

MANGROVE REHABILITATION AND CONSERVATION

RJA LOMA, JD COCHING, CL MONTILIJAO,
JP SAVARIS, JH PRIMAVERA



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The Turing Foundation is a Netherlands-based private charity established in 2006. It seeks to promote and encourage a sustainable and respectful relationship with nature. Respect is in the interest of nature itself. Sustainability ensures that the needs of present generations can be met, without reducing the possibilities of future generations to fulfill theirs. In trying to achieve these aims, the Turing Foundation limits its scope to the protection and sustainable management of the nurseries of the sea in developing countries, the areas in seas and along coasts that have the highest concentration of life and biodiversity, and sustainable organic agriculture and cattle breeding (in developing countries in Africa).

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- Back cover: Nabitasan Katunggan Ecopark in Barangay Nabitasan, Leganes, Iloilo as a learning destination for participants of the Training of Trainers on Mangrove and Beach Forest Conservation and Rehabilitation, 26 November 2015 (photo by Vincent Gado)
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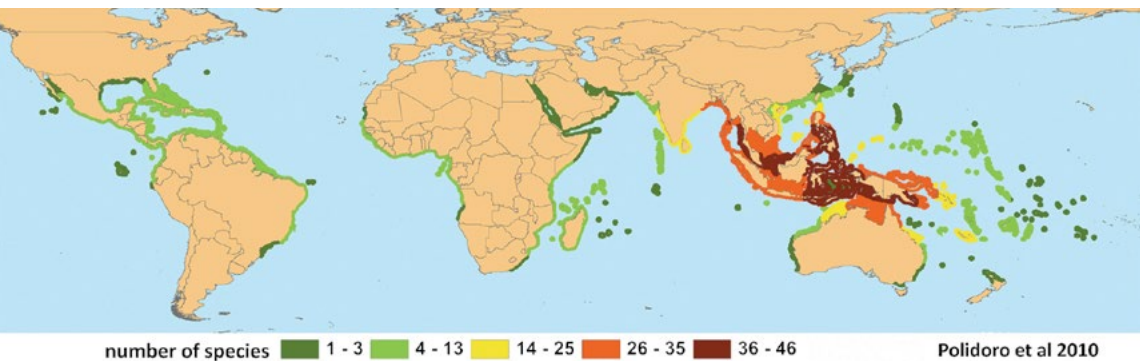


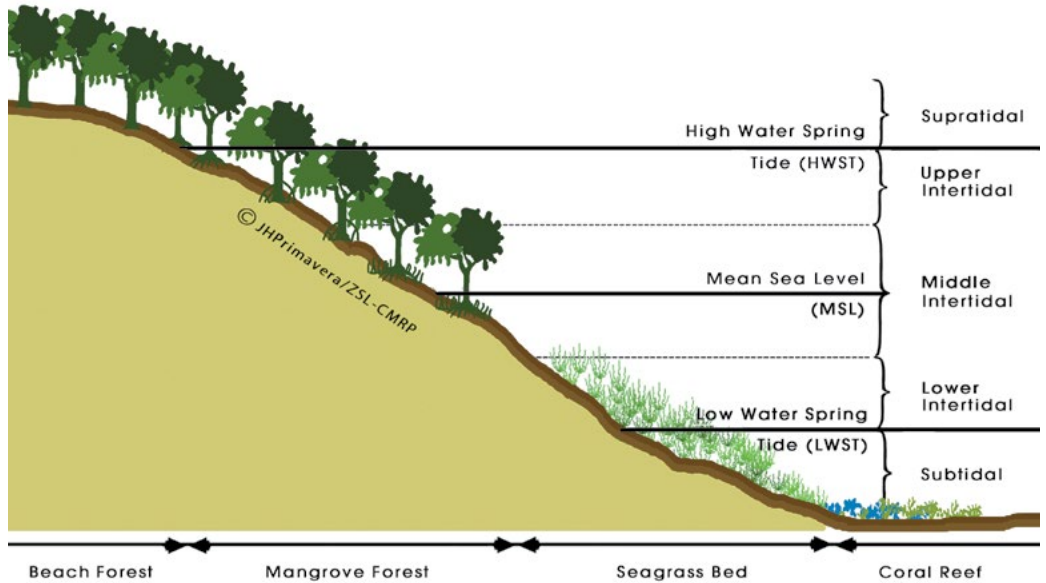


WHAT ARE MANGROVES?

Mangroves are plants which predominantly grow in the intertidal area of tropical and subtropical shorelines. The widest mangrove area and most species are found in Southeast Asia.

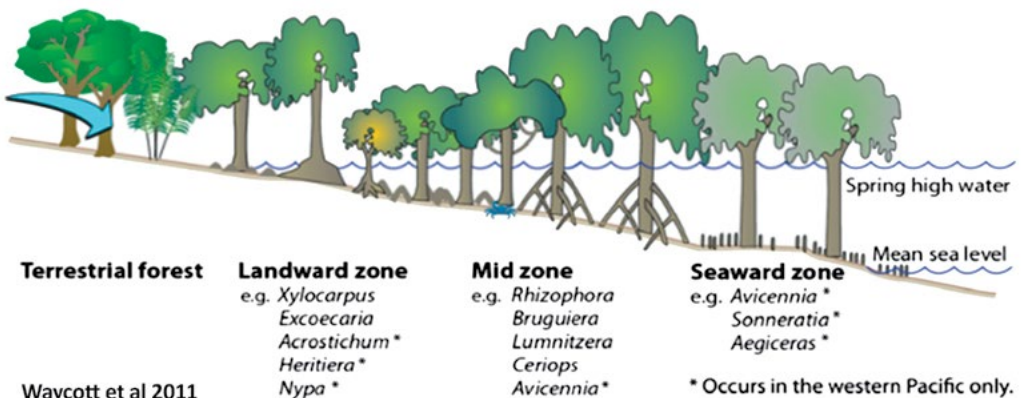
They can tolerate saltwater and oxygen-poor soil. They have propagules able to survive in, and dispersed by, seawater.





