MODULE 1:
Site-Species Matching

A Field Manual on Forest Restoration Using Indigenous Species

energy
DEVELOPMENT CORPORATION

VISAYAS STATE UNIVERSITY

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A simple step-by-step guide in matching a site's condition with the appropriate plant species

A Field Manual On Forest Restoration Using Indigenous Species

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DEPARTMENT OF ENVIRONMENT
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Visayas Avenue, Diliman Quezon City

Foreword

The National Greening Program (NGP) of the Department of Environment and Natural Resources (DENR) is by far the largest reforestation program funded by the Government of the Philippines. With a staggering target of 1.5 billion trees covering 1.5 million hectares for a period of six years from 2011 to 2016, the program aims to reduce poverty, promote food security, environmental stability and biodiversity conservation, and enhance climate change mitigation and adaptation function of our forests.

In its fifth year of implementation, NGP has already planted 916.76 million seedlings in 1.35 million hectares of degraded lands as of the 4th quarter of 2015. This would not be possible without the support of various agencies such as the Energy Development Corporation (EDC). As one of our major partners, we would like to commend EDC for their remarkable contribution to NGP goals through their BINHI program.

This Forest Restoration Manual will be very useful as we implement the remaining years of NGP. In this regard, we would like to thank the College of Forestry and Environmental Science of the Visayas State University (VSU) for sharing their expertise and vast field experience on forest restoration as reflected in this manual.

We would also like to extend our gratitude to EDC for spearheading the production of this Manual. This Manual is not only relevant but also timely in the light of growing initiatives in forest restoration. May this manual equip your farmers and Forest Development Rangers to successfully restore the forests in your project sites.

HON. RAMON J.P. PAJE
Secretary

ENERGY DEVELOPMENT CORPORATION
Ortigas Center, Pasig City

Foreword

Energy Development Corporation (EDC) is the largest producer of geothermal energy in the Philippines with business operations in Bicol, Leyte, Negros Island and Mount Apo. With close to 40 years in the geothermal industry, the company provides clean, indigenous and renewable energy to support the country's growth prospects.

BINHI, our flagship reforestation program, helps sustain our geothermal operations. Six years into this 10-year program, we have managed to exceed our annual target of 1,000 hectares every year. From 2009 to 2015, we have reforested 7,937 hectares using indigenous and native trees. We have rescued 96 of 96 priority species of premium endangered trees in the country. We have also organized 117 farmer associations as partners in the BINHI program who help us protect the watershed areas in our project sites.

To enhance the implementation of the BINHI program and to further improve knowledge management in the field of forest restoration, EDC, in partnership with the DENR's Forest Management Bureau and the Visayas State University, has come up with the "Field Manual on Forest Restoration Using Indigenous Species". The Manual will guide EDC staff and partners in the implementation of forest restoration activities in watershed areas. The Manual draws from our experience in implementing BINHI, as well as from national and international best practices in forest restoration.

The Manual consists of three modules that lay down the technical procedures on forest restoration using indigenous tree species. While the Manual may seem too technical, we took great effort to simplify the technical terms and make it more understandable to readers.

It is our hope that this Manual will contribute to the improvement of forest restoration projects and activities that will translate into better seedlings and greener forests.

RICHARD B. TANTOCO
President

VISAYAS STATE UNIVERSITY
Visca, Baybay City, Leyte
6521 Philippines

Foreword

As I browsed the pages of this "Field Manual on Forest Restoration Using Indigenous Species", I am certain that this would really benefit not only those who are directly involved in forest restoration but as well as other stakeholders who are concerned of bringing back the dwindling remaining forest that we have. I commend the people behind the completion of this scholarly manual who devoted much of their time in order to come up with this output. This piece of work is a clear manifestation of how they love the environment, thus putting their best foot forward to educate everyone on the necessary steps to preserve this God-given resource — the forest.

It took several years to experiment and explore ways by which we can technically help our government in the restoration and preservation of our existing forests. Now that we have completed and documented all the initiatives in addressing this profound problem faced by the government, the VSU pool of experts was able to come up with this manual. We have high hopes to reach out those who need this information in resolving issues related to forest restoration using indigenous tree species.

This manual would guide every reader to the different modules adopted by the researchers in coming up with concrete solution to the forestry problem besetting our country. These modules include: site-species matching; production of quality planting materials; and forest restoration and best practices in grasslands, brushlands, and forest gaps.

Through the concerted efforts of our active partners in this endeavor, such as the Energy Development Corporation and the Department of Environment and Natural Resources, I am very optimistic that we can help each other in implementing the rules and regulations stipulated in Executive Order No. 26 "Declaring an Interdepartmental Convergence Initiative for a National Greening Program."

Let's join hands in addressing P-Noy's Matuwid na Daan through the National Greening Program.

JOSE L. BACUSMO, Ph.D.
University President IV

Acknowledgement

Special thanks goes to the faculty and staff of Visayas State University especially to Prof. Renezita Sales–Come, Mr. Marlito M. Bande, Ms. Angelica P. Baldos, Mr. Jimmy O. Pogosa, Mr. Hernando L. Mondal, Mr. Mizael B. Cerna and Ms. Elvira Gorre for sharing their skills, expertise, and field experiences to make this manual possible. Also thanks to Atty. Allan Barcena, Forester Liezel Salagubang, Forester Jimson Solatre, and Ms. Monette Evangelista of the Watershed Management Department of EDC for reviewing and for providing valuable comments to improve the contents of the manual.

We would also like to acknowledge important recommendations and standards on reforestation provided by the Technical Working Group of the Forest Management Bureau (FMB) headed by Dir. Ricardo Calderon and Forester Ma. Teresa Aquino and their technical staff Forester Bert Lansigan. Also to Dr. Tonie Balangue for his valuable technical contribution during the initial phase of this manual.

Preface

For decades conventional reforestation strategy in the country has been considering use of fast-growing tree species like gmelina, mangium, and mahogany; vast clearing of open areas in preparation for the 4 meters by 4 meters standard planting density; use of fewer species to simplify planting design; and weak consideration in the forest formation type and ecological succession as inputs to the site-species matching.

This could be due to limited technical references to guide reforestation initiatives in the country using indigenous species. Available data and references were mostly from western countries that are more applicable to temperate forests that are simpler in structure, compared to the complex design of a tropical rainforest.

Fortunately, there are already current initiatives in the country that use indigenous species in reforestation activities. This include the National Greening Program (NGP) of the Department of Environment and Natural Resources (DENR), the BINHI Program of the Energy Development Corporation (EDC) and other private and NGO forest restoration initiatives in the country. Most of these initiatives have promoted the concept of rainforestation technology pioneered by the Visayas State University (VSU). The said technology not only encourages the use of native species in restoration, it also emphasizes the importance of social preparation and environmental education during forest restoration activities, promotion of community volunteerism to sustain the initiatives, and realization of the concept of payment for environmental services (PES) to show communities the economic benefits of restoration initiatives.

However, there are several challenges that lead to high mortality of indigenous species in the field - most especially in highly degraded areas. This include mismatch of species used in a particular planting site, inappropriate planting design, poor quality of seedlings, and others. This manual was therefore developed to bridge the knowledge gaps and to assist the field implementers in restoring our degraded tropical rainforests using appropriate and good quality indigenous species to ensure survival and growth of the seedlings. This is based on over two decades of experience in forest restoration by the VSU, with inputs from the EDC experiences from its BINHI program.

This manual is an evolving document with plenty of rooms for innovations and technical improvements. In the adoption of this manual, field implementers are also encouraged to identify and develop new strategies that are more applicable to their respective site conditions. In the end, these initiatives aim to broaden the lessons in restoring our degraded forestlands by following the nature's process on forest succession.

How to Use this Field Manual

This Field Manual on Forest Restoration using Indigenous Species has the following modules:

Module 1: Site-Species Matching

The first module aims to guide its users on the procedures to characterize the forest restoration sites, match the site conditions to suitable indigenous forest species, and identify the appropriate planting strategy to be used.

Module 2: Production of Quality Planting Materials and Nursery Management

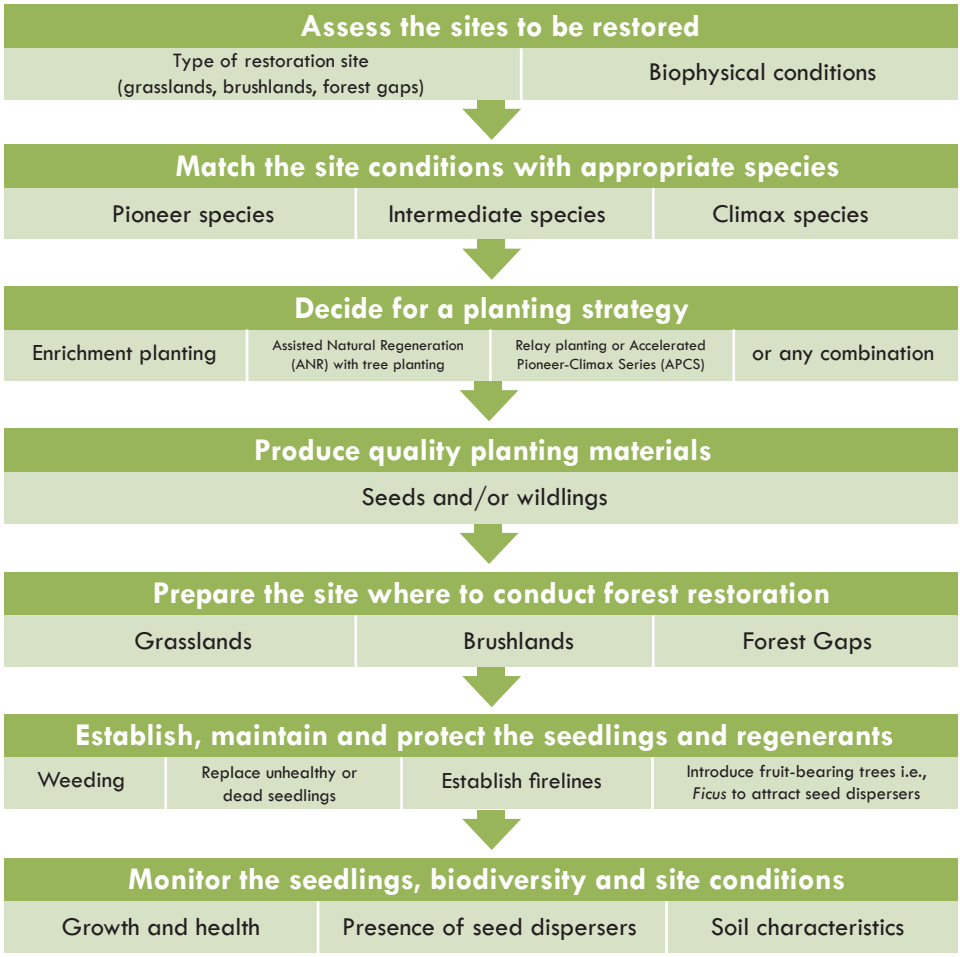
The second module aims to guide the users to further improve the processes and standards of producing quality planting materials. It is expected that a good quality planting material will produce a robust forest stand. It also provides the users recommended standards for effective monitoring and management of their nurseries.

