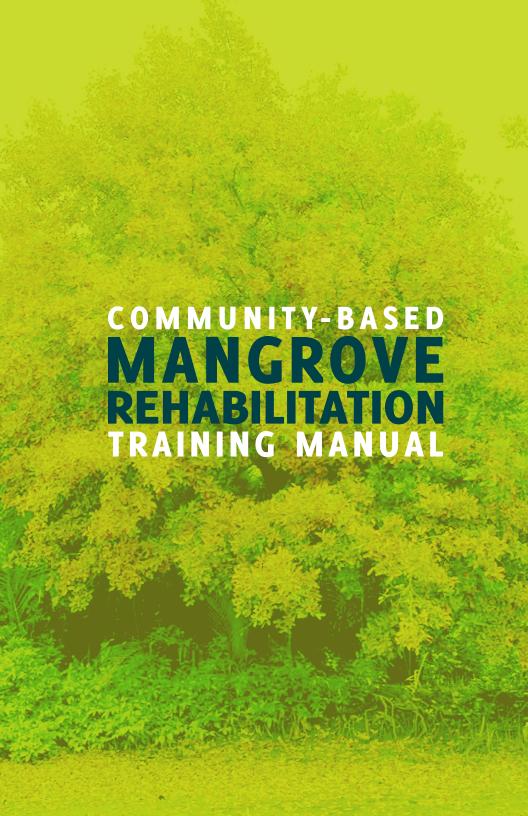
# COMMUNITY-BASED MANGROVE REHABILITATION TRAINING MANUAL













#### **PREFACE**

Awareness of mangrove importance, particularly for coastal protection, has grown among the general public over the past several years. In turn this has led to numerous planting initiatives by national government agencies, local government units and communities, nongovernment organizations, schools, and especially the corporate sector. However, most of these programs did not yield positive results mainly due to lack of science-guided protocols.

To address this gap, the Philippine Tropical Forest Conservation Foundation, Inc. (PTFCF) has produced this Manual for dissemination to groups that do mangrove rehabilitation. It is excerpted from the Manual for Community-based Mangrove Rehabilitation (Primavera et al., 2012), a documentation of the experience of Zoological Society of London-Philippines in mangrove nurseries and outplanting. Positive feedback from early users of the 2012 volume highlights the need for reproduction and wider dissemination of its guidelines. To facilitate this process, the section on Community Organizing, itself a critical component of mangrove management and rehabilitation, has not been included. It could form a second volume.

Annexed to this training manual is the Guide on Mangrove Damage and Recovery Assessment. Following the onslaught of Super Typhoon Yolanda (international name: Haiyan), we recognized the need to develop a tool that can be used by civil society organizations, including the academe and people's organizations; and local government units in order to determine the effects of natural calamities in mangrove and beach forest ecosystems. Doing so provides a concrete basis for developing area- and needs-specific plans for coastal forest and community rehabilitation. Although still a work in progress, the current version is already being used by communities affected by Super Typhoon Yolanda particularly in the provinces of Leyte, Samar, Iloilo and Capiz. We continue to seek feedback on how we can further enhance the tools and processes.

This training manual is for all those who continue to work to rehabilitate their forests and communities.



### THE **20** GOLDEN RULES OF MANGROVE REHABILITATION

- Assisted regeneration of mangroves through active planting of seedlings and wildings is required in areas of extensive historic deforestation with highly dependent communities vulnerable to typhoons with low food security.
- 2. Target rehabilitation areas should be in an intertidal location exposed during neap low tide (instead of spring low tide, the current practice), and reached by seawater during neap high tide. The middle and upper intertidal zones are therefore the most favorable.
- 3. Small, backyard nurseries enable communities to produce sufficient numbers of healthy mangrove seedlings such as Avicennia marina, for planting.
- 4. Wildings make an excellent source of plants for rehabilitation, but should be harvested sustainably so as not to affect natural recruitment.
- 5. Seafront planting is more successful using adapted seafront species, particularly Sonneratia alba, and by using taller, nursery-reared saplings of at least 0.5-1 m height.
- 6. Rhizophora (bakhaw) propagules generally do not grow well in seafront zones and therefore cannot be relied upon for mangrove rehabilitation in greenbelts.
- **7. Fixed quadrat monitoring** is the simplest, most efficient and robust form of monitoring for large scale rehabilitation initiatives.
- 8. A ratio of 4 hectares mangroves: 1 hectare pond area should be maintained or achieved by active fishponds for ecological sustainability.
- **9. Inner abandoned fishponds** more easily revert to mangrove forests than exposed seafronts, but they have more complex tenurial issues.
- **10. Protective structures**, including breakwaters and barriers, may be required in highly eroded areas with strong wave action to protect young mangrove plants.
- 11. Fences and signage can help protect young mangrove plants from boat traffic, fishing and gleaning activities, and domestic and wild animals.

- **12. Local government and community support** is required from the outset for successful implementation of community-based mangrove rehabilitation projects.
- 13. Partnerships with local governments, schools and technical support and specialist groups enhance the scale and scope of mangrove rehabilitation.
- **14. Engagement, mobilization and training empower** local communities in mangrove rehabilitation projects.
- **15. 'No Pay' Planting** should be promoted, where communities appreciate and recognize the importance of their mangrove resources to their livelihoods and their contribution of labor is the basis for ownership.
- **16. Counterpart funding** should be mobilized from communities, local governments and partner organizations, to maximize resources and underpin the collaborative approach to rehabilitation projects.
- 17. Tenurial instruments, such as the CBFMA, can be used to sustain community initiatives in the long term.
- **18. Livelihoods** should only be established if they are economically, ecologically and culturally sustainable.
- 19. Restoration of protective and productive greenbelts should be seen as means of securing better livelihoods for coastal communities through increased resilience against natural disasters and higher fisheries productivity.
- **20. Mangrove ecoparks** protect mangroves, provide a means of income and pride to local communities, and are a powerful educational and awareness raising tool.

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#### INTRODUCTION

Mangroves are intertidal shrubs and trees found in the tropics and subtropics. They grow at or above mean sea level or MSL (Fig. 1) which is tidally inundated not more than 30% of the time (Kjerfve, 1990). That is, the middle to upper intertidal zone, and not the lower levels with mudflats and sometimes seagrass beds. This means that the currently popular practice of planting more in the latter habitats and the lower intertidal zone is ecologically misguided.

#### A. Mangrove Zonation and Species Selection

Globally, there are some 50-60 species of mangroves belonging to 16 families, more than 50 of them in the Indo-Pacific and ~35 species in the Philippines alone (Table 1; Primavera et al, 2004). Mangrove species distribution is influenced by tidal elevation and flooding regime, salinity pattern, substrate and other factors. Species may be distributed both vertically according to low, mid, and high tidal level, and horizontally from downstream, intermediate and upstream (Fig. 2).

- ► Low elevation species are Avicennia marina, A. alba and Sonneratia alba coastally and Rhizophora mucronata, Sonneratia caseolaris, Xylocarpus granatum and Nypa fruticans in intermediate to upstream brackishwater areas.
- ► High elevation species are Bruguiera gymnorrhiza and Lumnitzera racemosa in coastal, high salinity areas and A. officinalis, B. cylindrica, Ceriops tagal and Heritiera littoralis in estuarine sites.
- ► Environmental factors of hydrology, salinity, substrate, rainfall and freshwater supply also affect mangrove growth.

Therefore species selection for any mangrove restoration project will depend primarily on the species match for the physical characteristics of a given site (Table 2), and secondarily on the objectives for rehabilitation.

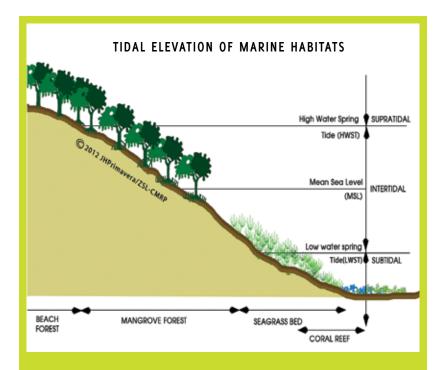
Fringing mangroves in the Philippines and the rest of Southeast Asia are naturally lined by a band of A. marina and/or S. alba frontliners with Rhizophora stylosa and R. apiculata immediately behind. Not many other species are able to withstand the extreme conditions of exposure and wave action. A wider species diversity can be found in the middle to landward sections of mangrove forests with a range of substrates,

salinities and tidal variation, and where biodiversity concerns can be addressed.