Mangroves are exclusively found in the upper to middle intertidal zone, submerged in seawater during spring high tide and exposed to air during neap low tide. Their associates are distributed above the high tide or high water line.

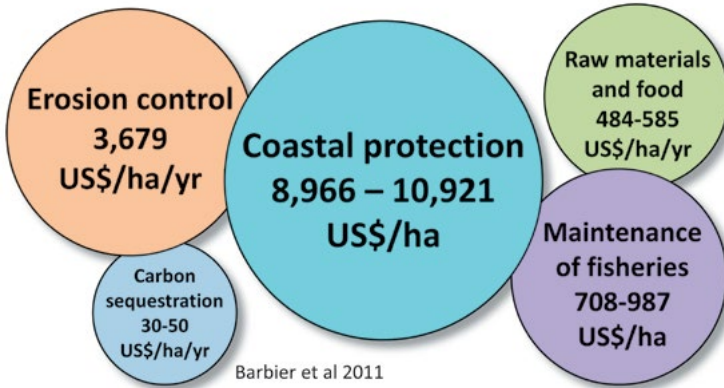
Mangroves are above seawater 70%, and are flooded only 30%, of the time. In the lower intertidal and subtidal zone are seagrasses and coral reefs.



Mangroves are important

Mangroves offer various ecosystem services that are beneficial to the environment and to people.

Value of mangrove ecosystem services



Coastal Protection (*lessen impact of wave action*)



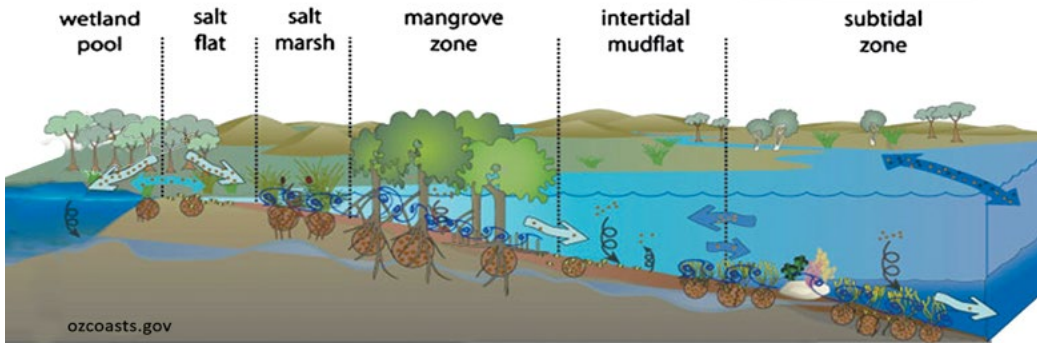
Fisheries (*providing food and nutrients for marine organisms*)



Biofiltration (root systems trap sediment)



Sediment Trapping and Stabilisation

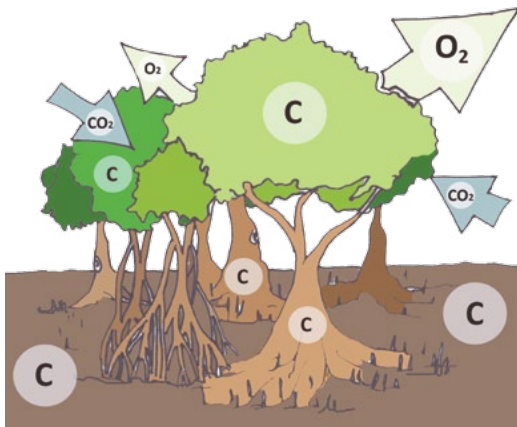


Habitat to wildlife (breeding, nursing, and feeding ground of various animals)



Carbon sequestration

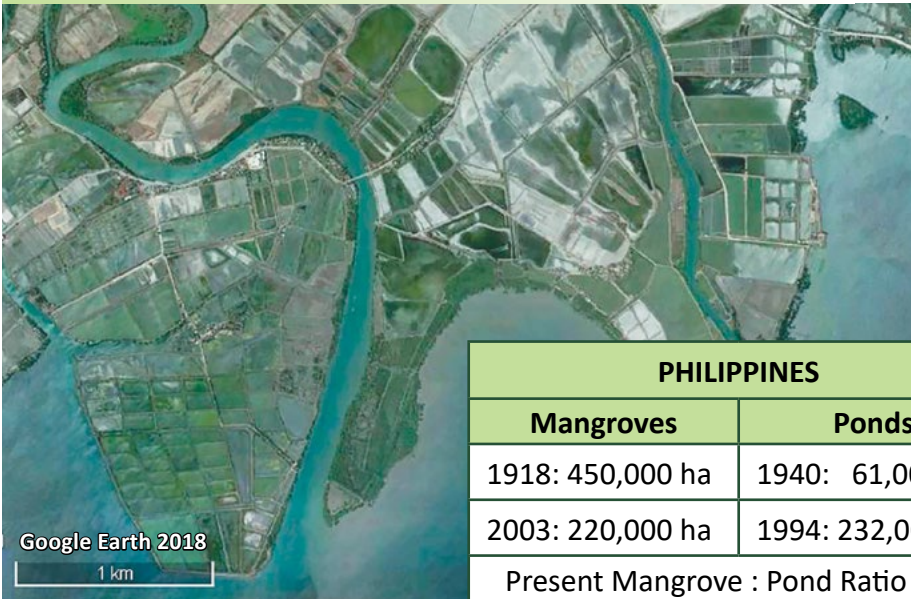
(removes carbon dioxide from the atmosphere and acts as carbon storage)



