single most important sediment characteristic for seagrass growth and development. Requirements for sediment depths vary with the different seagrass species (www.southeast.fws.gov).

Growth of seagrass meadow occurs by vegetative spread with the extension of the rhizome and the germinations of the seedlings (www.botany.hawaii.edu).

All species of Seagrasses must meet these factors in order to successfully colonize the sea. The plant must grow in a saline marine environment(being an obligate halophyte). Its growth habit must be completely submerged. It must be able to anchor itself well enough to withstand tidal actions. It must be able to complete entire life cycle (pollination) while submerged as well (www.fiu.edu).

E. Importance of Seagrasses

Seagrass beds are believed to rival rice paddies in their photosynthetic productivity and are very important as nurseries and habitat for many commercially important species of fish and prawns.

They are also an essential part of the marine environment. They do not only stabilize sand and mud banks but they form the basis of a complex ecosystem supporting forms of life from dugong to plankton (Tropical topics, 1993).

Seagrasses are important nursery grounds for many pelagic fish at one stage or another of their juvenile development. As many as 70% of pelagic fish which are important as commercial fish stocks spend at least a part of their juvenile life in seagrass beds. Many other animals breed in seagrass beds like crabs, prawns, worms, fish, other algae, sponges and other invertebrates (www.botany.hawaii.edu.).

Seagrasses are extremely efficient at capturing and utilizing nutrients, a major factor in their ability to maintain high productivity in relatively low nutrient environments (Zieman, 1982). They are apparently capable of absorbing nutrients through either their leaves or their roots. Sediment depth may play an important role in nutrient dynamics in the seagrass bed, for deeper sediments allow more extensive development of roots and rhizomes (www.dep.state.fl.us).

Seagrass root system stabilizes the sediment and prevents soil erosion. The leaves retard current flow to reduce water velocity, which allows particle to settle down.

Seagrass beds are often found close or adjacent to mangrove forests. Many seagrass fauna move between mangrove canopy and seagrass beds. Shallow seagrass beds provide ideal sow current conditions for mangrove seedlings to settle and germinate (Scholander, 1968).

Nowadays seagrasses have been made to serve as insulators, roofing thatch, mats, stuffing and packaging materials. Japanese fishermen use them as a material for making wet weather gear, mats, rugs and was once became a substitute for cotton (www.science.murdoch.edu.au).

F. Present Conditions of Seagrasses

Submerged aquatic vegetation (SAV) is a sensitive indicator of water quality and pollution in shallow coastal areas. According to recent reviews (Livingston, 1987; Zieman, 1982), seagrass beds are vulnerable to various forms of anthropogenous stress.

Because seagrasses grow in the same sheltered harbors and estuaries favored by people, they are greatly affected by direct and indirect human activities. Many seagrass beds have disappeared over the last thirty years, and much of the loss has been attributed to dredging, changes in the amount of sediment in the water and water pollution, in particular eutrophication (www.dep.state.fl.us).

Many seagrass meadows are near busy coastal cities and large port facilities where coastal development, dredging and marine developments can threaten them. Threats to seagrasses can originate long distances from the coast. Coastal agriculture in upper catchments may add to sediment and herbicide loads in run-off from the land, which has the potential to destroy large areas of seagrass. Global climate change may also threaten seagrass communities. Climate change is predicted to raise sea levels, concentrations of carbon dioxide in seawater, and seawater temperatures. Rising sea levels could increase the distribution of seagrass because more land will be covered by seawater.

However, rising sea levels are likely to destabilize the marine environment and cause seagrass losses. Higher concentrations of carbon dioxide in seawater could increase the area of seagrass because more carbon will be available for growth and seagrasses could increase their photosynthetic rates. Rising sea temperatures could cause burning or death of seagrasses in some places where they are close to their thermal limit. Deepwater seagrasses could be impacted by the reduction in light caused by coastal run-off. These communities may also be affected by trawling activities, although the scale of any impact is largely unknown and difficult to determine (Coles et al, 2004).

Human pollution has contributed most to seagrass declines around the world. The greatest pollution threat to seagrass population is from high levels of plant nutrients. High nutrient levels, often due to agricultural and urban runoff cause algae to blooms that shade seagrasses.

Some human activities also bring vast damage to seagrass beds. Dredging shallow oceans for development negatively impacts fill and adjacent areas. Damage from propellers and other sea vessels weaken damaged areas where diseases can infect the patches.

Overall, recent population growth, together with attendant forms of human impact, has been associated with substantial losses of seagrass beds in inshore marine areas. Coastal engineering projects –including beach nourishment, the construction of seawalls, bridges, and other coastal structures, and massive dredging and filling activities —have had a major adverse impact on SAV distribution. Long-term monitoring of seagrass beds is lacking, and effective planning in the face of multiple and varied assaults on marine habitats are almost nonexistent. These problems are due in part to lack of attention to an ecosystem approach in present-day methods of scientific research and management (Scholander, 1968).

Loss of seagrass habitats will mean losses in marine ecosystem productivity as well as extinction of species that depend on seagrass for survival (www.physiol.arizona.edu).

G. Studies Conducted on Seagrasses

The use of Age Reconstruction Technique based on Leaf Plastochrone Interval (PI) estimate was introduced recently to study seagrass population demography (Duarte et al., 1994; Vermaat et al, 1995). With this technique, seagrass population increase and decline as indicator of seagrass condition can be assessed using a one time destructive sampling.

Plastochrone Interval is the amount of time it takes for a plant to repeat an iterated module such as a leaf (Erickson and Michelini, 1957). The reconstructive technique utilizes patterns of leaf scars on seagrass short shoot as estimators of PI over time (Duarte and Sand-Jensen, 1990).

At present, very few studies on seagrasses using the above technique have been conducted in the Philippines, and these were mostly done in Bolinao, Pangasinan (Vermaat et al, 1995).

Biyo et al, (2001) used the Age Reconstruction Technique based on Leaf Plastochrone Interval (PI) estimates to describe the vegetative dynamics and reproductive effort of two common seagrass, Thalassia hemprichii and Cymodocea rotundata in Tando, Guimaras Island, Central Philippines. Based on the results, seagrasses in Guimaras have a fairly stable population. It was observed that Thalassia hemprichii which has a longer lifespan and slow rhizome growth tend to predominate in deeper, more stable areas while C. rotundata, which has a shorter lifespan and faster elongation rate occupy environmentally unstable areas.

Bayona et al, (2002) determined the community structure of seagrasses along the coastal areas of Davao del Sur, Davao del Norte, Aklan and Behold. In their study, the following seagrass species were found to be common on the coastal areas they have surveyed: *Thalassia hemprichii, Cymodocea rotundata, Cymodocea serrulata, Enhalus acoroides, Halophila ovalis, Halodule uninervis* and *Syringodium isoetifolium*.

Terrados et al., (1998), conducted a study on seagrass ramet size and based on their results, the size of the different architectural components of a ramet are closely scaled to one another and therefore, difference between species in an allocation of biomass and nutrients to them were size-independent. Differences in the nutritional status among SE Asian species are due to species-specific differences in nutrient acquisition or use rather than to differences in nutrient availability in the sediment.

Equally numerous studies have provided description and diversity of the invertebrate fauna in seagrass beds (Kikuchi & Peres, 1977; Ogden, 1977; Howard et al., 1989).

In Bolinao, de Guzman (1990) provided evidence that several interactive factors could influence general invertebrate abundance in seagrass beds.

In the ASEAN region, knowledge on the value of seagrass habitat is beginning to emerge. Unfortunately, this natural resource is still threatened or rapidly destroyed by the impact of multiple demands upon the coastal environment. Among the ASEAN countries, only the Philippines has formulated a National Seagrass Committee aimed at optimizing the use and conservation of seagrass systems (San Diego-Clone, 1995).

CHAPTER III

METHODOLOGY

A. Description of the Study Sites

This study was conducted in different coastal areas of the Philippines namely Guimaras, Concepcion (Northern Iloilo) and Romblon.

The first field sampling was conducted in Tando Island, Nueva Valencia, Guimaras. The first site has a muddy substratum and abundance of six seagrass species was observed. Further survey of the area showed that seagrass beds extend up to three kilometers from the shore.

The second study site was Odiongan, Tablas Island, Romblon. It has a rocky substratum. Although home to many marine organisms such as sea urchins, jellyfishes and different kinds of algae, very few seagrasses were found. However, in the nearby mangrove community, seagrass population was denser.

The third study site was Looc, Tablas Island, Romblon. It has both muddy and sandy substratum. The area was mono specific with only *Enhalus acoroides* dominating.

The last field sampling was conducted in Concepcion, Northern Iloilo. The last site has a sandy substratum. Only the *Cymodocea rotundata* and *Halodule uninervis* were thriving in the area.

