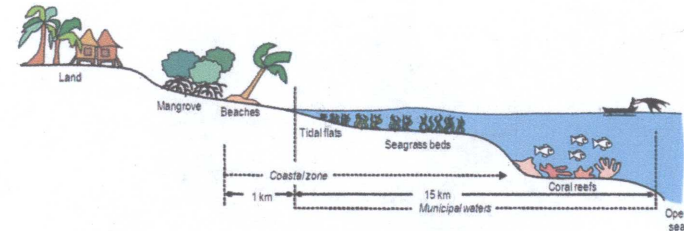


SAMPLING METHODS

Mangroves



The coastal zone

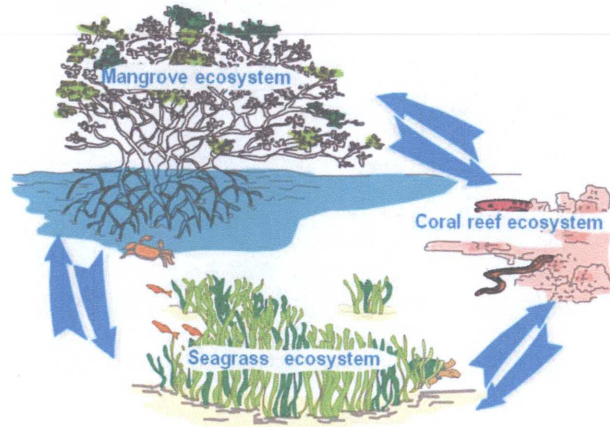


Coastal Zone is the interface where the land meets the ocean. It includes the shoreline environment and the adjacent coastal waters.

GENERAL PROCEDURES

- **Location:** habitat type (2 sites per habitat; impact-control)
- **Site selection:** access, safety, condition
- **Sampling frequency:** quarterly or biannually
- **Intensity:** replication (3 x 100m transects; 15 x 1m x 1m quadrats per transect)
- **Macroplots:** GPS coordinates; permanent markers
- **Methodology:** transect orientation, standardisation, consistency, equipment
- **Data:** recording (units), processing, summary and presentation, duplication and storage

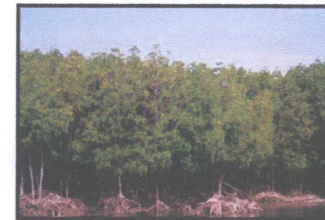
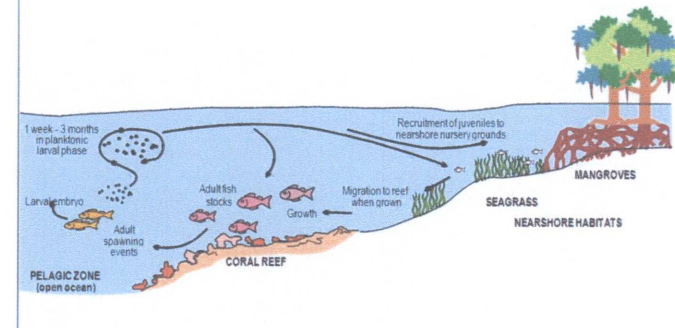
Mutual contributions of tropical coastal habitats



- A Philippine Coastal Zone has the following major ecosystems along its shallow coastlines

- coral reefs
- seagrass beds
- mangroves
- estuaries and lagoons

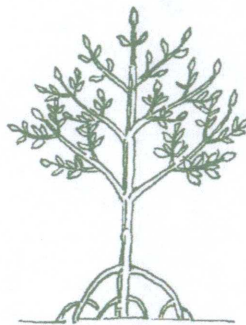
Typical life cycle of coral reef fish species and interconnectivity of habitats



Mangroves are woody, seed bearing plants adapted for life in brackish water. Serve as feeding and nursery grounds and refuges to many fish species, migratory birds and other marine organisms.