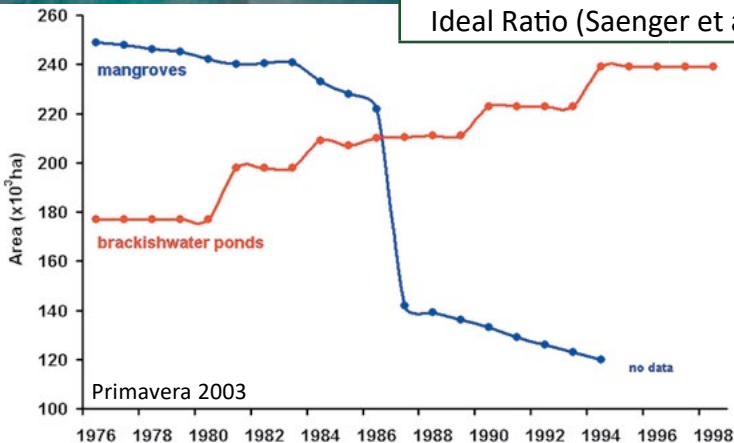
What are the threats to mangroves?

Mangroves are constantly threatened by both anthropogenic and natural factors. Anthropogenic factors pose greater threat to mangroves and conversion into aquaculture fishponds is the major cause of mangrove loss.

Aquaculture ponds



PHILIPPINES	
Mangroves	Ponds
1918: 450,000 ha	1940: 61,000 ha
2003: 220,000 ha	1994: 232,000 ha
Present Mangrove : Pond Ratio - 1:1 Ideal Ratio (Saenger et al. 1983) - 4:1	



Agriculture



Salt beds



Harbors and ports



Reclamation



Oil spills



Cutting for timber & fuel

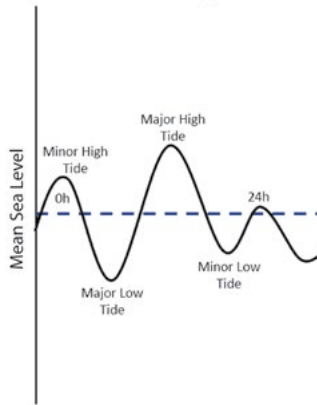


Tides and planting sites

The Philippines mainly has semi-diurnal tides, with two tidal cycles - minor and major cycles - over a 24-hr period

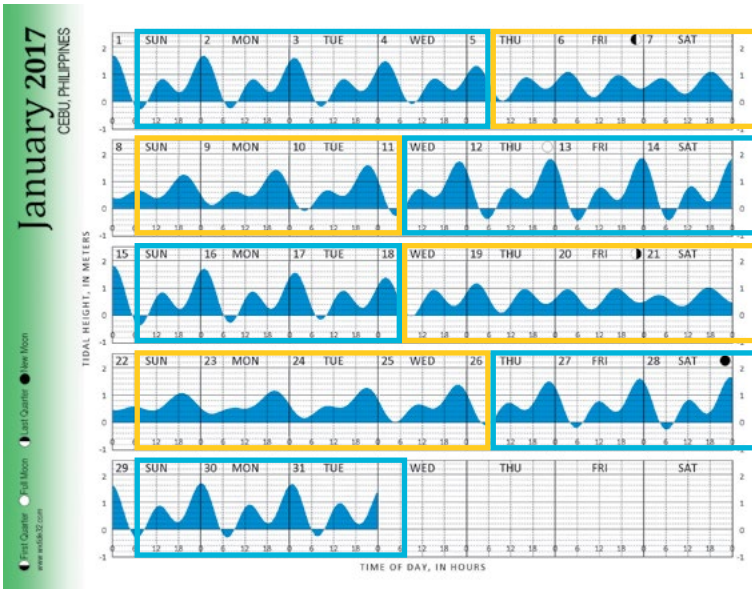
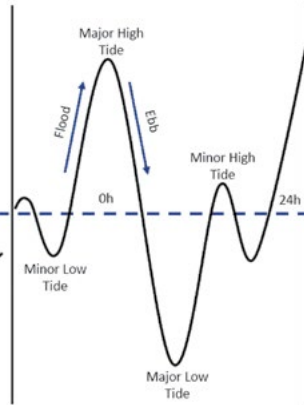
NEAP TIDE

occurs during the First Quarter and Last Quarter of the lunar cycle, characterized by a lower tidal range.

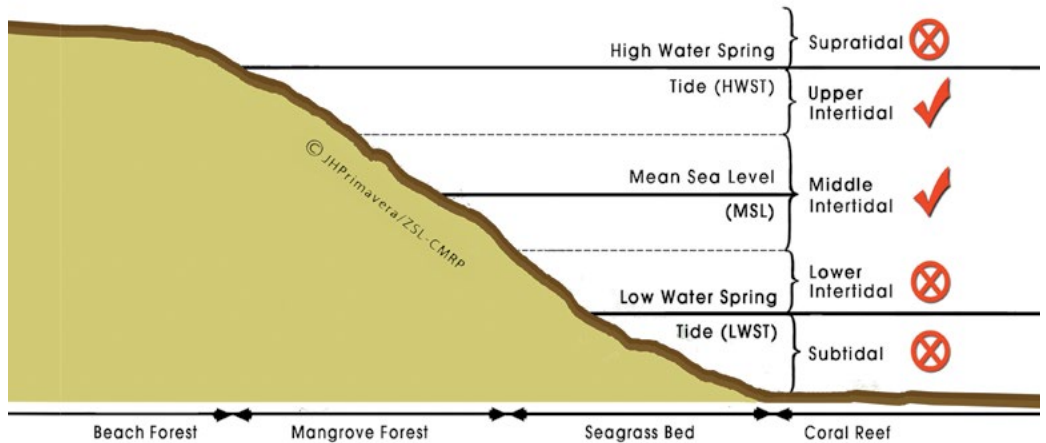


SPRING TIDE

occurs during the New Moon and Full Moon of the lunar cycle, characterized by a higher tidal range.



