FOREST RESOURCE INVENTORY

IN THE HEART OF BORNEO (HoB) SARAWAK

(2016-2020)

FOREST DEPARTMENT SARAWAK

With Collaboration of:

SARAWAK GOVERNMENT

MINISTRY OF ENERGY & NATURAL RESOURCES

FOREST RESEARCH INSTITUTE MALAYSIA

2021

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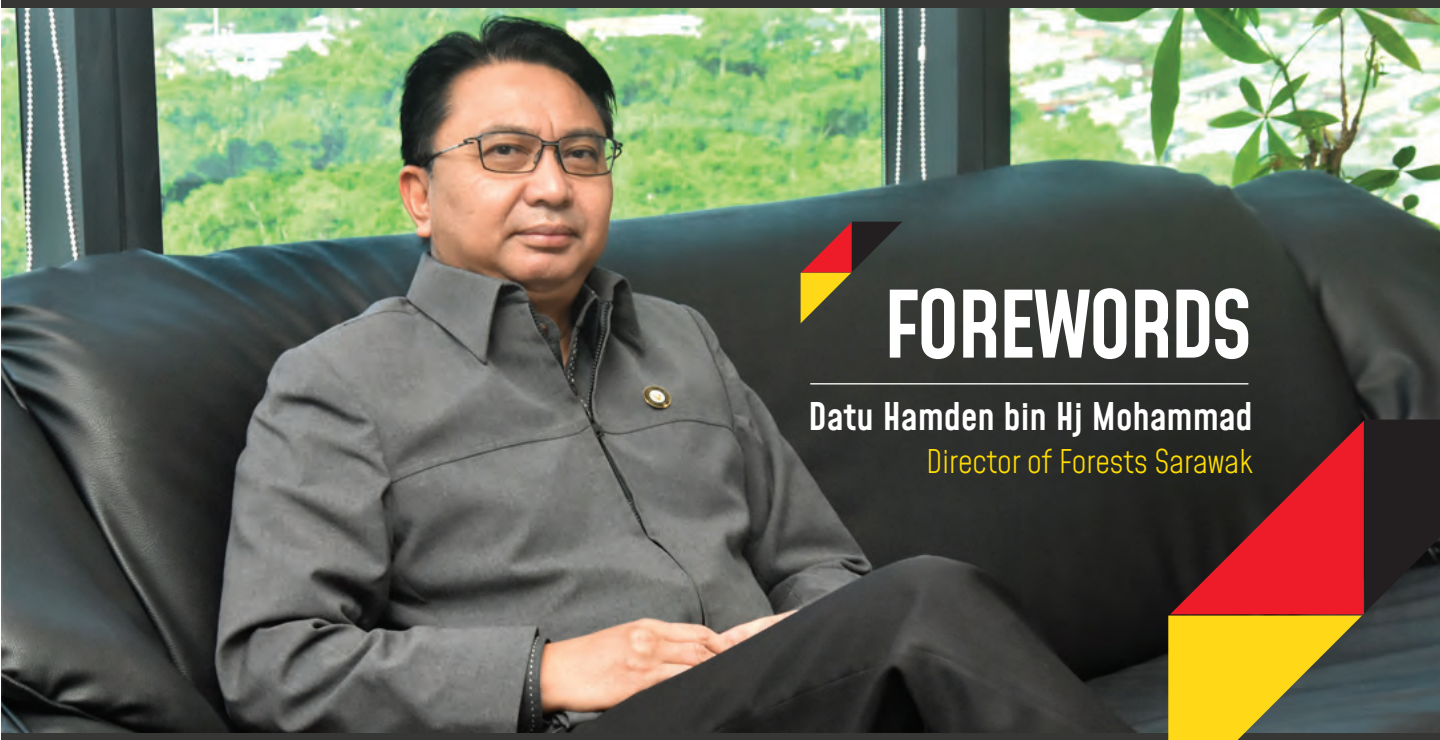
Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Forest Resource Inventory in the Heart of Borneo (HoB) Sarawak (2016-2020)
Bibliography:
1. Sarawak Forest Department 2. Forests and forestry–Malaysia.

Photo credit: Jabatan Hutan Sarawak, Forest Research Institute Malaysia

MS ISO 9001:2008 certified

Set in Helvetica (TT) 9.5 pt



FOREWORDS

Datu Hamden bin Hj Mohammad
Director of Forests Sarawak

Assalamualaikum Warahmatullahi-wabarakatuh.

First and foremost, I would like to congratulate and expressed my gratitude to our officers and staffs from Forest Department Sarawak (FDS) for successfully implementing the Forest Resource Inventory in the Heart of Borneo (HoB) Sarawak. Special gratitude to Federal Government of Malaysia especially the Ministry of Energy and Natural Resources (KeTSA), formerly the Ministry of Water, Land and Natural Resources (KATS) and State Government of Sarawak for approval and providing support to this project. Not to forgot Forest Research Institute of Malaysia (FRIM) as our project consultant and all stakeholders involved especially the related forestry's agencies, Forest Timber Licenses, and the communities within the project area.

I was made to understand that this is a technical project with massively expensive enormous investments in the form of technical human resources besides financial inputs. The information, data and results generated from FRI are remarkably important to establish the baseline data for future sustainable forest management planning, monitoring and research purposes. It will guide our policy makers and forest managers on forests management, conservation, and governance besides enabling science-based forest management. Results from FRI can estimates not only limited to sources of raw materials for downstream industries in Sarawak but could explore widely information on non-timber forest products, forest biomass content, carbon stocking and detecting existing of wildlife.

The forests are also providing numerous intangible ecosystem services and acts as major terrestrial sink of carbon. It also prevents soil erosion and loss of fertile topsoil, which again is a very important service provided by our forests, where loss of soil and other resources through soil erosion and landslide is a huge concern in a mountainous terrain like HoB area which become watershed for major rivers and Hydro-Electric Power (HEP) dams. The information and result generated from FRI are valued assets that will be useful and benefit us to understanding the actual role of forest for development process aside from environmental conservation and ecological values the forest provides. On this note, we are willing to share the First Phase of FRI reports to interested stakeholders for referral.

Therefore, let me once again commend the work of dedicated team of officers and staffs in Headquarters and all Regional Forest Offices throughout Sarawak for excellently coordinating and carrying out the works on difficult terrain and remote area for the first phase of FRI in Sarawak. What makes us proud is the fact that we have developed our own capacity over the time to carry out such a massive and challenging technical task. Therefore, congratulations once again and I wish the team a great success as they continue their effort working on next phases of FRI works.

ACKNOWLEDGEMENT

We would like to express our highest gratitude to the Federal Government especially the Ministry of Energy and Natural Resources (KeTSA) for approving this project under 11th Malaysian Plan and as well as the State Government of Sarawak for support and provide additional funds to complete this project. Our warmest thanks to Ministry of Urban Development and Natural Resources (MUDeNR) for providing direction, guidance and advises in implementing this project through the Forest Inventory Steering Committee that formed specially to oversee, coordinate, and monitor the progress of the project.

Special appreciation addressed to YBhg. Datu Ali Bin Yusop and Tuan Haji Sapuan Bin Ahmad, former Directors of Forests Sarawak who contributed much to initiating this project and putting endless endeavours to get this project approved.

Special thanks to Forest Research Institute of Malaysia (FRIM) as our project consultant and partner for providing continuous technical supports and cooperation right from the very beginning of this project and all forestry agencies such as Sarawak Forestry Corporation (SFC), Sarawak Timber Industry and Development Corporation (STIDC), Forestry Department Peninsular Malaysia and Forestry Department Sabah.

Not to forget to the related stakeholders especially the timber companies operated within project area such as Samling Group of Companies, Shin Yang Group of Companies, STIDC, and WTK Holdings Bhd., as well as the local communities and the individuals who involved directly or indirectly towards the implementation of this project.

Finally, all praise to all department officers and staffs who are very dedicated and committed in making this project a success.

DEDICATION

We would like to dedicate this report to Forest Department Sarawak officers and staffs from Headquarters as well as to all Regional Forest Offices throughout the State as in the list below, who had given their full commitment in all stages of project implementation especially in planning, management, and collection of data on ground.

1. **Abang Ahmad Abang Morni**
2. **Abd Rahman Bin Morshidi**
3. **Abdillah Bin Zaini**
4. **Abdul Raffar Bin Abdul Razak**
5. **Abdul Rahman Bin Nona**
6. **Abdul Wahed Bin Ehwan**
7. **Abg. Roslan Bin Abg. Ibrahim**
8. **Affendi Anak Bunchuan**
9. **Ahmad bin Amit**
10. **Ajmal Asraff Bin Ibrahim**
11. **Akbar Bin Jobeli**
12. **Alyani Izzareena Binti Maskin**
13. **Aminan Bin Akup**
14. **Andrew Ilup Bin Bluyo**
15. **Angela Baun Abell**
16. **Anthony Bayan**
17. **Arifin Awang Zulkifli**
18. **Asrimin Bin Taib**
19. **Attlee Banyang Anak Peter Remun**
20. **Azirulazwa Bt Sapiee**
21. **Begiling Anak Gelu**
22. **Danny Ipan Anak Winston Bale**
23. **Deru Anak Sido**
24. **Dr. Affendi Bin Shuhaili**
25. **Erickson Unchau Anak Edward**
26. **Georgina Kunyan**
27. **Gerald Anak Ulok**
28. **Grace Eza Anak Jikim**
29. **Datu Hamden Bin Mohammad**
30. **Haji Ahmad Ashrin Bin Mohamad Bohari**
31. **Haji Mohamad Ali Bin Yacob**
32. **Hamdan Bin Julai**
33. **Hamidy Bin Khatan**
34. **Hamzah Bin Ayup**
35. **Hanu Bin Amin**
36. **Hariz Luther Abdullah**
37. **Hj Whera Bin Mazlan**
38. **Ismail Sapong**

39. Ismaily Bin Rebi
40. Ismawie Bin Suleiman
41. Jack Anak Liam
42. Japin Bin James
43. Japin James
44. Jasni Bin Bujang
45. Jefri bin Adi
46. Jimbai Sugit
47. Jimmy Bin Jabol
48. Johan Bin Juiene
49. Johneddy Ak. Dana
50. Jolkarnain Bin Abd. Samat
51. Josephine Wong Lua Ming
52. Justin Juty Anak Chun
53. Kenety Ak Etin
54. Lindsay Anak Mactson
55. Liam Anak Dibor
56. Mahmod Bin Saadi
57. Mctatus Merang
58. Michael Ak Ngelai
59. Micheal Anak Tupong
60. Mohd Basri Bin Mahidin @ Mohiden
61. Mohd Sanusi Hj Juni
62. Mohammad Azwan Bin Haji Hamidon
63. Mohammad Salbia Bin Muhamad Akbar
64. Mohamad Saufi Bin Hussain
65. Mohamed Nazriel Abdullah
66. Mohammad Bin Medani
67. Nurazima Binti Yusof
68. Oscar Johin Ngayop
69. Peter Anak Sigam - Pengawas Hutan
70. Ricky Jonathan Alex
71. Roslan Bin Othman
72. Rosli Bin Usop
73. Rufus Anak Jonathan Alex
74. Ruzy Anak Marin
75. Salina Binti Hamdi
76. Shamat bin Amit
77. Sue Zahrine Bt Yusop
78. Sulpice Januar Anak Affendi
79. Stanely Unggat Anak Nyadang
80. Steven Bin Usop
81. Suwardi Bin Sidik
82. Taha@Syukery Bin Amin
83. Uyo' Jau
84. Valerie Jude Anak Nios
85. Wikin Bin Keliew
86. Wan Mohammad Hazmi Bin Wan Alwie
87. Wan Yusuf Bin Wan Sapiee Sa'di
88. Yakub Bin Isa
89. Zaidi Bin Keram
90. Zailan @ Jai Bin Apandi
91. Zainal Bin Hj Senol

EXECUTIVE SUMMARY

Forest Resources Inventory in the Heart of Borneo (HoB) Sarawak (2016-2020) reports the findings of the forest resources inventory that have been implemented from year 2016 to 2020. The inventory of forest resources in the HoB Sarawak was started in 2016 with the Phase I implementation, covering an area of 2.1 million ha. This project ended in year 2018. The project was then continued to Phase II, which was implemented between years 2019 and 2020, covering HoB Extension area of about 0.6 million ha. The implementation of these two phases making and an area covered was about 2.7 million ha. Forests included in the project are namely (i) mixed dipterocarps forests (consisting of lowland dipterocarp, hill dipterocarp, upper hill dipterocarp forests), (ii) montane forest, (iii) mangrove forest, (iv) peat swamp forest, and (v) kerangas/heath forest (that includes Melaleuca swamp forest).

Forests are the major land cover and the major forest types in this area are mixed dipterocarp and montane forests, but there is also lowland dipterocarp in the lower parts of the HoB area. Areas that have been included in the inventory only Totally Protected Areas (TPA) and production forests under the sustainable forest management basis and that under the management of FDS. The total inventoried area was about 1.76 million ha, which is about 65.6% of the entire HoB area in Sarawak.

This report is divided into nine chapters, namely (1) Background of the Project, (2) The HoB of Sarawak (3) Sampling Design, (4) Forest Inventory Methodology, (5) Field Data Collection, (6) Analysis of Inventory Data, (7) Forest Inventory Results, (8) Recommendations, and (9) Conclusion. Chapter 7 is the core of this report where all the inventory results are presented. The inventory parameters that were measured in the forest resources inventory are divided into seven (7) major components, which are (i) stand density, (ii) timber volume, (iii) basal area, (iv) biomass & carbon stock, (v) trees species composition, (vi) non-timber resources, and (vii) fauna. Each parameter is generally structured into four (4) main categories where information is arranged by (i) overall project area, (ii) strata, (iii) forest types, and (iv) land status.

The average tree density in the entire project area was estimated at 1,499 trees/ha for trees with a diameter of 5 cm and above. About 83.9% (1,258 trees/ha) is dominated by non-dipterocarp trees, while the remaining 16.1% (241 trees/ha) is dipterocarp trees. In terms of timber volume, per hectare in the entire project area was estimated at 158.1 m^3 ha^{-1} for trees with a diameter of 5 cm and above. About 72.9% (115.2 m^3 ha^{-1}) is dominated by non-dipterocarp trees, while the remaining 27.1% (42.9 m^3 ha^{-1}) is dipterocarp trees.

In terms of carbon stock, results indicated that the biggest portion of biomass carbon is in the aboveground component of living trees, which comprised about 59.3% of the total carbon pools in the forest. It indicates that the aboveground component of biomass dominates the carbon pools, and it plays a major role in many biomass and carbon assessments of forests. It was followed by soil and belowground components, which consisted of about 23.1% and 13.0% of the total carbon pools respectively. Deadwood and litter have a relatively small portion, which is about 3.7 and 0.9%, respectively.

Total carbon per hectare in the concession area was estimated at 220.74 Mg C ha^{-1}. Intact and disturbed areas in TPA were estimated at 192.62 and 145.09 Mg C ha^{-1} respectively. The production forest has higher total carbon per hectare as compared with other lands. State land has the lowest average total carbon stcok with an average of 83.90 Mg C ha^{-1}. This occurred because all production forest/ concession areas comprise only mixed hill dipterocarp forest while the TPA areas comprises of all types of forest.

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LIST OF ABREVIATIONS

AGB	Aboveground Biomass
AGC	Aboveground carbon
BGB	Belowground Biomass
CDW	Coarse Woody Debris
CHM	Canopy Height Model
CS	Carbon stock
DBH	Diameter at Breast Height
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
FCD	Forest Canopy Density
FDS	Forest Department Sarawak
FMC	Forest Management Certification
FRI	Forest Resources Inventory
FTL	Forest Timber License
FRIM	Forest Research Institute Malaysia
GIS	Geographic Information System
GPS	Global Positioning System
HoB	Heart of Borneo
IPCC	Intergovernmental Panel on Climate Change
LEAF	Lowering Emission from Asia's Forests
LiDAR	Light Detection and Ranging
NFI	National Forest Inventory
NTV	Non-Tree Vegetation
OC	Organic Carbon
OLI	Operational Land Imager
OPL	Occupation Permit License
PFE	Permanent Forest Estate
PFs	Permanent Forests
PSP	Permanent Sample Plot
RIL	Reduced Impact Logging
TPA	Totally Protected Area
RS	Remote Sensing
SFM	Sustainable Forest Management
SOP	Standard Operating Procedure
SRTM	Shuttle Radar Topography Mission
STA	Sarawak Timber Association
UNFCCC	United Nation Framework Convention on Climate Change
USAID	United States Agency for International Development
HA	hectare
SAR	Synthetic Aperture Radar
SFC	Sarawak Forestry Corporation
KeTSA	Kementerian Tenaga dan Sumber Asli
MUDeNR	Ministry of Urban Development and Natural Resources Sarawak
UAV	Unmanned Aerial Vehicle

CHAPTER 1

BACKGROUND OF THE PROJECT

1.1 INTRODUCTION

Forest Resource Inventory (FRI) aims at producing timely and accurate estimates for a wide range of forest resource variables for a variety of users and applications. Time, cost, and precision constraints cause this program to seek technological innovations that contribute to measurement and estimation efficiencies and that facilitate the production and distribution of an increasing array of inventory data, estimates, and derived products. Many of the recent innovations have involved remotely sensed data and related statistical estimation techniques.

Remote sensing (RS) data have been used in forest inventories for a long time to support their inventory tasks. Remote sensing includes all air-borne and space-borne instruments for earth observation are included, from analogue aerial photography to space-borne digital instruments like synthetic aperture radar (SAR) and optical systems. Remote sensing does not replace the need for good field data but combining both provides better results than either method alone.

In the case of FRI in Sarawak, there is a need to conduct FRI for the whole state since the last one was about 45 years ago. The FRI must be carried out again to update the latest forest resources status in Sarawak for designing new strategies in sustainable forest management plan for Sarawak in the future.

Given the constraints in the implementation of the new FRI project in terms of sufficient financial allocation and adequate skilled manpower and tough geographical conditions on interior Sarawak, the method of RS Forest Resource Inventory seen more practical to be adapted in Sarawak. Therefore, this project is conducted to study the effectiveness of RS Forest Resource Inventory techniques and to identify the implementation issues that arise for full implementation of FRI project for Sarawak. Heart of Borneo of Sarawak is covering an area of about 210,000 km^2 will be used as study site of the project. The project will address the role of satellite remote sensing technologies as a tool for assessment, measurement and reporting of forest resources in the HoB.

The project has identified five issues and suggests immediate actions to build confidence and capacities during the preparatory phase of the FRI. Following are several issues that have been identified and will be addressed through this project:

- Define the role of satellite remote sensing
- Clarify technical opportunities and limitations
- Secure adequate and relevant data supply
- Enhance technical and institutional capacities
- Be flexible as the National Forest Inventory requirements are changing through time

The main arguments for the integration of remote sensing data are:

- Full coverage of the area in relatively short time
- Less costs due to reduced sampling intensity (some satellite data are freely available)
- Visual documentation of the situation and the changes
- Generation of map data
- Accessibility of information from terrestrial inaccessible or “difficult to access” areas
- Increase of national capacity in mapping, monitoring and reporting
- More harmonized information assessment for the whole country
- Retrospective assessment of changes (the changing situation from the past until today)

Remote sensing currently enhances forest inventory (FRI) in four primary ways:

- Providing faster and less expensive observation or measurement of some forest attributes,
- Increasing the precision of large area inventory estimates, often via stratified or weighted estimation,
- Providing inventory estimates with acceptable bias and precision for small areas for which sufficient field data are
- not available, and
- Producing forest thematic maps that can be used for purposes for forest land use such as planning for timber
- production, conservation area and ecological studies.

Forest Research Institute Malaysia (FRIM) is a research institution that committed to give assistance through research and development, and technology transfer. Specifically, on this scope, FRIM had conducted several studies and consultations projects on forest resource inventory, including with the use of RI technologies. The available expertise of FRIM may be in line with the requirement by Forest Department Sarawak (FDS) in conducting the forest resources inventory. FRIM was appointed as consultant, which acted to produce technical advice, to develop an overall inventory design, to deliver training and technology transfer, and to produce this report.

1.2 OBJECTIVES

The goal of this project is provide the latest information on forest resources in HoB area of Sarawak. Specific objectives of this project are as follow:

i. To develop an inventory design
ii. To stratify and map forest strata
iii. To assess resources and status of forests
iv. To quantify biophysical elements of all strata
v. To conduct capacity building and enhance inventory facilities
vi. To produce forest resource inventory report

This project aimed at providing a forest inventory report as one of the outputs. This report is anticipated to be one of the primary references for the forest resources particularly in the HoB of Sarawak and generally for the state of Sarawak. The information contained in this report will be useful for the management arm in the Forest Department Sarawak in future planning and productions of timbers, especially in the production forest. Besides, the project has produced a Field Inventory Manual as standardized guides for conducting field data collection. Several series of training and technology transfer programs have been organized with cooperation from FRIM to build capacity among department staffs. Facebook account was also created for the project, which is currently active and can be accessed via **https://www.facebook.com/ishsarawak/**.

Along with these outputs, the project has developed indirectly a database that stored a huge amount of data, particularly spatial data including satellite imageries and other related GIS data.

1.3 PROJECT APPROACH

This project will consist of four (4) major phases in which several activities involved within each phase **(Figure 1.1)**. Activities that have been involved in each phase are listed in **Table 1.1**.

Figure 1.1 : Framework of the forest resources inventory work

Table 1.1 : Activities involved in each phase

1 Phase - 1 : Study Phase

1.1	User needs
1.2	Initial investigation
1.3	Formulation of inventory objectives: • Necesisity of the inventory, information needed • Potential users of the results • Formulation of the inventory objectives • Priorities of the objectives
1.4	Determination of the administrative and logistic situations: • Bodies responsible for execution • Budget (available funds, bodies providing funds, financial administration, time available) • Legal basis (right of access to privately owned forest) • Available information (maps, aerial photo, data from previous forest inventories an other types of survey, scientific studies in the inventory area, general details of the forest. Data on variation, description of the terrain, accessibility, and climatic conditions) • Potential use of aerial photo and remote sensing imagery • Possibilities for recruiting qualified staff • Available equipment (vehicle computers and software, measuring equipment, tents) • Responsible bodies (staff management, financial administration, monitoring of data security, data release, dissemination of data, definition of forest inventory objectives and methods, execution of field surveys, data evaluation, formulation and release of the final results, publication, additional analysis)
1.5	User review
1.6	Study phase report

2 Phase - 2 : Design Phase

2.1	General system review
2.2	Compilation of data catalogue and stipulation for measurements: • Listing off all variables to be analysed (depending on inventory objectives) • Definition of qualitative data • Instructions for measurement of quantitative data
2.3	Inventory design • Description of the design to be employed • Sampling method • Description of the sampling units, especially their form, size, number and description • Computation of the necessary sample size for each inventory level, survey intensity • Description of inventory level (UAV data, satellite data, field survey, questionnaires) • Map construction • Estimation of areas • Description of statistical methods for evaluation, estimation procedures, correlations to be applied, and the computed parameters • Methods of volume determination (e.g., volume functions, points of measurement on tree, volume inside or outside bark) • Determination of regeneration conditions • Determination of timber quality • Description of road and transport networks
2.4	Database and/or information system design
2.5	Control requirements
2.6	Software selection
2.7	Equipment selection/acquisition
2.8	Staff recruitment
2.9	Field manual
2.10	Plans for work progress
2.11	Design phase report

3 Phase - 3 : Development Phase

3.1	Implementation planning
3.2	Computer program design
3.3	User review
3.4	Equipment acquisition and installation
3.5	Field test/pilot survey
3.6	Computer program testing
3.7	System testing
3.8	Reference manual preparation
3.9	Personnel training
3.10	Plans for work progress
3.11	Development phase report preparation
3.12	User acceptance report

4 Phase – 4 : Operation Phase

4.1	Interpretation of remote sensing data • Instruments (interpretation instrument, computers, software) • Organization, staff, comptence, duties • Documentation and backup of the results
4.2	Field survey • Organization, central coordination • Communication between field surver teams and central coordinatiors • Recording and delivery of data • Training for field staff (localization of sample plot centers, assessments on sample plots, use of instruments) • Check cruises
4.3	Data evaluation • Digitalization of data • Checking and correction of data • Data analysis • Operating, system management, data security
4.4	Final Report • Preparation (output format printed, Web-based, DVD or disk drives) • Approval for release • Reproduction • Dissemination
4.5	Performance Evaluation

1.4 THE PROJECT AREA

The project area is the Heart of Borneo (HoB) Sarawak, which is located at the southern part of Sarawak, stretching along from the east to the west of the state. It covers about 2.7 million ha bordering Sabah, Brunei and Kalimantan (Indonesia). The topography within HoB is generally hilly and mountainous with elevation of > 200 m up to 2,413 m, the highest summit in Sarawak. Forest is the major land cover and the major forest types in this area are mixed dipterocarp and montane forests, but there is also lowland dipterocarp in the lower parts of HoB. Agriculture crops, settlements area, mixed horticulture, shifting cultivation, paddy crops, and other plantations are also found in this area. Some of the forests are meant for production purpose. Detailed explanations on the project area are provided in Chapter 2.

Generally, in Sarawak there are a total of 120 PFs which constitute of 44 Protected Forests, 47 Forest Reserves, 18 Communal Forests and 1 Government Reserve with the area of 3,964,880 hectares had been gazetted as PFs (as of 2018). Whereas a total of 1,178,634 hectares of Planted Forests are overlapped with PFs (located within PFs) and another 2,357,113 hectares are located within Stateland **(Figure 1.2)**. The later would be potential areas to be gazetted as part of PFs in the future.

Forest Department Sarawak is responsible for the management of PFEs, especially in the concession areas that are designated for production purpose and has control over land use especially regulating logging by issuing licenses or permits for such activities. Totally Protected Areas (TPAs) such as National Parks and Wildlife Sanctuaries are managed by Sarawak Forestry Corporation (SFC).

There are three main categories of forests, supposedly to remain under forest cover in perpetuity and are classified as Permanent Forest (PF). PF consists of: (i) Forest Reserves (FR), which are generally production forests; (ii) Protected Forests, which are constituted for the primary purposes of protection of soils and waters where intensive production of forest crops is unlikely to be practicable; and (iii) Communal Forests, which are areas used by the community concerned. The administrative term of Permanent Forest Estates (PFE) is used for PF. According to international definition, production forests are forested area designated for production and extraction of both wood and non-wood products.

In Sarawak, PF covers 57.71% of the forested area and are mostly dedicated to production forestry. The total area already licensed out for timber extraction is not known, with expert analyses and guesses putting the figure at about 8.8 million ha in the early 1990s. If this figure was taken to be accurate, the total area approximately matched the entire PF category, meaning to say that all available forests have already been licensed out and have been logged, are being logged and are potentially to be logged in the near future. Therefore, over 90% of forest in Sarawak is available for logging, a figure which is almost the same as the total PF category. Only a small percentage of forested area, i.e., 6.64% has legal protection status as national parks, nature reserves or wildlife sanctuaries.

On the other hand, Stateland has more extensive coverage, with the least protection status, and can be potentially alienated and converted to other uses, including timber harvesting. Recently, forest plantations were established, and forms part of the permanent forests i.e., they are classified as PF. As most of the species planted are non-native, forest plantations may be constituted as plantations rather than forests.

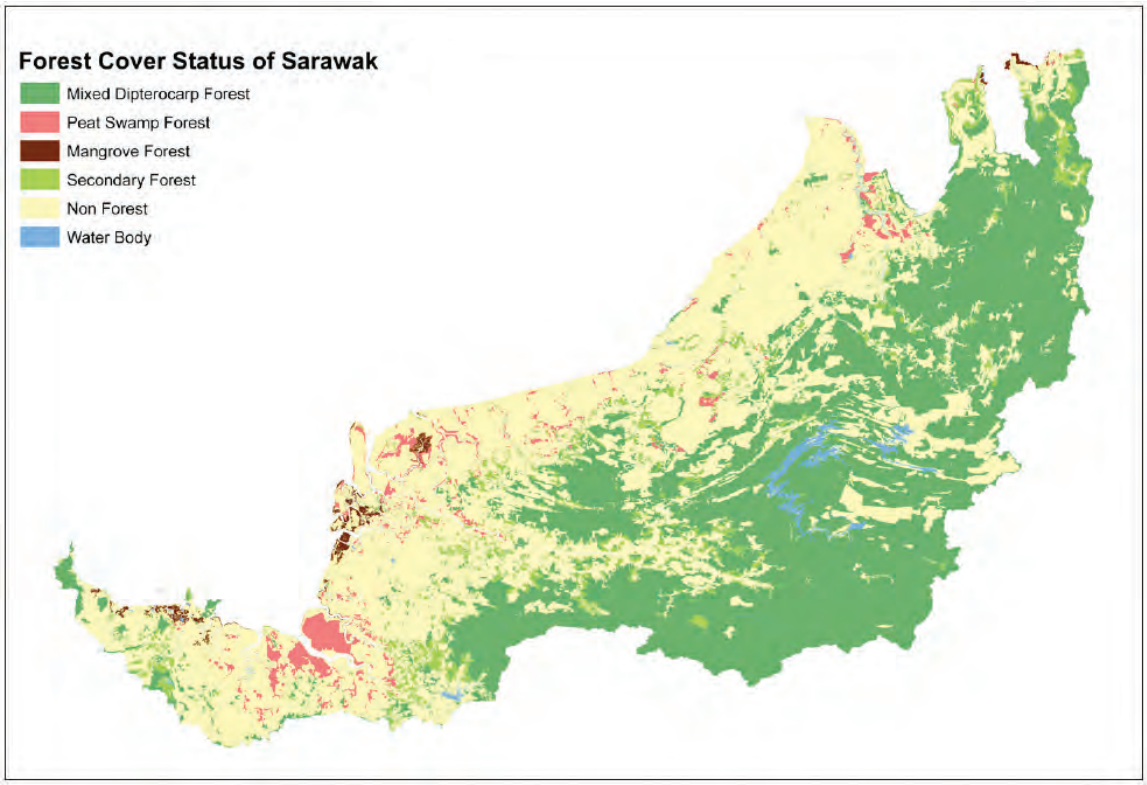


Figure 1.2 : Map showing the distribution of Forest type in Sarawak

1.5 PROJECT IMPLEMENTATION

This project has been implemented in two phases. Phase I concentrated at the original HoB area, which covers 2,125,551 million ha. This phase officially took 27 months starting from September 2016 to December 2018. The forest types in this area mainly inland mixed hill dipterocarps and montane forests. Phase II was then continued in years 2019 - 2020. Phase II was conducted in HoB Extension area, which cover about 0.6 million ha. The forest types within this area are various, but mainly divided into three types, which are mixed dipterocarps forest, peat swamp forest and mangrove forest. Altogether the project area covers some 2,690,802 mil/ha and this report include both phases as one project area, the HoB Sarawak. **Table 1.2** summarizes the overall implementation of this project.

Summary	Phase 1	Phase 2
Locality	HoB, Sarawak	Hob Extension, Sarawak
Total Coverage Area (ha)	2,125,551	565,251
Inventory/ Forested Area (ha)	1,550,367	213,879
Forest Types	Mixed Dipterocarps Forest Montane	Mixed Dipterocarps Forest Peat Swamp Mangrove Kerangas
Implementation Period (Years)	2016-2018	2019-2020

Table 1.2 : Summary of the project implementation

1.6 PROJECT FUNDS

This project was funded by the Ministry of Energy and Natural Resources – KeTSA (formerly known as Ministry of Water, Land and Natural Resources - KATS) under the 11th Malaysian Plan (RMk-11) and partly supported by the State Government of Sarawak. The expenditure was divided into three categories, which are (i) development of facilities, (ii) fieldwork, training, and capacity building, (iii) appointment of consultant.

CHAPTER 2

THE HoB OF SARAWAK

2.1 INTRODUCTION

Heart of Borneo (HoB) Initiative is a voluntary transboundary cooperation between Brunei, Indonesia and Malaysia to enable conservation and environment protection while enhancing sustainable development that improves the welfare of those living on the island. The three ASEAN nations cooperation was officially launched in Brazil on 27 March 2006. On 12 February 2007 the Minister of Natural Resources and Environment, Malaysia; the Minister of Forestry, Republic of Indonesia and the Minister of Industry and Primary Resources, Brunei Darussalam, signed and jointly issued a Declaration in Bali, Indonesia. In Sarawak, the HoB covers 2.689 million ha over a contiguous block along Sarawak's boundaries with Kalimantan and with Sabah and Brunei. **(Figure 2.1)** The HoB is fully in line with existing policies by both state and federal government.

In view of the global concerns and controversy about the tropical forest development, the long-term objective of the HoB Initiative, as enshrined in the Bali Declaration is as follows:

"With one conservation vision and with a view to promote peoples' welfare, we will cooperate in ensuring the effective management of forest resources and conservation of a network of protected areas, productive forests and other sustainable uses".

HoB Sarawak with the earliest total area of 2.1 million hectares is divided into three regions namely Northern Region covering the Miri and Limbang Divisions; Central Region covering the Kapit and Belaga Districts of the Kapit Division; and Southern Region covering Sri Aman, Sarikei and Sibu Divisions as well as the Song District of the Kapit Division.

In 2018, the extension area of HoB Sarawak to 2.69 mil hectares was approved by the State Cabinet. The expansion involves the area from Batang Ai to the western region of Sarawak. This covers the Kelingkang Range, Gunung Apeng National Park, Bungo Range National Park, Gunung Pueh National Park, Kubah National Park, Gunung Gading National Park, Samunsam Wildlife Sanctuary, Matang Wildlife Centre, Kuching Wetland National Park, Bako National Park, Sampadi National Park, Santubong National Park and Tanjung Datu National Park.

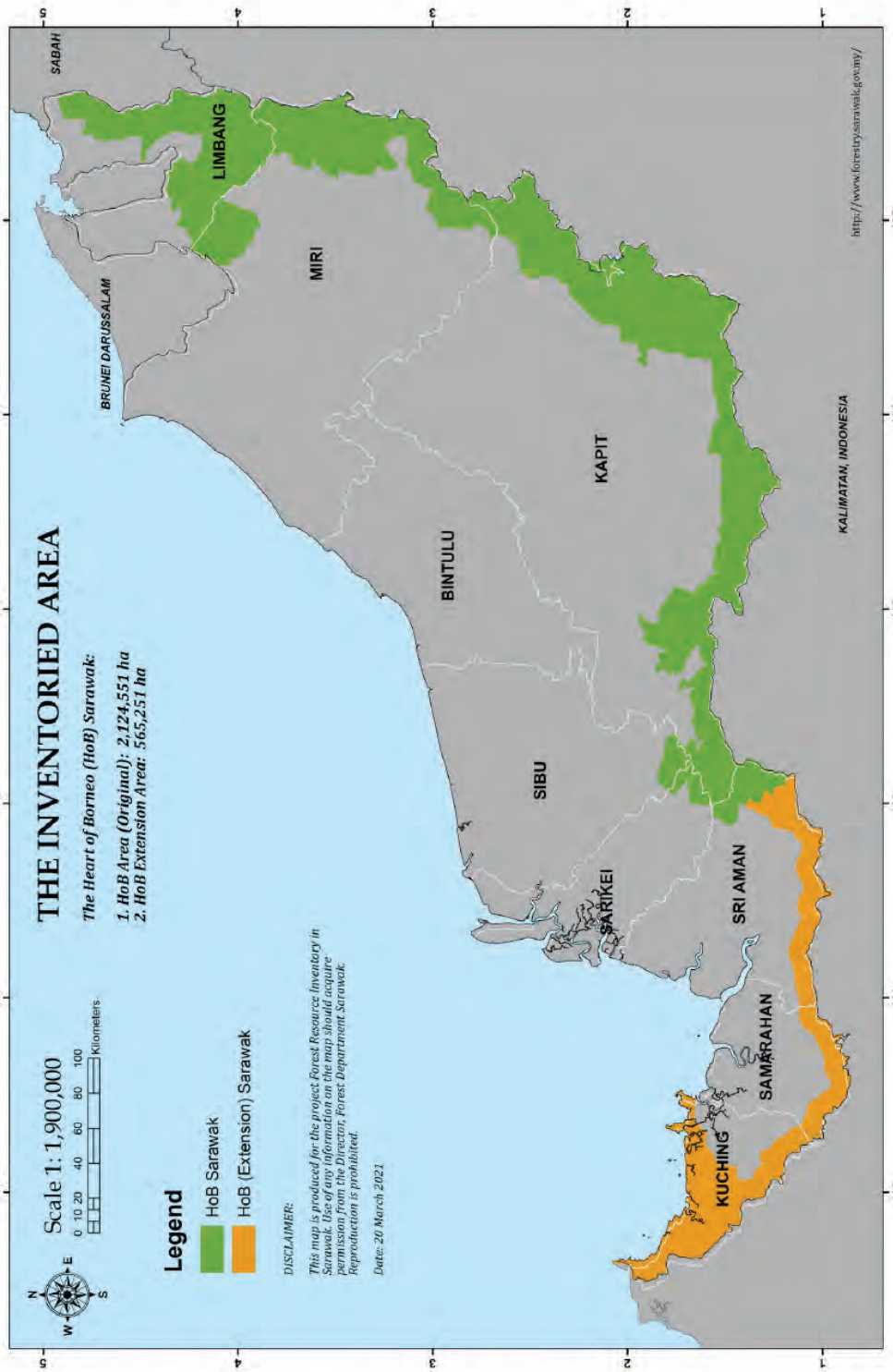


Figure 2.1 : Map showing the extents of HoB Sarawak

2.2 OBJECTIVES OF HoB INITIATIVES

The main objective of HoB initiative is to conserve the last expanse of contiguous forest in Borneo in particular :

1. Maximize Transboundary Linkages
2. Promote Expansion of Protected Area Networks
3. Maintain Forest Connectivity
4. Ensure Sustainable Land Use Practices

2.3 THE PILLARS OF HOB SARAWAK

The implementation of HoB Initiative is based on the 5 Pillars as following.

Pillar 1 - Sustainable Forest Management

Focusing on maintaining the balance between forest used and environmental protection.

Pillar 2 - Ecotourism Based on Culture, Adventure and Nature (CAN)

Focusing on developing the ecotourism involving the local communities to promote conservation and enhance socio-economic well-being.

Pillar 3 - Conservation of Biological Diversity

Focusing on effective management of Totally Protected Areas within the Heart of Borneo areas.

Pillar 4 - Sustainable Landuse/ Agriculture

Focusing on sustainable development of rural communities through wise management of natural resources and agriculture.

Pillar 5 - Community-Based/Rural Poverty Eradication Program

Focusing on the welfare of rural communities through effective management of Totally Protected Areas, production forests and agriculture.

2.4 LANDUSE IN HoB SARAWAK

Heart of Borneo Sarawak generally consisting of various land uses. However, the majority of landuse in the HoB are consisting of various types of forests, mainly the Hill Mixed Dipterocarp Forest. These areas are primarily fall under Permanent Forest Estate (PFE) with a composition of 53.2%, which are managed under the basis of sustainable forest management (SFM) and some 16.4% are under the Totally Protected Area (TPA) **(Table 2.1)**.

No.	Landuse	Area (Ha)	Percentage (%)
1.	Permanent Forest Estate (PFE)	1,431,736	53.2
2.	Totally Protected Area (TPA)	441,240	16.4
3.	Stateland Forest	681,125	25.3
4.	Forest Plantation	89,206	3.3
5.	Settlement	32,340	1.2
6.	Waterbody/Reservoir	14,155	0.5
	Total	**2,689,802**	**100.0**

Table 2.1 : Landuse in HoB Sarawak

Source: https://forestry.sarawak.gov.my/page-0-146-993-Heart-of-Borneo-HoB-Initiative.html

2.5 SUSTAINABLE FOREST MANAGEMENT IN HoB SARAWAK

In more recent time, forest plantations are expanding, resulting in significant land use changes in Sarawak. In 2008, the total forest plantation area in Sarawak was 207,502 ha, about a quarter of the total 863,296 ha throughout Malaysia. By 2009, the total planted area in Sarawak increased by 22.8% to 254,903 ha, which is equivalent to 2.07% of the total land area and 3.25% of the total forested area in Sarawak. Non-native species such as acacia (Acacia mangium) and eucalyptus (Eucalyptus spp.) were mostly planted, which accounted for 75.46% and 6.72% respectively of the total area of forest plantations, while native species such as kelampayan (Neolamarkia cadamba) and albizia (Paraserianthes falcataria) representing only 6.84% and 8.87% respectively. Up to October 2010, the total gross area licensed out for forest plantation was 2.8 Mha. Acacia is highly preferred

because of its outstanding growth performance with mean growth annual increment of 28 m^3 ha^{-1} and are harvestable after seven years, shorter than the 25-year cycle in natural forests. The expansion of forest plantations is highly encouraged, and Sarawak expects to reach the target of planted area of 1 million ha by 2020, similar to an average increment of 13.2% yr^{-1}.

These scenarios can be seen in HoB Sarawak. From the image classification that was performed on Landsat-8 data over 2016/2017, the category of land uses within HoB Sarawak was produced. **Table 2.2** summarizes the extents of each category and presented in **Figure 2.2**. **Table 2.3** shows the managed areas in HoB by Forest Department Sarawak.

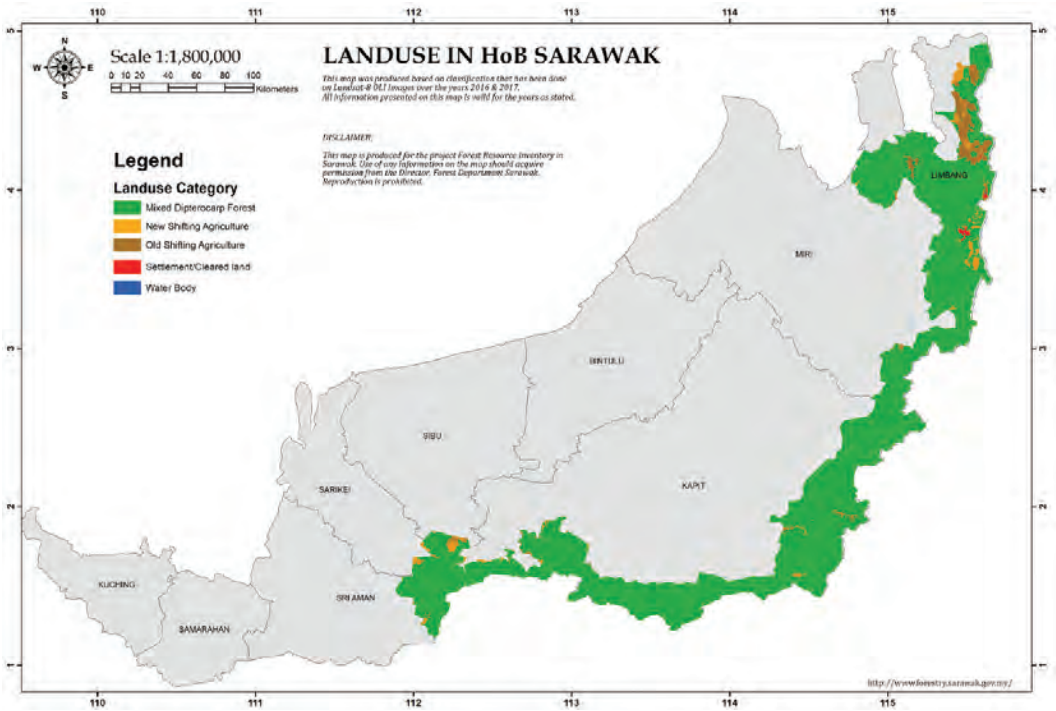


Figure 2.2 : Map showing the extents of original area of HoB Sarawak

Landuse Classes	Area (Ha)	Percentage (%)
New Shifting Cultivation*	50,183.15	2.36
Old Shifting Cultivation	71,492.39	3.37
Settlement/Open Area	5,355.16	0.25
Waterbody	3,358.68	0.16
Total Non-Forest	**130,389.38**	**6.14**
Forested Areas	**1,994,161.68**	**93.86**
Total HoB Sarawak	**2,124,551.05**	**100.0**

Table 2.2 : Types of land uses in the HoB Sarawak

**Note: Some new shifting oil palm plantation.*

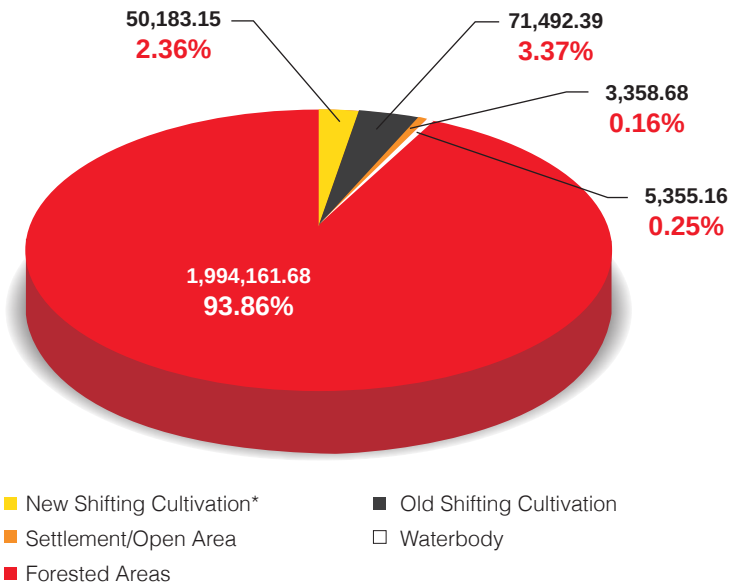


Figure 2.3 : The breakdown of land uses in the HoB of Sarawak

Managed Area	Area (Ha)
Licensed Planted Forest*	511,612.00
Totally Protected Area*	700,144.52
Timber Licensed	1,499,316.01

Table 2.3 : The managed areas in the HoB of Sarawak

**Note: Some licensed planted forests are overlapped with the licensed timber areas.*

2.6 FORESTED AREAS IN HoB (EXTENSION) SARAWAK

Out of the 565,251 ha of HoB Extension area, 37.8% or about 213,879 ha are forested. The remaining areas are covered by other non-forested land uses. Around 51.36% of the forested area is lowland dipterocarps forest with an area of 109,842.15 ha, followed by hill dipterocarps (23%) and kerangas/heath forests (10.16%). The remaining are consisted of mangroves, peat swamp and montane forests. The composition of forest types in the project area is summarized in **Table 2.4** and **Figure 2.4.**

Forest types	Forest classification	Area (Ha)	Percentage (%)
Mixed Dipterocarp Forest	Lowland Dipterocarp	109,842.15	51.36
	Hill Dipterocarp	49,198.44	23.00
	Upper Hill Dipterocarp	6,064.95	2.84
Montane Forest	-	837.35	0.39
Mangrove Forest	-	21,737.45	10.16
Peat Swamp Forest	-	984.79	0.46
Kerangas/Heath Forest	-	25,213.56	11.79
	Total Forested Area	**213,878.69**	**100.0**

Table 2.4 : Forested areas in HoB Extension Sarawak

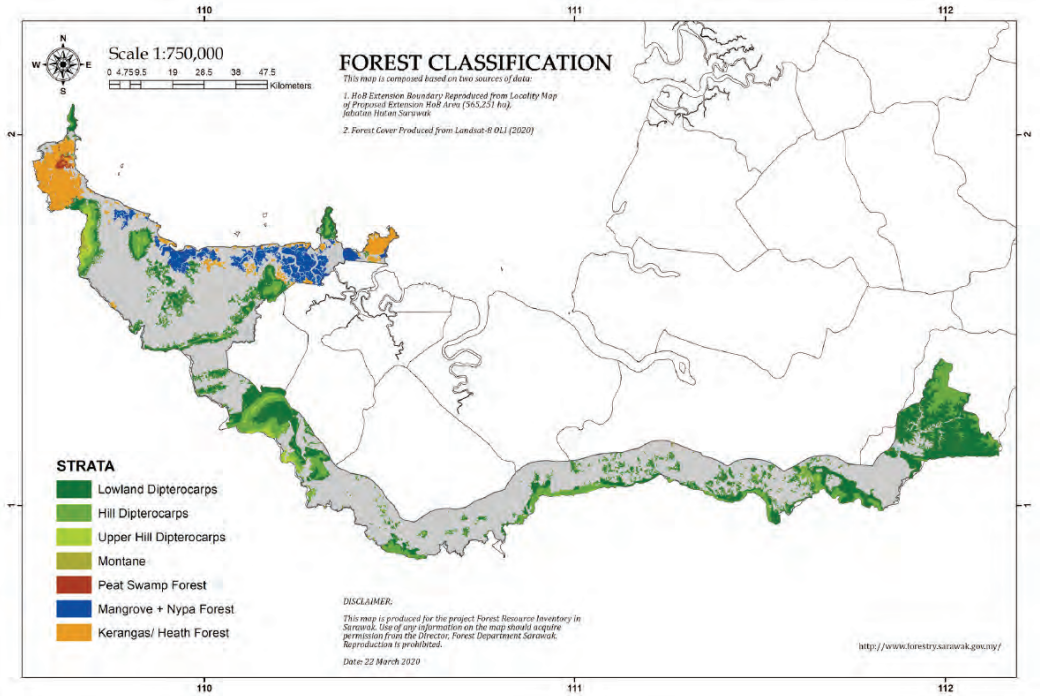


Figure 2.4 : Map showing the extents of HoB Extension Sarawak

2.7 MANAGEMENT OF FORESTS IN THE HoB AREA

Forest areas in the HoB is categorized based on forest functional classes as shown in **Figure 2.5**. These classes were based on land status and the prescribed activities such as Totally Protected Areas (TPA), Forest Timber License (FTL), and License Planted Forest (LPF).

2.7.1 TOTALLY PROTECTED AREAS

Table 2.5 lists all Totally Protected Areas (TPA's) within the HoB. The TPA are categorized into national parks, wildlife sanctuaries, and nature reserves. The extent of TPAs including those in proposed stage in the HoB is 599,434.80 ha. The reservation of these TPAs is prescribed in National Parks and Nature Reserves Ordinance (1998) and Wildlife Protection Ordinance (1998) constitutions. The management of TPAs in Sarawak are now placed under the Sarawak Forestry Corporation (SFC).

Tourism is allowed in national parks and nature reserves. In wildlife sanctuaries, tourism will be allowed only with the permission of the Chief Wildlife Warden. The Lanjak Entimau Wildlife Sanctuary in the south, and Gunung Mulu National Park (NP) and Pulong Tau NP in the north-east are the three largest TPA in the Sarawak. Gunung Mulu NP renowned for its rich plant and animal diversities, spectacular limestone formations and underground caves, is a World Heritage Site – the first in Sarawak (Anon, 2009).

No.	Gazetted Totally Protected Areas (TPAs)	Area (Ha)
	National Park	
1.	Bako National Park	2,727.00
2.	Baleh National Park	66,721.00
3.	Batang Ai National Park	24,040.00
4.	Batang Buli National Park	1,128.00
5.	Batu Iran National Park	4,953.00
6.	Bungo Range National Park	8,096.00
7.	Gunung Apeng National Park	1,174.00
8.	Gunung Buda National Park Gunung Buda National Park (Ext)	6,235.00 5,072.00
9.	Gunung Gading National Park	4,196.00
10.	Gunung Mulu National Park Gunung Mulu National Park (Ext I) Gunung Mulu National Park (Ext II)	52,865.00 4,555.00 28,251.00
11.	Gunung Pueh National Park	5,831.00
12.	Kalamuku National Park	17,527.00
13.	Kubah National Park	2,320.00
14.	Kuching Wetland National Park	6,610.00
15.	Long Repun National Park	8,531.00
16.	Matang Wildlife Center	56.00
17.	Pulong Tau National Park Pulong Tau National Park (Ext I)	59,817.00 10,000.00
18.	Sabal National Park	4,709.00
19.	Sempadi National Park	1,240.00
20.	Santubong National Park Santubong National Park (Ext I)	1,410.00 231.00
21.	Tanjung Datu National Park	752.00

No.	Gazetted Totally Protected Areas (TPAs)	Area (Ha)
	Nature Reserve	
22.	Pulau Perepat Nature Reserve	6.80
23.	Selabat Mudflats Nature Reserve	199.00
	Wildlife Sanctuary	
24.	Lanjak Entimau Wildlife Sanctuary Lanjak Entimau Wildlife Sanctuary (Ext I) - Area I & II	168,758.00 14,225.00
25.	Samunsam Wildlife Sanctuary Samunsam Wildlife Sanctuary (Ext. I)	6,092.00 16,706.00
26.	Sungai Jelangai Wildlife Sanctuary	19,331.00
	Total Area	**554,274.80**

No.	Proposed Totally Protected Areas (TPAs)	Area (Ha)
27.	Proposed Batang Ai National Park (Ext I)	7,944.00
28.	Proposed Bengoh Dam National Park	1,093.00
29.	Proposed Bungo Range National Park (Ext I)	1,193.00
30.	Proposed Klingkang Range National Park	4,230.00
31.	Proposed Paya Maga National Park	13,283.00
32.	Proposed Pulong Tau National Park (Ext II)	13,541.00
	Nature Reserve	
33.	Proposed Ulu Sebuang Nature Reserve	668.00
	Wildlife Sanctuary	
34.	Proposed Sungai Moh Wildlife Sanctuary	3,208.00
	Total	**45,160.00**

Table 2.5 : Totally Protected Areas (TPA) within the HoB

Source: Sarawak Forestry Corporation (SFC)

Under Program 2: Protected Areas Management of Programs and Plans of Actions for HoB initiative, the main aim is to enhance and promote effective management of protected areas within the HoB area, with the emphasis at those situated on the common border , to conserve and maintain forest biodiversity and the ecological linkages. The proposed actions are as in the **Table 2.6** following the current restructuring between FDS and SFC, the functions of protection and management of TPA and wildlife is now under the jurisdiction of SFC.

No.	Actions
1.	Identify, assess, and establish trans-boundary conservation zones to strengthen the management of these protected areas based on their cultural and natural heritage values, water catchments capacity and biodiversity richness.
2.	Develop and enhance standard operating procedures and systems for monitoring and evaluation of the trans boundary conservation area management and undertake joint monitoring and evaluation activities if necessary.
3.	Develop and enhance system and implementation for transboundary protected areas collaborative management program, including local community.
4.	Develop and enhance approaches for improving local and vegetation management on areas cultivated by local communities, within or adjacent protected areas.
5.	Establish a master list of protected areas within the HoB with information on the management objectives, special features and the relevant agencies and personnel involve as well as the respective country categories.
6.	Promote institutional linkages among the protected area within the HoB.

Table 2.6 : Proposed actions in the protected areas

Source: Anon (2008)

2.7.2 TIMBER PRODUCTION IN THE HoB AREA

The Forest Timber License (FTL) and Occupation Permit License (OPL) are designated for the timber productions within the HoB. There are 34 FTL and 5 OTL, which made up 1,364,514 ha and 23,318 ha, respectively. The cutting periods of the licenses are vary depending on the area and license terms and conditions. Based on report in Anon (2009), upon expiry, licenses may be renewed for another round of cut. Each license is divided into several annual felling coupes, with each coupe varying in size from about 1,500 ha to 2,500 ha. Each coupe is further divided into logging blocks averaging 100 ha each. The minimum diameter cutting limits are 60 cm DBH and 45 cm DBH respectively for Dipterocarp and Non-dipterocarp trees. Before felling is allowed, each timber licensee is required to carry out an inventory to identify and mark timber trees that have exceeded the minimum cutting limits. One tree per hectare is to be retained as mother trees.

In the year 2018, total forest size involved in the logging operation was 2,317,497 ha with total production of timbers were 2,160,470.28 m^3. Total amount of royalty collected as state's revenue from the logging operation in 2016 in the HoB was about RM 140 million.

Besides there are also License Planted Forest (LPF) within the HoB. There are 8 LPF in year 2018 with a total size of 347,692 ha. In the LPF areas, all merchantable trees will be salvaged before the forest is cleared. As reported in Anon (2009), many licensed planted forests (LPF) are located within existing timber licenses. Many of these plantation licenses have been excised from existing timber licenses. Acacia mangium, a fast-growing exotic, is the principal and preferred species due to its ability to adapt well to a wide range of local site conditions. Other exotics like Eucalyptus and several indigenous species such as Neolamarckia cadamba (Kelampayan). Acacia mangium fiber is suitable for pulp and paper production but varieties for solid timber have also been introduced. Planting distance is usually 3 m × 4 m. The mean annual increment is estimated at 2.7 cm, and the harvesting schedule is seven years after planting.