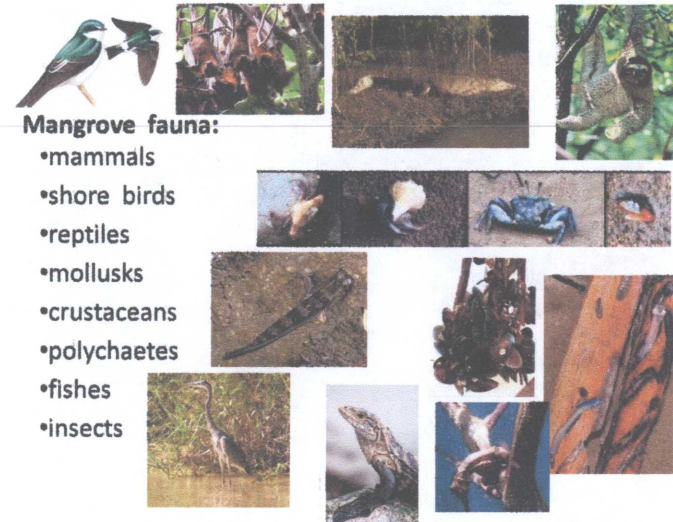
TWO MAJOR MANGROVE GENERA



Rhizophora



Avicennia

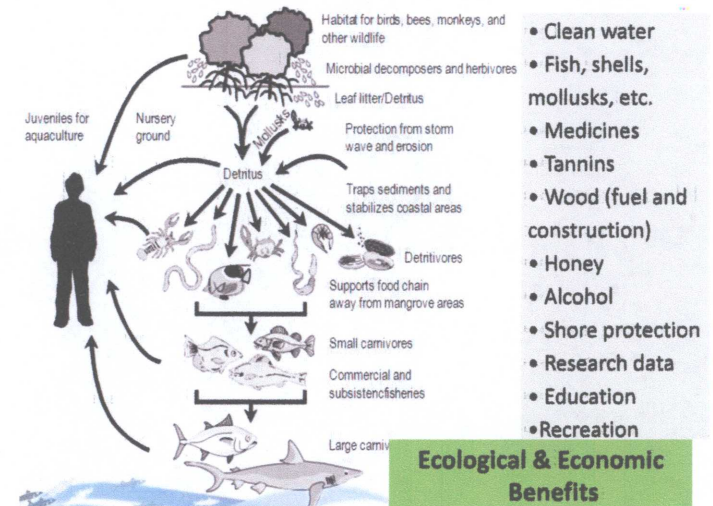
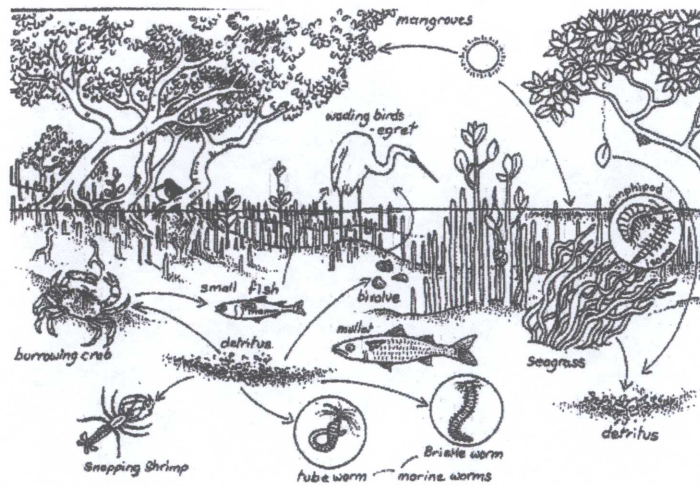
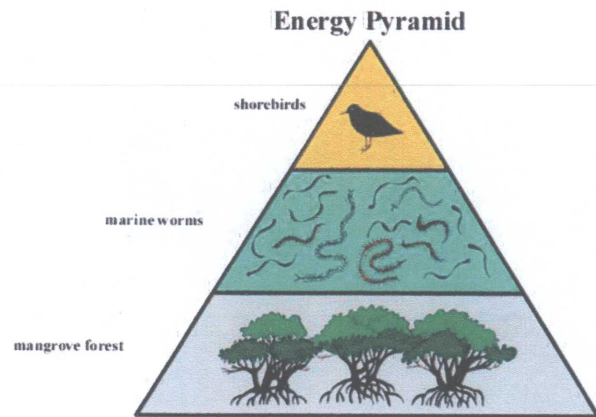


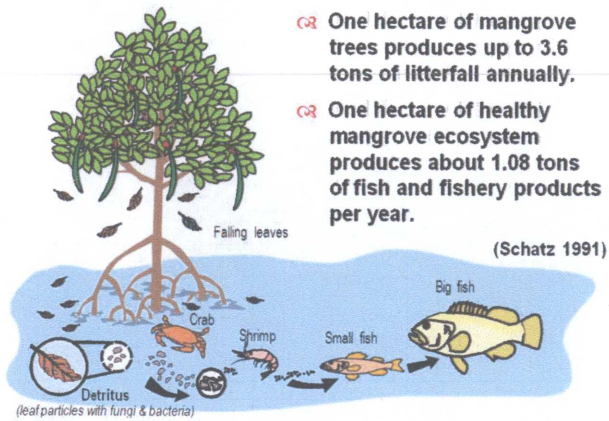
Mangrove fauna:

- mammals
- shore birds
- reptiles
- mollusks
- crustaceans
- polychaetes
- fishes
- insects

How many animals can you identify in this mangrove habitat?