TABLE 1. Mangrove species and families in the Philippines

FAMILY	SPECIES
Acanthaceae	<ol> <li>Acanthus ebracteatus</li> <li>A. ilicifolius</li> <li>A. volubilis</li> </ol>
Avicenniaceae	<ul><li>4. Avicennia alba</li><li>5. A. officinalis</li><li>6. A. marina</li><li>7. A. rumphiana</li></ul>
Bombacaceae	8. Camptostemon philippinensis
Combretaceae	9. Lumnitzera littorea 10. L. racemosa 11. L. roseaª
Euphorbiaceae	12. Excoecaria agallocha
Lythraceae	13. Pemphis acidula
Meliaceae	14. Xylocarpus granatum 15. X. moluccensis
Myrsinaceae	16. Aegiceras corniculatum 17. A. floridum
Myrtaceae	18. Osbornia octodonta
Palmae	19. Nypa fruticans
Rhizophoraceae	20. Bruguiera cylindrica 21. B. gymnorhiza 22. B. parviflora 23. B. sexangula 24. Ceriops decandra 25. C. tagal 26. Kandelia candel 27. Rhizophora apiculata 28. R. lamarckii <sup>a</sup> 29. R. mucronata 30. R. stylosa
Rubiaceae	31. Scyphiphora hydrophyllacea
Sonneratiaceae	32. Sonneratia alba 33. S. caseolaris 34. S. gulngai <sup>a</sup> 35. S. ovata

Sources: Brown & Fisher; 1920, Arroyo, 1979; Fernando & Pancho, 1980, Tomlinson; 1986, Spalding et. al., 1997; Yao, 1990. Ahybrids



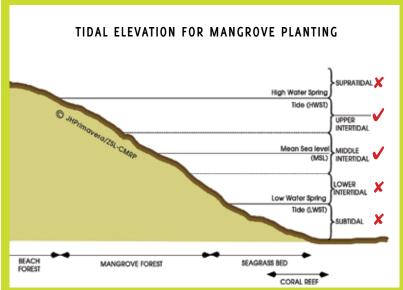


FIG. 1. Location of mangroves in relation to other coastal habitats, and tidal elevation suitable (✓) for planting (mid- to upper intertidal). Lower intertidal and subtidal sites (✗) experience high mortality.

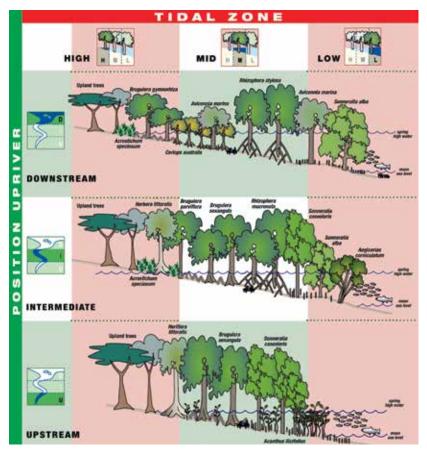


FIG. 2. Tidal zone (high, mid and low) and estuarine zone (up-, mid- and down-stream) location of mangroves (Duke, 2006).

TABLE 2. Site characteristics of common mangrove species with local names.

	Intertidal zone (position)ª	Estuarine position <sup>a</sup>	Salinity	Substrate	Remarks
<b>Avicennia marina</b> (bungalon/apiapi)	Lower	Downstream	Wide range	Varied	Front liner
Avicennia alba (bungalon/apiapi)	Lower	Mid-to downstream	Full salinity	Sandy-muddy	Front liner
Sonneratia alba (pagatpat)	Lower	Downstream	Full salinity	Sandy-muddy	Front liner
Rhizophora stylosa (bakhaw bato)	Lower	Downstream	Full salinity	Sandy	Behind A. marina-S. alba zone, other sheltered sites
<b>Rhizophora apiculata</b> (bakhaw lalaki)	Lower	Downstream	Full to brackish	Sandy-muddy	Behind A. marina – S. alba zone, along riverbanks, other sheltered sites, e.g., lagoons
Rhizophora mucronata (bakhaw babae)	Lower to middle	Mid-to downstream	Brackish	Muddy	Along tidal creeks and rivers
Bruguiera cylindrica	Middle to upper	Midstream	Brackish	Muddy	Often found along tidal creeks
Ceriops decandra	Middle	Midstream	Brackish	Muddy	Colonizer, invades grassland
A. rumphiana	Middle	Midstream to upstream	Brackish	Muddy	Often landward
A. officinalis	Middle	Midstream to upstream	Brackish	Muddy	Often landward
Xylocarpus granatum, X. moluccensis	Middle to upper	Midstream	Brackish	Muddy	Dioecious, leaves turn brown, orange, red then fall
Heritiera littoralis	Upper	Midstream to upstream	Brackish to fresh	Muddy-clay	Landward, rarely near the sea

 $^a$  refer to Fig. 2

#### B. Mangrove Functions and Valuation

TABLE 3. Valuation of mangrove services

VALUE OF MANGROVE	ECOSYSTEM SERVICES
	Examples of value (US\$)
Raw materials and food	484 - 585/ha/yr
Coastal protection	8,966 - 10,821/ha
Erosion control	3,879/ha/yr
Maintenance of fisheries	708 - 987/ha
Carbon sequestration	30 - 50/ha/yr
Water purification Tourism, recreation, education, and research	No estimates available

Source: Barbier EB, Hacker SD, Kennedy C, Loch EW, Stier AC, Siliman BR. 2011. The value of estuarine and coastal ecosystem services. Ecol. Mono. 81 (2): 169 - 193

Mangrove systems have contributed significantly to the well-being of coastal communities through a wide array of ecosystem services (Fig. 3) which have been classified into regulating, provisioning, cultural and supporting. The total value of such services ranges from US\$14,000 to \$16,000/ha with the biggest contribution from coastal protection (Table 3).

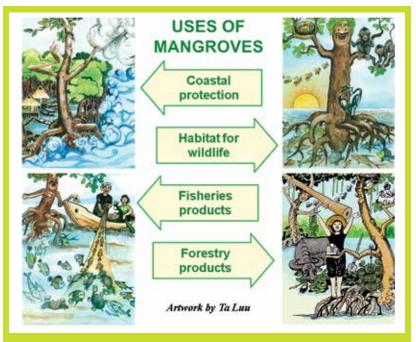
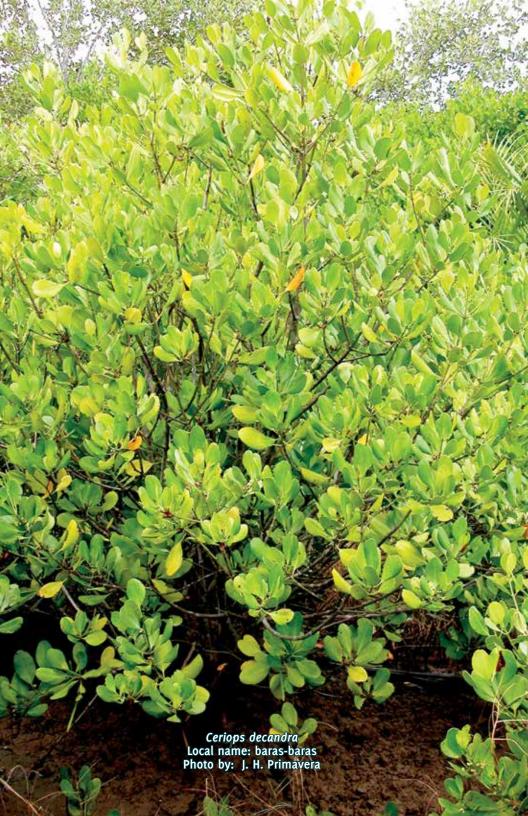


FIG. 3. The importance of mangroves is beautifully illustrated by Vietnamese artist Ta Luu.





## BIOPHYSICAL AND SOCIOECONOMIC CONSIDERATIONS

#### A. Biophysical

- 1) The Philippines has semidiurnal tides, meaning it has 2 tidal cycles over a 24-h period each with a Major and Minor Tide (Box 1, Fig. 4) with maximum tidal range of ~2 m. Areas exposed during neap tide will remain above water even during spring tide, a prerequisite for mangrove survival, as mangroves cannot stand flooding more than 30% of the time. Neap tide selection is a major paradigm shift from the past protocol of selecting exposed sites during spring tide which turn out to be flooded when the neap tides follow, resulting in mortality of seedlings.
- 2) The above guidelines have been simplified into a short checklist of criteria for selection of outplanting sites in Box 2, which also gives criteria for nurseries and evaluation questions for LGU buy-in and PO commitment.
- 3) Any natural or artificial beach structures that may affect tidal flow should be considered. For example, a concrete seawall in Balaring, Ivisan, Capiz caused a backwash of incoming waves affecting planted mangrove seedlings and resulting in high mortality.

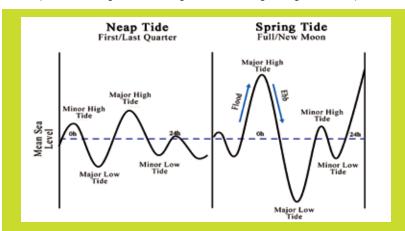


FIG. 4. The Philippines has semidiurnal tides – with a major and minor tide – over a 24-hour cycle. Tidal fluctuation is greater (max. 2.2 m) during spring tides during the New or Full Moon, as compared to neap tides during First or Last Quarter.