Module 3: Forest Restoration in Grasslands, Brushlands, and Forest Gaps

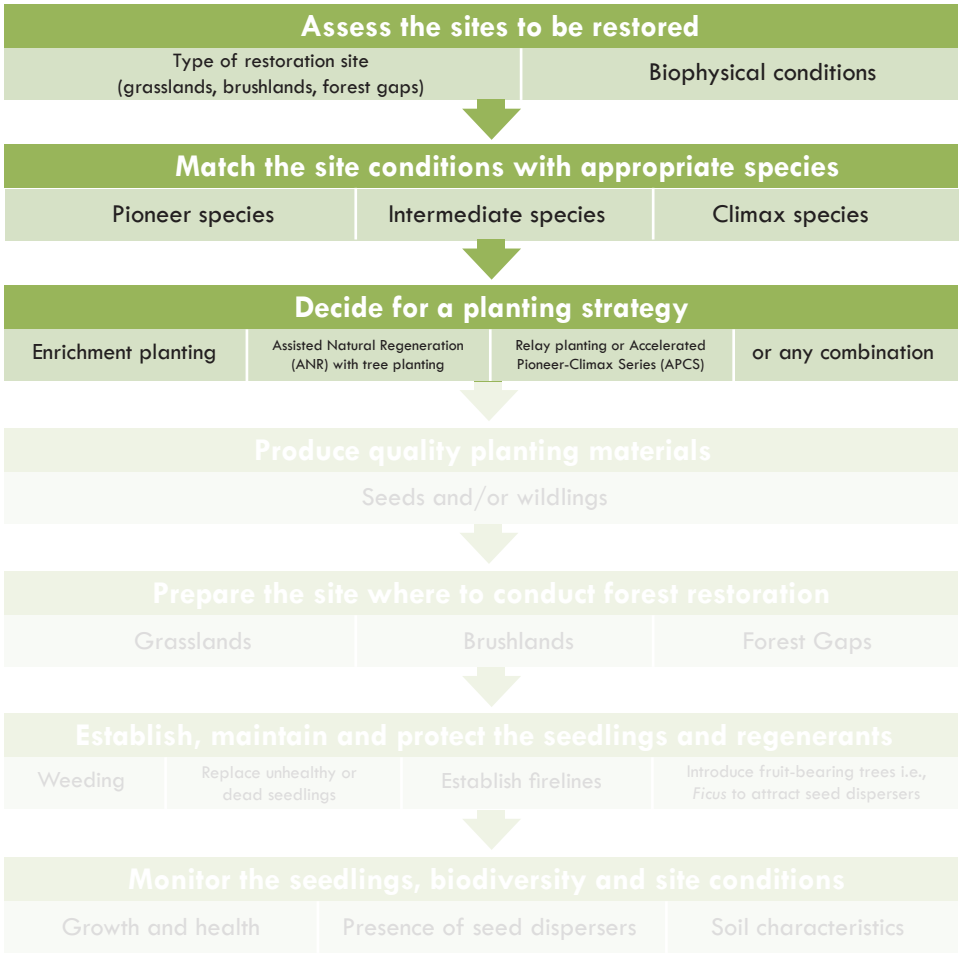
The third module aims to guide and to train the users on the step-by-step procedures on how to establish, protect and monitor indigenous forests in grasslands, brushlands, and forest gaps. The module aims to attain high survival rates and better growth performance of trees in the restoration sites.

The relationship of the above manuals is shown in the following framework:

General Flow of Procedures for Forest Restoration Using Indigenous Species



Scope of the restoration activities under Module 1



Meet Ali

This module will share additional information or highlights in green boxes through "Ali". Ali is a firefly and an indicator of a healthy forest ecosystem. Be reminded of the following when you see Ali:

Queries with answers

Standards and facts in forest restoration activities

Reminders and Suggestions

Other useful references and guide

You would also find a Glossary at the end of the module where you can find the meanings of some words or phrases written in bold italics. Most definitions used in this manual are based on the compilation of terms from the Philippine Official Reference for Forest-Related Terms and Definitions published by the Department of Environment and Natural Resources - Forest Management Bureau and International Tropical Timber Organization (DENR FMB-ITTO, 2006)

All forms or templates needed in this Field Manual can be found in ANNEXES while supplemental information can be found in APPENDICES.

MODULE 1:
Site-Species Matching

A simple step-by-step guide in matching a site's condition with the appropriate plant species

Introduction

Public and private sectors are nowadays recognizing the use of indigenous or ***native species*** on various ***reforestation*** initiatives over ***exotic species.*** With the shift of paradigm from "reforestation" to "forest restoration," there are some practices that need to be improved to ensure success of the restoration initiatives using ***indigenous species.*** One of which includes improving and acquiring more practical knowledge in the site-species matching.

An area's climatic type is one of the usual considerations in the site-species matching. Classification of trees according to their broad climatic requirements is often not sufficient to guide the field implementers in the choice of species. The former forest formation type and the existing forest ***succession stage*** of the areas to be restored are often overlooked during the site-species matching. As such, basic skills on these areas should be re-learned by the field implementers. This will also ensure that appropriate species are raised in the nursery and will gain a high survival rate in the field.

The general procedure for site-species matching is discussed below.

Scope of Module 1

This module intends to guide its users to:

1. Describe biophysical and ecological conditions of the site,
2. Choose tree species that best match the site conditions, and
3. Select planting strategy to be used in the site.

WHAT IS SITE – SPECIES MATCHING?

- Process of identifying tree species appropriate to the site condition.
- Determines the type of planting design that is optimal for the site and the species of plants that would grow best on it.
- Helps ensure the success of the forest restoration efforts in the site.

Procedures in Site–Species Matching

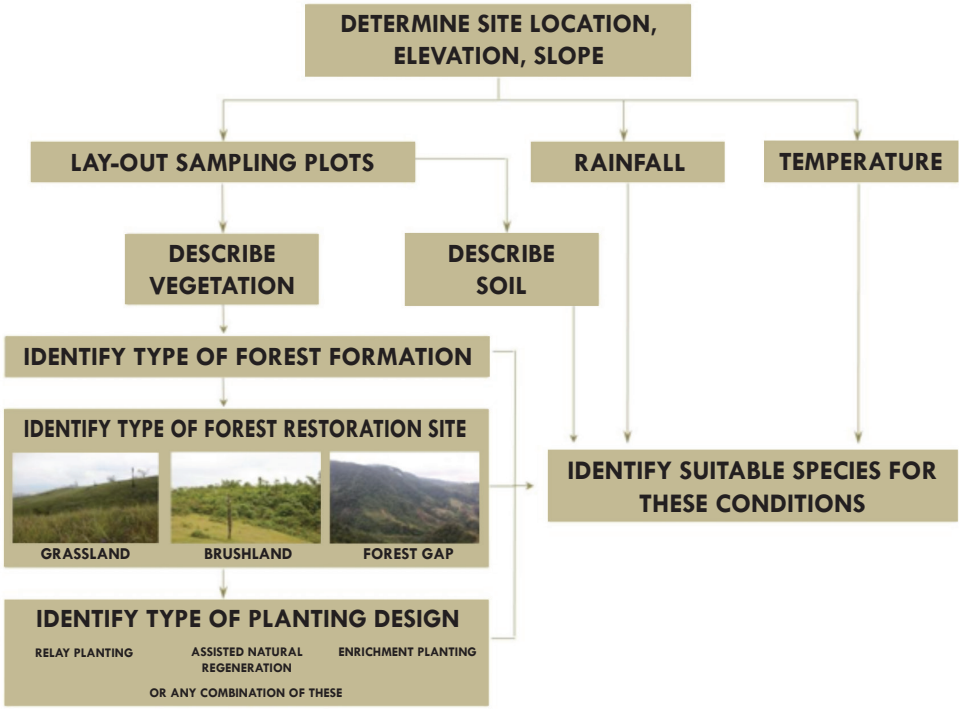


Figure 1. Summary of procedures for site-species matching.

WHY RESTORE OUR FORESTS USING NATIVE SPECIES?

For *biodiversity*

- Native species allow other species of trees to grow because they are not invasive.
- Native species attract many native birds and animals that can only be found in the Philippines.

For ecosystem resiliency

- Native species can survive against various local pests and diseases.
- Native species have different shapes, structures, and capacities to cope with harsh environmental and human disturbances.

For additional source of income

- Native species can provide non-timber forest products like resin or essential oils.
- Native species thrive well in tropical rainforest ecosystems thus producing optimum environmental goods such as water, including services such as ecotourism, carbon storage, and soil nutrients that are important to local businesses.
- Native seeds and ***seedlings*** are accessible to farmers which can be sold as additional income.

WHAT IS FOREST RESTORATION?

Forest Restoration is a management strategy applied in degraded primary forests to enhance and accelerate natural processes of forest ***regeneration*** and to regain the elastic capacity of the forest ecosystem *(DENR FMB-ITTO, 2006)*

It is also defined as a set of action which accelerates recovery of ***forest*** structure, ecological functioning, and biodiversity levels towards those typical of ***climax forest*** (Elliot et al 2013).

WHAT IS THE DIFFERENCE BETWEEN FOREST RESTORATION AND REFORESTATION?

- **Forest restoration** - considers the former composition, formation, and structure of the degraded forest being restored as inputs to the species and planting design to be applied to revegetate an area.

- **Reforestation** - establishes forest plantations on temporarily unstocked lands that are considered as forest (FAO 2001) and often does not consider the previous composition or structure of the site being restored.

WHAT TYPES OF AREAS ARE WE RESTORING?

The natural vegetation of the Philippines is a tropical rainforest. However most of our indigenous forests have been replaced by seral ***grasslands*** and ***brushlands*** (Quimio 1996) due to rampant logging in the 1950's and kaingin in the 1970's which led to ***deforestation*** and ***degradation***. Some or portions of these forests have now become fragmented, creating ***forest gaps*** or ***degraded residual natural forest***. These have become target areas for restoration.

I. Describing the biophysical and ecological conditions of the site.

Before selecting any species to be planted, it is important to know the biophysical and ecological conditions of the site to be restored such as:

- Existing ***vegetation*** and regenerants in the site,
- Soil and microclimatic conditions,
- Presence of birds or other animals as ***seed dispersers***, and/or
- Indicators of ***disturbance*** like fire or grazing.

WHAT IS RAPID SITE ASSESSMENT (RSA)?

- A process being done to assess the biophysical conditions of an area to be restored.
- Focuses on the physical and qualitative observations on the site rather than quantitative and exact measures.