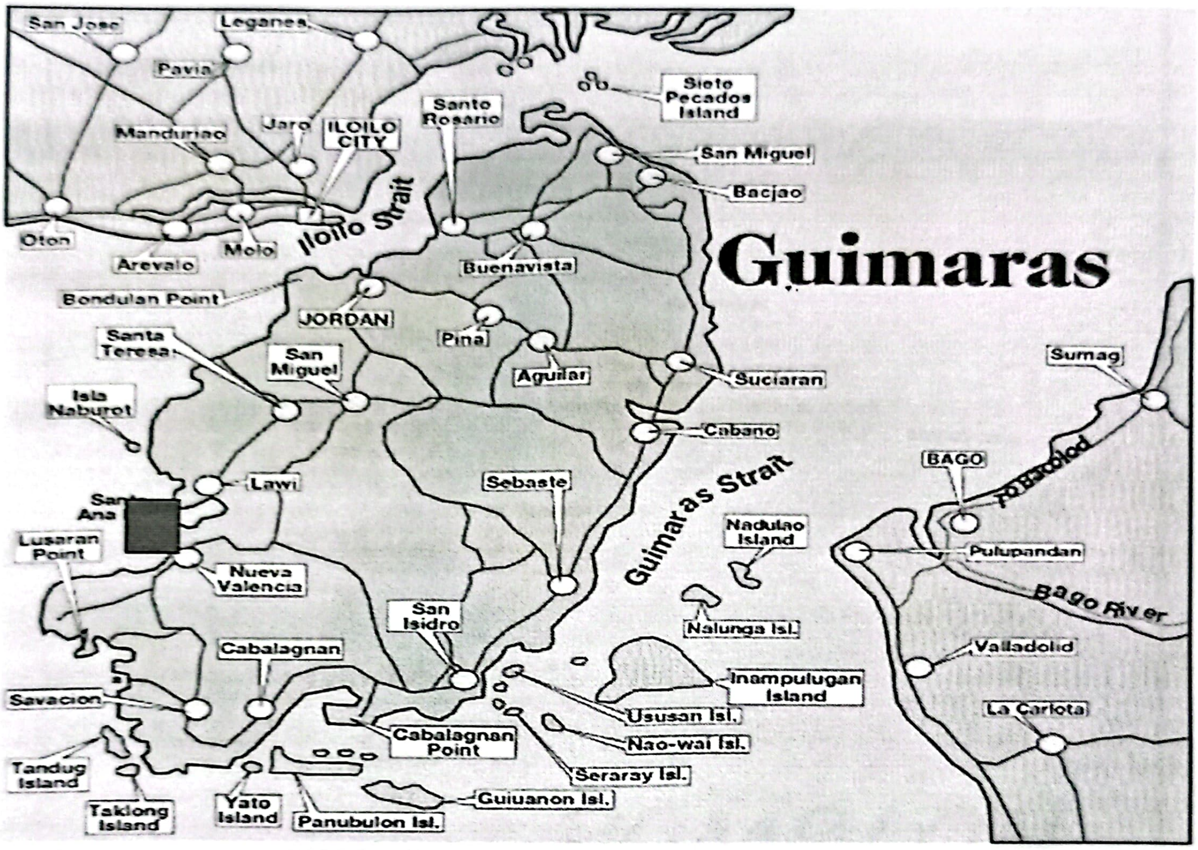

Figure 1. Map of Guimaras Island, showing location of sampling site in Nueva Valencia, Guimaras (■)

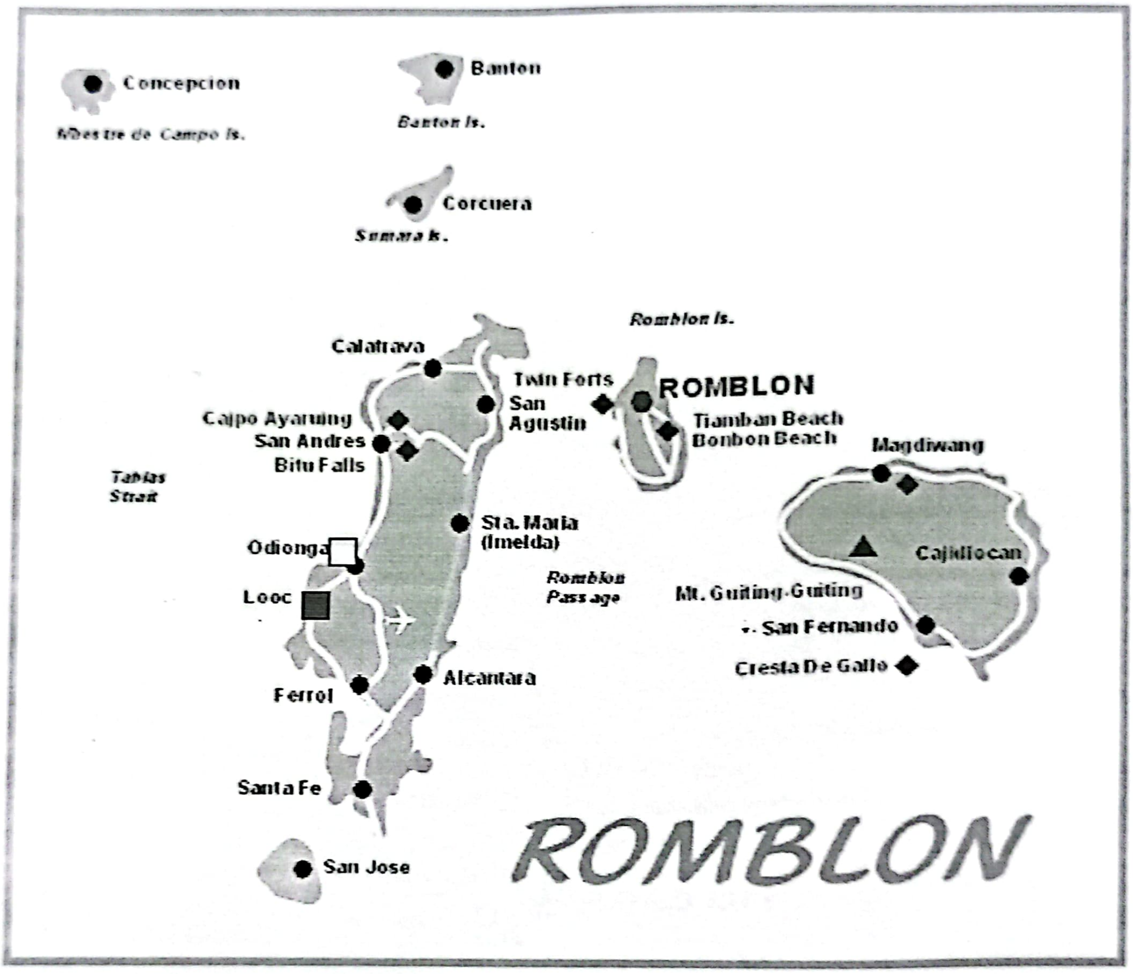

Figure 2. Map of Romblon, showing sampling sites in Looc (■) and in Odiongan (□), Tablas Island.

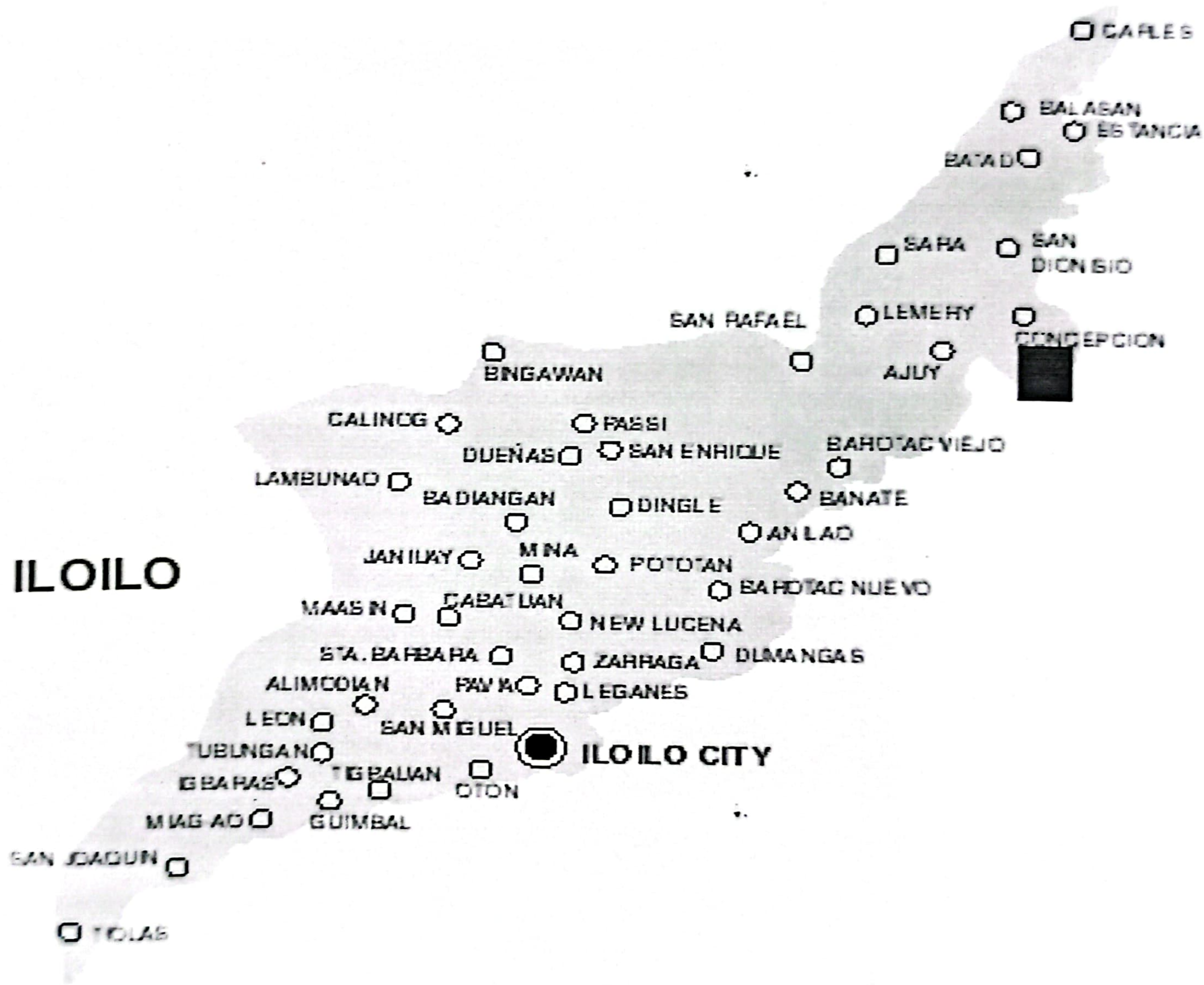

Figure 3. Map of Iloilo, showing sampling site in Concepcion, Northern Iloilo(■).

ate 1. Aluminum corer used for collecting seagrass samples in the field.