SPRING and **NEAP** tides occur alternately twice every month, simultaneous with the lunar cycle.



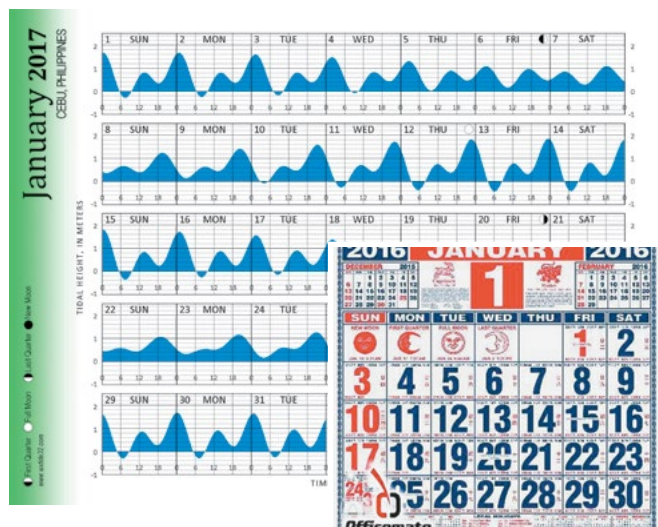
Mangrove planting sites should be exposed during **NEAP TIDE**. These are the upper to middle intertidal areas and remain above seawater 70% of the time, a prerequisite for mangrove survival. Biophysical and socio-economic considerations are listed in the site selection checklist for mangrove rehabilitation.

BIOPHYSICAL	✓ YES	✗ NO
a) Nursery		
flooded during spring tide (upper intertidal)		
protected from wave action		
substrate firm		
substrate flat		
well-drained location		
presence of trees for shade		
<i>first 5 criteria should be YES</i>		
b) Outplanting: seafront and outer abandoned pond		
exposed during neap tide (low tide)		
protected from wave action		
substrate firm (foot does not sink above ankle)		
remaining mangroves		
<i>first 3 criteria should be YES</i>		
c) Outplanting: inner abandoned pond		
not waterlogged		
substrate firm (foot does not sink above ankle)		

SOCIO-ECONOMIC	✓ YES	✗ NO
a) Socio: Local Government Unit		
open minded		
collaborative		
easy to work with		
willing to provide		
willing to have staff their trained		
shares common vision with the project		
<i>5/6 criteria should be YES</i>		
b) Socio: People's Organization (PO)		
present on site		
registered		
with constitution and by-laws (CBL)		
with structure		
complete set of officers		
c) Socio: no PO present		
community willing to organize PO		
d) Socio: Buy-in of Partners (e.g., BFAR, DENR, schools)		
willing to provide technical/other support and guidance		

Preparation for field activities

1 Consult a tidal calendar or commercial calendars (with tide levels) to select suitable date and time.



2 Wear appropriate clothes, rubber shoes/booties.



3 Prepare logistics and materials.

Transportation, drinking water, snacks, first aid kit, bagging and planting materials



Bagging activity

shovel, digging blade, trowel
seedling polybags
wildings - 8 x 12" (20 x 30.5 cm)
seeds - 4 x 6" (10 x 15 cm)

Planting activity

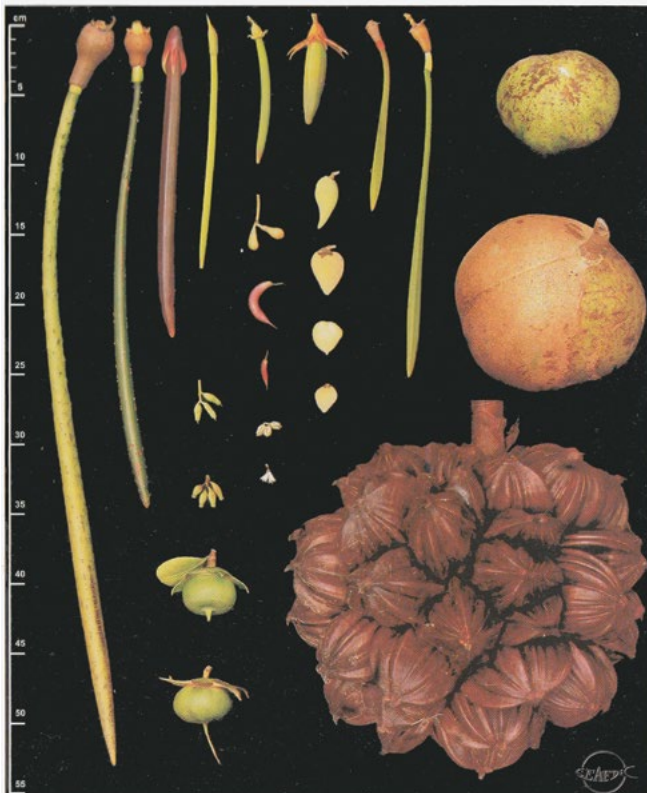
seedlings (nursery or wildings)
seedling carriers
shovel, digging blade, trowel
meter stick
bamboo stakes (1 m long)
pre-cut strings (20 cm long)



MANGROVE NURSERY TECHNIQUES

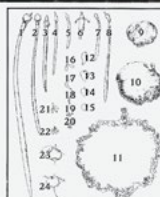
Why establish a nursery?