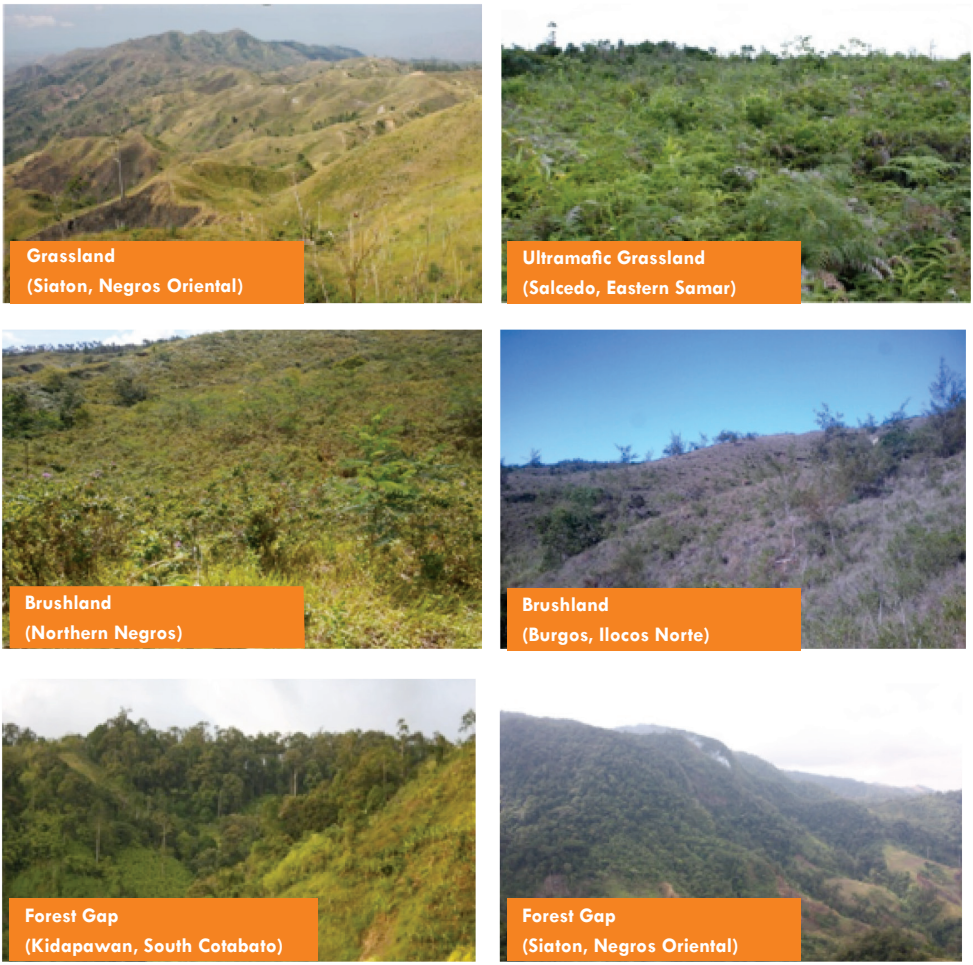


Figure 2. Example of areas being restored in the Philippines

Prepare and bring the following materials for RSA

GPS Unit

Bolo

Tape Measure

Shovel

String (5 meters long)

Site Assessment Form and Pen

Before doing any assessment activities, coordinate with the nearest ***DENR*** offices to verify if the proposed restoration site is classified or declared as ***Alienable and Disposable Land*** or ***forestland.***

Steps in Conducting Rapid Site Assessment

Figure 3. Locating the area using GPS unit.

STEP 1:
Determine the location, boundaries, and elevation of your site using a ***GPS*** unit.

Be sure to take a panoramic view of the restoration site with specific coordinates for future references.

STEP 2:
Determine the slope. Slope is the measure of flatness or steepness of an area.

To qualitatively estimate the slope using line of sight, please refer to the drawing of heads below.

31-50% = STEEP

11-30% = MODERATELY ROLLING/HILLY

0-10% = FLAT

Figure 4. Visual guide for determining the slope of the plot.

If the restoration site has a slope of more than 50%, it is **not recommended** to proceed planting. Conduct seed broadcasting instead. Otherwise, let natural succession take place.

STEP 3:

Conduct a 10% sampling intensity (SI) in the restoration site. In 1 hectare, this is equivalent to 12 random circular plots at 5-meter radius each. On the ground, randomly locate 12 points and record GPS coordinates for each point in the ANNEX A, Column 2.

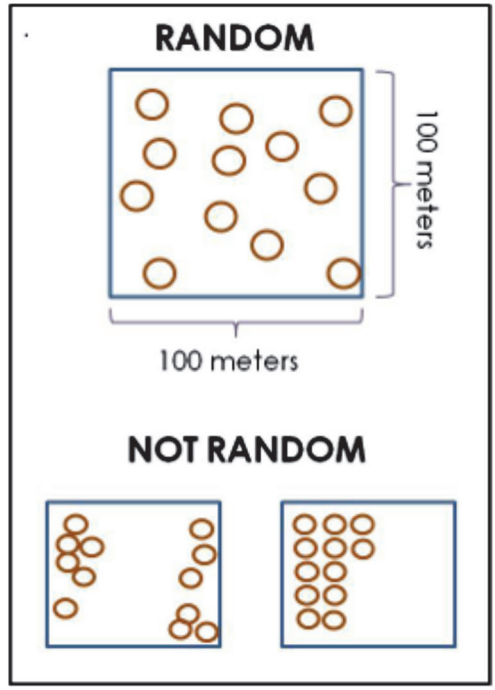


Figure 5. Proper and improper laying out of plots on the ground.

To establish a circular plot, a person stands at the identified point (the center of the circle) holding one end of the 5-meter rope while another person holds the other end of the rope and goes around in a circle. Mark the center of the circular plot with a bamboo stake for easy location once monitoring is conducted.

Figure 6. Proper surveying of the sampling plots.

Depending on the financial capability to restore the site, one could choose a higher sampling intensity (i.e. 20%).

STEP 4:

Gather and record the following information in each circular plot:

- Presence of ***disturbances*** like kaingin/cultivation/fire, livestock, or soil erosion (see Figure 7);
- ***Vegetation*** cover (see Figure 8 for the guide);
- Plant diversity (See Figure 9);
- Presence of ***trees*** and regenerants (See Figure 10).

Record the data in Site Assessment Form for Vegetation in ANNEX A.

Figure 7. Visual guide to physical disturbances such as fire, kaingin, soil erosion or presence of livestock.

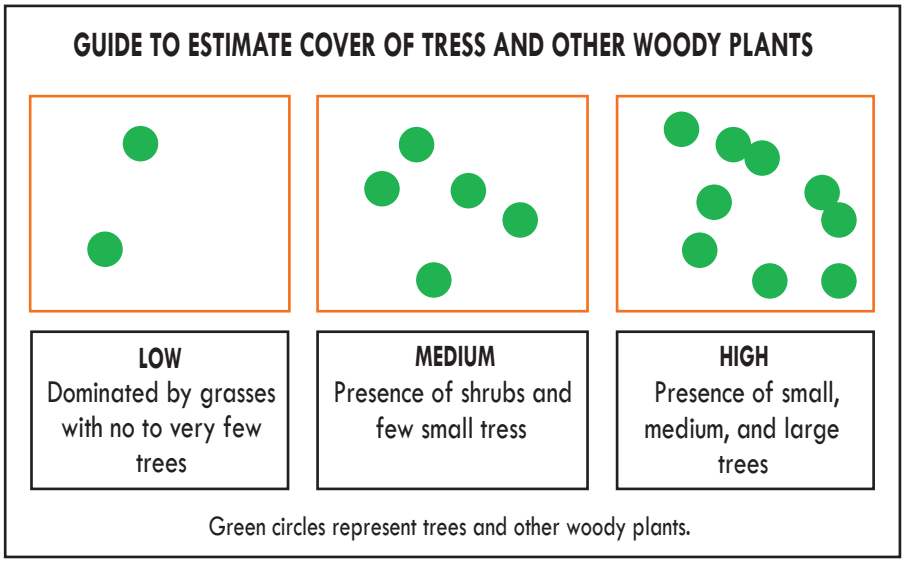


Figure 8. Visual guide to determine vegetation cover.

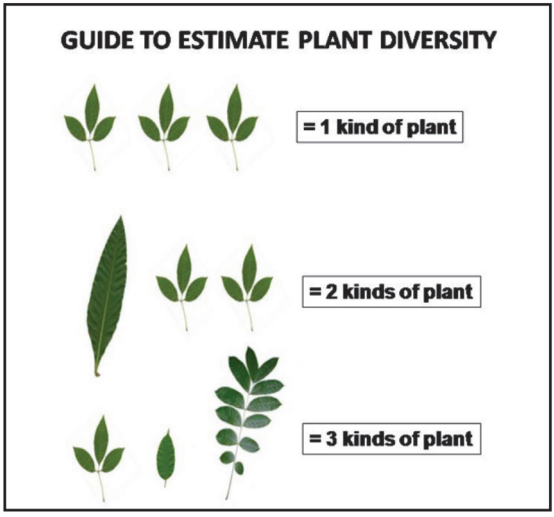


Figure 9. Visual guide to count plant diversity.

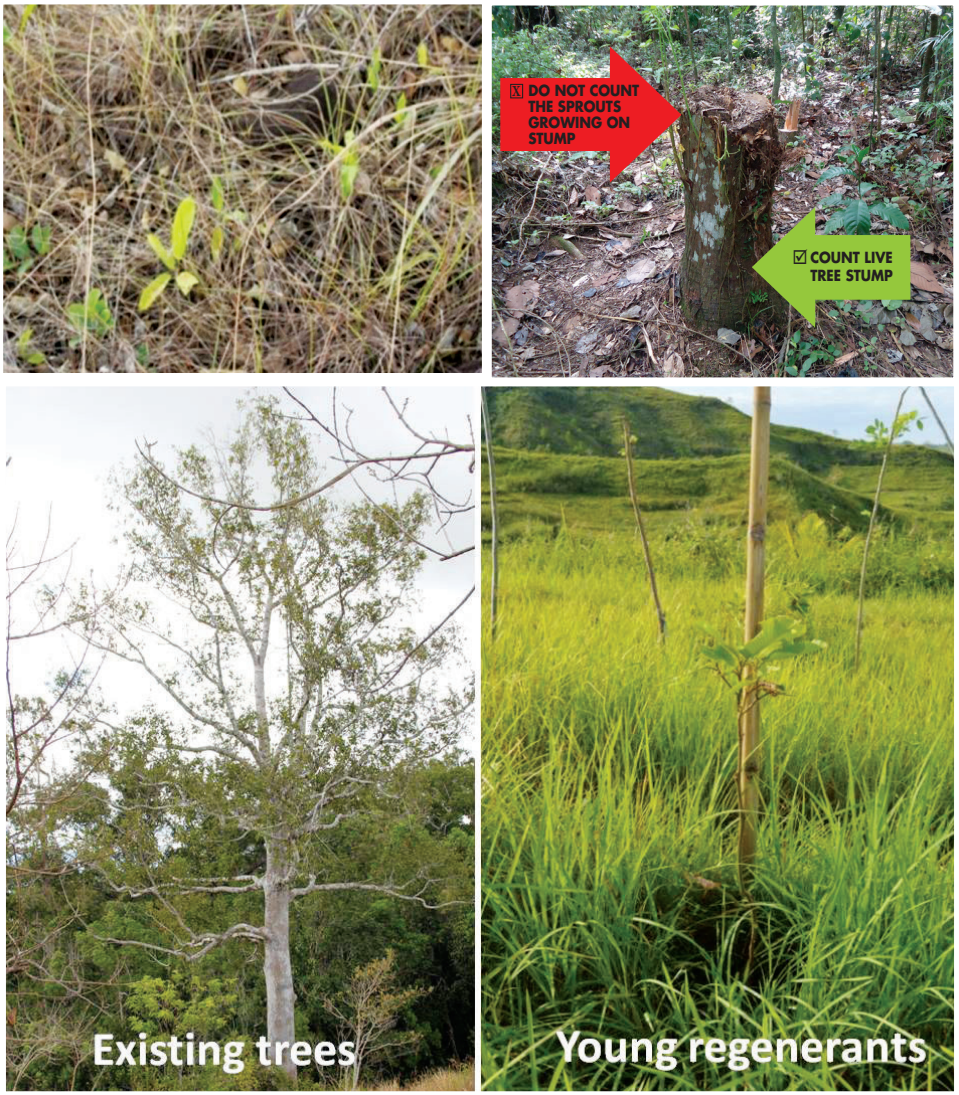


Figure 10. Visual guide to determine presence of regenerants.