Plate 3. Seagrass core samples in plastic screen bags.

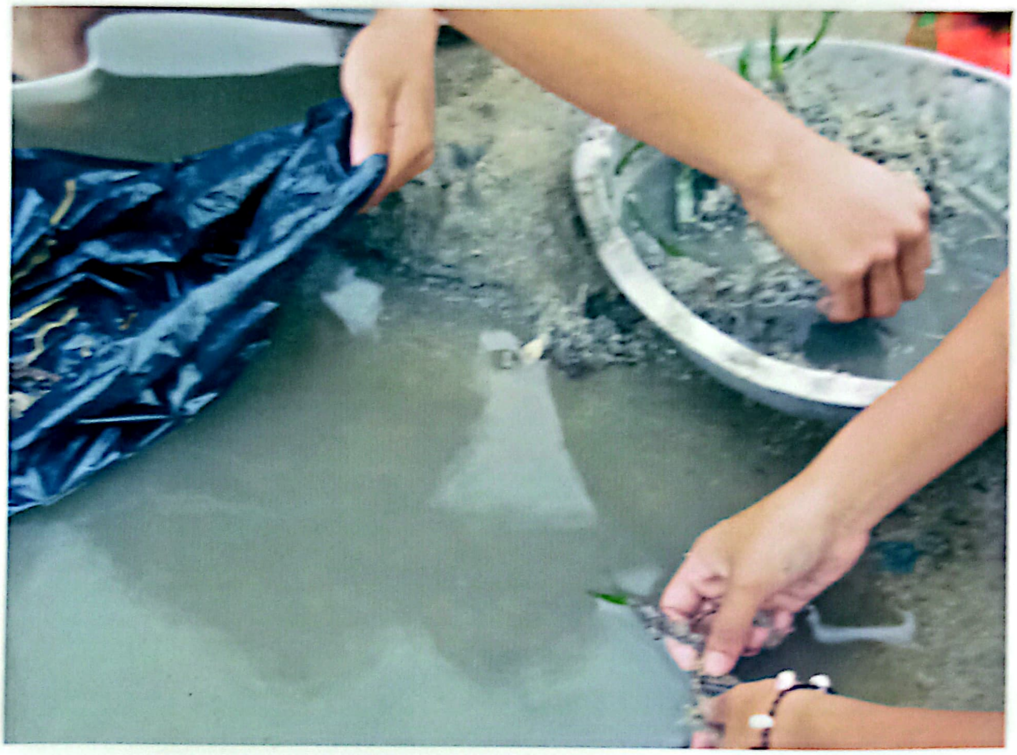

Plate 4. Washing of seagrass samples in the field.

Plate 5. Analyzing data for age reconstruction technique.

B. Seagrass Species, Composition and Shoot Density

An aluminum corer with a diameter of 20 cm and a height of 60 cm was used in collecting samples randomly in the field. The aluminum corer was pushed into the sediment to a depth of 20-30 cm. Plants collected were placed in a plastic sieve, and was then rinsed with seawater at the sampling sites. Plant samples were placed inside labeled plastic bags and brought to the PSHSWV laboratory for analysis. Ten core samples were collected from each site. Transfer of samples was done carefully so as not to damage parts used in the study.

Seagrass collected by core sampling were sorted to species based on the description of Philips *et al.* (1988) and Fortes (1990). The number of shoots from each species was recorded to estimate shoot density (shoots/sq m). Species composition in all core samples was noted.

C. Measurement of Seagrass Biomass

Seagrasses samples obtained in the field were further cleaned in the laboratory. They were fractioned into leaves and stems, rhizomes and roots. The leaves and stems were regarded as the aboveground parts, whereas rhizomes and roots were the belowground parts.

The seagrass aboveground parts were oven-dried to constant weight at 60-80 degrees to estimate biomass (gDW/sq m).

D. Leaf Plastochrone Interval (PI) Determination

The leaf plastochrone estimate (PI) in days that were used in the study was obtained from Biyo (2001). The methods Biyo (2001) for obtaining leaf PI is described as follows:

At the different study sites, four 50 x 50 cm iron quadrants were laid randomly in seagrass beds. Shoots within each quadrant were tagged with copper wires marked with colored ribbons. Two holes were punched at the base of all leaves of the tagged shoots using hypodermic needle. After seven days, the marked shoots were retrieved and the number of new leaves produced during the marking period was determined. Leaf PI was calculated using the formula:

$$\text{Leaf PI} = \frac{\text{Shoots marked x days of marking}}{\text{Total number of new leaves}}$$

Where PI = days; shoots marked= total number of shoots marked in all quadrants; and new leaves= new leaves formed in marked shoots between marking and recovery.

E. Shoot Age and Demography

Shoot age and demography of the two common species, *Thalassia hemprichii* and *Cymodocea rotundata* in each site were determined. In the laboratory, the number of leaf scars and standing leaves from each shoot were counted. Proper handling of seagrasses was ensured so as not to sever connections between shoots along a rhizome for subsequent analysis.

Shoot age was estimated as the total number of leaves produced during its life span (i.e. number of standing leaves plus leaf scar from shed leaves) multiplied by the mean time elapsed between the productions of successive leaves (PI). The mean and median ages of shoots were determined. Shoot age distribution tables were constructed from which recruitment and mortality rates were calculated.

Annual gross recruitment rate (R, in units/yr.) will be calculated from the total number of lives shoots (N_{total}) and the number of shoots older than one year (N_{age}>1yr) both present in the sampled population using the equation:

$$R = Ln\ (N_{total}) - Ln(N_{age} > 1\ yr.)$$

Shoot mortality rate (M, in units/yr) will be calculated for the site by fitting a curve through the shoot age data beginning at the mode of the age distribution using the exponential decay equation:

$$N_t = N_o e^{-Mt}$$

Where N_t is the population size at a specific time t and N_o is the initial population size. Net recruitment rate will be calculated using the formula:

$$R_{net} = R_{gross} - M$$

A negative Rnet value indicated a greater mortality than recruitment, and a declining population. All computations were done using SPSS- PC statistical program.

F. Vegetative and Reproductive Dynamics of Common Seagrass Species

F.1 Vertical Shoot Growth

At each site, vertical shoot growth rate of common seagrass species were measured from at least 75 shoots. Vertical shoot length was measured from the insertion of the vertical stem on the horizontal rhizome to the apical leaf producing meristem. Vertical elongation rate was estimated by dividing the vertical shoot length (cm) with shoot age (PI converted to years).

F.2 Horizontal Rhizome Growth

Horizontal rhizome growth was estimated by dividing the distances between two shoots connected along a section of rhizome against the difference in ages between these shoots.

F.3 Seasonality in Vertical Growth

Vertical internode lengths (mm) from at least ten shoots of common seagrass species will be measured sequentially, starting from the oldest internode up to the youngest.

The number of standing leaves will also be counted for each shoot. Using the leaf PI estimate in days for the two species, the vertical internode lengths will be plotted against a chronological time to determine seasonality in vertical growth.

F.4 Reproductive Dynamics of Common Seagrass Species

Flower marks were counted from all shoots sampled and the month of the flowering was determined from each shoot to determine seasonality and frequency in the flowering for the seagrass species.

G. Physico-chemical Factors Present in the Study Sites in Terms of:

G.1 Water Temperature

Water Temperature was obtained by dipping a thermometer directly in the water for five minutes. Five determinations were made at each study site.

G.2 Water Salinity

The Salinity- Conductivity- Temperature (SCT) meter Probe was dipped in the water and the salinity reading, in parts per thousand (ppt), was recorded.. Five determinations were made at each study site.

G.3 Dissolved Oxygen

The dissolved Oxygen (DO) meter probe was dipped into the water and the DO reading in mg/L was recorded. Five determinations were made at each study site.

CHAPTER IV

RESULTS AND DISCUSSION

A. Species Composition and Density of Seagrasses

Six seagrass species were observed in the coastal area of Tando Island, Nueva Valencia, Guimaras, five in Odiongan, Tablas Island, Romblon, two in Sitio Looc, Concepcion, Northern Iloilo, while one species was identified in Looc, Tablas Island, Romblon. In Tando Island, Nueva Valencia, Guimaras , the species are *Thalassia hemprichii, Cymodocea rotundata, Enhalus acoroides, Halophila ovalis, Halodule uninervis* (narrow leaf variety), *Syringodium isoetifolium.* While in Odiongan, Tablas Island, Romblon, *Syringodium isoetifolium* was not observed.

In Sitio Looc, Concepcion, Northern Iloilo, the two species observed were the *Cymodocea rotundata* and *Halodule uninervis.* In Looc, Tablas Island, Romblon, only the species *Enhalus acoroides* was observed.

The density of seagrasses in each sampling site is shown in Table 1. In Tando Island, Nueva Valencia, Guimaras, seagrass density was dominated by *Halophila ovalis* with a mean value of 933 shoots/sq m. On the other hand, *Thalassia hemprichii* was the dominant species in Odiongan, Tablas Island, Romblon with a mean value of 927 shoots/sq m. In Sitio Looc, Concepcion, Northern Iloilo, *Cymodocea rotundata* had the highest density at 6236 shoots/ sq m. In Looc, Tablas Island, Romblon, the only species is the *Enhalus acoroides* with 49 shoots/sq m.

The total seagrass density among the different study sites was highest in Concepcion, Iloilo with a mean of 3943 shoots/sq m. Seagrass density in the five study sites ranged from 49 to 7886 shoots/sq m.

Table 1. Density of Seagrasses (shoots/sq m) in selected coastal areas of the Philippines.