- Nursery-reared plants are sturdier
- Small seeds are not suitable for direct planting
- Seafront survival: higher for nursery-reared seedlings (vs. propagules)



FRUITS OF SOME MANGROVE SPECIES

- | | |
|----------------------------------|--|
| 1. <i>Rhizophora mucronata</i> | 13. <i>Avicennia officialis</i> |
| 2. <i>Rhizophora apiculata</i> | 14. <i>Avicennia rumphiana</i> |
| 3. <i>Bruguiera gymnorrhiza</i> | 15. <i>Avicennia marina</i> |
| 4. <i>Bruguiera parviflora</i> | 16. <i>Camptostemon philippinensis</i> |
| 5. <i>Bruguiera cylindrica</i> | 17. <i>Aegiceras corniculatum</i> |
| 6. <i>Bruguiera sexangula</i> | 18. <i>Aegiceras floridum</i> |
| 7. <i>Ceriops decandra</i> | 19. <i>Scyphiphora hydrophyllacea</i> |
| 8. <i>Ceriops tagal</i> | 20. <i>Osbornia octodonta</i> |
| 9. <i>Xylocarpus moluccensis</i> | 21. <i>Lumnitzera racemosa</i> |
| 10. <i>Xylocarpus granatum</i> | 22. <i>Lumnitzera littorea</i> |
| 11. <i>Nypa fruticans</i> | 23. <i>Sonneratia alba</i> |
| 12. <i>Avicennia alba</i> | 24. <i>Sonneratia caseolaris</i> |



Nursery site selection

Natural tidal flow/inundation during spring tide



Flat, firm substrate, well-drained



Protected from waves



Proximity to planting site



Under the shade of mangrove/ other trees



Preferably close to seed/propagule source



Bagging of mangrove wildings

1 Briefing/Orientation

- Ratio of 1 instructor/facilitator: 15-20 participants
- Divide into seed/wilding collectors, baggers, haulers



Arrive at least 1 hour before the targetted low tide level.

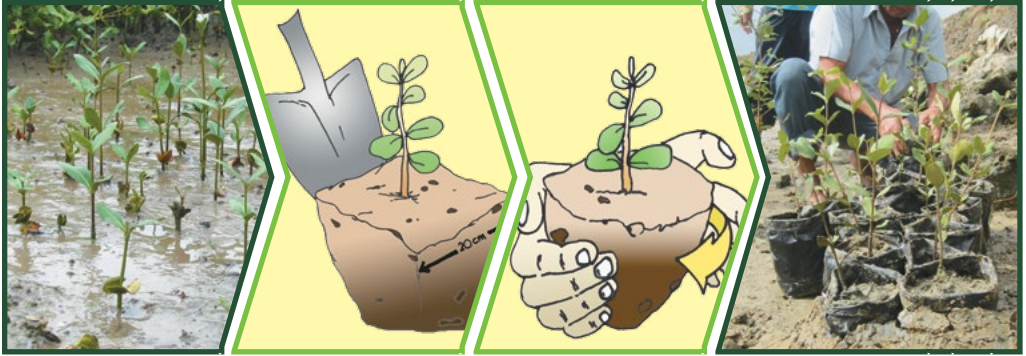
2 Look for “seedling banks”

- Sea strand/swash zone
- Under mother trees
- Dikes of abandoned fishponds



3 Collect wildings

- Plants not more than 40 cm high
- With at least 6 leaves for *Avicennia* spp.
- Use shovel or digging blade
- Soil should still be attached to the roots



4 Conditioning in the nursery

- Smaller wildings (10-20 cm)
= 3-12 months until they reach 30 cm and stems are hardened
- Bigger wildings (20-30 cm)
= may be transplanted directly



small wildings = nursery conditioning



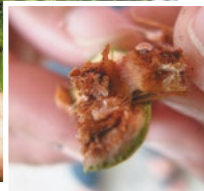
big wildings = direct planting

Collection and bagging of seeds and propagules

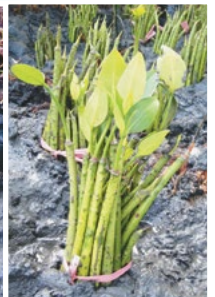
Collection during the peak of fruiting season.



Check the color and texture for maturity.
Exclude fruits with damage.



Check viability of *Rhizophora* propagules in mud.



Propagules should not be transported between islands.



This will avoid possible transfer of disease and potential negative impacts on the local gene pool.

Store in shady, cool and dry place and plant within 1 week to 1 month depending on species.

Sow and germinate seeds. Water and protect from pests.



Nursery maintenance

Visit nursery at least 2-3 times weekly.



Remove diseased plants and bury them.



Pest: *Coccotrypes fallax*
Remedy: sun-dry or air-dry for 1-2 weeks prior to planting in polybags

Place plastic sheet lining so roots do not penetrate the ground below seedling bags.



If seedlings are stunted due to small bags or roots emerge from the plastic bags, transfer to bigger bags.



MANGROVE OUTPLANTING

Site selection

BIOPHYSICAL	✓ YES	✗ NO
Outplanting: seafront and outer abandoned pond		
exposed during neap tide (low tide)		
protected from wave action		
substrate firm (foot does not sink above ankle)		
remaining mangroves		
<i>first 3 criteria should be YES</i>		
Outplanting: inner abandoned pond		
not waterlogged		
substrate firm (foot does not sink above ankle)		

Site selection for seafront planting

- 1 Go to potential seafront site during **NEAP TIDE**.
- 2 Delineate and mark boundaries of suitable areas.
- 3 Designate navigational lanes for areas with fishing boats.
- 4 Note remarkable features such as creeks and waterlogged areas where seedlings may drown.

Site selection is critical for seafront planting because area available is mostly lower intertidal, in contrast to abandoned ponds.



Mangrove outplanting strategy

WHAT to plant

Select species naturally found in the area.

Common mangrove colonizers typically found in fringing mangrove stands are *Avicennia marina*, *Sonneratia alba* and *Rhizophora* species. The latter are found behind the frontliners *A. marina* and *S. alba*.