STEP 5: Determine whether the area to be restored is a grassland, a brushland, or a forest gap (See Table 1 below and Figure 11a to 11c for guide).

Table 1. Guide to classifying an area into grassland, brushland and forest gap.

Indicator	Grassland	Brush Land	Forest Gap
Vegetation cover	Bare and is mostly dominated by grass / weeds; Devoid of tree seedlings.	Herbs and grasses cover more than 70% of the area; Tree seedlings rarely found among the ground flora.	Herbs and grass cover less than 50% of the area; Seedlings and saplings present in the area. *Note: This includes **Degraded Residual Natural Forest**.*
Average density of regenerants	<200 per hectare; sometimes none	200-800 per hectare	800-3,100+ per hectare
Framework species in the area	3 forest tree species or roughly 1% of the estimated number of trees in a desired forest	Less than 30 species of frameworks species	More than 30 species of framework species*

Indicator	Grassland	Brush Land	Forest Gap
Ratio of pioneer-climax species in an hectare	None/ absent	Climax tree species are absent or very rare	Climax species present; but pioneer are more common than climax species
Soil conditions	Exceedingly poor, compacted with signs of erosion	Remains mostly fertile; erosion risk increasing	Little localized disturbance; remains mostly fertile; erosion low

** Framework species ideally consists of at least 10% of the estimated number of trees in a desired climax forest. Estimated number is 300 species in a climax forest, hence at least 30 framework species per hectare.*

Figure 11a. General characteristics of grasslands

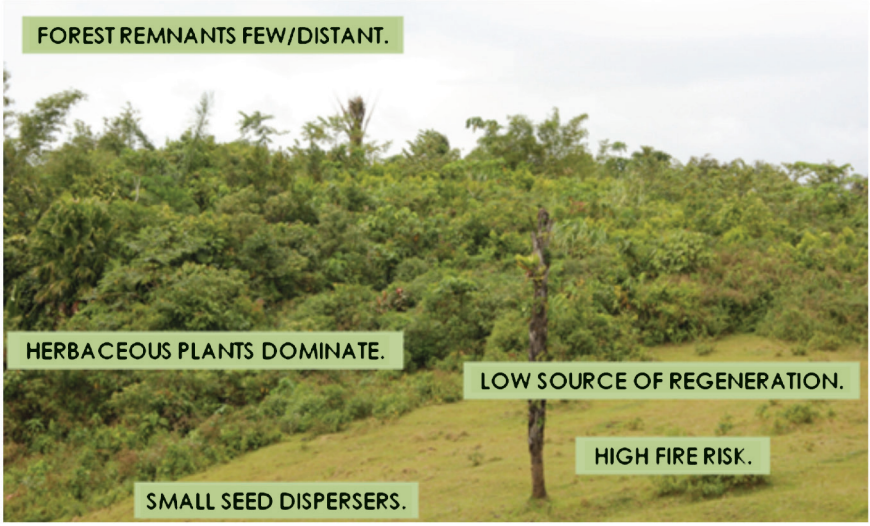


Figure 11b. General characteristics of brushlands

Figure 11c. General characteristics of forest gaps

Based on the ***rainforestation*** experience of the Visayas State University, 2,500 seedlings or saplings are needed to close the ***canopy*** of a 1-hectare site within 6 months to 1 year, with an approximate planting distance of 2 meters x 2 meters. This is expected to provide shade that will inhibit the growth of grasses such as talahib and cogon, which means less cost in maintenance.

STEP 6: Compute the seedling requirements per hectare. See below guidance in computation.

HOW TO COMPUTE FOR AVERAGE OF REGENERANTS PER PLOT?

1. Count the number of regenerants in the site and record in Column 5a-5c of the Site Assessment Form for Vegetation in Annex A (Location and Vegetation). The following are the types of regenerants:
    a. Existing trees,
    b. Existing live tree stumps (only the stumps, not the sprouts in each stump, are counted), and
    c. ***Saplings*** and ***wildlings*** (wildlings under the crown of an existing mother tree are not counted).

2. Add everything in the said column to get the grand total of regenerants. Let us say there are a total of 177 regenerants consisting of trees, stumps, seedlings and saplings in the area.

3. Get the average number of regenerants per plot by dividing the total number of regenerants by the number of circular plots used in the RSA. In the hypothetical example mentioned above this is computed as follows:

    Average regenerants per plot = 177 regenerants /12 plots
    = 14.75 regenerants per plot

HOW TO COMPUTE THE SEEDLINGS REQUIRED PER HECTARE?

1. To determine the number of actual regenerants per hectare, multipy the computed average regenerants in a plot by the total number of circular plots in 1 hectare. In this case, there are 127 circular plots with radius of 5m in a hectare (i.e. 10,000 sq.m. divided by area of 1 circular plot which is 78.5 sq.m = 127 circular plots)

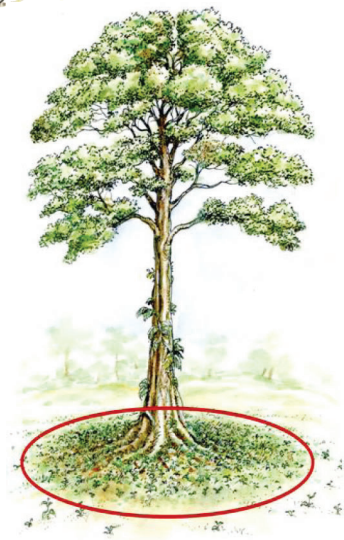
Estimated total number of regenerants/hectare = 14.75 regenerants * 127
= 1,873 regenerants

2. To determine the number of seedlings to be planted per hectare, subtract 2,500 to the estimated total number of regerants. The difference will indicate the number of seedlings needed to close the canopy in a year.

Required number of seedlings to be planted
= 2,500 seedlings - 1,873 regenerants
= 627 seedlings

3. Add 10% mortality to the seedlings to be planted.

627 + 63 = 690 seedlings



- In counting the regenerants, count those that are away or outside the crown.
- Do not include the wildlings under the crown.

Note: Outside the red circle.

STEP 7:

Describe the general characteristics of the soil per plot. Take note of the following soil parameters that would indicate the general soil condition of the site:

- ***Organic matter*** (See Figure 12 as a visual guide),
- ***Soil texture*** (See Figure 13 as a visual guide),
- ***Soil moisture*** (See Figure 14 as a visual guide)

Tick all observations in ANNEX B Columns 2-4 of the Site Assessment Form for Soil.

Generally, soils that are high in organic matter or darker in color, sandy-loamy, and have good moisture content, are the best substrates for the growth of seedlings.

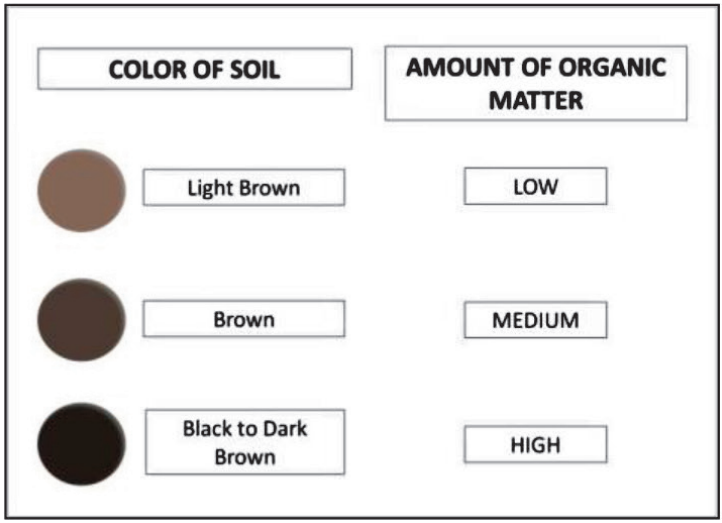


Figure 12. Visual guide to determining organic content of the soil.

Roll into wire and feel between palms.

SOIL TEXTURE INDICATOR		SOIL TEXTURE
Is wire formed?	*How does it feel when rolled between palms?*	
No	Grainy	**SANDY**
Only slightly	Floury, like powder	**SILTY**
Yes	Sticky	**CLAYEY**

Figure 13. Visual guide to determining soil texture.

Crush the soil.

Form the soil into a ball.

Figure 14. Visual guide to determining soil moisture.

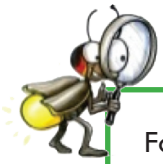
SOIL MOISTURE INDICATOR		SOIL MOISTURE STATUS
How does it feel when crushed?	*Does it form into a ball?*	
Dusty or hard	No	**DRY**
Not dusty; sticky	Yes	**MOIST**
Drops of water come out	Drops of water come out	**WET**

STEP 8:

Determine the soil depth.

1. Bore/dig a hole into at least three randomly selected circles within your site until you reach the bedrock. Assume that the soil depth is DEEP if the bedrock is still not reached at 100 cm (or 3 inches longer than a yard-stick).

2. In Column 5 of the Site Assessment Form for Soil in ANNEX B, record the soil depth whether it is SHALLOW (up to 30 cm depth or almost size of 1 ruler), MEDIUM DEPTH (35 – 100 cm depth or at least 2 rulers) DEEP (or more than 2 rulers), (more than 100 cm depth).



For soil depth of 30 cm and below, trees with horizontal rooting system such, as bamboo, shrubs, and balete (due to its aerial roots or props) may be planted;

For areas with a soil depth of 35 cm to 100 cm, bigger bamboo species, balete, palm, rattan, small trees, fruit trees, and short-term ***fast growing species*** may be planted.

For areas with a soil depth of greater than 100 cm, big, indigenous, long rotation trees may be planted.

STEP 9:

Check local rainfall and temperature.