Species	Tando, Guimaras	Odiongan, Romblon	Looc, Romblon	Concepcion, Iloilo
Thalassia hemprichii	869	927	-	-
Cymodocea rotundata	108	468	-	1650
Enhalus acoroides	34	44	49	-
Halophila ovalis	933	6	-	-
Halodule uninervis (narrow leaf variety)	407	32	-	6236
Syringodium isoetifolium	322	-	-	-
Total	**2673**	**1477**	**49**	**7886**

B. Seagrass Biomass

Seagrass biomass expressed as gram dry weight per square meter (g DW/sq m), is a measure of the total weight of a given seagrass sample and the area it inhabits. In, this study, only the aboveground biomass, consisting of leaves and the stems of the seagrass, were measured.

Aboveground biomass in the coastal areas of Tando Island in Nueva Valencia, Guimaras and Odiongan in Tablas Island, Romblon was dominated by *Thalassia hemprichii* with a mean value of 98 and 174 g DW/sq m, respectively (Table 2). *Enhalus acoroides* ranks next to *T. hemprichii* with an aboveground biomass of 55 g DW/sq m in

Tando Island and 74 g DW/sq m in Odiongan considering that *Enhalus acoroides* is the biggest seagrass species.

In Looc, Tablas Island, Romblon, the only observed seagrass species, *Enhalus acoroides* had a high aboveground biomass of 176 g DW/sq m. This mean value exceeds that of *T. hemprichii* in Tando Island, Nueva Valencia, Guimaras and Odiongan, Tablas Island, Romblon.

Cymodocea rotundata, found in Sitio Looc in Concepcion, Northern Iloilo, had the highest aboveground biomass with a mean value of 129 g DW/sq m, comprising 65.15% of the total aboveground biomass in the coastal area. No *Enhalus acoroides* was observed.

Results for seagrass aboveground biomass are shown in Table 2.

Table 2. Biomass of seagrasses (g DW/sq m) in selected coastal areas of the Philippines.

Species	Tando, Guimaras	Odiongan, Romblon	Looc, Romblon	Concepcion, Iloilo
Thalassia hemprichii	98	174	-	-
Cymodocea rotundata	7	22	-	129
Enhalus acoroides	55	74	176	-
Halophila ovalis	10	.10	-	-
Halodule uninervis (narrow leaf variety)	2	.20	-	69
Syringodium isoetifolium	5	-	-	-
Mean	30	54	176	99
Total	177	270.30	176	198

Plate 7. *Enhalus acoroides* collected from Tando Island, Nueva Valencia, Guimaras

Plate 8. *Cymodocea rotundata* beds in Sitio Looc, Concepcion, Iloilo

Plate 9. *Thalassia hemprichii* collected from Odiongan, Tablas Island, Romblo

Plate 10. Core sample containing different seagrass species obtained in Tando Island, Nueva Valencia, Guimaras.

Plate 11. Seagrass coexisting with mangrove community in Odiongan, Tablas Island, Romblon

C. Demographic characteristics of *Thalassia hemprichii* and *Cymodocea rotundata*

The leaf plastochrone (PI) estimate in days used for describing the shoot demographic characteristics of *Thalassia hemprichii* and *Cymodocea rotundata* in the coastal areas of Guimaras, Romblon, and Concepcion were based on values obtained by Biyo (2001) for the coastal area of Guimaras. These were ten days for *Thalassia hemprichii,* and 12.43 days for *Cymodocea rotundata.* Biyo (2001) recommended the use of leaf PI of *Thalassia hemprichii* and *Cymodocea rotundata* obtained in Guimaras for assessing seagrass demography of these species in other coastal areas of the country as these values were obtained from tagging experiments conducted monthly for one year. The leaf PI is the number of days it takes for a leaf to fully develop.

The demographic characteristics of the two seagrass species are shown in Table 3. Results show that the mean age of *Thalassia hemprichii* in Guimaras is 239.07 days, in Odiongan, Romblon it is 309.13 days. The mean age of *Cymodocea rotundata* in Concepcion is 261.50 days.

Gross recruitment rate was higher for *Thalassia hemprichii* in Guimaras than in Odiongan, Romblon. It is also higher than the gross recruitment rate of *Cymodocea rotundata* in Concepcion. Net recruitment rates for these two seagrass species were positive in all three sites, Concepcion, Guimaras and Odiongan, Romblon. The positive values in these three coastal areas indicate that seagrass populations are relatively stable.

Table 3. Seagrass demographic characteristics in the different coastal areas of the Philippines. Values are given; sample size in parenthesis.

Seagrass Demography	**Tando Island, Nueva Valencia in Guimaras** *Thalassia hemprichii*	**Odiongas, Tablas Island in Romblon** *Thalassia hemprichii*	**Sitio Looc, Concepcion in Iloilo** *Cymodocea rotundata*
PI	-	-	-
Mean Age of shoots(days)	239.07 (150)	309.13 (231)	261.50 (320)
Median Age of shoots(days)	200 (150)	270 (231)	170 (320)
Annual Gross Recruitment Rate(shoots/sq m/yr)	1.61 (150)	1.28 (231)	1.20 (320)
Mortality Rate (shoots/sqm/yr)	0.764 (150)	0.53 (231)	0.82 (320)
Net Recruitment Rate (shoots/sqm/yr)	0.85 (150)	0.76 (231)	0.38 (320)

Shoot age distribution for both species were relatively skewed towards younger age categories. The modal age for T. hemprichii in Guimaras tended to be around 10-25 Leaf PI's or 100-250 days(Figure 4).

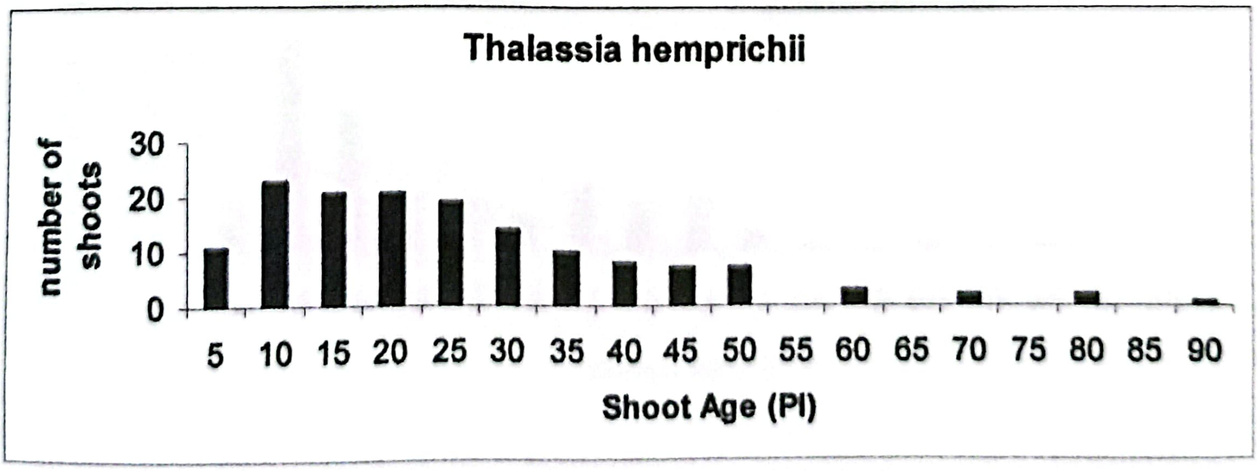

Figure 4. Shoot age frequency distribution of *Thalassia hemprichii* in Tando Island, Nueva Valencia in Guimaras constructed by pooling 150 shoot age estimates. Shoot age is expressed in leaf plastochrone interval (PI).

For C. rotundata in Concepcion, Iloilo, the modal age was also 10 Leaf PI or about 125 days(Figure 5).

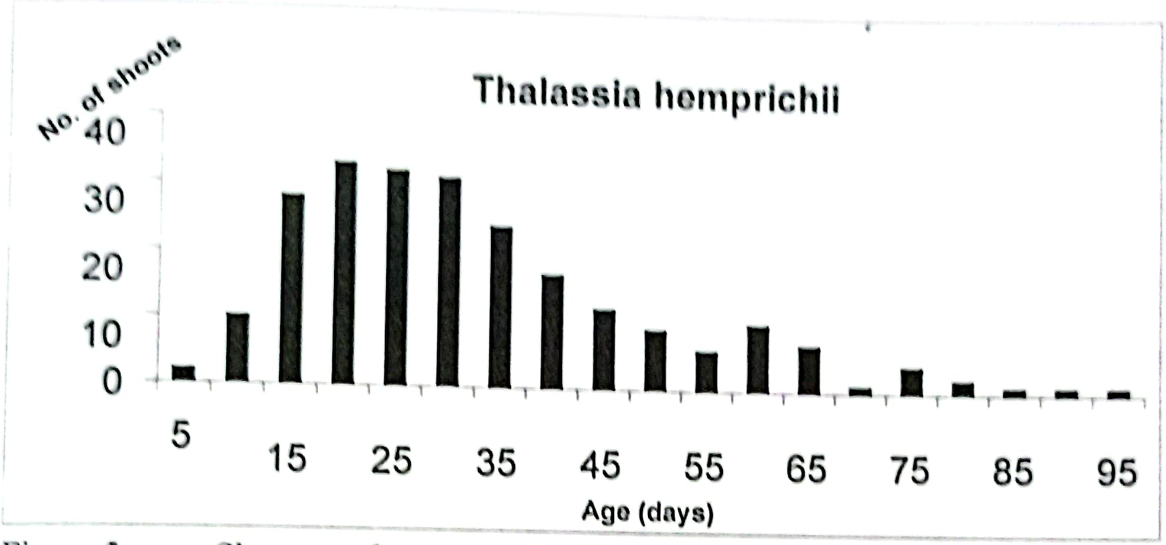

Figure 5. Shoot age frequency distribution of *Thalassia hemprichii* in Odiongan, Tablas Island in Romblon constructed by pooling 231 shoot age estimates. Shoot age is expressed in leaf plastochrone interval (PI).