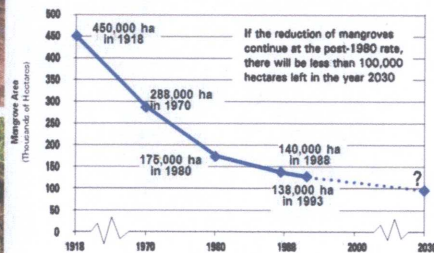


- ✎ One hectare of mangrove trees produces up to 3.6 tons of litterfall annually.
- ✎ One hectare of healthy mangrove ecosystem produces about 1.08 tons of fish and fishery products per year.

MANGROVES IN DECLINE!

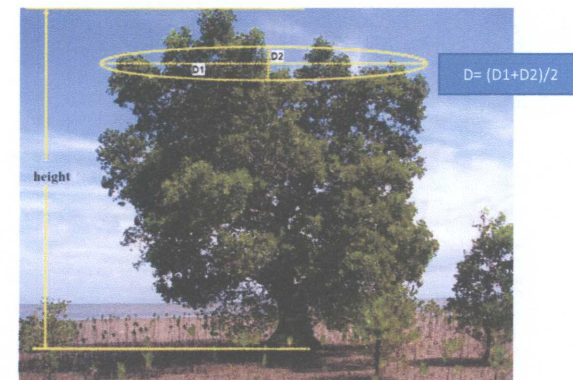


Decline of mangrove resource in the Philippines



MANGROVE METHODS

- Expected output data,
 - A. % crown cover/area (e.g. 23.50%/m²)
 - B. Average height of mangroves (e.g. 5.11 m)



Crown diameter (2 measures) - the average of the crown width at the widest point and a second width measurement made 90° to the diameter at the widest point.

MANGROVE METHODS

- Expected output data,
 - A. % crown cover/area (e.g. 23.50%/m²)
 - B. Average height of mangroves (e.g. 5.11 m)
 - C. Regeneration per area (e.g. 2 regenerations/m²)
 - D. Number of species per area

MANGROVE ASSESSMENT

Percent crown cover	=	$\frac{\text{Total crown cover of all trees}}{\text{Total area sampled}}$
Regeneration per m ²	=	$\frac{\text{Total regeneration count}}{\text{Total no. of regeneration plots}}$
Average height	=	$\frac{\text{Total height of all trees recorded}}{\text{Total number of trees recorded}}$

Condition	Criteria
Excellent	76% and above in % crown cover 1 regeneration per m ² Above 5 m in average tree height Undisturbed to negligible disturbance
Good	51-75% crown cover 0.1 - 0.76% regeneration per m ² 4m - 3m average height of trees Slight disturbance and few cuttings
Fair	26-50% crown cover 0.50 - 0.75% regeneration per m ² 3m - 2m average height of trees Moderate disturbance and noticeable cuttings
Poor	0-25% crown cover 0.50% regeneration per m ² 2m average height of trees Heavy disturbance/cuttings/pollution, rampant conversion to other uses, nearly destroyed

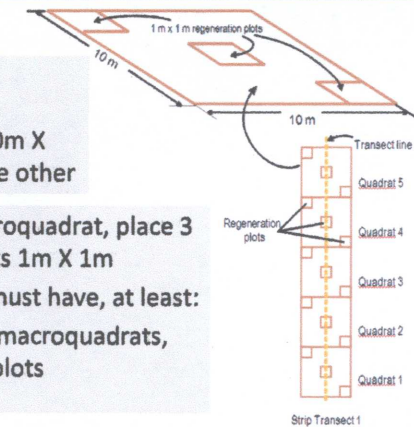
Mangrove Methods

- Locate your seagrass habitat macroplot (i.e. borders, beginning/ending)
- Record GPS coordinates of reference markers for your site macroplot
- Lay down 3 transect lines (50-100m/transect) perpendicular to shoreline. Transect lines should be 40-60m apart
- Each transect should extend seaward or perpendicular to the shoreline and should **start** where the **mangrove** habitat starts, and **ends**, where the habitat ends.