#### BOX 1. All about tides

In a single tidal cycle, the sea level rises on the flood tide and falls on the ebb tide. There is no flow in the period between flood and ebb, called slack, when the lowest point (low tide) and the highest point (high tide) of sea level are attained. The Philippines has mainly semidiurnal, or two – major and minor – tides in a day. (Other places have diurnal tides, or a single tidal cycle over a 24-h period.) Tidal elevation depends on the lunar phase such that spring tides (when tidal range, or difference between high and low tide, is greatest) occur during the New Moon and Full Moon, and neap tides (range least) during First Quarter and Last Quarter. Spring and neap tides occur around every two weeks.

#### B. Socio-economic-political

- 7) Buy-in and commitment of Local Government Units (LGUs) the LGU, having jurisdiction over mangrove management including conservation as well as implementation of community-based projects, must be open-minded, collaborative, easy to work with, willing to provide counterpart funds, open to having their staff trained, and share a common vision with the project.
- 2) Presence of POs as major stakeholders of community-based projects, POs provide the formal structure for decision-making and sustainability. In sites with no POs, the community must be able and willing to form one.
- 3) Access to technical support or specialist groups such as the Department of Environment and Natural Resources (DENR), Bureau of Fisheries and Aquatic Resources (BFAR) and academic institutions. Such groups can converge and discuss common problems and develop appropriate strategies to facilitate pond cancellation and reversion to mangroves, recommend project sites, and intervene in major concerns.

BOX 2. Criteria for mangrove rehabilitation sites – biophysical (nursery and outplanting of seafront, abandoned ponds) and socioeconomic (LGU, PO and partners) – as applied to Lipata, Carlos P. Garcia, Bohol (2012).

Biophysical	YES	NO
Nursery		
Flooded during spring tide (upper intertidal)	<b>/</b>	
Protected from wave action	<b>/</b>	
Substrate firm	<b>/</b>	
Substrate flat	<b>/</b>	
Well-drained location	<b>/</b>	
Presence of trees for shade	<b>/</b>	
Outplanting: seafront		
Exposed during neap tide (low tide)		
Protected from wave action		·
Substrate firm (foot does not sink above the ankle)	<b>/</b>	
Remaining mangroves	<b>/</b>	
First 3 criteria should be YES		
Outplanting: outer abandoned pond		
Exposed during neap tide (low tide)		
Protected from wave action		
Substrate firm (foot does not sink above the ankle)		
Remaining mangroves		•
First 3 criteria should be YES	, , , , , , , , , , , , , , , , , , ,	
<u> </u>		
Unitrianting: Inner anangoneg nong		
Outplanting: inner abandoned pond  No waterlogged		
No waterlogged Substrate firm (foot does not sink above the ankle)	<b>/</b>	
No waterlogged	<b>'</b>	
No waterlogged	<b>*</b>	
No waterlogged Substrate firm (foot does not sink above the ankle)	YES	NO
No waterlogged	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES  Socio: POs	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES  Socio: POs PO present on site	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES  Socio: POs PO present on site Registered	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES  Socio: POs PO present on site Registered With constitution and by-laws (CBL) With structure	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES  Socio: POs PO present on site Registered With constitution and by-laws (CBL) With structure Complete set of officers	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES  Socio: POs PO present on site Registered With constitution and by-laws (CBL) With structure Complete set of officers  Socio: If no POs	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES  Socio: POs PO present on site Registered With constitution and by-laws (CBL) With structure Complete set of officers  Socio: If no POs Community express willingness to organize	YES	NO
No waterlogged Substrate firm (foot does not sink above the ankle)  Socio-economic  Open minded Collaborative Easy to work with Willing to provide counterpart funds Willing to have their staff trained Shares a common vision with the project 5/6 criteria should be YES  Socio: POs PO present on site Registered With constitution and by-laws (CBL) With structure Complete set of officers  Socio: If no POs	YES	NO



#### **NURSERY**

Nurseries can provide mangrove seedlings of the required species in the required numbers and sizes at a given time. Otherwise, planting will be highly dependent on the availability of propagules, seeds or wildings. Nurseries are essential for large-scale reforestation – they meet the need for seedlings of different heights, e.g., taller plants for sites with deeper water or faster sedimentation. Additionally, nurseries provide temporary storage for excess seeds and propagules produced in the fruiting season which otherwise would be lost (Fig. 5).

Small seeds are not suitable for direct planting as they are easily washed away by currents; they need a nursery phase.

Survival along the seafront is higher for nursery-raised seedlings (vs propagules) because their woody stems and developed roots and bigger sizes can better withstand barnacle infestation and wave action. In contrast, these biophysical stressors are absent from the inner portions of abandoned ponds, so the latter can be directly planted with propagules.



FIG. 5. Avicennia marina seedling banks a, c) created by dense pneumatophores that slow down tidal flow and trap propagules; b, d) fewer wildings can withstand wave action along the beach strand.



FIG. 6. Small-scale CMRP nurseries (shaded by mature trees) are readily accessible because of their backyard location, as in Ajuy, Iloilo

#### A. Site Selection

In selecting a nursery site, the following factors should be considered:

- 1) Natural tidal flow/inundation during spring tide to minimize labor for watering plants.
- 2) Protection from waves during extreme storm events nurseries set up during the non-typhoon season may be destroyed when storms come.
- 3) Relatively flat, with firm substrate and well-drained (not waterlogged).
- 4) Under the shade of mangrove/other trees but should avoid insects (e.g., larvae from talisay leaves falling on mangrove seedlings).
- 5) **Proximity to the planting site** (for backyard nurseries, to reduce transport costs).
- 6) Preferably close to a freshwater supply.
- 7) Preferably close to seed/propagule sources.

#### B. Preparation for Field Collection

#### Prior to the fieldwork

 Consult commercial calendars (with tide levels coded in red or blue color) or a tidal calendar (Fig. 7) to select a suitable date and time.

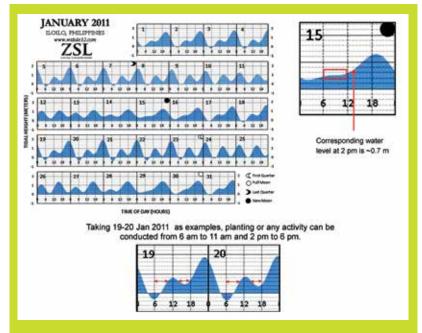


FIG. 7. A tidal calendar that shows the time and height of tides for Iloilo station in January 2011.

 Collectors (volunteers/P0 members) should prepare the following: appropriate clothes (longsleeved shirts, hats), rubber shoes/booties (Fig. 8).



**FIG. 8.** Requirements for mangrove planting activity: cap, long-sleeved shirt, long pants and booties/thick socks for footwear, and digging blades.

#### 3) Prepare logistics and materials

- ➤ transportation, snacks, certificates for volunteers
- ➤ seedling polybags
  - 8 x 12" (20 x 30.5 cm) for wildings
  - 4 x 6" (10 x 15 cm) for seeds
- shovels or digging blades (tagad)

#### • On the day of field work:

- 4) Give a brief orientation to the volunteers about nurseries, e.g. their importance, site requirements, and divide them into groups of seed/wilding collectors, baggers and haulers.
- 5) For better supervision, a ratio of one supervisor or facilitator (ZSL/project staff): 15-20 participants is recommended (Fig. 9). More than this will mean some volunteers may be unsupervised and apply wrong practices, e.g., throwing – instead of carefully carrying – the bagged seedlings, thereby causing higher mortality.



FIG. 9. Mangrove outplanting: a) briefing volunteers, b) marking rows of 1-1.5 m distance for staking and making holes, c-f) removing seedling from polybag, placing inside hole, levelling soil surface, and tying seedling to stake.

#### C. Collection and Bagging of Wildings

Wildings (also spelled wildlings) are often observed near mother trees, retained by mangrove roots (seedling bank), and dikes of abandoned ponds, or caught on the beach strand (Fig. 10). The latter are short-lived because of wave exposure, in contrast to those trapped by roots or along the dikes of ponds, which remain undisturbed and grow to one meter or more.

- 1) Collect wildings not more than 40 cm, preferably 10-30 cm tall (with at least 6 leaves).
- 2) Use a shovel or digging blade (Fig. 8) to carefully remove the plant with soil still attached to the roots to ensure they are surrounded by a ball of earth (Fig. 11).
- 3) Wildings removed from a sandy substrate may show higher mortality compared to more compact mud because sand particles tend to fall, exposing the root hairs to air.
  - Smaller wildings (10-20 cm long) need to be conditioned in the nursery (3-4 mo up to 1 yr) until they reach a minimum of 30 cm and the stems are sufficiently hardened.
  - Bigger wildings (20-30 cm long) may be transplanted directly to the rehabilitation site after removal, provided that enough soil remains with the roots to prevent dehydration and damage.