- ✔ Check the rainfall and temperature in your restoration site.
- ✔ Go to the nearest PAGASA weather station and ask for the following:
  1. Data on the average annual rainfall and the start of the rainy season
  2. Average annual temperature

The best time to start planting is one month after the start of the rainy season.

STEP 10:

Record presence of seed dispersers and ***soil macrofauna*** including mushrooms or mosses. Check any of these in ANNEX C.

The presence of wildlife could be confirmed by the following:

- Sightings or direct observation
- Animal tracks or droppings
- Perches or nests (feathers or egg shells)
- Asking local people in the restoration site

Figure 15. Endangered Tarictic Hornbill in a restoration site of EDC, Leyte

II. Selection of tree species that best match the site conditions

After the site assessment, choose the appropriate species to plant in the restoration area.

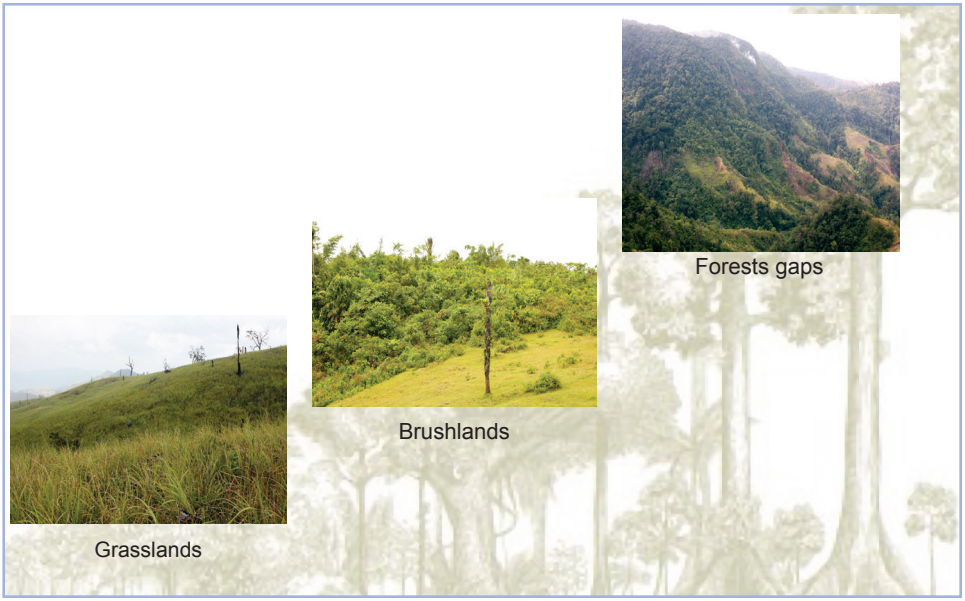


Figure 16. Common areas being restored in the Philippines

HOW IS ECOLOGICAL SUCCESSION USED IN FOREST RESTORATION?

Ecological succession is the gradual change of plant communities over time, usually in response to the changes brought about by the plants themselves to the soil conditions and other factors. Succession occurs in stages in which ***pioneer species*** initially occupy a disturbed or degraded site, followed by its gradual replacement of seral species, until the climax species composition is reached. Knowing the current ecological stage of the site to be restored will guide the choice of appropriate species to be planted.

WHY CAN WE NOT JUST ALLOW NATURAL SUCCESSION TO TAKE PLACE?

Natural forest succession can only restore forest gaps or disturbed areas that are: small enough to be covered by seed dispersal agents, near forested areas, and not frequently disturbed.

The grassland areas, which are the targets of reforestation in the country, have been there for a very long period of time and may no longer be suitable for natural succession due to the following reasons:

a) large extent or coverage;
b) periodic interventions due to grazing-related grass fires and kaingin making and upland farming activities of illegal occupants;
c) extreme rainfall events and typhoon rains visiting the areas annually resulting in the annual wash out of seeds dispersed in the area; and
d) hunting of medium size to big size birds and mammals that are effective seed dispersers as they travel longer distances that feed on forest fruits (Balangue, 2014).

In using ecological succession for forest restoration:

- The first species to be planted should improve the current site conditions thus, allowing the next species to grow. These are generally pioneer species.

- With better conditions, other species such seral or intermediate species replace the former vegetation.

- Towards the end, both the vegetation structure and ecological processes resemble forest being restored.

- Restoring an area to its climax composition will highly depend on the site's degree of damage.

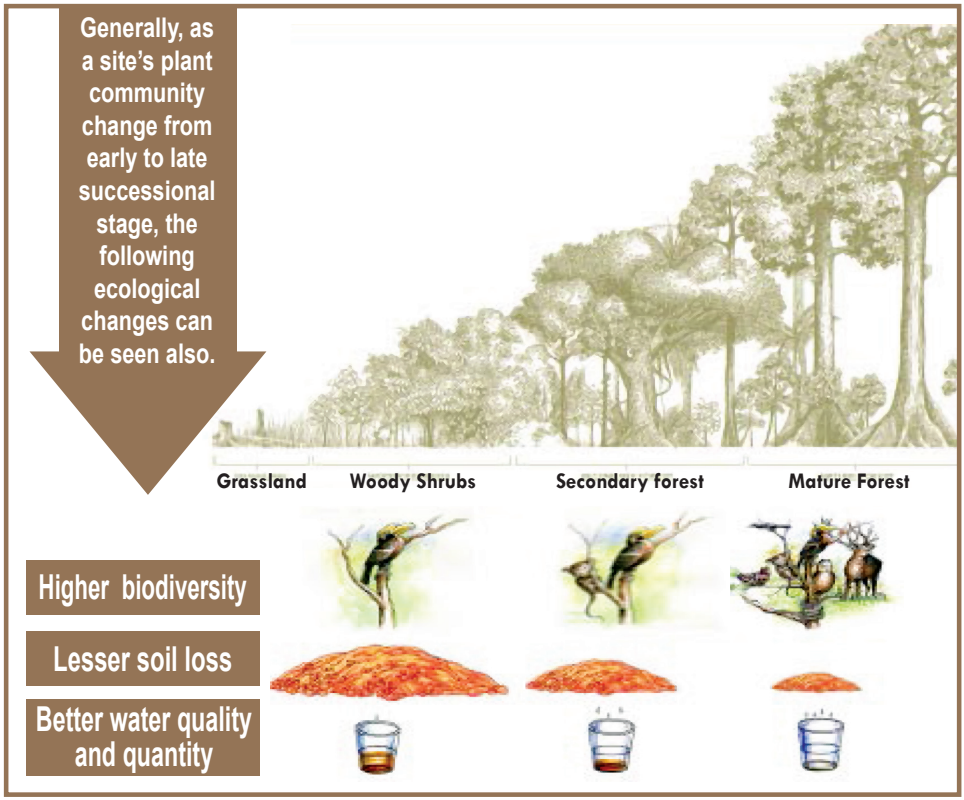


Figure 17. Ecological changes during forests succession.

Steps in Site-Species Matching

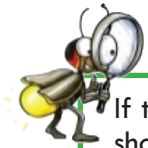
STEP 1:

Determine the former forest formation and the climatic type of the site to be restored. The different forest types in the Philippines have distinct habitat distribution patterns and elevation ranges which serve as good baseline information for forest type identification.

APPENDIX 1 shows the characteristics of the different forest formation in the Philippines. While Figure 18 shows the sample pictures of the different forest formations in the country.

APPENDICES 2-3 shows water and temperature requirements of some indigenous species.

APPENDICES 4-15 shows the species growing in different forest formation types.



If the area is originally a grassland ecosystem, field implementers should leave the area as it is. Qualified grassland areas are those previously covered with vegetation or forest.

STEP 2:

From the list of species growing in different forest formation type, identify the indigenous forest species that can survive in the current ecological succession stage of the area.

Tree species can be generally classified into two: pioneer and climax tree species.

Seeds of pioneers:
1. Can germinate only in full sunlight
2. Seedlings cannot grow in shade

Seeds of climax trees:
1. Can germinate in shade
2. Seedlings are shade-tolerant

(Source: Elliot, et.al., 2013)

APPENDICES 16-18 shows list of different pioneer and climax species. Table 2 below describes the general characteristics of pioneer, seral, and climax species.

Table 2. Characteristics of pioneer, intermediate/seral, or climax/late successional species

Indicators	Pioneer/early successional	Intermediate/seral species	Climax /late successional
Growth rate	Opportunistic and fast growing	Slower than pioneer but faster than climax	Slow growing
Survival span	Short-lived	Out-lives pioneer species but not climax sp.	Long-lived
Seed size and dispersal	Small-sized dispersed rapidly as seed rain or buried seed bank	Medium	Medium to large; lower rates of dispersal
Light exposure	Higher light conditions; shade intolerant	Higher light conditions; shade intolerant	Lower light conditions; shade tolerant
Canopy shape	Umbrella-like	Umbrella-like	Columnar, upward growing straight stems
Strength of wood	Weak wood	Slightly dense wood	Dense and strong wood
Example species	*Macaranga sp.,* *Trema sp.*	*Syzygium sp.* *Astoria sp.*	*Diptero sp.*

Take note that planting trees in open areas need not be limited to pioneer species. Planting selected climax tree species alongside pioneers 'shortens' the period that it would take to achieve a climax forest.

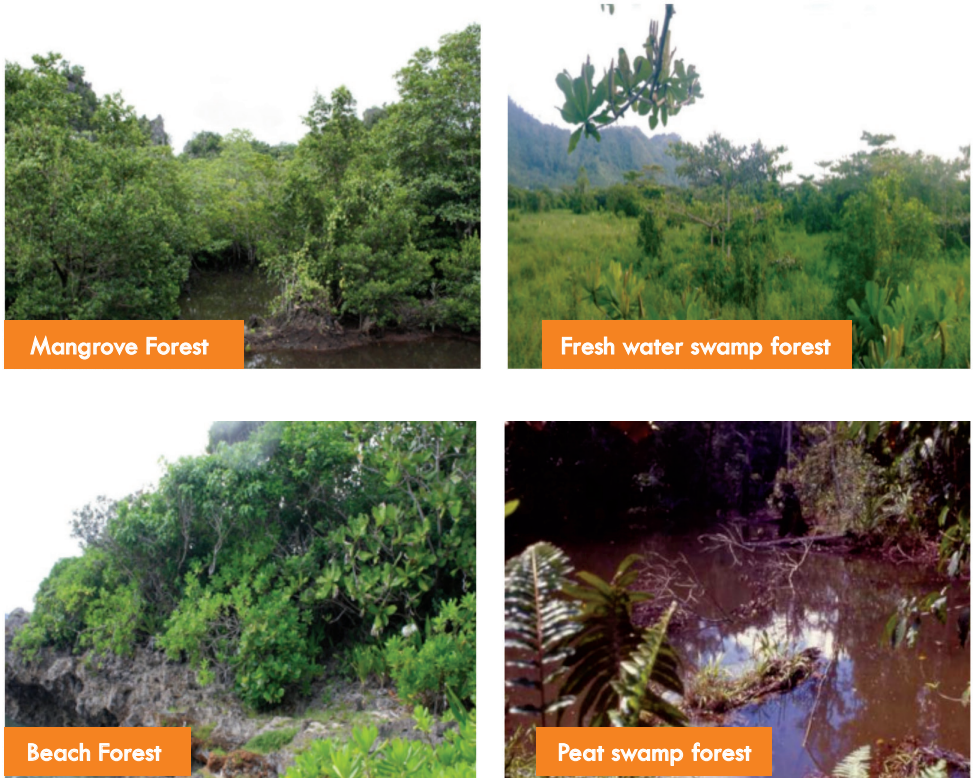


Figure 18a. The different forest formation types in the Philippines (Fernando, et.al., 2008)

Figure 18b. The different forest formation types in the Philippines (Fernando, et.al., 2008)

III. Identifying appropriate planting strategies

Deciding which planting strategy or approach to apply in a given restoration site is very important in order to cover the area the soonest possible time, regulate the micro climatic condition and improve soil fertility.