Mangrove Methods

- In each transect, establish 5 macroquadrats 10m X 10m, one after the other

- Within each macroquadrat, place 3 regeneration plots 1m X 1m
- All counted you must have, at least: 3 transect lines, 15 macroquadrats, 45 regeneration plots



Mangrove Methods

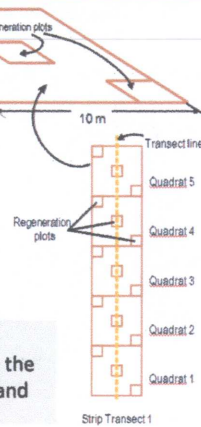
- Regeneration plots will be used to record ages of trees, where:

2 = saplings

3 = seedlings

1 = mature

Each kind of mangrove located within the regeneration plot will be counted according to the stage of its life cycle or age: seedling, sapling, and mature trees.



MANGROVE CLASSIFICATION:AGE

Seedling - up to 1m height and a trunk size less than 4cm in diameter

Sapling - greater than 1m height and a trunk size of 4cm in diameter

Mature tree - greater than 1m height and a trunk size greater than 4cm in diameter

Seedling



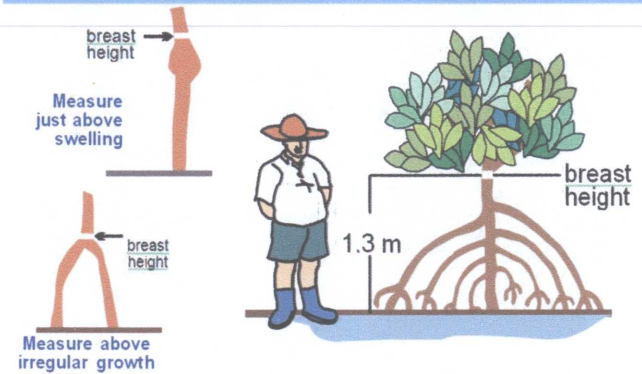
Mature tree



Sapling



If the growth of mangroves is irregular, determine breast height by any of the following:



DATA RECORDING

DATA SHEET FOR MANGROVE ASSESSMENT						
Transect No. _____		Location _____				
Recorder: _____		Site _____ Barangay _____				
Date: _____		Municipality _____ Province _____				
Quadrat No.	Tree No.	Substrate	SPECIES	Total Ht. (m)	Crone diameter (2 readings)	OBSERVATIONS (disturbance, breast, uses, cuttings, garbage, fauna)

DATA SHEET FOR MANGROVE REGENERATION				
Transect No. _____		Location _____		
Recorder: _____		Site _____ Barangay _____		
Date: _____		Municipality _____ Province _____		
Quadrat No.	Plot No.	SPECIES	Count	REMARKS (over height, status, etc.)
	1			
1	2			
	3			
	1			
2	2			
	3			

DATA SHEET FOR MANGROVE ASSESSMENT						
Transect no. <u>1</u>		Location <u>Mahayashay</u>		Duhaylungsod		
Recorder: <u>Renclar de los Reyes</u>		Site <u>Talibon</u>		Barangay <u>Bohol</u>		
Date <u>April 11, 2003</u>		Municipality		Province		
Quadrat no.	Tree no.	Substrate	Species	Height (m)	Crown diameter (average of 2 readings)	Observations (disturbance, threats, uses, cuttings, garbage, fauna)
1	1	Muddy	Bakawan babae (<i>Rhizophora mucronata</i>)	6	2	Crabs, birds, seashore, undisturbed
	2	Muddy	Bakawan lalaki (<i>Rhizophora apiculata</i>)	5	1.5	
	3	Muddy	Pagatpat (<i>Sonneratia alba</i>)	6	2	
	4	Muddy	Bakawan babae (<i>Rhizophora mucronata</i>)	5	2	
	5	Muddy	Bakawan lalaki (<i>Rhizophora apiculata</i>)	4	1.5	
2	1	Muddy	Pagatpat (<i>Sonneratia alba</i>)	5	1.5	Shells, undisturbed
	2	Muddy	Bakawan lalaki (<i>Rhizophora apiculata</i>)	4	1	
	3	Sandy	Bungalon (<i>Avicennia marina</i>)	6	1.5	
	4	Sandy	Piapi (<i>Avicennia lanata</i>)	5	1.5	
TOTAL				46	14.5	