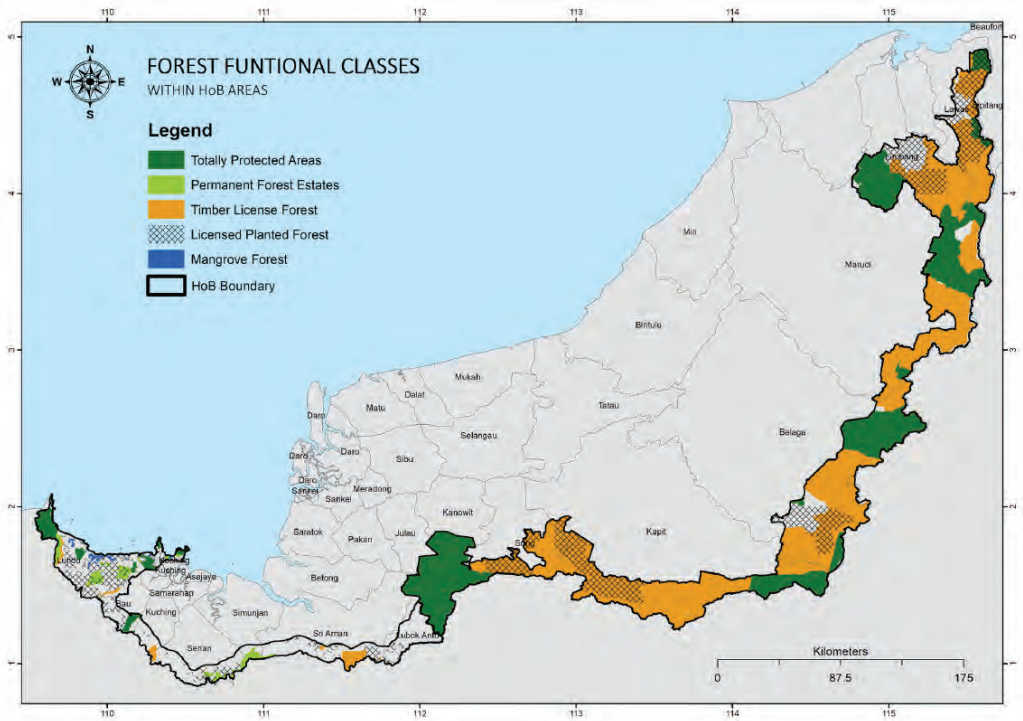


Figure 2.5 : Forest functional classes in the HoB Sarawak

2.8 THE INVENTORY AREAS

The forest inventoried under the project consisted MDF, Mangrove, PSF and Kerangas. For the purpose of replanting MDF is further divided into several classes based on land elevation. The forests inventories is given in **Table 2.7** and the overall land elevation in Sarawak is depicted in **Figure 2.6**.

HoB Sarawak	Extent (ha)
Lowland Dipterocarps Forest	251,315.15
Hill Dipterocarps Forest	609,066.44
Upper Hills Dipterocarps Forest	572,399.95
Montane Forest	283,564.35
Peat Swamp Forest	984.79
Mangrove Forest	21,737.45
Kerangas/Heath Forest	25,213.56
Total	**1,764,281.69**

Table 2.7 : The extent of the inventory area

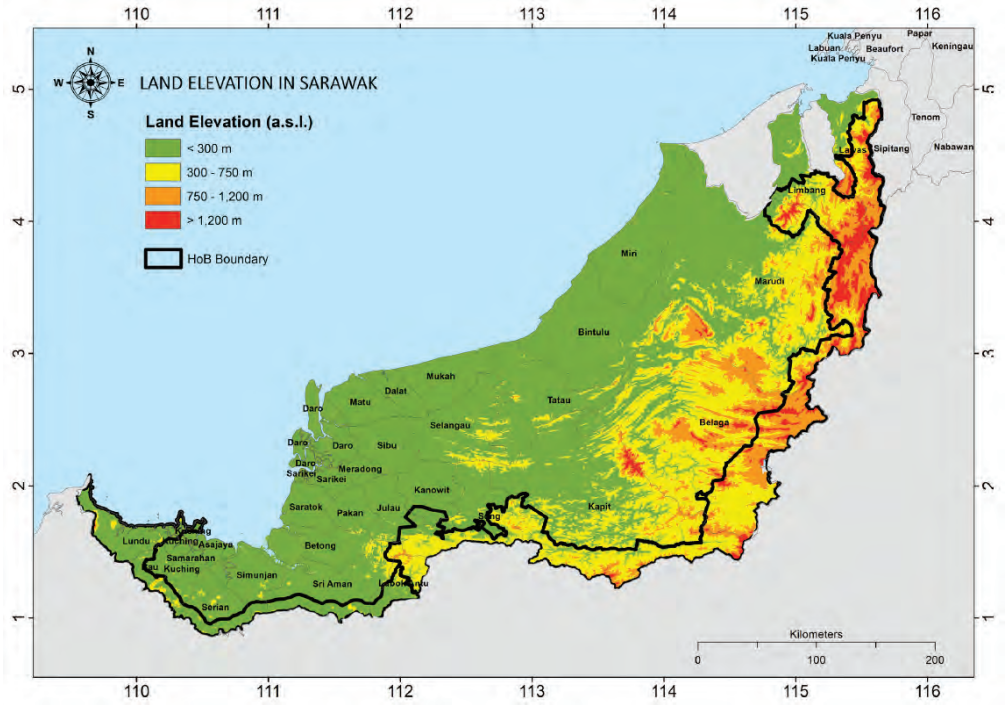
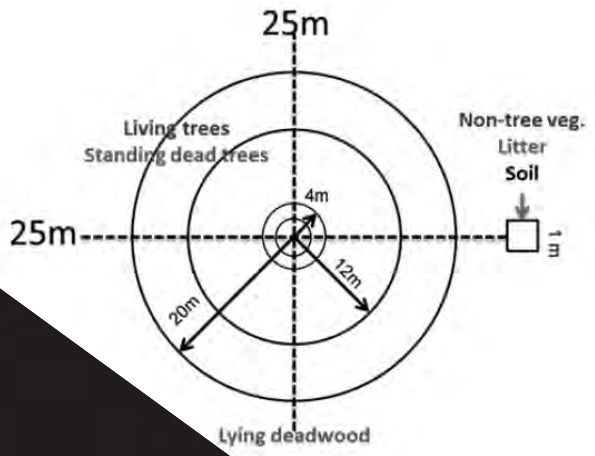


Figure 2.6 : Land elevation in Sarawak



CHAPTER 3

SAMPLING DESIGN

3.1 INTRODUCTION

This project adopted three designs of sampling plot, which are separated based on the major forest types in Malaysia, i.e., inland dipterocarp forest, peat swamp forest and mangrove forest. Followings describe each design in general and a detailed procedure are included in Fieldwork Manual (Manual Kerja Lapangan) document. Other types of forests will also be using these designs accordingly based on its forest conditions similarity. For example, kerangas and melaleuca swamp forests are adopting the peat swamp forest's sampling plot design.

3.2 FOREST TYPES IN SARAWAK

Sarawak is the second to Peninsular Malaysia in terms of landmass covering 12.4 million hectares and is located on the island of Borneo. The management of forest land in Sarawak is cover an area of the Permanent Forest Estate (Protected Forest, Forest Reserve and Communal Forest). About 62% (7.72 mil. ha) of the State land mass area is under forest cover (based on satellite imageries 2018). Forest land in Sarawak is classified mainly into three (3) categories i.e., Permanent Forest Estates, Totally Protected Areas (National Parks, Wildlife Sanctuaries and Nature Reserves) and Stateland Forest.

Sarawak has several different forest or vegetation types that are generally recognised. These include Hill Mixed Dipterocarp Forest (7.35 mil. ha), Peat Swamp Forest (0.33 mil. ha), Mangrove Forest (0.07 mil. ha) and others (Kerangas Forest, Montane Forest and Limestone Forest).

The State Government has designated about 6 million hectares of the forest areas are designated as the Permanent Forest which is meant for sustainable forest management and about 1 million hectares are designated as Totally Protected Areas.

Hill Mixed Dipterocarp Forest is the most widespread and arguably the most complex forest type in Sarawak. It occurs from the inland limit of the coastal peat swamps to the lower limit of the Montane Forest in the interior (1,500 m a.s.l) and is characterised by a great diversity of species and life forms. Trees, shrubs, herbs and climbers occupy the space from the forest floor up to the main canopy (at about 45m). Some trees emerge from the main canopy and can reach 60 metres tall. A high proportion of the trees in this forest type belong to the Dipterocarpceae family (e.g., Meranti, Selangan Batu, Kapur, Keruing and Mersawa) and produce valuable logs owing to their large size, cylindrical shape, and excellent timber properties. MDF is currently the most important forest type economically due to its wide extent and its composition.

Peat Swamp Forest is also extensive and is located chiefly on low-lying coastal plains and inland along the lower river systems where the water table is usually at or near the soil surface. It is less diverse than MDF but contains valuable and economically important timber tree species.

Mangrove Forest covers a comparatively small area as it occurs only in tidal and estuarine areas from coastal mudflats as far upriver, and landward, as the limits of saline influence. It includes only those few species that can survive periodic exposure to wave action and inundation by tidal or brackish water. Its composition varies from place to place depending on the frequency of inundation and the salinity of the water. Pure Bakau stands occur in some parts of the mangrove and these are an important source of poles for charcoal production. Mangrove forest is rich in other resources that local communities harvest (crabs, nipah sugar, atap) and is where prawns and fish breed, so is vital to local fisheries. The other forest types in Sarawak are neither extensive nor economically important.

Sarawak's natural forests have high plant diversity due to the great variety of habitats. There are about 3,000 known tree species of which 40% of Sarawak's plant species are endemic to Borneo. There are about 185 mammal species, 530 bird species, 166 snake species, 104 lizard species and 113 amphibian species in the State. A large proportion of Sarawak's animals are unique to Borneo and do not occur in mainland South-east Asia.

3.2.1 MIXED DIPTEROCARPS FOREST (MDF)

It is widespread, covering more than 80% of Sarawak's natural forest area. The Hill Mixed Dipterocarp Forests are richly diversified and contain the greatest number of economically important trees. These include Meranti (*Shorea* spp.), Kapur (*Dryobalanops* spp.), Keruing (*Dipterocarpus* spp.) and Mersawa (*Anisoptera* spp.) which are highly prized as timber.

The hill mixed dipterocarp forest is non-homogeneous, and five canopy layers can be identified, as shown in the diagram. The topmost layer comprises the biggest trees that reach to 60 meters in height, standing out singly or in clusters above a continuous second layer that reaches up to 45 m.

Below this level is an under-story of 23 to 30 m tall trees that sometimes intermeshes with the main canopy. Shorter woody treelets and shrubs form the fourth strata while the last layer is found on the forest floor which is carpeted with herbs and seedlings.

Because of the very nature of forest dynamics, the canopy is very tightly knitted since gaps (resulting from lightning strikes or the falling and decay of over-mature trees) are rapidly filled with sprouts of saplings and seedlings. The result is a tangled web of greenery wherever you go in the forest.

3.2.2 PEAT SWAMP FOREST

The peat swamp forests have a major role in the economic development of the State since 1947. They were the first forests to be logged commercially due to their easy access and the occurrence of the highly valuable timber, Ramin (*Gonystylus bancanus*). Peat swamp forests are located immediately behind the coastline and extend inland along the lower reaches of the main river systems.

Five peat swamp forest types are recognized:

[a] Mixed Swamp Forest

Occurring in the peripheral zone of the swamp, the mixed swamp forests cover extensive areas of mainly shallow peat near the coast. This is the most valuable forest type consisting of species such as Ramin (*Gonystylus bancanus*), Jongkong (*Dactylocladus stenostachys*), Geronggang Padang (*Cratoxylum glaucum*) and Swamp Meranti (*Shorea* spp.).

[b] Alan Batu Forest

This forest, in its primary condition, is similar to that of the mixed swamp forest except that it is dominated by large trees of Alan (*Shorea albida*). The total number of species in this forest type is only slightly less than that in mixed swamp forest.

[c] Alan Bunga Forest

The primary stands of Alan Bunga Forest are dominated by an even canopy of Alan (*Shorea albida*) which may reach a high volume. This forest type, generally, does not have any middle storey. The lower storey, although moderately dense, is composed of very few species.

[d] Padang Batu Forest

The mature stands of this forest type are usually dense, pole-like with small crowns, and have a stunted appearance. They consist of almost pure stands of Alan (*Shorea albida*).

[e] Padang Paya Forest

This is a group of several minor types which, for practical purposes, are grouped as one forest type. They are small in area, fragmentary in occurrence and of little commercial importance. One major type of the Padang Paya Forest is similar to the Padang Alan Forest but is not dominated by Alan. It is characterised by dense stands of pole-size trees which may reach rather high volume. The stands may be dominated by Medang (*Litsea* spp.), Geronggong Padang (*Cratoxylum glaucum*), Bintangor (*Calophyllum* spp.), Keruntum (*Combretocarpus rotundatus*) and/or other minor species.

3.2.3 MANGROVE FOREST

Mangrove Forests occur along the coastline and within estuaries of rivers where alluvium brought down by the rivers is deposited. They are liable to flooding by saline water, and the degree and frequency of inundation largely determine species distribution.

The pioneers of mud flats are Pedada and Perepat (*Sonneratia* spp.) which are always followed by Api-Api (*Avicennia* spp.). The latter form a barrier against the waves and tides with their long spreading root systems and numerous pneumatophores. The establishment of species of Rhizophoraceae (*Bruguiera and Rhizophora* spp.) then follows. In areas that are inundated at spring tides, Buta-Buta (*Excoecaria agallocha*) may form almost pure stands. The Nipah palm (*Nypa fruticans*) covers large areas where there is influence of fresh water.

The Mangrove Forests have been harvested mainly for firewood, charcoal, poles, cutch, thatch and woodchips. The nipah sugar is derived from the Nipah palm (*Nypa fruticans*). The intertwined tree roots of mangrove grow densely together stabilising the coastline, protecting it from erosion. The forest is a natural habitat for the proboscis monkeys which feed on the leaves of mangrove trees. Various forms of marine life also thrive in the mangrove.

3.2.4 KERANGAS FOREST

The word Kerangas, which means “land which cannot grow rice”, comes from the Iban language. Heath forests occur on acidic sandy soils that are the result of the area’s siliceous parent rocks. Permanently waterlogged heath forests are known as kerapah forests. The sandy soil of the heath forest is often lacking in nutrients; it is generally considered that nitrogen is the nutrient which is most lacking for plant growth in these forests. This contrasts with many other lowland rain forests where phosphorus is lacking.

3.2.5 MELALEUCA SWAMP FOREST

Melaleuca forest or locally known as Gelam forest mostly occur in beach ridges interspersed with swales (BRIS) sandy areas, coastal, wetland, peatland, and lowland regions. It is a mono-specific species dominance ecosystem, where Melaleuca cajuputi trees are dominant. It is fringing especially along the coast of Peninsular Malaysia, Sarawak and Sabah. The landscape is small, but it has equal importance to other ecosystems in terms of local environmental functions and economic contributions. The benefits include timber for building constructions and furniture and other traditional uses, such as for fuel wood, charcoal, tea-tree, honeybee breeding areas and others. Currently there are about 200 ha of Melalueca swamp forest in Sarawak and some of them are located within the HoB area.

3.2.6 MONTANE FOREST

Montane forests cover the Borneo highlands from around 1,000 metres to 3,300 metres (Mt Kinabalu, Sabah). At the higher end of this range, forests are dominated by oaks (Quercus species) and laurels (Lauraceae family), and rhododendrons (belonging to family Ericaceae) and pitcher plants are easily found. At their highest altitudinal limits, montane forests are covered by moss-draped bushes and epiphytes (orchids, ferns, moss, lichen, and liverworts). In general, the higher the altitude, the lower the canopy height. Example of montane forest found in Sarawak are Gunung Mulu National Park and Payeh Maga Montane Forest and both include in the HoB area.

3.3 FOREST LAND STATUS

3.3.1 PERMANENT FOREST ESTATE

The Forests Ordinance cap 126 provides for the establishment of three categories of permanent forests.

a. Forest Reserves. Forest Reserve is a part of the Permanent Forest Estate which will normally be a productive forest, destined to be the principal permanent source of the state's supply of timber and other forest produce which admits limited rights or privileges for the local people to utilize the forest produce. Forest Reserves are constituted wherever the strictest form of control is necessary for the realisation of sections (1) and (2) of the general statement of the Forest Policy.

b. Protected Forests. In Protected Forests, the Forests Ordinance cap 126 permits the people of Sarawak to take forest produce for their own domestic use, to hunt and to fish, and to pasture cattle. A Protected Forest may be constituted if the primary purpose of constitution is the general protection of soils and waters, and the terrain or vegetation is of such a nature that intensive management as an important productive forest is unlikely to be practicable; or if an extensive Permanent Forest is constituted in little-known territory, where the correct use of all the land cannot yet be determined.

c. Communal Forests. A Communal Forest will be constituted only where it is clearly the desire of a settled community to set aside a convenient area of woodland to provide the domestic needs of forest produce. Such forest shall be under the control of the Administration, who shall, however, consult the Forest Department on all important technical matters. Communal Forests will normally be large enough only to supply, permanently, the domestic needs of the community specified, allowing for a reasonable increase in population; but exceptions may be made when the necessity of preserving forests for protective reasons is combined with the need for domestic supplies of forest produce.

3.3.2 TOTALLY PROTECTED AREA (TPA)

Totally Protected Area (TPA) in Sarawak refers to forest lands so designated and established under the provisions of the National Parks Ordinance, 1998 and Wildlife Protection Ordinance, 1998. These forest lands are managed to generate sustainable benefits for the society. Their roles include:

- conservation and protection of wildlife and their habitat;
- preservation of specific natural geological or physiographical features, landscape and site, of special interest for archaeological, recreational, educational or conservation purposes, on land and in areas beneath the territorial waters of the State;
- facilitating study and research on the biodiversity of the State;
- preservation and protection of the natural scenic beauty, and the historical sites and historical monuments on land and in the territorial waters of the State; and
- affording opportunities for public appreciation, enjoyment, interest and education of the natural scenic beauty, wildlife habitat, flora and fauna, geological and physiographical features and landscape, historical sites and historical monuments of the State.
- The designated TPA system covers about 1 million hectares of forests, or 8% of Sarawak's total area. Inhabitants of Sarawak are prohibited from hunting, fishing, and taking any form of forest produce in the TPA.

These forest lands are classified as National Parks, Wildlife Sanctuaries, Wildlife Rehabilitation Centres, Nature Reserves and Marine Parks.

There are three categories of TPA's in Sarawak:

a. National Parks
b. Wildlife Sanctuaries
c. Nature Reserves

National parks are open to the public for recreation, but the wildlife sanctuaries have limited public access and are strictly for conservation and research. Nature reserves have the same functions as national parks except that they are smaller in size, being less than 1,000 ha.

3.4 PLOT DESIGN

The sample plot design adopted in this project are based on the forest types, which are generally divided into three (3) designs; (i) plot design for inland forest (i.e., mixed dipterocarps forest), (ii) peat swamp forest, and (iii) mangrove forest.

3.4.1 MIXED DIPTEROCARP FOREST

The sampling design in this study was a modified sampling design according to the standard operating procedure (SOP) that has been developed by Winrock International (Walker et al. 2012), which follows the IPCC standards (IPCC 2006). A cluster comprises four (4) plots and the design is shown in **Figure 3.1**. The plot was designed in circular with smaller nests inside **(Figure 3.2)**. The biggest nest measures 20 m in radius, followed by the smaller nests measuring 12 m and 4 m. The sizes of trees are measured according to the nest sizes, which is summarized in **Table 3.1**. Depending on the nest size, it indicates that not all stands are measured in a single plot. In additional to these nests, there is another small nest measuring 2 m in radius, which is used to count the saplings (i.e., trees measuring < 10 cm in diameter at breast height (dbh) and > 1.3 m in height). A cross-transect measuring 25 m in radius is laid on the plot, which made up a total of 100-m transect is used to measure lying deadwood. At the end of transect, a quarter-meter square plot (1 × 1 m), known as a clip-plot will be laid for sapling, litter and soil sampling. A cluster requires only 1 clip-plot to represent the entire cluster. It can be located at anyone (A/ B/ C/ D) of the sampling plot. The clustering of multiple plots at one sampling unit allows field crews to sample a larger area per sampling point. Clustering of plots at each sampling unit is recommended for natural forest areas particularly at selectively logged area. The sampling system is design in a way to make the data collection processes easier, faster, reliable and representative for a forest stratum.

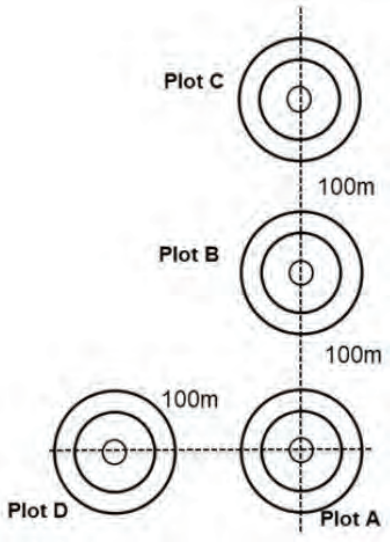


Figure 3.1 : Layout of a cluster for inland forest

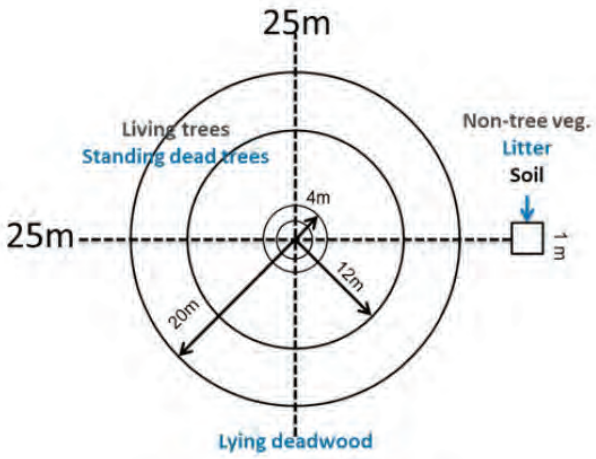


Figure 3.2 Layout of a sampling plot for inland forest

Nest radius (m)	Size	Tree size, dbh (cm)
2	Sapling	< 5 cm & > 1.3 m height
4	Small	5 - 14.9 cm
12	Medium	15 - 29.9 cm
20	Large	≥ 30 cm

Table 3.1 : Summary living trees measurement in a plot in inland forest

3.4.2 PEAT SWAMP FOREST

Peat swamp forests are oligotrophic terrestrial wetland ecosystems that have high soil acidity (pH less than 4.0) and are low in nutrients **(Dwiyono & Rachman 2006)**. Peat forests are those with organic soil horizons (peat). The supply of water and nutrients to the ecosystem may come solely from rainfall (ombrogenous) or flooding and groundwater (minerogenous). High rainfall rates, low drainage, and high temperatures with little seasonal variation influence peat formation in the tropics. Peat swamp forests are usually inundated at least during the rainy season, which promotes anaerobic conditions affecting rates and pathways of decomposition and accumulation **(Rieley et al. 1996)**. In tropical ecosystems, peat soils have been defined as those with a concentration >65% of organic matter and at least 50 cm thickness **(Rieley & Page 2005)**.

Ecologically, peat swamp forests ecosystem is uniquely different from inland and mangrove forests. Therefore, the sampling design of peat swamp forests is differently designed. However, approach and concept for field data collection and sampling is similar. The sampling is organised in a cluster, comprising 6 plots, as shown in **Figure 3.3**. The sampling technique for peat swamp forest is adopted from Kauffman et al. (2016) and the layout of sampling plots is depicted in **Figure 3.4**. The sizes of trees are measured according to the nest sizes, which is summarized in **Table 3.2**. Same design was applied for kerangas and melaleuca swamp forest.

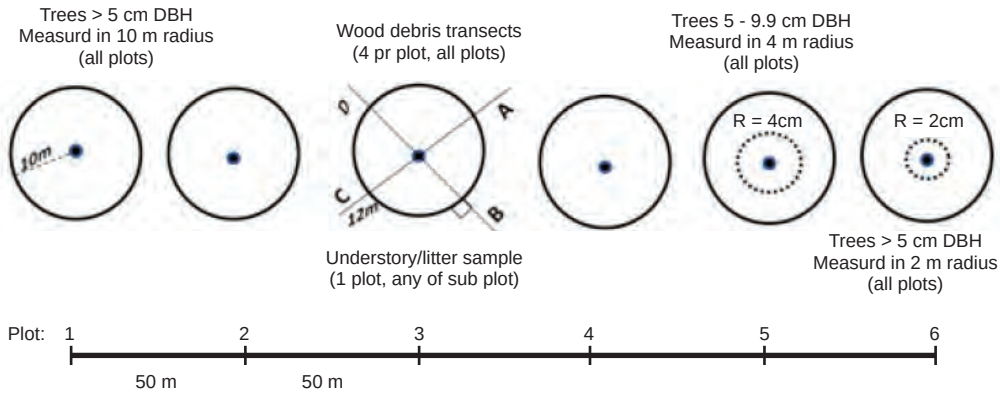


Figure 3.3 : Layout of a cluster for peat swamp forests

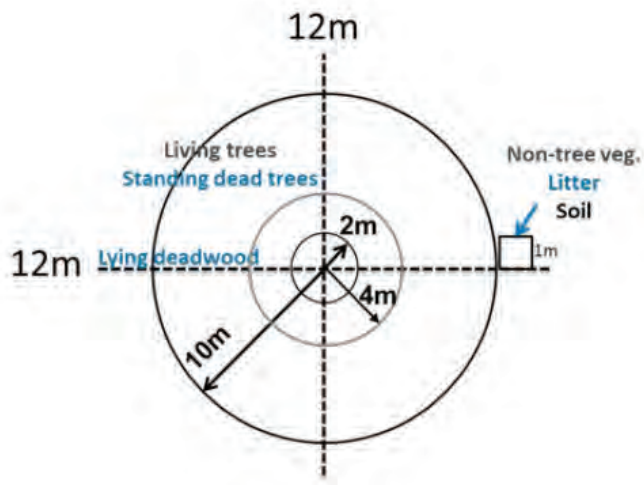


Figure 3.4 : Layout of a sampling plot for peat swamp forests

Peat swamp forests are oligotrophic terrestrial wetland ecosystems that have high soil acidity (pH less than 4.0) and are low in nutrients **(Dwiyono & Rachman 2006)**. Peat forests are those with organic soil horizons (peat). The supply of water and nutrients to the ecosystem may come solely from rainfall (ombrogenous) or flooding and groundwater (minerogenous). High rainfall rates, low drainage, and high temperatures with little seasonal variation influence peat formation in the tropics. Peat swamp forests are usually inundated at least during the rainy season, which promotes anaerobic conditions affecting rates and pathways of decomposition and accumulation **(Rieley et al. 1996)**. In tropical ecosystems, peat soils have been defined as those with a concentration >65% of organic matter and at least 50 cm thickness **(Rieley & Page 2005)**.

Nest radius (m)	Size	Tree size, dbh (cm)
2	Sapling	< 5 cm & > 1.3 m height
4	Small	5 - 14.9 cm
12	Medium	15 - 29.9 cm
20	Large	≥ 30 cm

Table 3.2 : Summary living trees measurement in a plot in peat swamp forests

3.4.3 MANGROVES FOREST

Mangroves are defined as an association of halophytic trees, shrubs and other plants growing in brackish to saline tidal waters of tropical and subtropical coastlines **(Mitsch & Gosselink 2007)**. Mangroves are generally restricted to the tidal zone. As such, mangroves in fringe areas will be inundated by practically all high tides, while those at the higher topographic boundaries may be flooded only during the highest of tides (spring tides) or during storm surges. Mangroves are typically found along tropical and subtropical coastlines between about 25° N and 25° S.

Mangrove is another forest ecosystem that are totally different compares to inland and peat swamp forests. Mangrove forest has its own habitat, which are unique in terms of ecology, stands structure and species composition. Therefore, the sampling method for mangrove forest is designed specifically for the mangroves. However, the approach and concept of field data collection is similar to that of peat swamp forests. The sampling can be organised in a cluster, comprising 6 plots **(Figure 3.5)**. The sampling technique for mangrove forest is adopted from Kauffman and Donato **(2012)** and the layout of sampling plots is depicted in **Figure 3.6**. The sizes of trees were measured according to the nest sizes, which is summarized in **Table 3.3**.

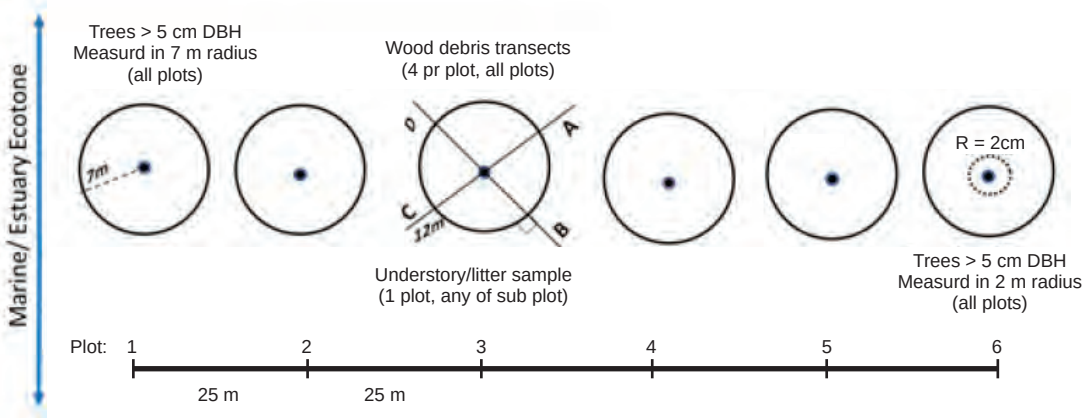


Figure 3.5 : Layout of a cluster for mangroves

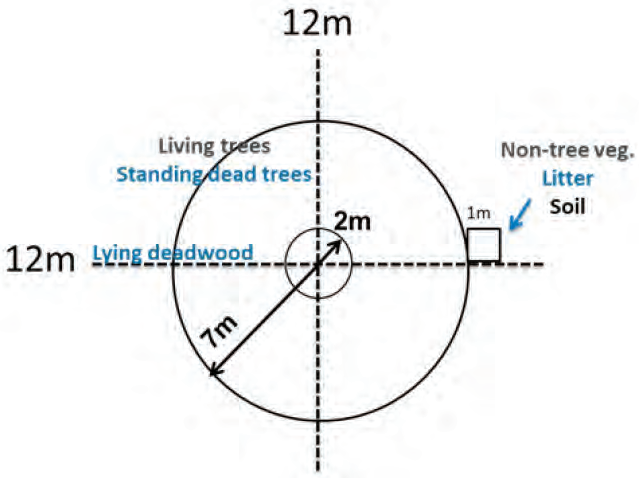


Figure 3.6 : Layout of a sampling plot for mangrove forest

Nest radius (m)	Size	Tree size, dbh (cm)
2	Sapling	< 5 cm & > 1.3 m height
7	Small - Large	≥ cm

Table 3.3 : Summary living trees measurement in a plot in mangrove forest

3.5 MEASUREMENT PROCEDURES

The procedure of physical parameters measurement for all forest types at different sampling plot design is as follow:

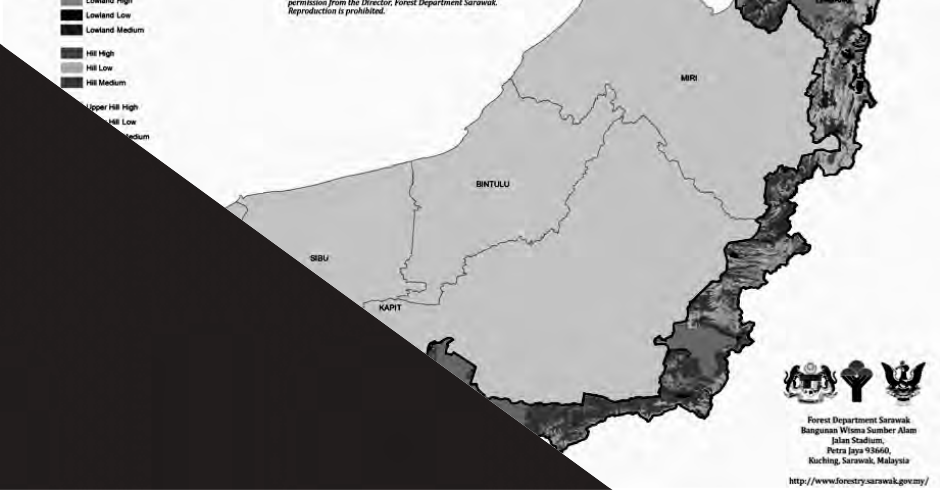
a. **Living trees:** the diameter at breast height, DBH (i.e., stem diameter at 1.3 m above the ground) of each tree will be measured in each nested plot following the size limit **(Table 1)**. Trees include all living stands with DBH >10 cm (small trees), DBH >20 cm (medium trees) and DBH >30 cm (large trees). Species of each individual will be also recorded.

b. **Sapling:** the number of stands for woody stems with DBH <10 cm, known as saplings, will be counted within the smallest nest of 2 m in radius. Size or height of these saplings are not recorded.

c. **Deadwood:** deadwood or woody debris is defined as any dead woody material (twigs, branches or stems of trees). There are two groups of woody debris which are (i) standing deadwood and (ii) lying deadwood. The standing deadwood was collected within a plot for parameters such as diameter at DBH at 1.3 m (cm), diameter at base at 0.1 m (cm), diameter at top (cm) and height (m). In contrast, the lying deadwood is collected for fallen trees and lied along the entire 100 m transect line through centre in north-south, east-west directions. Parameters such as actual piece diameter (cm), decomposition status (solid, intermediate, rotten) and diameter of hollow (if any, cm) will be recorded for the lying deadwood.

d. **Non-tree vegetation (NTV) and litter:** NTV is defined as all standing vegetation matter that does not reach breast height (1.3 m). This includes shrubs, tree seedlings, herbs and non-vascular plants. Litter on the floor is defined as the surface detritus and recognizable organic matter that lies on top of the mineral soil, excluding fragments of wood. Both NTV and litter samples are collected in square clip-plot measuring of 1 m × 1 m, where the clip-plot is placed at 25 m (for inland forest) and 12 m (for peat swamp and mangrove forests) beyond plot centre, normally at the end of the transect line. Materials within this clip-plot are collected, weighted, and recorded. Some subsamples will be brought back to the laboratory for drying process.

e. **Soil:** Three soil parameter measurements will be collected to determine the total soil organic carbon: 1) organic soil depth (to obtained soil volume per area); 2) bulk density (to obtain soil mass per area); and 3) proportion (%) of organic carbon (OC), to convert mass per area to C per area. A core sample is collected at 30 cm depth and about 100 g sample of soil profiles is collected for soil volume and OC estimation.



CHAPTER 4

FOREST INVENTORY METHODOLOGY

4.1 INTRODUCTION

The aim of any forest inventory is that the sampling design undertaken should be representative and able to capture optimal information during the sampling work carried out. Selection of a sampling design for a tropical forest inventory entails consideration of multiple principles. First, spatial balance is generally a preferred feature of sampling designs, which means that large geographic regions of the population do not remain unsampled. Spatial balance is often achieved by incorporating a systematic component into the sampling design. This may take the form of a network of perpendicular grid lines or a tessellation of the population into regular polygons. Spatially aligned designs establish plots at grid intersections or centers of polygons, whereas spatially unaligned designs establish plots at random locations within the rectangles formed by the grid lines or the regular polygons.

Remote sensing considerations may also be appropriate when selecting a sampling design. For example, tropical forests are often characterized as having relatively few days without cloud cover. Thus, cloud-free imagery for satellite-based sensors, such as Landsat or SPOT, may be difficult to obtain. Lidar data, which are currently acquired from airborne platforms and use laser techniques, are often proposed as an alternative. In addition, laser pulses penetrate forest canopies and produce useful information for estimating volume, biomass and the carbon content of trees. If plots are located at the intersections of perpendicular grids, acquisition of Lidar data from airborne platforms in strips is facilitated because straight flight lines can be used. Finally, when constructing grid networks and tessellations, consideration should be given to use of equal area projections. If not, then plots located at greater distances from the equator will represent less population area than plots located closer to the equator. Although weighting schemes can be used with unequal area projections, they are often complex and bothersome.

As previously noted, the greatest proportion of the cost of measuring a plot is travel to and from the plot location. This proportion may be very large in tropical forests with remote and inaccessible regions **(Tomppo et al. 2011)**. Thus, cost efficiency dictates that plots be established in clusters rather than singly. Multiple approaches to cluster sampling are popular. One approach is to configure a plot as multiple subplots in a regular pattern and near each other **(McRoberts et al. 2005)**. With this approach, the data for all subplots may be aggregated and attributed to the plot center. A second approach is to establish plots in clusters configured as rectangles, half-rectangles or other geographic shapes **(Tomppo, 2006)**. A third approach is two-stage cluster sampling. With this approach, primary sampling units such as polygons in the form of large rectangles are first randomly selected, and then multiple secondary sampling units in the form of plots are established within the selected polygons at randomly selected locations. When using cluster sampling, consideration should be given to the spatial correlation among observations for plots within

the same cluster. If distances between pairs of plots are less than the range of spatial correlation, observations will tend to be similar, and the sampling will tend to be less efficient.

There are two general sampling approaches: subjective or purposive sampling and probability sampling. Subjective sampling attempts to use professional judgement to select sample units believed to be representative of the entire population. These units are often convenient to measure, which reduces cost. Although data gathered in this way accurately describe the conditions on the sampled sites, they may not accurately characterize the entire population. Supporters of subjective sampling trust the ability of experts to select a representative sample and argue that this approach is good enough for practical purposes. In some simple situations, this may be true. However, some users of the data may lack the same confidence in the experts. Expensive data can become worthless because the sampling design is not sufficiently robust under scientific criticism. In addition, convenient sampling sites are often near roads, which are frequently associated with unique landforms, land uses, management histories and landscape patterns. Are such sites truly representative of the entire population? The answer is debatable. It is far easier to discredit the accuracy of population estimates from a subjective sample than prove otherwise.

Probability sampling replaces subjective judgements with objective rules based on known probabilities of selection for each member of a population. For example, if a 1 million ha forest comprises a population of 10 m x 10 m plots, there would be 100 million of those plots in the population. The selection of one of these plots at random amounts to a probability of 1/100,000,000. Selection of a simple random sample of 1,000 plots to estimate conditions in the entire 1-million ha population would give each member of that population a probability of selection of approximately 1,000/100,000,000=1/100,000, and each plot measured in the sample could be seen as representing 99,999 other unmeasured plots. The important lesson is that probability sampling is an objective method with precise rules and a mathematical foundation for estimating population attributes based on a sample. The probability that an expert will select any one potential sample plot is unknown, and the mathematics of subjective sampling cannot be applied in a scientifically defensible way. Thus, this chapter recommends probability rather than subjective sampling, and further recommends equal probability sampling in which possible sampling unit locations have equal probabilities of selection for the sample.

4.2 SELECTING INVENTORY DESIGN

Many of the difficulties associated with selecting a sampling design arise from two factors: first, sampling units are distributed in space and observations of them may be spatially correlated; and second, different sampling designs have different costs. Spatial correlation among observations of variables of interest strongly influences selection of sampling designs. Ecological, climatic and soil factors, and forestry management practices, cause observations from plots that are near to each other to be, on average, more similar than observations from plots that are farther apart. The result is that, in a strict sense, construction of a completely optimal sampling design is an impossible task because the numerous NFA-measured and derived variables vary quite differently in space. Thus, because optimal sampling designs are different for different variables, optimization may necessitate a focus on minimizing the standard error of a single important variable, such as wood volume, or on a weighted function of the standard errors for a small number of variables. One partial solution is to minimize the effects of spatial correlation by establishing sampling locations as far apart as possible. This also accommodates the fact that sample plot observations that deviate more from each other bring more information to the sample. In forest sampling, this often suggests hexagonal sampling designs. The primary sampling costs are attributed to travelling to and from the sampling unit location and measuring the unit. These costs, in turn depend on the structure of landscape and forests, measurements to be taken, and topographic, economic and transportations conditions.

A common starting point in selecting a sampling design is knowledge of the acceptable upper bounds for standard errors of estimates and an upper bound for cost. Optimizing the sampling design, given the sampling frame and plot configuration, involves selecting a procedure for spatially distributing the sampling unit locations in such a way that standard errors are minimized, while not exceeding the total allowable costs. Sometimes this will not be possible, and compromises may be necessary.

Generally, there are four (4) types of sampling designs that are selectively used for forest inventory, which are **(Figure 4.1)**: (i) simple random sampling, (ii) systematic sampling, (iii) cluster sampling, and (iv) stratified sampling (unaligned, clustered, systematic sampling design with the same number of plots but grouped into clusters). Since SFD have a systematic, complete classification system of forests in the entire state, stratified sampling design was selected for this inventory.

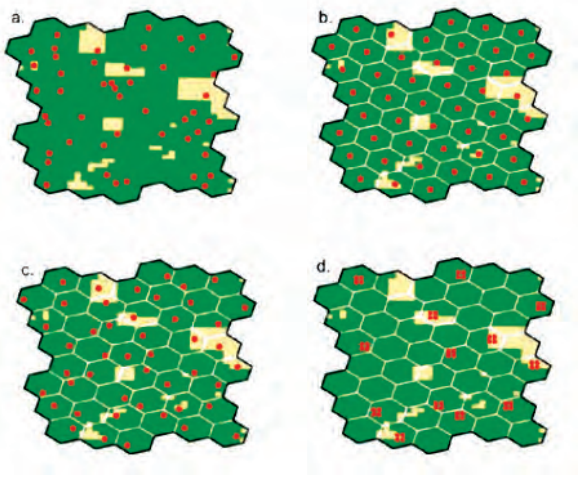


Figure 4.1 : Sampling designs that are selectively used for forest inventory

4.3 STRATIFIED SAMPLING DESIGN

In this project, the stratified sampling design is adopted. Stratified approaches to sampling are used for multiple reasons, but primarily to vary sampling intensities to accommodate selected criteria. Stratified sampling entails first dividing the population into non-overlapping subpopulations called strata that together comprise the entire population, and then drawing an independent sample from each stratum. If the sample in each stratum is a simple random sample, the whole procedure is described as “stratified random sampling”.

Numerous reasons may be given as first, stratification is used to increase the precision of population estimates. A second reason for stratification is that it may contribute to avoiding bias, depending on the estimator selected. A third reason for stratification is to accommodate different sampling protocols or different estimation procedures for different subpopulations.

The greatest benefits of stratified estimation are realized when the population is stratified, and stratum sample sizes are determined before sampling is conducted. The process of determining stratum sample sizes or, equivalently, allocating samples to strata, may be accomplished in several different ways and for several different purposes. Frequently, samples are allocated to strata in proportion to some attribute of the strata. An easily implemented approach is to allocate sample plots to strata in proportion to strata sizes. If simple random or systematic sampling is used within strata, then this approach leads to equal probability samples within strata, which may simplify estimation.

However, with this approach, the variances of stratum means may differ greatly. If comparably precise estimates of stratum means are desired, then samples may be allocated to strata in proportion to stratum variances. A potential disadvantage of this approach is that good estimates of stratum variances are necessary before samples are allocated to strata. Finally, it may be that estimates of means for some strata are more important than others. In this case, samples may be allocated to strata in proportion to a subjective assessment of strata importance.

Often the sampling objectives prohibit stratified random sampling. For example, a systematic sampling design may be used as a means of optimizing the precision of estimates for multiple variables simultaneously. Even though the greatest benefits of stratification may not be realized for any variable, the beneficial effects of increasing precision and precluding estimation bias may still warrant post-sampling stratification and stratified estimation. Thus, even if stratified sampling is not used, consideration of post-sampling stratified estimation is recommended because large increases in precision may often be realized with little additional cost or effort. Almost any source of data can be used to create strata if two tasks can be accomplished in a consistent manner.

First, stratum weights, calculated as the proportion of the population represented by each stratum, must be determined. Second, each plot must be assigned to one and only one stratum. The increasing availability of diverse thematic digital data layers opens vast possibilities for sources of data that can be used to create strata. In addition, the increasing availability of geographic information systems (GIS) greatly simplifies accomplishment of the two tasks. One popular choice of stratification data is land cover classifications from which aggregated forest and non-forest classes may be constructed and used as strata. Using a GIS with such a layer greatly simplifies the two stratification tasks. Within the GIS, each mapping unit of the land cover classification is assigned to a stratum based on the class assigned to the mapping unit. Calculation of stratum weights is then simply a matter of using GIS functionality to determine the total area of all mapping units assigned to the same stratum and dividing by the total area of the sampled population. A plot is assigned to the stratum of the mapping unit containing its centers. Other choices of digital data layers that can be used to create strata include, but are not limited to, soil maps, climate division maps, ecological provinces, administrative boundaries, ownership maps and land management units.

4.4 STRATIFICATION OF FORESTS

Stratification is a process of classifying forest cover into several further detailed categories that explain types and/or conditions of the forests. It is different from vertical stratification, which is a term used in the field of ecology refers to the vertical layering of a habitat, the arrangement of vegetation in layers. It classifies the layers (singular stratum, plural strata) of vegetation largely according to the different heights to which their plants grow. It is the most crucial process in any forest resources inventory projects as the accuracy of this process will influence the accuracy of the final inventory results. In this project, three different sets of secondary data have been used to stratify the forests in the project area. The datasets included (i) forest types, and (ii) forest canopy density layers.

Stratified sampling entails first dividing the population into non-overlapping subpopulations called strata that together comprise the entire population, and then drawing an independent sample from each stratum. If the sample in each stratum is a simple random sample, the whole procedure is described as stratified random sampling. Numerous reasons may be given as justification for stratified sampling. First, stratification is used to increase the precision of population estimates.

A second reason for stratification is that it may contribute to avoiding bias, depending on the estimator selected. For example, FRI field crews generally are granted access to plot locations on publicly owned lands. However, if the permission of private landowners is required to measure sample plots on their lands, inevitably some will deny access. In extreme cases, the ratio of privately owned to publicly owned plots in the accessible portion of the sample may be considerably less than the ratio of privately owned to publicly owned forest lands in the population. If the species compositions and/or management practices are substantially different on privately owned and publicly owned forest lands, bias may occur. One solution is to stratify lands by ownership, thus leading to independent sample estimates for the two ownership strata.

A third reason for stratification is to accommodate different sampling protocols or different estimation procedures for different subpopulations. For example, a substantial portion of sampling costs may be attributed to travel to and from plot locations. If data from remote sensors may be used to determine that some plots are located on non-forest land, then travel costs may be substantially reduced by not sending field crews to these plot locations. As a result of the different measurement technique, however, a different estimator may be required for these strata.

The greatest benefits of stratified estimation are realized when the population is stratified, and stratum sample sizes are determined before sampling is conducted. The process of determining stratum sample sizes or, equivalently, allocating samples to strata, may be accomplished in several different ways and for several different purposes. Frequently, samples are allocated to strata in proportion to some attribute of the strata. An easily implemented approach is to allocate sample plots to strata in proportion to strata sizes. If simple random or systematic sampling is used within strata, then this approach leads to equal probability samples within strata, which may simplify estimation.

4.5 DETERMINATION OF FOREST STRATA

Stratification is a process of categorizing the forest types and land use classes in the project area by using satellite images. The strata are based on the variations of visual appearance, texture, and separability of the pixel's groups. This exercise has been done on desktop basis and verified on the ground. Medium resolution images, which comprise of Landsat-8 Operational Land Imager (OLI) data was used to undertake this exercise.

Forest strata is important in any inventory framework because it will influence largely on the sampling design and sampling intensity of the forests. The stratification strategy that was proposed for this project involved 4 different levels of stratification. These levels are summarized in Table 2.4 and can be explained as follow:

- **Level 1:** The first level is to demarcate the project area. The boundary of the project area was developed by the Forest Department Sarawak and was used directly in this project without any adjustment.

- **Level 2:** This stratification is to separate forest and non-forest areas within the project area. Landsat-8 OLI data was used to perform this exercise. Seamless mosaic product (i.e., images without cloud cover) was produced from several scenes of Landsat-8 images over the entire project area. To produce a seamless mosaic, several scenes of Landsat-8, acquired from different dates were used. F_mask algorithm was applied to perform the cloud removal.

- **Level 3:** Classification of the forested area based on land elevation. Digital Elevation Model (DEM) acquired from Shuttle Radar Topography Mission (SRTM) was used to perform the classification. Land elevation – which represents the forest strata – has been categorized into four classes, which are < 300 m, 300 – 750 m, 750 – 1200 m, and > 1200 m, which represent Lowland Dipterocarp Forest, Hill Dipterocarp Forest, Upper Hill Dipterocarp Forest, and Montane Forest, respectively. Other forest types that have been delineated in this level are kerangas and melaleuca swamp forests, which are lying in lowland areas of < 300 m and were recognized from Landsat-8

images. The same images were also used to classify other land uses that are found within the project area, which are consisting of agricultural land, settlement areas, plantations, infrastructure, water body, and others.

- **Level 4:** These strata are the detailed classification of the forested areas. It is classified based on forest canopy density (FCD) that able to distinguish the quality of forests, which are (i) low density (< 33% canopy density), medium density (33 – 67% canopy density), and high density (> 67% canopy density).

Besides physical characteristics of the forests, administrative aspects are also considered in the stratification system used for this project. The boundary of production forests within the project area are used for this purpose. There are several concessioners that have active licenses for logging in the project area. The information on production within these areas has facilitated stratification system, especially in the production of FCD.

Forest canopy density mapping and monitoring model utilizes forest canopy density as an essential parameter for characterization of forest conditions. FCD data indicates the degree of degradation, thereby also indicating the intensity of rehabilitation treatment that may be required. The remote sensing data used in FCD model was Landsat-8 OLI satellite data **(Figure 4.2)**. The FCD model comprises bio-physical phenomenon modeling and analysis utilizing data derived from four indices: Advanced Vegetation Index (AVI), Bare Soil Index (BI), Shadow Index or Scaled Shadow Index (SI, SSI) and Thermal Index (TI). It determines FCD by modeling operation and obtaining from these indices.

The canopy density is calculated in percentage for each pixel. The FCD model requires less information of ground truth. Just for accuracy check and so on. FCD model is based on the growth phenomenon of forests. Consequently, it also becomes possible to monitor transformation of forest conditions over time such as the progress of forestry activities **(Rikimaru et al. 2002)**.

The resulting FCD was an image containing pixels with FCD values in form of index (0 – 1), which later can be translated as percentage (0 – 100%). These values have been divided into several classes or thresholds, which become strata of a forest type. In this case, the forest types were divided into three (3) categories; low, medium and high based on the FCD index. **Table 4.1** shows the threshold values that were used for the stratification. Based on the stratification by using FCD, the project has produced sixteen (16) forest strata as summarized in **Table 4.2**.

FCD threshold (Index)	Category/Class
0.00 - 0.33	Low
0.33 - 0.67	Medium
0.67 - 1.00	High

Table 4.1 : Threshold that was used for FCD classification

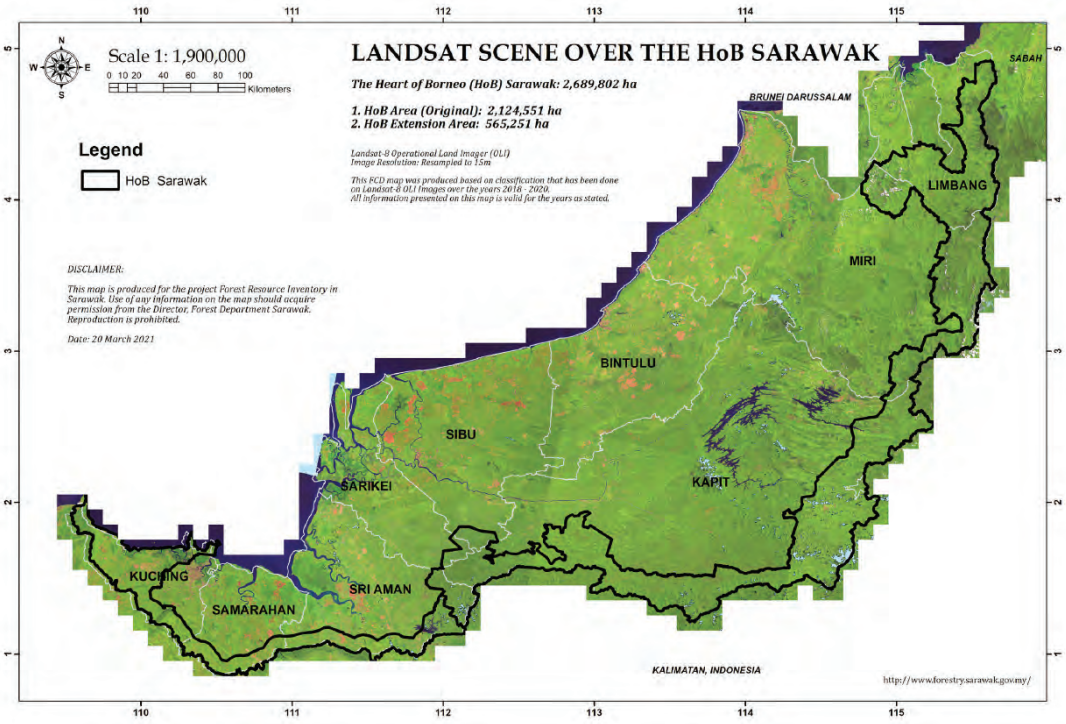


Figure 4.2 : Landsat OLI images over Sarawak

LEVEL 1	LEVEL 2 (Physical)		LEVEL 3 (Physical)	LEVEL 4 (Forest Canopy Density)	Strata Code
Locality HoB Sawarak	Forest Cover	Forest Types	Lowland Dipterocarp (<300 m)	Low Density (< 33%)	LD-L
				Medium Density (33 - 67%)	L-M
				High Density (< 67%)	LD-H
			Hip Dipterocarp (300 - 750 m)	Low Density (< 33%)	HD-L
				Medium Density (33 - 67%)	HD-M
				High Density (< 67%)	HD-H
			Upper Hip Dipterocarp (750 - 1200 m)	Low Density (< 33%)	UH-L
				Medium Density (33 - 67%)	UH-M
				High Density (< 67%)	UH-H
			Montane Forest (>1200 m)	n.a	MTN
			Peat Swamp Forest	Low Density (< 33%)	PS-L
				Medium Density (33 - 67%)	PS-M
				High Density (< 67%)	PS-H
			Mangrove Forest	n.a	MGV
			Kerangas Forest	n.a	KGS
			Melaleuca Swamp Forest	n.a	ML
	Non-Forest	Other Land Use	Agriculture land (including shifting agriculture)	-	-
			Settlement	-	-
			Plantations	-	-
			Infrastructures	-	-
			Water Body	-	-
			Others	-	-

Table 4.2 : Stratification system of the project area

4.6 SAMPLING INTENSITY

The sampling design chosen to support the technical program used for an FRI requires a theoretical basis that can be implemented on the ground. Understanding the basic concepts of statistical design and estimation method is a key component of the overall process for information management and data registration for FRI.

This project anticipated that the FRI method should come with a reduced cost, less manpower, shorter time, and without sacrificing the final accuracy of the inventory result. This can be achieved by integrating remote sensing technology and some ground measurement information. A method needs to be developed to join these two sets of data and to come out with a forest resource map that cover the entire Project area. Biophysical characteristics of forest can only be measured on the ground and satellite remote sensing can scale these up to provide large scale maps. One data source has the accuracy while the other provides the coverage. When these two are combined in a smart way, we get the best of both. The concept of upscaling has been used widely in forest inventory by using remotely sensed data.

Figure 4.3 shows the concept of upscaling by using multi sensors remote sensing systems. Sampling plots were established on the ground at several sampling unit that comprise high resolution imagery particularly SPOT-6/7, WorldView-2/3, Pleiades, or RapidEye, whichever available for all sampling unit. The information was projected to the larger areas by using satellite imagery data, which comprise stratification information that was generated earlier in this project. The high-resolution images were also used to assess the accuracy of the FCD that have been produced by the Landsat OLI images. It was found that, by using the high-resolution images combined with the ground truth work, the overall accuracy of the generated FCD was at 87%.