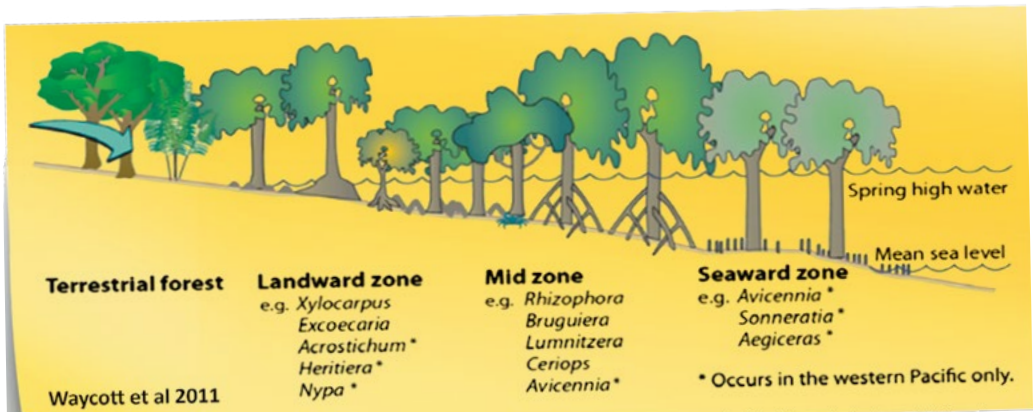
Mangrove species zonation is influenced by factors such as salinity, elevation and substrate type.



Avicennia marina



Sonneratia alba



Bigger wildings may be directly planted.

Nearby wildings may also be directly planted in abandoned ponds and for enrichment planting of inner seafront sites protected from wave action.



Rhizophora apiculata

Planting materials can be sourced from nurseries.

Seedling sizes for planting will depend on location and substrate. Seafront/outer abandoned ponds/muddy portions of ponds - bigger sizes at least 50 cm to 1-1.5 m high; inner abandoned ponds - smaller sizes at least 30 cm high.



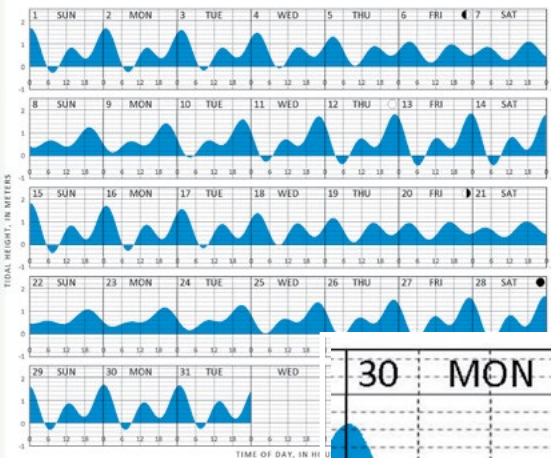
WHEN to plant

Season

Season with least wave action. Strong wind and wave action can uproot (left) or bury (right) planted seedlings under the sediment.

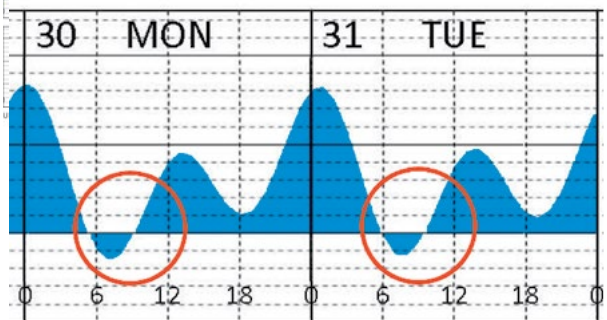


January 2017
CEBU, PHILIPPINES



Tide

Consult tidal calendar for daytime low tide



Time

Early morning or late afternoon

HOW to plant

Density

Seafront/outer abandoned ponds

- Closer distance/higher density
- 0.5 m x 0.5 m to 1 m x 1 m



Inner abandoned ponds

- Wider distance/lower density
- 1.5 m x 1.5 m to 2 m x 2 m

Strip planting

- Planting of 2-5 rows closest to the mangrove area
- Additional rows further away when seedlings grow bigger

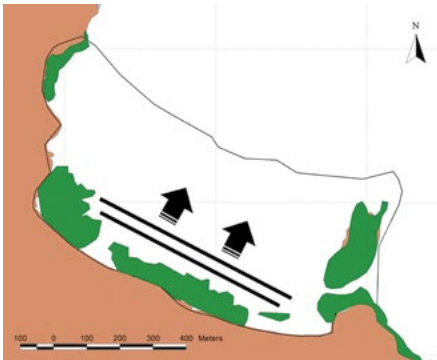
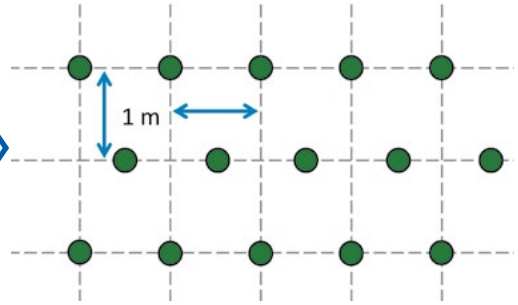


Cluster planting

- 2-3 seedlings planted per hole
- Can also be done during bagging

Pattern

zigzag pattern of individual plants



rows planted from **landward** to **seaward** (*pa-abante*)

Steps in mangrove outplanting

1 Briefing/Orientation

- Ratio of 1 instructor/facilitator: 15-20 participants
- Divide into groups for hauling, making lines, digging holes, distributing seedlings



2 Make parallel lines as guides

- Seafront - 0.5 m to 1 m
- Abandoned ponds - 1.5 m to 2m
- Enrichment planting - vacant spaces $\geq 2 \text{ m}^2$



3 Mark with bamboo stakes on points for holes



4 Dig holes at marked points

- ~30 cm deep by ~20 cm wide



5 Haul nursery seedlings or wildings to planting site



6 Place seedling inside hole

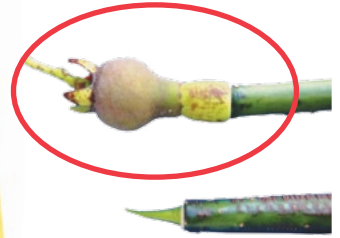
- Keep the soil intact and do not damage the roots
- The top of the plant soil should be level as the ground