FIG. 10. Seeds and wildings of different mangrove species

#### D. Collection and Planting of Seeds/Propagules

- Collection should be done during peak of the fruiting season (Table 4), usually in June-August after the April-May flowering. Newly fallen fruits may also be collected from the ground, provided they have no insect and other damage.
- 2) When collecting fruits, check the color and texture for maturity, e.g., dark green-reddish hypocotyls of *Rhizophora* and cracked skin of *Sonneratia* and *Xylocarpus* fruits (Table 4). Exclude fruits with insect damage, e.g., the pinhead sized holes of beetle larvae, disease and malformed shapes.
- 3) When purchasing Rhizophora propagules in the hundreds or more, it is advisable to give only 30-50% down payment, and first check for viability by planting the propagules in mud. Propagules that grow roots are viable and the balance can be paid.
- 4) To avoid potential negative impacts on the local gene pool or possible transfer of diseases and pests, propagules should not be transported between islands.
- 5) Seeds and propagules can be stored in a shady, cool and dry place and should be planted within 1 week to 1 month, depending on the species, e.g., 10-20 days for A. marina and A. corniculatum and one month for Rhizophora, during which they remain viable.



FIG. 11. Wildings are earthballed (carefully removed with soil) to prevent root damage, then transferred to polybag.

**TABLE 4.** Mangrove propagules/seed collection time (Panay Is.) and maturity indicators.

SPECIES	SEEDS or Propagules	INDICATORS OF MATURITY <sup>2</sup>	COLLECTION TIME <sup>b</sup>
Avicennia spp. (api-api)	Propagules	Seed coat changes from green to light yellow; seed coat becomes wrinkly and oftentimes opens	May/June-Sep
A. marina (bungalon)	Propagules	Seed coat changes from green to light yellow; seed coat becomes wrinkly and oftentimes opens	May-Sep
Bruguiera spp. (busain)	Propagules	No ring-like mark; green propagules turns brownish/bronze and drops without the pericarp or cap	Year round
Bruguiera spp. (pototan lalake)	Propagules	Tip of hypocotyl changes from green to brown	Year round
Ceriops tagal (tangal)	Propagules	Presence of ring-like mark (abscission layer) below pericarp or cap (up to 1 cm wide)	Year round
Rhizophora apiculata (bakawan lalake)	Propagules	Presence of ring-like mark (abscission layer) below pericarp or cap (up to 1 cm wide)	Year round
R. mucronata (bakawan babae)	Propagules	Presence of ring-like mark (abscission layer) below pericarp or cap (up to 1 cm wide)	Year round

SPECIES	SEEDS or Propagules	INDICATORS OF MATURITY <sup>2</sup>	COLLECTION TIME <sup>b</sup>
R. stylosa (bakawan bato)	Propagules	Presence of ring-like mark (abscission layer) below pericarp or cap (up to 1 cm wide)	Year round
S. alba (pagatpat)	Seeds	Fruits turn shiny or yellowish and soft	Year round
X. granatum (tabigi)	Seeds	Fruits change from light brown to dark brown	April, August

<sup>&</sup>lt;sup>a</sup> from Field, 1996. <sup>b</sup> from Primavera et al., 2004

- 6) After seed collection, the seeds are sowed and germinated, maintained through watering, fertilization and pest protection, and hardened prior to transport and outplanting.
  - Larger seeds of Avicennia may be germinated directly in individual containers.
  - Very small seeds of Sonneratia are best germinated on a seedbed prior to transfer to separate bags.
  - Large propagules of *Rhizophora*, *Bruguiera* and other *Rhizophoraceae* may be planted directly in individual polybags commensurate to their size.
- 7) Steps in fruit collection, seed germination, bagging of seedlings and outplanting are described in Box 3.

#### BOX 3. Protocols for growing pagatpat Sonneratia alba.

Avicennia marina and Sonneratia alba are the two major colonizers of fringing coastlines but wildings are much rarer in nature for the latter, and nursery techniques relatively undeveloped (perhaps related to their small, non-viviparous seeds) compared to the first. The following protocols for pagatpat rehabilitation jointly developed by the P.O. Kapunungan sa Gagmay'ng Mangingisda sa Concepcion and the Philippine Tropical Forest Conservation Foundation or PTFCF (Buduan and Ballon, 2012) will greatly contribute to mangrove rehabilitation in the country and in Southeast Asia.

Collected ripe fruits are macerated to release the seeds which are then soaked in water to separate viable seeds (they sink) from nonviable floaters. These seeds are sown on a thin layer of mud lined below with canvas, germinate after 3-5 days, are removed and broadcast on a suitable substrate, e.g., abandoned ponds, at ~50 seedlings/sq m. After 4 mo, the seedlings are mudballed (removed with intact root system held in place by mud) for transplanting nearby or for transport to other rehabilitation sites.

#### E. Maintenance

7) After wildings are bagged and seeds germinated, the nursery needs to be visited at least 2-3 times weekly to check that the plants remain upright (Fig. 12) and are healthy, and to ensure regular watering (by the tide, etc.), and protection from pests and stray animals.



FIG. 12. Regular nursery check-up is important to prevent: a) dying Avicennia marina (not reached by tidal water), b) fallen Rhizophora, and c) overgrown Sonneratia alba with roots reaching the ground through the plastic bag (inset).

- 2) Healthy plants have green leaves and are pest-free. Yellowing of leaves in the first month may be due to stress, but if discoloration persists, and leaf wilting and/or powdery material appears on the surface, the plant may be diseased.
  - ➤ Such attacks may be caused by beetle *Coccotrypes* (formerly *Poecilips*) *fallax* larvae which bore into *Rhizophora* propagules (Fig. 13).
  - ➤ To avoid this, propagules are sun-dried or air-dried for 1-2 weeks prior to planting in polybags to reduce moisture content, harden the covering and discourage egg-laying by beetles.



FIG. 13. Pests of Rhizophora propagules include the boring isopod Sphaeroma terebrans (Culajao, Roxas City plantation), and beetle Coccotrypes fallax larvae (Basyaw Cove, Nueva Valencia, Guimaras nursery).

- 3) Remove diseased plants and bury them.
- 4) If nursery rearing is longer than 6 months, polybags should be separated from the bottom of the nursery with a plastic sheet lining (e.g., recycled plastics, tarpaulins: to prevent roots from reaching the ground: Fig. 12). Otherwise, the roots could be damaged during transfer for outplanting.
- 5) If seedlings are stunted due to small bags, transfer to bigger bags without damaging the roots.

#### F. Seedling Selection and Transport

- 1) Regularly segregate seedlings by species and size for easy transport and hauling of required sizes for planting and/or sale.
- 2) Transport may be needed if planting site is far, although it is best to plant wildings onsite. Prepare crates or modified seedling carriers, e.g., sack material attached to bamboo poles.
- 3) Buyers from commercial nurseries are responsible for the transportation of mangrove seedlings.





#### OUTPLANTING

#### A. Physical Interventions

Mangroves have very specific hydrological and substrate requirements. Correct elevation is marked by surviving trees in background. Potential rehabilitation sites may therefore require interventions to optimize future mangrove growth and survival. In some cases, local hydrology will have changed so dramatically that even areas that historically were mangrove forests cannot automatically be assumed to be suitable for rehabilitation. Where intensive ponds have been excavated (to maximize depth for intensive pond culture), substrate levels will need to be restored, along with the natural hydrology, to allow survival and growth of natural or planted mangrove recruits.

ZSL used the following approaches based on a philosophy of sourcing local materials that are relatively low cost and techniques that could be implemented by the POs working with LGU engineers (where necessary). Collaboration with academia helped provide technical input on the type and location, with local knowledge giving important guidance on the water and weather conditions that might influence the effectiveness of such interventions. These interventions are:

- 7) Barriers (Fig. 14) made of bamboo, rocks and other locally available materials. Barriers are placed in front of the plantation to reduce the energy of oncoming waves giving some protection while young seedlings become established; of secondary benefit is the increase in sediment elevation behind the structure.
- 2) Breakwater to mitigate shoreline erosion which had removed more than 1 meter of sediment at some points along the Pedada, Ajuy coastline, two breakwaters were designed measuring 0.9 m high by 1 2 m wide by 70 m and 110 m long made of locally sourced rocks with a break to allow for boat traffic (Fig. 15). They were constructed in 2010 after some preliminary planting trials demonstrated that the extensive erosion and high wave action in the area meant that no other alternative was possible to reestablish the site as viable for mangrove reforestation. Since the installation of the barrier, the substrate level has increased by 10 50 cm. An accreting band behind the breakwater 9 m wide has stabilized 2 years after construction, and now supports the growth of both planted and wild recruits.