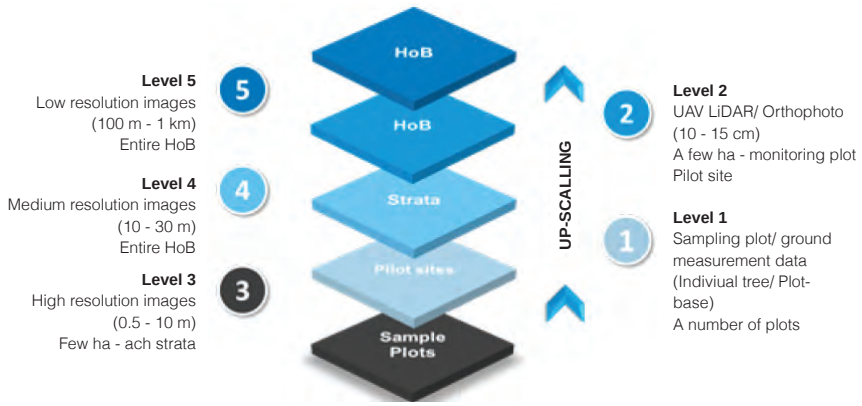


Figure 4.3 : The concept of upscaling from the sample plot information to the entire project area

4.6.1 DETERMINATION OF SAMPLING INTENSITY

Determination of sampling intensity is one of the most crucial steps in constructing a sampling design. If the sample is too small, then uncertainty will be great; if the sample is too large, then the cost will be unnecessarily high. It is possible to quantify the expected confidence in future estimates made from a valid probability sample. As the number of sample plots increases, the variance of the estimation error decreases, the precision of the estimate increases, and more confidence can be placed in the estimate. Usually, the exact value of the estimate is known but not the true condition of the forest. With probability samples, the probability that an estimate is within a specified distance from the true value may be determined. These are the roles of the "confidence interval", an estimated range of proportions likely to include the true, but unknown, proportion of forest, and the "confidence coefficient", the probability that similar confidence intervals constructed using different samples will contain the true proportion of forest. At the simplest level, the number of plots required should be calculated as follows:

$$n = \frac{t^2 \times (CV\%)^2}{(AE\%)^2} \quad \text{q. 1}$$

Where;

n = the number of sampling unit,

t = the sample statistic from the t-distribution for the percentage of confidence interval (normally 90% and 95% are considered) and (t = 1.654 for 90% confidence interval; t = 1.960 for 95% as sample size is unknown at this stage)

AE% = Allowable Error (normally set at 20%)

CV% = Coefficient of Variation

$$CV = \frac{\sigma}{\mu} \quad \text{q. 2}$$

σ = standard deviation

μ = mean

In this case, the CV was determined by using the statistics of FCD within the entire project area. In this project the confidence interval was fixed at 90%. Since the project area is stratified into different types and strata, the sample size determination has been conducted for each stratum. Finally, the total project sampling intensity has bee determined as summarized in **Table 4.3**. Based on this statistic, the sampling intensity in terms of area was at 0.02%, which was sufficient for a regional level forest inventory.

Forest types	Area (Ha)	Percentage (%)	Number of Clusters	Number of Plots	Plot Area (Ha)
Lowland Dipterocarps Forest	251,315.15	14.2	44	176	88.00
Hill Dipterocarps Forest	609,066.44	34.5	69	276	138.00
Upper Hills Dipterocarps Forest	572,399.95	32.4	37	148	74.00
Montane Forest	283,564.35	16.1	5	20	10.00
Peat Swamp Forest	984.79	0.1	16	96	18.24
Mangrove Forest	21,737.45	1.2	15	90	8.10
Kerangas/ Heath Forest (including Melaleuca Forest)	25,213.56	1.4	5	30	3.47
Total	**1,764,281.69**	**100.0**	**191**	**836**	**339.81**

Table 4.3 : Number of sample plots required for the inventory work

4.6.2 SAMPLING DISTRIBUTION

The entire extent of Project area has been divided into several grids measuring 10 km x 10 km (10,000 ha). A total of 465 grids has been generated which covers the entire project area. Some of the grids are not necessarily entirely cover the Project area because the shape of the boundary is irregular. This system was used to facilitate the determination of locations for the field data collections on the ground.

Each grid is considered as the sampling unit and these units were distributed evenly throughout the project area. While concerning the evenness of the distribution, factors such as access to the sampling locations was also one of the greatest concerns. The distributed sampling locations need to be accessible by the field crews. The system was made in such a way so that the mobilization of manpower and fieldwork planning can be done easily and systematically, considering the cost, time and ground access to the sampling unit while retaining the desired accuracy of the inventory data.

Within each sampling unit, high resolution satellite images were acquired during the implementation of inventory work in this project. Both data were used intensively for FCD mapping, which was validated by the ground sampling data. Once the stratification system, sampling unit and locations of sampling plots have been determined, the field data collection work were commenced. Locations of the sample plots that were surveyed are shown according to grids indicated on the respective maps in **Figure 4.4**.

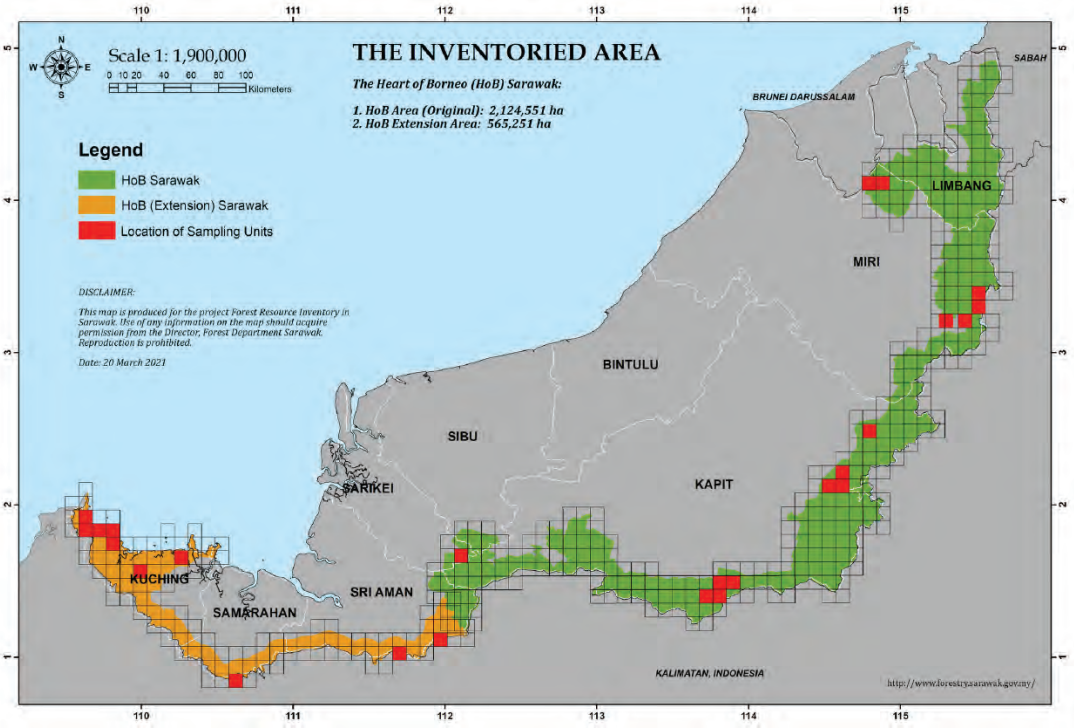


Figure 4.4 : Location of sampling units in the project area

CHAPTER 5

FIELD DATA COLLECTION

5.1 INTRODUCTION

Forest resources inventory aimed to acquire and update a quantitative and qualitative information of forest resources in the project area in Sarawak. This information can only be acquired when field data are available. Although this project highlights the use of remote sensing and GIS technologies for the inventory processes, field data is compulsory to describe the real condition on the ground. This chapter describes in detail the approach, procedures and protocols considered for field data collection. A Field Inventory Manual, which contains the detailed, step-by-step explanations on how to conduct the fieldwork has been produced by this project. This document has been used by field crews as a standard guide so that all data collected at the field can be retained in terms of quality and accuracy.

5.2 INVENTORY PARAMETERS

A parameter, generally, is any characteristic that can help in defining or classifying a particular system (meaning an event, project, object, situation, etc.). That is, a parameter is an element of a system that is useful, or critical, when identifying the system, or when evaluating its performance, status, condition, etc.

Parameter has more specific meanings within various disciplines, including mathematics, computing and computer programming, engineering, statistics, logic and linguistics. Within and across these fields, careful distinction must be maintained of the different usages of the term parameter and of other terms often associated with it, such as argument, property, axiom, variable, function, attribute, etc.

For the purpose of this inventory, some geographic and forest stand parameters take into consideration that has to be clearly understood and identified to ensure that the inventory work can be implemented smoothly and meet its objectives. The parameters involved are listed in **Table 5.1**.

No.	Inventor Parameter	Parameter Recorded
1.	Survey team information	• Team leader • Recorder • Number of crew • Date of survey • Start Time • End time • Duration
2.	Geographic	• Topography • Slope • Elevation
3.	Forest stand	• Type of Forest • Forest Strata • Resam • Bamboo • Rattan • Bertam • Palm • Medicinal Plants • Climber / Liana • Ficus
4.	Trees stand	• Tree species • Diameter at breast height (dbh) • Canopy form • Lighting
5.	Dead trees (standing/laying)	• Base diameter • Top diameter • Tree height • Rotten density class (Solid: S, Intermediate: I, Rotten: R) • Hole diameter • Forest litter • Soil density

Table 5.1 : Parameters included in the inventory records

5.3 PROTOCOLS AND PROCEDURES

5.3.1 IDENTIFICATION OF SAMPLING PLOT LOCATION

Identification of location for each sample plot should be determined prior to the fieldwork. This could be done by referring to the base maps, forest strata, access roads, topography, and other geographic features information. The census could be carried out systematically when the plots are accessible.

The positions of the sample plot in coordinates are installed into GPS for navigation purpose. The field navigation is performed with the use of GO TO> WAYPOINT function in the GPS. The coordinate of the starting location is to be obtained before navigation towards sample plot location start. The poles are set up at the center of the sample plot and the coordinates from GPS readings for that plot location is recorded on the inventory form before other information are recorded. The sample plots are descripted with unique name to avoid confusion. Below are the examples of the sample plot name:-

20032017-P01-A
20032017-P01-B
20032017-P01-C
20032017-P01-D

(DDMMYYY-ID Cluster-ID Plot)

If there are 2 or more teams work on the same day, each team should understand to choose the Cluster ID to be used.

All the required information is confirmed to be recorded on the inventory form along with all the equipment to the next plot location. The second sub plot located at least 100 m and the above process is repeated until 4 plots are completed for 1 cluster.

Guidelines for handling GPS and coordinate navigation are provided. The direction to the plot location could be determined by compass. At least two (2) reference trees for plot tie points are identified and recorded into the inventory form for each plot. This record could help the crew to rediscover all established sample plot if the poles are damaged or missing. Slope correction is required, and this could be done with clinometer. If location of the sample plot is on the slope of topography, radial correction for the sample plot should be made.

5.3.2 CREW MOVEMENT IN A CLUSTER

Figure 5.1 shows the crew movement in a cluster of inland mixed dipterocarp forest. The inventory work is initiated from plot A and after data collection completed in the plot A, the crew will move to plot B and then continue to plot C. The route to plot D, the crew would turn back to plot A and then the navigation to plot D could be initiated. The crew could directly move from plot A to plot D by aided skill in handling GPS.

These plots' location will form the letter "L" and in some condition plot D can also be placed on the left or right of plot C. The most important criteria are the distance between the plots should be at least 100 m. In some cases, this distance would exceed 100 m, however, this decision depends on the environmental factors and accessibility. The changes which different from planning are allowed to facilitate the movement and accelerate the work and to avoid lost incident during the fieldwork. The same process were adopted for peat swamp and mangrove forests sampling plot designs.

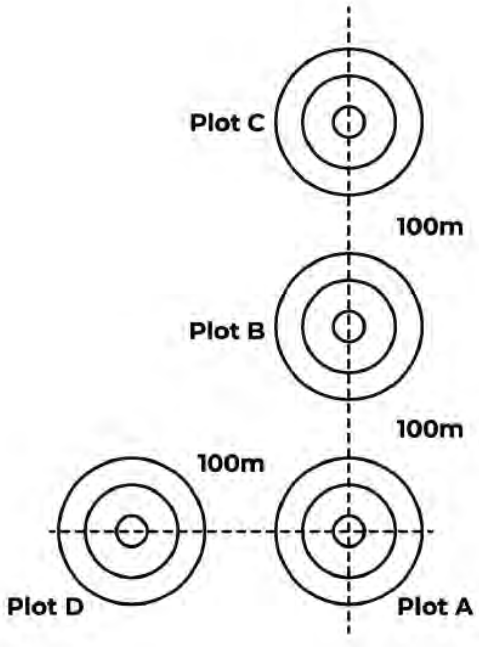


Figure 5.1 : Crew movement in a cluster

5.3.3 CREW MOVEMENT IN A CLUSTER

The protocol for the measurement is based on Winrock International (USAID/ LEAF), which applies to the tropical forest ecosystems. The following steps have been applied to determine the various components of the carbon group.

Live tree: dbh (bole diameter at 1.3 m above ground) for each tree is measured in each plot according to the size has been described previously. The tree includes all living stand with ≥5 - 14.9 cm dbh (small tree), ≥15- 29.9 cm dbh (simple trees) and ≥30 cm dbh (large tree). Dbh and species for each tree are to be measured and recorded.

5.3.3.1 Tree Measurement < 5 cm dbh – ≥ 1.3 m height [Nest with 2 m radius]

Number of seedlings is recorded in the size of <5 cm dbh - 1.3 m height in the smallest circle (2 m radius). Tree size, species or height is not recorded.

5.3.3.2 Tree Measurement ≥ 5 cm – 29.9 cm dbh [Nest with 4 dan 12 m radius]

All recorded species need to be identified during the fieldwork and to be recorded by the name and its 4-letter code. Species which could not be identified during the fieldwork will be brought back to office along with the specimen together and photographic image for further identification. Dbh for each tree must be measured using a diameter tape. Dbh is measured in centimeters and to be rounded to one decimal point.

Measurement of buttress and defective tree should be carried out at the top of the chest level. For the buttress trees, the measurement is 30 cm above the buttress while for the defective tree the measurement is at the top of the defect area.

5.3.3.3 Tree Measurement ≥ 30 cm dbh [Nest with 20 m radius]

All recorded species need to be identified during the fieldwork and to be recorded by the name and code. Species which could not be identified during the fieldwork will be brought back to office along with the specimen together and photographic image for further identification.

Diameter for each tree must be measured using a diameter tape. Dbh is measured in centimeters and to be rounded to one decimal point.

Measurement of buttress and defective tree should be carried out at the top of the chest level. For the buttress trees, the measurement is 30 cm above the buttress while for the defective tree the measurement is at the top of the defect area.

For tree size ≥ 30cm dbh, some other parameters are also taken:

i. Timber quality
ii. Canopy form
iii. Lighting
iv. Climbers
v. Ara (Ficus)

5.3.4 SAMPLING METHOD FOR DEAD TREE/WOOD

Dead tree/wood: Dead tree/wood or wood debris is defined as any dead wood material (twigs, branches or tree trunks). Two groups dead wood:

i. Standing dead trees
ii. Lying deadwood.

Both groups are measured and recorded for diameter ≥10 cm Dbh.

All standing dead wood / tree inside a 20 x 20 m plot are measured. Parameters such as standing dead wood class (Class 1 or Class 2), dbh, diameter at base 0.1 m (cm) from ground level, upper diameter (cm), distance from the plot center to the location of standing dead tree/ wood and height (m) should be recorded.

For lying deadwood, the measurement is only for the tree that fall along the 100 m transect from North-South and East-West cord through the center of the plot. Parameters such as diameter (cm), density class (S = Solid, I = Intermediate and R = Rotten) and hole diameter (if any, cm) need to be recorded.

5.3.5 SAMPLING METHOD FOR NON-TIMBER VEGETATION AND FOREST LITTER

Non-timber vegetation (NTV) and forest litter: non-timber vegetation is defined as standing plants with height less than chest level (1.3 m) such as shrubs, tree seeds, herbs and non-vascular plants. The forest litter is defined as a surface of dead organic waste on mineral soil, including dry leaves, twigs, small trunks, and hay. Both NTV and forest litter need to be collected in a square clip plot of 50 cm × 50 cm. The clip plot is located at the end of the transect line and usually 25 m outside the center of the plot. All collected samples in this clip plot are weighed and recorded. Some samples are then removed (at least 30g) are recorded and labeled to be brought to the lab for the drying process.

5.3.6 SOIL SAMPLING METHOD

Soil is defined as a surface of the earth that comprises mineral and organic matter. Three parameters to be consider determining the organic carbon soil:

i. shredded organic soil depth (e.g., 30 cm)
ii. Soil bulk density (oven-dry) and
iii. Organic carbon percentage (laboratory carbon analysis)

Soil samples are extracted at the same location as NTV and forest litter sampling. Soil samples are dredged from 30 m depth after NTV and forest litter data and are recorded.

Soil bulk density is calculated from 15cm depth vertically from the ground. Material inside coring iron needs to be brought to office and would not be tampered. Material outside the coring is allowed to cut such as roots if present, and then wrapped with paper tape.

The organic carbon percentage of is also calculated from a 0 – 30 m depth vertically. A minimum of 100 g soil needs to be brought back to laboratory for further analysis.

Materials in the plot are weighed, recorded, and labelled for take-off to calculate bulk density data and organic carbon percentage.

5.3.7 WILD ANIMAL OBSERVATION

All members in the inventory team will report the presence of wild animals in the sampling unit. The observation is by footprint, dropping and obvious the claw or sound.

5.4 QUALITY CHECK & ASSURANCE

Quality check and assurance are the steps that are to be undertaken for field data collection. These steps are divided into three categories that are (i) before field data collection, (ii) during data collection, and (iii) after data collection.

Before fieldwork data collection the steps involve on the understanding the basic knowledge of field data collection. Knowledge before field work data collection involve the technique on mapping, understanding the SOP in handling instrument such as compass, distance tape and laser equipment. Appropriate training on this topic should be provided. In the meantime, all equipment that is to be used in this field data collection should be confirmed to be reliable to provide the result. Therefore, scheduled calibration on the equipment should be planned.

During the fieldwork data collection a few measures should be understood and verified. The most critical steps are on handling the equipment which is reducing the potential error in the result. For example, in measuring the direction of the tree location, compass is used to obtain the azimuth. It is suggested that only one crew is assigned to measure the direction. The result would be more consistent if the same crew uses the compass.

After fieldwork data collection, some steps should be undertaken which is the verification on the collected data before moving to other plots. In some cases, the collected raw data are to be mapped and this could be verified by estimating the location on the map to ensure the data are in the right location. The verification for azimuth measurement could also being done by roughly estimate the direction by using compass.

External audit (by officers who are competent) should also be carried out at accessible plots, whenever required. A randomly selected sampling plots that have been surveyed will be revisit and census work are repeated at the same sampling plot location. The results will then be compared with those completed previously. This process is called cross-check validation, conducted to ensure that the inventory data is at the highest accuracy.

5.5 TRAINING AND CAPACITY BUILDING PROGRAMS

Procedures and protocols in all stage of field data collection processes need to be complied by field supervisors as well as field crews who really do the work on the ground. Series of training and capacity building programs have been conducted to ensure that all personnel understand thoroughly every single process involved in data collection. The process starts from planning the fieldwork, collecting data at the field, managing field data, samples handling, data entry, analysis, and reporting. **Table 5.2** summarizes training programs that have been conducted during the implementation of the project.

No.	Training Program	Date	Venue
1.	Kursus Kemahiran Kerja Lapangan Projek Inventori Sumber HUtan Sarawak Fasa II	7 -11 October 2019	Union Yes Retreat & Training Centre, Lundu, Kuching
2.	Bengkel Kemasukan Dan Analisis Data Lapangan	14 May 2018	FRIM
3.	Latihan Lanjutan Pemprosesan Data Spatial Bagi Aplikasi Perhutanan Jabatan Hutan Sarawak	7 - 8 December 2017	FRIM
4.	Field Data Collection Refreshment Course	25 - 29 September 2017	Sibu Sarawak
5.	Latihan Pemprosesan Data Spatial Bagi Aplikasi Perhutanan Jabatan Hutan Sarawak	23 - 25 May 2017	FRIM
6.	The Advance Forest Inventory Course	2 - 6 May 2017	Gunung Mulu National Park
7.	Kursus Teknik Kerja Lapangan Inventori Hutan	28 - 30 November 2016	Lambir Hills National Park, Miri

Table 5.2 : Training and capacity building programs conducted

CHAPTER 6

ANALYSIS OF INVENTORY DATA

6.1 INTRODUCTION

Details on field inventory data analysis are elaborated in this chapter. This includes parameters to be assessed, procedures taken before analysis has been done and calculation of the inventory parameters. This chapter also elaborates analysis on tree species composition, medicinal plants, and fauna. In general, data analysis involved a process of data entry, cleaning, and analysis.

6.2 DATA ENTRY

Tree Calculator System, which is a Microsoft Excel Sheets was developed for the project. Inventory data which has been collected on the ground were key-in into the system. It was originally designed by Winrock International, following the Intergovernmental Panel on Climate Change (IPCC) standards for forest biomass assessment. The system was modified to suits the purpose of this project. Data entry process is done immediately after data collection had been done at the fields.

This system is used to calculate all parameters included in the inventory. The users need to input the data that has been collected on the ground into the system, and it will compute all parameters automatically. The interface of Tree Calculator is depicted in **Figure 6.1**.

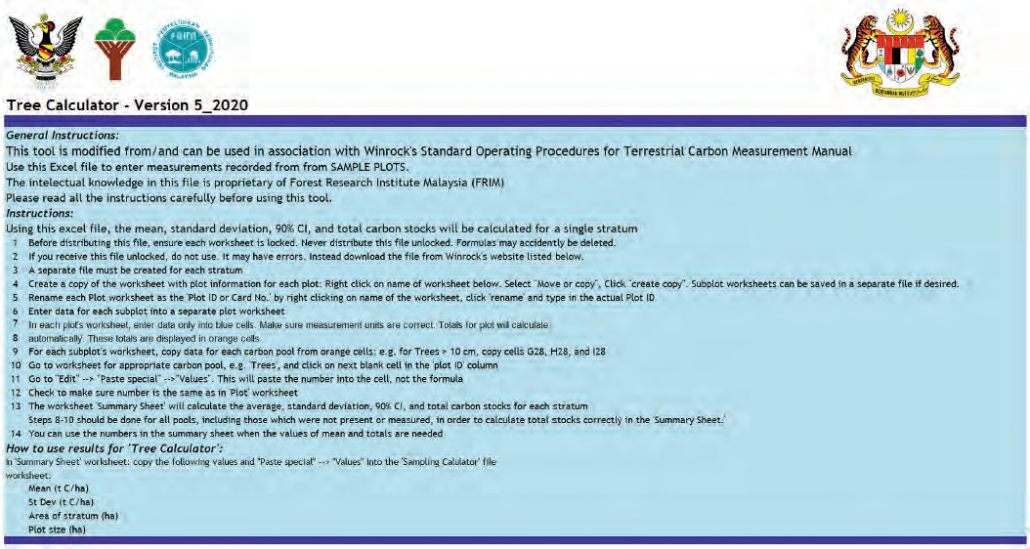


Figure 6.1 : Interface of Tree Calculator System

6.3 DATA CLEANING

Data quality is very important aspect in data analysis as it will affect the quality of the end results. Thus, data cleaning had been taken before analysis been done to ensure the quality of the data. Methods of data cleaning that has been taken is as follow:

a. Checking and correction on:
   - DBH size;
   - Species name;
   - Species group;
   - Duplication;
   - Missing data; and
   - Cluster ID, plot ID, plot location, and others.

b. Outlier detection using stem-and-leaf and boxplot methods. The data that has been checked is as follows;
   - DBH size of each tree;
   - Stand density of each plot
   - Basal area of each plot
   - Volume of each plot

6.4 DATA ANALYSIS

There are six (6) main parameters were assessed using field inventory data, which are:

i. Stand Density
ii. Basal Area
iii. Stand volume
iv. Biomass And Carbon Stock
v. Tree species composition
vi. Non-wooden vegetation, medicinal plants, and fauna

Other parameters that have been assessed were tree species composition, non-tree vegetation, medicinal plants, and fauna. Most of the analysis were done using R software. R codes for the analysis of the first four main parameters is shown in **Appendix 6.1**. Analysis was done at HoB, forest types, and strata levels.

6.4.1 STAND DENSITY

Stand density is a quantitative measure of tree cover on an area, i.e., the number (count) of trees per unit area or space (usually in a hectare). Conventionally, measures of stand density are accepted as being absolute and unaffected by management objectives. Because they are absolute, measures of stand density are more precise and more useful in analysis and estimation of forest growth and yield than stocking. Stand density is important in forestry because, within limits, the more growing space made available to a tree, the less competition it will face and the faster it will grow. Thus, an important role of the forester is to regulate stand density through initial planting spacing, thinning and other silvicultural practices.

Calculation of stand density is shown below:

i. Stand density per hectare of one (1) plot

$$\mathbf{TPHi = SFi \times TTN}$$

Where:

TPHi - Stand density per hectare of one (1) plot
SFi - Scaling factor of each tree based on nest size
TTN - Total trees in each nest size

6.4.2 BASAL AREA

Basal area is the cross-sectional area of trees at breast height (1.3 m above ground). It is a common way to describe stand density. The measurement unit is normally expressed as in m^2/ha. In forest management, basal area usually refers to merchantable timber and is given on a per hectare basis. In forest ecology, basal area is used as a relatively easily measured surrogate of total forest biomass and structural complexity and change in basal area over time is an important indicator of forest recovery during succession.

Calculation of basal area is shown below:

i. Basal area of each tree

$$BATi = pi \times (DBHi)2 / 40000$$

Where:

BATi - Basal area of each tree (m^2)
pi - 3.142
DBHi - Diameter at breast height of each tree (cm)

ii. Basal area per hectare of one (1) plot

$$BAPi = \sum (SFi \times BATi)$$

Where:

BAPi - Total basal area per hectare of each plot (m^2 ha^{-1})
SFi - Scaling factor of each tree based on nest size
BATi - Basal area of each tree

6.4.3 STAND VOLUME

Stand volume is determined by the DBH and merchantable height measurements. It is one of many parameters that are measured to document the size of individual trees. Tree volume measurements serve a variety of purposes, i.e., for economic (timbers) and scientific. Measurements may include just the volume of the trunk, or the volume of the trunk and the branches depending on the detail needed and the sophistication of the measurement methodology. In this inventory, only merchantable (trunk) volume is considered, and the measurement unit is m3/ha.

The estimation of stand volume was based on the volume function that is used by Forestry Department Peninsular Malaysia. This one-way volume equation is relatively general in nature and may be used as general volume function since there no other local volume equation available. Volume of each tree in mixed dipterocarps forest is estimated based on the following formula:

i. Stand volume of a tree in a mixed dipterocarps and peat swamp forests

$$VOTi = BATi \times f \times L$$

Where:

VOTi - Stand volume of each tree (m3)
BATi - Basal area of each tree (m2)
f - 0.65
L - Log's length:

Diameter class (cm)	Log's Length (m)
5 - 29.9 cm	5
30 - 59.9 cm	10
60 - 74.9 cm	15
≥ 75 cm	20

ii. Stand volume of a tree in a mangrove forest (Salim & Ismail, 2020)

$$VOTi = 0.00045 \times (DBHi)2.02248$$

Where:

VOTi - Stand volume of each tree (m3)
DBHi - Diameter at breast height of each tree (cm)

iii. Total stand volume per hectare of one (1) plot

$$VOPi = \sum (SFi \times VOTi)$$

Where:

VOPi - Total stand volume per hectare of each plot (m3 ha-1)
SFi - Scaling factor of each tree based on nest size
VOTi - Volume of each tree

6.4.4 CARBON STOCK

Since carbon stock is a new parameter that is mostly included in modern forest inventory, this project also included this parameter in the inventory. Carbon stock is the quantity of carbon contained in a "pool", meaning a reservoir or system which has the capacity to accumulate or release carbon. Forest carbon stock is the amount of carbon that has been sequestered from the atmosphere and is now stored within the forest ecosystem, mainly within living biomass and soil, and to a lesser extent also in dead wood and litter.

Generally, there are five (5) carbon pools in a forest ecosystem, which are (i) aboveground living biomass, (ii) belowground or roots biomass, (iii) deadwood biomass, (iv) litters, and (v) soil organic carbon. Composition of carbon that is stored in each pool is different from one to another. To estimate the total carbon stock in all carbon pools, both field and laboratory data must be analysed and combined. The carbon stock reported in this section only represent the aboveground component of the carbon stock, which covers aboveground, belowground, and deadwood. Carbon stock in non-tree vegetation, litters and soil is presented in the next section. Carbon stock is usually reported in metric tonne (t) or megagram (Mg) carbon per hectare (Mg C ha^{-1}).

The carbon pools included in the assessment are summarized in **Table 6.1** and visualized in **Figures 6.2** and **6.3**. A carbon pool is a system with capacity to accumulate or release carbon in mass unit, Mg C. This includes a (i) aboveground biomass - living vegetation, sapling, deadwood, and litter, and (ii) belowground biomass- root biomass and soil carbon (soil organic matter at least 30 cm depth).

Terrestrial	Pools	Description
Aboveground	1. Living vegetation	Woody stands, sapling and non-tree vegetation (NTV)
	2. Deadwood	Standing deadwood
	3. Litter	Lying deadwood
Belowground	4. Root biomass	Dead leaves
	5. Soil carbon	Dead twigs of woody stands

Table 6.1 : Description of the measured carbon pools

Carbon stocks differ due to influences of physical factors such as soil type, vegetation type, precipitation, elevation, slope and aspect, drainage, disturbance history, rural population density, distance to transportation networks or settlements and distance to deforested land or forest edge. The association of carbon stock with a specific forest stratification in relevant to other locations will result in more accurate and precise estimates of carbon.

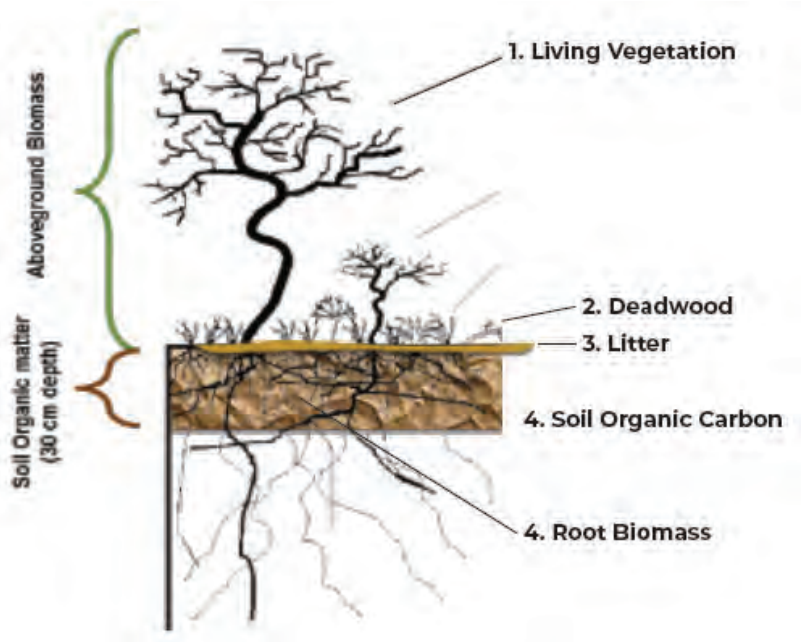


Figure 6.2 : Carbon pools in a forest ecosystem

Figure 6.3 : Carbon pools that were sampled in the project

Calculation of total carbon stock in all carbon pools is shown below:

i. Total carbon stock per hectare of one (1) plot

$$\mathbf{CSPi = AGCPi + BGCPi + CDCPi + NTLPi + SLCPi}$$

Where:

CSPi - Total carbon stock per hectare of each plot (kg ha^{-1})
AGCPi - Total aboveground carbon per hectare of each plot (kg ha^{-1})
BGCPi - Total below ground carbon per hectare of each plot (kg ha^{-1})
CDCPi - Total carbon per hectare of coarse woody debris or deadwood of each plot (kg ha^{-1})
NTLPi - Total carbon per hectare of non-tree vegetation and litter of each plot (kg ha^{-1})
SLCPi - Soil carbon (kg ha^{-1})

ii. AGCPi: Total aboveground carbon per hectare of one (1) plot

$$\mathbf{AGCPi = 0.47 \times AGBPi}$$

Where:

AGBPi - Total aboveground biomass per hectare of each plot (kg ha^{-1})

iii. AGBPi: Total aboveground biomass per hectare of one (1) plot

$$\mathbf{AGBPi = \sum (SFi \times AGBTi)}$$

Where:

AGBPi - Total aboveground biomass per hectare of each plot (kg ha^{-1})
SFi - Scaling factor of each tree based on nest size
AGBTi - Total biomass of each tree (kg/tree)

iv. AGBTi: Aboveground biomass of each tree in was calculated based on allometric equation that was developed by Chave et al. (2014).

$$\mathbf{AGBTi = [exp\ (-1.803 - 0.976E + 0.976\ ln(\rho) + 2.673\ ln(DBHi) - 0.0299\ [ln(DBHi)]2]}$$

Where:

AGBTi - Total aboveground biomass of each tree (kg/tree)
DBHi - Diameter at breast height of each tree (cm)
E - Bioclimatic variable (available at http://chave.upstlse.fr pantropicalallometry.htm)
ρ - Wood specific gravity / wood density 0.57 g/cm^3 (Reyes et al. 1992)

i. AGBTi: The allometric equations for the calculation of above groundbiomass of peat swamp forest can be reffered to Kauffman et al. (2016).

$$\mathbf{AGBTi = 0.136 \times (DBHi)2.51}$$

Where:

AGBTi - Total biomass of each tree (kg/tree)
DBHi - Diameter at breast height of each tree (cm)

ii. AGBTi: The allometric equations for the calculation of above ground biomass of mangrove forest can be referred to Komiyama et al. (2005).

$$\mathbf{AGBTi = 0.251 \times \rho \times (DBHi)2.46}$$

Where:

AGBTi - Total biomass of each tree (kg/tree)
DBHi - Diameter at breast height of each tree (cm)
ρ - Wood specific gravity / wood density 0.752 g/cm^3

iii. BGCPi: Belowground biomass (BGB) is another pool of carbon, which comprises the living coarse and fine roots of trees. The BGB is an important part of total forest biomass after AGB, representing up to 25% of the total biomass. Total below ground carbon per hectare of one (1) plot of mixed dipterocarps and peat swamp forests was calculated based on equation adopted from Niiyama et al. (2010).

$$\mathbf{BGBTi = 0.023 \times DBHi2.59}$$
$$\mathbf{BGCPi = \sum (BGBTi \times SFi)}$$

Where:

BGBTi - Total below ground carbon per hectare of each plot (kg ha^{-1})
SFi - Scaling factor of each tree based on nest size
DBHi - Diameter at breast height of each tree (cm)

iv. BGBTi: Belowground biomass of a tree in mangrove forest was calculated based on the following formula (Komiyama et al. 2005):

$$\mathbf{BGBTi = 0.199 \times \rho 0.899 \times (DBHi)2.22}$$

Where:

BGBTi - Total below ground of a tree (kg/tree)
DBHi - Diameter at breast height of each tree (cm)

v. CDCPi: Coarse Woody Debris (CDW) involves large pieces of standing and lying dead wood. Depending on the forest type, stage of succession, land use history and management practices, CDW can be a significant contributor to the total AGB. Total carbon per hectare of coarse woody debris or deadwood of one (1) plot

$$\mathbf{CDCPi = \sum (0.47 \times SFi \times WDi \times VOTi)}$$

Where:

CDCPi - Total carbon per hectare of each plot coarse woody debris or deadwood of each plot (kg ha^{-1})
SFi - Scaling factor of each tree based on nest size
VOTi - Volume of each standing or lying dead tree (m^3)
WDi - Wood density of each tree

Category	Wood density (g/cm^3)
Solid	0.57
Intermdiate	0.39
Rotten	0.21

vi. NTLPi: The oven-dry mass per area of this category was obtained from the samples that have been collected in the field. Total carbon per hectare of non-tree vegetation and litter of one (1) plot

$$\mathbf{NTLPi = DMPi \times DF}$$

Where:

NTLPi - Total carbon per hectare of non-tree vegetation and litter of each plot (kg ha^{-1})
DMPi - Dry mass of non-tree vegetation and litter
DF - IPCC default factor (0.40)

vii. SLCPi: Samples were oven-dry at a constant temperature of 115°C for about 24 hours and the dry mass was used to obtain bulk density. Samples were then analysed at the soil laboratory for organic carbon (OC) by using the combustion method, after pre-treatment to remove carbonate. Soil OC (%) was then multiplied by soil bulk density and soil depth to obtain total soil carbon stock per unit area. Total carbon per hectare of non-tree vegetation and litter of one (1) plot

$$\mathbf{SLCPi = OCPi \times BD \times D}$$

Where:

SLCPi - Total soil carbon per hectare of each plot (kg ha^{-1})
OCPi - Soil organic carbon (OC) (%)
BD - Bulk density
D - Depth (30 cm)

The acquisition of several parameters in calculating carbon for the estimation of coarse woody debris or deadwood, non-tree vegetation and litter, and soil carbons can be referred to Appendix 6.2.

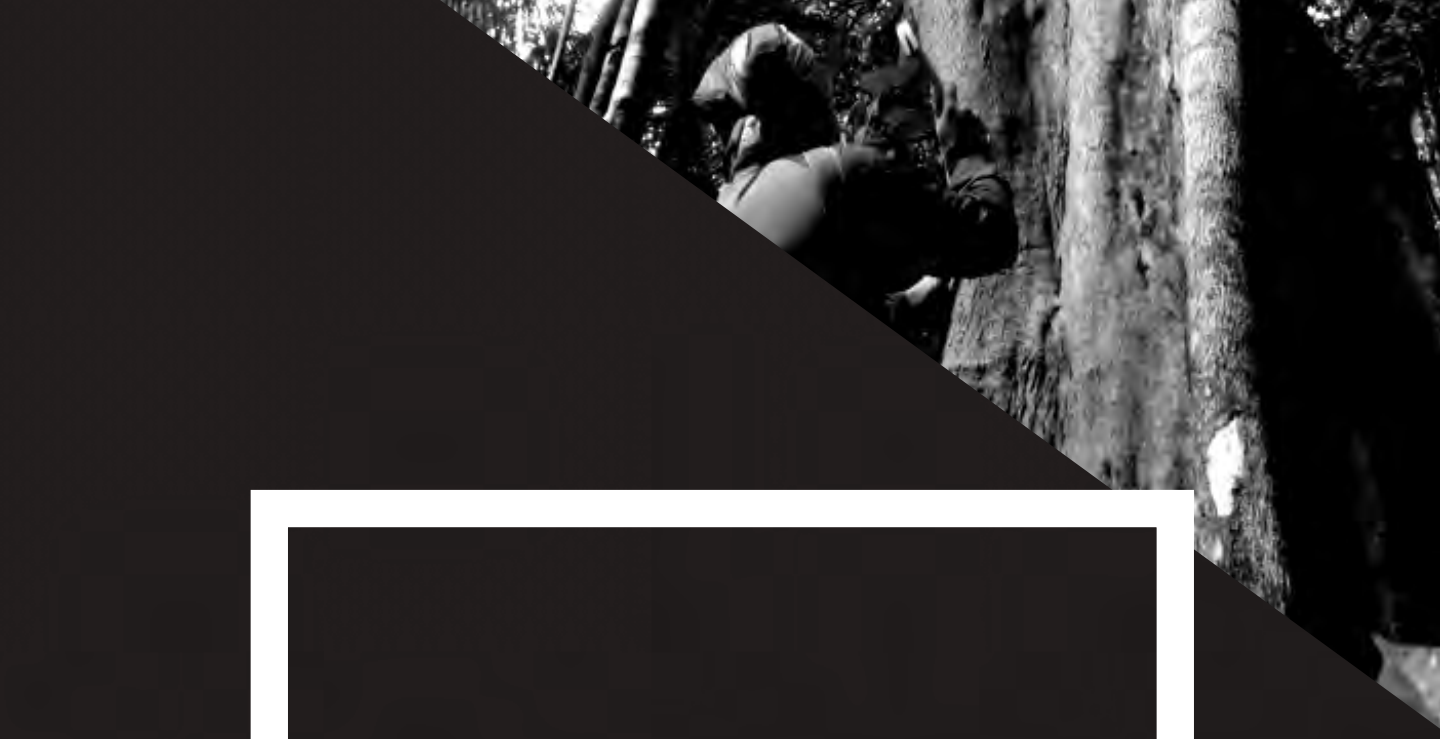
6.4.5 TREE SPECIES COMPOSITION

Tree species composition was also analyzed at HoB level, forest types and strata. Aside from analysis of stand density, basal area and volume per hectare for each species, others analysis involved most common species found in HoB, each forest type, and each stratum. Analysis on rare species has also been done.

6.4.6 NON-TREE VEGETATION, MEDICINAL PLANTS AND FAUNA

Analysis for non-tree vegetation, medicinal plants and fauna was carried out based on the presence-absent approach. Each fauna that was traced/detected at the field was recorded. The record was then rechecked to confirm the scientific name of the fauna. Similar analysis has been carried out for medicinal and herbaceous plant. Plants that have been recorded at the field are checked to confirm the scientific name. The data was then sorted to identify the number of each species.

The observation of fauna has been conducted based on sighting. This process is carried out by 'presence-absent' approach. Fauna that will be included in the observation include birds, big and small mammals, and reptiles. The presence of fauna is detected by sound, scratch scars, footprint, sewerages, and path/ tracks effects. Each fauna that is detected/sighted around the sampling plot area will be recorded in the inventory form. The record, usually the local name of the fauna, will be checked to confirm the scientific name. This analysis will be carried out separately, according to the forest type. Fauna observation was conducted in inland and for peat swamp forests only and not in mangrove forest.



CHAPTER 7

FOREST INVENTORY RESULTS AND DISCUSSION

This chapter reports the results of all parameters that were measured in the forest resources inventory. It is divided into seven (7) major components, which are:

i. stand density,
ii. timber volume,
iii. basal area,
iv. biomass & carbon stock,
v. trees species composition,
vi. non-timber resources, and
vii. fauna.

The reports for each parameter are generally structured into four (4) main categories where information is arranged by (i) overall project area, (ii) strata **(Table 7.1)**, (iii) forest types, and (iv) land status **(Table 7.2)**. This chapter highlights only the main results of these parameters; detailed data are included as separated appendices.

Forest Type	Strata	Forest Canopy Density (FCD)	Strata Code	Description
Mixed Dipterocarp Forest	Lowland Dipterocarp	High	LD-H	Forested areas reside on land with elevation <300 m with an FCD of >67%.
Mixed Dipterocarp Forest	Lowland Dipterocarp	Medium	LD-M	Forested areas reside on land with elevation <300 m with an FCD of 33-67%.
Mixed Dipterocarp Forest	Lowland Dipterocarp	Low	LD-L	Forested areas reside on land with elevation <300 m with an FCD of <33%.
Mixed Dipterocarp Forest	Hill Dipterocarp	High	HD-H	Forested areas reside on land with elevation 300 to 750 m with an FCD of >67%.
Mixed Dipterocarp Forest	Hill Dipterocarp	Medium	HD-M	Forested areas reside on land with elevation 300 to 750 m with an FCD of 33-67%.
Mixed Dipterocarp Forest	Hill Dipterocarp	Low	HD-L	Forested areas reside on land with elevation 300 to 750 m with an FCD of <33%.
Mixed Dipterocarp Forest	Upper Hill	High	UH-H	Forested areas reside on land with elevation 750 to 1200 m with an FCD of >67%.

Forest Type	Strata	Forest Canopy Density (FCD)	Strata Code	Description
Mixed Dipterocarp Forest	Upper Hill	Medium	UH-M	Forested areas reside on land with elevation 750 to 1200 m with an FCD of 33-67%.
Mixed Dipterocarp Forest	Upper Hill	Low	UH-L	Forested areas reside on land with elevation 750 to 1200 m with an FCD of <33%.
Mixed Dipterocarp Forest	Montane	-	MTN	Forested areas reside on land with elevation <1200 m
Peat Swamp Forest	Peat Swamp	High	PS-H	Peat swamp forest with FCD of >67%.
Peat Swamp Forest	Peat Swamp	Medium	PS-M	Peat swamp forest with FCD of 33-67%.
Peat Swamp Forest	Peat Swamp	Low	PS-L	Peat swamp forest with FCD of <33%.
Mangrove Forest	Mangrove	-	MGV	Mangrove forest
Kerangas/Heath Forest	Kerangas/ Health	-	KGS	Kerangas/Heath Forest
Melaleuca Forest	Melaleuca	-	ML	Melaleuca forest

Table 7.1 : Strata categories used in the inventory report

Land status	Status	Description
TPA (Intact)	Primary Intact Forest	Areas that are cover mostly by intact forest
TPA (Disturbed)	Secondary Forest	Areas that are covered mostly by intact forest with minor secondary forest
Production Forest	Concession areas	Areas that are designated for production purposes and licensed to concessioners
Stateland	Forested	A forested area that is not either in TPA or production areas

Table 7.2 : Land status used in the inventory report

In general, a total of 723 sample plots have been surveyed in the fields. **Table 7.3** summarizes the number of sample plots, and the detailed list of the sample plots is included in **Appendix 7.1**. Overall summary of the inventory results is included in **Appendix 7.2**. The reports of certain inventory parameters are divided into 4 diameter classes, which are (i) 5.0 - 14.9 cm (saplings category), (ii) 15.0 – 29.9 cm (seedlings category), (iii) 30.0 – 44.9 cm (potential crop tree – PCT), and (iv) > 45.0 cm (harvestable trees – HT).

Strata	Number of Plots	Total tree enumerated	Average trees/hectare
Lowland Dipterocarp, High, LD-H	65	1,717	930
Lowland Dipterocarp, Medium, LD-M	65	1,218	927
Lowland Dipterocarp, Low, LD-L	46	454	548
Hill Dipterocarp, High, HD-H	140	5,320	2,378
Hill Dipterocarp, Medium, HD-M	93	2,158	1,310
Hill Dipterocarp, Low, HD-L	27	250	626
Upper Hill, High, UH-H	91	3,658	2,292
Upper Hill, Medium, UH-M	25	584	1,110
Upper Hill, Low, UH-L	9	82	335
Montane, MTN	12	389	1,867
Peat Swamp, High, PS-H	21	592	1,613
Peat Swamp, Medium, PS-M	56	1,421	1,539
Peat Swamp, Low, PS-L	31	536	1,149
Mangrove, MGV	18	452	1,631
Kerangas/Heath, KGS	18	309	825
Melaleuca, ML	6	65	704

Table 7.3 : Summary of the sample plots

7.1 STAND DENSITY

7.1.1 STAND DENSITY IN HoB AREA

Figure 7.1 shows an average tree density per hectare in the project area. The average tree density in the entire project area was estimated at 1,499 trees/ha for trees with a diameter of 5 cm and above. About 83.9% (1,258 trees/ha) is dominated by non-dipterocarp trees, while the remaining 16.1% (241 trees/ha) is dipterocarp trees. Smaller trees with dbh 5 to 14.9 cm for dipterocarp and non-dipterocarp trees dominate the area with a tree density of 1,174 trees/ha (78.3%), followed by 15 to 29.9 cm (249 trees/ha (16.6%)) and 30 to 44.9 cm (52 trees/ha (3.5%)). Larger trees with dbh at 45 cm and above contributed only 1.6%, which is 23.9 trees/ha of the total number of trees per hectare basis.

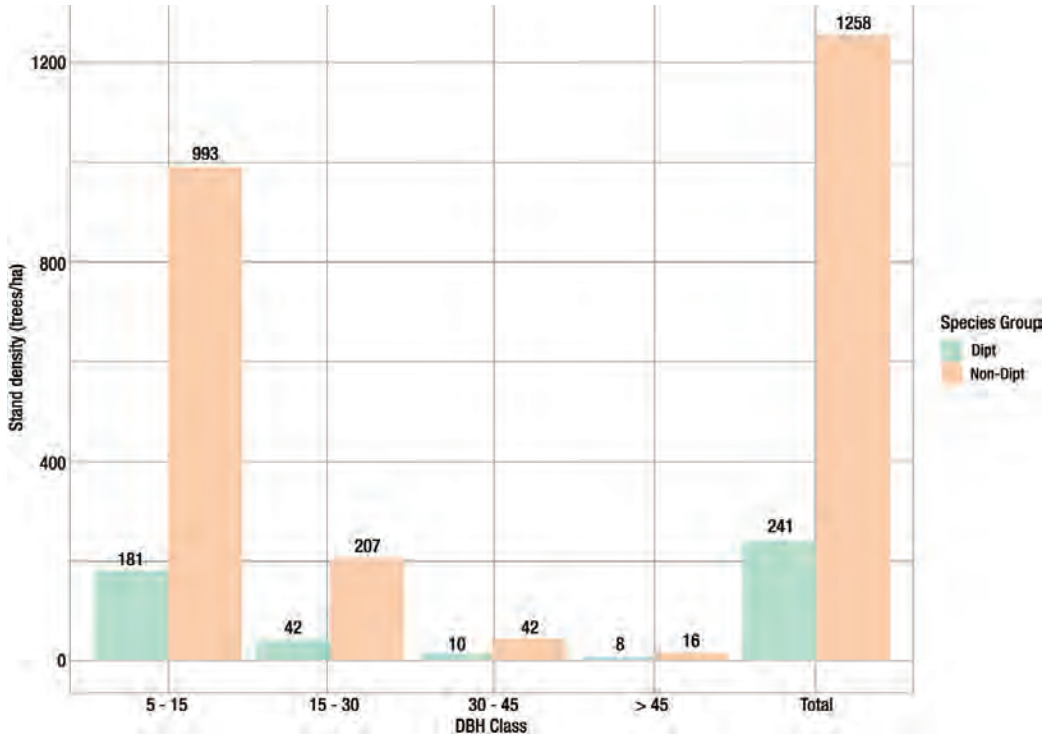


Figure 7.1 : Stand density based on diameter classes in the project area

7.1.2 STAND DENSITY ACCORDING TO LAND STATUS

Comparison of tree density between four (4) land statuses is shown in **Figure 7.2** and **Table 7.4**. In general, the concession area has higher tree density as compared with other lands, which were TPA (forested), TPA (disturbed), and state land. Stand density in the concession area was estimated at 1,809 trees/ha. Forested and disturbed areas in TPA were estimated at 978 and 1,321 trees/ha respectively. State land has the lowest stand density among the other lands with total trees estimated at 646 trees/ha. Smaller trees dominate the area in terms of quantity.

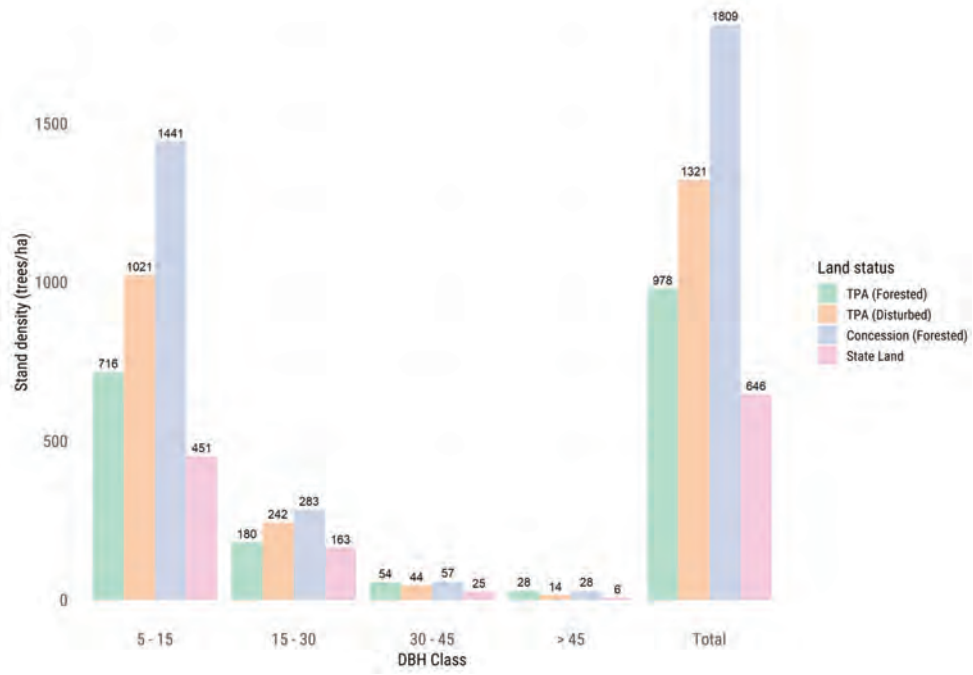


Figure 7.2 Stand density based on diameter classes in each land status

Land status	5 -15 cm		15 -30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
TPA Intact (TPA-F)	78	638	31	149	8	46	10	18	127	851
TPA Disturbed (TPA-D)	138	883	40	202	12	32	8	6	197	1,124
Production Forest (CON-F)	243	1,198	51	232	11	46	9	19	314	1,495
State Land (STL)	19	432	2	161	0	25	0	6	22	624

Table 7.4 : Stand density (trees/ha) based on diameter classes in each land status

7.1.3 STAND DENSITY ACCORDING TO FOREST TYPES

Stand density according to five forest types in the project area is shown in **Figure 7.3**. Mangrove forest has higher stand density as compared to other forests with an estimate at 1,631 trees/ha and almost 90% of trees contributed by trees in 5 – 15 cm category. Mixed dipterocarp forest has the second highest in terms of stand density with an estimate at 1,534 trees/ha followed by peat swamp forest with an estimate at 1,441 trees/ha. Kerangas/heath and Melaleucas forests have lower overall stand density with an estimate at 825 and 704 trees/ha respectively. For melaleuca forest, 63% of the stand density is contributed by tress in the 15 – 30 cm category. Details on the stand density of each forest type based on species groups can be referred to in **Table 7.3**.

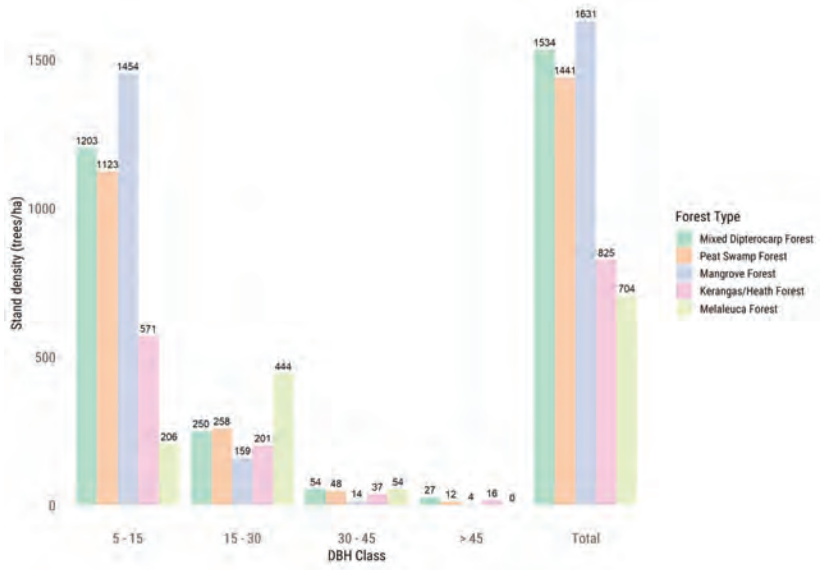


Figure 7.3 : Stand density based on diameter classes in each forest type

Forest Type	5 -15 cm		15 -30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Mixed Dipterocarp Forest, MXD	193	1,010	44	206	10	44	9	18	256	1,278
Peat Swamp Forest, PS	170	953	45	213	10	38	6	6	231	1,210
Mangrove Forest, MGV	0	1,454	0	159	0	14	0	4	0	1,631
Kerangas/Health Forest, KGS	86	485	37	164	7	30	4	12	134	691
Melaleuca Forest, ML	0	206	0	444	0	54	0	0	0	704

Table 7.5 : Stand density (trees/ha) based on diameter classes in each forest type

7.1.4 STAND DENSITY ACCORDING TO STRATA

Estimation on stand density per hectare and cumulative stand density per hectare based on diameter classes in each stratum are shown in **Tables 7.6** and **7.7**. In general, high-density forests show higher total trees per hectare as compared to medium and low-density forests. HD-H has the highest total stand density with an estimate at 2,378 trees/ha followed by UH-H and MTN with a total stand density estimate at 2,292 and 1,868 trees/ha respectively. HD-L, LD-L, and UH-L are the lowest three strata, which have the lowest total tree density, with an estimate at 626, 548, and 335 trees/ha respectively.