7 Fill in remaining space with soil



- **bagged seedlings** - tear polybag on side & slowly remove plant
- **wildings** - keep all attached soil by earthballing
- **propagules** - remove caps & bury 1/3 of the propagule length



8 Secure stakes 3-5 cm from the plant



9 Tie plant to the stake using pre-cut string



Secure the string to the stake first and make a loose loop (to avoid breakage) around the mid-stem of the plant

10 Collect discarded polybags and other garbage

- Do not leave trash on site



MONITORING

Fixed-point quadrat method

- Preferred way of monitoring mangrove survival and growth
- Advantage with large scale rehabilitation projects

- Monitor 10-20% of mangrove plantation
- Several 100 m² plots
- Permanent mark on corners
- No replacement planting inside plot

1 Count total number of plants within the 100 m² quadrat on the day of planting (this is baseline data)



2 Return to the site noting the date and count all surviving plants



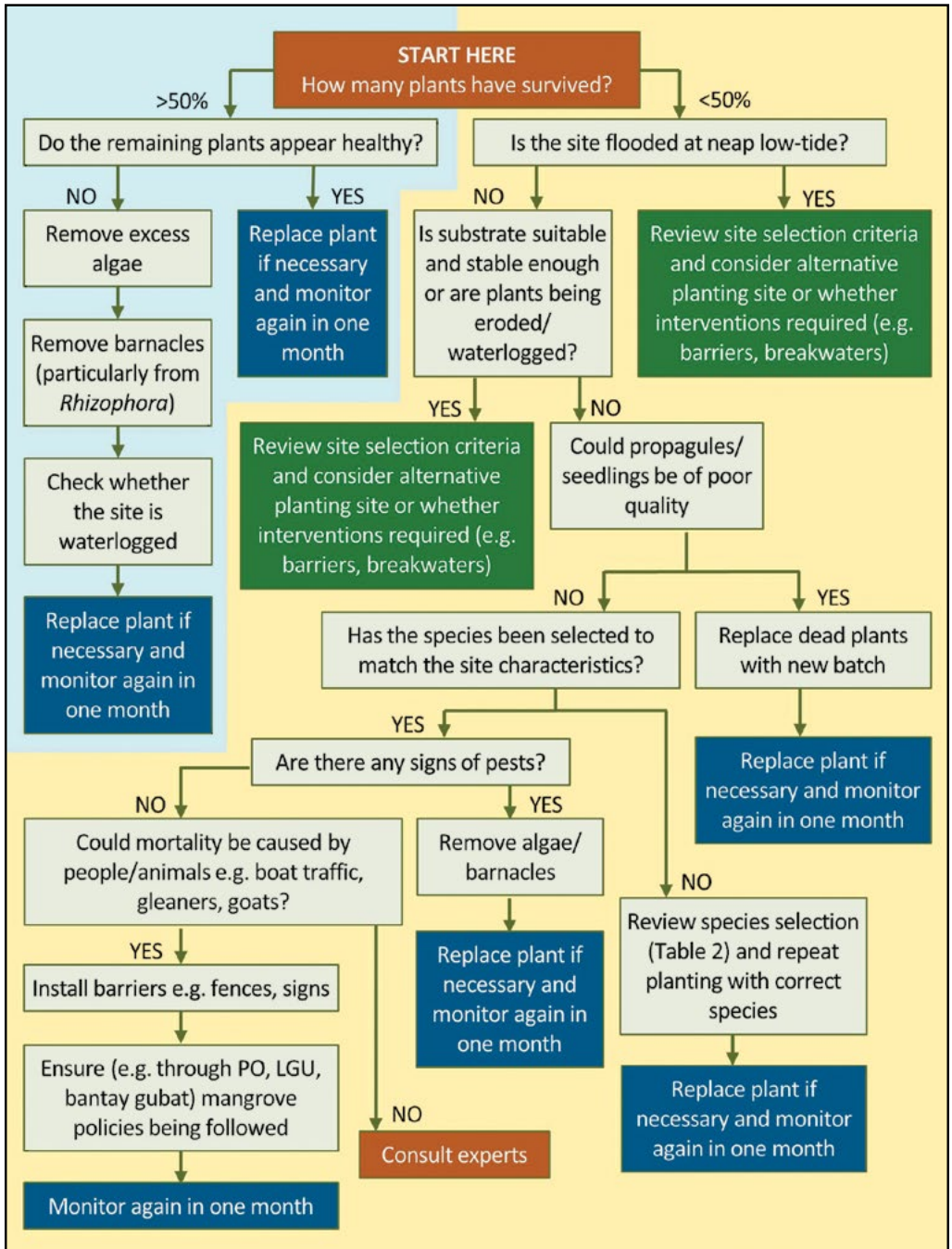
3 Compute survival rate (%)

$$\text{Survival rate (\%)} = \frac{\text{No. of survivors}}{\text{Initial no.}} \times 100$$

Frequency of monitoring

Month 1-3 : monthly
Month 4-12 : quarterly
Month 12-48 : biannual
>48 months : annual

Community decision tree



PROTECTION AND MAINTENANCE

Physical threats

Wave action

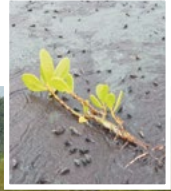
- Encountered in seafront areas or seaward portion of abandoned ponds without dikes
- Can topple down or burry newly planted seedlings

Erosion

- Caused by wave action
- Common in seafront areas or seaward portion of abandoned ponds

Solution

- Install barriers or breakwater



Burial of seedlings

- Caused by sedimentation
- Can cover leaves of small seedlings, leading to plant death

Solution

- Plant taller seedlings (>50 cm)
- Transfer planting site, if burial by sediment continues