FIG. 14. Barriers made of a, b, c) rocks in Ermita, Dumangas, Iloilo (2007-2008), and d) bamboo support mangrove growth by reducing wave energy and trapping sediment.



FIG. 15. Two lengths of breakwater, 0.9 m high by 1-2 m wide by 70 m and 110 m long, have consolidated sediment and provided both substrate and protection to planted and natural mangrove recruits in Pedada, Ajuy, Iloilo.

3) Restored tidal and freshwater flows – dikes were built to hold water required for growing fish and shrimp in ponds. The flows of both tidal and freshwater creeks that have been subsequently altered need to be restored (by breaking the dikes at strategic points) to allow mangrove growth.

#### B. Site Selection

Site selection is critical for seafront planting because the area available for mangroves along the beach is mostly lower intertidal. In contrast, abandoned ponds are generally suitable for mangrove reversion, as they are located in former mangrove areas in the middle to upper intertidal, provided that pond excavation has been minimal (e.g., extensive culture ponds).

- n) During neap tide, go to the potential seafront site, delineate and mark with stakes the boundaries of the suitable area (exposed during neap tide, and/or aligned with the edge of the pneumatophores or the peat layer, if present).
- 2) Use a Global Positioning System (GPS), if available, to take readings. Otherwise, note the points followed in the area, based on permanent local landmarks or features.
  - ➤ Areas with many fishing boats should allow for designated navigational lanes (5-10 m wide) to facilitate traffic.
  - Fencing the planting area can help reduce boat damage and clearly identify the area to community members.
- 3) For seafront sites, note remarkable features such as creeks, waterlogged portions which may drown the seedlings, and in the case of ponds, dikes, gates and other structures which may affect water flow.
- 4) For abandoned ponds, draw a map of the area including mangrove trees and wildings, topography (mounds, excavations, waterlogged parts, dikes, gates), hydrology (seawater/freshwater channels, tidal levels) and other features. Any level portion may be planted excluding waterlogged areas and high dikes.

## C. Planting Strategy

#### 1) What

Select species of mangroves naturally found in the area. Nearby wildings may also be directly planted in abandoned ponds, and

for enrichment planting of inner seafront sites protected from wave action. Planting materials can be sourced from nurseries. Mangrove sizes for planting will depend on location and substrate:

- ➤ bigger sizes (minimum 50 cm to 1-1.5 m for A. marina, S. alba, R. apiculata, R. mucronata, R. stylosa) for seafront planting, also very muddy portions of ponds.
- ➤ smaller sizes (minimum 30 cm A. marina, S. alba to 40-60 cm R. apiculata, R. mucronata, R. stylosa) inner abandoned ponds (no wave action).

#### 2) When

Schedule planting during the season of least wave action, e.g., northwest monsoon or *amihan* for southern Panay, and southwest monsoon or *habagat* for northern Panay. Consult a tidal calendar (Fig. 7) for daytime low tides. Because of the relatively lower elevation, seafront planting will require spring water low tides, while inner abandoned ponds can be planted during either spring or neap low tides.



FIG. 16. Mangroves may be sourced from a) nurseries or c) wildings, and planted b) closely spaced together along the seafront, or d) wider apart in inner abandoned ponds.

## 3) How (density and pattern)

- ➤ Inner sites along the seafront and in abandoned ponds with little wave action can be planted at 1.5-2 m intervals.
- ➤ Seaward sites exposed to frequent wave action and debris brought by the incoming tide need to be planted at closer intervals of 0.5-1 m (Fig. 16) and/or in clusters of 2-3 seedlings each.
- ➤ Offset the planting of seedlings in consecutive rows so that the columns appear in zigzag pattern, avoiding uniformly empty rows between rows of plants. For the 1st batch in a given site, do trial planting of a few rows, then observe for the next few months. Plant additional rows only if the seedlings/saplings show good growth and survival.
- ➤ Whether seafront sites or abandoned ponds, plant starting from the beach or landward portion moving in a seaward direction (pa-abante). This is a major change from the past practice of planting from the seaward boundary in a landward direction (pa-atras).
- ➤ Depending on the number of planters, 2-5 rows may be planted on a given day during the 2-4 hr planting window allowed by the tides.

# D. Outplanting Protocols

Fisherfolk and other community members with experience in mangrove planting need minimum supervision. But students, members of civil society and other volunteers need the guidance of more knowledgeable facilitators (at a ratio of 1 facilitator: 15-20 volunteers)

- 1) Before the activity proper, planters/volunteers should be given introductory lectures, including topics on proper field wear, species to be planted and planting methods.
- 2) Wear a hat, long-sleeved shirt, long pants or knee-length short pants, booties or old rubber shoes (for the mud and water), apply sunblock, insect repellent and bring plenty of drinking water.
- 3) Prepare the following materials (in numbers proportional to area/ no. of planters)
  - seedlings (from nursery or wildings for direct planting)
  - shovel, digging blades and trowels
  - meter stick

- nylon rope, with knots tied at predetermined spacing (e.g., 10 or 20 m)
- bamboo stakes, 1 m long
- pre-cut strings/plastic straw, ~20 cm long
- large plastic bags, preferably recycled
- pen/pencil and notebook
- camera
- seedling carriers plastic crates or improvised sacks with sides attached along the length of two bamboo poles
- Global Positioning System (GPS) device, if available
- 4) Plan the travel such that arrival at the planting site is at least 1 hr before the tide becomes low enough so planting can start.
- 5) Divide the planters into smaller groups for the specific tasks of hauling of seedlings, marking the lines, digging holes, etc.
- 6) Planting steps (Fig. 9)
  - Using a meter stick, steel tape or measuring tape, mark parallel rows with distances of 1 m for seafront sites, or 1.5-2 m for abandoned ponds. For enrichment planting of sparse mangrove sites, plant seedlings in open/vacant spaces at least 2 sq m wide.
  - Within the same row, mark out 1, 1.5 or 2 m distances with bamboo stakes. Alternatively, seafront planting may use clusters of 2-3 instead of single seedlings. Plants in consecutive rows should be offset by 0.5-0.75 m to create a zigzag pattern for the columns.
  - Next to the stakes, dig holes ~30 cm (= 1 foot) deep using a trowel, shovel or digging blade (tagad).
  - Haul or transfer the bagged seedlings from the vehicle, or wildings newly collected nearby, to the planting site.
  - For bagged seedlings, remove the plant carefully from the bag to keep the soil attached, then place inside the hole. The top of the plant soil should be the same level as the ground.
  - For Rhizophora propagules, make sure to remove their caps(Fig. 17).
  - For direct planting, place the wilding together with the attached soil inside the hole.
  - Fill in with soil any remaining spaces in the hole.

- For seafronts and on muddy substrates, place a bamboo stake securely beside the plant and tie it just loose enough (to avoid breakage) at mid-stem to the stake for support, e.g., during strong wave action. Where plants are to be monitored and need tagging, attach gina cloth tag.
- Collect discarded polybags and other garbage inside the large (recycled) plastic bags for appropriate disposal when you reach home. Do not leave trash in the planting sites (Fig. 17).



FIG. 17. Planting tips include removing a, b) the caps of Rhizophora propagules, and d) plastic bags, and e, f) collecting them for disposal elsewhere; and c) avoiding highly sedimented sites.

## E. Problems

Planting is only the first step towards restoring mangroves. During the first 1-2 yrs, the plants are vulnerable to various man-made and natural stressors. Therefore monitoring (of growth and survival) and maintenance (by removing algae, other pests) are two major activities in mangrove rehabilitation.

## 1) Physical

Wave action, flooding and burial in the substrate can damage young seedlings. This is a particular problem where inundation and sedimentation rates are high, as in the lower intertidal to subtidal flats. For example, seedlings in Dumangas, Iloilo planted in the lower intertidal zone died within 3 months, mainly from inundation as evidenced by rotting stems.

## 2) Biological

a) Infestation of filamentous algae (Fig. 18) peaks in the summer and disappears with the rains; it is also frequently observed near fishponds which regularly drain effluents (containing excess feeds and fertilizers) to the sea. Heavy growth of filamentous algae (Enteromorpha, Cladophora and Oscillatoria) can choke and break seedlings.



FIG. 18. Regular maintenance by removal of a) fishing nets, and b) algae using scissors, and c) placing inside bags for disposal outside the plantation.

b) Boring isopods identified as Sphaeroma terebrans attacked Rhizophora saplings in Culajao, Roxas City (Fig. 13); the crustaceans showed no apparent negative effects on mature A. marina trees. c) Barnacle infestation varies with mangrove age (declining in older >2 yr-old seedlings) and species. The adhesive cement of barnacles may be deleterious to plant growth and survival. Avicennia and Sonneratia appear to tolerate barnacle infestation better than Rhizophora, perhaps related to their seafront dominance where barnacle incidence is higher and to the flaking bark of S. alba (Fig. 19).