Stratum	5 -15 cm		15 - 30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Lowland Dipterocarp, High, LD-H	83	536	40	157	15	52	19	29	156	774
Lowland Dipterocarp, Medium, LD-M	86	618	27	132	8	37	6	13	127	800
Lowland Dipterocarp, Low, LD-L	30	381	8	109	2	16	1	2	41	507
Hill Dipterocarp, High, HD-H	382	1,546	65	285	13	52	11	23	472	1,906
Hill Dipterocarp, Medium, HD-M	109	905	39	199	10	34	3	12	161	1,150
Hill Dipterocarp, Low, HD-L	29	494	20	58	3	18	1	3	54	572
Upper Hill, High, UH-H	308	1,511	61	291	13	62	17	29	399	1,893
Upper Hill, Medium, UH-M	32	788	11	203	4	59	2	11	48	1,061
Upper Hill, Low, UH-L	0	221	7	71	4	30	0	1	12	323
Montane, MTN	414	1,078	83	193	7	47	21	25	525	1,343
Peat Swamp, High, PS-H	150	1,012	58	265	18	68	24	18	250	1,363
Peat Swamp, Medium, PS-M	179	1,010	51	240	12	40	2	4	244	1,294
Peat Swamp, Low, PS-L	168	810	25	130	2	12	0	1	195	954
Mangrove, MGV	0	1,454	0	159	0	14	0	4	0	1,631
Kerangas/ Health, KGS	86	485	37	164	7	30	4	12	134	691
Melaleuca, ML	0	206	0	444	0	54	0	0	0	704

Table 7.6 : Stand density (trees/ha) based on diameter classes in each stratum

Stratum	> 5 cm		> 15 cm		> 30 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Lowland Dipterocarp, High, LD-H	156	774	74	238	34	81	19	29
Lowland Dipterocarp, Medium, LD-M	127	800	41	182	14	50	6	13
Lowland Dipterocarp, Low, LD-L	41	507	11	127	3	18	1	2
Hill Dipterocarp, High, HD-H	472	1,906	89	360	24	75	11	23
Hill Dipterocarp, Medium, HD-M	161	1,150	52	245	13	46	3	12
Hill Dipterocarp, Low, HD-L	54	572	24	79	4	21	1	3
Upper Hill, High, UH-H	399	1,893	91	382	30	91	17	29
Upper Hill, Medium, UH-M	48	1,061	17	273	6	70	2	11
Upper Hill, Low, UH-L	12	323	11	102	4	31	0	1
Montane, MTN	525	1,343	111	265	28	72	21	25
Peat Swamp, High, PS-H	250	1,363	100	351	42	86	24	18
Peat Swamp, Medium, PS-M	244	1,294	65	284	14	44	2	4
Peat Swamp, Low, PS-L	195	954	27	143	2	13	0	1
Mangrove, MGV	0	1,631	0	177	0	18	0	4
Kerangas/Health, KGS	134	691	48	206	11	42	4	12
Melaleuca, ML	0	704	0	498	0	54	0	0

Table 7.7 : Cumulative stand density (trees/ha) based on diameter classes in each stratum

7.2 BASAL AREA

7.2.1 BASAL AREA IN HoB AREA

Figure 7.4 shows an average total basal area per hectare in the project area. The average basal area per hectare in the entire project area was estimated at 30.9 m2 ha^{-1} for trees with a diameter of 5 cm and above. About 77.7% (24.03 m^2 ha^{-1}) is dominated by non-dipterocarp trees, while the remaining 32.3% (6.90 m^2 ha^{-1}) is dipterocarp trees. Smaller trees with dbh 5 to 14.9 cm for dipterocarp and non-dipterocarp trees dominate the area with basal area per hectare of 9.60 m^2 ha^{-1} (31%), followed by 15 to 29.9 cm (9.2 m^2 ha^{-1} (29.8%)) and trees larger than 45 cm (22 m^2 ha^{-1} (6.8%)). Trees with dbh 30 – 44.9 cm contributed 17.2%, which is 5.3 m^2 ha^{-1}, of the total basal area per hectare basis.

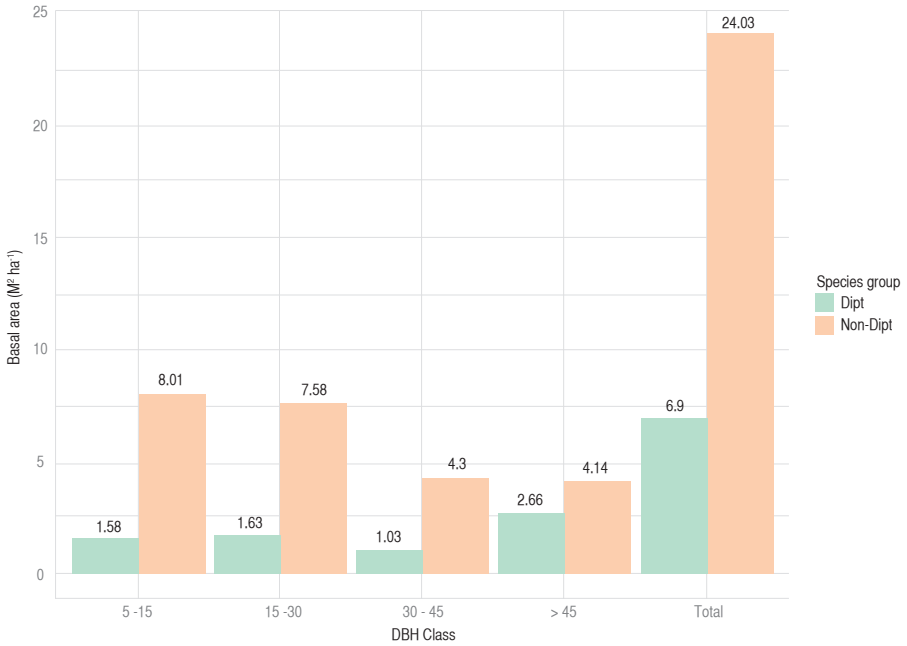


Figure 7.4 : Average total basal area based on diameter classes in the project area

7.2.2 BASAL AREA ACCORDING TO LAND STATUS

Comparison of tree density between four (4) land statuses is shown in **Figure 7.5** and **Table 7.8**. In general, the concession area has a higher basal area per hectare as compared with other lands, which were TPA (forested), TPA (disturbed), and state land. Basal area per hectare in the concession area was estimated at 36.31 m^2 ha^{-1}. Forested and disturbed areas in TPA were estimated at 26.66 and 23.90 m^2 ha^{-1} respectively. State land has the lowest basal area per hectare among other lands with basal area per hectare estimated at 13.58 m^2 ha^{-1}.

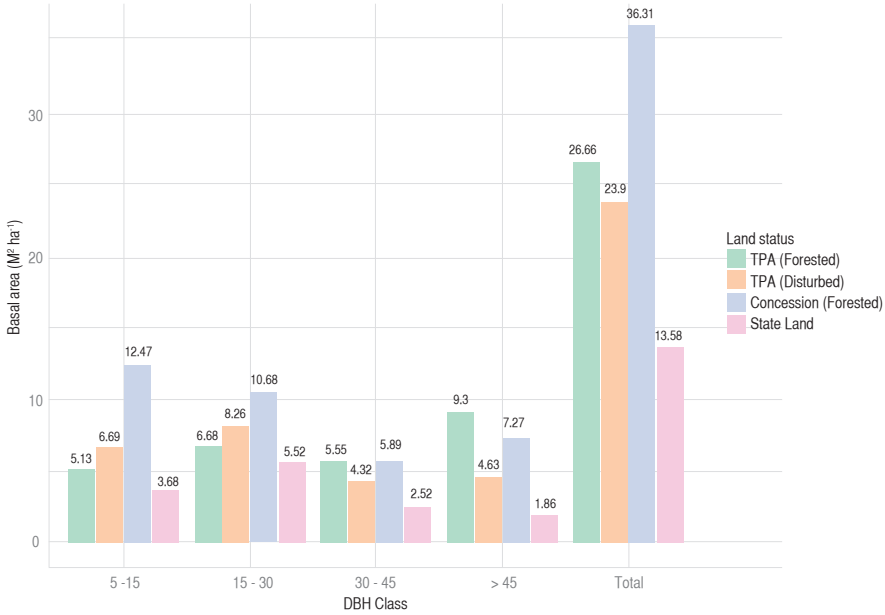


Figure 7.5 : Average total basal area based on diameter classes in each land status

Land status	5 -15 cm		15 - 30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
TPA (Forested), TPA-F	0.59	4.54	1.28	5.40	0.85	4.70	3.89	5.41	6.61	20.05
TPA (Disturbed), TPA-D	0.93	5.76	1.47	6.79	1.20	3.12	2.81	1.82	6.41	17.49
Concession (Forested), CON-F	2.24	10.23	1.96	8.72	1.15	4.74	2.56	4.71	7.91	28.40
State Land, STL	0.17	3.51	0.10	5.42	0.03	2.49	0.05	1.81	0.35	13.23

Table 7.8 : Average total basal area (m^2 ha^{-1}) based on species group and diameter classes in each land status

7.2.3 BASAL AREA ACCORDING TO FOREST TYPES

Basal area according to five forest types in the project area is shown in **Figure 7.6**. Mixed dipterocarp forest has a higher average total basal area per hectare as compared to other forests with an estimate at 33.10 m^2 ha^{-1}. Peat swamp forest has the second highest in terms of basal area per hectare with an estimate at 24.22 m^2 ha^{-1} followed by Melaleuca Forest with an estimate at 22.17 m^2 ha^{-1}. Kerangas/heath and mangrove forests have a lower average total basal area with an estimate at 20.17 and 15.73 m^2 ha^{-1} respectively. For melaleuca forest, 66.1% of basal area per hectare is contributed by tress in the 15 – 30 cm category. Details on the average total basal area per hectare of each forest type based on species groups can be referred to in **Table 7.9**.

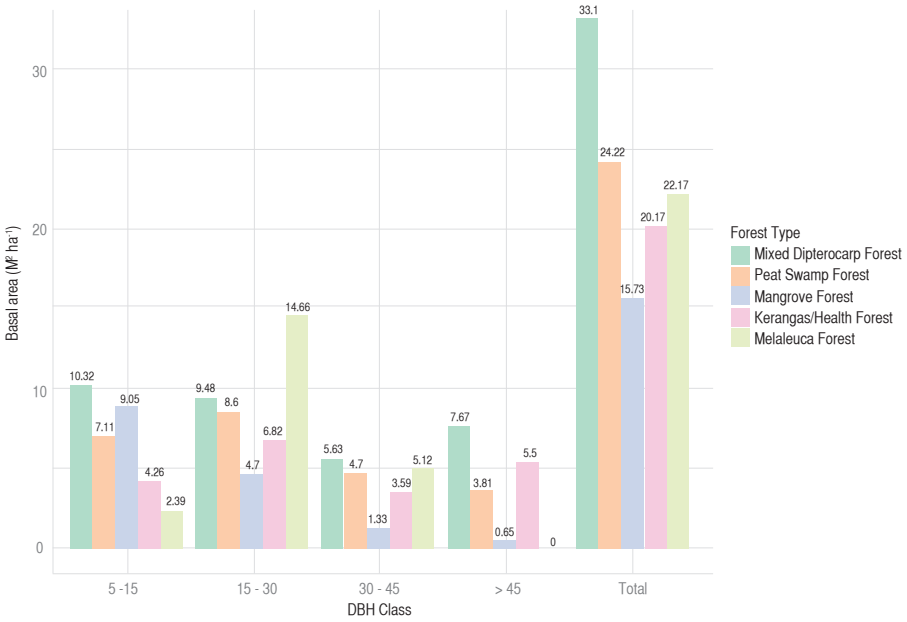


Figure 7.6 : Average total basal area based on diameter classes in each forest type

Forest Type	5 -15 cm		15 -30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Mixed Dipterocarp Forest, MXD	1.77	8.55	1.71	7.77	1.08	4.55	2.89	4.78	7.45	25.65
Peat Swamp Forest, PS	1.14	5.97	1.61	6.99	1.04	3.66	2.36	1.45	6.15	18.07
Mangrove Forest, MGV	0.00	9.05	0.00	4.70	0.00	1.33	0.00	0.65	0.00	15.73
Kerangas/Health Forest, KGS	0.49	3.77	1.26	5.56	0.65	2.94	0.74	4.76	3.14	17.03
Melaleuca Forest, ML	0.00	2.39	0.00	14.66	0.00	5.12	0.00	0.00	0.00	22.17

Table 7.9 Average total basal area (m^2 ha^{-1}) based on species group and diameter classes in each forest type

7.2.4 BASAL AREA ACCORDING TO STRATA

Estimation on average total basal area per hectare and cumulative basal area per hectare based on diameter classes in each stratum are shown in **Tables 7.10** and **7.11**. In general, high-density forests show a higher average total basal area per hectare as compared to medium and low-density forests. UH-H has the highest average total basal area per hectare with an estimate at 50.26 m^2 ha^{-1} followed by HD-H and PS-H with average total basal area per hectare estimate at 46.74 and 42.87 m^2 ha^{-1} respectively. LD-L, HD-L, and UH-L are the lowest three strata, which have the lowest average total basal area per hectare, with an estimate at 9.41, 8.82, and 7.84 m^2 ha^{-1} respectively.

Stratum	5 -15 cm		15 - 30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Lowland Dipterocarp, High, LD-H	0.70	3.95	1.73	6.05	1.63	5.43	7.04	9.06	11.10	24.49
Lowland Dipterocarp, Medium, LD-M	0.71	4.84	1.07	4.99	0.91	3.79	1.60	3.18	4.29	16.80
Lowland Dipterocarp, Low, LD-L	0.24	2.89	0.34	3.66	0.20	1.53	0.13	0.42	0.91	8.50
Hill Dipterocarp, High, HD-H	3.44	13.49	2.46	10.90	1.40	5.34	3.57	6.14	10.87	35.87
Hill Dipterocarp, Medium, HD-M	1.00	7.27	1.45	7.28	0.98	3.40	0.78	3.06	4.21	21.01
Hill Dipterocarp, Low, HD-L	0.13	3.25	0.69	1.97	0.34	1.74	0.12	0.58	1.28	7.54
Upper Hill, High, UH-H	3.07	13.63	2.46	11.14	1.34	6.55	4.95	7.12	11.82	38.44
Upper Hill, Medium, UH-M	0.24	6.84	0.42	7.17	0.43	5.71	0.38	2.52	1.47	22.24
Upper Hill, Low, UH-L	0.00	1.57	0.27	2.55	0.50	2.81	0.00	0.14	0.77	7.07
Montane, MTN	3.96	9.68	3.87	7.81	0.86	5.25	4.18	4.56	12.87	27.30
Peat Swamp, High, PS-H	0.97	6.48	2.00	8.98	1.82	6.97	10.68	4.97	15.47	27.40
Peat Swamp, Medium, PS-M	1.22	6.42	1.91	7.75	1.20	3.84	0.54	0.83	4.87	18.84
Peat Swamp, Low, PS-L	1.11	4.81	0.81	4.27	0.22	1.09	0.00	0.18	2.14	10.35
Mangrove, MGV	0.00	9.05	0.00	4.70	0.00	1.33	0.00	0.65	0.00	15.73
Kerangas/ Health, KGS	0.49	3.77	1.26	5.56	0.65	2.94	0.74	4.76	3.14	17.03
Melaleuca, ML	0.00	2.39	0.00	14.66	0.00	5.12	0.00	0.00	0.00	22.17

Table 7.10 : Average total basal area (m^2 ha^{-1}) based on species group and diameter classes in each stratum

Basal area according to five forest types in the project area is shown in **Figure 7.6**. Mixed dipterocarp forest has a higher average total basal area per hectare as compared to other forests with an estimate at 33.10 m^2 ha^{-1}. Peat swamp forest has the second highest in terms of basal area per hectare with an estimate at 24.22 m^2 ha^{-1} followed by Melaleuca Forest with an estimate at 22.17 m^2 ha^{-1}. Kerangas/heath and mangrove forests have a lower average total basal area with an estimate at 20.17 and 15.73 m^2 ha^{-1} respectively. For melaleuca forest, 66.1% of basal area per hectare is contributed by tress in the 15 – 30 cm category. Details on the average total basal area per hectare of each forest type based on species groups can be referred to in **Table 7.9**.

Stratum	> 5 cm		> 15 cm		> 30 cm		> 45 cm	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Lowland Dipterocarp, High, LD-H	11.10	24.49	10.40	20.54	8.67	14.49	7.04	9.06
Lowland Dipterocarp, Medium, LD-M	4.29	16.80	3.58	11.96	2.51	6.97	1.60	3.18
Lowland Dipterocarp, Low, LD-L	0.91	8.50	0.67	5.61	0.33	1.95	0.13	0.42
Hill Dipterocarp, High, HD-H	10.87	35.87	7.43	22.38	4.97	11.48	3.57	6.14
Hill Dipterocarp, Medium, HD-M	4.21	21.01	3.21	14.74	1.76	6.46	0.78	3.06
Hill Dipterocarp, Low, HD-L	1.28	7.54	1.15	4.29	0.46	2.32	0.12	0.58
Upper Hill, High, UH-H	11.82	38.44	8.75	24.81	6.29	13.67	4.95	7.12
Upper Hill, Medium, UH-M	1.47	22.24	1.23	15.40	0.81	8.23	0.38	2.52
Upper Hill, Low, UH-L	0.77	7.07	0.77	5.50	0.50	2.95	0.00	0.14
Montane, MTN	12.87	27.30	8.91	17.62	5.04	9.81	4.18	4.56
Peat Swamp, High, PS-H	15.47	24.70	14.50	20.92	12.50	11.94	10.68	4.97
Peat Swamp, Medium, PS-M	4.87	18.84	3.65	12.42	1.74	4.67	0.54	0.83
Peat Swamp, Low, PS-L	2.14	10.35	1.03	5.54	0.22	1.27	0.00	0.81
Mangrove, MGV	0.00	15.73	0.00	6.68	0.00	1.98	0.00	0.65
Kerangas/Health, KGS	3.14	17.03	2.65	13.26	1.39	7.70	0.74	4.76
Melaleuca, ML	0.00	22.17	0.00	19.78	0.00	5.12	0.00	0.00

Table 7.11 : Cumulative basal area (m^2 ha^{-1}) based on species group and diameter classes in each stratum

7.3 STAND VOLUME

7.3.1 STAND VOLUME IN HoB AREA

Figure 7.7 shows an average total volume per hectare in the project area. The average volume per hectare in the entire project area was estimated at 158.1 m^3 ha^{-1} for trees with a diameter of 5 cm and above. About 72.9% (115.2 m^3 ha^{-1}) is dominated by non-dipterocarp trees, while the remaining 27.1% (42.9 m^3 ha^{-1}) is dipterocarp trees. Each dbh category for non-dipterocarp trees shows little variations in terms of the average total volume per hectare. Conversely, dipterocarp trees for trees above 45 cm show a significant difference in the average total volume per hectare as compared to dbh classes. It contributes to 60.1% of the total volume for dipterocarp trees.

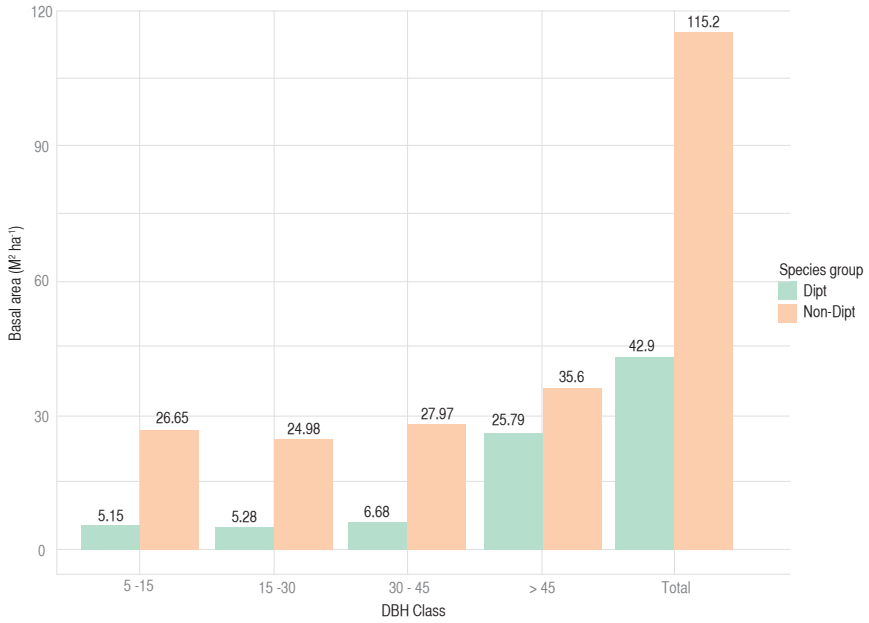


Figure 7.7 : Average total stand volume based on diameter classes in the project area

7.3.2 BASAL AREA ACCORDING TO FOREST TYPES

Comparison of average total volume per hectare between four (4) land statuses is shown in **Figure 7.8** and Table **7.12**. In general, the concession area has a higher basal area per hectare as compared with other lands, which were TPA (forested), TPA (disturbed), and state land. The average total volume per hectare in the concession area was estimated at 177.00 m^3 ha^{-1}. Forested and disturbed areas in TPA were estimated at 166.15 and 121.50 m^3 ha^{-1} respectively. State land has the lowest average total volume per hectare among other lands with an average total volume per hectare estimated at 68.75 m^3 ha^{-1}.

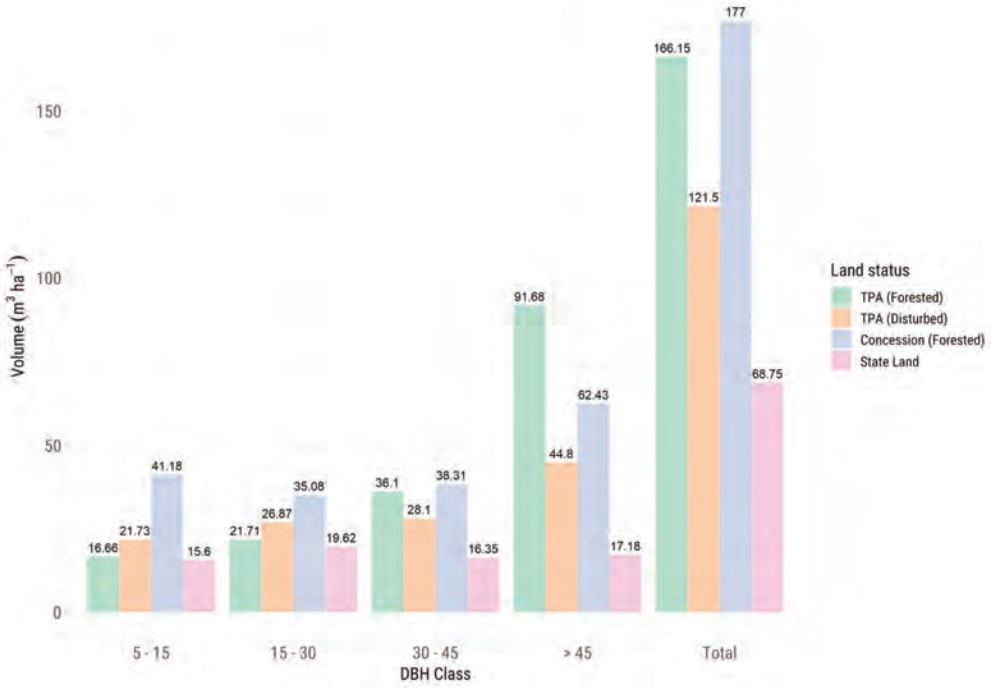


Figure 7.8 : Average total stand volume based on diameter classes in each land status

Land status	5 -15 cm		15 -30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
TPA Intact (TPA-F)	1.90	14.76	4.14	17.57	5.53	30.57	41.21	50.47	52.78	113.37
TPA Disturbed (TPA-D)	3.02	18.71	4.79	22.08	7.82	20.28	28.62	16.18	44.25	77.25
Production Forest (CON-F)	7.29	33.89	6.37	28.71	7.49	30.82	23.49	38.94	44.64	132.36
State Land (STL)	0.56	15.04	0.33	19.29	0.23	16.12	0.35	16.83	1.47	67.28

Table 7.12 : Average total stand volume (m^3 ha^{-1}) based on species group and diameter classes in each land status

7.3.3 STAND VOLUME ACCORDING TO FOREST TYPES

The average total volume per hectare according to five forest types in the project area is shown in Figure 7.9. Mixed dipterocarp forest has a higher average total volume per hectare as compared to other forests with an estimate at 169.75 m^3 ha^{-1}. Peat swamp forest has the second highest in terms of average total volume per hectare with an estimate at 117.79 m^3 ha^{-1} followed by Kerangas/heath forest with an estimate at 114.29 m^3 ha^{-1}. Mangrove and Melaleuca forests have a lower average total volume per hectare with an estimate at 95.99 and 88.74 m^3 ha^{-1} respectively. For mangrove forest, 57.1% of total volume per hectare is contributed by tress in 15 – 30 cm category while total volume for kerangas/heath and mixed dipterocarp forests are contributed from trees in 45 cm and above by more than 40%. Details on the average total volume per hectare of each forest type based on species groups can be referred to in **Table 7.13**.

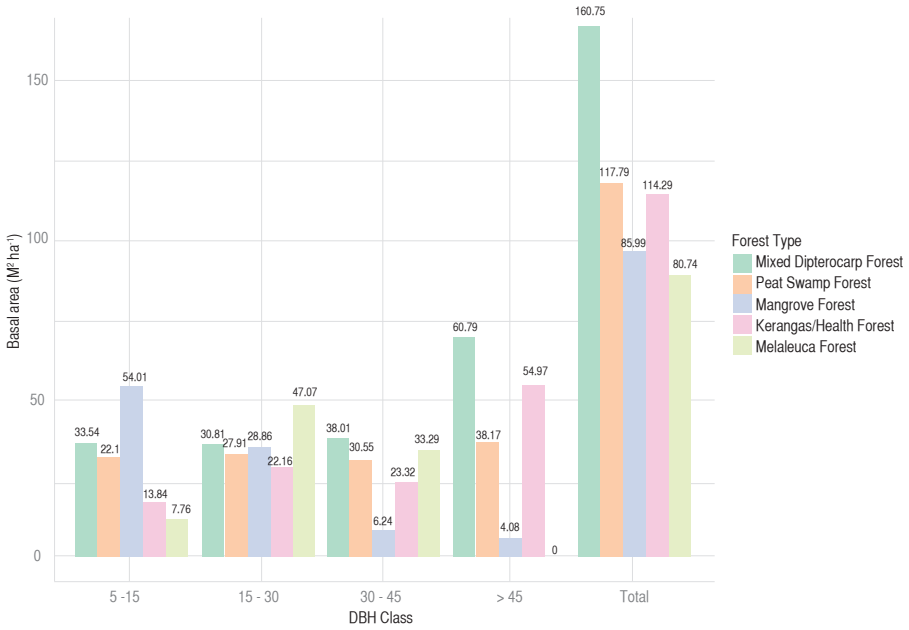


Figure 7.9 : Average total stand volume based on diameter classes in each forest type

Forest Type	5 -15 cm		15 -30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Mixed Dipterocarp Forest, MXD	5.75	8.55	5.55	25.26	7.02	29.59	27.71	41.08	46.03	123.72
Peat Swamp Forest, PS	3.70	5.97	5.24	22.73	6.75	23.80	24.83	11.34	40.52	77.27
Mangrove Forest, MGV	0.00	9.05	0.00	28.86	0.00	8.24	0.00	4.08	0.00	95.99
Kerangas/Health Forest, KGS	1.59	3.77	4.09	18.07	4.22	19.10	4.83	50.14	14.73	99.56
Melaleuca Forest, ML	0.00	2.39	0.00	47.67	0.00	33.29	0.00	0.00	0.00	88.74

Table 7.13 : Average total stand volume (m^3 ha^{-1}) based on species group and diameter classes in each forest type

7.3.4 STAND VOLUME ACCORDING TO STRATA

The average total volume per hectare according to five forest types in the project area is shown in **Figure 7.9**. Mixed dipterocarp forest has a higher average total volume per hectare as compared to other forests with an estimate at 169.75 m^3 ha^{-1}. Peat swamp forest has the second highest in terms of average total volume per hectare with an estimate at 117.79 m^3 ha^{-1} followed by Kerangas/heath forest with an estimate at 114.29 m^3 ha^{-1}. Mangrove and Melaleuca forests have a lower average total volume per hectare with an estimate at 95.99 and 88.74 m^3 ha^{-1} respectively. For mangrove forest, 57.1% of total volume per hectare is contributed by tress in 15 – 30 cm category while total volume for kerangas/heath and mixed dipterocarp forests are contributed from trees in 45 cm and above by more than 40%. Details on the average total volume per hectare of each forest type based on species groups can be referred to in **Table 7.13**.

Stratum	5 -15 cm		15 - 30 cm		30 - 45 cm		> 45 cm		Total	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Lowland Dipterocarp, High, LD-H	2.27	12.83	5.62	19.66	10.58	35.33	73.97	86.92	92.44	154.74
Lowland Dipterocarp, Medium, LD-M	2.30	15.74	3.46	16.21	5.93	24.67	14.29	25.70	25.98	82.32
Lowland Dipterocarp, Low, LD-L	0.79	9.39	1.11	11.90	1.32	9.94	1.36	3.16	4.58	34.39
Hill Dipterocarp, High, HD-H	11.19	43.85	7.98	35.44	9.11	34.73	34.12	52.86	6.240	166.88
Hill Dipterocarp, Medium, HD-M	3.25	23.63	4.71	23.67	6.35	22.12	6.84	25.65	21.15	95.07
Hill Dipterocarp, Low, HD-L	0.41	10.56	2.25	6.39	2.21	11.31	0.80	4.07	5.67	32.33
Upper Hill, High, UH-H	9.98	44.31	8.01	36.22	8.75	42.56	46.40	58.80	73.14	181.89
Upper Hill, Medium, UH-M	0.78	22.22	1.36	23.32	2.81	37.14	3.41	18.43	8.36	101.11
Upper Hill, Low, UH-L	0.00	5.10	0.89	8.28	3.28	18.26	0.00	0.91	4.17	32.55
Montane, MTN	12.88	31.47	12.57	25.39	5.61	34.14	27.82	29.62	58.88	120.62
Peat Swamp, High, PS-H	3.14	21.06	6.51	29.18	11.81	45.32	116.43	42.25	137.89	137.81
Peat Swamp, Medium, PS-M	3.96	20.85	6.20	25.21	7.78	24.97	4.23	5.38	22.17	76.41
Peat Swamp, Low, PS-L	3.62	15.64	2.65	13.88	1.45	7.11	0.00	1.15	7.72	37.78
Mangrove, MGV	0.00	54.81	0.00	28.86	0.00	8.24	0.00	4.08	0.00	95.99
Kerangas/ Health, KGS	1.59	12.25	4.09	18.07	4.22	19.10	4.83	50.14	14.73	99.56
Melaleuca, ML	0	7.78	0.00	47.67	0.00	33.29	0.00	0.00	0.00	88.74

Table 7.14 : Average total stand volume (m^3 ha^{-1}) based on species group and diameter classes in each stratum

Stratum	> 5 cm		> 15 cm		> 30 cm		> 45 cm	
	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt	Dipt	Non Dipt
Lowland Dipterocarp, High, LD-H	92.44	154.74	90.17	141.91	84.55	122.25	73.97	86.92
Lowland Dipterocarp, Medium, LD-M	25.98	82.32	23.68	66.58	20.22	50.37	14.29	25.70
Lowland Dipterocarp, Low, LD-L	4.58	34.39	3.79	25.00	2.68	13.10	1.36	3.16
Hill Dipterocarp, High, HD-H	62.40	166.88	51.21	123.03	43.23	87.59	34.12	52.86
Hill Dipterocarp, Medium, HD-M	21.15	95.07	17.90	71.44	13.19	47.77	6.84	25.65
Hill Dipterocarp, Low, HD-L	5.67	32.33	5.26	21.77	3.01	15.38	0.80	4.07
Upper Hill, High, UH-H	73.14	181.89	63.16	137.58	55.15	101.36	46.40	58.80
Upper Hill, Medium, UH-M	8.36	101.11	7.58	78.89	6.22	55.57	3.41	18.43
Upper Hill, Low, UH-L	4.17	32.55	4.17	27.45	3.28	19.17	0.00	0.91
Montane, MTN	58.88	120.62	46.00	89.15	33.43	63.76	27.82	29.62
Peat Swamp, High, PS-H	137.89	137.81	134.75	116.75	128.24	87.57	116.43	42.25
Peat Swamp, Medium, PS-M	22.17	76.41	18.21	55.56	12.01	30.35	4.23	5.38
Peat Swamp, Low, PS-L	7.72	37.78	4.10	22.14	1.45	8.26	0.00	1.15
Mangrove, MGV	0.00	95.99	0.00	41.18	0.00	12.32	0.00	4.08
Kerangas/Health, KGS	14.73	99.56	13.14	87.31	9.05	69.24	4.83	50.14
Melaleuca, ML	0	88.74	0.00	80.96	0.00	33.29	0.00	0.00

Table 7.15 : Cumulative stand volume (m^3 ha^{-1}) based on species group and diameter classes in each stratum

7.4 BIOMASS AND CARBON STOCK

7.4.1 CARBON STOCK IN HoB AREA

Basic statistics on carbon stock for each carbon pool in the project area are shown in **Table 7.16** while the average carbon stock for each carbon pool is shown in **Figure 7.10**. Results indicated that the biggest portion of biomass carbon is in the aboveground component of living trees, which comprised about 59.3% of the total carbon pools in the forest. It indicates that the aboveground component of biomass dominates the carbon pools, and it plays a major role in many biomass and carbon assessments of forests. It was followed by soil and belowground components, which consisted of about 23.1% and 13.0% of the total carbon pools respectively. Deadwood and litter have a relatively small portion, which is about 3.7 and 0.9%, respectively.

Carbon Pool	Mininum	Maximum	Average	Standard Deviation
Aboveground trees, AG	0.17	629.04	143.65	86.64
Belowground trees, BG	0.36	147.82	31.40	19.59
Litter falls, LF	0.02	7.25	2.19	1.69
Dead wood, DW	0.17	66.74	9.01	9.60
Soil, SL	13.75	199.56	56.08	33.80

Table 7.16 : Composition of carbon stock (Mg C ha^{-1}) in the corresponding carbon pools in the project area

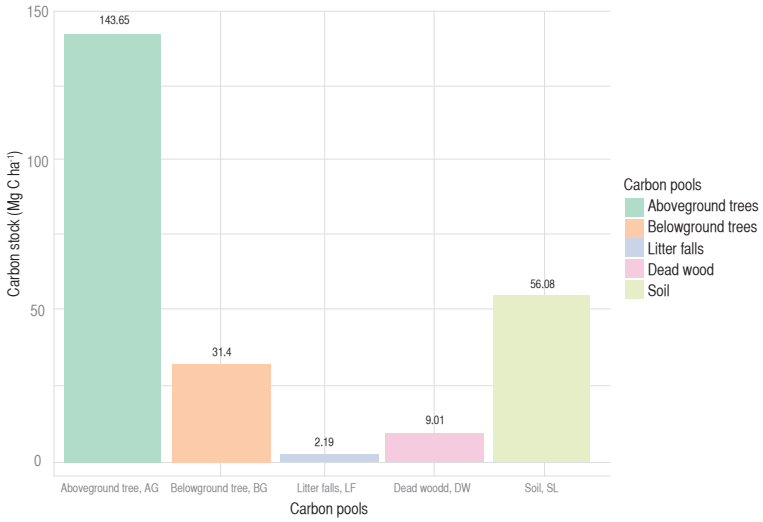


Figure 7.10 : Average carbon stock within carbon pools in the project area

7.4.2 CARBON STOCK ACCORDING TO LAND STATUS

Comparison of average total carbon per hectare between four (4) land statuses is shown in **Figure 7.11** and **Table 7.17**. In terms of total carbon stock, the concession area has higher total carbon per hectare as compared with other lands, which were TPA (forested), TPA (disturbed), and state land. Total carbon per hectare in the concession area was estimated at 220.74 Mg C ha^{-1}. Forested and disturbed areas in TPA were estimated at 192.62 and 145.09 Mg C ha^{-1} respectively. State land has the lowest. This occurred because all production forest/ concession areas comprise only mixed hill dipterocarp forest while the TPA areas comprises of all types of forest. 83.90 Mg C ha^{-1}.

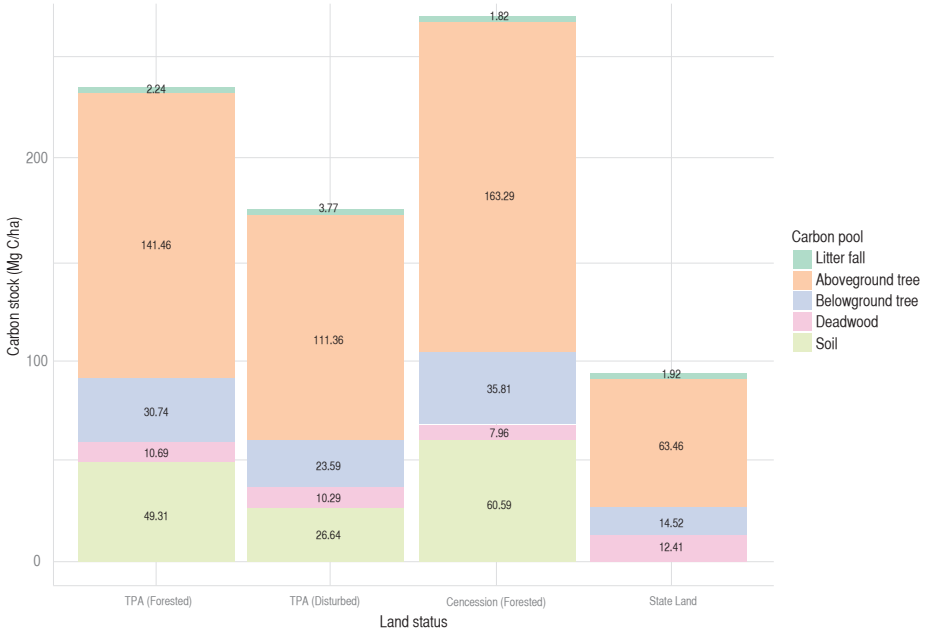


Figure 7.11 : Average carbon stock in corresponding of carbon pools in according to land status

Land status	AG[1]	BG[2]	LF[3]	DW[4]	SL[5]	TOTAL
TPA (Intact), TPA-F	1.90	14.76	4.14	17.57	5.53	30.57
TPA (Disturbed), TPA-D	3.02	18.71	4.79	22.08	7.82	20.28
Production Forest, CON-F	7.29	33.89	6.37	28.71	7.49	30.82
State Land, STL	0.56	15.04	0.33	19.29	0.23	16.12

[1]AG: Aboveground living trees; [2]BG: Belowground living trees; [3]LF: Litter falls; [4]DW: Dead wood; [5]SL: Soil

Table 7.17 : Average composition of carbon stock (Mg C ha^{-1}) in corresponding of carbon pools in according to land status

7.4.3 CARBON STOCK ACCORDING TO FOREST TYPES

Figure 7.12 shows the average carbon stock per hectare according to five forest types in the project area. Mixed dipterocarp forest has higher carbon stock per hectare as compared to other forests with an estimate at 209.20 Mg C ha^{-1}. Other forest types have significantly lower carbon stocks than mixed dipterocarp forest. This is due to incomplete data, especially on soil component. However, total carbon per hectare for peat swamp, kerangas/heath, and Melaleuca forests are at a range of 130 – 140 Mg C ha^{-1}. Mangrove forest has lower total carbon per hectare, which is below than 100 Mg C ha^{-1}.

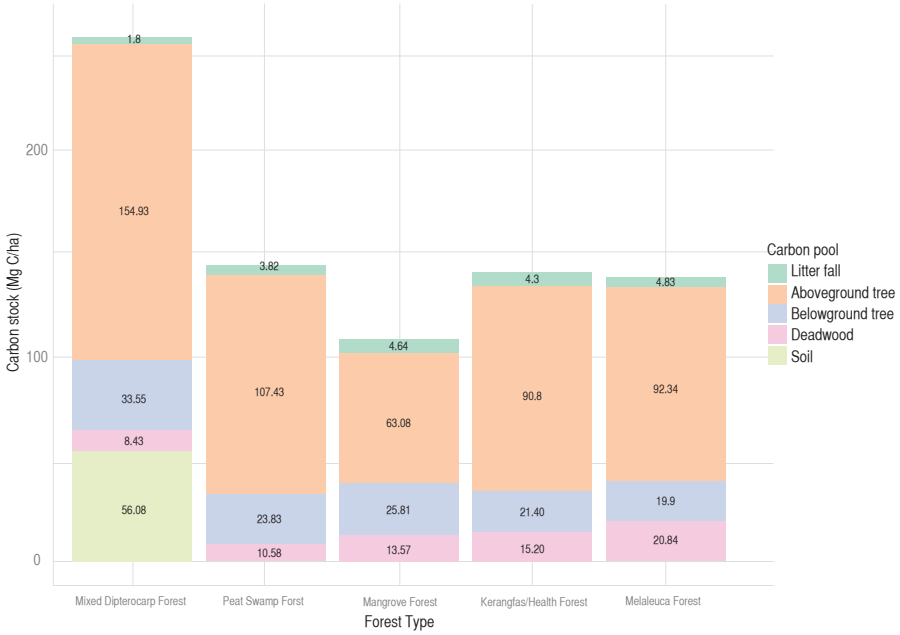


Figure 7.12 : Average carbon stock in corresponding of carbon pools in according to forest type

Forest Type	AG[1]	BG[2]	LF[3]	DW[4]	SL[5]	TOTAL
Mixed Dipterocarp Forest, MXD	154.93	33.55	1.80	8.43	56.0	209.20
Peat Swamp Forest, PS	107.43	23.13	3.82	10.18	n.a	139.66
Mangrove Forest, MGV	63.88	25.81	4.64	13.57	n.a	93.97
Kerangas/Health Forest, KGS	98.80	21.49	4.30	15.26	n.a	131.16
Melaleuca Forest, ML	92.34	19.90	4.83	20.84	n.a	137.10

Table 7.18 : Average composition of carbon stock (Mg C ha^{-1}) in corresponding of carbon pools in according to forest type

7.4.4 CARBON STOCK ACCORDING TO STRATA

Estimation of average carbon stock per hectare for each carbon pool in each stratum is shown in **Figure 7.13** and **Table 7.19**. In general, high-density forests show higher average total carbon stock per hectare as compared to medium and low-density forests. UH-H has the highest average total carbon stock per hectare with an estimate at 308.27 Mg C ha^{-1} followed by PS-H and HD-H with average total carbon stock per hectare estimate at 282.18 and 275.84 Mg C ha^{-1} respectively. UH-L, LD-L and HD-L are the lowest three strata that have the lowest average total carbon stock per hectare with an estimate at 60.13, 59.30, and 53.79 Mg C ha^{-1} respectively.

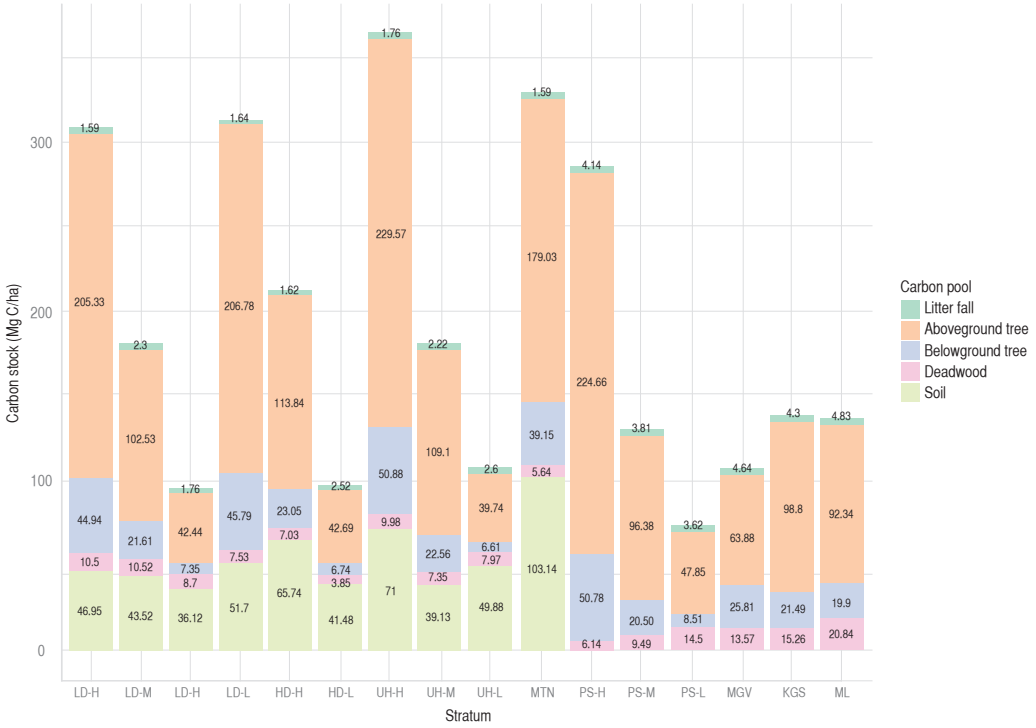


Figure 7.13 : Average carbon stock in the corresponding carbon pools according to forest stratum

Stratum	AG[1]	BG[2]	LF[3]	DW[4]	SL[5]	TOTAL
Lowland Dipterocarp, High, LD-H	205.33	44.94	1.59	10.50	46.95	271.80
Lowland Dipterocarp, Medium, LD-M	102.53	21.61	2.30	10.52	43.52	140.54
Lowland Dipterocarp, Low, LD-L	42.44	7.35	1.76	8.70	36.12	59.30
Hill Dipterocarp, High, HD-H	206.78	45.79	1.64	7.53	51.70	275.84
Hill Dipterocarp, Medium, HD-M	113.84	23.85	1.62	7.03	65.74	160.19
Hill Dipterocarp, Low, HD-L	42.69	6.74	2.52	3.65	41.48	53.79
Upper Hill, High, UH-H	229.57	50.88	1.76	9.98	71.00	304.27
Upper Hill, Medium, UH-M	109.10	22.56	2.22	7.35	39.13	147.02
Upper Hill, Low, UH-L	39.74	6.61	2.60	7.97	49.88	60.13
Montane, MTN	179.03	39.15	1.59	5.64	103.14	258.86
Peat Swamp, High, PS-H	224.86	50.78	4.14	6.14	0.00	282.18
Peat Swamp, Medium, PS-M	96.38	20.59	3.81	9.49	0.00	125.82
Peat Swamp, Low, PS-L	47.85	8.51	3.62	14.50	0.00	68.13
Mangrove, MGV	63.88	25.81	4.64	13.57	0.00	93.97
Kerangas/Health, KGS	98.80	21.49	4.30	15.26	0.00	131.16
Melaleuca, ML	92.34	19.90	4.83	20.84	0.00	137.10

[1]AG: Aboveground living trees; [2]BG: Belowground living trees; [3]LF: Litter falls; [4]DW: Dead wood; [5]SL: Soil

Table 7.19 : Average composition of carbon stock (Mg C ha^{-1}) in the corresponding of carbon pools in according to forest stratum

7.4.5 CARBON STOCK FOR ABOVEGROUND LIVING TREE

Tables 7.20 and **7.21** show the aboveground carbon stock and cumulative aboveground carbon stock of living trees by diameter classes at different levels of analysis. Overall, the aboveground carbon stock of living trees in the project area is estimated at 132.91 Mg C ha^{-1}. Larger trees where trees at dimeter class dbh 45 cm and above contribute more carbon stock than other diameter classes categories. At the land status level, the concession area (CON-F) has the largest amount of carbon stock with an estimate at 151.54 Mg C ha^{-1}. This is followed by TPA-F, TPA-D, and STL with an estimate at 131.83, 101, and 57.18 Mg C ha^{-1} respectively. At forest type level, mixed dipterocarp forest has the highest amount of aboveground carbon stocks with an estimate at 143.25 Mg C ha^{-1}. This is followed by peat swamp, kerangas/heath, and Melaleuca forests with an estimate at 99.11, 93.21, and 87.13 Mg C ha^{-1} respectively. Mangrove forest has the lowest aboveground carbon stock with an estimate at 61.38 Mg C ha^{-1}. As for the strata analysis, UH-H, PS-H, and HD-H are the top three strata that have the highest amount of aboveground carbon stocks with an estimate at 216.50, 216.07, and 194.86 Mg C ha^{-1} respectively. On the other hand, LD-L, HD-L, and UH-L are the bottom three strata that have the lowest amount of aboveground carbon stocks with an estimate at 35.09, 32.89, and 32.24 Mg C ha^{-1} respectively.

Level	Sub Level	Diameter Class			
		5 - 15	15 - 30	30 - 45	45
Overall					
	Project area, HoB	23.81	35.85	27.46	45.78
Land Status					
	TPA (Intact), TPA-F	12.14	25.96	28.60	65.13
	TPA (Disturbed), TPA-D	15.52	31.37	22.05	32.06
	Production Forest, CON-F	31.32	41.84	30.44	47.94
	State Land, STL	10.23	21.43	12.90	12.62
Forest Type					
	Mixed Dipterocarp Forest, MXD	25.67	37.09	29.07	51.41
	Peat Swamp Forest, PS	16.31	32.39	23.88	26.54
	Mangrove Forest, MGV	28.83	20.79	7.48	4.28
	Kerangas/Health Forest, KGS	10.38	25.84	18.16	38.83
	Melaleuca Forest, ML	6.26	55.10	25.76	0.00
Stratum					
	Lowland Dipterocarp, High, LD-H	11.18	30.75	36.59	112.71
	Lowland Dipterocarp, Medium, LD-M	13.42	23.74	24.37	31.00
	Lowland Dipterocarp, Low, LD-L	7.53	15.17	8.84	3.55
	Hill Dipterocarp, High, HD-H	42.29	52.37	34.82	65.39
	Hill Dipterocarp, Medium, HD-M	20.36	33.84	22.47	25.01
	Hill Dipterocarp, Low, HD-L	7.92	10.06	10.60	4.30
	Upper Hill, High, UH-H	42.27	53.52	40.90	79.80
	Upper Hill, Medium, UH-M	17.79	29.11	31.16	18.24
	Upper Hill, Low, UH-L	3.83	10.82	16.77	0.81
	Montane, MTN	34.42	47.04	32.32	52.80
	Peat Swamp, High, PS-H	17.21	41.54	45.16	112.16
	Peat Swamp, Medium, PS-M	17.54	36.32	25.48	8.54
	Peat Swamp, Low, PS-L	13.48	19.09	6.57	1.04
	Mangrove, MGV	28.83	20.79	7.48	4.28
	Kerangas/Health, KGS	10.38	25.84	18.16	38.83
	Melaleuca, ML	6.26	55.10	25.76	0.00

Table 7.20 : Aboveground carbon stock (Mg C ha^{-1}) by diameter classes at different levels

Level	Sub Level	Diameter Class			
		> 5 cm	> 15 cm	> 30 cm	> 45 cm
Overall					
	Project area, HoB	132.91	109.09	73.24	45.78
Land Status					
	TPA (Intact), TPA-F	131.83	119.69	93.73	65.13
	TPA (Disturbed), TPA-D	101.00	85.48	54.11	32.06
	Production Forest, CON-F	151.54	120.22	78.83	47.94
	State Land, STL	57.18	46.95	25.51	12.62
Forest Type					
	Mixed Dipterocarp Forest, MXD	143.25	117.57	80.49	51.41
	Peat Swamp Forest, PS	99.11	82.80	50.41	26.54
	Mangrove Forest, MGV	61.38	32.55	11.76	4.28
	Kerangas/Health Forest, KGS	93.21	82.83	56.99	38.83
	Melaleuca Forest, ML	87.13	80.87	25.76	0.00
Stratum					
	Lowland Dipterocarp, Medium, LD-M	92.54	79.11	55.37	31.00
	Lowland Dipterocarp, Low, LD-L	35.09	27.55	12.39	3.55
	Hill Dipterocarp, High, HD-H	194.86	152.58	100.21	65.39
	Hill Dipterocarp, Medium, HD-M	101.67	81.32	47.47	25.01
	Hill Dipterocarp, Low, HD-L	32.89	24.96	14.90	4.30
	Upper Hill, High, UH-H	216.50	174.23	120.71	79.80
	Upper Hill, Medium, UH-M	96.30	78.51	49.40	18.24
	Upper Hill, Low, UH-L	32.24	28.40	17.58	0.81
	Montane, MTN	166.57	132.15	85.12	52.80
	Peat Swamp, High, PS-H	216.07	198.86	157.32	112.16
	Peat Swamp, Medium, PS-M	87.88	70.34	34.02	8.54
	Peat Swamp, Low, PS-L	40.18	26.70	7.61	1.04
	Mangrove, MGV	61.38	32.55	11.76	4.28
	Kerangas/Health, KGS	93.21	82.83	56.99	38.83
	Melaleuca, ML	87.13	80.87	25.76	0.00

Table 7.21 : Cumulative aboveground carbon stock (Mg C ha^{-1}) by diameter classes at different levels

7.5 SPECIES COMPOSITION

7.5.1 SPECIES COMPOSITION IN HoB AREA

Table 7.22 shows the basic description of trees enumerated in the project area. Based on 723 plots that have been established, the total alive trees enumerated are 19,205 trees. A total of 275 species from 66 different families have been identified. The list of dipterocarp species that have successfully been identified is shown in **Table 7.23**. *Shorea* spp. is the most enumerated tree with a total tree of 1,455. However, this number may decrease if the identification can be made at the species level since there are a lot of species under the genus of *Shorea*. *Vatica* spp. and *Dryobalanops* spp. are among the top three species together with *Shorea* spp. with a total tree of 608 and 325 respectively. Conversely, five dipterocarp tree species were enumerated once. Those species are *Dipterocarpus conformis, Shorea ovalis, Shorea palembanica, Shorea rubra*, and *Shorea teysmanniana*.

Parameter	Value
Total trees enumerated	19,205
Number of species	275
Number of families	66

Table 7.22 : Basic description on tree enumerated in the project area

Species	Number of tress	Species	Number of tress
Shorea spp.	1,455	*Shorea leprosula*	9
Vatica spp.	608	*Shorea kunstleri*	8
Dryobalanops spp.	325	*Shorea laevis*	8
Shorea parvifolia	322	*Shorea pauciflora*	8
Shorea macroptera	179	*Hopea nutans*	7
Dipterocarpus spp.	149	*Parashorea macrophylla*	7
Hopea spp.	107	*Shorea myrionerva*	7
Cotylelobium burckii	79	*Shorea faguetiana*	6
Dipterocarpus grandiflorus	34	*Hopea micrantha*	5
Shorea albida	34	*Parashorea smythiesii*	5
Anisoptera spp.	33	*Shorea scabrida*	4
Shorea macrophylla	30	*Anisoptera laevis*	3
Dryobalanops fusca	29	*Shorea curtisii*	2
Shorea scaberrima	27	*Shorea pubistyla*	2
Shorea sagittata	19	*Dipterocarpus conformis*	1
Dryobalanops beccarii	13	*Shorea ovalis*	1
Shorea agamii	12	*Shorea palembanica*	1
Dryobalanops lanceolata	10	*Shorea rubra*	1
Shorea dispar	10	*Shorea teysmanniana*	1

Table 7.23 : List of dipterocarp tree species enumerated in the project area

7.5.2 SPECIES COMPOSITION ACCORDING TO FOREST TYPES

A total species that have been identified based on forest type for trees at different diameter classes are shown in **Table 7.24**. Mixed dipterocarp forest has the highest number of species for trees above 5 cm dbh with a total species of 254. This is followed by peat swamp and kerangas/heath forests with a total species of 81 and 61 respectively. Only mangrove and Melaleuca forests have a small number of species with 5 and 4. This is expected since the species composition of these forests is small as compared to the other three forest types. Furthermore, based on inventory data, there are no dipterocarp trees that can be found in these forests. Large trees with dbh more 45 cm, the numbers of dipterocarps species are smaller than that of non-dipterocarp species.

Forest Type	> 5 cm		> 45 cm	
	Dipt	Non Dipt	Dipt	Non Dipt
Mixed Dipterocarp Forest, MXD	35	219	29	1118
Peat Swamp Forest, PS	12	69	4	9
Mangrove Forest, MGV	0	5	0	1
Kerangas/Heath Forest, KGS	10	51	1	6
Melaleuca Forest, ML	0	4	0	0

Table 7.24 : Number of species based on diameter classes according to forest type

Figure 7.14 shows the top five dipterocarp and non-dipterocarp tree species in mixed dipterocarp forests. For all trees (trees above 5 cm dbh), the top five dipterocarp species are *Shorea* spp., *Vatica* spp., *Dryobalanops* spp., *Shorea macroptera*, and *Shorea parvifolia. Syzygium* spp., *Macaranga* spp., *Alseodaphane* spp., *Lithocarpus* spp., and *Dacyodes* spp. are the top five species for non-dipterocarp. For larger trees (trees above 45 cm dbh), *Shorea* spp. is still the most enumerated tree for dipterocarp tree, followed by *Dryobalanops* spp., *Dipterocarpus* spp., *Vatica* spp., and *Shorea parvifolia*. As for the non-dipterocarp tree, *Syzygium* spp. is also still the most enumerated tree, followed by *Alseodaphane* spp., *Lithocarpus* spp., *Dacryodes* spp., and *Palaqium* spp.