In Odiongan, Romblon, modal age was 20-30 Leaf PIs or 200-300 days(Figure 6).

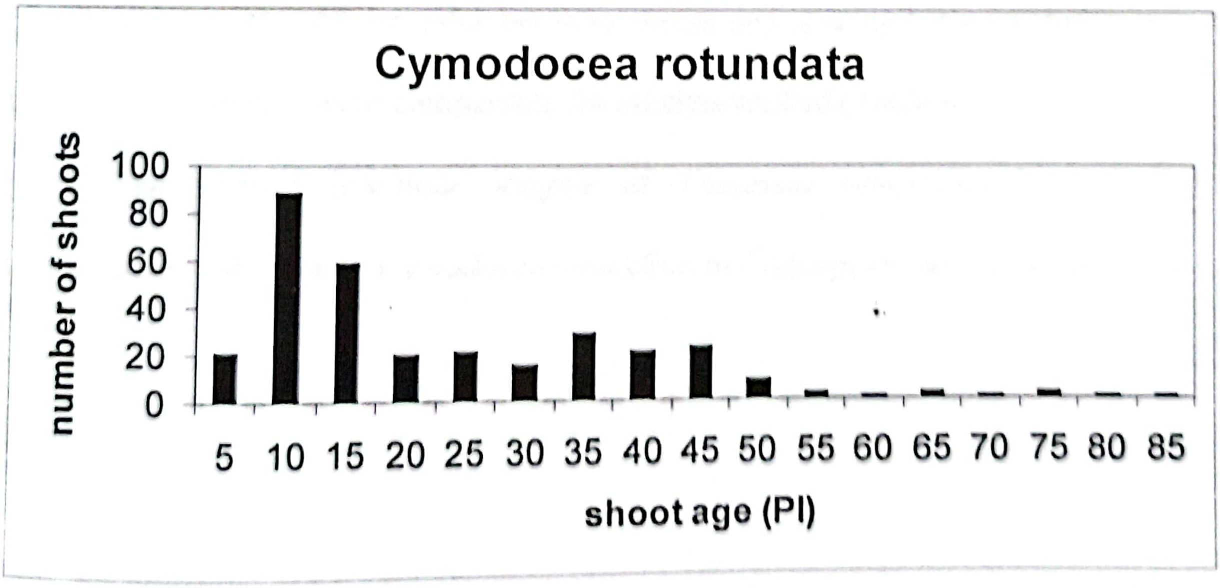

Figure 6. Shoot age frequency distribution of *Cymodocea rotundata* in Sitio Looc, Concepcion in Iloilo constructed by pooling 320 shoot age estimates. Shoot age is expressed in leaf plastochrone interval (PI).

D. Vegetative Dynamics of *Thalassia hemprichii* and *Cymodocea rotundata*

The total number of leaf scars and standing leaves from the seagrass samples were counted and converted into real time using leaf PI estimates for these species.

Following the tool previously explained (Duarte et al.,1994;Vermaat et al.,1995; Duarte et al.,1997), shoot height and spacing between shoots were measured to compute for vertical and horizontal elongations rates.

The vegetative characteristics of *Thalassia hemprichii* in the coastal areas of Guimaras and Odiongan, Romblon and of *Cymodocea rotundata* in Concepcion are shown in Table 4. Vertical elongation rate of *Thalassia hemprichii* in Odiongan, Romblon , 3.87 cm/sht/yr is the highest value obtained as compared to those of *Cymodocea rotundata* in Concepcion, 2.44cm/sht/yr, and *Thalassia hemprichii* in Guimaras, 2.91 cm/sht/yr.

Horizontal elongation rate in cm/shoot apex/yr for *Thalassia hemprichii* was highest in Concepcion and lowest in Odiongan, Romblon.

The horizontal internodes between shoots and spacing between rhizomes in these two seagrass species were comparable for all sites studied (Table 4).

The vertical internode lengths of *Thalassia hemprichii* in Guimaras and Odiongan, Romblon and *Cymodocea rotundata* in Concepcion are shown in Table 4..

Table 4. Vegetative dynamics of *Thalassia hemprichii* and *Cymodocea rotundata* in selected coastal areas of the Philippines. Sample sizes are in parenthesis.

Seagrass Vegetative Dynamics	**Tando Island, Nueva Valencia in Guimaras** *Thalassia hemprichii*	**Odiongan, Tablas Island in Romblón** *Thalassia hemprichii*	**Sitio Looc, Concepcion in Iloilo** *Cymodocea rotundata*
Vertical Elongation Rate (cm/shoot/yr)	2.91 (150)	3.87 (231)	2.44 (320)
Horizontal Rhizome Growth (cm/shoot/yr)	56.38 (30)	42.17 (46)	56.77 (270)
Horizontal Internodes between shoots (cm)	4.10 (30)	4.94 (46)	3.50 (270)
Vertical Internodes along rhizome (cm)	0.10 (10)	0.12 (10)	0.12 (10)

The vertical internode lengths for these two species showed definite annual cycles, indicating seasonal changes in vertical growth. For *Thalassia hemprichii,* the annual cycle shows three minima in a year: the first minima is between January and February, the time of shortest day length, the second minima in March, where the length of night and day are equal and the third minima in August, the time of the rainy southwest monsoon. The annual cycle of *Cymodocea rotundata* show two minima in a year: the first minima is in March and the second in November, a cold month.

The two species in all sites showed longer vertical internode lengths during the summer months of March to April, indicating faster stem growths during these periods.

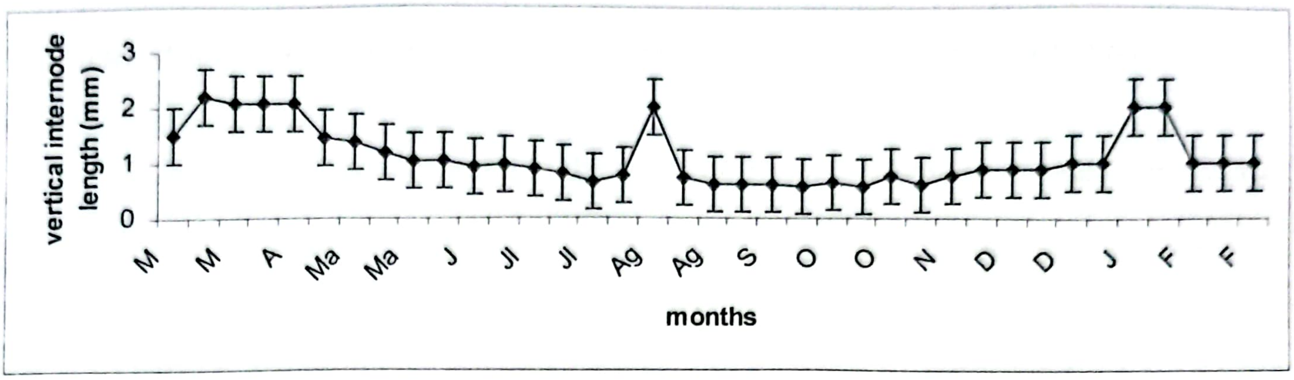

Figure 7. Seasonality in vertical growth of *Thalassia hemprichii* collected in Odiongan, Tablas Island, Romblon on April 7, 2005. Seasonality in vertical growth was computed from 10 shoots examined.

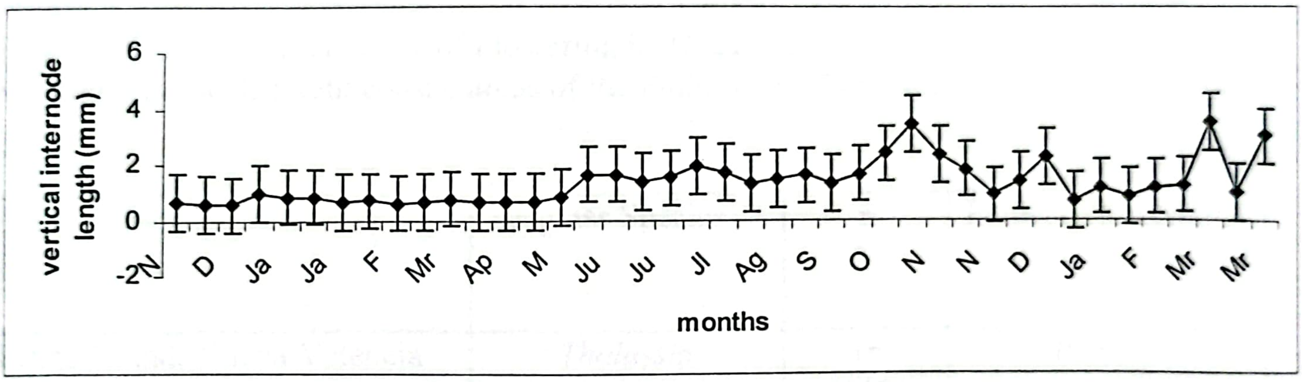

Figure 8. Seasonality in vertical growth of *Cymodocea rotundata* collected in Sitio Looc, Concepcion in Iloilo on May 7, 2005. Seasonality in vertical growth was computed from 10 shoots examined.