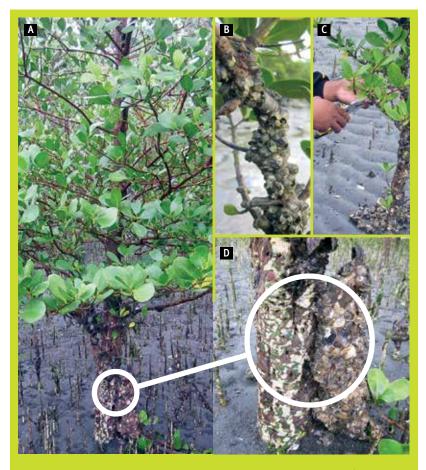


FIG. 19. Barnacles are harmless to Sonneratia alba which a, d) regularly sheds its bark, but need to be removed from b) Avicennia marina c) by means of long-nosed pliers.

d) Oysters may physically weigh down the plants, but do not seem to affect survival of Avicennia and Sonneratia.

#### e) Insects:

- Larvae of the tussock moth *Euproctis* sp. attack *Rhizophora* leaves. Scolytid beetle *Coccotrypes* (*Poecilips*) fallax larvae infest *Rhizophora* seedlings and propagules (Fig. 13); indicators are the presence of holes and/or powdery material (called "frass") on the surface.
- Tide-watching Mangrove Moth *Aucha velans* larvae attack natural *A. marina* stands (but not nearby *Rhizopora* and *Sonneratia* trees), eating leaves and shoots whose branches eventually die; but new buds allow the trees to recover (P. Sage, unpub.).
- Ambrosia beetle *Platypus* sp. adults bore holes through *A. marina* bark, make tunnels where they lay eggs, and cause defoliation.

## Anthropogenic

Fishing gears, boat traffic, and gleaning (for shellfish and crabs) have negative impacts on mangrove plantations. Sites close to populated centers have problems with garbage and debris (fishing nets, plastic bags, etc.), and domestic animals (e.g., pigs, goats, cattle). In plantations near primary forests, wild animals such as boars and monkeys feed on newly planted *Rhizophora*.

### F. Protection and Maintenance

Regular patrolling should be undertaken by the community (or LGU or school group), for seafront plantations. On the other hand, it is best that a caretaker (hired by the LGU or NGO) maintains plantations inside abandoned ponds with no organized communities, particularly while tenurial negotiations are ongoing.

- 1) Planting is recommended in the rainy season to avoid algal blooms during the summer months. Otherwise, algae should be regularly removed using a pair of scissors (Fig. 18). Collected algae should be placed in bags for disposal elsewhere.
- 2) The most effective way to remove barnacles is with long-nosed pliers (Fig. 19) do not use your bare hands as the shells have sharp edges! *Rhizophora* plantations are particularly prone to barnacle infestation, so a proactive solution is to avoid planting bakhaw along the seafront (where they do not belong). Otherwise, avoid monoculture plantations that are vulnerable to pests by interplanting with *A. marina* and/or *S. alba*. Because it regularly

- sheds its bark (Fig. 19), pagatpat S. alba is unaffected by barnacles and oysters.
- 3) Relatively taller seedlings should be planted in seafront sites with high sediment load and in deeper water, so the higher leaves remain exposed and are less prone to gathering sediment and flooding, allowing the plants to survive.
- 4) For protection from wave action, install barriers made of rocks or closely spaced bamboo poles (Fig. 14). Such barriers also help to trap sediment and increase the substrate level, further enhancing plant growth. In places where erosion is a major problem, a breakwater can be constructed.



FIG. 20. Political will is important – for example, the hut (and caretaker) provided by the Leganes, Iloilo municipal government has facilitated cross visits by LGU officials, NGOs and other groups.

- 5) Alternatively, relatively sheltered portions of the plantation with a gentle slope have recruits washed up by the tide. The Balaring, Capiz P.O. NewBAMA installed a bamboo fence in July 2010 to keep out gleaners and other passersby from their plantation. After one year, the protected area has been colonized by ~500 A. marina wildings, now measuring ~1 m high, in an area of 0.5 ha.
- 6) For protection from boat traffic during high tide when plants cannot be seen, NewBAMA installed floating markers made of packaging strap material attached to bamboo poles staked around the perimeter of the plantation.
- 7) If the mangrove site is far from road access, a rest house with toilet facilities and other amenities will provide planters rest from sun and shade. Such is the hut constructed by the Leganes, Iloilo LGU (Fig. 20), which also displays the municipal ordinance that protects the mangroves and other mangrove laws.
- 8) Visit the plantation regularly to repair fences and remove debris (plastics, fish nets), filamentous algae, barnacles and sediment from leaves and stems. Gather algae, debris and trash in old plastic bags and dispose of away from the plantation (Fig. 17). Do not throw these back into the water/planting site. Dead plants should be replaced with nursery-sourced seedlings or wilding transplants, especially in the 1st year.

## G. Monitoring

Often overlooked in mangrove rehabilitation programmes, regular monitoring is fundamental in determining whether objectives of reforestation have been achieved. In many cases, the mere numbers of propagules or seedlings planted are considered indicators of success (especially given the propensity for photo 'ops' meaning opportunities). Yet subsequent investigation demonstrates that very few plants have survived because either the site or species selection has been inappropriate. Allocating time and resources into monitoring (Fig. 21) is a key component of a successful mangrove rehabilitation program.



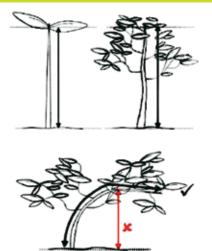


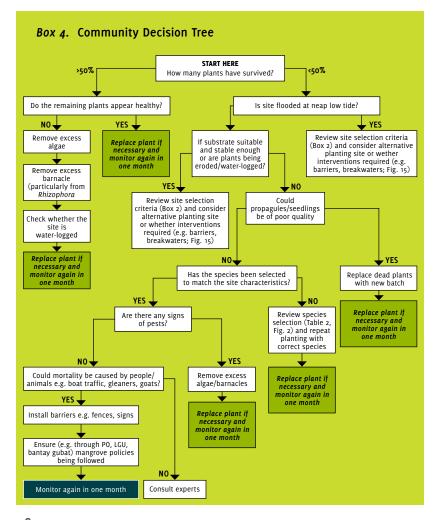
FIG. 21. Plant height is the basic parameter for growth, and is measured from the base to the tip of the stem; plants bent (by algae and other factors) must first be straightened before measuring (bottom, right).

Basic features to be measured and recorded are height and number of leaves (see below).

## MONITORING GROWTH **Species:** Site: Date: Plant No. Height (cm) No. of Leaves No. of Nodes\* Nodal Distance (cm)\* Remarks 1 2 3 4 5 6 7 8 9 10

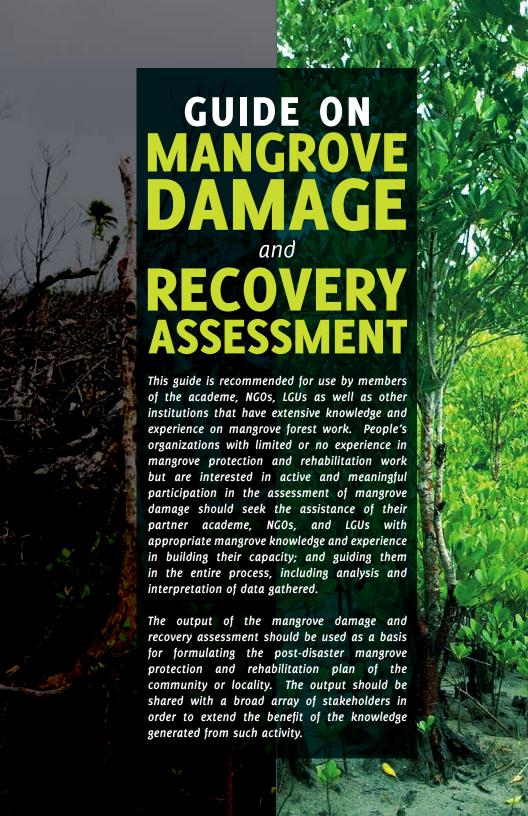
## Community monitoring

The fixed quadrat monitoring approach is within the technical capability and resources of some trained local monitoring teams, though interpretation of results can be challenging. The primary objective of communities involved in mangrove rehabilitation projects is to conduct the most resource effective approaches to start gaining the resource benefits from recovered mangrove forests. In this case, therefore, communities need to focus on monitoring survival, identifying problems early and knowing how to solve them. The CMRP has therefore developed a simple decision tree as a troubleshooting tool which should be translated into the local dialect (Box 4).