WHAT ARE THE DIFFERENT PLANTING DESIGNS?

1. Assisted Natural Regeneration
   - any set of activities (i.e. liberating existing tree species from grass competitors), excluding tree planting that enhances the natural processes of forest regeneration (Elliot et al 2013).

2. Relay Planting (Accelerated Pioneer-Climax Series)
   - involves planting of pioneer species to act as nurse trees to climax species that would be interplanted later.

3. Enrichment Planting
   - planting in between gaps of existing trees or regenerants using high valued timber species.

Table 3 below is a guide to the recommended planting strategy depending on the area to be restored.

Table 3. Recommended planting strategy per level of degradation.

Indicators	Grassland	Brush Land	Forest Gap
Vegetation	Grasses dominate	Herbaceous plants dominate	Trees dominate over grasses
Natural regeneration	Very few/no sources of natural regeneration	Low source of regeneration	Many sources of regeneration
Remnant forest	Forest usually absent within seed dispersal distance	Forest remnants few/distant	Intact forest remains
Seed dispersers	Seed dispersers mostly gone	Small seed dispersers	Seed dispersers common
Fire risk	Very high	High	Low to very low
Recommended planting strategy	Assisted Natural Regeneration with Tree Planting Relay Planting (Accelerated Pioneer-Climax Series Combination of both	Assisted Natural Regeneration with Tree Planting Relay Planting (Accelerated Pioneer-Climax Series Combination of both	Assisted Natural Regeneration with Tree Planting Enrichment planting Combination of both

Note down of the proposed planting strategy in the Site Assessment Form for Vegetation in Annex A. More details on planting strategies are provided in Module 3 of this manual.

Summary of Procedures

- Assess the biophysical characteristics (i.e. vegetation, soil, elevation, slope, rainfall, temperature, and biodiversity) of the site to be restored using the Rapid Site Assessment method.

- Using the results from the Rapid Site Assessment:
    1. Know the likely former forest type of area to be restored;
    2. Identify the type of restoration area;
    3. Choose the suitable species that match the site conditions, and
    4. Identify the appropriate planting strategy.

- Keep records of all relevant information about the site's biophysical characteristics to monitor changes in the site.

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Glossary

Alienable and disposable land – land of the public domain, which has been classified declared as such and available for disposition

Biodiversity – the variety of life encompassing genes, species and ecosystems

Brushland – an area characterized by discontinuous cover of shrubby and non-wood vegetation including grasses.

Canopy – a continuous cover of branches and foliage formed collectively by the crowns of adjacent trees consisting of one or several layers

CENRO – refers to Community Environment and Natural Resources Office

Climax forest – the final stage of successional development on a forest site under specific climactic and other environmental conditions, leading to a more or less stable equilibrium underlying minor changes in species composition

Climax tree species – tree species that comprise climax forest

Deforestation – the conversion of forest to another land use or the long-term reduction of the tree canopy below the minimum 10% threshold

Degradation – a decline in the productivity of an area of land or in its ability to suport natural ecosystems or types of agriculture

Degraded Residual Natural Forest – refers to a severely disturbed natural forest of whatever cause with a basal area of less than five (5) square meters per hectare of all commercial tree species, with dbh/dab of less than 65 centimeters

DENR – Department of Environment and Natural Resources

Disturbance – it is a temporary change in environmental conditions that causes a pronounced change in an ecosystem

Ecological succession – the gradual change on the species structure and composition of an ecological community over time

Exotic species (alien species) – species that have been transported by human activity, intentional, or accidental, into a region where it does not naturally occur. Also called introduced, exotic, non-indigenous, or non-native species.

Fast growing species – a tree species that grows relatively faster than common forest trees and whose rotation age is 4 to 20 years with a mean annual increment of at 10 cubic meter per hectare under favorable site conditions.

Forest – land with an area of more than 0.5 hectare and tree crown cover (or equivalent stocking level) of more than 10%. The trees should be able to reach a minimum height of 5 meters at maturity in situ.

Forest gaps – the space occurring in a forest community due to individual or group tree mortality or blow down

Forest land – includes public forest, permanent forest or forest reserves, and forest reservations

Grasslands – areas predominantly vegetated with grasses suchasThemeda sp, Saccharum sp., among others

GPS – Global Positioning System

Indigenous – species or genotypes that have evolved in the same area, region or biotope and are adapted to the specific predominant ecological conditions at the time of establishment

Lichens – mutualistic association of algae and fungi

MAO – Municipal Agricultural Office

Native species – species that is normally found as part of a particular ecosystem

Organic matter – all decomposed, partly decomposed and undecomposed organic materials of plant and animal origin

Pioneer species – plants capable of invading bare sites (e.g. newly exposed soil) and persisting there or colonizing them until supplanted by sucessional species

Rainforestation – a forest restoration technique, developed in the Philippines that uses indigenous tree species to restore ecological integrity and biodiversity while also producing a diverse range of timbers and other forest products for local people

Reforestation – the establishment of forest plantations on temporarily unstocked lands that are considered as forest; also called as artificial regeneration

Regeneration – the process of reestablishing a forest stand by natural or artificial means

Remnant forest – small areas of forest that survive in a landscape following large-scale deforestation

Sapling – a tree from 5 to less that 15 centimeters in DBH

Seed dispersers – are animals that directly or indirectly distribute seeds or fruits that they consume or come in contact with

Seedling – nursery grown planting material smaller than 5 centimeters in diameter developed out of a seed

Soil depth – the thickness of the soil from the top down to the bedrock

Soil macrofauna – a general term to refer to organisms like insects, worms, ants that use soil as their habitat

Soil moisture – the term used for the moisture condition of a horizon at the time the profile is described

Soil texture – the proportion of the various particle-size classes (sand, silt, and clay)

Succession – the natural sequence of plant community replacement beginning with bare ground and resulting in a final, stable community in which a climax forest is reached

Tree – a woody and perennial plant, typically large and with a well-defined stem or stems carrying a more or less definite crown; sometimes defined as attaining a minimum diameter of 12.7 centimeters and a minimum height of 4.6 meters at maturity with no branches within 1 meter.

Vegetation – the total mass of plant life that occupies a given area

Wildlings – young trees that have germinated and grown in their natural habitats close to the mother trees; A naturally grown seedling transplanted and used in forest planting

ANNEXES

ANNEX A . SITE - ASSESSMENT FORM (Location and Vegetation)

Plot #	GPS Reading (center)	DISTURBANCE ☑ if present ☒ if absent			VEGETATION COVER ☑ where applicable			PRESENCE OF TREES AND REGENERANTS			PLANT DIVERSITY
		KAINGIN/ CULTIVATION	*LIVESTOCK*	*EROSION*	LOW	MED	HIGH	*No. of trees*	*No. of live tree stumps*	*No. of seedlings/saplings*	*No. of Species*
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Ave. elevation (m asl): _____
Ave. Slope (%) _____
General Vegetation Cover: ____ **Grasslands** ____**Brushlands** ____**Forest Gaps**
Proposed Planting Design: ____ **EP** ____ **ANR** _____ **Relay planting/APCS**

Size of the restoration area (in hectares): _____

Likely type of forest formation: _____

(A) Average no. of regenerants*[Grand Total / 12 Circles]*: _____

(B) Average for One Hectare *[(A)x 10,000 sq.m/78.5 sq.m.]*: _____

No. of Trees to Plant per Hectare *[2500 – (B)]*:_____

Average no. of species *[Grand Total / 12 Circles]*: _____

Name of Recorder:

Date Recorded:

*Important information i.e. elevation and soil type are based on forest formations in the Philippines (Fernando et al, 2008).
**The one with the most frequent entries would indicate the general vegetation cover of the site.

ANNEX B. SITE ASSESSMENT FORM (Soil)

Plot #	ORGANIC MATTER ☑ where applicable			TEXTURE ☑ where applicable			MOISTURE ☑ where applicable			DEPTH ☑ where applicable		
	LOW	MEDIUM	HIGH	SANDY	SILTY LOAM	CLAYEY	DRY	MOIST	WET	SHALLOW	MEDIUM DEPTH	DEEP
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

Take note that the one with the most frequent entries would indicate the general soil condition of the site.

ANNEX C. OTHER SITE CHARACTERISTICS

Plot #	INDICATORS OF WILDLIFE PRESENCE ☑ if present ☒ if absent					SOIL MACROFAUNA ☑ if present ☒ if absent		OTHER BIO-INDICATORS ☑ if present ☒ if absent	
	Sightings	Nests	Droppings/ Urine	Footprints	Others (e.g. Feathers/ Skin cast-off/ Egg shells)	Earthworms/ Worm casts	Termites/ Termite Mounds/ Anthills	Mushrooms	Mosses/ Lichens
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
COMMENTS/ ADDITIONAL OBSERVATIONS:									

Take note that the one with the most frequent entries would indicate the general soil condition of the site.