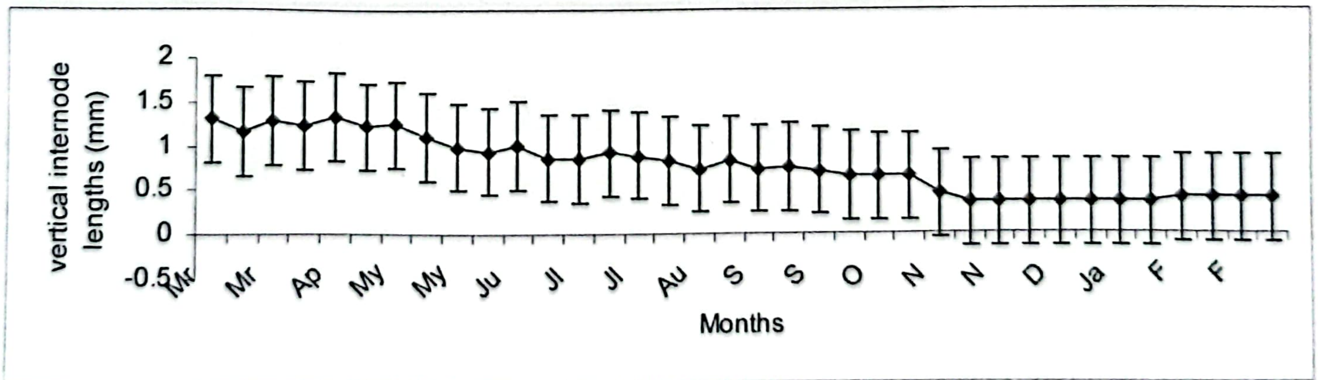

Figure 9. Seasonality in vertical growth of *Thalassia hemprichii* collected in Tando Island, Guimaras on April 4, 2005. Seasonality in vertical growth was computed from 10 shoots examined.

E. Reproductive Strategies of *Thalassia hemprichii* and *Cymodocea rotundata*

Flower marks were counted in the stems of *Thalassia hemprichii* and *Cymodocea rotundata* collected in the study areas to estimate frequency and seasonality in flowering for these two species. Results showed that Romblon had the higher percent flowering of *Thalassia hemprichii* with 15.58% compared to Guimaras with 10.67% (Table 5).

Meanwhile, *Cymodocea rotundata* in Concepcion showed a high percentage of flowering shoots (15.94%).

Table 5. Percent Frequency of Flowering in *Thalassia hemprichii* and *Cymodocea rotundata* in the different coastal areas of the Philippines. Sample sizes are in parenthesis.

Study Sites	Seagrass Species	n	Percent Flowering
Tando Island, Nueva Valencia in Guimaras	*Thalassia hemprichii*	16 (150)	10.67 %
Odiongan, Tablas Island in Romblon	*Thalassia hemprichii*	36 (231)	15.58 %
Sitio Looc, Concepcion in Iloilo	*Cymodocea rotundata*	51 (320)	15.94 %

Seasonality in flowering for *T. hemprichii* and *C. rotundata* in the different sites are shown in Figures 10, 11 and 12.

In Guimaras, Iloilo and Odiongan, Romblon, flowering for *T. hemprichii* both peaked in January.

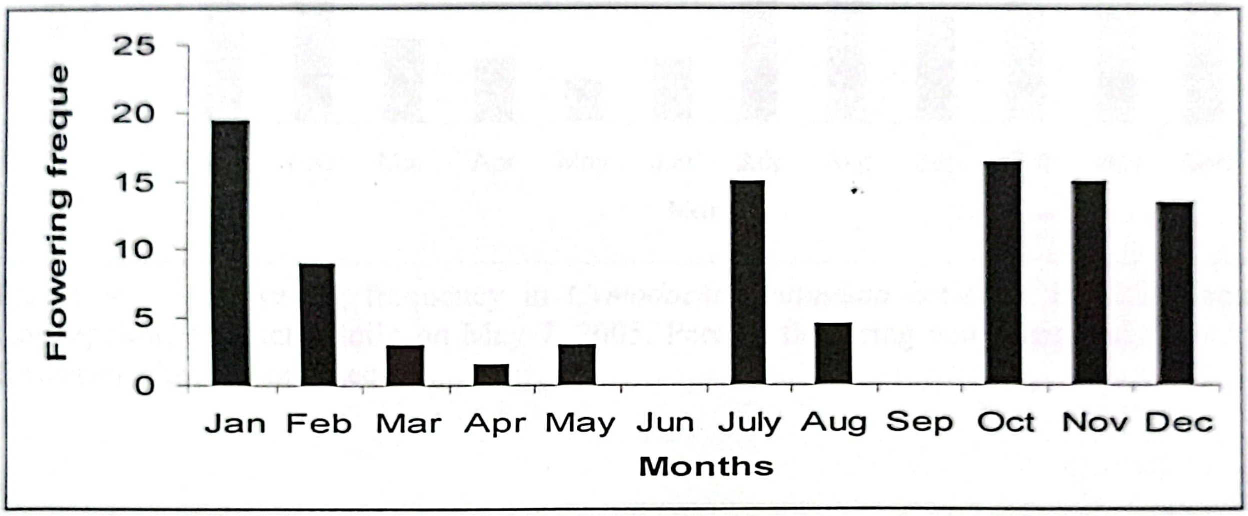

Figure 10. Flowering frequency in *Thalassia hemprichi*i collected in Odiongan, Tablas Island, Romblon on April 7, 2005. Percent flowering was computed from 36 flowering shoots examined.

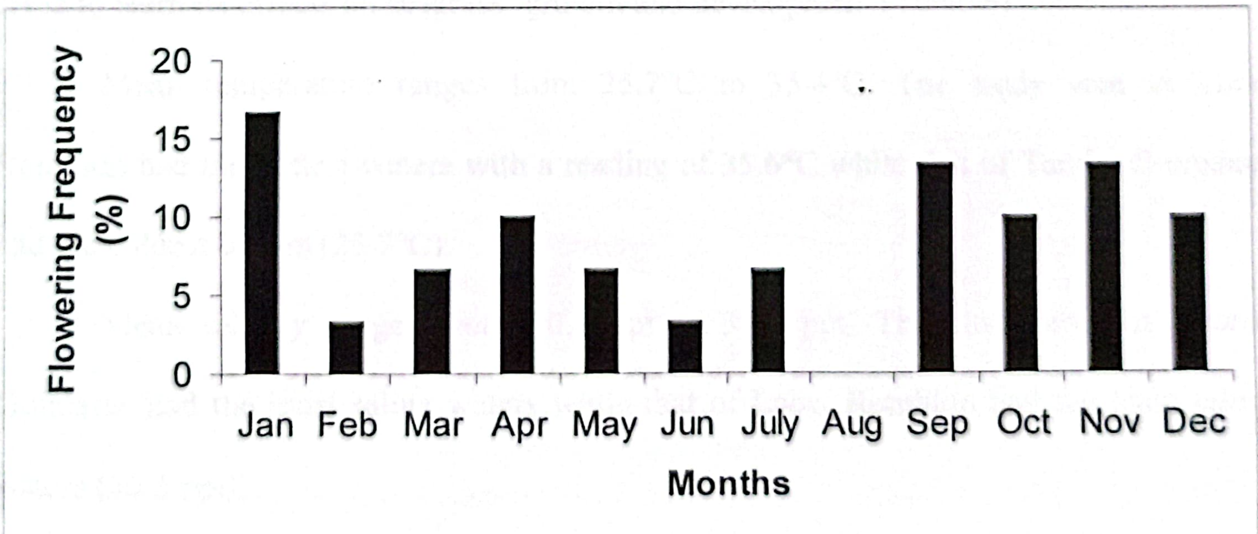

Figure 11. Flowering frequency in *Thalassia hemprichii* collected in Tando Island, Nueva Valencia in Guimaras on April 5, 2005. Percent flowering was computed from 16 flowering shoots examined.

In Concepcion, Iloilo, *C. rotundata* flowers the whole year round. Flowering frequency for this species showed a unimodal trend which peaks in August (Figure 12).

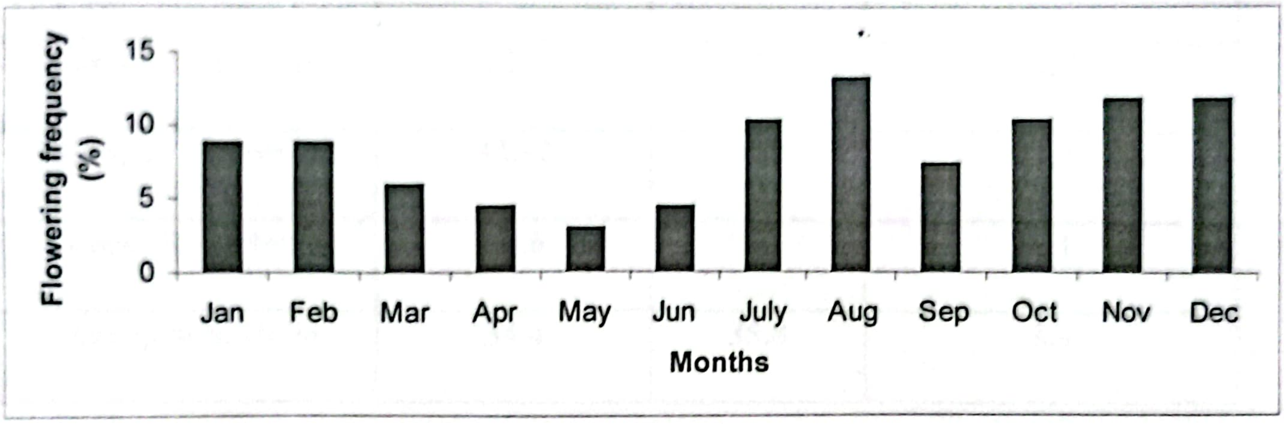

Figure 9. Flowering frequency in *Cymodocea Rotundata* collected in Sitio Looc, Concepcion, Northern Iloilo on May 7, 2005. Percent flowering was computed from 51 flowering shoots examined.

F. Physico - Chemical Factors Affecting the Growth and Development of Seagrasses

Different physico – chemical parameters were measured in the different study areas to learn its effects on seagrass' growth and development (Table 6).