DATA PROCESSING

- Crown diameter (2 measures) - the average of the crown width at the widest point and a second width measurement made 90° to the diameter at the widest point.
- Crown cover is calculated using the formula $\pi/4d^2$ or $0.7854d^2$ (d as the total crown diameter)
- To get the crown cover for each tree = $0.7854 \times (\text{crown diameter})^2$
- To get the total crown diameter = $0.7854(2)^2 + 0.7854(1.5)^2 + 0.7854(2)^2 + 0.7854(1.5)^2 + 0.7854(1.5)^2 + 0.7854(1)^2 + 0.7854(1.5)^2 + 0.7854(1.5)^2 = 19.04 \text{ m}^2$ [SEE SAMPLE DATA SHEET]

DATA PROCESSING

- To get percent crown cover:

$$\frac{\text{Total crown cover of all trees}}{\text{Total area sampled}} = \frac{19.04}{2 \text{ quadrats} \times 100\text{m}^2} = \frac{19.04}{200} = 9.53\%$$

- To get the average height:

$$\frac{\text{Total height of all trees recorded}}{\text{Total number of trees recorded}} = \frac{46}{9} = 5.11 \text{ m}$$

DATA SHEET FOR MANGROVE REGENERATION				
Transect no. <u>1</u>		Location <u>Mahayashay</u>		Duhaylungsod
Recorder: <u>Renclar de los Reyes</u>		Site <u>Talibon</u>		Barangay <u>Bohol</u>
Date <u>April 11, 2003</u>		Municipality		Province
Quadrat no.	Plot	Species	Count	Remarks (average height, status, etc.)
1	1	Bakawan lalaki (<i>Rhizophora apiculata</i>)	2	Other seedlings were not seen due to high tide
		Pagatpat (<i>Sonneratia alba</i>)	1.5	
	2	Bungalon (<i>Avicennia marina</i>)	2	
		Pagatpat (<i>Sonneratia alba</i>)	2	
		Piapi (<i>Avicennia lanata</i>)	1	
2	1	Pagatpat (<i>Sonneratia alba</i>)	1	
		Piapi (<i>Avicennia lanata</i>)	1	
	3	Bungalon (<i>Avicennia marina</i>)	1.5	

$$\text{Regeneration per m}^2 = \frac{\text{Total regeneration count}}{\text{Total no. of regeneration plots}} = \frac{2 + 2 + 1 + 1 + 2 + 1 + 1}{6} = \frac{12}{6} = 2$$

MANGROVE ASSESSMENT

$$\text{Percent crown cover} = \frac{\text{Total crown cover of all trees}}{\text{Total area sampled}}$$

$$\text{Regeneration per m}^2 = \frac{\text{Total regeneration count}}{\text{Total no. of regeneration plots}}$$

$$\text{Average height} = \frac{\text{Total height of all trees recorded}}{\text{Total number of trees recorded}}$$

Condition	Criteria
Excellent	76% and above in % crown cover 1 regeneration per m ² Above 5 m in average tree height Undisturbed to negligible disturbance
Good	51-75% crown cover +1 - 0.76% regeneration per m ² +5m - 3m average height of trees Slight disturbance and few cuttings
Fair	26-50% crown cover 0.50 - 0.75 regeneration per m ² +3m - 2m average height of trees Moderate disturbance and noticeable cuttings
Poor	0-25% crown cover +0.50 regeneration per m ² +2m average height of trees Heavy disturbance/cuttings/pollution, rampant conversion to other uses, nearly destroyed

RESULTS SUMMARY:

1. % crown cover = 9.53%
2. Average height = 5.11 m
3. Regeneration per m² = 2

Therefore, the mangrove area with the data used in the example above is in **poor condition**.