APPENDICES

APPENDIX 1. Forest formations in the Philippines

CLIMATE	SOIL-WATER REGIME	LOCALITIES	SOILS	ELEVATION	FOREST FORMATIONS (HABITAT)
Ever Wet	Dry land	Inland	Zonal soils	Lowland to 1200 m	Tropical lowland evergreen rainforest
				Mountains 1200-1500 m	Tropical lower montane rainforest
				1500-3000 m	Tropical upper montane rainforest
				3000 m –tree line	Tropical sub-alpine forest
			Limestone	Mostly lowlands	Forest over limestone
			Ultramafic rocks	Mostly lowlands	Forest over ultramafic rocks
		Coastal	Sandy	Sea level – 50 m	Beach forest
	Water table high, at least periodically	Salt water & brackish water			Mangrove forest
		Freshwater	Oligotrophic peats		Peat swamp forest
			Eutrophic (muck & mineral soils	Almost permanently wet to periodically wet	Freshwater swamp forest
Seasonally Dry	Moderate annual shortage				Tropical semi-evergreen rainforest
	Marked annual shortage				Tropical moist deciduous forest
Source:	Fernando et al 2008				

APPENDIX 2. Rainfall requirements of some indigenous tree species

SPECIES	PRECIPITATION REQUIREMENT (mm)	SOURCE
Agoho	700 – 2000, 200-300, <5000	Rimando & Florido, RISE Vol. 1. No.1-10, 1989
Bagras	2500 - 3500	Florido & Saplan, RISE, Vol. 2, No. 1-12, 1990
Benguet Pine	1000 - 2000	Florido & Reaviles, RISE Vol. 1. No 1-10, 1989
Gubas	No distinct wet and dry season	Cadiz & Mizal, RISE Vol 1. No. 1-10, 1989
Kaatoang Bangkal	150 - 5000	Cadiz, Modino & Dotig, RISE Vol.1. No. 1-10, 1989
Narra	< 2366	Cadiz & Mizal, RISE Vol 1. No. 1-10, 1989

APPENDIX 3. Temperature and water requirements of some indigenous trees species

SPECIES	TEMPERATURE AND WATER REQUIREMENTS	ANALYSIS AND INTERPRETATION
Akle	Water-loving growing near water sources where its roots can reach the ground water level	Water-loving, implied full sunlight
Alupag	Intolerant of shade	Full sunlight
Amuguis	Near streams, requires high ground moisture lover, shade intolerant species	Water-loving, full sunlight
Balakat	Moist soil, intolerant of shade	Water-loving, full sunlight
Balinghasay	Partly deciduous during dry season, in lowlands, intolerant of shade	Potential drought-resistant, full sunlight
Banuyo	Intolerant of shade, prefers dry places	Potential drought resistant
Dao	In moist slopes close to streams, intolerant of shade	Water-loving, full sunlight
Dungon	Intolerant of shade, drier condition in dipterocarp forest	Full sunlight, potential drought-resistant
Dungon late	Beach lower and upper in mangroves, Intolerant of shade	Water-loving, full sunlight

SPECIES	TEMPERATURE AND WATER REQUIREMENTS	ANALYSIS AND INTERPRETATION
Kalantas	Grows along stream banks, not tolerant to shade	Full sunlight, water-loving
Kupang, Salinkugi, & Akleng parang	Intolerant of shade, destitute or nearly destitute of leaves	Full sunlight, potential drought-resistant.
Liusin	On moist and dry soils and is intolerant of shade	Water-loving, full sunlight
Malugai	Slightly intolerant of shade	Partial shade-loving
Narra	In not pronounced dry season, nearly always occupying flat coastal plains behind mangrove swamps, or very scattered along streams in the low hills near the coast, light-loving deciduous.	Water-loving, full sunlight, potential drought-resistant
Palosapis	Wholly deciduous, for a day or two	Potential drought-resistant
Supa	Intolerant of shade, no distinct dry season	Water-loving, full sunlight
Tabigi	Mangrove swamp	Water-loving
Taluto	Deciduous in short period	Potential drought-resistant
Toog	Isolated along streams	Water-loving, partial shade
Tuai	Isolated along streams	Water-loving, implied full sunlight
Source: Whitford, 1911.		

APPENDIX 4. Beach forest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Agoho	*Casuarina equisetifolia*	Casuarinaceae
Alagao dagat	*Premna serratifolia*	Lamiaceae
Bani	*Pongamia pinnata*	Fabaceae
Bitanghol	*Calophyllum inophyllum*	Clusiaceae
Botong	*Barringtonia asiatica*	Lecythidaceae
Dapdap	*Erythrina orientales*	Fabaceae
Talisay	*Terminalia catappa*	Combretaceae
	Guettarda speciosa	
	Sterculia ceramica	Malvaceae
	Morinda citrifolia	Rubiaceae

APPENDIX 5. Mangrove forest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Api-api	*Avicennia alba*	Avicenniaceae
Bakawan babae	*Rhizophora mucronata*	Rhizophoraceae
Bakawan lalake	*Rhizophora apiculata*	Rhizophoraceae
Bungalon	*Avicennia marina*	Avicenniaceae
Busain	*Bruguiera gymnorhiza*	Rhizophoraceae
Buta-buta	*Excoecaria agallocha*	Euphorbiaceae
Dungon late	*Heritiera littoralis*	Malvaceae
Kulasi	*Lumnitzera racemosa*	Combretaceae
Pedada	*Sonneratia alba*	Sonneratiaceae
Saging-saging	*Aegiceras corniculatum*	Aegiceratataceae
Tabau	*Lumnitzera littorea*	Combretaceae
Tangal	*Ceriops tagal*	Rhizophoraceae
Taualis	*Osbornia octodonta*	Myrtaceae
Tinduk-tindukan	*Aegiceras floridum*	Aegiceratataceae
	Rhizophora stylosa	Rhizophoraceae

APPENDIX 6. Peat swamp forest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Balat-buaia	Fagraea racemosa	Laganiaceae
Baluno	*Mangifera caesia*	Anacardiaceae
Dangula	*Teijsmanniondendron ahernianum*	Lamiaceae
Kamandilis	*Garcinia rubra*	Clusiaceae
	Vatica sp.	Dipterocarpaceae
	Syzygium sp.	Myrtaceae
	Palaquim sp.	Sapotaceae
	Ardisia sp.	Myrsinaceae
	Cinammomum sp.	Lauraceae

APPENDIX 7. Freshwater swamp forest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Baluno	*Mangifera caesia*	Anacardiaceae
Bangkal	*Nauclea orientalis*	Rubiaceae
Katmon	*Dillenia philippinensis*	Dilleniaceae
Libas	*Spondias pinnata*	Anacardiaceae
Putat	*Barringtonia racemosa*	Lecythidaceae
	Terminalia copelandii	Combretaceae
	Cebrera manghas	

APPENDIX 8. Forest over limestone species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Akle	*Albizia acle*	Fabaceae
Bagtikan	*Parashorea malaanonan*	Dipterocarpaceae
Balakat	*Ziziphus talanai*	Rhamnaceae
Bansalagin	*Mimusops elengi*	Sapotaceae
Banuyo	*Wallaceodendron celebicum*	Fabaceae
Batete	*Kingiodenron alternifolium*	Fabaceae
Batitinan	*Lagerstroemia piriformis*	Lythraceae
Bayok	*Pterospermum diversifolium*	Malvaceae
Bogo	*Garuga floribunda*	Burseraceae
Dungon	*Heritiera sylvatica*	Malvaceae
Ebony	*Diospyros ferrea*	Ebenaceae
Guijo	*Shorea guiso*	Dipterocarpaceae
Ipil	*Intsia bijuga*	Fabaceae
Kalantas	*Toona calantas*	Meliaceae
Kalumpit	*Terminalia microcarpa*	Combretaceae
Lanete	*Wrigthia pubescens*	Apocynaceae
Liusin	*Maranthes corymbosa*	Chrysobalanaceae
Mabunot	*Gomphandra luzoniensis*	Icacinaceae
Magabuyo	*Celtis luzonica*	Celtidaceae
Malaanonang	*Shorea polita*	Dipterocarpaceae
Malugai	*Pometia pinnata*	Sapindaceae
Manggachapoi	*Hopea acuminata*	Dipterocarpaceae
Mayapis	*Shorea palosapis*	Dipterocarpaceae
Molave	*Vitex parviflora*	Lamiaceae
Narig	*Vatica mangachapoi*	Dipterocarpaceae
Narra	*Pterocarpus indicus*	Fabaceae
Supa	*Sindora supa*	Fabaceae
Talisai gubat	*Terminalia foetidissima*	Combretaceae
Taluto	*Pterocymbium tinctorium*	Malvaceae
Tindalo	*Afzellia rhomboidea*	Fabaceae
White lauan	*Shorea contorta*	Dipterocarpaceae
Yakal saplungan	*Hopea plagata*	Dipterocarpaceae
Yakal yamban	*Shorea falciferoides*	Dipterocarpaceae
	Shorea assamica	Dipterocarpaceae
	Mallotus floribundus	Euphorbiaceae
	Sterculia comosa	Malvaceae

APPENDIX 9. Forest over ultramafic rocks species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Banai-banai	*Albizia acle*	Fabaceae
Liusin	*Maranthes corymbosa*	Chrysobalanaceae
Pagsahingin	*Canarium asperum*	Burseraceae
	Ardisia romanii	Myrsinaceae
	Buchanania insignis	Anacardiacea
	Buchanania microphylla	
	Decaspermum parviflorum	
	Dillenia monantha	Dilleniaceae
	Exocarpus latifolius	
	Ochrosia glomerata	
	Premna congesta	Lamiaceae
	Protium connarifolium	
	Salacia marginata	
	Scolopia luzoniensis	
	Terminalia darlingii	
	Xanthostemon fruticosus	

APPENDIX 10. Tropical lowland evergreen forest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Almon	*Shorea almon*	Dipterocarpaceae
Antipolo	*Artocarpus blancoi*	Moraceae
Apitong	*Dipterocarpus grandiflorus*	Dipterocarpaceae
Bagtikan	*Shorea malaanonan*	Dipterocarpaceae
Balobo	*Diplodiscus paniculatus*	Malvaceae
Bitanghol	*Calophyllum blancoi*	Clusiaceae
Duguan	*Myristica philippinensis*	Myristicaceae
Gisok-gisok	*Hopea philippinensis*	Dipterocarpaceae
Guijo	*Shorea guiso*	Dipterocarpaceae
Kapulasan	*Nephelium ramboutanake*	Sapindaceae
Katmon	*Dillenia philippinensis*	Dilleniaceae
Narig	*Vatica mangachapoi*	Dipterocarpaceae
Red lauan	*Shorea negrosensis*	Dipterocarpaceae
Tailed-leaf apitong	*Dipterocarpus caudatus*	Dipterocarpaceae
Tanguile	*Shorea polysperma*	Dipterocarpaceae
White lauan	*Shorea contorta*	Dipterocarpaceae
Yakal	*Shorea astylosa*	Dipterocarpaceae
Yakal yamban	*Shorea falciferoides*	Dipterocarpaceae
	Canarium spp.	Burseraceae
	Garcinia mindanensis	Clusiaceae
	Syzygium spp.	Myrtaceae

APPENDIX 11. Tropical semi-evergreen rainforest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Almon	*Shorea almon*	Dipterocarpaceae
Antipolo	*Artocarpus blancoi*	Moraceae
Apitong	*Dipterocarpus grandiflorus*	Dipterocarpaceae
Bagtikan	*Shorea malaanonan*	Dipterocarpaceae
Balobo	*Diplodiscus paniculatus*	Malvaceae
Bitanghol	*Calophyllum blancoi*	Clusiaceae
Duguan	*Myristica philippinensis*	Myristicaceae
Gisok-gisok	*Hopea philippinensis*	Dipterocarpaceae
Guijo	*Shorea guiso*	Dipterocarpaceae
Kapulasan	*Nephelium ramboutanake*	Sapindaceae
Katmon	*Dillenia philippinensis*	Dilleniaceae
Narig	*Vatica mangachapoi*	Dipterocarpaceae
Red lauan	*Shorea negrosensis*	Dipterocarpaceae
Tailed-leaf apitong	*Dipterocarpus caudatus*	Dipterocarpaceae
Tanguile	*Shorea polysperma*	Dipterocarpaceae
White lauan	*Shorea contorta*	Dipterocarpaceae
Yakal	*Shorea astylosa*	Dipterocarpaceae
Yakal yamban	*Shorea falciferoides*	Dipterocarpaceae
	Canarium spp.	Burseraceae
	Garcinia mindanensis	Clusiaceae
	Syzygium spp.	Myrtaceae