Mean temperature ranges from 25.7°C to 35.4°C. The study area in Looc Romblon had the hottest waters with a reading of 35.6°C while that of Tando, Guimaras had the coldest waters (25.7°C).

Mean salinity ranges from 30.5 ppt to 37.8 ppt. The study area in Tando, Guimaras had the most saline waters while that of Looc, Romblon had the least saline waters (30.5 ppt).

Mean dissolved oxygen ranges from 4.4 ppm to 9.1 ppm. The study area in Looc Romblon had the highest value in terms of dissolved oxygen while that of Odiongan, Romblon had the least value of dissolved oxygen (4.4).

Table 6. Physico-chemical factors of sampling sites located in selected coastal areas of the Philippines.

Site	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (ppm)
Tando, Guimaras	25.7	37.8	4.7
Odiongan , Romblon	32.12	35.2	4.4
Looc, Romblon	35.6	30.5	9.1
Concepcion, Iloilo	34.4	35.8	8.4

G. Discussion of Results

There are 60 species of seagrasses worldwide (Kuo and McComb, 1995). Sixteen species of seagrasses have been reported for the Philippines (Fortes, 1995). In our study six seagrass species were observed from the four sites. In a similar study conducted by Bayona et al, they have observed seven seagrass species but six of the seven species were similar to the ones we have observed. This could mean that the six species observed, namely, *Thalassia hemprichii, Cymodocea rotundata, Syringodium isoetifolium, Halodule uninervis, Halophila ovalis and Enhalus acoroides* are common to most of the coastal areas in the Philippines.

Many factors have contributed to the variation of density, biomass, demographic characteristics as well as vegetative and reproductive dynamics of seagrasses.

The high percentage in flowering of *T. hemprichii* in Tablas Island, Romblon was due to the fact that in Tablas Island, Romblon, the site is a sanctuary in the middle of a mangrove forest away from the open sea compared to *T. hemprichii* in Tando, Island, Guimaras where the site is located beyond the sea shore. Thus, *T. hemprichii* in Tablas Island, Romblon is less prone to any disturbance, human or environmental, that might affect its capability to produce flowers. Nonetheless, seagrasses are highly susceptible to disturbance and will die rapidly under excessive stress. Recovery, on the other hand, is comparatively very slow (www.seaweb.org).

The seagrass species in all sites peaked during months where rain is often experienced and the weather is cold. Thus, the rate of flowering for *C. rotundata* in Concepcion, Iloilo, *T. hemprichii* in Tando Island, Guimaras and *T. hemprichii* in Tablas Island, Romblon, could be attributed to the weather and temperature of its surrounding waters.

The two species showed the longest internode length during the summer months of March-April, and also during cold months of October-January. This is because growth rates in seagrasses typically exhibit seasonal patterns, which follow a general trend of increasing growth rates with increasing solar insolation during Spring and early summer(Zimmerman et al, 1989).

Seagrasses in Queensland are abundant in late October through December after months of clear skies, increasing day length and rising temperatures provide optimal conditions for growth(Coles et al).

This is because during rainy seasons, river water discharge would increase sediment loading to the water column towards the coastal waters (www.southeast.fws.gov). Together with these sediments that are being runoff to the coastal waters are nutrients that are very essential to the growth and development of seagrasses. In general, they assimilate nitrogen and phosphorus from the sediments via their roots and rhizomes and from the water column via their leaves.

Climate change is predicted to raise sea levels, concentrations of carbon dioxide in seawater, and seawater temperatures. Rising sea levels could increase the distribution of seagrass because more land will be covered by seawater (Coles et al, 2004).

However, these hypotheses are not always true. Rising sea temperatures could cause burning or death of seagrasses in some places where they are close to their thermal limit. Deepwater seagrasses could be impacted by the reduction in light caused by coastal run-off (Coles et al, 2004).

It was observed that Looc, Romblon is monospecific with only *Enhalus acoroides* in the area. This could be due to the high temperature. This is because an increase in water temperature would reduce the productivity and cause the die-back of those seagrasses growing in areas already around the upper limit of their thermal tolerance. Increased temperatures may also combine with nutrient pollution to further enhance the growth of competitive algae (i.e., seaweed and phytoplankton); an increase in algal production can lead to reductions in the sunlight and carbon that seagrass require for survival (www.seaweb.org).

Only the species, *Enhalus acoroides* can withstand the temperature, thus, only it thrives in the area, compared to Tando Island, Guimaras where the temperature of the water is between the desired temperature range for seagrasses. Thus, more seagrass species were found in the area.

Salinity could also be a factor of why Looc, Romblon is monospecific with only *Enhalus acoroides* in the area. Seagrasses require specific salinities for reproduction and propagation; shifting salinity regimes would limit the reproduction and distribution of some seagrass species yet favor those that are more salt-tolerant (www.seaweb.org). Thus, only *Enhalus acoroides* can tolerate the salinity range in the said area while other species can not.

Shoot age distribution for both species were relatively non-symmetric towards younger age categories. Thus, all the three sites contain a younger population of seagrasses within the ages of 100-250 days. Bayona et al showed a similar range of modal ages that are relatively skewed to younger generation of seagrasses.

Mean age of T. hemprichii in Guimaras and Romblon showed a lower value compared to those obtained from Bolinao Pangasinan which was 668 days and for Guimaras which was 520 days (Vermaat et al). Median ages for both seagrasses in the three sites were lower compared with those obtained from Guimaras (Biyo 2001) and in Bolinao (Vermaat et al, 1995).

It was observed that the net recruitment rate for the three species were all positive. It means that there were more seagrasses growing annually than dying. We can safely conclude that seagrass population in the study sites are in no way threatened. This may be so because of the increased awareness of the people about the significance of seagrasses and their roles as producers in the food chain in the coastal areas studied. We may also say that in these coastal areas, human activities that inhibit the growth of seagrasses are very few.

But still long-term monitoring of seagrass beds is lacking and effective planning in the face of multiple and varied assaults on marine habitats are almost nonexistent. These problems are due in part to lack of attention to an ecosystem approach in present-day methods of scientific research and management (Scholander, 1968).

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

A. Summary and Conclusion

Seagrasses are greatly productive and dynamic, and are essential components of the marine environment and are determinants of the amount of fishes and other organisms that a marine environment can hold. They provide food and shelter, and serve as nursery and breeding grounds for fishes and marine invertebrates; many of which are commercially important. Seagrass leaves act as substrate stabilizers which increase light penetration and water clarity to the marine environment. They also reduce wave and current energy decreasing soil erosion.

Reports have shown that seagrass population is drastically decreasing despite their economic and ecological importance. Likewise, the data on their taxonomy, distribution, and ecology in the ASEAN region are a few.

Age reconstruction technique based on plastochrone interval (PI) estimates, as being a new tool for assessing coastal areas, has been utilized by few researchers to describe seagrass demography, and vegetative and reproductive dynamics.

This study described the community structure of seagrasses along selected coastal areas in the Philippines in terms of species composition, density and biomass of the shoots. Age reconstruction technique based on leaf PI estimates was used to describe demographic characteristics, and vegetative and reproductive dynamics of species *Thalassia hemprichii* and *Cymodocea rotundata* with determined leaf PIs of 10 and 12.5 days respectively.

Results of this study are summarized as follows:

1. Six seagrass species were observed in the coastal area of Tando Island, Nueva Valencia, Guimaras, five in Odiongan, Tablas Island, Romblon, two in Sitio Looc, Concepcion, Northern Iloilo, while one species was identified in Looc, Tablas Island, Guimaras, the *Enhalus acoroides*. *Halophila ovalis* was the dominant species in Island, Nueva Valencia, Guimaras, *Thalassia hemprichii* in Odiongan, Tablas Island, Romblon, and *Cymodocea rotundata* in Sitio Looc, Concepcion, Northern Iloilo (Table 1).

2. With densities ranging from 1477 to 7886 shoots/sq m, and aboveground biomass ranging from 177 to 447.3 g DW/sq m, the coastal areas of Tando Island, Odiongan and Sitio Looc (Concepcion, Northern Iloilo) are highly productive. Sitio Looc, Concepcion, Northern Iloilo has the highest seagrass density while Odiongan, Tablas Island, Romblon has the highest seagrass biomass. The only observed species in Looc, Tablas Island, Romblon, the *Enhalus acoroides* has a density and a high biomass of 49 shoots/sq m and 176 g DW/sq m, respectively.

3. The age reconstruction technique based on leaf plastochrone interval (PI) estimates proved to be more than helpful in assessing seagrass demography as well as in describing the vegetative and reproductive strategies of *Thalassia hemprichii* and *Cymodocea rotundata* in the coastal areas of Guimaras, Concepcion and Odiongan, Romblon. Using this technique, the following significant findings were revealed:

a) *Thalassia hemprichii* had longer median ages compared with *Cymodocea rotundata*. *Cymodocea rotundata* also had lower recruitment rate, and rhizome elongation rate which is faster than *Thalassia hemprichii*. (Tables 3 and 4).

b) Vertical elongation rate for *Thalassia hemprichii* in Odiongan, Romblon was higher as compared with the values obtained from Guímaras, indicating possible high sedimentation in the bay.

c) Net recruitment rate for the two species in the three study sites indicate stable seagrass population. Net recruitment rate for *Thalassia hemprichii* in Guimaras(0.85 ln units/yr), *Thalassia hemprichii* in Odiongan, Romblon(0.76 ln units/yr) and *Cymodocea rotundata* in Concepcion, Iloilo (0.38 ln units/yr) were higher, indicating that for these species, more new shoots are added to the population annually compared to the number of shoots that have died(Table 3).

d) The age reconstruction technique revealed that the length of the vertical internodes in *T. hemprichii and C. rotundata* two species showed definite annual cycles. Three growth minima were observed: the first and second occurring in the cold months of January and March, and the third during the rainy months of July-August. The annual cycle of *Cymodocea rotundata* show two minima in a year: the first minima is in March and the second in November, a cold month. The two species in all sites showed longer vertical internode lengths during the summer months of March –April (Figures 7, 8 and 9).

e). Results also revealed that in the coastal area of Guimaras, 10.67% of *T. hemprichii* shoots are flowering while in Romblon, 15.58 % of *T. hemprichii* are flowering. In Concepcion, Iloilo, flowering frequency for C. rotundata was 15.94 % (Table 5). High reproductive efforts in seagrasses were observed in areas where there is less human or environmental disturbances and water surrounding the area is nutrient enriched due to surrounding fauna.

f). In Concepcion, Iloilo, *C. rotundata* flowers the whole year round. Flowering frequency for this species showed a unimodal trend which peaks in August (Figure 11). In Guimaras, Iloilo and Odiongan, Romblon, flowering for *T. hemprichii* both peaked in January (Figure 10 and 12).