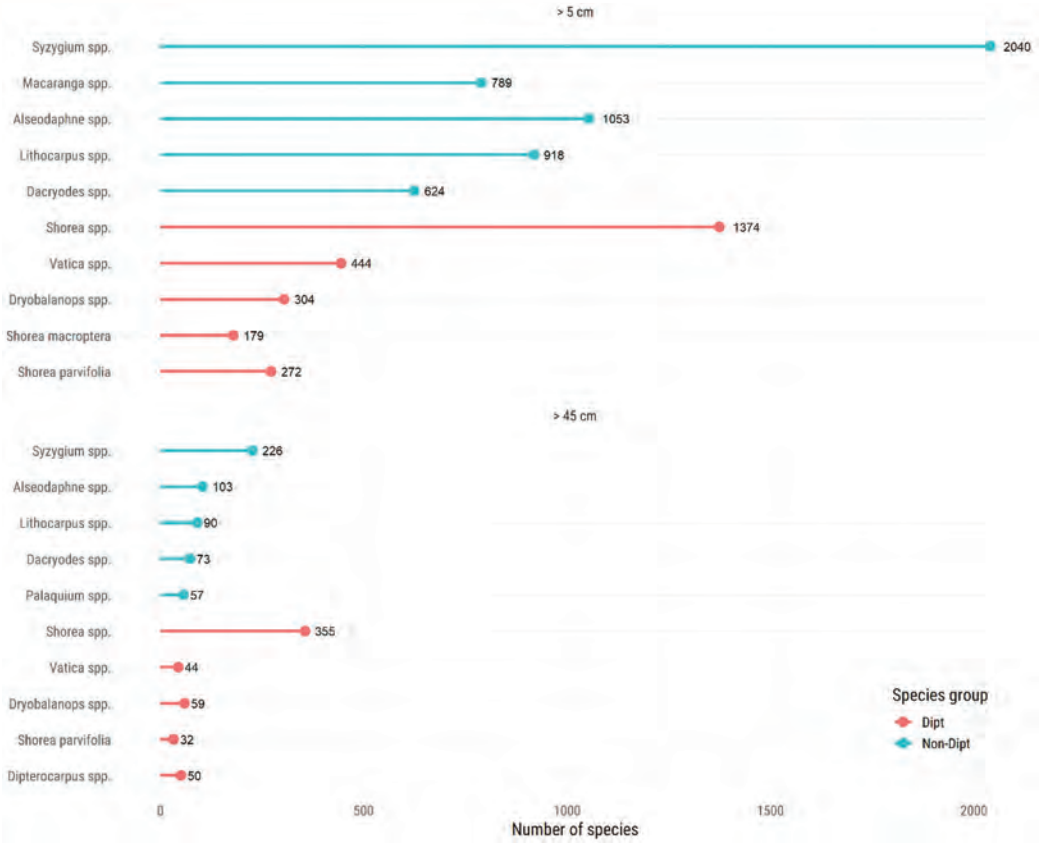


Figure 7.14 : Top five dipterocarp and non-dipterocarp tree species in mixed dipterocarp forest

Figure 7.14 shows the top five dipterocarp and non-dipterocarp tree species in mixed dipterocarp forests. For all trees (trees above 5 cm dbh), the top five dipterocarp species are *Shorea* spp., *Vatica* spp., *Dryobalanops* spp., *Shorea macroptera*, and *Shorea parvifolia*. *Syzygium* spp., *Macaranga* spp., *Alseodaphane* spp., *Lithocarpus* spp., and *Dacyodes* spp. are the top five species for non-dipterocarp. For larger trees (trees above 45 cm dbh), *Shorea* spp. is still the most enumerated tree for dipterocarp tree, followed by *Dryobalanops* spp., *Dipterocarpus* spp., *Vatica* spp., and *Shorea parvifolia*. As for the non-dipterocarp tree, *Syzygium* spp. is also still the most enumerated tree, followed by *Alseodaphane* spp., *Lithocarpus* spp., *Dacryodes* spp., and *Palaqium* spp.

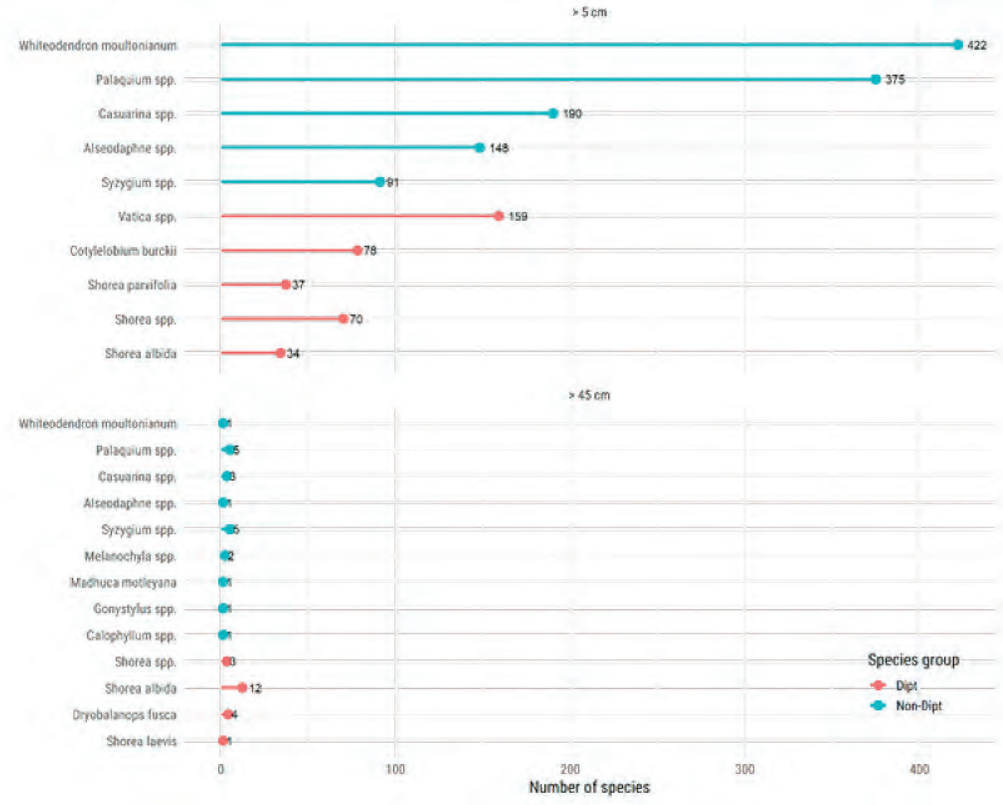


Figure 7.15 : Top five dipterocarp and non-dipterocarp tree species in peat swamp forest

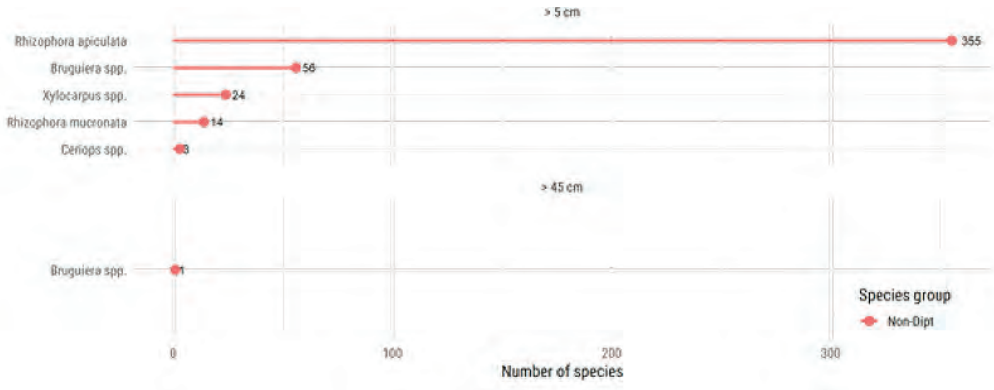


Figure 7.16 : Top dipterocarp and non-dipterocarp tree species in mangrove forest

Figure 7.17 shows top dipterocarp and non-dipterocarp tree species in kerangas/heath forests. *Syzygium* spp. has the highest number of enumerated trees for non-dipterocarp trees for all trees (trees above 5 cm dbh) with a total tree of 26, followed by *Whiteodendron moultonianum, Palaquium* spp., *Alseodaphne* spp., and other species with 17, 17, 15, and 16 respectively. As for dipterocarp trees, *Shorea parvifolia, Shorea* spp., *Vatica* spp., *Dryobalanops* spp., and *Shorea agamii* are the top five species with the most enumerated trees with a total tree of 13, 11, 5, 5, and 4 respectively. In contrast, only two *Dryobalanops* spp. trees that were enumerated where these trees have dbh larger than 45 cm.

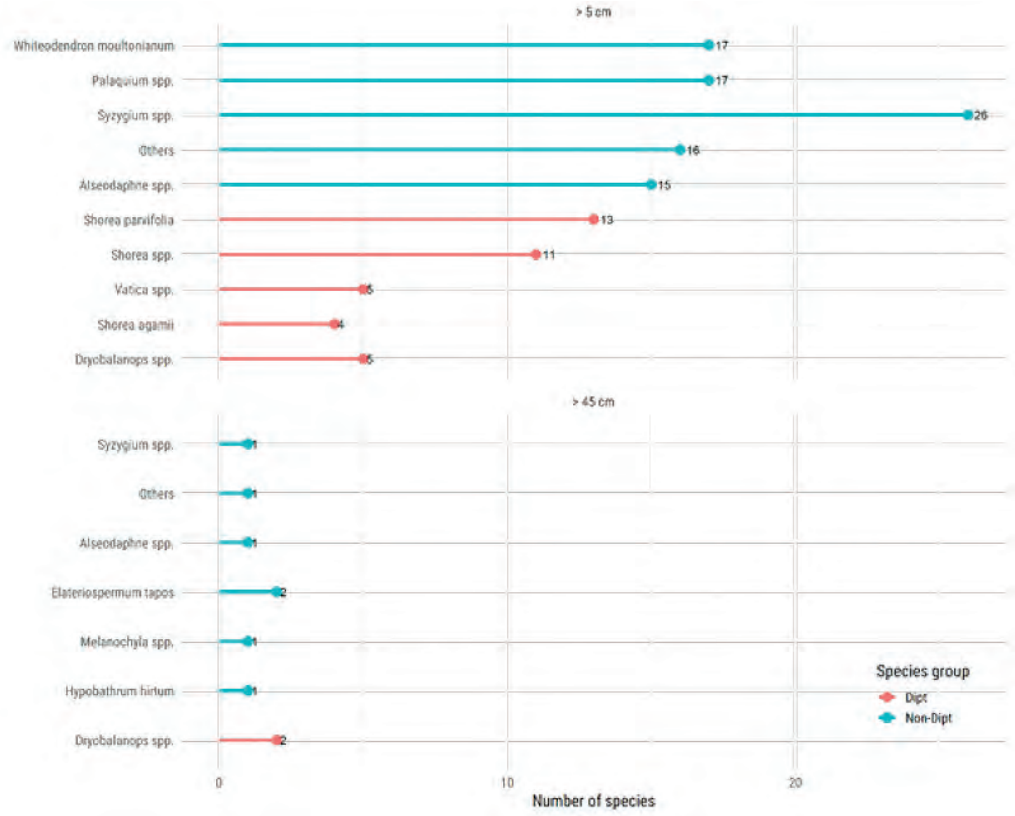


Figure 7.17 : Top dipterocarp and non-dipterocarp tree species in kerangas/heath forest

Like mangrove forests, only non-dipterocarp trees were enumerated in the Melaleuca swamp forest **(Figure 7.18)**. The most dominant species in this forest is Melaleuca spp. with a total tree of 61. Other non-dipterocarps species are also found in this forest *Syzygium* spp., *Acacia* spp., and others. Since all trees in this forest are below 45 cm dbh, there are no top species that can be determined for this class (trees above 45 cm dbh).

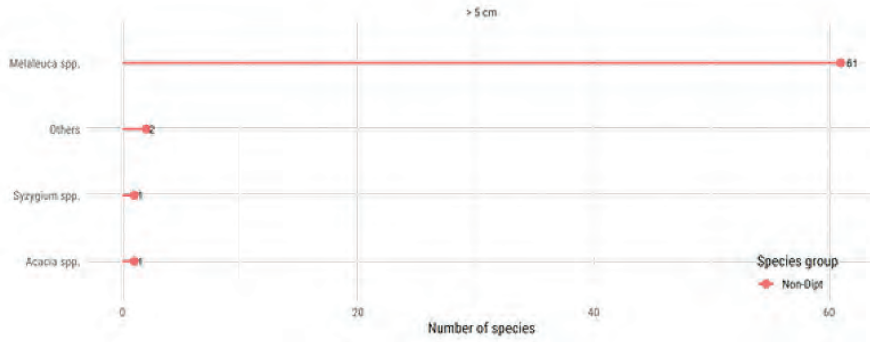


Figure 7.18 : Top dipterocarp and non-dipterocarp tree species in melaleuca swamp forest

7.5.3 STAND DENSITY IN HoB AREA

Figure 7.19 shows the top species of dipterocarp tree in each stratum for trees above 5 and 45 cm. In general, only 14 strata have the most enumerated species for dipterocarp trees. The other two strata, which are mangrove and Melaleuca, do not have dipterocarp trees. *Shorea* spp. has the most enumerated trees in 8 strata, followed by *Vatica* spp. (4), *Shorea parvifolia* (1), and *Dryobalanops* spp. (1). For trees above 45 cm dbh, Shorea spp. is still the most enumerated tree in 8 strata, followed by *Shorea albida* with 2 strata, and *Shorea parvifolia, Dryobalanops* spp., *Shorea sagittate*, and *Dryobalanops lanceolata* with 1 stratum.

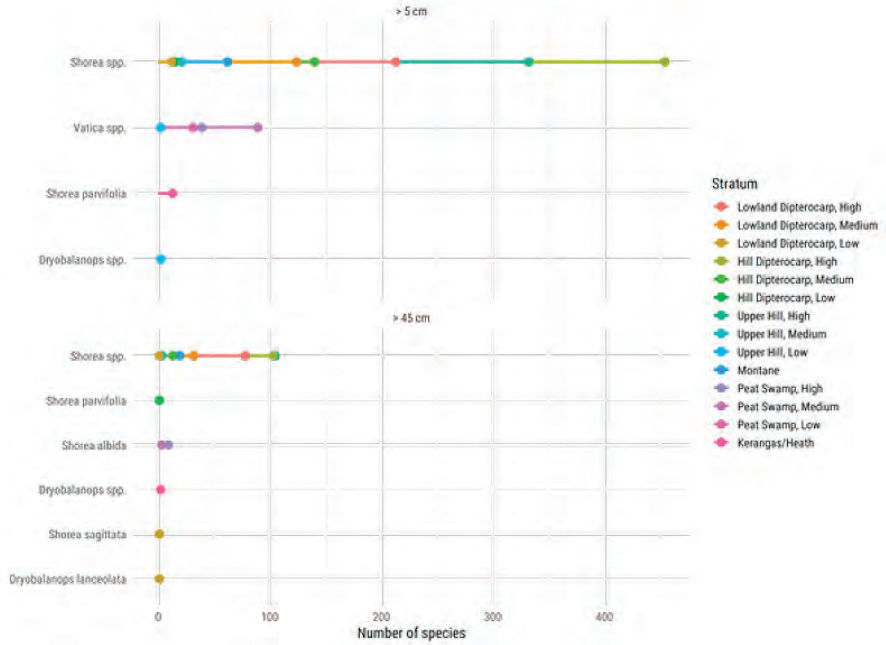


Figure 7.19 : Top species of dipterocarp trees in each stratum for trees above 5 and 45 cm

As for the non-dipterocarp tree, each respective stratum has the most enumerated tree species for trees above 5 and 45 cm. For trees above 5 cm dbh, *Syzygium* spp. is the most enumerated species in 10 strata, followed by *Whiteodendron moultonianum* (3), *Macaranga* spp. (1), *Rhizophora apiculata* (1), and *Melaleuca* spp. (1). As for trees above 45 cm dbh, *Syzygium* spp. is still the most enumerated tree in 11 strata.

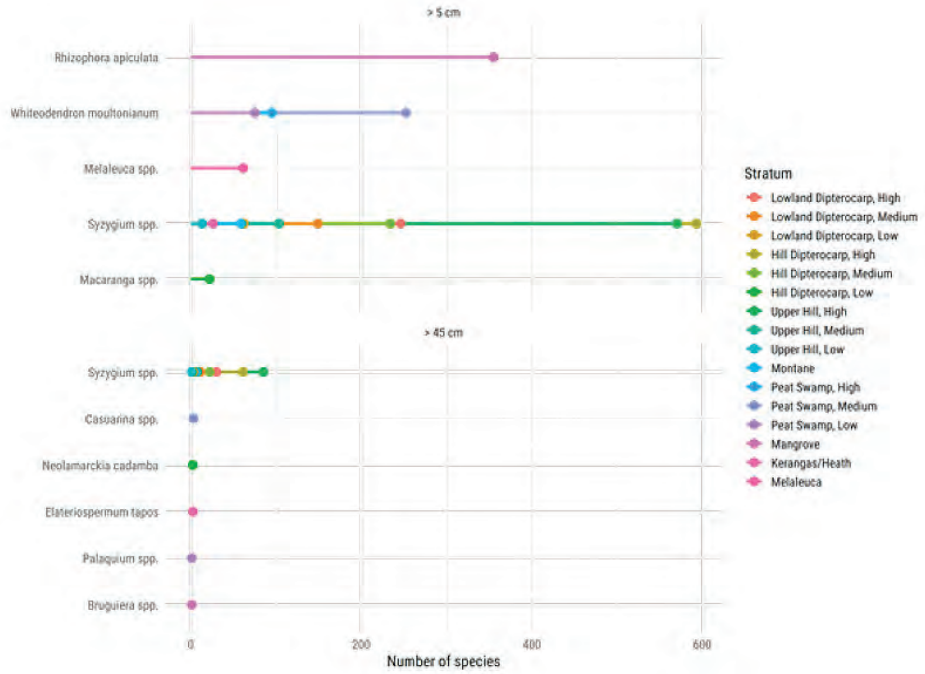


Figure 7.20 : Top species of non-dipterocarp trees in each stratum for trees above 5 and 45 cm

7.5.4 SPECIES RICHNESS AND DIVERSITY

Three diversity indexes, which are richness, Simpson, and Shannon, were calculated in this project. Those indexes calculated based on forest type are shown in **Table 7.25**. In terms of richness, the mixed dipterocarp forest has the highest richness index with a value of 13. Peat swamp and kerangas/heath forests are the top three forests that have a higher richness index. The richness index for peat swamp and kerangas/heath forests are 11 and 10. Mangrove and Melaleuca forests have a lower index than the other three forest types. As for Simpson and Shannon indexes, they follow the same result as richness index where mixed dipterocarp, peat swamp, and kerangas/heath forests have a higher index than mangrove and *Melaleuca* forests.

Forest Type	Richness	Simpson	Shannon
Mixed Dipterocarp Forest, MXD	35	219	29
Peat Swamp Forest, PS	12	69	4
Mangrove Forest, MGV	0	5	0
Kerangas/Heath Forest, KGS	10	51	1
Melaleuca Forest, ML	0	4	0

Table 7.25 : Average species diversity based on forest type

Table 7.26 shows the average diversity indexes for each stratum. In general, the high-density forest has higher diversity index value than the low-density forest. This can be seen in lowland dipterocarp, hill dipterocarp, upper hill, and peat swamp strata. In terms of richness, UH-H, HD-H, and MTN are the top three strata that have a high richness index as compared to other strata. The richness value for UH-H, HD-H, and MTN are 17, 16, and 15. MGV and ML have the lowest richness value with 3 and 2 respectively. The result for Simpson and Shannon indexes are also following the same result as the richness index.

Stratum	Richness	Simpson	Shannon
Lowland Dipterocarp, High, LD-H	13	0.836	2.133
Lowland Dipterocarp, Medium, LD-M	10	0.813	1.975
Lowland Dipterocarp, Low, LD-L	6	0.717	1.533
Hill Dipterocarp, High, HD-H	16	0.874	2.396
Hill Dipterocarp, Medium, HD-M	12	0.835	2.127
Hill Dipterocarp, Low, HD-L	6	0.730	1.562
Upper Hill, High, UH-H	17	0.877	2.419
Upper Hill, Medium, UH-M	12	0.840	2.113
Upper Hill, Low, UH-L	6	0.662	1.401
Montane, MTN	15	0.884	2.402
Peat Swamp, High, PS-H	13	0.871	2.290
Peat Swamp, Medium, PS-M	12	0.844	2.132
Peat Swamp, Low, PS-L	10	0.833	2.032
Mangrove, MGV	3	0.345	0.591
Kerangas/Health, KGS	10	0.851	2.134
Melaleuca, ML	2	0.349	0.521

Table 7.26 : Average species diversity based on stratum

7.6 NON-TIMBER RESOURCES

Table 7.27 shows list of non-timber species found in Project area. The data was collected based on observation at each sample plot. The non-timber plants data listed in the table represent all data that have been collected at the field. There are 3156 of herbaceous plants and 40 species of non-timber plants.

Figure 7.21 shows the number of non-timber resources found in the project area. It is obvious that the project area is dominated by *Alpinia*.spp (Halia/Tepus) plant. It is followed by *Calameae* spp., *Etlingera littoralis, Echinocloa crus*, and *Pandanus* spp.

No.	Local Name	Scientific	Total
1.	Akar Kelawit	*Uncaria gambier*	5
2.	Aping	*Arenga brevipes spp.*	35
3.	Bertam	*Dendrocalamus spp.*	1
4.	Palma	*Licuala spp.*	4
5.	Buluh		30
6.	Cangkuk Manis	*Sauropus albicals*	1
7.	Daun Palas	*Licuala spinosa*	11
8.	Paku Pakis	*Platycerium*	165
9.	Halia	*Alpinia spp.*	748
10.	Hujan Panas	*Goniothalamus velutinus*	2
11.	Kacip Fatimah	*Labisia pumila*	8
12.	Keladi	*Caladium*	51
13.	Kemiding	*Stenochlaena palustris*	155
14.	Kemunting	*Rhodomyrtus tomentosa*	51
15.	Lelamas	*Alpinia ligulata K.Schum.*	5
16.	Lemba	*Cucurligo latifolia*	39
17.	Medang Tija	*Cinnamomum iners*	5
18.	Mertama Ribu	*Anisophyllea distichabaill.*	46
19.	Nibong	*Dendrobium spp.*	31
20.	Orkid		6
21.	Paku Gajah	*Angiopteris evecta*	8
22.	Paku Kelindang	*Nephrolepis biserrata*	1
23.	Palma (Biruk)	*Licuala spp.*	4
24.	Pandan	*Pandanus spp.*	169
25.	Pantu	*Eugeissonia insignis Becc.*	16
26.	Pinang Hutan	*Cyrtostachys spp.*	5
27.	Pinang Lakka	*Cyrtostachys lakka Becc.*	29
28.	Riang	*Begonia spp.*	1
29.	Ridan	*Salacca affinis var. borneensis*	1
30.	Rotan	*Calameae spp.*	686
31.	Rotan (Segak)	*Daemonorops grandis*	15
32.	Rotan Angin	*Flagellaria indica*	12
33.	Rotan Cincin	*Daemonorops macrophyllus*	13
34.	Rotan Hering	*Freycinetia angustifolia*	5
35.	Rumput Padi Burung	*Echinochloa crus-galli*	340
36.	Senduduk	*Melastoma malabathricum*	20
37.	Sesenduk	*Endospermum spp*	2
38.	Sirih Hutan	*Piper caninum*	23
39.	Tepus	*Etlingera littoralis*	360
40.	Tongkat Ali	*Eurycoma Longifolia*	47
		Total	3,156

Table 7.27 : Total number and list of non-timber resources found in project area

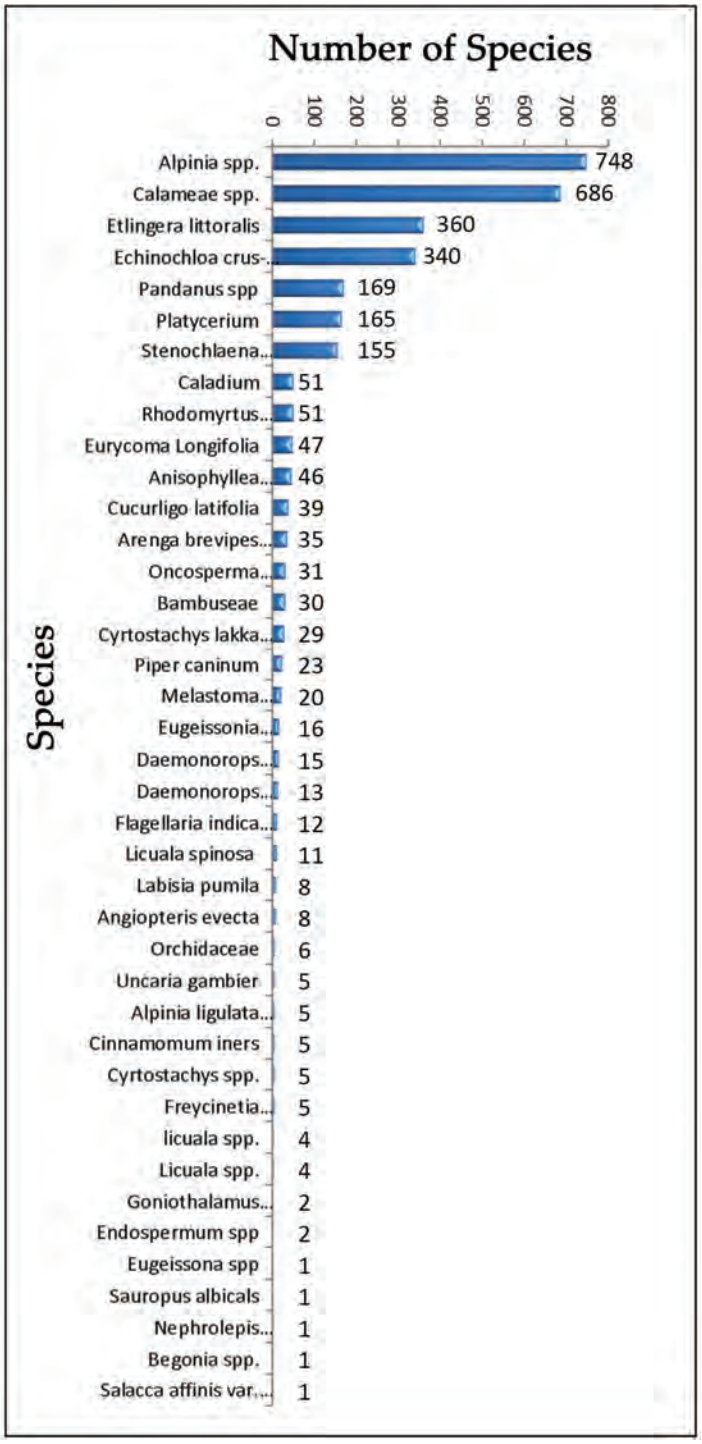


Figure 7.21 : Number of non-timber/ herbaceous plants

7.7 FAUNA

Data inventory for fauna has been collected by using the same method as non-timber resources data which by doing manually observation within plot and grid towards scratches, foot print, sound, smell and dunk. 43 species of fauna are found and recorded in Table 7.28. Location of discovered fauna is recorded by forest strata and referred to Wildlife Protection Ordinance (WPO), 1998 (Sarawak Forestry) for further purpose. In additional to the WPO, each fauna species that was recorded was perused with the International Union for Conservation of Nature (IUCN) Red List. The IUCN Red List is a critical indicator of the health of the world's biodiversity. Far more than a list of species and their status, it is a powerful tool to inform and catalyze action for biodiversity conservation and policy change, critical to protecting the natural resources we need to survive. It provides information about range, population size, habitat and ecology, use and/or trade, threats, and conservation actions that will help inform necessary conservation decisions.

The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. It divides species into nine categories: Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct.

- **Data Deficient (DD)**
  A taxon is Data Deficient (DD) when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking.

- **Least Concern (LC)**
  A taxon is Least Concern (LC) when it has been evaluated against the Red List criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened.

- **Near Threatened (NT)**
  A taxon is Near Threatened (NT) when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

- **Vulnerable (VU)**
  A taxon is Vulnerable (VU) when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

- **Endangered (EN)**
  A taxon is Endangered (EN) when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

- **Critically Endangered (CR)**
  A taxon is Critically Endangered (CR) when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

- **Extinct In The Wild (EW)**
  A taxon is Extinct in The Wild (EW) when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

- **Extinct (EX)**
  A taxon is Extinct (EX) when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

No.	Local Name	Scientific Name	Strata	WPO (1998)	IUCN Status
1.	Kedurau	Mephitis mephitis	HD		LC
2.	Beruang Matahari	Helarctos malayanus	HD	P	VU
3.	Burung Gagak	Corvus brachyrhynchos	UH		LC
4.	Landak	Hystrix brachyura	UH	P	VU
5.	Burung Chilin	Platylophus coronatus	UH		
6.	Burung Semalau Hutan	Copsychus malabaricus	UH		
7.	Helang	Haliastur indus	UH/HD		LC
8.	Ayam Hutan (Sepidan)	Lophura Ignita	UH		NT
9.	Burung Hantu	Niox scutulata	HD	P	LC
10.	Burung Murai	Copsychus malabaricus	HD/LD/UH		LC
11.	Burung Betitir	Geopelia striata	HD		LC
12.	Burung Keruak	Amaurornis phoenicurus	HD/LD/UH		LC
13.	Burung Bubut	Centropus sinensis	HD	P	VU
14.	Beruk	Macaca nemestrina	HD	/	LC
15.	Tupai Pinang	Callosciurus notatus	HD		LC
16.	Burung Pipit Merah	Amandava amandava	LD		LC
17.	Burung Kenyalang	Buceros rhinoceros	LD/HD	TP	LC
18.	Burung Kuncit	Dicaeum trochileum	LD	TP	CR
19.	Burung Tajai	Rhinoplax vigil	LD		LC
20.	Burung Madu	Colibri thalassinus	LD		
21.	Pelanduk	Tragulus javanicus	LD		LC
22.	Burung Cuit	Cisticola juncidis	LD		NT
23.	Burung Entu Mendu	Pityriasis gymnocephala	LD		
24.	Cikada	Tibicen linnei	HD		LC
25.	Burung Kelicap	Cinnyris jugularis	UH/HD		VU
26.	Burung Merbah	Setornis criniger	UH/HD		VU
27.	Babi	Sus	LD/UH	/	
28.	Babi Hutan	Sus scrofa	HD/LD/UH		
29.	Burung Belatuk	Picidae	HD/UH/LD		LC
30.	Beruang	Ursidae	LD	P	DD/VU/NT
31.	Beruang Matahari	Helarctos malayanus	HD		
32.	Kijang	Muntiacus muntjak	UH/LD/HD	P	CR
33.	Burung Merbah Beringin	Alophoixus ochraceus	UH	TP	VU
34.	Kera	Macaca fascicularis	HD	P	LC
35.	Burung Empulu	Pycnonotidae	LD	TP	NT
36.	Tenggiling	Manis javanica	UH	/	
37.	Landak	Erethizon dorsatum	UH	/	
38.	Burung Ruai	Argusianus argus	UH/HD/LD	/	
39.	Tajai	Buceros vigil	LD		LC
40.	Pelanduk	Tragulus	LD	/	NT

Table 7.28 : List of fauna in the inventory area

CHAPTER 8

RECOMMENDATIONS

8.1 DEVELOPMENT OF VOLUME ESTIMATION FUNCTION

Using accurate volume functions to get reliable estimate of timber volume or total stem volume is extremely important. Estimation of volume are important is assessing the commercial value of production forests, assessing health and productivity of forests as well as for payment of taxes such royalty, premium and silvicultural cess. Thus, it is prudent that volume functions used to estimate volume of a particular forest best represent that forest. Usage of a single volume function for various forest types and large geographical areas such as at the national or state-wide (regional) level may not be adequate due to variations influenced by soil, climate, and vegetation composition.

In this inventory of the HoB Sarawak, it was found that there were no representative volume equations developed for the site. The volume equation available was developed by FAO in the 1970's mainly for trees above 45 cm dbh. It is not proper to use a volume function if the objects of prediction have values of the independent variable, which are beyond the range of values of the measurements that had been taken to build the model. As in this case, the sample trees for the volume function available for Sarawak were in a diameter range of 45 cm to 120 cm and it is not a good idea to use this model for trees below 50 cm dbh; that may introduce large errors.

The Sarawak volume function also required height measurements. A test of using this volume equation showed high level uncertainty and unreliable estimates for smaller sized trees 10 cm to 40 cm dbh. As such, volume functions used in Peninsular Malaysia where volume is a function of dbh and with inclusion of a constant form factor. This one-way volume equation is relatively general in nature and may be used as general volume function if there no other local volume equation available. A test of this volume equations for large trees (dbh ≥45 cm) compared well with Sarawak volume equation and volume estimates for the smaller sized trees were also more reasonable.

Using two-way volume functions with both dbh and height variables are expected to produce more accurate estimates. This is applicable in local areas where it is expected to show relatively strong relationships between dbh and height and between dbh and form factor. However, there were concerns that taking height measurements by the field crew for the HoB area will result in relatively large errors and considering the additional time needed to complete the field data collection and increased cost of the inventory, height measurements were not carried out. Thus, only dbh measurements were taken and use of local volume equations were preferred.

In this regard, it is recommended that a local volume equation be developed for the inland forests of the HoB region in Sarawak. The huge effort taken, and high cost allocated to get reliable data for the inventory conducted should not be undermined by the use of volume equations that was not up to date and not representing the region. Development of volume equations currently are easier and cheaper to undertake compared to the past where measurements taken needed sample trees to felled to get accurate measurements of diameter at various heights along the diameter of the sample tree stem. Currently such measurements can be undertaken without the need for destructive samples. Standing trees can be accurately measured using the latest laser-based hypsometers. It would be highly cost-effective for Sarawak to develop its own up-to-date volume functions to get accurate and reliable estimates.

8.2 APPLICATIONS OF LIDAR TECHNOLOGY

LiDAR (light detection and ranging) is a remote sensing technique that is based on measuring the time it takes a laser pulse to strike an object and return to the source. Typically, a laser scanner is flown in an airplane, the exact location of which is tracked by a GPS satellite. State-of-the-art scanners can transmit and receiving as many as 500,000 pulses of laser light per second, resulting in data that can be used to map the reflecting object in high three-dimensional detail.

Discrete LiDAR data continues to prove itself useful in many natural resource applications. However, while nearly all LiDAR data can be useful for some applications, not all LiDAR datasets are equal. Probably the most important single characteristic that determines the appropriate use of a LiDAR dataset is the mean number of pulses/m^2. For example, relatively low pulse-density data (0.5 to 1 pulse/ m^2) is typically only useful for bare earth or terrain models. Medium pulse-density (1-3 pulses/ m^2) data has the additional potential of providing canopy height models. Forest structure information, however, requires relatively high pulse-density data (typically $\geq$ 3 pulses/ m^2). In addition, meaningful forest structure information from LiDAR data requires a significant investment in field plot inventory data (existing plot data is usually not adequate). It also requires that the general procedures of this document – including identifying and testing statistical relationships between LiDAR derived variables and forest inventory variables – are performed successfully. In other words, high-quality (high pulse density) LiDAR data alone are insufficient for deriving detailed forest structure information across a landscape – additional significant investments in field data, data processing, and statistical modeling are also required. Without making the additional required investments, the extra cost of acquiring high-quality LiDAR data is wasted.

Generally, LiDAR signal is produced in point-cloud form (typically in *.LAS format). Each point in the point-cloud contains two major types of information, which are signal intensity (i.e., strength of return) and height of the object. From this information, several parameters can be produced and manipulated. In this study, eight (8) LiDAR variables were produced which are intensities from all returns, first return, second return, third return, last return, digital surface model (DSM), digital terrain model (DTM), canopy density (CD), and canopy height model (CHM). These parameters are correlated to the biophysical parameters of forest stands, such as trees volume and biomass acquired from sample plots. An overall process for LiDAR processing is depicted in **Figure 8.1**.

Digital surface model is the first reflective surface model that contains elevations of natural terrain features in addition to vegetation and cultural features such as buildings and roads. Digital terrain model is a bare-earth model that contains elevations of natural terrain features such as bare land and river valleys **(Figure 8.2)**. In DTM, elevations of vegetation and cultural features, such as buildings and roads, need to be removed. The DTM will be generated by triangulating elevation values only from the bare earth LiDAR point cloud data, while the DSM was generated by triangulating elevation only from the first return LiDAR point cloud data. The first essential step in many LiDAR based applications is conversion of point clouds to uniform raster surfaces. Surfacing is used to interpolate the ground points and generate the DTM. The intensity image will be generated by triangulating intensity from the first-return LiDAR points.

Most of LiDAR processing software will have a graphical interface that will render the numerical point cloud into an image, but there is a great range of options and functionalities that will vary among the different options. In some of the cases, bare earth DTM does not represent true ground elevation. Hence, the model needs to clean and edit to obtain a representable DTM. Canopy height model is calculated from the LiDAR data by subtracting the DTM from the DSM. The CHM represents the absolute height of all above-ground features relative to the ground.

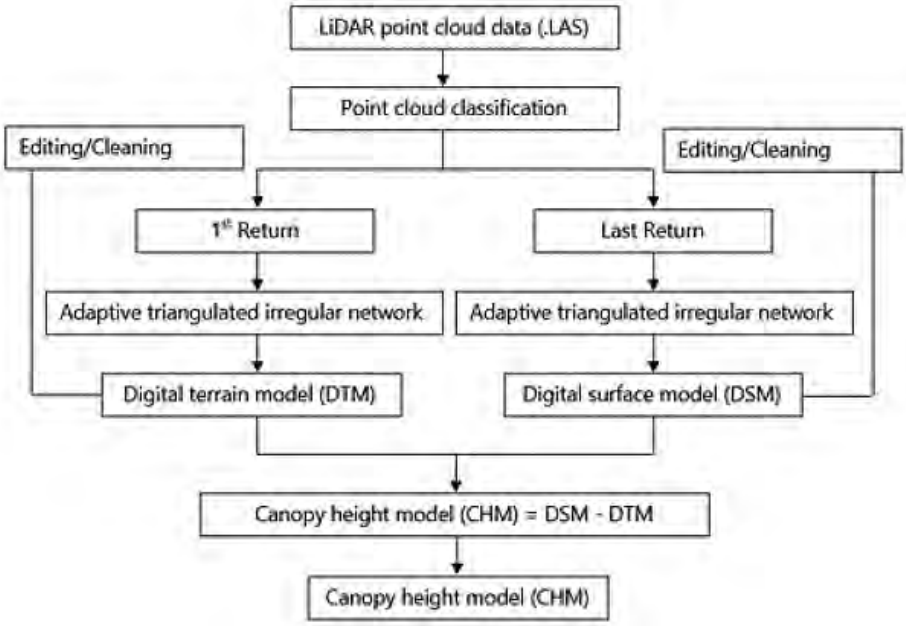


Figure 8.1 : LiDAR point cloud data processing workflow for CHM extraction

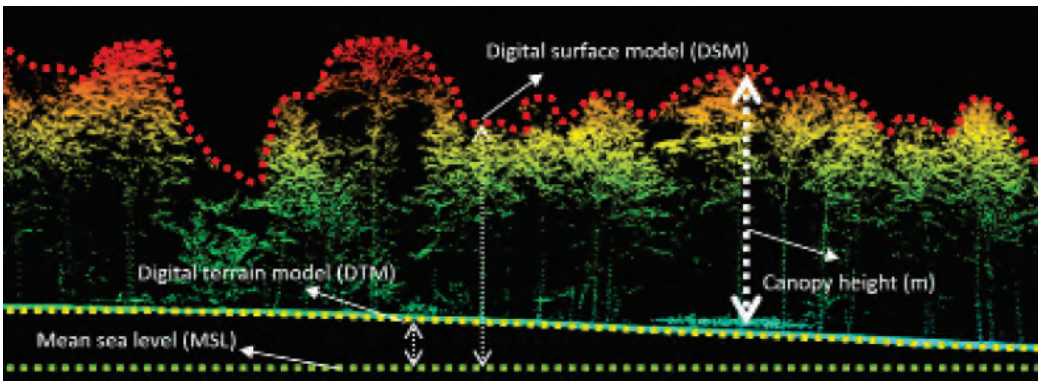


Figure 8.2 : Example of cross-section through LiDAR point cloud

8.3 SPECIES IDENTIFICATION EXPERTS

Species identification was found to be a serious setback. It wold have been opportune to be able to identify trees up to the species level to enable better reporting of species composition. It was found that only a small number of species could be identified up to the species level. Most the trees were identified up to the genus level. This makes it difficult to estimate aspects such species abundance and dominance. In addition, the number people capable of identifying trees even up to the genus level were limited. This gave rise to the assignment of field crews where the number of crews had to be limited thus affecting the total time taken to complete the inventory. It is recommended that additional staff be trained particularly among the younger field staff to ensure that such issues will not rise in future inventories and that the quality of data collected are more reliable.

8.4 ADAPTATION OF THE APPROACH AND METHODOLOGY

The approach and inventory design that was introduced in this inventory work was proven practical to be implemented and suitable for forests conditions in Sarawak. Therefore, the project suggests that this inventory work should be the yardstick for the future implementation of forest inventory in a wider landscape coverage. Training should be conducted to wider audiences among the Sarawak Forest Department so that more staffs will have experience in conducting forest inventory work at both the fields and laboratory (or office). By far, the most effective way towards an efficient forest inventory system is to equip internal staffs with the skills and hands-on experiences with the processes involved in the inventory work. Taking this forest inventory report as a guideline, the methodology, processes, and protocols involved in every stage of the inventory system can be adapted and implemented soon.

8.5 SAMPLING DESIGN FOR MONTANE FOREST

Stands structure and species composition in a montane forest is generally different from mixed dipterocarps forest. The application of sampling design that was designated for dipterocarps forest in a montane forest would lead to either over- or under-estimations of forest inventory parameters. This will create uncertainties in the forest inventory results and thus produce unreliable information, which is serious when the results are to be reported at international fora. Therefore, it is suggested that a specific design for montane forest should be produced and applied when carrying field data collection in the forest. A study should be conducted to customize the design. Repeating measurements with a reliable reference data will assure the accuracy of the reported inventory parameters.

8.6 EXTENSION OF FOREST INVENTORY TO THE ENTIRE SARAWAK

The current forest inventory undertaken for the HoB area in Sarawak which represented a very important region where forest resources play a critical role in both production and protection purposes. It is also bordering Kalimantan and have not been assessed over long periods. The forest inventory that has been conducted will provide very useful baseline information that will assist Sarawak to plan and manage the HoB region.

However, the assessment of the forest resources in the HoB only represents about 25% of the total forest land in Sarawak. Thus, it is highly recommended that a state-wide regional inventory be conducted to cover all the remaining permanent forests in Sarawak. The approach used in the current inventory can be expanded and applied. The experienced by the Forest Department Sarawak in undertaking the HoB inventory would be very useful. The field crew has also been trained to conduct the inventory accurately and the gained experiences would be useful in addressing various issue and challenges in field data collection.

Using a similar sampling design, plot layout and data analysis approach will enable results to be comparable with the HoB area and thus a good representation for the entire Sarawak. Based on the experience of the current HoB inventory, FRIM will also be happy to be involved in an advisory capacity to assist the Forest Department Sarawak in successfully executing the inventory for the entire Sarawak. A complete inventory will enable Sarawak better plan and manage its forest resources sustainably and uplift its image, both nationally and internationally, as a state that treasures its invaluable natural resources.

8.7 ESTABLISHMENT OF PERMANENT PLOTS

It is recommended that some of the plots be made as permanent sample plots to monitor stand (PSP) dynamics in terms of monitoring changes in species composition and regeneration. This will allow managers to better understand the long-term species dynamics in the HoB thus enhancing capacity in planning and management. The specifications of the PSPs may be similar the ones already established in other parts of Sarawak or new specification may be developed.

8.8 PROJECTIONS (SUSTAINABILITY IN THE NEXT 50 – 100 YEARS)

Management practices that have been applied by the FDS is the key indicators for the sustainable resources of forest in Sarawak.

'Sustainable forest management (SFM) is the process of managing forests to achieve one or more clearly specified objectives of management about the production of a continuous flow of desired forest products and services, without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment.' (ITTO, 1998).

Sarawak has embraced SFM as early as 1990s. The ITTO Mission to Sarawak in 1989/1990 to assess sustainable forest management in the State had stated that forest management in Sarawak was of a higher standard than in most other tropical timber producing countries. As a follow-up to the recommendation by the Mission, the Model Forest Management Area (MFMA) Project was implemented in 1993 and Phase II was completed at the end of 2000. A Malaysian-Germany Technical Co-operation Project entitled "Promotion of sustainable forest management in Sarawak" was also set up in January 1995. A pilot study area in the Upper Baram has been established to demonstrate the sustainable forest management system proposed by this Project.

Since then, in its endeavour to enhance SFM, July 2014, the State had announced the Forest Management Certification (FMC) Policy that all long-term Forest Timber License (FTL) areas within the Heart of Borneo are to be certified by 2017. In November 2017, this requirement has been extended to all long-term FTL in Sarawak. The FMC is no longer voluntarily, all long-term FTL holders are to obtain their FMC by 2022.

To enable the successful implementation of SFM and FMC, the key document which is Forest Management Plan is diligently examined by Technical Committee to ensure that FTL holder follow the requirements of SFM practices. To support SFM implementation on the ground particularly on forest harvesting operation, Reduced Impact Logging (RIL) guidelines has been standardised and evaluated to suit local condition.

Respective multi-stakeholder frameworks have also been established to address issues related to management, technical, social issues related to local communities directly and or indirectly affected by forest operations.

The timber industry also recognises the importance of SFM and has taken steps to upgrade the logging skills of its workers. The Forest Department and Sarawak Timber Association (STA) have conducted training courses for tree fellers since 1996.These training courses cover directional tree felling, chainsaw maintenance and associated safe working practices. Courses for other categories of forest workers are also planned. The program for capacity building and awareness on SFM and FMC for relevant agencies, timber industries and local communities has been developed and implemented as an on-going activity.

Figure 8.3 summarizes the averaged stand density of two contrasting status of forest, i.e., concession forest and TPA (at good condition). In general, the concession forest indicated higher stand density than that of TPA, however this is attributed by small trees (dbh 5 – 15 cm). Focusing on the regenerating stands with dbh 15 – 30 cm, which was recognized as regenerating trees, has even greater number than the TPA has. The potential crop trees (i.e., dbh 30 – 45 cm) also indicates the almost same figures within both categories. Ironically, harvestable trees with dbh ≥45 cm shows the exact same stand density for both categories. This demonstrates that the management practices being practiced by FDS is effective and showing the sustained resources, in terms of timbers. Referring to this finding, the forest resources in HoB could be maintained for 30 to 90 years, or even more if the management is maintained, and can even produced better yield if the management practices are improvised.

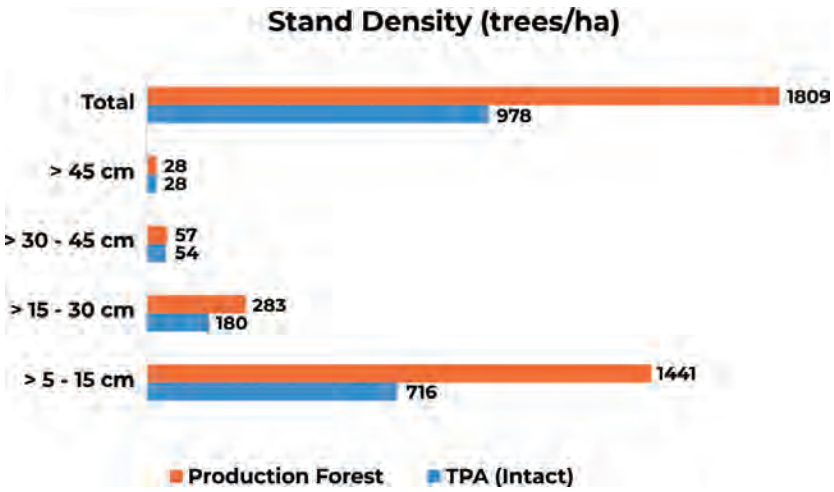


Figure 8.3 : Average stand density in concession forest and TPA

Based on the inventory findings, planning strategy and implementation actions taken throughout this project, Forest Department Sarawak are recommended to:

i. Revisit current forest policy and relevant procedures on forestry;
ii. Prepare new or revise current FMP based on new finding on forest stocking;
iii. Accelerate restoration and enrichment planting programmes especially in areas with low and medium FCD that considered as poor or degraded forests;
iv. Explore the advantages of advance remote sensing technology in facilitate forest inventory works in various aspects;
v. Develop human capacity on forest inventory works, especially to produce experts on species identification and remote sensing fields;
vi. Establish Permanent Sample Plots (PSP) of at least 10% from the inventories areas;
vii. Develop Forest Resources Database and customized processing system; and
viii. Conduct further research related to the latest forestry issues such as carbon assessment, non-timber forest produces, ecosystem services and wildlife detection, especially on the species that are classified as threatened.

CHAPTER 9

CONCLUSIONS

9.1 SUMMARY OF THE INVENTORY FINDINGS

The project area with an extent of about 1.76 million ha out of 2.7 million ha of the HoB in Sarawak strategically located within a long strip of land along the Kalimantan border in the south. The total inventoried area was about 65.6% of the entire HoB area in Sarawak. The inventory conducted at the landscape level of the HoB assessed the condition and stocking of the forests to assist the Forest Department Sarawak plan and manage the forest area sustainably. Although the Department was faced with many challenges in conducting the inventory particularly due to its remoteness and lack of accessibility, the data collection was successfully completed, and the inventory report is published.

In general, a total of 723 sample plots have been surveyed in the fields. Forests included in the project are (i) mixed dipterocarps forests (consisting of lowland dipterocarp, hill dipterocarp, upper hill dipterocarp forests), (ii) montane forest, (iii) mangrove forest, (iv) peat swamp forest, and (v) kerangas/heath forest (that includes Melaleuca swamp forest). The inventory parameters that were measured in the forest resources inventory are divided into seven (7) major components, which are (i) stand density, (ii) timber volume, (iii) basal area, (iv) biomass & carbon stock, (v) trees species composition, (vi) non-timber resources, and (vii) fauna. Each parameter is generally structured into four (4) main categories where information is arranged by (i) overall project area, (ii) strata, (iii) forest types, and (iv) land status

The average tree density in the entire project area was estimated at 1,499 trees/ha for trees with a diameter of 5 cm and above. About 83.9% (1,258 trees/ha) is dominated by non-dipterocarp trees, while the remaining 16.1% (241 trees/ha) is dipterocarp trees.

In terms of stocking the HoB has an average volume per hectare in the entire project area was estimated at 158.1 m^3 ha-1 for trees with a diameter of 5 cm and above. About 72.9% (115.2 m^3 ha^{-1}) is dominated by non-dipterocarp trees, while the remaining 27.1% (42.9 m^3 ha^{-1}) is dipterocarp trees. It was good to discover that the percentage of dipterocarps in terms of volume for the mixed dipterocarps forest was found to be relatively high (37%). This will enhance the commercial value of the production forest. Much of the forest has not fully recovered having a large dominance of smaller sized trees. This also indicates that most of the forests are still young and regenerating.

In this inventory, the average carbon stocks for all the five pools in mixed dipterocarp forest was at 209.2 Mg C ha^{-1}. Soil carbon was not assessed in the other types of forests, making the data for this pool is not available. As expected, among the five pools, the above ground biomass and carbon contributed most comprising 75% of the total carbon. The averages aboveground carbon stock for mixed dipterocarp forest (154.93 Mg C ha^{-1}), peat swamp forest (107.43 Mg C ha^{-1}), mangrove forest (63.88 Mg C ha^{-1}), kerangas/heath forest (98.80 Mg C ha^{-1}), melaleuca forest (92.34 Mg C ha^{-1}). Kho and Jepsen (2015) have reviewed the thresholds of aboveground carbon stock for all forest types in Malaysia and **Table 9.1** summarized the values of those found in Sarawak.

Forest type	Vegetation type	Location	Carbon stock (Mg C ha^{-1})
Primary Forest	Forest over limestone	Lambir NP	257 - 308
		Gunung Mulu NP	384
	Forest over limestone	Kota Samarahan	148
		Lingga Water Catchment	200
		Kuching Wetlands	172
	Forest over limestone	Gunung Mulu NP	277
		Bako NP	145
		Gunung Pueh FR	267
	Forest over limestone	Gunung Mulu NP	224

Table 9.1 : Average values of aboveground carbon stock of major forests in Sarawak

The inventory results shown normal trend for tree density, basal area and volume for logged-over forest or secondary forest of Hill Mixed Dipterocarp Forest (HMDF). The data from project area can considered to represent other HMDF areas in Sarawak. Based on current forest conditions data from the project area, Forest Management Plan (FMP) need to be prepared and reviewed based with new objectives of "forest beyond timber", sustainable development & biodiversity conservation to ensure the management actions are undertaken effectively with more transparent integrity.

Most of the forest resources in HoB are regenerating, evident from large number and stocking of small trees that dominant in the inventory findings. Restoration and enrichment planting programs are needed to carry out systematically to enhance the quality and quantity of forest areas.

Integrating advance remote sensing technologies are crucial to facilitate in collecting the latest and accurate data, can contribute on less sampling plots establishment and can minimize utilization of skilled manpower on ground. The attempts taken in this project to adopt remote sensing approach for forest inventory has proven effective in terms of data gathering to produce accurate forest resources data as compared to the conventional methods. However, there are gaps exist in a few aspects that require improvements. In is concluded that the FRI project is a huge project that requires high investments in terms of cost, manpower, and time. The amount of data collected from the FRI project is overwhelming even though only seven (7) parameters were used for reporting.

9.2 ADVANTAGES AND LIMITATIONS

The forest inventory was conducted taking into account the limited resources in terms of man power and finance. Consideration had to also be given to remote geographical location of the HoB, which is narrow strip on the southernmost area of Sarawak bordering Kalimantan. Thus difficulties in reaching plots to undertake ground inventory had to be seriously considered.

The inventory design adopted was two stage sampling design trying to maximize the use of remote sensing data while minimizing field inventory. The first stage involved acquiring satellite data for stratification into various forest types and forest canopy density classes. Subsequently, ground plots were established based on various strata. This approach was found to be the most appropriate to ensure representativeness and data reliability. Considering the size of the HoB landscape and difficulties in access, cluster of plots were established on each sampling point.

During the conduct of the inventory, it was found that accessibility of reaching remotely located plots remained a big challenge that had resulted in delays in the data collection schedule. It had also resulted in increased in time and cost of conducting the inventory.

A big advantage of this inventory was the collection data for estimating biomass and carbon for all the five pools entailing above ground, below ground, soil, deadwood and litter. The availability of such data will provide the Forest Sarawak Department useful baseline data needed to address various issues related mitigation and adaptation to climate change.

9.3 LESSONS LEARNED

There were many lessons learn in the conduct of the inventory for both the Forestry Department personnel who were mainly responsible in the field data collection as well as FRIM which provided technical advices.

Having capable and well trained field crew were crucial in ensuring quality data are being collected and results produced are reliable. In this regard, sufficient allocation was given in acquiring field instruments and time was allocated in training staff in the data collection particularly in collecting data for estimation of biomass and carbon which most field crew was not familiar with. A limiting factor in the assignment of crew was those with the ability to reliably identify tree species/genus. The department need to train more staff in species identification.

Due to the remoteness of many of the sampling points, a great deal of planning and monitoring had to be made to ensure that field crew were properly equipped and able to reach all the plots to collect the needed data safely and in a timely manner. Sometimes poor weather hindered the data collection.

Data quality assurance requirements were given due emphasis. Field crew were trained in all aspects of the data collection. Data validation were conducted both in the field and as well as during data input.

Having a dedicated inventory unit at the Forest Department Sarawak Headquarters with well trained staff would be ideal to overcome many of shortages of qualified field crew.

Due to the difficulties and high costs involved in undertaking field data collection, forest inventory designs that minimizes ground sampling should be fully explored. Remote sensing technology which is improving rapidly needs to be better used in carrying landscape level forest inventories.