APPENDIX 12. Tropical moist deciduous forest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Almon	*Shorea almon*	Dipterocarpaceae
Banahaw igem	*Dacrycarpus cumingii*	Podocarpaceae
Mayapis	*Shorea palosapis*	Dipterocarpaceae
Philippine Maple	*Acer laurinum*	Sapindaceae
Tanguile	*Shorea polysperma*	Dipterocarpaceae
White lauan	*Shorea contorta*	Dipterocarpaceae
	Calophyllum sp.	Clusiaceae
	Elaeocarpus spp.	Elaeocarpaceae
	Lithocarpus celebicus	Fagaceae
	Lithocarpus spp.	Fagaceae
	Litsea spp.	Lauraceae
	Neolitsea spp.	Lauraceae
	Syzygium spp.	Myrtaceae
	Engelhardtia spicata	

APPENDIX 13. Tropical lower montane rainforest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Almaciga	*Agathis philippinensis*	Araucariaceae
Almon	*Shorea almon*	Dipterocarpaceae
Banahaw igem	*Dacrycarpus cumingii*	Podocarpaceae
Mayapis	*Shorea palosapis*	Dipterocarpaceae
Philippine Maple	*Acer laurinum*	Sapindaceae
Tanguile	*Shorea polysperma*	Dipterocarpaceae
White lauan	*Shorea contorta*	Dipterocarpaceae
	Calophyllum sp.	Clusiaceae
	Elaeocarpus spp.	Elaeocarpaceae
	Lithocarpus spp.	Fagaceae
	Lithocarpus celebicus	Fagaceae
	Litsea spp.	Lauraceae
	Neolitsea spp.	Lauraceae
	Syzygium spp.	Myrtaceae
	Engelhardtia spicata	

APPENDIX 14. Tropical upper montane rainforest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Matang-araw	*Melicope triphylla*	Rutaceae
Kolalabang	*Saurauia latibractea*	Actinidiaceae
	Litsea villosa	Lauraceae
	Persea philippinensis	Lauraceae
	Weinmannia luzoniensis	
	Leptospermum flavescens	
	Syzygium acrophilum	Myrtaceae
	Neolitsea megacarpa	Lauraceae
	Podocarpus rotundus	Podocarpaceae
	Symplocos whitfordii	Symplocaceae
	Elaeocarpus argenteus	Elaeocarpaceae
	Weinmannia luzoniensis	
	Leptospermum flavescens	
	Dacrycarpus imbricatus	

APPENDIX 15. Tropical sub-alpine forest species

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
	Dacrycarpus cumingii	
	Falcatifolium gruezoi	
	Leptospermum flavescens	
	Patersonia lowii	
	Phyllocladus hypophyllus	
	Podocarpus glaucus	
	Symplocos pendula	Podocarpaceae
	Vaccinium woodianum	Symplocaceae

APPENDIX 16. Sun-demanding forest tree species in volcanic soils.

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Agoho	*Casuarina equisetifolia*	Casuarinaceae
Akleng parang	*Albizia procera*	Fabaceae
Amugis	*Koordersiodendron pinnatum*	Anacardiaceae
Anabiong	*Trema orientalis*	Cannabaceae
Anii	*Erythrina fusca*	Fabaceae
Antipolo	*Artocarpus blancoi*	Moraceae
Ayangile	*Acacia confusa*	Fabaceae
Bagalunga	*Melia dubia*	Meliaceae
Bahai	*Ormosia calavensis*	Fabaceae
Baleteng ibon	*Ficus sumatrana*	Moraceae
Banai-banai	*Radermachera pinnata.*	Bignoniaceae
Batino	*Alstonia macrophylla.*	Apocynaceae
Bato-bato	*Drypetes littoralis.*	Putranjivaceae
Bitanghol	*Calophyllum blancoi*	Clusiaceae
Bogo	*Garuga floribunda.*	Burseraceae
Dangula	*Teijsmanniodendron ahernianum*	Lamiaceae
Danupra	*Toona sureni*	Meliaceae
Dao	*Dracontomelon dao*	Anacardiaceae
Dita	*Alstonia scholaris*	Apocynaceae
Dulit	*Canarium hirsutum*	Burseraceae
Dungon	*Heritiera sylvatica*	Malvaceae
Gubas	*Endospermum peltatum*	Euphorbiaceae
Gumihan	*Artocarpus sericarpus*	Moraceae
Igyo	*Dysoxylum gaudichaudianum*	Meliaceae
Ipil	*Intsia bijuga*	Fabaceae
Kalimutain	*Dysoxylum arborescens*	Meliaceae
Kalingag	*Cinnamomum mercadoi*	Lauraceae
Kalumpit	*Terminalia microcarpa*	Combretaceae
Kariskis	*Albizia lebbekoides.*	Fabaceae
Kubi	*Artocarpus nitidus*	Moraceae

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Kulatingan	*Pterospermum obliquum*	Malvaceae
Lamio	*Dracontomelon edule*	Anacardiaceae
Lanipga	*Toona philippinensis*	Meliaceae
Lingo-lingo	*Viticipremna philippinensis*	Lamiaceae
Liusin	*Maranthes corymbosa*	Chrysobalanaceae
Malabayabas	*Tristaniopsis decorticata*	Myrtaceae
Malakawayan	*Podocarpus rumphii*	Podocarpaceae
Malaruhat	*Cleistocalyx operculatus*	Myrtaceae
Malugai	*Pometia pinnata*	Sapindaceae
Molave	*Vitex parviflora*	Lamiaceae
Mountain agoho	*Gymnostoma rumphianum*	Casuarinaceae
Narra	*Pterocarpus indicus*	Fabaceae
Pagsahingin bulog	*Canarium calophyllum*	Burseraceae
Paguringon	*Cratoxylum sumatranum*	Clusiaceae
Salingkugi	*Albizia saponaria*	Fabaceae
Subiang	*Bridelia insulana*	Phyllanthaceae
Talisai gubat	*Terminalia foetidissima*	Combretaceae
Taluto	*Pterocymbium tinctorium*	Malvaceae
Tamayuan	*Strombosia philippinensis*	Olacaceae
Tangisang bayawak	*Ficus variegata*	Moraceae
Tindalo	*Afzelia rhomboidea*	Fabaceae
Toog	*Petersianthus quadrialatus*	Lecythidaceae
Ulaian	*Lithocarpus celebicus*	Fagaceae
Yellow lanutan	*Polyalthia flava*	Annonaceae

APPENDIX 17. Sun-demanding forest tree species in limestone areas

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Alagao	*Premna odorata*	Lamiaceae
Alagasi	*Leucosyke capitellata*	Urticaeae
Anabiong	*Trema orientalis*	Cannabaceae
Anilao	*Colona serratifolia*	Malvaceae
Anislag	*Flueggea flexuosa*	Euphorbiaceae
Antipolo	*Artocarpus blancoi*	Moraceae
Ayangile	*Acacia confusa*	Fabaceae
Bagalunga	*Melia dubia*	Meliaceae
Bahai	*Ormosia calavensis*	Fabaceae
Balete	*Ficus balete* Merr.	Moraceae
Baleting ibon	*Ficus sumatrana* Miq.	Moraceae
Baleting pagong	*Ficus forstenii* Miq.	Moraceae
Balobo	*Diplodiscus paniculatus*	Malvaceae
Banitlong	*Cleistanthus pilosus*	Phyllanthaceae
Bayag-usa	*Voacanga globosa*	Apocynaceae
Bayanti	*Aglaia rimosa*	Meliaceae
Dao	*Dracontomelon dao*	Anacardiaceae
Dungon	*Heritiera sylvatica*	Malvaceae
Igyo	*Dysoxylum gaudichaudianum*	Meliaceae
Inyam	*Antidesma tomentosum*	Phyllanthaceae
Ipil	*Intsia bijuga*	Fabaceae
Kalumpit	*Terminalia microcarpa*	Combretaceae
Kamagong	*Diospyros blancoi*	Ebenaceae
Kariskis	*Albizia lebbekoides*	Fabaceae
Kubi	*Artocarpus nitidus*	Moraceae
Kulatingan	*Pterospermum obliquum*	Malvaceae
Libas	*Spondias pinnata*	Anacardiaceae
Lingo-lingo	*Viticipremna philippinensis*	Lamiaceae
Malapapaya	*Polyscias nodosa*	Araliaceae
Malugai	*Pometia pinnata*	Sapindaceae
Molave	*Vitex parviflora*	Lamiaceae
Mountain agoho	*Gymnostoma rumphianum*	Casuarinaceae

LOCAL NAME	SCIENTIFIC NAME	FAMILY NAME
Narra	*Pterocarpus indicus*	Fabaceae
Salibotbot	*Tabernaemontana pandacaqui*	Apocynaceae
Salingkugi	*Albizia saponaria* (Lour.)	Fabaceae
Tindalo	*Afzelia rhomboidea*	Fabaceae
Ulaian	*Lithocarpus celebicus*	Fagaceae

APPENDIX 18. List of pioneer, seral and climax species in different Dipterocarp forests classified by Whitford.

PIONEER SPECIES	SERAL SPECIES	CLIMAX SPECIES
Lauan – Hagakhak forest type		
Kulis pakatan	Malaikmo	Dao
Tambalau	Canarium Spp.	Hagakhak
Tanghas	Laurel	Narra
Balingayo	Dapdap	Amuguis
Malabagio	Kupang	Gisok-gisok
Calantas	Dungon	White lauan
Calliandra	Macaranga	
Hinlaumo	Malugai	
Anabiong	Akle	
Ipil-ipil		
Bignai		
Bignay pugo		
Balete		
Ilang-ilang		
Yakal-Lauan Forest Type		
Antipolo		Yakal
Ilang-ilang		White lauan
Liusin		Red lauan
Canarium		Tanguile
Kamatog		Molave
Amugis		
Malugai		
Alupag		
Balakat		
Taluto		
Calophyllum		
Anisoptera Sp.		
Hopea sp.		
Batitinan		
Sakat		

PIONEER SPECIES	SERAL SPECIES	CLIMAX SPECIES
Palaquium spp.		
Lanete		
Calamansanay		
Lauan-Apitong Forest Type		
Antipolo	Tindalo	
Tangisang-Bayawak	Pili	
Tamayuan	Pahutan	
Duguan	Lamio	
Liusin	Dao	
Akle	Amuguis	
Tanglin	Nato	
Kupang	Mangachapuy	
Pagsahingin		
Tuai		
Hamindang		
Binunga		
Gubas		
Alupag		
Balakat		
Taluto		
Bitanghol		
Banaba		
Sakat		
Kalumpit		
Binggas		
Maniknik		
Bolong-eta		
Dita		

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