The age reconstruction technique is a useful tool in determining seasonality and flowering frequency in seagrasses since it requires less sampling effort (Bayona et al). However, this tool cannot be used with accuracy to determine fruit or seed production based on flower scars because the reconstructive frequency maybe treated only as a "flowering potential" since there are cases when flowers were initiated but after some time, aborted (Rollon, 1998).

Long term monitoring of seagrass beds is lacking and effective planning in the face of multiple and varied assaults on marine habitats are almost nonexistent. These problems are due in part to lack of attention to an ecosystem approach in present-day methods of scientific research and management.

Loss of seagrass habitats will mean losses in marine ecosystem productivity as well as extinction of species that depend on seagrasses for survival.

B. Recommendations

While this research has processed data on the community structure of seagrasses along selected coastal areas of the Philippines, more innovations and researches should be conducted to further establish the significance of seagrass beds to our marine ecosystem, most especially within the Philippine coastal waters.

Future research perspectives on seagrasses are as follows:

1. Determination of leaf plastochrone interval (PI) estimates of other seagrass species in different coastal areas of the country
2. Possible industrial innovations on seagrasses
3. Seagrass transplantation techniques
4. Community structure of seagrass fauna in the different seagrass areas in the country
5. Responses of seagrasses to environmental stress
6. Responses of seagrass fisheries to environmental stress
7. Further study on the specific effects of physico-chemical factors on the growth and development of seagrasses

LITERATURE CITED

Anonymous. 1975. Seagrass Ecosystem Study Proposal. http://www.botany.hawaii.edu/.

Anonymous. 1993. Seagrasses. Tropical topics (an interpretative newsletter for the tourism industry). 1: (not specified).

Anonymous. 1995. Delimiting the Species.http://www.botany.hawaii.edu/.

Anonymous. Nontropical Reef types and Associated Communities- Seagrass Communities. Coastal Department of Florida. www.dep.state.fl.us.

Australian Institute of Marine Science. Seagrasses. 1996- 2003. http://www.physiol.arizona.edu/.

Bayona, Iris Isabelle G., Biyo, Jono Angelo t., Lamzon, Jessel Loise P. 2002. Community structure of seagrasses along selected coastal areas of the Philippines. Research paper. Philippine Science High school, Iloilo City. 71pp.

Biyo, J.T. 2001a. Community structure, growth, and productivity of seagrasses in the coastal area of Tando, Nueva Valencia, Guimaras Island, Central Philippines. Ph. D. Dissertation, De La Salle University, Taft Avenue, Manila, Philippines.

Biyo, J.T. 2001b. Vegetative and reproductive dynamics of the seagrasses, Thalassia hemprichii and Cymodocea rotundata in Guimaras Island, Central Philippines. The Philippine Scientist, pp.63-82.

Coles, R., McKenzie, L., Campbell, S., Mellors, J., Waycott, M., Goggin, L. 2004. Common Seagrass Species. http://www.reef.crc.org.au/.

De Guzman, A.B., 1990. Community Structure of macro benthic invertebrates on exploited reef flats of Santiago Island, Bolinao, Pangasinan. Quezon City: University of the Philippines. Master's Thesis, Marine Science Institute, University of the Philippines, Quezon City, 141pp.

Dowes, C.J., J.H. Andorfer, C.D. Rose, C. Uranowski, N. Ehringer. Regrowth of the seagrass Thalassia *testudinum* into propeller scars. http://www.fiu.edu/.

Duarte, C.M., N. Marba, N. Agawin, J. Cebrian, S. Enriquez, M.D. Fortes, M.E. Gallegos, Merino, B. Olesen, K. Sand-Jensen, J. Uri, and J. Vermaat. 1994. Reconstruction of seagrass dynamics: age determination and associated tools for the seagrass ecologist. Mar. Ecol. Prog. Ser. 107: 195- 209.

Duarte, C.M. and Sand-Jensen, K. 1990. Seagrass colonization: biomass development and shoot demography in Cymodocea nodosa patches. Marine Ecology Progress Series. Vol. 67:97- 103.

Erickson RO, Michelini FJ. 1957. The plastochrone index. Am J Bot 44: 297- 305.

Florida Department of Environmental Protection. SEAGRASSES Multi-Species Recovery Plan for South Florida: Figure 1.The distribution of seagrasses in South Florida. Report from Florida Department of Environmental Protection. http.//www.southeast.fws.gov/.

Fortes, M.D. 1989. Seagrasses: a resource unknown in the ASEAN region. ICLARM Education Series 5, International Center for Living Aquatic Resources Management, Manila, Philippines: 15 pp.

Fortes, M.D. 1990. Taxonomy and distribution of seagrasses in the ASEAN Region Paper presented at SEAGREM 2: Advanced Training Course/ Workshop on Seagrass Resources Research and Management. University of the Philippines, Diliman, Q.C., 08-26 January 1990.

Fortes, M.D. 1995. Seagrasses of East Asia: Environment and Management Perspectives. RCU/EAS Technical Report Series No. 6. United Nations Environment Programme, Bangkok.

Howard, R.K., Edgar, G.J. & Hutchings, P.A. 1989. Faunal assemblages of seagrass beds. In: Larkum, A.W.D., McComb, A.J., and Shepherd, S.A.(eds.) **Biology of Seagrasses.** Elsevier, Amsterdam, Pp 536-564.

Kevlan, M. 1995. Significance of Seagrasses. http://wwwscience.mudroch.edu.au/.

Kikuchi, T. & Peres, J.M. 1977. Consumer ecology of seagrass beds. In: Mcroy, C.P. and Helffherich, C.(eds.) **Seagrass Ecosystems: A Scientific Perspective,** Marcel Dekker, New York and Basel, Pp 147-193.

Kiswara,W. 1992. Community structure and biomass distribution of seagrasses at Banten Bay, West-Java Indonesia. Research and development center for Oceanology, Indonesian Institute of Sciences. Jakarta, Indonesia.

Kuo, J. and McComb, A.J. 1989. Seagrass taxonomy, structure and Development. In: A.W.D. Larkum, A.J. McComb and S.A. Shepherd (eds.): Biology of Seagrasses: A treatise on the biology of seagrasses with special reference to the Australian Region. Elsevier, Amsterdan, 841 pp.

Lanyon, J. 1986. Guide to the identification of seagrasses in the Great Barrier Reef region. Queensland: GBRMPA Publishing.

Leumanoment, K., Deetae, S. and Srimanobhas, V. 1996. Seagrasses of Thailand. In: Seagrass Biology: Proceedings of an International Workshop (Kuop, J., Phillips, R.C., Walker, D.I., and Kirkman, H. (eds.). Faculty of Sciences, the University of Western Australia, Nedlands, pp. 21-26.

Ogden, J.C. 1980. Faunal relationships in Caribbean seagrass beds. In: Philips, R.C. and McRoy, C.P.(eds.) **Handbook of Seagrass Biology: An Ecosystem Perspective.** Garland STPM Press, New York and London, Pp 173-198.

Philips, R.C., and Meñez, E.G. 1988. Seagrasses. Smithsonian Contrib. Mar. Science. Pp 34.

Scholander, P.F. 1968. How mangroves desalinate seawater. Physiol plant. 21: 258-268.

The State of Queensland. Environmental Protection Agency. 2004. http://www.epa.qld.gov.au/.

Terrados, J., Duarte, C., Fortes, M.D., Borum, J., Agawin, N.S.R., Bach, S., Thampaya, U., Kamp-Nielson, L., Kenworthy, W.J., Geertz-Hansen, O. and Vermaat J., 1998. Changes in community structure and biomass of seagrass communities along gradients of siltation in SE Asia. Est. Coast and Shelf Sci., 46(in press).

Vermaat, J.E. 1996. The capacity of seagrasses to survive increased turbidity and siltation: the significance of growth form and light use. Ambio Vol. 25: 499- 504.

Vermaat JE, Agawin NSR, Duarte DM, Fortes MD, Marba N, Uri JS, 1995. Meadow maintenance, growth and productivity of a mixed Philippine seagrass bed. Mar Ecol Prog Ser 124: 215-225.

World Seagrass Association. 2004. About Seagrass. http://www.worldseagrass.org/biology.htm.

Zieman, J.C. 1982. The ecology of the seagrasses of south Florida: A community profile. *U.S. Fish and Wildlife Services.* Office of Biological Services: Washington, D.C. FWD/OBI-82/25. 158 pp.

APPENDIX

Appendix 1. Exploring seagrass beds in Tando Island, Nueva Valencia, Guimaras

Appendix 2. Low tide in the coastal area of Sitio looc, Concepcion, Northern Iloilo

Appendix 3. Other organisms found in seagrass beds of the coastal area of Sitio Looc, Concepcion, Northern Iloilo.

Appendix 4. Departure from Sitio Looc, Cocepcion, Northern Iloilo