List of Materials

- 100m pvc transect tape or calibrated polyethylene rope (calibrated every 5 m interval)
- Macroquadrats (10m X 10m) polyethylene rope
- Quadrats 1m X 1m: regeneration plots
- Underwater slates with attached pencil
- Field guide to Philippine Mangroves (Primavera and Dianala)
- Invertebrates, identification guides (optional)
- Global positioning system (GPS)
- Digital camera with 4Gb memory










List of Materials

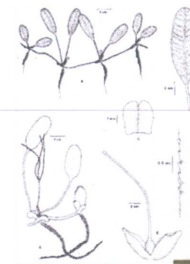
- Pre-formatted data sheets
- Marked stakes
- Nails (5cm) and hammer (optional)

SAMPLING METHODS

Seagrass beds – Mangroves – Sandy
Beaches – Coral Reefs

Indo-Pacific Seagrass

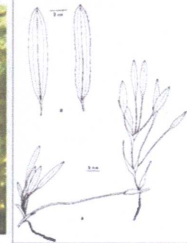
 <p><i>Thalassia hemprichii</i></p> <ul style="list-style-type: none"> • Flat leaves 10-60cm and rhizomes with scale leaves 	 <p><i>Enhalus acoroides</i></p> <ul style="list-style-type: none"> • Strap-like leaves with wavy margin, 30-150cm and rhizomes with bristles 	
 <p><i>Syringodium isoetifolium</i></p> <ul style="list-style-type: none"> • Round leaves 10-60cm 	 <p><i>Cymodocea serrulata</i></p> <ul style="list-style-type: none"> • Flat leaves 6-20cm with serrated tips, often on a short stem 	
 <p><i>Halodule uninervis</i></p> <ul style="list-style-type: none"> • Thin, flat leaves with 3-pointed tips, 15cm 	 <p><i>Cymodocea rotundata</i></p> <ul style="list-style-type: none"> • Flat leaves 7-15cm with rounded tips 	
 <p><i>Halophila decipiens</i></p> <ul style="list-style-type: none"> • Paddle-shaped leaves, with serrated edges and leaf hairs, 1-2cm 	 <p><i>Thalassodendron cilium</i></p> <ul style="list-style-type: none"> • Sickle-shaped leaves 15cm with serrated tips on long stem; woody rhizomes 	
 <p><i>Halophila ovalis</i></p> <ul style="list-style-type: none"> • Smooth oval leaves, 1-3cm 	<p>Several other seagrass species occur in some areas of the region (World Atlas of Seagrasses, Green and Short 2003)</p>	



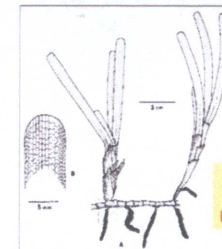
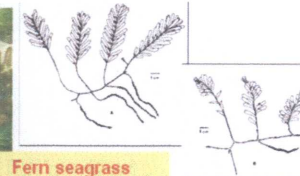
Spoon seagrass
Halophila ovalis
Family Hydrocharitaceae



Beccari's seagrass
Halophila beccarii
Family Hydrocharitaceae



Fern seagrass
Halophila spinulosa
Family Hydrocharitaceae



Sickle seagrass
Thalassia hemprichii
Family Hydrocharitaceae



SEAGRASS BEDS

- Seagrass beds are seed-producing marine plants that occur in shallow, nearshore waters, and are often found between coral reefs and mangrove areas, colonizing the soft, shallow and sandy-muddy bottom.



- Underwater flowering plants
- Valuable coastal ecosystem
- Form vast meadows to small patches
- 24 species in the Indo-Pacific
- Nurseries, shelter and food for fish
- Dugongs & sea turtles eat seagrass
- The Philippine has 16 known species of seagrass, the second highest in the world to Australia's 23



As dead seagrass breaks down, it becomes part of the coastal food chain, supporting snails, shrimp, and fish. Throughout the Indo-Pacific, people harvest sea food from seagrass meadows as a major source of protein.

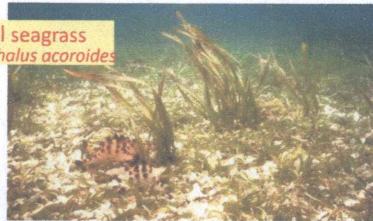
Seagrass contributes to a healthy coastal marine environment. Seagrass provides habitat for commercially and recreationally important fish and shellfish species. It is a nursery for young marine creatures. Seagrass filters the water of sediments and pollution. The seagrass root mat adds stability to the coastal zone, and seagrass leaves lessen the impact of wave energy on the shoreline.