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APPENDICES

APPENDIX 6.1

R Source Code for Calculating Stand Density, Basal Area, Volume and Biomass

```
#load library
library(dplyr)
library(openxlsx)

#Pra-analisa 1----
#import data
data.flora <- read.csv("./DATA/SUMMARY FOREST TYPE UPDATE SP 20181023.csv", header = T)

# list.of.sp <- unique(data.flora$Nama.Sains)
# list.of.sp <- as.data.frame(list.of.sp)
# length(list.of.sp)

#filter untuk data HOB
data.input.filter <- data.flora %>%
  filter(DBH..cm. >= 5)

#Add dbh category & pekali bagi per hectare
dif.bin <- data.input.filter$DBH..cm. >= 5 & data.input.filter$DBH..cm. < 15
data.input.filter$DBH.Class[dif.bin] <- 1
data.input.filter$f[dif.bin] <- 10000/(pi*16)
dif.bin <- data.input.filter$DBH..cm. >= 15 & data.input.filter$DBH..cm. < 30
data.input.filter$DBH.Class[dif.bin] <- 2
data.input.filter$f[dif.bin] <- 10000/(pi*144)
dif.bin <- data.input.filter$DBH..cm. >= 30 & data.input.filter$DBH..cm. < 45
data.input.filter$DBH.Class[dif.bin] <- 3
data.input.filter$f[dif.bin] <- 10000/(pi*400)
dif.bin <- data.input.filter$DBH..cm. >= 45
data.input.filter$DBH.Class[dif.bin] <- 4
data.input.filter$f[dif.bin] <- 10000/(pi*400)

#kira pekali L untuk julat dbh
dif.bin <- data.input.filter$DBH..cm. >= 5 & data.input.filter$DBH..cm. < 30
data.input.filter$l[dif.bin] <- 5
dif.bin <- data.input.filter$DBH..cm. >= 30 & data.input.filter$DBH..cm. < 60
data.input.filter$l[dif.bin] <- 10
dif.bin <- data.input.filter$DBH..cm. >= 60 & data.input.filter$DBH..cm. < 75
data.input.filter$l[dif.bin] <- 15
dif.bin <- data.input.filter$DBH..cm. >= 75
data.input.filter$l[dif.bin] <- 20
```

```
#tambah column untuk bil pokok, basal area, volume & biomass per/hectare
#TPH
data.input.filter$TPH <- data.input.filter$f

#Basal area
data.input.filter$BA <- (pi*(data.input.filter$DBH..cm.)^2/40000)*data.input.filter$f

#volume
data.input.filter$VOL    <-    (0.65*(pi*(data.input.filter$DBH..cm.)^2/40000)*data.input.filter$l)*data.
input.filter$f

#Biomass
data.input.filter$BIO <- ((0.57*exp(-1.499 + (2.148*log(data.input.filter$DBH..cm.)) +
                          (0.207*(log(data.input.filter$DBH..cm.))^2) -
                          (0.0281*(log(data.input.filter$DBH..cm.))^3))))*data.input.filter$f

#pecahkan data mengikut kump spesis
DIF.DIPT <- data.input.filter %>%
        filter(SPECIES.GROUP == 'Dipterocarp')
DIF.NONDIPT <- data.input.filter %>%
           filter(SPECIES.GROUP == 'Non-Dipterocarp')

#summarize dipt data
DIPT.RD.TPH <- tapply(DIF.DIPT$TPH, DIF.DIPT[,c('PLOT.ID', 'DBH.Class')], sum)
DIPT.RD.BA <- tapply(DIF.DIPT$BA, DIF.DIPT[,c('PLOT.ID', 'DBH.Class')], sum)
DIPT.RD.VOL <- tapply(DIF.DIPT$VOL, DIF.DIPT[,c('PLOT.ID', 'DBH.Class')], sum)

#summarize non-dipt data
NONDIPT.RD.TPH <- tapply(DIF.NONDIPT$TPH, DIF.NONDIPT[,c('PLOT.ID', 'DBH.Class')], sum)
NONDIPT.RD.BA <- tapply(DIF.NONDIPT$BA, DIF.NONDIPT[,c('PLOT.ID', 'DBH.Class')], sum)
NONDIPT.RD.VOL <- tapply(DIF.NONDIPT$VOL, DIF.NONDIPT[,c('PLOT.ID', 'DBH.Class')], sum)

#gantikan nilai NA kepada 0
DIPT.RD.TPH[is.na(DIPT.RD.TPH)] <- 0
DIPT.RD.BA[is.na(DIPT.RD.BA)] <- 0
DIPT.RD.VOL[is.na(DIPT.RD.VOL)] <- 0
NONDIPT.RD.TPH[is.na(NONDIPT.RD.TPH)] <- 0
NONDIPT.RD.BA[is.na(NONDIPT.RD.BA)] <- 0
NONDIPT.RD.VOL[is.na(NONDIPT.RD.VOL)] <- 0
```

```
#tambah categori untuk kelas dbh 5-8 untuk dipt
#TPH
DIPT.RD.TPH <- as.data.frame(DIPT.RD.TPH)
#>=5 cm
DIPT.RD.TPH$'5' <- rowSums(DIPT.RD.TPH, na.rm = F)
#>=15 cm
DIPT.RD.TPH$'6' <- rowSums(DIPT.RD.TPH[,c(2:4)], na.rm = F)
#>=30 cm
DIPT.RD.TPH$'7' <- rowSums(DIPT.RD.TPH[,c(3:4)], na.rm = F)
#>=45 cm
DIPT.RD.TPH$'8' <- DIPT.RD.TPH$'4'

#BASAL AREA
DIPT.RD.BA <- as.data.frame(DIPT.RD.BA)
#>=5 cm
DIPT.RD.BA$'5' <- rowSums(DIPT.RD.BA, na.rm = F)
#>=15 cm
DIPT.RD.BA$'6' <- rowSums(DIPT.RD.BA[,c(2:4)], na.rm = F)
#>=30 cm
DIPT.RD.BA$'7' <- rowSums(DIPT.RD.BA[,c(3:4)], na.rm = F)
#>=45 cm
DIPT.RD.BA$'8' <- DIPT.RD.BA$'4'

#VOLUME
DIPT.RD.VOL <- as.data.frame(DIPT.RD.VOL)
#>=5 cm
DIPT.RD.VOL$'5' <- rowSums(DIPT.RD.VOL, na.rm = F)
#>=15 cm
DIPT.RD.VOL$'6' <- rowSums(DIPT.RD.VOL[,c(2:4)], na.rm = F)
#>=30 cm
DIPT.RD.VOL$'7' <- rowSums(DIPT.RD.VOL[,c(3:4)], na.rm = F)
#>=45 cm
DIPT.RD.VOL$'8' <- DIPT.RD.VOL$'4'

#tambah categori untuk kelas dbh 5-8 for non-dipt
#TPH
NONDIPT.RD.TPH <- as.data.frame(NONDIPT.RD.TPH)
#>=5 cm
NONDIPT.RD.TPH$'5' <- rowSums(NONDIPT.RD.TPH, na.rm = F)
#>=15 cm
NONDIPT.RD.TPH$'6' <- rowSums(NONDIPT.RD.TPH[,c(2:4)], na.rm = F)
#>=30 cm
NONDIPT.RD.TPH$'7' <- rowSums(NONDIPT.RD.TPH[,c(3:4)], na.rm = F)
#>=45 cm
NONDIPT.RD.TPH$'8' <- NONDIPT.RD.TPH$'4'
```

```
#BASAL AREA
NONDIPT.RD.BA <- as.data.frame(NONDIPT.RD.BA)
#>=5 cm
NONDIPT.RD.BA$'5' <- rowSums(NONDIPT.RD.BA, na.rm = F)
#>=15 cm
NONDIPT.RD.BA$'6' <- rowSums(NONDIPT.RD.BA[,c(2:4)], na.rm = F)
#>=30 cm
NONDIPT.RD.BA$'7' <- rowSums(NONDIPT.RD.BA[,c(3:4)], na.rm = F)
#>=45 cm
NONDIPT.RD.BA$'8' <- NONDIPT.RD.BA$'4'

#VOLUME
NONDIPT.RD.VOL <- as.data.frame(NONDIPT.RD.VOL)
#>=5 cm
NONDIPT.RD.VOL$'5' <- rowSums(NONDIPT.RD.VOL, na.rm = F)
#>=15 cm
NONDIPT.RD.VOL$'6' <- rowSums(NONDIPT.RD.VOL[,c(2:4)], na.rm = F)
#>=30 cm
NONDIPT.RD.VOL$'7' <- rowSums(NONDIPT.RD.VOL[,c(3:4)], na.rm = F)
#>=45 cm
NONDIPT.RD.VOL$'8' <- NONDIPT.RD.VOL$'4'

#gabung data
STATS.PLOT.DIPT <- cbind(DIPT.RD.TPH, DIPT.RD.BA, DIPT.RD.VOL)
STATS.PLOT.NONDIPT <- cbind(NONDIPT.RD.TPH, NONDIPT.RD.BA, NONDIPT.RD.VOL)

#Tukar ke data frame
STATS.PLOT.DIPT <- as.data.frame(STATS.PLOT.DIPT)
STATS.PLOT.NONDIPT <- as.data.frame(STATS.PLOT.NONDIPT)

#rename the column
colnames(STATS.PLOT.DIPT) <- c('DIPT.TPH1', 'DIPT.TPH2', 'DIPT.TPH3', 'DIPT.TPH4',
                               'DIPT.TPH5', 'DIPT.TPH6', 'DIPT.TPH7', 'DIPT.TPH8',
                               'DIPT.BA1', 'DIPT.BA2', 'DIPT.BA3', 'DIPT.BA4',
                               'DIPT.BA5', 'DIPT.BA6', 'DIPT.BA7', 'DIPT.BA8',
                               'DIPT.VOL1', 'DIPT.VOL2', 'DIPT.VOL3', 'DIPT.VOL4',
                               'DIPT.VOL5', 'DIPT.VOL6', 'DIPT.VOL7', 'DIPT.VOL8')
colnames(STATS.PLOT.NONDIPT) <- c('NONDIPT.TPH1', 'NONDIPT.TPH2', 'NONDIPT.TPH3',
'NONDIPT.TPH4',
                                  'NONDIPT.TPH5', 'NONDIPT.TPH6', 'NONDIPT.TPH7', 'NONDIPT.TPH8',
                                  'NONDIPT.BA1', 'NONDIPT.BA2', 'NONDIPT.BA3', 'NONDIPT.BA4',
                                  'NONDIPT.BA5', 'NONDIPT.BA6', 'NONDIPT.BA7', 'NONDIPT.BA8',
                                  'NONDIPT.VOL1', 'NONDIPT.VOL2', 'NONDIPT.VOL3', 'NONDIPT.VOL4',
                                  'NONDIPT.VOL5', 'NONDIPT.VOL6', 'NONDIPT.VOL7', 'NONDIPT.VOL8')
```

```
#tambah column plot ID
STATS.PLOT.DIPT$PLOT.ID <- rownames(STATS.PLOT.DIPT)
rownames(STATS.PLOT.DIPT) <- 1:nrow(STATS.PLOT.DIPT)
STATS.PLOT.NONDIPT$PLOT.ID <- rownames(STATS.PLOT.NONDIPT)
rownames(STATS.PLOT.NONDIPT) <- 1:nrow(STATS.PLOT.NONDIPT)

#gabung dan susun data dipt & non-dipt
STATS.PLOT.DIPT <- STATS.PLOT.DIPT[, c(25, 1:24)]
STATS.PLOT.ALL <- STATS.PLOT.DIPT
STATS.PLOT.ALL <- left_join(STATS.PLOT.ALL, STATS.PLOT.NONDIPT, 'PLOT.ID')

STATS.PLOT.ALL <- STATS.PLOT.ALL[, c(2,26,3,27,4,28,5,29,6,30,7,31,8,32,9,33,10,34,11,35,12,36,
13,37,
                                     14,38,15,39,16,40,17,41,18,42,19,43,20,44,21,45,22,46,23,47,24,48,25,49,1)]


#Pra-analisa 2----
#panggil fail maklumat plot
DATA.PLOT <- read.csv('./DATA/SUMMARY INVENTORY-PLOT DATA 20181001.csv', header = T)
#panggil fail untuk daerah
DATA.REGION <- read.csv('./DATA/REGION HOB.csv', header = T)

#subset data yang berkaitan sahaja
DATA.PLOT <- DATA.PLOT %>%
    select(c(GRID.ID, PLOT.ID,STRATA.CODE, STRATA.ACTUAL, FOREST.TYPE, STATUS.ADMIN,
STATUS.CURRENT))

#gabung status admin & status semasa
DATA.PLOT$MGMNT.STATUS <- paste(DATA.PLOT$STATUS.ADMIN, DATA.PLOT$STATUS.
CURRENT, sep = ' - ')

#gabungkan dengan maklumat region
DATA.PLOT <- left_join(DATA.PLOT, DATA.REGION, 'GRID.ID')

#tukar PLOT.ID dari factor kepada character untuk join table
DATA.PLOT$PLOT.ID <- as.character(DATA.PLOT$PLOT.ID)

#gabung dengan data statistik untuk setiap plot
STATS.PLOT.ALL <- left_join(STATS.PLOT.ALL, DATA.PLOT, 'PLOT.ID')

#tambah column overall untuk analisa HoB
STATS.PLOT.ALL$OVERALL <- 'OVERALL'

#Analisa data----
#Analisa data di peringkat HOB, landuse, FOREST.TYPE, STRATA.CODE (3 kategori)
```

```
#panggil data senarai strata
STRATA.LIST <- read.csv('./DATA/LIST OF STRATA.csv', header = T)
STRATA.LIST$STRATA.CODE <- as.character(STRATA.LIST$STRATA.CODE)

#kira statistik
#overall
STATS.PLOT.J.0 <- STATS.PLOT.ALL %>%
  group_by(OVERALL) %>%
  summarise_at(c(1:48), mean, na.rm = F)
#landuse
STATS.PLOT.J.1 <- STATS.PLOT.ALL %>%
  group_by(MGMNT.STATUS) %>%
  summarise_at(c(1:48), mean, na.rm = F)
#forest type
STATS.PLOT.J.2 <- STATS.PLOT.ALL %>%
  group_by(FOREST.TYPE) %>%
  summarise_at(c(1:48), mean, na.rm = F)
#strata
STATS.PLOT.J.3 <- STATS.PLOT.ALL %>%
  group_by(STRATA.CODE) %>%
  summarise_at(c(1:48), mean, na.rm = F)

#rename column pertama kepada kod strata
colnames(STATS.PLOT.J.0) <- colnames(STATS.PLOT.J.3)
colnames(STATS.PLOT.J.1) <- colnames(STATS.PLOT.J.3)
colnames(STATS.PLOT.J.2) <- colnames(STATS.PLOT.J.3)

#gabung hasil
STATS.PLOT.J <- rbind(STATS.PLOT.J.0, STATS.PLOT.J.1, STATS.PLOT.J.2, STATS.PLOT.J.3)

#susun hasil mengikut STRATA.LIST
HASIL.AKHIR <- left_join(STRATA.LIST, STATS.PLOT.J, "STRATA.CODE")

#tukar NA kepada 0
HASIL.AKHIR <- replace(HASIL.AKHIR, is.na(HASIL.AKHIR), 0)

#Species Analysis----
#Pra-analisa 1----
#import data
data.flora <- read.csv("./DATA/DATA FLORA.csv", header = T)

# list.of.sp <- unique(data.flora$Nama.Sains)
# list.of.sp <- as.data.frame(list.of.sp)
# length(list.of.sp)
```

```
#filter untuk data HOB
data.input.filter <- data.flora %>%
  filter(DBH..cm. >= 5)

#tentukan bilangan plot
no.of.plots <- length(unique(data.input.filter$PLOT.ID))

#Add dbh category & pekali bagi per hectare
dif.bin <- data.input.filter$DBH..cm. >= 5 & data.input.filter$DBH..cm. < 15
data.input.filter$DBH.Class[dif.bin] <- 1
data.input.filter$f[dif.bin] <- 10000/(pi*16)
dif.bin <- data.input.filter$DBH..cm. >= 15 & data.input.filter$DBH..cm. < 30
data.input.filter$DBH.Class[dif.bin] <- 2
data.input.filter$f[dif.bin] <- 10000/(pi*144)
dif.bin <- data.input.filter$DBH..cm. >= 30 & data.input.filter$DBH..cm. < 45
data.input.filter$DBH.Class[dif.bin] <- 3
data.input.filter$f[dif.bin] <- 10000/(pi*400)
dif.bin <- data.input.filter$DBH..cm. >= 45
data.input.filter$DBH.Class[dif.bin] <- 4
data.input.filter$f[dif.bin] <- 10000/(pi*400)

#kira pekali L untuk julat dbh
dif.bin <- data.input.filter$DBH..cm. >= 5 & data.input.filter$DBH..cm. < 30
data.input.filter$l[dif.bin] <- 5
dif.bin <- data.input.filter$DBH..cm. >= 30 & data.input.filter$DBH..cm. < 60
data.input.filter$l[dif.bin] <- 10
dif.bin <- data.input.filter$DBH..cm. >= 60 & data.input.filter$DBH..cm. < 75
data.input.filter$l[dif.bin] <- 15
dif.bin <- data.input.filter$DBH..cm. >= 75
data.input.filter$l[dif.bin] <- 20

#tambah column untuk bil pokok, basal area, volume & biomass per/hectare
#TPH
data.input.filter$TPH <- data.input.filter$f

#Basal area
data.input.filter$BA <- (pi*(data.input.filter$DBH..cm.)^2/40000)*data.input.filter$f

#volume
data.input.filter$VOL    <-    (0.65*(pi*(data.input.filter$DBH..cm.)^2/40000)*data.input.filter$l)*data.
input.filter$f

#Biomass
data.input.filter$BIO <- ((0.57*exp(-1.499 + (2.148*log(data.input.filter$DBH..cm.)) +
                           (0.207*(log(data.input.filter$DBH..cm.))^2) -
                           (0.0281*(log(data.input.filter$DBH..cm.))^3))))*data.input.filter$f
```

```
DIF.SP <- data.input.filter %>%
  arrange(SCIENTIFIC.NAME)

#summarize dipt data
RD.TPH <- tapply(DIF.SP$TPH, DIF.SP[,c('SCIENTIFIC.NAME', 'DBH.Class')], sum)
RD.BA <- tapply(DIF.SP$BA, DIF.SP[,c('SCIENTIFIC.NAME', 'DBH.Class')], sum)
RD.VOL <- tapply(DIF.SP$VOL, DIF.SP[,c('SCIENTIFIC.NAME', 'DBH.Class')], sum)

#gantikan nilai NA kepada 0
RD.TPH[is.na(RD.TPH)] <- 0
RD.BA[is.na(RD.BA)] <- 0
RD.VOL[is.na(RD.VOL)] <- 0

#summarize dipt data
RD.TPH <- RD.TPH/no.of.plots
RD.BA <- RD.BA/no.of.plots
RD.VOL <- RD.VOL/no.of.plots

#tambah categori untuk kelas dbh 5-8 untuk dipt
#TPH
RD.TPH <- as.data.frame(RD.TPH)
#>=5 cm
RD.TPH$'5' <- rowSums(RD.TPH, na.rm = F)
#>=15 cm
RD.TPH$'6' <- rowSums(RD.TPH[,c(2:4)], na.rm = F)
#>=30 cm
RD.TPH$'7' <- rowSums(RD.TPH[,c(3:4)], na.rm = F)
#>=45 cm
RD.TPH$'8' <- RD.TPH$'4'

#BASAL AREA
RD.BA <- as.data.frame(RD.BA)
#>=5 cm
RD.BA$'5' <- rowSums(RD.BA, na.rm = F)
#>=15 cm
RD.BA$'6' <- rowSums(RD.BA[,c(2:4)], na.rm = F)
#>=30 cm
RD.BA$'7' <- rowSums(RD.BA[,c(3:4)], na.rm = F)
#>=45 cm
RD.BA$'8' <- RD.BA$'4'
```


```
#VOLUME
RD.VOL <- as.data.frame(RD.VOL)
#>=5 cm
RD.VOL$'5' <- rowSums(RD.VOL, na.rm = F)
#>=15 cm
RD.VOL$'6' <- rowSums(RD.VOL[,c(2:4)], na.rm = F)
#>=30 cm
RD.VOL$'7' <- rowSums(RD.VOL[,c(3:4)], na.rm = F)
#>=45 cm
RD.VOL$'8' <- RD.VOL$'4'

#gabung data
STATS.SP <- cbind(RD.TPH, RD.BA, RD.VOL)

#Tukar ke data frame
STATS.SP <- as.data.frame(STATS.SP)

#rename the column
colnames(STATS.SP) <- c('TPH1', 'TPH2', 'TPH3', 'TPH4', 'TPH5', 'TPH6', 'TPH7', 'TPH8',
                        'BA1', 'BA2', 'BA3', 'BA4', 'BA5', 'BA6', 'BA7', 'BA8',
                        'VOL1', 'VOL2', 'VOL3', 'VOL4', 'VOL5', 'VOL6', 'VOL7', 'VOL8')

#tambah column species
STATS.SP$SCIENTIFIC.NAME <- rownames(STATS.SP)
rownames(STATS.SP) <- 1:nrow(STATS.SP)

#tambah nama tempatan
sp.local.name <- data.input.filter[!duplicated(data.input.filter$SCIENTIFIC.NAME), c('SCIENTIFIC.
NAME', 'LOCAL.NAME')]
sp.local.name$SCIENTIFIC.NAME <- as.character(sp.local.name$SCIENTIFIC.NAME)
STATS.SP <- left_join(STATS.SP, sp.local.name, 'SCIENTIFIC.NAME')

#susun column
STATS.SP <- STATS.SP[, c(25,26, 1:24)]

#save in excel format----
#write.xlsx(HASIL.AKHIR, "./OUTPUT/20181017 HOB Structure Appendix.xlsx")

wb <- createWorkbook("Output")
addWorksheet(wb, 'General')
addWorksheet(wb, 'Species')

writeData(wb, sheet = 'General', HASIL.AKHIR)
writeData(wb, sheet = 'Species', STATS.SP)
saveWorkbook(wb, "./OUTPUT/20181017 HOB Structure Appendix.xlsx", overwrite = T)
```

APPENDIX 6.2

Manual for Lab Procedures and Laboratory Analysis for Acquiring Parameters of Coarse Woody Debris, Deadwood, Non-Tree Vegetation and Litter, and Soil Carbon

Isi Kandungan

1. PERALATAN YANG DIPERLUKAN

Peralatan utama yang diperlukan adalah seperti berikut:

a. Oven saintifik : untuk mengeringkan sampel
b. Penimbang elektronik: untuk menimbang jisim sampel. Peninbang hendaklah berketepatan sekurang kurangnya 0.1 g
c. Dulang keluli : untuk meletakkan sampel di dalam oven semasa proses pengeringan
d. Borang Pengeringan Oven telah yang dicetak

Peralatan lain yang diperlukan untuk memudahkan kerja:

e. Kertas akhbar terpakai
f. Pen marker berdakwat kekal
g. Stapler
h. Pensel
i. Pemadam
j. Clipboard
k. Plastik sampah
l. Kamera untuk merakam gambar.

2. LANGKAH-LANGKAH KERJA

A. Sampel yang dikumpulkan di lapangan terdiri daripada empat (4) kategori iaitu:

- Sarap hutan
- Tumbuhan bukan kayu
- Sampel Tanah (dalam core ring untuk pengiraan ketumpatan)
- Sampel Tanah (dalam plastic sampel untuk pengiraan karbon)

B. Asingkan sampel mengikut kategori. Pastikan bilangan mencukupi mengikut bilangan sub-plot yang telah dibanci. Pastikan semua sampel mempunyai label. Jika terdapat sampel yang tidak mempunyai label, buat semakan borang bancian lapangan dan tuliskan ID sampel pada plastik sampel.

C. Sediakan sampul sampel menggunakan akhbar terpakai mengikut bilangan. Sampul hanya untuk sampel sarap **hutan** dan **tumbuhan bukan kayu** sahaja.

D. Pindahkan sampel sarap hutan dari plastik sampel ke dalam sampul kertas akhbar. **PASTIKAN ID** sampel ditulis pada sampul menggunakan pen marker.

3. PROSEDUR ANALISA

A. Setelah kesemua sampel disediakan mengikut kategori dan dimsukkan ke dalam sampul akhbar, proses timbangan boleh dimulakan.

i. Timbang berat basah untuk sarap hutan. Rekod bacaan jisim pada borang.
ii. Timbang berat basah untuk tumbuhan bukan kayu. Rekod bacaan jisim pada borang.
iii. Timbang berat basah tanah dalam core ring bersama-sama core ring.
iv. Sampel karbon tanah perlu dihantar ke makmal tanah.

B. Setelah kesemua sampel ditimbang berat basah, proses pengeringan boleh dimulakan.

C. Keringkan sampel mengikut suhu dan masa seperti yang disarankan di dalam **Rajah 1** di bawah. Sampel sarap hutan dan tumbuhan bukan kayu BOLEH dimasukkan sekali memandangkan ia memerlukan suhu pengeringan yang sama.

D. Setelah semua sampel didapati kering (setelah jisim konsisten), ulangi proses timbangan untuk berat kering. Proses timbangan adalah sama seperti di dalam item A di atas.

E. Untuk sampel dalam *core ring*, pastikan tanah dibuang dan jisim core ring kosong juga ditimbang.

F. Pastikan semua data direkodkan di dalam borang. Semak bacaan jisim secara keseluruhan.

G. Kemaskan tempat dan persekitaran kerja. Sampel dan sampul yang tidak digunakan boleh dibuang.

H. Daftarkan (*key-in*) data setiap sub-plot ke dalam *sheet Tree Calculator* bersama-sama dengan maklumat inventori pokok untuk dijumlahkan.

I. Simpan borang di dalam fail projek.

Sarap Hutan	Tumbuhan Bukan Kayu	Ketumpatan Pukal Tanah	Karbon Tanah
• 24 jam • 70^{0}C • periksa jisim selepas 24 jam • Tambah 6 jam jika perlu • Ulang langkah di atas sehingga jisim konsisten • **Amaran!** Jangan masukkan plastik sampel ke dalam oven	• 24 jam • 70^{0}C • periksa jisim selepas 24 jam • Tambah 6 jam jika perlu • **Amaran!** Jangan masukkan plastik sampel ke dalam oven	• 48 jam • 105^{0}C • **Amaran!** Jangan asingkan tanah dari *core ring* semasa proses pengeringan Buka salah satu penutup (atas) untuk mempercepat proses pengeringan	• Labelkan sampel • Hantar ke makmal tanah untuk analisa

Rajah 1 : Prosedur kerja pengeringan sampel

Appendix 7.1 Basic Plot Information

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
103-C1-A	0.86285	110.59175	9-Nov-20	MONGKOS	HD-M	Mixed Dipterocarp Forest	State Land
103-C1-B	0.863717	110.591917	9-Nov-20	MONGKOS	HD-L	Mixed Dipterocarp Forest	State Land
103-C1-C	0.86445	110.5919	9-Nov-20	MONGKOS	HD-L	Mixed Dipterocarp Forest	State Land
103-C1-D	0.864583	110.591067	9-Nov-20	MONGKOS	HD-M	Mixed Dipterocarp Forest	State Land
103-C2-A	0.86365	110.594583	8/11/2020	MONGKOS	HD-L	Mixed Dipterocarp Forest	State Land
103-C2-B	0.86275	110.594483	7/11/2020	MONGKOS	HD-M	Mixed Dipterocarp Forest	State Land
103-C2-C	0.862733	110.593567	7/11/2020	MONGKOS	HD-L	Mixed Dipterocarp Forest	State Land
103-C2-D	0.862767	110.5927	7/11/2020	MONGKOS	HD-H	Mixed Dipterocarp Forest	State Land
107-C1-A	3 12 29.3	115 16 9.2	19.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C1-B	3 12 28.2	115 16 13.4	19.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C1-C	3 12 26.3	115 16 14.7	18.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C1-D	3 12 21.7	115 16 13.8	6.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C10-A	3 13 7.7	115 16 13.8	26.3.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C10-B	3 13 10.7	115 16 16.1	20.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C10-C	3 13 13.4	115 16 18.1	20.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C10-D	3 13 16.6	115 16 16.9	20.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C11-A	3 13 30.3	115 17 7.2	13.10.2017	MERAWA	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
107-C11-B	3 13 30.9	115 17 11.2	13.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C11-C	3 13 27.2	115 17 11.9	25.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C11-D	3 13 24.0	115 17 12.6	25.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C2-A	3 13 11.8	115 16 41.5	6.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C2-B	3 13 13.7	115 16 38.9	6.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C2-C	3 13 19.5	115 16 36.4	6.10.2017	MERAWA	MTN	Mixed Dipterocarp Forest	Concession (Forested)
107-C2-D	3 13 9.2	115 16 43.2	9.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C3-A	3 12 21.3	115 17 9.5	9.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C3-B	3 12 23.6	115 17 7.7	17.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
107-C3-C	3 12 17.0	115 17 21.1	20.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C3-D	3 12 21.7	115 17 13.8	13.10.2017	MERAWA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
107-C4-A	3 12 12.0	115 17 52.7	13.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C4-B	3 12 15.8	115 17 52.6	25.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C4-C	3 12 18.2	115 17 53.3	25.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C4-D	3 12 18.8	115 17 56.6	19.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C5-A	3 12 18.4	115 18 40.8	18.10.2017	MERAWA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
107-C5-B	3 12 19.7	115 18 36.0	9.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C5-C	3 12 21.3	115 18 32.7	16.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C5-D	3 12 23.9	115 18 34.3	16.10.2017	MERAWA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
107-C6-A	3 12 41.6	115 19 8.0	16.10.2017	MERAWA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
107-C6-B	3 12 40.2	115 19 5.1	17.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C6-C	3 12 39.5	115 19 2.6	9.10.2017	MERAWA	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
107-C6-D	3 12 34.3	115 19 3.5	16.10.2017	MERAWA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
107-C7-A	3 13 17.2	115 19 57.8	18.10.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C7-B	3 13 14.4	115 19 56.0	18.10.2017	MERAWA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
107-C7-C	3 13 12.4	115 19 54.0	23.3.2017	MERAWA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
107-C7-D	3 13 18.5	115 19 54.4	23.3.2017	MERAWA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C8-A	3 13 18.6	115 16 24.3	26.3.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C8-B	3 13 16.8	115 16 20.9	26.3.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C8-C	3 13 16.5	115 16 17.6	23.3.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C8-D	3 13 22.2	115 16 23.8	19.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C9-A	3 13 36.7	115 16 7.8	17.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C9-B	3 13 38.9	115 16 10.7	17.10.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C9-C	3 13 41.7	115 16 13.6	23.3.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
107-C9-D	3 13 38.4	115 16 16.2	26.3.2017	MERAWA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
129 C-A	1.059433	111.727633	27/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
129 C-B	1.059817	111.717883	27/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land
129 C-C	1.0602	111.727583	27/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land
129 C-D	1.06055	111.726833	27/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land
149-C2-A	1.1364	111.942117	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
149-C2-B	1.1364	111.9425	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
149-C2-C	1.138283	111.942683	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
149-C2-D	1.13855	111.943483	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
153 C-A	1.063317	111.73375	29/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land
153 C-B	1.064233	111.733917	29/10/2020	ENGKELILI	LD-M	Mixed Dipterocarp Forest	State Land
153 C-C	1.064383	111.733083	29/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land
153 C-D	1.064	111.7347	29/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land
159-C1-A	4.10492	114.84708	5.5.2017	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C1-B	4.10489	114.84801	5.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C1-C	4.10504	114.84901	5.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C1-D	4.10598	114.84886	5.5.2017	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C10-A	4.088315162	114.8386492	22.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C10-B			22.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C10-C			22.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C10-D			23.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C11-A	4.131803938	114.8457386	23.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C11-B			26.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C11-C			26.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C11-D			26.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C2-A	4.10023	114.84351	5.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C2-B	4.10028	114.84444	5.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C2-C	4.10034	114.84544	5.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
159-C2-D	4.09932	114.84519	5.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C4-A	4.095509	114.8386	19.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C4-B			19.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C4-C			19.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C4-D			19.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C8-A	4.138143069	114.8467114	20.11.2018	MULU NATIONAL PARK	LD-L	Mixed Dipterocarp Forest	TPA (Forested)
159-C8-B			20.11.2018	MULU NATIONAL PARK	LD-L	Mixed Dipterocarp Forest	TPA (Forested)
159-C8-C			20.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C8-D			21.11.2018	MULU NATIONAL PARK	LD-L	Mixed Dipterocarp Forest	TPA (Forested)
159-C9-A	4.08689216	114.8450796	21.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C9-B			21.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
159-C9-C			21.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
159-C9-D			22.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
167-C1-A	1.13075	111.940217	7-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
167-C1-B	1.13075	111.940217	7-Nov-20	BATANG AI	LD-M	Mixed Dipterocarp Forest	State Land
167-C1-C	1.129017	111.939483	7-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
167-C1-D	1.129567	111.938717	7-Nov-20	BATANG AI	LD-H	Mixed Dipterocarp Forest	State Land
167-C2-A	1.137767	111.94445	6-Nov-20	BATANG AI	LD-M	Mixed Dipterocarp Forest	State Land
167-C2-B	1.136283	111.944983	6-Nov-20	BATANG AI	LD-M	Mixed Dipterocarp Forest	State Land
167-C2-C	1.135467	111.945267	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
167-C2-D	1.134967	111.944633	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
174-C1-A	4.08593	114.82695	4.5.2017	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C1-B	4.08607	114.82597	4.5.2017	MULU NATIONAL PARK	LD-L	Mixed Dipterocarp Forest	TPA (Forested)
174-C1-C	4.08562	114.82557	4.5.2017	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C1-D	4.08506	114.82505	4.5.2017	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C10-A	4.078389418	114.8292674	6.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
174-C10-B			6.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C10-C			7.12.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C10-D			7.12.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C2-A	4.08321	114.82895	4.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C2-B	4.08327	114.83007	4.5.2017	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C2-C	4.08313	114.83107	4.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C2-D	4.08404	114.83105	4.5.2017	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C3-A	4.088949	114.8335	27.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C3-B	4.0962	114.83834	27.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C3-C	4.09613	114.83125	27.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C3-D	4.09533	114.83919	27.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C4-A	4.096208271	114.8346158	28.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C4-B			28.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C4-C			28.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C4-D			28.11.2018	MULU NATIONAL PARK	LD-L	Mixed Dipterocarp Forest	TPA (Forested)
174-C5-A	4.104737	114.8371	29.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C5-B			29.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C5-C			29.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C5-D			29.11.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C6-A	4.109596797	114.8326403	30.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C6-B			30.11.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C6-C			3.12.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C6-D			3.12.2018	MULU NATIONAL PARK	LD-L	Mixed Dipterocarp Forest	TPA (Forested)
174-C7-A	4.104861414	114.829493	3.12.2018	MULU NATIONAL PARK	LD-L	Mixed Dipterocarp Forest	TPA (Forested)
174-C8-A	4.081928841	114.8176799	4.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
174-C8-B			4.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C8-C			5.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C8-D			5.12.2018	MULU NATIONAL PARK	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
174-C9-A	4.073287575	114.8299754	5.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C9-B			5.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C9-C			6.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
174-C9-D			6.12.2018	MULU NATIONAL PARK	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
178-C1-A	2 29 20.0	114 49 04.6		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C1-B	2 29 16.7	114 48 59.0		T/3283 DANUM PF SAMLING PF	UH-L	Mixed Dipterocarp Forest	Concession (Forested)
178-C1-C	2 29 13.1	114 48 50.2		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C1-D	2 29 12.9	114 48 55.0		T/3283 DANUM PF SAMLING PF	UH-L	Mixed Dipterocarp Forest	Concession (Forested)
178-C10-A	2 30 51.7	114 48 54.0	27.10.2017	T/3283 DANUM	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C10-B	2 30 48.4	114 48 53.2	27.10.2017	T/3283 DANUM	UH-L	Mixed Dipterocarp Forest	Concession (Forested)
178-C10-C	2 30 44.9	114 48 52.3	27.10.2017	T/3283 DANUM	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C10-D	2 30 53.4	114 48 51.2	27.10.2017	T/3283 DANUM	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C11-A	2 30 17.0	114 46 27.5	09.10.2017	T/3283 DANUM	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C11-B	2 30 14.2	114 46 24.7	09.10.2017	T/3283 DANUM	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C11-C	2 30 11.5	114 46 22.5	09.10.2017	T/3283 DANUM	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C11-D	2 30 8.6	114 46 24.4	09.10.2017	T/3283 DANUM	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C2-A	2 29 39.6	114 49 14.7		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C2-B	2 29 39.9	114 49 18.3		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C2-C	2 29 40.4	114 49 21.8		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C2-D	2 29 42.8	114 49 13.6		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C3-A	2 31 8.8	114 46 23.6		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
178-C3-B	2 31 5.9	114 46 24.8		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C3-C	2 31 10.2	114 46 26.6		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C3-D	2 31 12.0	114 46 29.4		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C4-A	2 31 19.8	114 47 12.2		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C4-B	2 31 21.0	114 47 9.1		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C4-C	2 31 18.8	114 47 6.6		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C4-D	2 31 17.1	114 47 3.7		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C5-A	2 31 13.5	114 48 20.1		T/3283 DANUM PF SAMLING PF	MTN	Mixed Dipterocarp Forest	Concession (Forested)
178-C5-B	2 31 16.5	114 48 21.6		T/3283 DANUM PF SAMLING PF	MTN	Mixed Dipterocarp Forest	Concession (Forested)
178-C5-C	2 31 19.3	114 48 23.3		T/3283 DANUM PF SAMLING PF	MTN	Mixed Dipterocarp Forest	Concession (Forested)
178-C5-D	2 31 14.6	114 48 17.0		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C6-A	2 29 26.7	114 46 19.4		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C6-B	2 29 24.4	114 46 14.8		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C6-C	2 29 25.2	114 46 11.4		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C6-D	2 29 21.7	114 46 10.0		T/3283 DANUM PF SAMLING PF	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C7-A	2 29 47.6	114 47 11.5		T/3283 DANUM PF SAMLING PF	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C7-B	2 29 51.0	114 47 12.3		T/3283 DANUM PF SAMLING PF	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C7-C	2 29 54.4	114 47 12.4		T/3283 DANUM PF SAMLING PF	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C7-D	2 29 53.4	114 47 9.0		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C8-A	2 29 44.6	114 46 22.9		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C8-B	2 29 42.8	114 46 25.7		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C8-C	2 29 45.9	114 46 26.6		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C8-D	2 29 49.1	114 46 27.5		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
178-C9-A	2 31 15.9	114 49 38.3		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C9-B	2 31 13.7	114 49 35.6		T/3283 DANUM PF SAMLING PF	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
178-C9-C	2 31 12.2	114 49 32.4		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
178-C9-D	2 31 19.0	114 49 36.7		T/3283 DANUM PF SAMLING PF	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
182-C1-A	1.064417	111.735333	29/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land
182-C1-B	1.064433	111.734517	29/10/2020	ENGKELILI	LD-L	Mixed Dipterocarp Forest	State Land
182-C1-C	1.0636	111.734417	29/10/2020	ENGKELILI	LD-M	Mixed Dipterocarp Forest	State Land
182-C1-D	1.06275	111.734367	29/10/2020	ENGKELILI	LD-M	Mixed Dipterocarp Forest	State Land
188-C1-A	1.134817	111.942917	6-Nov-20	BATANG AI	LD-M	Mixed Dipterocarp Forest	State Land
188-C1-B	1.135383	111.943583	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
188-C1-C	1.136017	111.944267	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
188-C1-D	1.136767	111.943667	6-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
189-C1-A	1.812817	109.696767	22.07.2020	GUNUNG PUEH	HD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
189-C1-B	1.81295	109.697467	22.07.2020	GUNUNG PUEH	HD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
189-C1-C	1.8122	109.6975	22.07.2020	GUNUNG PUEH	HD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
189-C1-D	1.811333	109.6974	22.07.2020	GUNUNG PUEH	HD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
200-C10-A	2 12 59.5	114 34 41.9		BAHAU-MELARANG FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C10-B	2 12 56.3	114 34 42.5		BAHAU-MELARANG FMP	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
200-C10-C	2 12 52.9	114 34 42.7		BAHAU-MELARANG FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C10-D	2 12 52.7	114 34 39.3		BAHAU-MELARANG FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C11-A	02 15 16.7	114 37 02.9	24.11.2018	Bahau Melarang Forest Management	MTN	Mixed Dipterocarp Forest	Concession (Forested)
200-C11-B	02 15 16.8	114 37 06.7	24.11.2018	Bahau Melarang Forest Management	MTN	Mixed Dipterocarp Forest	Concession (Forested)
200-C11-C	02 15 17.1	114 37 10.2	24.11.2018	Bahau Melarang Forest Management	MTN	Mixed Dipterocarp Forest	Concession (Forested)
200-C11-D	02 15 13.8	114 37 10.2	24.11.2018	Bahau Melarang Forest Management	MTN	Mixed Dipterocarp Forest	Concession (Forested)
200-C2-A	2 10 46.0	114 36 17.5		BAHAU-MELARANG FMP	UH-L	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
200-C2-B	2 10 43.1	114 36 15.7		BAHAU-MELARANG FMP	UH-L	Mixed Dipterocarp Forest	Concession (Forested)
200-C2-C	2 10 39.8	114 36 15.2		BAHAU-MELARANG FMP	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
200-C2-D	2 10 40.0	114 36 11.9		BAHAU-MELARANG FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C3-A	2 11 41.54	114 35 40.9		BAHAU-MELARANG FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C3-B	2 11 42.0	114 35 44.2		BAHAU-MELARANG FMP	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
200-C3-C	2 11 42.7	114 35 47.5		BAHAU-MELARANG FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C3-D	2 11 40.6	114 35 47.6		BAHAU-MELARANG FMP	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
200-C4-A	02 15 25.5	114 34 28.7	27.11.2018	Bahau Melarang Forest Management	MTN	Mixed Dipterocarp Forest	Concession (Forested)
200-C4-B	02 15 25.5	114 34 28.7	27.11.2018	Bahau Melarang Forest Management	MTN	Mixed Dipterocarp Forest	Concession (Forested)
200-C4-C	02 15 26.1	114 34 35.6	27.11.2018	Bahau Melarang Forest Management	MTN	Mixed Dipterocarp Forest	Concession (Forested)
200-C4-D	02 15 29.3	114 34 35.9	27.11.2018	Bahau Melarang Forest Management	MTN	Mixed Dipterocarp Forest	Concession (Forested)
200-C7-A	02 14 10.4	114 34 59.5	26.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C7-B	02 14 14.0	114 34 58.5	26.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C7-C	02 14 17.5	114 34 57.8	26.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C7-D	02 14 17.8	119 35 01.1	27.11.2018	Bahau Melarang Forest Management	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
200-C8-A	02 14 49.7	114 38 15.0	20.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C8-B	02 14 46.3	114 38 15.1	20.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C8-C	02 14 45.6	114 38 18.7	21.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C8-D	02 14 44.9	114 38 22.0	21.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C9-A	02 14 34.2	114 37 48.2	22.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C9-B	02 14 37.4	114 37 48.8	22.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C9-C	02 14 40.6	114 37 50.2	22.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
200-C9-D	02 14 39.4	114 37 53.3	22.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C0-A	1.06236	110.37575	08.10.2019	GUNUNG GADING NP	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
201-C0-B	1.69406425	109.843947	08.10.2019	TAMAN NEGARA GUNUNG GADING	LD-M	Mixed Dipterocarp Forest	TPA (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
201-C0-C	1.69369651	109.8446247	08.10.2019	TAMAN NEGARA GUNUNG GADING	LD-L	Mixed Dipterocarp Forest	TPA (Forested)
201-C0-D	1.6933	109.84473	08.10.2019	TAMAN NEGARA GUNUNG GADING	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
201-C1-A	2 10 4.9	114 35 31.9		BAHAU-MELARANG FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C1-B	2 10 7.7	114 35 30.3		BAHAU-MELARANG FMP	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
201-C1-C	2 10 10.8	114 35 29.2		BAHAU-MELARANG FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C1-D	2 10 8.6	114 35 26.4		BAHAU-MELARANG FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C2-A	2 9 38.8	114 35 56.6		BAHAU-MELARANG FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C2-B	2 9 36.8	114 35 53.8		BAHAU-MELARANG FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C2-C	2 9 34.4	114 35 57.5		BAHAU-MELARANG FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C2-D	2 9 37.0	114 35 49.1		BAHAU-MELARANG FMP	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
201-C3-A	2 8 23.6	114 35 49.9	29.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C3-B	2 8 20.5	114 35 47.9	29.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C3-C	2 8 18.5	114 35 51.0	30.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C3-D	2 8 16.5	114 35 54.1	30.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C4-A	2 7 45.0	114 36 4.8	27.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C4-B	2 7 48.2	114 36 5.8	27.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C4-C	2 7 51.3	114 36 7.3	27.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C4-D	2 7 49.7	114 36 10.4	27.11.2018	Bahau Melarang Forest Management	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C5-A	2 7 40.1	114 35 9.8	28.11.2018	Bahau Melarang Forest Management	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
201-C5-B	2 7 38.5	114 35 12.9	28.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C5-C	2 7 36.7	114 35 16.0	28.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
201-C5-D	2 7 39.3	114 35 18.1	28.11.2018	Bahau Melarang Forest Management	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
210-C2-A	1.8371	109.661033	19.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
210-C2-B	1.836617	109.661033	19.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
210-C2-C	1.836233	109.661033	19.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
210-C2-D	1.835683	109.661033	19.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
210-C2-E	1.835333	109.661	19.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
210-C2-F	1.83485	109.66105	19.07.2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
211-C0-A	1.132017	111.937917	7-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
211-C0-B	1.130083	111.938133	7-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
211-C0-C	1.130233	111.938433	7-Nov-20	BATANG AI	LD-M	Mixed Dipterocarp Forest	State Land
211-C0-D	1.130533	111.9393	7-Nov-20	BATANG AI	LD-L	Mixed Dipterocarp Forest	State Land
211-C1-A	2 9 23.8	114 32 13.4		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C1-B	2 9 18.2	114 32 11.6		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C1-C	2 9 15.1	114 32 13.2		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C1-D	2 9 12.1	114 32 11.1		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C11-A	2 9 20.4	114 31 21.3		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C11-B	2 9 17.1	114 31 21.7		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C11-C	2 9 13.7	114 31 22.0		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C11-D	2 9 13.6	114 31 25.4		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C2-A	2 8 30.1	114 31 27.4		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C2-B	2 8 31.7	114 31 30.4		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C2-C	2 8 33.6	114 31 31.1		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C2-D	2 8 31.1	114 31 35.3		BUNGAU FMP	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C3-A	2 8 10.5	114 31 37.3		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C3-B	2 8 7.2	114 31 37.4		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C3-C	2 8 10.5	114 31 37.3		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C3-D	2 8 11.4	114 31 34.0		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C4-A	2 7 55.9	114 30 44.4		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
211-C4-B	2 7 52.8	114 30 45.7		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C4-C	2 7 54.0	114 30 48.9		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
211-C4-D	2 7 55.2	114 30 52.1		BUNGAU FMP	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
211_4_A	1.840139	109.662833	16/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
211_4_B	1.840444	109.66275	16/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
211_4_C	1.841	109.662667	16/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
211_4_D	1.841639	109.6625	16/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
211_4_E	1.841972	109.662417	16/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
211_4_F	1.842361	109.662194	16/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
214_5_A	1.831533	109.6605	20/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
214_5_B	1.831317	109.6602	20/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
214_5_C	1.831067	109.6599	20/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
214_5_D	1.830883	109.659467	20/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
214_5_E	1.830633	109.6591	20/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
214_5_F	1.830433	109.658667	20/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
216-C1-A	1.908417	109.5985	8/7/2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)
216-C1-B	1.909139	109.601167	8/7/2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)
216-C1-C	1.908806	109.601444	8/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
216-C1-D	1.9085	109.601778	8/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
216-C1-E	1.908194	109.602167	8/7/2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)
216-C1-F	1.907944	109.602444	8/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
216-C2-A	1.834467	109.65975	19.07.2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
216-C2-B	1.834433	109.659333	19.07.2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
216-C2-C	1.834467	109.658917	19.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
216-C2-D	1.834567	109.658417	19.07.2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
216-C2-E	1.834767	109.658033	19.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
216-C2-F	1.8348	109.65755	19.07.2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
217-C1-A	1.908194	109.617389	13.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C1-B	1.90775	109.617611	13.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C1-C	1.907389	109.617833	13.07.2020	SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Disturbed)
217-C1-D	1.907	109.618028	13.07.2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)
217-C1-E	1.906639	109.618306	13.07.2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C1-F	1.906194	109.618528	13.07.2020	SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Disturbed)
217-C10-A	1.908558	109.602778	9/7/2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)
217-C10-B	1.908722	109.603167	8/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C10-C	1.908722	109.608722	8/7/2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)
217-C10-D	1.908889	109.604056	8/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C10-E	1.909	109.604528	8/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C10-F	1.909083	109.604944	8/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C2-A	1.907861	109.607639	13/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C2-B	1.907861	109.608083	13/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C2-C	1.907861	109.608528	13/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C2-D	1.907806	109.609	13/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C2-E	1.907833	109.609417	13/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C2-F	1.907833	109.609917	13/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C3-A	1.922306	109.641139	10/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Forested)
217-C3-B	1.921944	109.640917	10/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Forested)
217-C3-C	1.921611	109.640639	10/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Forested)
217-C3-D	1.921222	109.640278	10/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Forested)
217-C3-E	1.920861	109.640056	10/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Forested)
217-C3-F	1.920556	109.639778	10/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Forested)
217-C4-A	1.914167	109.644722	10/7/2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Forested)
217-C4-B	1.914056	109.64425	10/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
217-C4-C	1.914111	109.643889	10/7/2020	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
217-C4-D	1.914	109.643444	10/7/2020	SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Forested)
217-C4-E	1.913944	109.642972	10/7/2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Forested)
217-C4-F	1.913917	109.642583	10/7/2020	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Forested)
217-C5-A	1.908556	109.607472	13/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217-C5-B	1.909056	109.607528	13/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
217-C5-C	1.909444	109.6075	13/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
217-C5-D	1.909917	109.607556	13/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
217-C5-E	1.910417	109.607611	13/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
217-C5-F	1.910833	109.6075	13/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
217_C6_A	1.839472	109.663	16.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217_C6_B	1.83925	109.662556	16.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217_C6_C	1.839083	109.662167	16.07.2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
217_C6_D	1.838917	109.66175	16.07.2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
217_C6_E	1.838778	109.661333	16.07.2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
217_C6_F	1.838556	109.660778	16.07.2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
217_C7_A	1.908417	109.5985	8/7/2020	SAMUNSAM WILDLIFE SANCTUARY	KGS	Kerangas/Heath Forest	TPA (Disturbed)
217_C7_B	1.908833	109.5985	8/7/2020	SAMUNSAM WILDLIFE SANCTUARY	KGS	Kerangas/Heath Forest	TPA (Disturbed)
217_C7_C	1.909278	109.598583	8/7/2020	SAMUNSAM WILDLIFE SANCTUARY	KGS	Kerangas/Heath Forest	TPA (Disturbed)
217_C7_D	1.90975	109.598583	8/7/2020	SAMUNSAM WILDLIFE SANCTUARY	KGS	Kerangas/Heath Forest	TPA (Disturbed)
217_C7_E	1.910167	109.598611	8/7/2020	SAMUNSAM WILDLIFE SANCTUARY	KGS	Kerangas/Heath Forest	TPA (Disturbed)
217_C7_F	1.910667	109.598694	8/7/2020	SAMUNSAM WILDLIFE SANCTUARY	KGS	Kerangas/Heath Forest	TPA (Disturbed)
217_C8_A	1.832917	109.66135	20/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
217_C8_B	1.83255	109.661583	20/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
217_C8_C	1.832183	109.665517	20/7/2020	SAMUNSAM WS	PS-L	Peat Swamp Forest	TPA (Disturbed)
217_C8_D	1.831917	109.66175	20/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
217_C8_E	1.831517	109.661933	20/7/2020	SAMUNSAM WS	PS-H	Peat Swamp Forest	TPA (Disturbed)
217_C8_F	1.831017	109.661967	20/7/2020	SAMUNSAM WS	PS-M	Peat Swamp Forest	TPA (Disturbed)
254-C1-A	1.52915	113.86079	16.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C1-B	1.52823	113.86055	16.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C1-C	1.52749	113.86038	16.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C1-D	1.52718	113.86107	16.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C10-A	1.50276	113.93636	19.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C10-B	1.5034	113.93575	19.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C10-C	1.50268	113.93513	20.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C10-D	1.50209	113.93449	20.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C11-A	1.49	113.91621	14.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C11-B	1.48925	113.91679	14.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
254-C11-C	1.48864	113.91715	15.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C11-D	1.48799	113.91699	15.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C2-A	1.50708	113.8694	28.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C2-B	1.50636	113.8688	28.10.2017	T/3132 SANITAMA SDN BHD	LD-H	Mixed Dipterocarp Forest	Concession (Forested)
254-C2-C	1.50575	113.86826	29.10.2017	T/3132 SANITAMA SDN BHD	LD-H	Mixed Dipterocarp Forest	Concession (Forested)
254-C2-D	1.50524	113.86872	29.10.2017	T/3132 SANITAMA SDN BHD	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C3-A	1.50246	113.87536	26.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C3-B	1.50256	113.87477	26.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
254-C3-C	1.50289	113.8737	27.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C3-D	1.50365	113.87402	27.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C4-A	1.52676	113.88985	30.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C4-B	1.52617	113.88916	30.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C4-C	1.52559	113.88847	30.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C4-D	1.52629	113.8879	30.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C5-A	1.51881	113.93308	22.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
254-C5-B	1.51858	113.93382	22.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C5-C	1.51832	113.93462	23.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C5-D	1.51917	113.93494	23.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C6-A	1.5153	113.9205	21.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C6-B	1.51498	113.9213	21.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C6-C	1.51573	113.92169	21.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C6-D	1.51645	113.92228	21.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C7-A	1.48005	113.94106	12.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
254-C7-B	1.47911	113.94202	12.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C7-C	1.47892	113.94289	13.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C7-D	1.47792	113.94211	13.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C8-A	1.49341	113.92873	17.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
254-C8-B	1.49345	113.92947	17.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C8-C	1.4933	113.93017	18.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C8-D	1.4924	113.93037	18.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
254-C9-A	1.52573	113.91357	24.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C9-B	1.52521	113.91283	24.10.2017	T/3132 SANITAMA SDN BHD	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
254-C9-C	1.52444	113.91225	25.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
254-C9-D	1.52408	113.91312	25.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C1-A	1.51467	113.84895	10.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C1-B	1.51588	113.84912	10.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C1-C	1.51596	113.849982	11.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C1-D	1.51602	113.85085	11.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C10-A	1.51789	113.81758	6.10.2017	T/3132 SANITAMA SDN BHD	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C10-B	1.51791	113.81863	6.10.2017	T/3132 SANITAMA SDN BHD	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C10-C	1.51829	113.8192	7.10.2017	T/3132 SANITAMA SDN BHD	LD-L	Mixed Dipterocarp Forest	Concession (Forested)
258-C10-D	1.51725	113.81951	7.10.2018	T/3132 SANITAMA SDN BHD	LD-M	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
258-C11-A	1.51316	113.8118	8.10.2017	T/3132 SANITAMA SDN BHD	LD-L	Mixed Dipterocarp Forest	Concession (Forested)
258-C11-B	1.51315	113.81105	8.10.2017	T/3132 SANITAMA SDN BHD	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C11-C	1.51319	113.80993	9.10.2017	T/3132 SANITAMA SDN BHD	LD-L	Mixed Dipterocarp Forest	Concession (Forested)
258-C11-D	1.51408	113.80997	9.10.2017	T/3132 SANITAMA SDN BHD	LD-L	Mixed Dipterocarp Forest	Concession (Forested)
258-C2-A	1.5207	113.829221	4.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C2-B	1.51981	113.82938	4.10.2017	T/3132 SANITAMA SDN BHD	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C2-C	1.51891	113.82938	5.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C2-D	1.51907	113.83042	5.10.2017	T/3132 SANITAMA SDN BHD	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C3-A	1.50584	113.78868	10.2.2018	T/3343 STIDC	LD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C3-B	1.50639	113.78912	11.2.2018	T/3343 STIDC	LD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C3-C	1.50691	113.7886	11.2.2018	T/3343 STIDC	LD-L	Mixed Dipterocarp Forest	Concession (Forested)
258-C3-D	1.50754	113.78943	12.2.2018	T/3343 STIDC	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C4-A	1.49754	113.7908	19.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C4-B	1.49822	113.79025	19.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C4-C	1.49882	113.78955	20.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C4-D	1.4981	113.7889	20.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C5-A	1.46542	113.79198	15.2.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C5-B	1.46611	113.79256	15.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C5-C	1.46669	113.79319	16.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C5-D	1.46608	113.79383	16.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C6-A	1.47031	113.79003	17.2.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C6-B	1.46996	113.78916	17.2.2018	T/3343 STIDC	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
258-C6-C	1.47094	113.78878	18.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C6-D	1.47175	113.78854	18.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C7-A	1.50354	113.81209	7.2.2018	T/3343 STIDC	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C7-B	1.50374	113.81329	8.2.2018	T/3343 STIDC	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C7-C	1.50383	113.81454	9.2.2018	T/3343 STIDC	LD-H	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
258-C7-D	1.50441	113.81377	8.2.2018	T/3343 STIDC	LD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C8-A	1.48517	113.78886	21.2.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C8-B	1.48527	113.7898	21.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C8-C	1.48433	113.78977	22.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C8-D	1.48378	113.78978	22.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C9-A	1.50364	113.80034	13.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
258-C9-B	1.50481	113.79993	13.2.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C9-C	1.50542	113.79979	14.2.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
258-C9-D	1.50533	113.79919	14.2.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C1-A	1.4376	113.7667	4.8.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C1-B	1.43672	113.76667	4.8.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
259-C1-C	1.43583	113.76663	4.8.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C1-D	1.43583	113.76569	4.8.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C11-A	1 26 05.7	113 47 23.8	21.11.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
259-C11-B	1 26 06.4	113 47 20.7	21.11.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
259-C11-C	1 26 07.1	113 47 17.7	22.11.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C11-D	1 26 04.8	113 47 16.2	14.11.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C2-A	1.44446	113.7849	5.8.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C2-B	1.44443	113.78572	6.8.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C2-C	1.44435	113.78655	6.8.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C2-D	1.44518	113.78667	7.8.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C3-A	1 25 28.6	113 49 54.0	11.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C3-B	1 25 29.9	113 49 51.4	13.11.2018	T/3343 STIDC	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
259-C3-C	1 25 31.1	113 49 48.4	13.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C3-D	1 25 28.0	113 49 47.5	13.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C4-A	1 25 41.3	113 48 41.6	17.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C4-B	1 25 38.7	113 48 39.5	18.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
259-C4-C	1 25 36.6	113 48 37.6	19.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C4-D	1 25 35.0	113 48 40.3	11.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C8-A	1 25 37.5	113 49 10.4	14.11.2018	T/3343 STIDC	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
259-C8-B	1 25 36.8	113 49 12.6	15.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C8-C	1 25 36.5	113 49 15.9	16.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
259-C8-D	1 25 39.2	113 49 17.5	17.11.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C1-A	1.35741	113.71577	18.7.2018	T/3343 STIDC	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
263-C1-B	1.35725	113.71637	19.7.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C1-C	1.3564	113.71667	19.7.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C1-D	1.35561	113.71709	20.7.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C10-A	1.43486	113.74966	24.3.2018	STIDC 7/3343	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C10-B	1.43551	113.74901	24.3.2018	STIDC 7/3343	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C10-C	1.43605	113.74853	25.3.2018	STIDC 7/3343	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C10-D	1.43684	113.74987	25.3.2018	STIDC 7/3343	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C11-A	1.4411	113.7644	16.3.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C11-B	1.44203	113.76433	17.3.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C11-C	1.44301	113.76445	17.3.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C11-D	1.443	113.76358	18.3.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C2-A	1.3625	113.72585	21.7.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C2-B	1.36165	113.72511	22.7.2018	T/3343 STIDC	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
263-C2-C	1.3609	113.72556	19.7.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C2-D	1.36024	113.72629	23.7.2018	T/3343 STIDC	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
263-C3-A	1.37124	113.71392	15.7.2018	T/3343 STIDC	UH-L	Mixed Dipterocarp Forest	Concession (Forested)
263-C3-B	1.37161	113.71313	15.7.2018	T/3343 STIDC	UH-L	Mixed Dipterocarp Forest	Concession (Forested)
263-C3-C	1.37198	113.71227	16.7.2018	T/3343 STIDC	UH-L	Mixed Dipterocarp Forest	Concession (Forested)
263-C3-D	1.37113	113.71196	16.7.2018	T/3343 STIDC	UH-L	Mixed Dipterocarp Forest	Concession (Forested)
263-C4-A	1.37074	113.72659	24.7.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
263-C4-B	1.37075	113.72735	25.7.2018	T/3343 STIDC	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C4-C	1.37079	113.72833	26.7.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C4-D	1.36992	113.72833	26.7.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C5-A	1.37596	113.73244	27.7.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C5-B	1.3768	113.7324	28.7.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C5-C	1.37776	113.73228	28.7.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C5-D	1.37778	113.73169	29.7.2018	T/3343 STIDC	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C6-A	1.39261	113.7384	30.7.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C6-B	1.39261	113.73753	31.7.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C6-C	1.39264	113.73663	31.7.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C6-D	1.39173	113.73669	1.8.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C7-A	1.40802	113.74619	19.3.2018	STIDC 7/3343	HD-L	Mixed Dipterocarp Forest	Concession (Forested)
263-C7-B	1.40867	113.74683	19.3.2018	STIDC 7/3343	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C7-C	1.40955	113.74725	20.3.2018	STIDC 7/3343	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C7-D	1.40876	113.74812	21.3.2018	STIDC 7/3343	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C8-A	1.41344	113.7478	22.3.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C8-B	1.41427	113.74815	27.3.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C8-C	1.41509	113.74869	23.3.2018	T/3343 STIDC	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C8-D	1.41539	113.74793	23.3.2018	T/3343 STIDC	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
263-C9-A	1.43071	113.7403	26.3.2018	STIDC 7/3343	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C9-B	1.43157	113.7403	26.3.2018	STIDC 7/3343	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C9-C	1.43164	113.73956	27.3.2018	STIDC 7/3343	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
263-C9-D	1.4316	113.73854	27.3.2018	STIDC 7/3343	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
342-C1-A	1 41.287	112 8.836	21.4.2018	LANJAK ENTIMAU	LD-L	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C1-B	1 41.230	112 8.833	21.4.2018	LANJAK ENTIMAU	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C1-C	1 41.178	112 8.828	21.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C1-D	1 41.171	112 8.887	21.4.2018	LANJAK ENTIMAU	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
342-C10-A	1 41.547	112 7.512	13.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C10-B	1 41.542	112 7.560	13.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C10-C	1 41.535	112 7.617	13.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C10-D	1 41.487	112 7.617	13.4.2018	LEWS	LD-L	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C11-A	1 41.718	112 7.144	11.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C11-B	1 41.705	112 7.204	11.4.2018	LEWS	LD-L	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C11-C	1 41.663	112 7.245	11.4.2018	LEWS	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C11-D	1 41.609	112 7.245	11.4.2018	LEWS	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C2-A	1 41.329	112 8.498	25.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C2-B	1 41.387	112 8.497	25.4.2018	LANJAK ENTIMAU	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C2-C	1 41.440	112 8.492	25.4.2018	LANJAK ENTIMAU	LD-L	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C2-D	1 41.441	112 8.547	25.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C3-A	1 41.707	112 7.923	15.4.2018	LEWS	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C3-B	1 41.765	112 7.919	15.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C3-C	1 41.855	112 7.936	15.4.2018	LEWS	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C3-D	1 41.857	112 7.990	15.4.2018	LEWS	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C4-A	1 41.947	112 8.098	16.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
342-C4-B	1 42.001	112 8.099	16.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
342-C4-C	1 42.058	112 8.102	16.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
342-C4-D	1 42.061	112 8.034	16.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
342-C5-A	1 41.097	112 8.557	24.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C5-B	1 41.047	112 8.559	24.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C5-C	1 40.993	112 8.561	24.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C5-D	1 40.990	112 8.505	24.4.2018	LANJAK ENTIMAU	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C6-A	1 40.761	112 8.551	26.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
342-C6-B	1 40.815	112 8.560	26.4.2018	LANJAK ENTIMAU	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
342-C6-C	1 40.867	112 8.563	26.4.2018	LANJAK ENTIMAU	LD-H	Mixed Dipterocarp Forest	TPA (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
342-C6-D	1 40.867	112 8.506	26.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
342-C7-A	1 41.532	112 8.614	20.4.2018	LEWS	LD-L	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C7-B	1 41.531	112 8.678	20.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C7-C	1 41.528	112 8.723	20.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C7-D	1 41.469	112 8.723	20.4.2018	LEWS	LD-M	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C8-A	1 41.558	112 8.947	23.4.2018	LANJAK ENTIMAU	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
342-C8-B	1 41.503	112 8.943	23.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
342-C8-C	1 41.451	112 8.944	23.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
342-C8-D	1 41.455	112 8.891	23.4.2018	LANJAK ENTIMAU	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
342-C9-A	1.69	112.13609	10.4.2018	LEWS	LD-H	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C9-B	1.69091	112.13611	10.4.2018	LEWS	LD-L	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C9-C	1.69178	112.13603	10.4.2018	LEWS	LD-L	Mixed Dipterocarp Forest	TPA (Disturbed)
342-C9-D	1 41.609	112 7.245	10.4.2018	LEWS	LD-L	Mixed Dipterocarp Forest	TPA (Disturbed)
48-C1-A	3 26 27.6	115 31 31.7	17.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C1-B	3 26 28.4	115 31 28.4	17.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C1-C	3 26 29.6	115 31 25.2	17.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C1-D	3 26 32.5	115 31 26.4	17.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C10-A	3 30 54.7	115 31 51.6	09. 12. 2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C10-B	3 30 58.1	115 31 53.7	09. 12. 2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C10-C	3 31 01.2	115 31 55.2	09. 12. 2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C10-D	3 31 02.7	115 31 51.1	12. 10. 2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C11-A	3 31 27.4	115 31 35.9	12. 10. 2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C11-B	3 31 24.0	115 31 35.2	12. 10. 2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C11-C	3 31 20.2	115 31 34.4	12. 10. 2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C11-D	3 31 19.2	115 31 38.2	20.11.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C2-A	3 27 04.0	115 31 43.1	19.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C2-B	3 27 05.9	115 31 40.9	19.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
48-C2-C	3 27 8.4	115 31 38.9	19.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C2-D	3 27 10.5	115 31 40.4	20.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C3-A	3 27 23.0	115 31 58.7	20.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C3-B	3 27 31.1	115 31 56.0	20.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C3-C	3 27 30.2	115 31 52.5	20.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C3-D	3 27 27.3	115 31 54.5	20.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C4-A	3 27 55.0	115 31 52.7	22.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C4-B	3 27 26.5	115 31 49.8	22.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C4-C	3 27 58.3	115 31 46.8	22.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C4-D	3 28 01.4	115 31 47.7	22.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C5-A	3 28 16.0	115 31 37.0	23.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C5-B	3 28 13.3	115 31 39.1	23.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C5-C	3 28 10.5	115 31 41.2	23.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C5-D	3 28 12.2	115 331 43.9	23.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C6-A	3 28 59.0	115 31 49.8	24.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C6-B	3 29 01.9	115 31 51.5	24.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C6-C	3 39 04.6	115 31 53.5	24.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C6-D	3 29 06.2	115 31 50.9	24.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C7-A	3 29 40.4	115 31 35.3	11. 12. 2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C7-B	3 29 43.1	115 31 34.7	11. 12. 2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C7-C	3 29 46.3	115 31 33.0	11. 12. 2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C7-D	3 29 48.0	115 31 36.6	11. 12. 2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C8-A	3 30 02.0	115 31 29.5	13.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C8-B	3 30 04.7	115 31 27.3	13.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C8-C	3 30 07.0	115 31 25.4	13.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C8-D	3 30 10.0	115 31 26.8	13.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C9-A	3 30 30.6	115 31 42.2	14.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
48-C9-B	3 30 29.7	115 31 45.1	14.12.2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
48-C9-C	3 30 29.3	115 31 48.6	14.12.2018	PA DALIH	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
48-C9-D	3 30 32.8	115 31 49.9	09. 12. 2018	PA DALIH	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C1-A	3 13 23.1	115 24 54.9	4.4.2018	LONG BANGA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C1-B	3 13 26.2	115 24 56.7	4.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C1-C	3 13 29.0	115 24 58.7	4.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C1-D	3 13 26.6	115 25 1.2	4.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C10-A	3 14 36.7	115 26 21.2	10.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C10-B	3 14 36.4	115 26 18.1	10.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C10-C	3 14 33.2	115 26 14.5	10.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C10-D	3 14 35.9	115 26 13.0	10.4.2018	LONG BANGA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C11-A	3 14 22.3	115 27 0.3	11.4.2018	LONG BANGA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C11-B	3 14 19.5	115 27 2.0	11.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C11-C	3 14 15.7	115 27 0.5	11.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C11-D	3 14 17.1	115 26 57.8	11.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C2-A	3 11 58.2	115 25 52.8	3.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C2-B	3 12 0.0	115 25 56.2	3.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C2-C	3 12 1.2	115 25 59.9	3.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C2-D	3 11 58.1	115 26 1.6	3.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C3-A	3 11 34.7	115 26 5.1	2.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C3-B	3 11 37.4	115 26 20.7	2.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C3-C	3 11 40.7	115 26 20.1	2.4.2018	LONG BANGA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C3-D	3 11 39.5	115 26 16.7	2.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C4-A	3 11 48.1	115 27 5.6	30.3.2018	LONG BANGA	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C4-B	3 11 51.4	115 27 5.1	30.3.2018	LONG BANGA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C4-C	3 11 54.5	115 27 6.3	30.3.2018	LONG BANGA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C4-D	3 11 54.3	115 27 10.0	30.3.2018	LONG BANGA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
72-C5-A	3 11 38.9	115 27 47.5	31.3.2018	LONG BANGA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C5-B	3 11 40.8	115 27 44.7	31.3.2018	LONG BANGA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C5-C	3 11 42.1	115 27 41.2	31.3.2018	LONG BANGA	UH-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C5-D	3 11 44.5	115 27 44.6	31.3.2018	LONG BANGA	UH-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C6-A	3 14 17.2	115 24 42.9	5.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C6-B	3 14 14.3	115 24 41.9	5.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C6-C	3 14 11.4	115 24 41.4	5.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C6-D	3 14 10.4	115 25 44.5	5.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C7-A	3 14 30.1	115 25 14.3	6.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C7-B	3 14 26.6	115 25 14.2	6.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C7-C	3 14 22.9	115 25 13.5	6.4.2018	LONG BANGA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C7-D	3 14 24.0	115 25 10.3	6.4.2018	LONG BANGA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C8-A	3 14 51.0	115 25 33.0	7.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C8-B	3 14 47.2	115 25 32.1	7.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C8-C	3 14 43.9	115 25 31.0	7.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C8-D	3 14 45.0	115 25 27.7	7.4.2018	LONG BANGA	HD-M	Mixed Dipterocarp Forest	Concession (Forested)
72-C9-A	3 15 3.4	115 26 5.1	9.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C9-B	3 15 0.9	115 26 2.4	9.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C9-C	3 14 59.0	115 25 59.5	9.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
72-C9-D	3 15 0.7	115 25 57.7	9.4.2018	LONG BANGA	HD-H	Mixed Dipterocarp Forest	Concession (Forested)
GELAM 2_A	1.792861	109.81875	15/7/2020	PUGU, LUNDU	ML	Melaleuca Forest	State Land
GELAM 2_B	1.792861	109.818417	15/7/2020	PUGU, LUNDU	ML	Melaleuca Forest	State Land
GELAM 2_C	1.792861	109.817972	15/7/2020	PUGU, LUNDU	ML	Melaleuca Forest	State Land
GELAM 2_D	1.792861	109.817528	15/7/2020	PUGU, LUNDU	ML	Melaleuca Forest	State Land
GELAM 2_E	1.792861	109.817528	15/7/2020	PUGU, LUNDU	ML	Melaleuca Forest	State Land
GELAM 2_F	1.792861	109.817528	15/7/2020	PUGU, LUNDU	ML	Melaleuca Forest	State Land
LD (N1) A	1.801117	109.710717	19/11/2019	GUNUNG PUEH	LD-M	Mixed Dipterocarp Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
LD (N1) B	1.801967	109.710717	19/11/2019	GUNUNG PUEH	LD-L	Mixed Dipterocarp Forest	Concession (Forested)
LD (N1) C	1.8029	109.7108	19/11/2019	GUNUNG PUEH	LD-L	Mixed Dipterocarp Forest	Concession (Forested)
LD (N1) D	1.802917	109.702917	19/11/2019	GUNUNG PUEH	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
LD10-A	1.733017	109.7994		GUNUNG GADING NP	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
LD10-B	1.73295	109.8005		TAMAN NEGARA GUNUNG GADING	LD-H	Mixed Dipterocarp Forest	TPA (Forested)
LD10-C	1.732917	109.80145		TAMAN NEGARA GUNUNG GADING	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
LD10-D	1.7326	109.798767		TAMAN NEGARA GUNUNG GADING	LD-M	Mixed Dipterocarp Forest	TPA (Forested)
LDNEW02(A)	1.801617	109.70935	22/11/2019	GUNUNG PUEH	LD-H	Mixed Dipterocarp Forest	Concession (Forested)
LDNEW02(B)	1.801917	109.7086	22.11.2019	GUNUNG PUEH	LD-H	Mixed Dipterocarp Forest	Concession (Forested)
LDNEW02(C)	1.802	109.707867	22.11.2019	GUNUNG PUEH	LD-M	Mixed Dipterocarp Forest	Concession (Forested)
LDNEW02(D)	1.802517	109.708133	22.11.2019	GUNUNG PUEH	LD-H	Mixed Dipterocarp Forest	Concession (Forested)
M1 A	1.7851	109.78395	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M1 B	1.785283	109.783967	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M1 C	1.785517	109.783917	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M1 D	1.7858	109.783933	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M1 E	1.78605	109.7839	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M1 F	1.78625	109.783917	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M2 A	1.782233	109.781617	21/11/2019	SEMATAN	MGV	Mangrove Forest	State Land
M2 B			21/11/2019	SEMATAN	MGV	Mangrove Forest	State Land
M2 C			21/11/2017	SEMATAN	MGV	Mangrove Forest	State Land
M2 D			21/11/2019	SEMATAN	MGV	Mangrove Forest	State Land
M2 E			21/11/2019	SEMATAN	MGV	Mangrove Forest	State Land
M2 F			21/11/2019	SEMATAN	MGV	Mangrove Forest	State Land
M3 A	1.777967	109.78405	21/11/2019	Sematan	MGV	Mangrove Forest	Concession (Forested)
M3 B	1.777567	109.784083	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
M3 C	1.777383	109.784	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M3 D	1.777183	109.784017	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M3 E	1.776967	109.78405	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
M3 F	1.77675	109.784033	21/11/2019	SEMATAN	MGV	Mangrove Forest	Concession (Forested)
P01 (A)	1.935633	109.6388	16/11/2019	SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Forested)
P01 (B)	1.9361	109.638917	16/11/2019	SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Forested)
P01 (C)	1.936533	109.638867	16/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
P01 (D)	1.937033	109.638917	16/11/2019	SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Forested)
P01 (E)	1.937433	109.63895	16/11/2019	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Forested)
P01 (F)	1.937783	109.638667	16/11/2019	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Forested)
P02 A	1.935633	109.641483	16/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P02 B	1.936067	109.641467	16/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P02 C	1.93655	109.64145	16/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P02 D	1.93705	109.6415	16/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P02 E	1.937433	109.6416	16/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P02 F	1.93785	109.641617	16/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P03 A	1.91655	109.64375	18/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
P03 B	1.91615	109.643783	18/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
P03 C	1.91545	109.64375	18/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
P03 D	1.91665	109.643683	18/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
P03 E	1.914417	109.643667	18/11/2019	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Forested)
P03 F	1.905617	109.643517	18/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
P04 (A)	1.90925	109.616867		SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
P04 (B)	1.909517	109.61725		SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
P05 (A)	1.908733	109.615017		SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
P05 (B)	1.9092	109.61505		SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
P06 (A)	1.958417	109.6318	20/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)