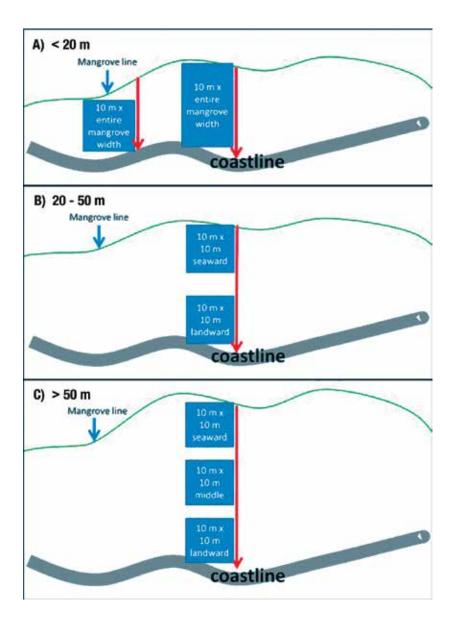
# DAMAGE AND RECOVERY ASSESSMENT

(from Primavera et al., 2014)

- 1. Fringing mangroves (along a coastline) are first to suffer damage when a typhoon makes landfall. In the Philippines, fringing mangroves vary in width from <20 meters to >100 meters.
- Mangrove damage and recovery assessment is best done during low tide (so roots are visible to aid in species identification, seedlings/ saplings also need to be counted). Check local tide calendar to determine appropriate time.
- 3. To survey mangrove damage, sampling plots are marked along a transect line perpendicular to the shoreline (landward margin) stretching to the seaward margin of the mangrove forest. The number of plots will depend on the width of the mangrove band:
  - less than 20 m wide: make 2 plots X m wide (= width of mangrove)
     by 10 m long covering the narrowest and widest areas
  - 20-50 m wide: 2 plots of 10 m x 10 m located seaward and landward
  - more than 50 m wide: 3 plots of 10 m x 10 m located seaward, middle, landward

If the plots are 2 or more, distribute them evenly/equally along the transect. If the length of the fringing mangrove is more than 1 kilometer, 2 sets of plots can be sampled.

- 4. The plot size should preferably be 100 square meters in area (10 m x 10 m or 5 m x 20 m) and enclosed using wood/bamboo stakes and nylon string or straw. Note that the width of the plot is along the width of the mangrove band, and the length is parallel to the coastline.
- 5. The recommended number of persons per plot is:
  - a) 1 person to measure and enclose the plot (and take GPS readings, if available), then mark trees already classified and documented using masking tape.
  - b) 1 person to identify species and classify the damage.
  - c) 1 person to record data on slate board or notebook (maybe same as person b).



- 6. Conduct two assessments: initial at 1st month, and final at 4th 6th month, after the storm event. Classify the recorded plants within the plot as to -
  - **seedlings:** <1 meter height, stem <4 centimeters circumference or pencil size

- saplings: >1 meter height, stem <4 centimeters circumference or pencil size
- *trees:* >1 meter height, stem or trunk >4 cm circumference

Use a meter stick (or premarked stick) for measuring height, and tape measure (or premarked rope) for tree circumference or diameter.

## The assessment must be able to generate the following:

- Mangrove species present (indicate if naturally growing or planted) to determine species composition;
- Number of trees with shoots/new leaves vs. trees still defoliated to determine density (trees per hectare), percentage of damaged and recovering trees;
- Number of seedlings and saplings (live and dead) to determine recovery potential of the mangrove forest;
- Presence of waste materials that shall determine the need for cleaning.

### Damage

- a) **Seedlings and saplings** count no. of dead and alive, total number, and compute percent, and density (no/hectare).
- b) *Trees* classify by species as to the following, count total no. of trees, and compute percent for each:

No Damage - intact, alive

Partial Damage - some broken twigs, partial defoliation

(at 1 - 5 months), assumed alive

Total Damage/Dead – tree uprooted, no leaves at 4 - 6 months Proportion (%) of live vs. dead trees can be estimated only in untouched, non-cleared areas.

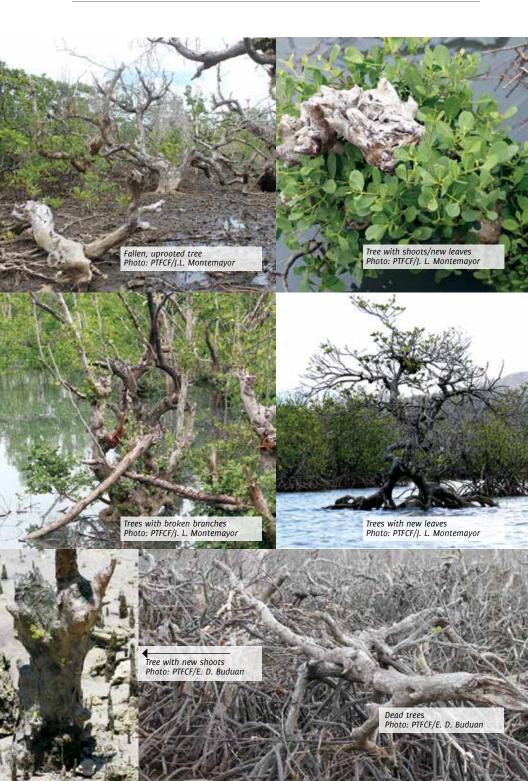
# Recovery

- a) **Trees** After 6 months to 1 year, trees that remain defoliated (no new leaves) can be considered dead.
- b) **Shoots** (young leaves)
  - may appear as late as 4 months after the storm, for pagatpat (Sonneratia alba).

- first appear on topmost branches, for bakhaw (Rhizophora species).
- Seedlings and Saplings (from fruits/propagules released by trees before the storm)
  - Wait up to 4 months for germination period before making final counts of seedlings and saplings.
  - Sites with seedlings below 1,000/hectare may not recover (e.g., plantations in Maliwaliw) and will need replanting (please refer to Community-Based Mangrove Rehabilitation Manual or "CMRP Mangrove Manual No. 1" by Primavera et al, 2012).
  - Those with 1,000-5,000 seedlings/hectare may need enrichment planting (please refer to the CMRP Mangrove Manual No. 1 by Primavera et al, 2012).
  - Those with 5,000-10,000 seedlings/hectare and higher have good chances of recovery.
- 7. Materials and equipment needed:
  - a) Global Positioning System or GPS (optional)
  - b) transect tape or pre-measured rope (40+ m, marked every 10 m)
  - c) meter stick or premeasured/marked stick
  - d) tape measure or premeasured/marked rope
  - e) masking tape
  - f) improvised white slates (PVC board of 20 cm x 30 cm)
  - g) pencils
  - h) camera (optional)
  - i) tablet with camera and/or GPS (alternative to camera and GPS)



Global Positioning System or GPS Handheld Gadget Source: www.garmin.com



# COMMUNITY-LEVEL MANGROVE DAMAGE AND RECOVERY ASSESSMENT

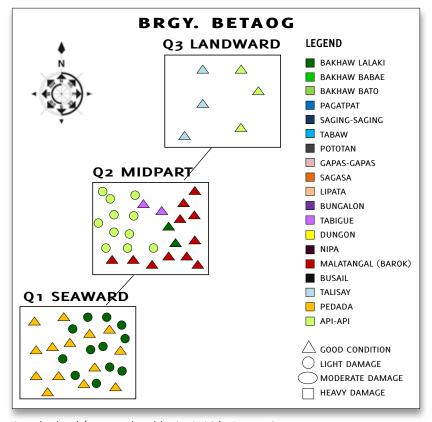
(Montemayor, Buduan, Primavera, et al., 2015)



Communities affected by natural calamities that would like to determine the extent of damage to their mangrove forest may conduct their own "Community-level Mangrove Damage and Recovery Assessment." Notwithstanding, the benefits from the conduct of the rapid assessment can be optimized if the community will work in cooperation with experts and specialists from the academe, NGOs and LGUs. These experts and specialists can aid the community in the analysis of the output of the rapid community assessment as well as provide guidance and support in crafting the community mangrove protection and rehabilitation plan. Other POs with extensive experience in mangrove protection and rehabilitation work (especially those with experience in post-disaster forest and community rehabilitation work) can also be consulted.

7. Draw a sketch of the community or locality (alternatively, secure a copy of the land cover or land-use map or other available appropriate map of the community or locality); depending on the scope and coverage of the initiative, the map/sketch can be at the level of:

- a. Sitio
- b. Barangay
- c. Municipality/City
- d. Multiple (sitios, barangays, municipalities/cities, etc.)



Sample sketch/map produced by SeaSPOC in Eastern Samar.