Needle seagrass
Halodule uninervis
Family Cymodoceae

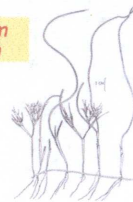
Ribbon seagrass
Cymodocea rotundata
Family Cymodoceaceae



Eel seagrass
Enhalus acoroides



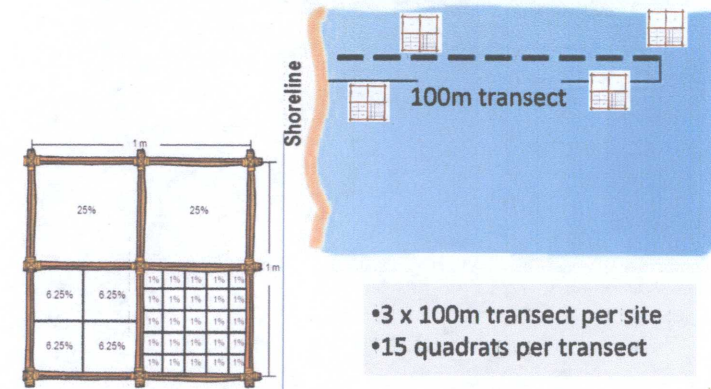
Syringodium isoetifolium



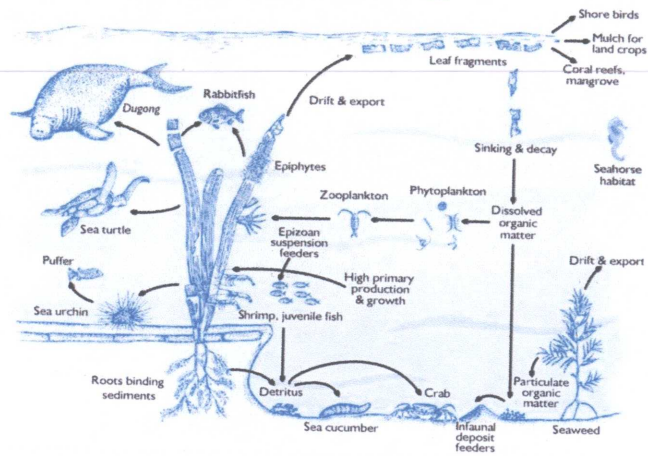
Seagrass/Seaweed Methods

- Locate your seagrass habitat macroplot (i.e. borders, beginning/ending)
- Record GPS coordinates of reference markers for your site macroplot
- Lay down 3 transect lines (100m/transect) perpendicular to shoreline. Transect lines should be 50-100m apart parallel from each other.
- Place quadrats 0.5m from one side of the transect line at 5m intervals. Alternate quadrat placement alongside the transect line

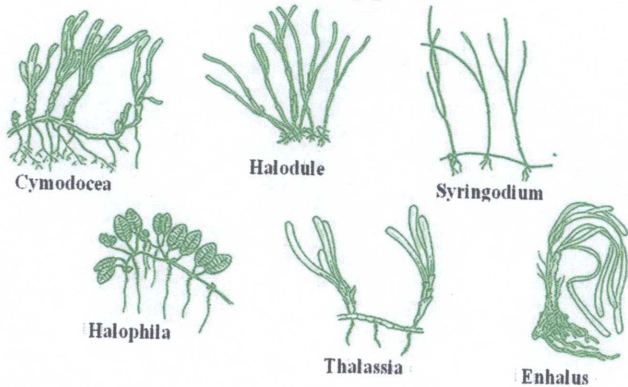
**Seagrass transect
perpendicular to shoreline**



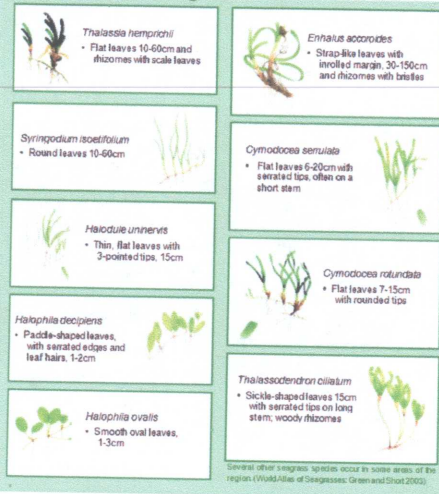
SEAGRASS FOOD WEB



Types of seagrasses commonly found in the Philippines



Indo-Pacific Seagrass



missing side

12/3/2011

Seagrass/Seaweed Methods

- Record the coverage per species of seagrass (e.g. *Thalassia*, *Enhalus*, *Turbinaria*, *Ulva*, *Sargassum*) for each quadrat. Take note of substrate type (i.e. sand, silt, rock)
- Record the coverage per species of seaweed (e.g. *Turbinaria*, *Ulva*, *Sargassum*) for each quadrat. Take note of substrate type (i.e. sand, silt, rock)
- Have another person record the number of macroinvertebrates (e.g. seastar, shrimp, urchin, sea cucumber)

missing

Species	1	2	3	4	5	6	7	8	9	10	Total	Average (per quadrat)	Frequency
<i>Thalassia</i>	50	60	25	0	50	0	0	0	0	0	185	18.5	4
<i>Enhalus</i>	0	0	0	0	0	5	0	0	0	0	5	0.5	1
TOTAL											190	19.0	5