Plot ID	Latitude	Longitude	Date	Location	Stratum	FOR.TYPE2	Land Status
P06 (B)	1.958883	109.631833	20/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
P06 (C)	1.959333	109.631917	20/11/2019	SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Forested)
P06 (D)	1.9598	109.631917	20/11/2019	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Forested)
P06 (E)	1.96025	109.631933	20/11/2019	SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Forested)
P06 (F)	1.9607	109.631967	20/11/2019	SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Forested)
P10 A	1.96384	109.63879	15/11/2019	Samunsam	KGS	Kerangas/Heath Forest	TPA (Forested)
P10 B	1.9643	109.6388	15/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P10 C	1.96465	109.63878	15/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P10 D	1.96506	109.63892	15/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P10 E	1.965531	109.638953	15/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
P10 F	1.965983	109.639033	15/11/2019	SAMUNSAM	KGS	Kerangas/Heath Forest	TPA (Forested)
PO4 (C)	1.909817	109.61755		SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
PO4 (D)	1.910033	109.617933		SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)
PO4 (E)	1.910467	109.618333		SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Disturbed)
PO4 (F)	1.910617	109.618667		SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
PO5 (C)	1.909683	109.615017		SAMUNSAM	PS-M	Peat Swamp Forest	TPA (Disturbed)
PO5 (D)	1.9101	109.615033		SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)
PO5 (E)	1.910567	109.615133		SAMUNSAM	PS-H	Peat Swamp Forest	TPA (Disturbed)
PO5 (F)	1.911033	109.615167		SAMUNSAM	PS-L	Peat Swamp Forest	TPA (Disturbed)

Appendix 7.2 Overall Summary of Inventory Results for Every Plot

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
103-C1-A	1,198.94	24.33	103.93	90.69	3.74	0.04	94.47	21.31	0.06	0.00	0.00	0.00	0.00	115.84
103-C1-B	895.68	14.00	63.71	51.97	28.05	0.00	80.02	10.65	0.00	0.00	0.00	0.00	0.00	90.67
103-C1-C	252.88	7.38	45.89	35.24	9.35	0.00	44.59	7.22	0.00	1.13	0.00	1.13	0.00	52.94
103-C1-D	911.60	24.57	155.02	122.76	9.35	0.00	132.11	28.85	0.00	5.21	8.26	13.47	0.00	174.43
103-C2-A	297.08	6.34	29.14	24.10	28.05	0.00	52.15	4.94	0.14	0.00	0.00	0.00	0.00	57.23
103-C2-B	292.68	15.42	84.83	76.48	0.00	0.00	76.48	17.97	0.00	9.43	0.00	9.43	0.00	103.88
103-C2-C	39.80	4.51	29.23	23.76	14.96	0.00	38.72	4.87	0.00	3.83	0.00	3.83	0.00	47.42
103-C2-D	45.98	18.65	228.25	140.55	0.00	0.00	140.55	33.03	0.00	20.64	0.00	20.64	0.00	194.22
107-C1-A	3,539.32	64.79	299.28	257.47	3.55	0.08	261.10	60.51	1.96	2.07	4.66	6.73	0.00	330.30
107-C1-B	3,047.74	43.43	210.76	172.16	18.70	0.00	190.86	40.46	0.00	13.43	1.96	15.39	0.00	246.71
107-C1-C	4,053.88	71.43	337.94	285.46	3.37	0.13	288.96	67.08	0.00	0.00	0.00	0.00	0.00	356.04
107-C1-D	2,038.82	50.20	207.18	200.53	22.44	0.00	222.97	47.12	0.00	0.33	10.90	11.23	0.00	281.32
107-C10-A	2,389.88	51.91	224.40	202.69	24.43	0.27	227.39	47.63	0.00	10.59	17.35	27.94	28.10	331.06
107-C10-B	2,361.60	69.63	465.84	347.22	7.53	0.00	354.75	81.60	0.00	1.09	0.00	1.09	0.00	437.44
107-C10-C	3,054.82	68.35	373.63	308.42	17.83	0.00	326.25	72.48	0.00	0.00	0.00	0.00	0.00	398.73
107-C10-D	2,312.96	71.98	382.39	336.64	11.22	1.61	349.47	79.11	0.93	0.99	0.95	1.94	42.59	474.04
107-C11-A	390.78	23.74	122.46	111.50	10.07	0.42	121.99	26.20	0.00	4.60	0.00	4.60	22.03	174.82
107-C11-B	716.14	42.59	274.70	221.61	3.81	0.00	225.42	52.08	0.00	2.01	2.38	4.39	0.00	281.89
107-C11-C	2,236.92	58.62	334.82	274.02	7.49	0.00	281.51	64.39	0.00	0.52	0.00	0.52	0.00	346.42
107-C11-D	3,117.56	49.07	210.71	178.21	16.11	1.61	195.93	41.88	0.79	3.79	0.86	4.65	145.19	388.44
107-C2-A	864.70	43.05	253.02	214.91	22.44	0.09	237.44	50.50	2.83	4.77	0.00	4.77	0.00	295.54
107-C2-B	236.08	24.64	176.13	138.75	1.87	0.00	140.62	32.61	0.00	25.65	9.38	35.03	0.00	208.26
107-C2-C	1,385.48	26.66	123.20	112.07	16.83	0.00	128.90	26.34	0.00	9.64	2.04	11.68	0.00	166.92
107-C2-D	2,004.40	38.94	186.76	163.50	11.22	0.26	174.98	38.42	3.14	6.25	8.41	14.66	0.00	231.20
107-C3-A	2,605.62	45.67	198.00	173.38	20.57	0.02	193.97	40.74	1.82	3.77	2.64	6.41	0.00	242.94
107-C3-B	2,452.70	45.16	242.17	193.00	13.09	0.00	206.09	45.35	0.00	13.58	0.00	13.58	0.00	265.02

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
107-C3-C	3,346.56	59.87	274.95	232.88	11.22	0.00	244.10	54.73	0.00	2.32	4.26	6.58	0.00	305.41
107-C3-D	2,095.46	32.30	117.79	105.87	20.57	0.04	126.48	24.88	2.12	5.24	0.00	5.24	0.00	158.72
107-C4-A	4,257.22	72.02	299.63	269.88	3.93	0.06	273.87	63.42	5.37	0.00	5.00	5.00	0.00	347.66
107-C4-B	2,791.28	80.94	465.56	381.01	26.18	0.00	407.19	89.54	0.00	3.99	0.00	3.99	0.00	500.72
107-C4-C	3,426.12	87.21	423.83	371.10	18.70	0.00	389.80	87.21	0.00	20.43	3.33	23.76	0.00	500.77
107-C4-D	2,468.62	39.04	201.21	161.14	13.09	0.71	174.94	37.87	2.25	0.00	0.00	0.00	0.00	215.06
107-C5-A	1,809.86	27.22	114.39	102.20	9.35	0.08	111.63	24.02	4.09	0.00	0.00	0.00	0.00	139.74
107-C5-B	2,667.52	50.20	239.60	211.54	11.22	0.00	222.76	49.71	0.00	7.03	1.23	8.26	0.00	280.73
107-C5-C	3,198.04	61.64	343.19	269.21	3.37	0.00	272.58	63.26	0.00	7.35	1.68	9.03	0.00	344.87
107-C5-D	1,175.06	26.01	114.20	101.76	13.09	0.06	114.91	23.91	2.82	0.00	0.00	0.00	0.00	141.64
107-C6-A	1,625.10	23.57	101.77	89.19	1.87	0.60	91.66	20.96	2.62	3.43	11.77	15.20	0.00	130.44
107-C6-B	1,628.66	33.35	153.20	137.15	0.00	0.00	137.15	32.23	0.00	0.00	5.08	5.08	0.00	174.46
107-C6-C	1,436.78	11.18	36.35	27.66	1.87	0.00	29.53	5.67	0.00	0.00	0.00	0.00	0.00	35.20
107-C6-D	1,151.18	18.19	69.45	66.10	7.48	0.02	73.60	15.53	4.07	1.61	0.00	1.61	0.00	94.81
107-C7-A	1,947.84	45.13	234.44	200.02	5.61	0.00	205.63	47.00	2.70	6.07	12.63	18.70	0.00	274.03
107-C7-B	2,053.04	27.67	141.60	118.20	3.74	0.00	121.94	27.78	0.00	0.00	0.85	0.85	0.00	150.57
107-C7-C	1,337.76	21.13	91.52	76.23	24.31	0.00	100.54	17.91	0.00	13.72	16.71	30.43	0.00	148.88
107-C7-D	2,217.44	49.87	210.59	203.46	0.00	0.17	203.63	47.81	1.50	8.22	5.00	13.22	0.00	266.16
107-C8-A	2,581.76	97.78	727.81	539.15	20.57	0.17	559.89	126.70	2.51	14.61	23.57	38.18	0.00	727.28
107-C8-B	2,490.64	49.05	198.44	185.65	3.55	0.00	189.20	43.63	0.00	0.00	0.00	0.00	0.00	232.83
107-C8-C	3,012.32	92.49	595.20	466.88	4.30	0.00	471.18	109.72	0.00	19.25	0.00	19.25	0.00	600.15
107-C8-D	3,353.68	77.15	449.85	363.96	18.70	0.09	382.75	85.53	2.24	15.97	15.41	31.38	0.00	501.90
107-C9-A	2,809.86	51.28	229.05	204.92	20.57	0.34	225.83	48.16	1.75	36.84	0.00	36.84	0.00	312.58
107-C9-B	2,120.24	52.28	308.26	252.06	13.09	0.00	265.15	59.23	0.00	37.03	1.67	38.70	0.00	363.08
107-C9-C	5,143.08	82.37	304.22	300.26	22.44	0.00	322.70	70.56	0.00	2.95	1.14	4.09	0.00	397.35
107-C9-D	2,679.00	73.65	471.45	378.40	14.96	0.28	393.64	88.92	1.69	18.30	8.04	26.34	0.00	510.59

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
129 C-A	140.56	5.74	20.88	23.14	0.00	0.00	23.14	4.74	0.00	0.00	0.00	0.00	0.00	27.88
129 C-B	265.20	10.02	32.59	38.84	0.00	0.00	38.84	7.96	0.00	0.00	0.00	0.00	0.00	46.80
129 C-C	140.56	7.38	42.59	36.59	0.00	0.00	36.59	7.50	0.00	0.00	0.00	0.00	0.00	44.09
129 C-D	90.18	4.63	22.29	20.41	0.00	0.00	20.41	4.18	0.00	0.00	0.00	0.00	0.00	24.59
149-C2-A	480.10	8.41	35.64	30.98	0.00	0.08	31.06	6.35	0.09	0.89	6.33	7.22	0.00	44.72
149-C2-B	503.98	8.68	38.45	31.38	0.00	0.00	31.38	6.43	0.00	0.00	6.41	6.41	0.00	44.22
149-C2-C	82.22	3.48	15.38	14.38	16.83	0.00	31.21	2.95	0.00	0.00	2.94	2.94	0.00	37.10
149-C2-D	464.18	5.88	19.11	16.09	16.83	0.00	32.92	3.30	0.00	0.00	3.29	3.29	0.00	39.51
153 C-A	341.28	9.73	42.18	38.79	0.00	0.00	38.79	7.95	0.00	0.00	0.00	0.00	0.00	46.74
153 C-B	200.68	13.51	69.88	67.77	0.00	0.00	67.77	15.93	0.00	0.00	0.00	0.00	0.00	83.70
153 C-C	156.48	7.33	31.20	31.34	0.00	0.00	31.34	6.42	0.00	0.00	0.00	0.00	0.00	37.76
153 C-D	596.82	2.00	6.47	3.39	0.00	0.00	3.39	0.69	0.00	0.00	0.00	0.00	0.00	4.08
159-C1-A	1,265.20	29.66	126.46	119.91	5.98	0.00	125.89	28.18	0.00	6.24	22.80	29.04	0.00	183.11
159-C1-B	1,532.26	32.16	172.71	155.03	4.68	0.00	159.71	36.43	0.00	1.37	9.04	10.41	0.00	206.55
159-C1-C	790.44	29.23	147.27	133.54	20.57	0.00	154.11	31.38	0.00	2.61	6.46	9.07	0.00	194.56
159-C1-D	1,784.24	20.87	76.09	65.24	4.68	0.00	69.92	15.33	0.00	6.38	17.64	24.02	0.00	109.27
159-C10-A	1,009.74	26.44	147.96	123.44	28.05	0.04	151.53	29.01	0.12	10.03	5.12	15.15	91.02	286.83
159-C10-B	1,446.44	39.18	174.39	170.89	13.09	0.00	183.98	40.16	0.00	0.00	3.38	3.38	0.00	227.52
159-C10-C	1,211.30	24.90	103.46	101.28	0.00	0.00	101.28	23.80	0.00	5.64	0.00	5.64	0.00	130.72
159-C10-D	660.50	14.59	76.72	65.84	3.74	0.12	69.70	15.47	0.68	0.00	0.00	0.00	52.19	138.04
159-C11-A	1,481.88	34.71	212.19	164.25	5.61	0.01	169.87	38.60	0.10	0.00	4.32	4.32	54.35	267.24
159-C11-B	439.42	23.97	166.34	131.14	7.48	0.00	138.62	30.82	0.00	0.00	2.61	2.61	0.00	172.05
159-C11-C	556.14	16.17	88.59	76.35	11.22	0.00	87.57	17.94	0.00	0.00	2.20	2.20	0.00	107.71
159-C11-D	968.16	22.83	116.22	97.77	3.74	0.02	101.53	22.98	0.14	5.25	0.00	5.25	62.59	192.49
159-C2-A	1,634.84	36.63	294.08	196.92	9.35	0.00	206.27	46.28	0.00	5.15	12.44	17.59	0.00	270.14
159-C2-B	1,777.18	42.46	250.89	197.43	29.92	0.00	227.35	46.40	0.00	7.65	8.00	15.65	0.00	289.40

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
159-C2-C	1,794.88	49.87	327.82	253.72	22.44	0.00	276.16	59.62	0.00	3.40	1.77	5.17	0.00	340.95
159-C2-D	1,861.18	49.31	297.06	238.38	3.74	0.00	242.12	56.02	0.00	3.07	15.20	18.27	0.00	316.41
159-C4-A	1,184.80	24.18	112.36	99.09	15.61	0.13	114.83	23.29	0.05	15.97	3.27	19.24	46.01	203.42
159-C4-B	688.74	25.60	138.36	124.29	9.35	0.00	133.64	29.21	0.00	0.00	1.09	1.09	0.00	163.94
159-C4-C	1,000.00	21.03	89.95	78.40	20.57	0.00	98.97	18.42	0.00	7.13	8.45	15.58	0.00	132.97
159-C4-D	1,710.88	33.74	163.63	137.26	9.35	0.12	146.73	32.26	0.17	2.90	5.77	8.67	47.19	235.02
159-C8-A	516.34	7.99	28.77	26.88	11.22	0.11	38.21	5.51	0.44	9.28	0.00	9.28	46.68	100.12
159-C8-B	1,100.80	11.72	50.73	40.50	18.70	0.00	59.20	8.30	0.00	0.00	1.71	1.71	0.00	69.21
159-C8-C	799.28	16.42	70.89	65.87	9.35	0.00	75.22	15.48	0.00	7.12	0.00	7.12	0.00	97.82
159-C8-D	715.28	10.98	38.09	35.01	9.35	0.01	44.37	7.18	0.08	0.00	2.05	2.05	42.05	95.73
159-C9-A	1,274.10	54.71	395.42	299.48	20.57	0.02	320.07	70.38	0.25	3.26	0.00	3.26	55.60	449.56
159-C9-B	1,082.22	25.24	133.29	115.92	4.11	0.00	120.03	27.24	0.00	0.00	7.94	7.94	0.00	155.21
159-C9-C	1,033.58	42.58	322.90	247.12	4.68	0.00	251.80	58.07	0.00	1.23	0.00	1.23	0.00	311.10
159-C9-D	738.32	33.63	331.30	220.59	4.86	0.03	225.48	51.84	0.61	7.74	7.46	15.20	42.53	335.66
167-C1-A	349.24	10.99	50.99	47.37	13.09	0.04	60.50	9.71	0.04	3.09	0.00	3.09	0.00	73.34
167-C1-B	1,192.76	26.14	133.59	110.21	3.37	0.00	113.58	25.90	0.00	0.00	0.00	0.00	0.00	139.48
167-C1-C	0.00	0.00	0.00	0.00	3.37	0.00	3.37	0.00	0.00	0.00	0.00	0.00	0.00	3.37
167-C1-D	542.00	25.12	206.52	151.66	28.05	0.00	179.71	35.64	0.00	6.93	0.00	6.93	0.00	222.28
167-C2-A	614.48	14.39	61.64	64.21	11.22	0.05	75.48	15.09	0.11	11.18	0.00	11.18	0.00	101.86
167-C2-B	534.04	13.36	67.50	61.13	0.00	0.01	61.14	12.53	0.02	0.45	2.08	2.53	0.00	76.22
167-C2-C	546.40	11.74	44.45	42.26	0.00	0.00	42.26	8.66	0.00	0.00	0.00	0.00	0.00	50.92
167-C2-D	817.86	7.48	24.29	19.33	0.00	0.00	19.33	3.96	0.00	0.00	0.00	0.00	0.00	23.29
174-C1-A	1,078.70	15.65	71.30	61.45	7.48	0.00	68.93	12.60	0.00	7.09	8.31	15.40	0.00	96.93
174-C1-B	1,989.40	10.35	33.63	21.22	3.74	0.00	24.96	4.35	0.00	9.93	0.00	9.93	0.00	39.24
174-C1-C	543.74	19.01	85.71	77.23	7.48	0.00	84.71	18.15	0.00	2.25	3.98	6.23	0.00	109.09
174-C1-D	1,412.02	20.67	101.14	84.88	11.22	0.00	96.10	19.95	0.00	18.00	3.08	21.08	0.00	137.13

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
174-C10-A	1,055.72	35.68	255.47	188.13	13.09	0.07	201.29	44.21	0.35	11.26	1.04	12.30	46.72	304.87
174-C10-B	638.42	65.90	566.53	414.87	7.56	0.03	422.46	97.49	0.38	9.36	0.00	9.36	81.94	611.63
174-C10-C	984.08	16.82	92.29	77.73	8.84	0.00	86.57	18.27	0.00	7.49	1.95	9.44	0.00	114.28
174-C10-D	1,088.40	25.32	121.51	103.65	22.83	0.00	126.48	24.36	0.00	12.52	2.57	15.09	0.00	165.93
174-C2-A	993.82	31.16	212.18	157.20	20.57	0.00	177.77	36.94	0.00	1.32	3.14	4.46	0.00	219.17
174-C2-B	485.40	20.17	126.12	103.33	26.18	0.00	129.51	24.28	0.00	1.00	2.07	3.07	0.00	156.86
174-C2-C	463.30	26.82	180.28	146.81	9.35	0.00	156.16	34.50	0.00	4.42	9.22	13.64	0.00	204.30
174-C2-D	1,453.60	44.32	341.01	240.16	16.83	0.00	256.99	56.44	0.00	0.00	0.98	0.98	0.00	314.41
174-C3-A	131.76	19.72	159.20	120.66	7.48	0.02	128.16	28.36	0.30	0.00	0.00	0.00	49.64	206.46
174-C3-B	484.56	44.86	397.95	282.88	18.91	0.00	301.79	66.48	0.00	1.59	2.59	4.18	0.00	372.45
174-C3-C	398.78	28.18	205.00	158.73	20.67	0.00	179.40	37.30	0.00	16.01	3.41	19.42	0.00	236.12
174-C3-D	411.14	22.50	178.65	133.14	22.53	0.02	155.69	31.29	0.22	3.52	0.00	3.52	48.19	238.91
174-C4-A	1,679.84	23.58	76.58	77.03	18.70	0.00	95.73	18.10	0.14	9.69	3.93	13.62	55.53	183.12
174-C4-B	1,453.52	39.96	177.90	167.29	24.31	0.00	191.60	39.31	0.00	6.88	1.00	7.88	0.00	238.79
174-C4-C	2,018.58	32.77	146.53	124.59	5.80	0.00	130.39	29.28	0.00	12.14	1.51	13.65	0.00	173.32
174-C4-D	650.72	12.50	50.45	46.35	3.55	0.05	49.95	9.50	0.12	2.93	0.00	2.93	48.22	110.72
174-C5-A	1,106.10	32.02	150.72	138.17	11.23	0.01	149.41	32.47	0.08	12.99	3.65	16.64	43.90	242.50
174-C5-B	778.08	31.18	178.25	154.24	18.70	0.00	172.94	36.25	0.00	0.00	0.00	0.00	0.00	209.19
174-C5-C	1,594.16	42.78	222.34	191.59	13.09	0.00	204.68	45.02	0.00	4.32	2.29	6.61	0.00	256.31
174-C5-D	2,091.02	41.78	181.78	166.75	28.05	0.00	194.80	39.19	0.34	10.20	0.00	10.20	53.21	297.74
174-C6-A	829.34	17.25	76.46	67.30	20.57	0.06	87.93	15.82	0.29	2.64	4.46	7.10	27.97	139.11
174-C6-B	840.86	26.35	125.95	113.71	13.09	0.00	126.80	26.72	0.00	0.00	0.00	0.00	0.00	153.52
174-C6-C	793.10	20.76	108.57	93.58	18.70	0.00	112.28	21.99	0.00	20.64	0.00	20.64	0.00	154.91
174-C6-D	574.68	9.90	32.19	35.18	9.35	0.00	44.53	7.21	0.19	13.49	3.35	16.84	36.29	105.06
174-C7-A	1,519.00	15.44	57.02	48.68	8.92	0.06	57.66	9.98	0.81	0.00	1.22	1.22	27.97	97.64
174-C8-A	643.66	40.41	279.16	222.00	16.83	0.06	238.89	52.17	0.33	7.67	3.23	10.90	91.54	393.83

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
174-C8-B	673.76	40.77	348.87	247.82	22.44	0.01	270.27	58.24	0.16	5.12	0.00	5.12	81.57	415.36
174-C8-C	346.58	34.11	270.36	200.21	22.44	0.00	222.65	47.05	0.00	22.22	10.81	33.03	0.00	302.73
174-C8-D	736.54	21.44	121.44	99.31	5.05	0.00	104.36	23.34	0.00	5.39	2.74	8.13	0.00	135.83
174-C9-A	404.96	27.76	192.52	156.29	26.18	0.06	182.53	36.73	0.15	0.64	5.83	6.47	49.24	275.12
174-C9-B	939.00	47.95	397.78	286.45	18.70	0.07	305.22	67.32	0.13	12.37	2.58	14.95	37.72	425.34
174-C9-C	1,825.82	34.68	252.08	180.36	3.93	0.00	184.29	42.38	0.00	3.21	0.00	3.21	0.00	229.88
174-C9-D	1,252.00	50.80	297.07	263.97	20.57	0.00	284.54	62.03	0.00	1.82	0.00	1.82	0.00	348.39
178-C1-A	794.88	20.71	119.55	98.38	14.96	0.05	113.39	23.12	4.54	0.00	3.82	3.82	0.00	144.87
178-C1-B	145.90	9.60	55.10	45.06	18.70	0.00	63.76	9.24	0.00	0.00	11.19	11.19	0.00	84.19
178-C1-C	1,846.14	25.39	100.91	84.92	7.48	0.00	92.40	19.96	0.00	8.74	2.59	11.33	0.00	123.69
178-C1-D	224.56	12.06	54.66	53.55	13.09	0.05	66.69	10.98	1.84	2.95	3.96	6.91	0.00	86.42
178-C10-A	618.04	18.76	88.62	76.59	6.69	0.17	83.45	18.00	3.02	2.98	2.04	5.02	0.00	109.49
178-C10-B	778.96	12.93	62.46	49.83	4.36	0.00	54.19	10.22	0.00	2.20	5.90	8.10	0.00	72.51
178-C10-C	786.92	15.88	74.33	60.53	10.90	0.00	71.43	12.41	0.00	3.47	3.50	6.97	0.00	90.81
178-C10-D	234.30	14.75	73.56	67.95	4.57	0.17	72.69	15.97	4.62	4.35	1.95	6.30	0.00	99.58
178-C11-A	1,259.96	52.48	302.77	260.28	0.00	0.54	260.82	61.17	1.05	0.00	16.00	16.00	0.00	339.04
178-C11-B	1,999.16	51.22	369.81	264.32	0.00	0.00	264.32	62.12	0.00	0.00	3.02	3.02	0.00	329.46
178-C11-C	1,435.02	41.09	201.65	180.32	6.54	0.00	186.86	42.38	0.00	3.45	3.50	6.95	0.00	236.19
178-C11-D	2,432.34	45.66	189.85	169.71	4.57	0.61	174.89	39.88	0.92	0.00	7.71	7.71	0.00	223.40
178-C2-A	531.34	29.44	152.27	139.14	24.31	0.00	163.45	32.70	0.00	0.00	2.47	2.47	0.00	198.62
178-C2-B	1,013.26	41.76	294.20	213.59	26.18	0.00	239.77	50.19	0.00	0.00	0.00	0.00	0.00	289.96
178-C2-C	802.84	22.29	131.03	112.23	22.44	0.15	134.82	26.37	0.32	2.78	4.05	6.83	0.00	168.34
178-C2-D	419.06	22.12	106.92	101.52	3.74	0.16	105.42	23.86	2.23	5.15	0.00	5.15	0.00	136.66
178-C3-A	2,294.36	30.54	110.36	93.73	4.11	0.10	97.94	22.03	3.94	0.00	0.00	0.00	0.00	123.91
178-C3-B	584.38	16.73	64.92	63.46	0.00	0.00	63.46	14.91	0.00	0.00	4.79	4.79	0.00	83.16
178-C3-C	2,454.44	35.55	158.37	136.38	28.05	0.00	164.43	32.05	0.00	0.00	1.49	1.49	0.00	197.97

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
178-C3-D	3,308.54	53.99	218.45	194.73	14.96	0.84	210.53	45.76	0.45	2.37	7.33	9.70	0.00	266.44
178-C4-A	3,597.66	76.69	344.57	307.27	3.74	2.85	313.86	72.21	4.31	0.00	4.24	4.24	0.00	394.62
178-C4-B	3,684.32	61.52	263.53	235.41	3.74	0.00	239.15	55.32	0.00	0.00	9.81	9.81	0.00	304.28
178-C4-C	4,600.32	62.74	256.55	226.83	9.35	0.00	236.18	53.31	0.00	1.69	6.54	8.23	0.00	297.72
178-C4-D	4,425.26	64.55	264.97	232.92	13.09	0.22	246.23	54.74	0.30	0.00	4.70	4.70	0.00	305.97
178-C5-A	2,329.76	51.09	216.08	201.02	5.61	0.23	206.86	47.24	6.09	0.00	8.21	8.21	0.00	268.40
178-C5-B	671.06	46.40	235.81	224.13	3.74	0.00	227.87	52.67	0.00	0.00	7.26	7.26	0.00	287.80
178-C5-C	3,370.44	56.93	233.54	207.01	9.35	0.00	216.36	48.65	0.00	2.47	1.85	4.32	0.00	269.33
178-C5-D	3,392.54	60.92	250.99	227.25	3.74	1.18	232.17	53.40	0.46	3.22	0.00	3.22	0.00	289.25
178-C6-A	929.26	27.24	131.20	117.72	9.35	0.82	127.89	27.66	0.67	0.00	7.03	7.03	0.00	163.25
178-C6-B	1,281.16	25.10	114.85	103.16	13.09	0.00	116.25	24.24	0.00	0.00	6.55	6.55	0.00	147.04
178-C6-C	1,731.20	31.94	134.18	119.52	9.35	0.00	128.87	28.09	0.00	1.06	4.49	5.55	0.00	162.51
178-C6-D	1,007.92	24.49	104.32	95.85	7.48	0.51	103.84	22.52	0.33	4.91	0.00	4.91	0.00	131.60
178-C7-A	881.46	25.51	107.52	102.07	26.18	0.11	128.36	23.99	0.93	0.00	3.21	3.21	0.00	156.49
178-C7-B	1,152.08	28.79	141.71	120.96	7.48	0.00	128.44	28.43	0.00	0.00	3.59	3.59	0.00	160.46
178-C7-C	805.46	16.78	73.05	66.41	11.22	0.00	77.63	15.61	0.00	0.00	4.52	4.52	0.00	97.76
178-C7-D	696.66	22.09	91.59	90.60	20.57	0.09	111.26	21.29	0.97	1.51	0.00	1.51	0.00	135.03
178-C8-A	728.58	20.48	112.85	92.44	16.83	0.27	109.54	21.72	0.77	0.00	16.24	16.24	0.00	148.27
178-C8-B	595.94	20.97	109.15	92.87	22.44	0.00	115.31	21.82	0.00	0.00	7.13	7.13	0.00	144.26
178-C8-C	826.72	23.49	135.12	109.25	28.05	0.00	137.30	25.67	0.00	7.65	0.00	7.65	0.00	170.62
178-C8-D	589.72	36.33	232.95	191.80	3.37	0.25	195.42	45.07	2.71	11.00	0.00	11.00	0.00	254.20
178-C9-A	2,555.20	41.21	156.70	142.32	3.74	0.40	146.46	33.45	0.34	0.00	2.61	2.61	0.00	182.86
178-C9-B	1,303.22	30.72	125.10	118.55	7.48	0.00	126.03	27.86	0.00	0.00	8.62	8.62	0.00	162.51
178-C9-C	2,695.80	44.92	174.70	156.58	16.83	0.00	173.41	36.80	0.00	1.45	3.16	4.61	0.00	214.82
178-C9-D	3,575.56	58.72	234.26	209.43	9.35	0.09	218.87	49.22	4.90	3.11	1.49	4.60	0.00	277.59
182-C1-A	1,201.56	16.51	55.68	52.03	0.00	0.00	52.03	10.67	0.00	0.00	0.00	0.00	0.00	62.70

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
182-C1-B	685.22	12.29	39.94	38.52	0.00	0.00	38.52	7.90	0.00	0.00	0.00	0.00	0.00	46.42
182-C1-C	475.66	16.01	79.64	67.98	0.00	0.00	67.98	15.98	0.00	0.00	0.00	0.00	0.00	83.96
182-C1-D	210.42	15.49	87.98	79.66	0.00	0.00	79.66	18.72	0.00	0.00	0.00	0.00	0.00	98.38
188-C1-A	674.60	23.21	101.88	103.12	3.93	0.03	107.08	24.23	0.19	4.37	0.00	4.37	0.00	135.87
188-C1-B	281.12	12.13	46.96	50.82	3.74	0.00	54.56	10.42	0.00	0.00	0.00	0.00	0.00	64.98
188-C1-C	377.48	14.10	53.70	56.18	28.05	0.00	84.23	11.52	0.00	0.00	0.00	0.00	0.00	95.75
188-C1-D	518.12	8.89	44.14	39.80	13.09	0.00	52.89	8.16	0.00	0.00	0.00	0.00	0.00	61.05
189-C1-A	998.22	22.12	102.28	96.40	0.00	0.00	96.40	22.65	0.00	0.00	0.00	0.00	0.00	119.05
189-C1-B	949.58	68.92	701.13	481.66	0.00	0.00	481.66	113.19	0.00	0.00	0.00	0.00	0.00	594.85
189-C1-C	873.54	22.71	102.03	95.18	0.00	0.00	95.18	22.37	0.00	0.00	0.00	0.00	0.00	117.55
189-C1-D	1,229.00	22.74	118.38	97.94	0.00	0.00	97.94	23.02	4.62	0.00	0.00	0.00	0.00	125.58
200-C10-A	478.34	45.03	313.63	248.98	4.68	0.25	253.91	58.51	2.80	0.00	0.00	0.00	60.59	375.81
200-C10-B	302.38	22.53	157.65	119.68	22.44	0.00	142.12	28.12	0.00	0.00	5.03	5.03	0.00	175.27
200-C10-C	410.26	42.62	326.99	244.02	4.11	0.27	248.40	57.34	1.40	0.00	2.08	2.08	19.44	328.66
200-C10-D	743.62	45.85	370.17	266.72	3.93	0.00	270.65	62.68	0.00	0.00	13.68	13.68	0.00	347.01
200-C11-A	1,633.06	32.76	142.72	133.56	14.52	0.04	148.12	31.39	0.35	1.77	2.46	4.23	96.42	280.51
200-C11-B	1,846.14	35.10	144.82	136.16	9.91	0.00	146.07	32.00	0.00	2.91	0.00	2.91	0.00	180.98
200-C11-C	1,603.00	28.01	135.05	117.35	17.57	0.00	134.92	27.58	0.00	0.00	1.30	1.30	0.00	163.80
200-C11-D	1,914.22	37.68	167.74	158.38	13.87	0.15	172.40	37.22	0.37	2.63	2.46	5.09	98.10	313.18
200-C2-A	524.30	9.76	37.28	32.72	3.74	0.03	36.49	6.71	0.92	0.00	0.00	0.00	49.88	94.00
200-C2-B	511.94	11.00	52.97	44.64	11.22	0.00	55.86	9.15	0.00	0.00	1.41	1.41	0.00	66.42
200-C2-C	549.96	16.17	81.34	72.95	22.44	0.27	95.66	17.14	3.35	0.00	17.95	17.95	40.99	175.09
200-C2-D	1,141.50	42.64	243.39	210.73	14.96	0.00	225.69	49.52	0.00	0.00	2.81	2.81	0.00	278.02
200-C3-A	629.56	30.57	188.18	158.18	5.61	0.01	163.80	37.17	1.87	0.00	3.35	3.35	59.95	266.14
200-C3-B	706.44	19.60	94.42	83.30	16.83	0.00	100.13	19.58	0.00	0.00	3.95	3.95	0.00	123.66
200-C3-C	227.28	30.95	245.25	181.82	0.00	0.00	181.82	42.73	0.00	0.00	2.61	2.61	0.00	227.16

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
200-C3-D	1,811.68	34.19	146.53	128.14	3.74	0.04	131.92	30.11	1.79	0.00	1.10	1.10	28.11	193.03
200-C4-A	2,076.92	40.83	178.48	164.46	18.97	0.24	183.67	38.65	0.30	2.81	5.51	8.32	132.11	363.05
200-C4-B	2,151.18	48.07	209.73	196.59	13.87	0.00	210.46	46.20	0.00	1.65	1.49	3.14	0.00	259.80
200-C4-C	1,701.14	36.42	172.52	160.87	9.94	0.00	170.81	37.80	0.00	3.49	0.00	3.49	0.00	212.10
200-C4-D	1,723.24	42.14	194.38	187.26	14.25	0.42	201.93	44.01	0.84	2.76	4.94	7.70	85.92	340.40
200-C7-A	1,656.94	35.09	163.12	149.83	11.89	0.06	161.78	35.21	0.39	0.00	0.00	0.00	132.11	329.49
200-C7-B	2,414.68	38.54	160.18	141.52	7.81	0.18	149.51	33.26	0.28	4.71	9.84	14.55	78.36	275.96
200-C7-C	1,699.36	35.11	159.18	144.86	11.57	0.00	156.43	34.04	0.00	4.71	4.38	9.09	0.00	199.56
200-C7-D	1,427.94	25.85	118.32	102.70	13.67	0.00	116.37	24.13	0.00	4.16	0.00	4.16	0.00	144.66
200-C8-A	1,914.22	43.49	219.55	187.65	10.07	0.13	197.85	44.10	0.54	4.18	2.77	6.95	132.11	381.55
200-C8-B	2,378.40	47.33	235.77	203.29	12.30	0.00	215.59	47.77	0.00	5.25	3.82	9.07	0.00	272.43
200-C8-C	2,894.78	55.59	249.38	224.79	13.67	0.00	238.46	52.83	0.00	7.39	2.20	9.59	0.00	300.88
200-C8-D	2,792.20	64.78	326.38	281.17	18.46	0.20	299.83	66.07	0.40	2.98	0.90	3.88	85.71	455.89
200-C9-A	977.90	32.23	222.42	173.41	16.41	0.13	189.95	40.75	0.29	3.55	2.17	5.72	132.11	368.82
200-C9-B	1,442.08	36.48	189.91	166.99	9.45	0.16	176.60	39.24	0.44	7.48	2.97	10.45	65.49	292.22
200-C9-C	1,656.94	36.71	189.57	161.92	7.56	0.00	169.48	38.05	0.00	5.14	5.04	10.18	0.00	217.71
200-C9-D	2,046.86	54.88	399.22	279.46	13.49	0.00	292.95	65.67	0.00	3.32	2.04	5.36	0.00	363.98
201-C0-A	147.68	30.30	274.48	201.15	7.50	0.17	208.82	47.27	3.02	2.50	2.04	4.54	0.00	263.65
201-C0-B	114.06	15.10	141.93	94.49	5.62	0.00	100.11	22.21	0.00	2.27	5.90	8.17	0.00	130.49
201-C0-C	63.68	7.09	46.09	38.32	5.63	0.00	43.95	7.86	0.00	1.50	3.50	5.00	0.00	56.81
201-C0-D	129.98	13.40	108.25	76.01	7.49	0.17	83.67	17.86	4.62	2.50	2.04	4.54	0.00	110.69
201-C1-A	316.52	25.13	168.49	136.21	0.00	0.13	136.34	32.01	0.91	0.00	0.00	0.00	34.27	203.53
201-C1-B	610.08	20.27	100.75	93.73	4.11	0.00	97.84	22.03	0.00	0.00	0.00	0.00	0.00	119.87
201-C1-C	411.14	48.07	485.46	337.43	13.09	0.39	350.91	79.30	1.74	0.00	0.00	0.00	40.24	472.19
201-C1-D	610.08	26.21	184.77	141.06	13.09	0.00	154.15	33.15	0.00	0.00	6.59	6.59	0.00	193.89
201-C2-A	1,778.96	46.58	216.90	203.24	13.09	0.16	216.49	47.76	2.47	0.00	6.35	6.35	20.53	293.60