- 2. Identify (locate and mark) in the sketch/map the following:
  - a. Mangrove forest and beach forest
    - i. Natural growth
    - ii. Plantation
  - Existing mangrove forest protection/conservation areas (pinpoint or mark in the sketch/map and indicate the size in hectares, and indicate the period covered - year it started and up to what year the instrument is in effect).
    - i. Protected Areas
    - ii. CBFM

- iii. Stewardship
- iv. Other forms of forest protection/stewardship
- c. Reforestation/rehabilitation projects/activities in the past 3 to 5 years (pinpoint or mark in the sketch/map and indicate the size in hectares as well as the species planted local or scientific name).
  - i. National Greening Program (NGP)
  - ii. Other projects, please identify as much as you can recall
  - iii. Existing community tree nursery/ies
- d. Location of the community, pinpoint or mark in the sketch/map the location of the following:
  - i. Houses/households
  - ii. Barangay hall
  - iii. Municipal/City Hall
  - iv. Schools (day care, preschool, elementary, high school, college, technical/vocational, others)
  - v. Market and stores
  - vi. Livelihood/economic areas (i.e. fishing area, farm area, etc.)
  - vii. Other important features in the community/locality
- 3. Characterize in the sketch/map the condition of the mangrove forest based on the direct observation of the community members.
  - a. The characterization of the mangrove condition should be done during the following period:
    - i. 1 month after the disaster event
    - ii. 6 months after the disaster event
    - iii. 12 months after the disaster event
  - b. Describe the level of damage based on the following description; and color the area with the appropriate color code.
    - i. No damage (GREEN) all trees intact and visibly alive.
    - ii. Partial damage (ORANGE) some broken branches, trees totally or partially defoliated.
    - iii. Total damage (RED) trees totally uprooted, trunks (Rhizophora sp.) broken.
  - c. Pinpoint or mark the areas where there is solid waste/garbage; mark these areas BROWN.
  - d. Pinpoint or mark the areas where there are seedlings and/or saplings.
    - i. mark the areas with "v"
    - ii. if the community can estimate the number of seedlings and saplings, indicate the count in the sketch/map.



#### 4. Direct observations by the community

- a. Go to an elevated area where the community members can see the top view of the mangrove forest; and take photos (using mobile phones or cameras).
- During high tide, use a boat to directly observe the condition of the mangrove forest; and take photos (preferably using camera with GPS).
- c. If the mangrove area has an existing boardwalk or trail, the community can go through the boardwalk and trail to directly observe the area; and take photos (preferably using camera with GPS).
- d. If there are no existing boardwalks or trails, the community can trek inside the mangrove area during low tide carefully, so as not to disturb or damage the seedlings and saplings.

### 5. Additional information:

- a. Indicate the "north" direction in all maps and sketches
- b. If available, use as base existing maps with complete features, i.e., north arrow, coordinates, information on forest cover, land-use, etc.

After completing the data gathering/direct observation, the community should do community mapping of the extent of mangrove damage.

Use the data and the community mapping and analysis to draw the community's post-disaster forest and community rehabilitation plan. This may include forest protection (from further harm or damage and to allow and facilitate natural regeneration), enhancement planting of appropriate species for mangrove areas that are only partially damaged, and mangrove rehabilitation of fully damaged areas (please refer to the CMRP Mangrove Manual No. 1 by Primavera et al, 2012).

# GUIDELINES FOR CLEANING TYPHOON-AFFECTED MANGROVES

(from Primavera et al., 2014)



- 1. Conduct Mangrove Damage and Recovery Assessment prior to any mangrove cleaning activities.
- 2. Workers must be oriented on the Dos and Don'ts in cleaning mangrove forests before they are fielded.
- 3. Go to the site on a boat during high tide to avoid trampling/stepping on seedlings and saplings or on foot during low tide.
- 4. Be careful not to trample on the seedlings and saplings.
- 5. Remove plastics and other solid wastes clinging to the trees, and other debris and garbage from the area; and sort biodegradable materials from plastics and other non-biodegradables.
- 6. Do not allow burning of collected garbage and debris
- Narrow mangrove bands (<20 meters) sustaining minimal to partial damage with only a few fallen twigs and branches should be left untouched.
- 8. For wider mangroves with significant damage:
  - a. Remove broken branches and cut only twisted, barely hanging branches.

- b. Do not cut fallen trees with roots still connected to the ground.
- c. Do not cut the trunks or branches of seemingly dead trees.
- d. Do not cut bare, defoliated branches that are still connected to the trunk.
- e. Do not cut bare, defoliated trunks that are still standing or fallen trunks with roots still connected to the ground or roots of fallen trees.
- f. Retain/ leave some dead roots, twigs, etc. to provide protection (as tree guards) around regenerating seedlings and saplings, and even to later transplanted seedlings.

In case of *bakhaw* plantations, remove fallen trunks and bigger branches to prevent shellfish mortality from released tannins (ZSL Seminar-Workshop on Sustainable *Imbao* (*Anodontia philippiana*) Fisheries, Bantayan, Cebu, 22 Sept. 2014).

- 9. Branches may be fashioned into artificial reefs and installed in appropriate areas.
- **10.** Suitable-recovered broken and twisted branches may be made into art works and sold.
- 11. Broken mangrove branches maybe brought home for fuel wood
- 12. Collection and bagging of abundant seedlings may be done simultaneously with mangrove cleaning but ensure that there is significant number of seedlings left for regeneration. More so, a nursery must be prepared prior to collection and bagging of seedlings.



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#### PTFCF'S FOREST AND COMMUNITY REHABILITATION PROGRAM

On November 8, 2013, Super Typhoon Yolanda (International name: Haiyan) hit the Philippines. It was the strongest and most destructive typhoon the country has experienced in recent history. It destroyed infrastructure, human habitations and livelihoods. To date, government authorities continue to validate the total death toll.

Super Typhoon Yolanda also left various ecosystems, such as mangrove and beach forests damaged.

In response to calls for support towards ecosystems rehabilitation, the Philippine Tropical Forest Conservation Foundation, Inc. (PTFCF) implemented its Forest and Community Rehabilitation Program. This program aspires to support efforts in the Yolanda-affected provinces of Capiz, Iloilo, Leyte, Eastern Samar and Northern Palawan by providing grants and technical assistance to people's organizations (POs) and non-government organizations (NGOs) for ecosystems assessment, capacity building, actual forest protection and rehabilitation activities, and advocacy campaigns, among others.

It was observed from assessments and field visits after Yolanda that many organizations are taking part in mangrove rehabilitation. The unfortunate truth however, is that some of these projects were against the natural growth and survival of mangroves. This prompted the PTFCF to partner with Zoological Society of London (ZSL)-Philippines and Foundation for Communication Initiatives, Inc. (FOCI) to implement a strategic communications project that aspires to disseminate the right information to the right people through proper knowledge management. Part of this project is this updated and enhanced Community-Based Mangrove Rehabilitation Training Manual.

This training manual is an abridged version of the Manual on Community-based Mangrove Rehabilitation - Mangrove Series No. 1 by Primavera JH, Savaris JP, Bajoyo B, Coching, JD, Curnick DJ, Golbeque RL, Guzman AT, Henderin JQ, Joven RV, Loma RA, Koldewey, HJ (2012). Published by ZSL, it is a documentation of their experience in mangrove nurseries and outplanting.

ZSL would like to acknowledge the support of the following organizations in the development of the content of this manual:













This training manual, together with mangrove field guide and posters, will be distributed in Capiz, Iloilo, Eastern Samar, Leyte, Northern Palawan, and other Yolanda-affected coastal communities; and will be used to help increase awareness of proper mangrove rehabilitation and conservation.





The Philippine Tropical Forest Conservation Foundation, Inc. (PTFCF) was established under two bilateral agreements between the governments of the United States of America and the Republic of the Philippines under the U.S. Tropical Forest Conservation Act (TFCA). PTFCF works towards biologically diverse Philippine forests that are sustainably managed and equitably accessible to responsible stakeholders by working with non-governmental organizations and community groups in forest protection, natural resource management, capacity building, research, livelihood support, coastal forest resource management, as well as sustainable use of diverse animals and plants.

From 2005 to 2014, PTFCF was able to support 383 projects, which effectively improved the management of approximately 1.5 million hectares of forest lands, restored approximately 4,200 hectares of forests through the re-introduction of appropriate native tree species, established over 40 community conserved areas in key biodiversity areas and critical watersheds, instituted over 60 community-level sustainable enterprises that provide additional income to community members, and increased awareness of forest conservation issues particularly the ecosystem services provided by the forests.

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### THE ZOOLOGICAL SOCIETY OF LONDON

The Zoological Society of London (ZSL), a charity founded in 1826, is a world-renowned centre of excellence for conservation science and applied conservation. ZSL's mission is to promote and achieve the worldwide conservation of animals and their habitats. This is realized by carrying out field conservation and research in over 50 countries across the globe and through education and awareness at our two zoos, ZSL London Zoo and ZSL Whipsnade Zoo, inspiring people to take conservation action. We strive to achieve our mission by:

- Conducting world-leading conservation science
- Implementing effective field conservation projects globally
- · Providing decision-makers with the best possible conservation advice, and
- Building conservation capacity and inspiring people to connect with the natural world.