DATA PROCESSING



- Add all values for every species and divide by the total number quadrats used (in this example 10 quadrats were used). The result below showed that average seagrass cover for *Thalassia* is only 18.5% even though in some quadrats, cover was higher than 50%.
- Determine the frequency of occurrence by counting the number of times a certain species was recorded in the transect. For example, *Thalassia* only occurred 4 times in the transect, while *Enhalus* only occurred 1 times. This indicates that *Thalassia* is more common than *Enhalus*.

5 species

missing side

quadrats

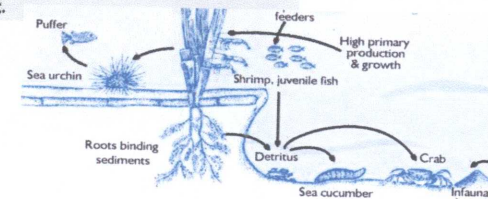
100%

12/3/2011

Species	1	2	3	4	5	6	7	8	9	10	Average (per quadrat)	Density (per hectare)	Frequency of occurrence
Urchins	0	0	0	0	0	0	0	0	0	0	0	0	0
Conch	0	0	0	0	0	0	0	0	1	0	0.1	1000	1
Shells	0	0	0	0	0	2	0	0	1	0	0.3	3000	2
Clam	4	2	0	1	0	0	1	0	0	0	0.8	8000	4
seastar	2	3	2	1	0	1	0	2	2	2	1.5	15000	8

DATA PROCESSING-INVERTEBRATES

- List down all invertebrates present in the area and write down their corresponding values below the quadrat number
- Determine frequency of occurrence by counting the number of times a certain species occurred in the transect.



and invertebrates

with quadrats

DATA PROCESSING: DIVERSITY

Biodiversity index can be computed from abundance data (counts)

Sample computation

$$P_i = \frac{\text{count per species}}{\text{Total no. of count of all species}} = \text{For gastropods species \# 1} = \frac{15.67}{31.67} = 0.1190$$

$\ln(P_i)$ = natural logarithm of 0.1190 is -2.1286 (use scientific calculator or excel program to get the value of \ln) or can use the excel program for easy computation of the results

$$-P_i (\ln(P_i)) = -(0.1190)(-2.1286) = 0.25332$$

$$\text{DIVERSITY INDEX } \sum P_i(\ln P_i) = 0.25332 + 0.16561 + 0.27203 + \dots + 0.03706 = 2.69$$

Example

Macrobenthic Species	Ave. # found	P _i (proportion of each species in the sample)	ln(P _i)	-P _i (ln(P _i))
Gastropods Species 1	15.67	0.1190	-2.1286	0.25332
Species 2	7.67	0.0583	-2.8430	0.16561
Species 3	18	0.1367	-1.9899	0.27203
Species 4	10.67	0.0810	-2.5129	0.20363
Species 5	1.33	0.0101	-4.5951	0.04642
Species 6	7.33	0.0557	-2.8883	0.16057
Species 7	4	0.0304	-3.4765	0.10642
Species 8	1	0.0076	-4.8803	0.03706
Species 9	0.67	0.0051	-5.2808	0.02687
Species 10	4.67	0.0329	-3.4147	0.11229
Bivalves Species 1	4.67	0.0329	-3.4147	0.11229
Species 2		0.0228	-3.7817	0.08616
Species 3		0.0051	-5.2808	0.02687
Species 4		0.0025	-5.9890	0.01501
Polychaetes Species 1	0.33	0.0025	-5.9890	0.01501
Species 2	0.33	0.0025	-5.9890	0.01501
Species 3	1.33	0.0101	-4.5951	0.04642
Other organism Species 1	1	0.0076	-4.8803	0.03706
	131.67	1.00	-85.94	2.69
DIVERSITY INDEX = 2.69				
From scale 0-4, 4 has the highest diversity				

DATA PROCESSING: DIVERSITY