Biological threats

Insect infestation

- Mangrove moth larvae (*Aucha velans*) feed on *bungalon/piapi* leaves



- Scolytid beetle (*Coccotrypes fallax*) infests *Rhizophora* seedlings and propagules

Solution

Avoid monoculture plantations particularly in seafront areas

- Constant monitoring of planted and nursed seedlings
- Remove seedlings that show signs of infestation
- Remove dying and dead seedlings and dispose by burying or burning

Oysters and Barnacles

- Adhesive cement of barnacles may affect growth negatively
- Weighs down plant and may cause breakage
- *Rhizophora* spp. (bakhaw) more prone to barnacle infestation than *S. alba* (pagatpat) or *A. marina* (bungalon/piapi)



Solution

Manual removal from plants

- Use of long-nose pliers and thick gloves
- Plant pagatpat seedlings in areas prone to barnacle infestation



Filamentous algae infestation

- Frequent in areas near fishponds
- Peaks during summer
- Chokes and weighs down seedlings causing breakage, specifically in *A. marina* (not *S. alba*)



Solution

Manual removal of algae from seedlings using scissors

- Easier if algae still wet and/or floating
- Dispose of collected algae on higher ground or bury deep in the ground to prevent being washed back to the planting site
- Plant *S. alba* (pagatpat)

Man-made threats

Fishing gears, boat traffic, gleaners, domestic animals, large debris

- Physically damage plants
- Can cause breakage, uprooting, defoliation of plants



Solution

- Install floating markers and signage around the planting area
- Bamboo poles with packaging straps to serve as fence visible at high tide
- Hire caretakers for areas with no organized community
- Regular visits to plantation to remove debris

INVOLVING COMMUNITIES IN MANGROVE REHABILITATION

Site selection

SOCIO-ECONOMIC	✓ YES	✗ NO
Socio: LGU buy-in and commitment (interviews)		
Open mined		
Collaborative		
Easy to work with		
Willing to provide counterpart funds		
Willing to have their staff trained		
Shares a common vision with the project		
<i>5/6 criteria should be YES</i>		
Socio: People's Organization (PO)		
PO present onsite		
Registered		
With constitution and by-laws (CBL)		
With structure (officers and committees)		
Complete set of officers		
Socio: if no PO		
Community shows willingness to organize		
Socio: Buy-in of partners (BFAR, DENR, academe)		
Willing to provide technical/other support and guidance		



Organizing communities

Defined as the process by which the community identifies its needs and objectives, develops confidence to take action, and in doing so extends and develops cooperative and collaborative attitudes and practices

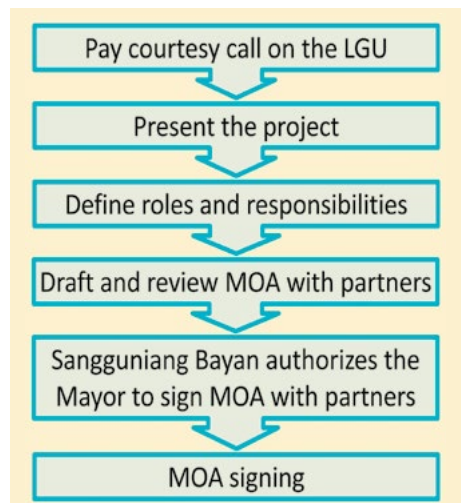
Process

1 Forge agreements with partners (Year 1)

Partners must develop and sign legal agreement in the form of a Memorandum of Agreement (MOA)

2 Get to know the community (Year 1)

Community organizer is immersed in the site to familiarize and identify potential leaders using a set of criteria



Training of Local Research Assistants to establish the situation for the area using participatory methods

3 Form and re-build People's Organization (Year 1)

Formation in areas without POs or conduct of Organizational Diagnosis in areas with existing POs



4 Build capacity of PO (Year 2-4)

Actions taken to improve effectiveness and enhance ability to achieve mission

Approaches

- Conduct of trainings and seminars



- Mobilize and engage communities
- Implement alternative livelihoods project using mangroves as the base resource to augment existing income



5 Secure tenure and sustain community initiatives

Mangroves need long-term management and through sustaining mangroves that communities benefit from its ecosystem services



Approaches

- Assist PO in applying for tenure such as Community-based Forest Management Agreement (CBFMA)
- Mainstream mangrove agenda with the LGU
- Maintain partnership and linkage with LGUs and schools
- Promote no-pay planting
- Formulate PO strategic plan

Mangrove rehabilitation plan

A mangrove rehabilitation plan is a sequence of steps to achieve the goal of restoring mangroves to good condition, operation, or capacity. It explains in detail what needs to be done, when, how and by whom.

Why do we need a plan?

- To serve as guide in the day-to-day activities
- To ensure that the targets are achieved in a given time frame
- To ensure that resources are adequate and they are maximized
- To distribute tasks among members

- To estimate the number of seedlings needed taking into consideration spacing and species appropriate for planting
- To serve as basis for evaluation and decision-making

Parts of the plan

1 Name of the project

2 Objectives

SMART (simple, measurable, attainable, realistic, and time-bound)

3 Brief description of the area

Basic demographics, location of sites, current mangrove status, presence or absence of communities, possible involved parties

4 Defined area/ location of planting site

Map area showing the mangroves, where to establish nurseries, outplanting areas, areas for protection

5 Seedling requirement

6 Materials needed

7 Set of activities

8 Schedule and Budget of Activities

Activities	Timeframe	Responsible person	Budget
Project preliminaries			
Site assessment			
Nursery establishment			
Outplanting			
Monitoring and maintenance			

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“The potential of coastal mangrove greenbelts to mitigate sea level rise and increasing storm frequency and intensity caused by climate change cannot be over-emphasized. Rehabilitate mangroves we must, but let us follow science-based guidelines.”

Jurgenne H. Primavera, March 2010