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
201-C2-B	1,710.88	37.20	169.14	152.41	9.35	0.00	161.76	35.82	0.00	0.00	5.73	5.73	0.00	203.31
201-C2-C	1,365.16	35.94	176.19	161.38	9.35	0.00	170.73	37.92	0.00	0.00	9.08	9.08	0.00	217.73
201-C2-D	1,510.16	30.86	139.34	125.21	5.61	0.23	131.05	29.42	1.39	0.00	6.45	6.45	59.25	227.56
201-C3-A	3,204.22	55.60	272.80	235.63	11.89	0.19	247.71	55.37	0.40	5.59	0.36	5.95	74.22	383.65
201-C3-B	2,762.14	54.61	261.50	237.20	8.06	0.00	245.26	55.74	0.00	1.87	6.54	8.41	0.00	309.41
201-C3-C	3,021.20	62.60	317.24	273.18	9.76	0.00	282.94	64.20	0.00	1.44	3.20	4.64	0.00	351.78
201-C3-D	1,805.46	40.09	188.55	177.77	13.35	0.16	191.28	41.78	0.28	0.00	0.00	0.00	65.60	298.94
201-C4-A	1,877.98	47.60	257.99	217.54	9.91	0.41	227.86	51.12	0.67	2.30	5.65	7.95	91.17	378.77
201-C4-B	1,952.24	48.16	237.78	209.68	13.67	0.00	223.35	49.27	0.00	3.28	12.80	16.08	0.00	288.70
201-C4-C	2,114.94	43.67	214.40	189.24	19.28	0.00	208.52	44.47	0.00	4.20	7.72	11.92	0.00	264.91
201-C4-D	1,976.12	47.47	244.94	213.86	17.35	0.31	231.52	50.26	0.81	4.20	9.36	13.56	91.62	387.77
201-C5-A	1,183.02	26.34	160.87	123.81	11.71	0.11	135.63	29.10	0.41	10.35	0.00	10.35	47.04	222.53
201-C5-B	2,129.08	42.90	235.36	196.54	17.16	0.00	213.70	46.19	0.00	1.92	21.15	23.07	0.00	282.96
201-C5-C	2,804.60	37.26	166.91	140.59	13.87	0.00	154.46	33.04	0.00	11.66	5.97	17.63	0.00	205.13
201-C5-D	1,855.88	38.44	202.99	166.75	19.52	0.20	186.47	39.19	0.21	1.65	3.27	4.92	40.01	270.80
210-C2-A	1,265.25	23.54	104.82	89.43	4.86	0.51	94.80	21.02	2.82	9.76	1.49	11.25	0.00	129.89
210-C2-B	1,058.35	27.12	107.72	103.65	9.91	0.00	113.56	24.36	0.00	1.38	5.90	7.28	0.00	145.20
210-C2-C	1,034.48	22.70	93.21	86.02	13.46	0.00	99.48	20.21	0.00	4.77	3.50	8.27	0.00	127.96
210-C2-D	350.13	15.37	76.57	70.15	6.55	0.00	76.70	16.49	0.00	0.00	3.50	3.50	0.00	96.69
210-C2-E	2,045.09	32.58	116.55	113.25	7.48	0.00	120.73	26.61	0.00	2.47	1.49	3.96	0.00	151.30
210-C2-F	2,299.74	17.06	55.41	44.35	16.08	0.00	60.43	9.09	0.00	4.91	3.50	8.41	0.00	77.93
211-C0-A	415.54	12.63	59.45	52.81	0.00	0.02	52.83	10.83	0.13	1.57	0.00	1.57	0.00	65.36
211-C0-B	243.10	7.32	23.77	26.75	7.48	0.00	34.23	5.48	0.00	0.00	0.00	0.00	0.00	39.71
211-C0-C	521.68	14.02	72.95	61.83	5.61	0.00	67.44	12.68	0.00	0.00	0.00	0.00	0.00	80.12
211-C0-D	120.24	7.54	49.71	39.13	28.05	0.00	67.18	8.02	0.00	0.00	46.49	46.49	0.00	121.69
211-C1-A	884.22	33.83	189.43	163.92	13.09	0.10	177.11	38.52	2.18	0.00	22.82	22.82	40.64	281.27

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
211-C1-B	1,137.94	34.09	165.80	149.78	13.09	0.00	162.87	35.20	0.00	0.00	5.11	5.11	0.00	203.18
211-C1-C	1,180.36	37.35	191.79	176.02	16.83	0.00	192.85	41.36	0.00	0.00	12.57	12.57	0.00	246.78
211-C1-D	724.14	30.38	152.00	139.62	11.22	1.68	152.52	32.81	2.12	0.00	9.47	9.47	13.75	210.67
211-C11-A	1,796.66	49.58	239.46	217.50	13.09	0.15	230.74	51.11	2.19	0.00	10.86	10.86	37.85	332.75
211-C11-B	1,656.06	46.72	217.60	195.55	9.35	0.00	204.90	45.95	0.00	0.00	2.25	2.25	0.00	253.10
211-C11-C	2,045.98	52.65	240.56	224.58	9.35	0.00	233.93	52.78	0.00	3.82	7.82	11.64	0.00	298.35
211-C11-D	2,060.12	46.53	221.08	202.95	9.35	0.32	212.62	47.69	1.64	5.11	3.90	9.01	42.87	313.83
211-C2-A	1,919.52	48.47	219.84	200.31	9.35	0.23	209.89	47.07	1.70	0.00	8.71	8.71	64.86	332.23
211-C2-B	2,082.22	51.60	240.12	221.02	9.35	0.00	230.37	51.94	0.00	0.00	1.10	1.10	0.00	283.41
211-C2-C	1,877.10	49.66	235.09	215.07	7.48	0.00	222.55	50.54	0.00	0.00	2.69	2.69	0.00	275.78
211-C2-D	1,885.06	49.31	241.84	219.67	7.48	0.30	227.45	51.62	1.55	0.00	7.98	7.98	47.18	335.78
211-C3-A	2,039.80	46.38	218.75	196.88	13.09	0.32	210.29	46.27	1.75	0.00	3.02	3.02	74.92	336.25
211-C3-B	1,837.30	40.70	183.70	166.70	9.35	0.00	176.05	39.17	0.00	0.00	6.22	6.22	0.00	221.44
211-C3-C	2,472.14	46.34	204.57	182.39	14.96	0.00	197.35	42.86	0.00	7.73	14.75	22.48	0.00	262.69
211-C3-D	2,252.88	50.63	239.69	214.05	9.35	0.11	223.51	50.30	1.32	2.26	6.40	8.66	61.49	345.28
211-C4-A	1,955.80	37.38	177.72	151.06	9.35	0.14	160.55	35.50	4.78	0.00	8.30	8.30	23.02	232.15
211-C4-B	2,530.48	50.11	224.98	202.01	13.09	0.00	215.10	47.47	0.00	0.00	1.33	1.33	0.00	263.90
211-C4-C	2,066.30	43.20	195.27	173.55	11.22	0.00	184.77	40.78	0.00	1.84	3.27	5.11	0.00	230.66
211-C4-D	1,929.26	50.19	241.06	220.04	5.61	0.29	225.94	51.71	1.59	0.00	6.32	6.32	32.82	318.38
211_4_A	3,517.25	25.20	81.87	70.64	3.74	0.40	74.78	16.60	2.40	2.27	0.00	2.27	0.00	96.05
211_4_B	2,586.21	26.76	94.43	79.43	13.09	0.00	92.52	18.67	0.00	3.74	0.00	3.74	0.00	114.93
211_4_C	2,618.04	19.29	62.61	53.81	15.33	0.00	69.14	11.03	0.00	0.00	1.98	1.98	0.00	82.15
211_4_D	1,734.75	18.88	73.28	62.98	11.03	0.17	74.18	14.80	4.62	0.82	0.00	0.82	0.00	94.42
211_4_E	127.32	1.46	4.75	3.79	7.48	0.17	11.44	0.78	4.62	15.74	0.00	15.74	0.00	32.58
211_4_F	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.00	3.02	2.45	2.04	4.49	0.00	7.68
214_5_A	2,196.29	22.57	88.95	73.13	17.95	0.17	91.25	17.19	3.02	9.98	0.95	10.93	0.00	122.39

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
214_5_B	1,663.13	28.75	128.83	110.77	8.98	0.00	119.75	26.03	0.00	2.26	1.23	3.49	0.00	149.27
214_5_C	2,331.57	21.96	79.63	68.07	19.64	0.00	87.71	16.00	0.00	9.89	3.50	13.39	0.00	117.10
214_5_D	1,002.65	37.86	206.02	179.25	25.43	0.17	204.85	42.12	4.62	0.54	0.51	1.05	0.00	252.64
214_5_E	1,026.52	42.05	206.88	195.54	11.59	0.17	207.30	45.95	4.62	3.61	2.04	5.65	0.00	263.52
214_5_F	1,225.46	44.52	226.91	215.90	8.98	0.17	225.05	50.74	4.62	15.04	2.04	17.08	0.00	297.49
216-C1-A	445.62	13.27	61.03	57.95	5.61	0.17	63.73	11.88	3.02	10.57	20.35	30.92	0.00	109.55
216-C1-B	509.28	11.47	37.34	39.31	3.74	0.00	43.05	8.06	0.00	2.44	29.75	32.19	0.00	83.30
216-C1-C	986.73	24.42	110.28	100.62	9.35	0.00	109.97	23.65	0.00	1.52	2.06	3.58	0.00	137.20
216-C1-D	827.58	18.20	68.35	65.26	3.74	0.17	69.17	15.34	4.62	9.98	0.00	9.98	0.00	99.11
216-C1-E	63.66	0.70	2.27	1.74	3.74	0.17	5.65	0.36	0.00	4.62	5.04	9.66	0.00	15.67
216-C1-F	636.60	20.86	83.49	86.01	3.74	0.17	89.92	20.21	4.62	0.00	0.00	0.00	0.00	114.75
216-C2-A	1,265.25	33.00	155.80	143.59	11.41	0.66	155.66	33.74	3.29	0.00	0.00	0.00	0.00	192.69
216-C2-B	1,559.68	34.03	150.68	141.80	14.21	0.00	156.01	33.32	0.00	3.55	0.00	3.55	0.00	192.88
216-C2-C	2,379.31	28.77	101.82	85.12	25.06	0.00	110.18	20.00	0.00	1.08	0.00	1.08	0.00	131.26
216-C2-D	3,366.05	50.37	251.44	198.15	17.95	0.00	216.10	46.57	0.00	0.61	0.00	0.61	0.00	263.28
216-C2-E	2,180.37	24.83	80.69	74.28	12.72	0.00	87.00	17.46	0.00	0.91	0.00	0.91	0.00	105.37
216-C2-F	1,830.24	17.46	56.76	53.37	12.53	0.00	65.90	10.94	0.00	0.00	0.00	0.00	0.00	76.84
217-C1-A	1,392.57	21.21	77.19	73.16	7.85	0.31	81.32	17.19	2.93	2.09	0.00	2.09	0.00	103.53
217-C1-B	1,106.10	28.13	139.61	120.62	9.91	0.00	130.53	28.35	0.00	3.62	0.00	3.62	0.00	162.50
217-C1-C	2,116.71	61.04	464.85	337.54	13.46	0.00	351.00	79.32	0.00	7.75	0.00	7.75	0.00	438.07
217-C1-D	1,472.15	10.07	32.75	24.12	29.92	0.00	54.04	4.94	0.00	14.67	0.00	14.67	0.00	73.65
217-C1-E	1,933.69	21.87	84.06	77.49	11.78	0.00	89.27	18.21	0.00	0.00	0.00	0.00	0.00	107.48
217-C1-F	2,586.21	38.71	185.25	160.03	4.86	0.01	164.90	37.61	0.04	0.00	0.00	0.00	0.00	202.55
217-C10-A	1,464.19	16.95	55.03	52.34	3.74	0.17	56.25	10.73	4.62	3.13	9.05	12.18	0.00	83.78
217-C10-B	1,488.06	32.01	142.37	125.56	11.78	0.17	137.51	29.51	3.02	2.07	9.97	12.04	0.00	182.08
217-C10-C	1,241.38	12.05	39.17	38.18	15.52	0.00	53.70	7.83	0.00	0.07	25.89	25.96	0.00	87.49

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
217-C10-D	740.05	18.22	86.10	77.19	12.34	0.00	89.53	18.14	0.00	0.86	14.05	14.91	0.00	122.58
217-C10-E	1,201.59	21.23	78.20	75.26	13.46	0.17	88.89	17.69	4.62	22.71	20.35	43.06	0.00	154.26
217-C10-F	1,862.07	22.00	86.78	73.85	10.85	0.17	84.87	17.35	4.62	0.90	20.35	21.25	0.00	128.09
217-C2-A	1,877.99	20.65	91.22	75.28	13.84	0.06	89.18	17.69	0.65	0.00	0.58	0.58	0.00	108.10
217-C2-B	2,204.25	19.18	73.94	60.71	16.46	0.00	77.17	12.45	0.00	0.51	0.00	0.51	0.00	90.13
217-C2-C	2,626.00	31.40	134.42	117.98	26.37	0.00	144.35	27.73	0.00	1.70	0.00	1.70	0.00	173.78
217-C2-D	1,392.57	18.25	68.69	61.94	10.85	0.00	72.79	12.70	0.00	0.00	0.00	0.00	0.00	85.49
217-C2-E	2,387.27	25.01	81.25	76.22	6.92	0.00	83.14	17.91	0.00	0.00	0.00	0.00	0.00	101.05
217-C2-F	2,188.33	29.15	121.62	103.65	14.59	0.00	118.24	24.36	0.00	0.00	0.00	0.00	0.00	142.60
217-C3-A	2,045.10	15.77	63.94	52.84	5.61	0.17	58.62	10.83	3.02	3.64	9.05	12.69	0.00	85.16
217-C3-B	907.16	21.53	100.72	95.46	3.74	0.00	99.20	22.43	0.00	2.30	14.95	17.25	0.00	138.88
217-C3-C	1,145.89	15.06	65.48	54.77	9.35	0.00	64.12	11.23	0.00	1.12	0.00	1.12	0.00	76.47
217-C3-D	907.16	20.42	96.16	81.39	3.74	0.17	85.30	19.13	4.62	1.74	2.54	4.28	0.00	113.33
217-C3-E	1,002.65	29.34	141.25	125.33	3.74	0.17	129.24	29.45	4.62	6.64	20.35	26.99	0.00	190.30
217-C3-F	1,185.68	6.00	19.45	13.91	3.74	0.17	17.82	2.85	4.62	3.27	10.16	13.43	0.00	38.72
217-C4-A	946.95	9.56	31.07	28.09	7.11	0.17	35.37	5.76	3.02	8.93	18.37	27.30	0.00	71.45
217-C4-B	1,464.19	25.83	125.20	115.98	12.90	0.00	128.88	27.26	0.00	11.03	39.33	50.36	0.00	206.50
217-C4-C	946.95	16.43	82.27	73.03	9.35	0.00	82.38	17.16	0.00	5.96	36.94	42.90	0.00	142.44
217-C4-D	931.03	54.56	511.05	343.98	3.74	0.17	347.89	80.84	4.62	0.97	5.09	6.06	0.00	439.41
217-C4-E	843.50	12.57	56.39	43.68	5.05	0.17	48.90	8.95	4.62	11.23	8.34	19.57	0.00	82.04
217-C4-F	1,734.75	15.95	51.82	47.04	4.86	0.17	52.07	9.64	4.62	9.98	50.17	60.15	0.00	126.48
217-C5-A	3,230.78	23.00	85.60	67.11	11.03	0.15	78.29	15.77	0.00	0.60	1.15	1.75	0.00	95.81
217-C5-B	1,599.47	17.46	69.08	57.77	17.39	0.00	75.16	11.84	0.00	1.96	0.16	2.12	0.00	89.12
217-C5-C	1,320.95	32.74	148.64	141.75	9.35	0.00	151.10	33.31	0.00	2.24	0.00	2.24	0.00	186.65
217-C5-D	1,726.79	35.28	266.87	177.06	20.94	0.00	198.00	41.61	0.00	2.84	0.00	2.84	0.00	242.45
217-C5-E	2,283.82	37.75	156.84	145.27	4.68	0.00	149.95	34.14	0.00	1.98	0.69	2.67	0.00	186.76

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
217-C5-F	1,265.25	39.93	217.26	187.25	9.91	0.00	197.16	44.00	0.00	4.38	1.41	5.79	0.00	246.95
217_C6_A	2,753.32	25.89	92.41	81.31	7.85	0.31	89.47	19.11	2.93	2.09	0.00	2.09	0.00	113.60
217_C6_B	2,076.92	28.66	103.05	97.22	9.91	0.00	107.13	22.85	0.00	3.62	0.00	3.62	0.00	133.60
217_C6_C	1,599.47	27.65	128.87	104.18	13.46	0.00	117.64	24.48	0.00	7.75	0.00	7.75	0.00	149.87
217_C6_D	453.58	10.82	43.51	41.85	29.92	0.00	71.77	8.58	0.00	14.67	0.00	14.67	0.00	95.02
217_C6_E	1,137.93	14.07	53.20	44.63	11.78	0.00	56.41	9.15	0.00	0.00	0.00	0.00	0.00	65.56
217_C6_F	1,050.40	9.33	30.32	26.50	4.86	0.01	31.37	5.43	0.04	0.00	0.00	0.00	0.00	36.84
217_C7_A	954.90	52.84	483.30	326.73	14.77	0.09	341.59	76.78	1.45	9.98	20.35	30.33	0.00	450.15
217_C7_B	668.43	13.85	45.00	45.93	3.74	0.00	49.67	9.42	0.00	1.95	55.56	57.51	0.00	116.60
217_C7_C	286.47	3.91	12.72	10.92	9.35	0.00	20.27	2.24	0.00	0.00	0.00	0.00	0.00	22.51
217_C7_D	445.62	8.43	35.17	28.75	3.74	0.17	32.66	5.89	4.62	0.00	0.00	0.00	0.00	43.17
217_C7_E	413.79	5.65	18.42	15.90	3.74	0.17	19.81	3.26	4.62	0.00	0.00	0.00	0.00	27.69
217_C7_F	541.11	16.45	63.20	63.86	3.74	0.17	67.77	15.01	4.62	0.38	15.78	16.16	0.00	103.56
217_C8_A	3,716.19	39.62	199.56	151.44	12.16	4.42	168.02	35.59	6.66	1.94	2.46	4.40	0.00	214.67
217_C8_B	2,530.51	18.92	61.46	49.90	7.48	0.00	57.38	10.23	0.00	1.78	5.90	7.68	0.00	75.29
217_C8_C	2,005.31	15.47	50.28	45.97	11.59	0.00	57.56	9.42	0.00	9.24	3.50	12.74	0.00	79.72
217_C8_D	1,535.81	18.89	70.28	65.74	7.67	0.17	73.58	15.45	4.62	9.98	2.04	12.02	0.00	105.67
217_C8_E	1,798.41	32.00	178.79	141.84	9.91	0.17	151.92	33.33	4.62	1.49	0.51	2.00	0.00	191.87
217_C8_F	1,631.30	23.98	105.66	87.61	18.33	0.17	106.11	20.59	4.62	34.68	8.14	42.82	0.00	174.14
254-C1-A	865.62	13.38	64.03	53.82	10.07	0.00	63.89	11.03	0.00	0.00	4.38	4.38	0.00	79.30
254-C1-B	82.22	5.46	25.83	26.76	5.62	0.00	32.38	5.49	3.04	0.00	0.00	0.00	0.00	40.91
254-C1-C	814.36	25.98	149.23	128.55	22.00	0.00	150.55	30.21	2.69	0.00	0.00	0.00	0.00	183.45
254-C1-D	636.58	18.42	93.25	80.55	3.21	0.00	83.76	18.93	0.00	0.00	0.00	0.00	0.00	102.69
254-C10-A	541.96	22.09	135.17	106.36	3.96	0.00	110.32	24.99	0.00	2.55	0.27	2.82	0.00	138.13
254-C10-B	709.02	22.19	81.07	84.67	7.52	0.00	92.19	19.90	0.00	6.02	0.00	6.02	0.00	118.11
254-C10-C	664.86	19.93	77.23	81.61	7.83	0.00	89.44	19.18	1.31	0.00	0.00	0.00	0.00	109.93

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
254-C10-D	1,132.60	21.46	95.95	86.91	25.68	0.00	112.59	20.42	1.49	0.58	1.10	1.68	0.00	136.18
254-C11-A	1,221.04	17.66	87.58	76.96	6.54	0.00	83.50	18.09	2.09	0.00	0.00	0.00	0.00	103.68
254-C11-B	501.28	28.71	162.14	137.48	0.00	0.00	137.48	32.31	5.39	0.00	3.19	3.19	0.00	178.37
254-C11-C	284.68	17.72	115.77	89.70	6.54	0.00	96.24	21.08	0.00	2.41	4.87	7.28	0.00	124.60
254-C11-D	680.82	7.93	37.86	32.21	2.42	0.00	34.63	6.60	0.00	1.82	0.00	1.82	0.00	43.05
254-C2-A	2,406.72	25.69	106.61	88.90	10.54	0.00	99.44	20.89	2.52	2.27	0.00	2.27	0.00	125.12
254-C2-B	641.88	31.68	174.04	155.18	26.52	0.00	181.70	36.47	2.57	0.00	0.00	0.00	0.00	220.74
254-C2-C	1,175.92	38.36	183.95	166.57	5.59	0.00	172.16	39.14	0.00	2.37	0.00	2.37	0.00	213.67
254-C2-D	903.64	17.75	103.28	82.39	12.60	0.00	94.99	19.36	0.00	0.00	0.00	0.00	0.00	114.35
254-C3-A	502.20	9.79	37.39	34.94	5.01	0.00	39.95	7.16	0.00	0.00	0.00	0.00	0.00	47.11
254-C3-B	1,273.16	32.99	143.94	142.18	20.51	0.00	162.69	33.41	0.00	1.58	0.00	1.58	0.00	197.68
254-C3-C	717.02	16.11	64.70	65.65	31.42	0.00	97.07	15.43	2.88	1.15	0.00	1.15	0.00	116.53
254-C3-D	546.40	6.32	24.53	20.23	0.00	0.00	20.23	4.15	2.12	3.45	0.00	3.45	0.00	29.95
254-C4-A	30.06	1.37	7.13	6.05	9.13	0.00	15.18	1.24	0.00	0.00	0.00	0.00	0.00	16.42
254-C4-B	98.14	7.23	40.88	37.88	23.57	0.00	61.45	7.77	3.44	0.00	0.00	0.00	0.00	72.66
254-C4-C	1,580.90	20.13	87.84	75.13	7.58	0.00	82.71	17.66	2.22	0.00	0.00	0.00	0.00	102.59
254-C4-D	1,267.02	26.40	127.20	118.38	8.92	0.00	127.30	27.82	0.00	2.80	0.00	2.80	0.00	157.92
254-C5-A	464.14	10.05	32.69	33.11	20.60	0.00	53.71	6.79	0.00	2.98	0.00	2.98	0.00	63.48
254-C5-B	312.96	13.47	59.05	56.82	15.26	0.00	72.08	11.65	0.00	8.06	0.00	8.06	0.00	91.79
254-C5-C	158.26	17.00	152.02	104.72	23.72	0.00	128.44	24.61	0.73	0.00	0.00	0.00	0.00	153.78
254-C5-D	718.80	21.08	86.13	84.25	10.86	0.00	95.11	19.80	1.58	10.09	0.00	10.09	0.00	126.58
254-C6-A	664.90	5.95	28.13	21.96	7.81	0.00	29.77	4.50	0.00	0.00	0.00	0.00	0.00	34.27
254-C6-B	174.18	11.65	60.04	55.20	21.98	0.00	77.18	11.32	2.54	5.62	0.00	5.62	0.00	96.66
254-C6-C	68.08	4.10	20.43	18.59	0.00	0.00	18.59	3.81	2.72	2.94	0.00	2.94	0.00	28.06
254-C6-D	755.08	15.22	68.86	62.03	3.74	0.00	65.77	12.72	0.00	0.00	1.98	1.98	0.00	80.47
254-C7-A	387.22	26.86	169.44	141.15	16.91	0.00	158.06	33.17	1.37	0.00	0.00	0.00	0.00	192.60

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
254-C7-B	148.52	4.94	20.28	19.00	0.00	0.00	19.00	3.89	0.00	0.00	0.00	0.00	0.00	22.89
254-C7-C	911.56	25.53	120.00	112.25	2.45	0.00	114.70	26.38	2.18	2.28	0.00	2.28	0.00	145.54
254-C7-D	333.28	14.67	53.88	61.09	15.98	0.00	77.07	12.52	0.00	0.00	0.00	0.00	0.00	89.59
254-C8-A	1,359.82	17.86	73.21	68.38	24.34	0.00	92.72	16.07	2.34	1.98	0.00	1.98	0.00	113.11
254-C8-B	672.86	12.48	57.05	49.38	7.48	0.00	56.86	10.12	1.42	1.68	0.00	1.68	0.00	70.08
254-C8-C	259.06	5.11	21.73	18.35	0.00	0.00	18.35	3.76	0.00	0.00	0.00	0.00	0.00	22.11
254-C8-D	706.44	28.90	189.64	147.57	2.21	0.00	149.78	34.68	0.00	10.60	0.00	10.60	0.00	195.06
254-C9-A	552.58	11.23	36.50	38.03	0.00	0.00	38.03	7.80	0.00	0.00	0.00	0.00	0.00	45.83
254-C9-B	862.06	8.66	28.17	23.72	0.00	0.00	23.72	4.86	0.00	0.00	0.00	0.00	0.00	28.58
254-C9-C	957.50	33.74	153.03	152.05	6.00	0.00	158.05	35.73	1.32	6.34	0.00	6.34	0.00	201.44
254-C9-D	638.28	31.77	125.76	138.79	15.17	0.00	153.96	32.62	2.32	0.00	0.00	0.00	0.00	188.90
258-C1-A	2,014.10	43.36	197.46	176.08	11.22	0.00	187.30	41.38	4.11	1.38	0.00	1.38	0.00	234.17
258-C1-B	1,426.16	22.08	105.38	87.49	16.36	0.00	103.85	20.56	0.00	2.40	3.29	5.69	0.00	130.10
258-C1-C	785.14	20.37	129.62	97.06	3.90	0.00	100.96	22.81	2.78	1.18	0.82	2.00	0.00	128.55
258-C1-D	1,389.88	32.89	133.13	131.47	1.93	0.00	133.40	30.90	0.00	4.22	0.00	4.22	0.00	168.52
258-C10-A	805.46	20.59	149.31	102.21	13.70	0.00	115.91	24.02	0.00	0.00	0.39	0.39	0.00	140.32
258-C10-B	2,842.62	29.68	129.00	104.70	21.34	0.00	126.04	24.60	2.67	1.02	0.94	1.96	0.00	155.27
258-C10-C	148.52	8.72	65.33	46.25	0.00	0.00	46.25	9.48	1.17	0.00	0.00	0.00	0.00	56.90
258-C10-D	3,230.72	37.24	141.34	124.92	4.83	0.00	129.75	29.36	0.00	0.00	0.00	0.00	0.00	159.11
258-C11-A	150.30	8.45	42.71	39.50	0.00	0.00	39.50	8.10	3.62	0.00	0.00	0.00	0.00	51.22
258-C11-B	957.54	25.94	123.07	112.04	2.05	0.00	114.09	26.33	0.00	0.00	0.00	0.00	0.00	140.42
258-C11-C	379.30	12.88	55.99	53.66	8.06	0.00	61.72	11.00	0.00	0.17	0.00	0.17	0.00	72.89
258-C11-D	7.96	1.31	8.49	7.55	0.00	0.00	7.55	1.55	4.32	0.00	0.00	0.00	0.00	13.42
258-C2-A	389.04	18.82	120.28	99.83	3.35	0.00	103.18	23.46	2.33	0.00	0.00	0.00	0.00	128.97
258-C2-B	1,230.78	24.71	157.25	118.26	25.11	0.00	143.37	27.79	1.04	3.23	0.00	3.23	0.00	175.43
258-C2-C	376.64	26.80	148.62	136.02	11.97	0.00	147.99	31.96	0.00	4.47	0.00	4.47	0.00	184.42

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
258-C2-D	608.26	28.82	203.77	159.47	13.09	0.00	172.56	37.48	0.00	3.77	0.54	4.31	0.00	214.35
258-C3-A	2,394.32	45.32	235.93	182.04	11.28	0.01	193.33	42.78	0.61	4.63	0.00	4.63	0.00	241.35
258-C3-B	1,208.64	30.65	153.25	134.77	15.83	0.00	150.60	31.67	0.46	0.00	0.00	0.00	0.00	182.73
258-C3-C	1,078.70	15.59	67.28	56.09	12.09	0.00	68.18	11.50	0.00	0.00	0.00	0.00	0.00	79.68
258-C3-D	1,773.66	25.72	114.31	96.18	15.54	0.00	111.72	22.60	0.00	11.78	0.00	11.78	0.00	146.10
258-C4-A	1,788.66	47.36	219.63	196.86	16.93	0.00	213.79	46.26	1.17	7.38	0.82	8.20	0.00	269.42
258-C4-B	4,793.96	59.84	223.96	192.11	6.32	0.00	198.43	45.15	0.98	0.00	0.00	0.00	0.00	244.56
258-C4-C	2,266.12	37.12	180.79	147.41	15.17	0.00	162.58	34.64	0.00	1.05	0.00	1.05	0.00	198.27
258-C4-D	973.46	29.07	151.38	133.69	10.53	0.00	144.22	31.42	0.00	5.41	1.95	7.36	0.00	183.00
258-C5-A	608.30	21.76	137.02	106.03	13.20	0.00	119.23	24.92	0.00	4.23	0.49	4.72	0.00	148.87
258-C5-B	1,751.48	39.61	171.56	149.20	5.62	0.00	154.82	35.06	0.82	1.96	0.00	1.96	0.00	192.66
258-C5-C	1,322.66	50.90	259.04	225.90	6.69	0.04	232.63	53.09	1.20	1.10	1.93	3.03	0.00	289.95
258-C5-D	3,183.90	51.31	225.37	193.37	22.53	0.00	215.90	45.44	0.00	27.39	1.13	28.52	0.00	289.86
258-C6-A	1,448.22	31.07	123.01	118.06	4.25	0.06	122.37	27.74	1.64	0.00	2.08	2.08	0.00	153.83
258-C6-B	526.08	12.38	55.58	49.98	0.00	0.00	49.98	10.25	0.00	0.00	0.00	0.00	0.00	60.23
258-C6-C	740.94	26.62	205.26	150.88	3.82	0.00	154.70	35.46	1.33	8.20	4.92	13.12	0.00	204.61
258-C6-D	2,236.96	52.78	312.67	245.21	8.79	0.00	254.00	57.62	0.00	1.90	3.69	5.59	0.00	317.21
258-C7-A	662.24	23.46	111.66	103.93	0.00	0.00	103.93	24.42	3.17	2.24	0.00	2.24	0.00	133.76
258-C7-B	284.68	19.51	99.40	98.79	12.30	0.23	111.32	23.22	0.94	32.32	0.00	32.32	0.00	167.80
258-C7-C	937.22	32.50	171.85	148.85	31.36	0.00	180.21	34.98	0.00	25.20	0.00	25.20	0.00	240.39
258-C7-D	318.30	31.53	186.85	175.53	26.29	0.00	201.82	41.25	0.00	58.40	0.00	58.40	0.00	301.47
258-C8-A	1,568.54	29.11	152.63	127.78	26.99	0.00	154.77	30.03	0.00	0.00	0.00	0.00	0.00	184.80
258-C8-B	4,609.12	54.31	201.61	182.33	5.08	0.00	187.41	42.85	1.46	3.60	1.10	4.70	0.00	236.42
258-C8-C	5,786.00	87.84	357.88	307.81	3.74	0.04	311.59	72.34	1.21	1.54	0.27	1.81	0.00	386.95
258-C8-D	2,735.64	35.05	160.67	137.06	5.80	0.00	142.86	32.21	0.00	8.75	5.03	13.78	0.00	188.85
258-C9-A	1,944.24	47.68	213.84	199.70	0.00	0.02	199.72	46.93	1.68	15.84	0.00	15.84	0.00	264.17

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
258-C9-B	1,321.80	26.77	102.20	97.65	9.72	0.00	107.37	22.95	0.00	0.00	0.00	0.00	0.00	130.32
258-C9-C	1,793.98	27.78	148.51	115.66	4.64	0.00	120.30	27.18	1.29	0.00	0.00	0.00	0.00	148.77
258-C9-D	3,672.84	41.09	153.72	133.94	7.49	0.00	141.43	31.48	0.00	1.49	1.10	2.59	0.00	175.50
259-C1-A	4,480.00	80.61	346.07	305.40	12.27	0.17	317.84	71.77	3.02	10.41	3.79	14.20	0.00	406.83
259-C1-B	938.06	22.00	79.77	79.89	0.00	0.00	79.89	18.77	0.00	0.90	0.00	0.90	0.00	99.56
259-C1-C	3,742.66	65.73	260.15	228.58	25.09	0.00	253.67	53.72	0.00	4.95	2.38	7.33	0.00	314.72
259-C1-D	5,938.00	131.92	606.38	518.72	21.04	0.17	539.93	121.90	4.62	0.66	0.51	1.17	0.00	667.62
259-C11-A	1,836.40	29.46	106.81	98.41	28.74	0.00	127.15	23.13	0.00	0.00	0.00	0.00	0.00	150.28
259-C11-B	2,286.44	29.72	131.88	112.36	25.02	0.00	137.38	26.40	0.00	37.84	0.00	37.84	46.90	248.52
259-C11-C	1,847.04	62.45	407.22	339.64	28.37	0.00	368.01	79.82	0.00	4.15	0.00	4.15	71.50	523.48
259-C11-D	2,762.14	46.64	198.76	172.36	9.06	0.00	181.42	40.50	0.00	1.68	5.77	7.45	0.00	229.37
259-C2-A	7,932.64	118.04	405.04	385.94	15.26	0.17	401.37	90.70	3.02	1.80	0.00	1.80	0.00	496.89
259-C2-B	3,540.12	63.48	262.74	233.54	13.09	0.00	246.63	54.88	0.00	6.79	0.00	6.79	0.00	308.30
259-C2-C	5,517.16	89.60	354.16	318.18	0.00	0.00	318.18	74.77	0.00	8.60	0.00	8.60	0.00	401.55
259-C2-D	2,691.36	54.00	256.46	218.82	10.90	0.17	229.89	51.42	4.62	0.71	5.42	6.13	0.00	292.06
259-C3-A	3,715.22	52.28	178.17	169.11	8.36	0.00	177.47	39.74	0.38	0.00	0.00	0.00	53.30	270.89
259-C3-B	2,587.92	37.58	131.97	124.73	8.92	0.00	133.65	29.31	0.00	1.36	7.29	8.65	69.70	241.31
259-C3-C	905.38	31.51	188.80	149.69	20.13	0.00	169.82	35.18	0.00	0.00	3.50	3.50	0.00	208.50
259-C3-D	1,691.36	35.97	137.78	133.95	7.07	0.00	141.02	31.48	0.00	1.00	23.91	24.91	0.00	197.41
259-C4-A	2,155.58	38.98	145.54	134.45	14.37	0.00	148.82	31.60	2.27	3.50	0.00	3.50	34.09	220.28
259-C4-B	2,912.48	52.41	281.80	217.37	10.58	0.00	227.95	51.08	0.00	1.60	1.42	3.02	0.00	282.05
259-C4-C	4,265.18	65.90	247.63	227.32	29.68	0.00	257.00	53.42	0.00	3.22	1.35	4.57	167.68	482.67
259-C4-D	1,859.40	40.84	186.91	170.28	7.62	0.00	177.90	40.02	0.00	2.16	3.68	5.84	0.00	223.76
259-C8-A	2,742.70	27.69	98.10	83.34	25.02	0.00	108.36	19.58	0.00	0.00	0.00	0.00	0.00	127.94
259-C8-B	1,518.08	38.17	179.04	169.60	26.34	0.00	195.94	39.86	0.00	5.83	0.00	5.83	76.24	317.87
259-C8-C	3,724.96	65.87	238.89	219.37	30.95	0.00	250.32	51.55	0.00	5.70	0.76	6.46	86.60	394.93

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
259-C8-D	1,911.60	37.22	182.50	159.52	7.25	0.00	166.77	37.49	0.00	0.53	23.91	24.44	0.00	228.70
263-C1-A	3,213.10	11.61	39.44	24.04	6.68	0.17	30.89	4.93	3.02	0.00	2.15	2.15	0.00	40.99
263-C1-B	3,011.50	30.84	136.68	118.04	5.15	0.00	123.19	27.74	0.00	0.00	2.15	2.15	0.00	153.08
263-C1-C	1,580.90	27.56	173.06	127.09	15.27	0.00	142.36	29.87	0.00	1.74	3.50	5.24	0.00	177.47
263-C1-D	1,015.92	23.78	139.35	119.50	15.10	0.17	134.77	28.08	4.62	1.85	2.04	3.89	0.00	171.36
263-C10-A	2,722.30	39.56	143.71	129.26	5.70	0.00	134.96	30.38	1.49	0.99	2.04	3.03	23.36	193.22
263-C10-B	2,165.32	34.47	144.76	126.95	13.38	0.00	140.33	29.83	1.37	0.28	0.00	0.28	21.87	193.68
263-C10-C	815.20	22.34	105.12	97.79	8.00	0.00	105.79	22.98	0.00	1.03	0.00	1.03	0.00	129.80
263-C10-D	3,131.74	45.95	255.68	191.10	15.15	0.00	206.25	44.91	0.00	2.74	0.00	2.74	0.00	253.90
263-C11-A	6,236.92	57.71	200.36	169.39	25.76	0.00	195.15	39.81	3.18	6.60	2.15	8.75	59.82	306.71
263-C11-B	2,291.70	46.47	191.20	174.55	11.10	0.00	185.65	41.02	0.80	0.00	0.00	0.00	22.54	250.01
263-C11-C	1,679.94	55.25	338.08	274.35	24.31	0.00	298.66	64.47	0.00	1.03	1.11	2.14	0.00	365.27
263-C11-D	1,709.10	36.90	213.80	173.00	10.11	0.00	183.11	40.66	0.00	0.00	1.76	1.76	0.00	225.53
263-C2-A	594.16	14.73	75.30	66.83	19.28	0.17	86.28	15.71	3.02	0.54	0.00	0.54	0.00	105.55
263-C2-B	656.94	8.34	34.53	30.42	17.07	0.00	47.49	6.24	0.00	7.64	0.00	7.64	0.00	61.37
263-C2-C	461.52	21.61	162.01	118.63	23.48	0.00	142.11	27.88	0.00	0.00	0.00	0.00	0.00	169.99
263-C2-D	1,525.18	13.28	43.16	36.88	23.38	0.17	60.43	7.56	4.62	1.60	0.00	1.60	0.00	74.21
263-C3-A	52.16	3.23	13.32	14.55	0.00	0.17	14.72	2.98	3.02	0.00	2.15	2.15	0.00	22.87
263-C3-B	15.92	1.39	9.06	6.84	0.00	0.00	6.84	1.40	0.00	4.27	5.90	10.17	0.00	18.41
263-C3-C	7.96	0.58	3.78	2.70	0.00	0.00	2.70	0.55	0.00	22.32	0.00	22.32	0.00	25.57
263-C3-D	753.30	10.08	41.90	40.24	15.98	0.17	56.39	8.25	4.62	0.00	1.49	1.49	0.00	70.75
263-C4-A	3,681.66	78.65	439.42	355.03	17.84	0.17	373.04	83.43	3.02	1.63	2.15	3.78	0.00	463.27
263-C4-B	801.06	23.50	133.62	111.94	13.87	0.00	125.81	26.31	0.00	5.52	5.90	11.42	0.00	163.54
263-C4-C	2,571.12	56.86	232.80	222.75	13.22	0.00	235.97	52.35	0.00	8.46	9.86	18.32	0.00	306.64
263-C4-D	3,565.86	45.46	196.34	160.02	3.27	0.17	163.46	37.60	4.62	2.15	12.87	15.02	0.00	220.70
263-C5-A	3,248.42	49.38	215.85	186.98	13.24	0.17	200.39	43.94	3.02	3.93	0.00	3.93	0.00	251.28

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
263-C5-B	2,709.94	49.20	196.12	182.51	23.95	0.00	206.46	42.89	0.00	6.93	0.00	6.93	0.00	256.28
263-C5-C	3,166.16	54.49	201.10	184.18	30.26	0.00	214.44	43.28	0.00	0.00	0.00	0.00	0.00	257.72
263-C5-D	2,163.56	84.15	486.77	400.10	5.58	0.17	405.85	94.02	4.62	6.83	1.42	8.25	0.00	512.74
263-C6-A	2,669.30	58.90	292.88	249.48	8.54	0.17	258.19	58.63	3.02	6.36	0.36	6.72	0.00	326.56
263-C6-B	2,820.44	46.73	196.70	178.56	4.36	0.00	182.92	41.96	0.00	3.36	1.58	4.94	0.00	229.82
263-C6-C	1,791.32	42.10	183.16	162.47	8.20	0.00	170.67	38.18	0.00	1.72	0.00	1.72	0.00	210.57
263-C6-D	594.16	18.90	102.86	87.25	0.00	0.17	87.42	20.50	4.62	8.59	3.62	12.21	0.00	124.75
263-C7-A	1,078.70	10.05	47.08	37.84	5.84	0.03	43.71	7.76	2.13	3.86	0.00	3.86	41.48	98.94
263-C7-B	1,879.76	36.38	187.21	160.61	18.71	0.00	179.32	37.74	0.99	3.92	0.18	4.10	24.62	246.77
263-C7-C	2,607.40	44.01	182.38	162.52	3.91	0.00	166.43	38.19	0.00	4.55	0.00	4.55	0.00	209.17
263-C7-D	1,990.26	42.60	221.00	185.06	3.72	0.00	188.78	43.49	0.00	11.49	2.04	13.53	0.00	245.80
263-C8-A	8,908.88	89.88	331.14	279.46	11.42	0.03	290.91	65.67	1.47	7.66	0.00	7.66	18.14	383.85
263-C8-B	3,163.50	60.94	255.56	239.27	32.01	0.08	271.36	56.23	1.74	2.09	0.00	2.09	25.16	356.58
263-C8-C	4,928.38	63.92	301.95	233.90	22.46	0.00	256.36	54.97	0.00	0.00	0.00	0.00	0.00	311.33
263-C8-D	439.42	20.54	129.17	102.12	11.74	0.00	113.86	24.00	0.00	0.00	0.00	0.00	0.00	137.86
263-C9-A	5,917.72	97.27	444.14	374.20	3.24	0.11	377.55	87.94	1.03	2.71	2.04	4.75	24.34	495.61
263-C9-B	4,373.90	63.85	254.94	225.90	15.39	0.00	241.29	53.09	2.00	0.00	5.90	5.90	42.97	345.25
263-C9-C	3,417.30	55.71	238.49	212.89	8.39	0.00	221.28	50.03	0.00	2.02	3.50	5.52	0.00	276.83
263-C9-D	5,985.82	67.89	236.39	199.95	15.66	0.00	215.61	46.99	0.00	1.29	2.04	3.33	0.00	265.93
342-C1-A	606.52	10.99	46.33	42.33	7.25	0.92	50.50	8.68	4.37	0.00	0.00	0.00	16.47	80.02
342-C1-B	1,580.86	34.63	135.98	136.97	10.07	0.00	147.04	32.19	0.00	0.00	0.00	0.00	0.00	179.23
342-C1-C	198.06	18.69	105.37	100.20	3.22	0.00	103.42	23.55	0.00	0.00	0.70	0.70	0.00	127.67
342-C1-D	101.70	24.94	250.47	173.92	20.14	0.40	194.46	40.87	3.69	18.77	2.04	20.81	0.00	259.83
342-C10-A	397.00	30.60	257.71	185.28	18.70	0.89	204.87	43.54	3.73	0.00	0.00	0.00	14.29	266.43
342-C10-B	233.46	32.78	261.30	197.00	3.37	0.00	200.37	46.29	0.00	0.00	0.00	0.00	0.00	246.66
342-C10-C	664.02	26.97	159.44	130.65	5.05	0.00	135.70	30.70	0.00	8.19	0.00	8.19	0.00	174.59

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
342-C10-D	974.34	15.37	57.26	53.12	5.61	0.89	59.62	10.89	3.73	31.97	0.00	31.97	0.00	106.21
342-C11-A	1,202.46	45.78	339.11	243.60	9.35	1.92	254.87	57.25	3.59	0.00	0.00	0.00	27.14	342.85
342-C11-B	174.18	9.28	49.27	41.72	18.70	0.00	60.42	8.55	0.00	0.00	0.00	0.00	0.00	68.97
342-C11-C	843.48	19.68	79.53	76.40	5.61	0.00	82.01	17.95	0.00	66.74	0.00	66.74	0.00	166.70
342-C11-D	1,792.20	22.45	80.22	72.30	22.44	0.86	95.60	16.99	5.52	32.73	0.00	32.73	0.00	150.84
342-C2-A	573.84	19.52	111.32	89.94	5.44	1.53	96.91	21.14	4.18	0.00	0.00	0.00	29.91	152.14
342-C2-B	975.24	34.53	185.31	166.17	4.23	0.00	170.40	39.05	0.00	0.00	0.00	0.00	0.00	209.45
342-C2-C	817.86	5.97	19.40	13.79	8.06	0.00	21.85	2.83	0.00	0.00	0.00	0.00	0.00	24.68
342-C2-D	425.28	16.64	87.15	80.37	24.17	1.25	105.79	18.89	3.68	0.00	0.00	0.00	0.00	128.36
342-C3-A	1,239.58	18.24	66.76	60.36	13.09	1.53	74.98	12.37	3.83	0.00	2.61	2.61	21.67	115.46
342-C3-B	196.28	27.35	266.57	176.07	5.61	0.00	181.68	41.38	0.00	0.00	10.18	10.18	0.00	233.24
342-C3-C	573.84	23.15	165.92	123.85	18.70	0.00	142.55	29.10	0.00	0.00	2.32	2.32	0.00	173.97
342-C3-D	128.20	18.20	169.27	117.28	5.61	2.85	125.74	27.56	2.70	0.00	0.00	0.00	46.07	202.07
342-C4-A	894.80	46.58	413.65	288.07	16.83	1.11	306.01	67.70	3.79	0.00	0.00	0.00	20.93	398.43
342-C4-B	710.00	35.48	269.73	206.03	14.96	0.00	220.99	48.42	0.00	0.00	0.00	0.00	0.00	269.41
342-C4-C	555.26	36.04	252.93	201.75	29.92	0.00	231.67	47.41	0.00	0.00	0.00	0.00	0.00	279.08
342-C4-D	535.82	22.86	189.66	130.58	7.85	0.92	139.35	30.69	3.89	0.00	23.28	23.28	0.00	197.21
342-C5-A	1,817.86	25.59	114.12	101.02	20.14	1.23	122.39	23.74	4.16	0.00	0.00	0.00	16.79	167.08
342-C5-B	1,293.52	24.37	100.45	91.23	12.08	0.00	103.31	21.44	0.00	0.00	0.00	0.00	0.00	124.75
342-C5-C	1,329.76	26.23	103.73	104.06	30.21	0.00	134.27	24.45	0.00	3.14	2.51	5.65	0.00	164.37
342-C5-D	1,114.06	30.73	185.67	159.94	22.16	2.38	184.48	37.59	4.82	4.20	6.83	11.03	0.00	237.92
342-C6-A	1,396.10	24.88	166.17	125.15	16.11	0.88	142.14	29.41	4.56	0.00	0.00	0.00	22.86	198.97
342-C6-B	909.82	33.66	356.20	232.37	6.04	0.00	238.41	54.61	0.00	0.00	0.00	0.00	0.00	293.02
342-C6-C	551.74	25.08	196.65	142.68	20.14	0.00	162.82	33.53	0.00	15.33	0.00	15.33	0.00	211.68
342-C6-D	1,148.56	23.18	165.18	120.97	3.22	0.96	125.15	28.43	4.20	8.95	0.00	8.95	0.00	166.73
342-C7-A	1,099.02	9.42	35.40	28.82	0.00	0.94	29.76	5.91	3.24	0.00	0.00	0.00	35.19	74.10

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
342-C7-B	850.60	35.22	284.24	204.55	6.17	0.00	210.72	48.07	0.00	0.00	0.00	0.00	0.00	258.79
342-C7-C	1,208.64	37.59	235.28	192.83	3.74	0.00	196.57	45.32	0.00	4.41	0.00	4.41	0.00	246.30
342-C7-D	1,661.34	27.54	116.91	107.60	4.68	1.32	113.60	25.29	4.35	0.00	0.00	0.00	0.00	143.24
342-C8-A	608.30	32.29	286.09	215.26	16.11	0.90	232.27	50.59	2.52	0.00	4.77	4.77	16.90	307.05
342-C8-B	344.84	12.27	71.77	61.22	10.07	0.00	71.29	12.55	0.00	0.00	0.00	0.00	0.00	83.84
342-C8-C	992.04	16.79	75.66	63.42	10.07	0.00	73.49	14.90	0.00	0.00	0.79	0.79	0.00	89.18
342-C8-D	389.04	20.51	147.97	113.85	6.04	0.83	120.72	26.75	3.67	8.52	0.00	8.52	0.00	159.66
342-C9-A	1,313.00	44.86	351.27	260.99	13.09	1.07	275.15	61.33	3.77	0.00	1.97	1.97	32.22	374.44
342-C9-B	1,334.20	12.31	42.29	34.66	16.83	0.00	51.49	7.11	0.00	0.00	0.00	0.00	0.00	58.60
342-C9-C	781.54	14.77	50.16	50.04	20.57	0.00	70.61	10.26	0.00	0.00	0.00	0.00	0.00	80.87
342-C9-D	496.02	8.40	38.91	33.97	24.31	1.42	59.70	6.96	4.08	0.00	0.00	0.00	0.00	70.74
48-C1-A	1,669.26	31.34	117.22	111.36	15.85	0.12	127.33	26.17	0.35	1.24	0.00	1.24	113.64	268.73
48-C1-B	1,327.98	22.95	83.45	79.03	8.84	0.00	87.87	18.57	0.00	7.49	1.95	9.44	0.00	115.88
48-C1-C	1,251.06	35.10	161.74	152.61	22.83	0.00	175.44	35.86	0.00	12.52	2.57	15.09	0.00	226.39
48-C1-D	2,163.54	37.17	155.87	135.09	15.85	0.12	151.06	31.75	0.34	1.24	0.00	1.24	0.00	184.39
48-C10-A	1,331.54	34.56	172.80	152.37	8.92	0.03	161.32	35.81	0.61	0.00	1.90	1.90	126.45	326.09
48-C10-B	1,413.76	41.78	273.76	214.99	3.97	0.00	218.96	50.52	0.00	0.00	0.00	0.00	0.00	269.48
48-C10-C	1,737.38	40.13	198.02	173.73	14.35	0.00	188.08	40.83	0.00	5.39	0.00	5.39	0.00	234.30
48-C10-D	1,287.34	33.08	230.08	166.72	29.16	0.02	195.90	39.18	0.36	0.00	0.00	0.00	59.63	295.07
48-C11-A	1,359.82	29.31	114.61	105.76	5.70	0.04	111.50	24.85	0.24	0.00	0.00	0.00	73.17	209.76
48-C11-B	1,134.38	26.83	123.18	109.37	13.38	0.00	122.75	25.70	0.00	32.90	9.13	42.03	0.00	190.48
48-C11-C	1,571.12	26.45	94.87	89.53	6.69	0.00	96.22	21.04	0.00	0.92	2.85	3.77	0.00	121.03
48-C11-D	1,528.70	24.57	98.50	91.64	8.92	0.08	100.64	21.54	0.22	2.76	2.94	5.70	91.90	220.00
48-C2-A	1,243.14	22.78	98.06	82.99	16.41	0.09	99.49	19.50	0.26	7.80	0.00	7.80	82.43	209.48
48-C2-B	1,108.72	24.46	93.17	88.84	27.18	0.00	116.02	20.88	0.00	0.00	6.40	6.40	0.00	143.30
48-C2-C	1,579.08	27.44	100.24	91.84	18.91	0.00	110.75	21.58	0.00	8.60	0.95	9.55	0.00	141.88

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
48-C2-D	2,029.12	33.55	122.41	118.57	24.43	0.01	143.01	27.86	0.31	11.17	5.19	16.36	43.92	231.46
48-C3-A	1,618.88	34.57	136.72	128.06	17.35	0.32	145.73	30.09	0.40	4.90	0.00	4.90	68.03	249.15
48-C3-B	1,152.92	35.47	212.97	166.67	21.20	0.00	187.87	39.17	0.00	10.80	3.23	14.03	0.00	241.07
48-C3-C	1,743.56	30.28	126.43	121.10	19.52	0.00	140.62	28.46	0.00	0.00	4.05	4.05	0.00	173.13
48-C3-D	1,694.96	34.80	175.14	150.63	17.45	0.11	168.19	35.40	0.40	0.85	5.75	6.60	91.10	301.69
48-C4-A	1,538.40	39.16	173.42	160.79	12.30	0.10	173.19	37.79	0.11	0.00	5.47	5.47	54.18	270.74
48-C4-B	1,082.22	29.43	141.37	134.45	11.15	0.00	145.60	31.60	0.00	4.26	12.18	16.44	0.00	193.64
48-C4-C	2,487.16	39.52	182.14	156.29	5.78	0.00	162.07	36.73	0.00	0.00	0.00	0.00	0.00	198.80
48-C4-D	1,699.32	34.72	151.07	142.12	9.45	0.21	151.78	33.40	0.04	0.00	5.63	5.63	74.30	265.15
48-C5-A	1,868.20	36.96	139.85	131.56	9.45	0.05	141.06	30.92	0.23	0.00	0.00	0.00	75.67	247.88
48-C5-B	2,794.82	39.21	207.12	161.58	13.67	0.00	175.25	37.97	0.00	3.23	4.52	7.75	0.00	220.97
48-C5-C	3,053.88	40.15	146.87	131.64	2.05	0.00	133.69	30.94	0.00	0.00	5.20	5.20	0.00	169.83
48-C5-D	2,493.30	37.64	140.47	131.87	7.56	0.03	139.46	30.99	0.15	0.00	30.84	30.84	51.61	253.05
48-C6-A	3,289.06	42.23	150.27	136.39	1.91	0.18	138.48	32.05	0.11	0.80	1.25	2.05	59.97	232.66
48-C6-B	3,325.30	54.32	205.35	191.14	7.52	0.00	198.66	44.92	0.00	0.00	0.00	0.00	0.00	243.58
48-C6-C	3,568.48	42.40	145.66	126.20	11.35	0.00	137.55	29.66	0.00	0.79	0.00	0.79	0.00	168.00
48-C6-D	3,066.24	37.26	126.27	112.47	5.67	0.05	118.19	26.43	0.10	0.00	1.22	1.22	55.87	201.81
48-C7-A	1,342.12	25.30	86.93	85.71	5.86	0.10	91.67	20.14	0.21	13.14	3.48	16.62	199.56	328.20
48-C7-B	770.96	23.33	115.95	104.31	10.25	0.00	114.56	24.51	0.00	0.00	9.93	9.93	0.00	149.00
48-C7-C	1,167.06	27.95	132.70	121.36	15.85	0.00	137.21	28.52	0.00	0.00	4.51	4.51	0.00	170.24
48-C7-D	1,315.62	27.81	111.30	104.56	13.70	0.05	118.31	24.57	0.30	3.02	1.45	4.47	43.66	191.31
48-C8-A	1,542.84	28.68	114.36	108.51	11.57	0.12	120.20	25.50	0.08	0.00	2.60	2.60	130.86	279.24
48-C8-B	1,074.26	24.91	145.80	121.77	5.94	0.00	127.71	28.62	0.00	49.01	0.76	49.77	0.00	206.10
48-C8-C	1,222.78	33.17	162.35	143.73	21.81	0.00	165.54	33.78	0.00	0.76	3.29	4.05	0.00	203.37
48-C8-D	1,593.22	26.35	93.83	89.76	13.70	0.01	103.47	21.09	0.25	3.59	0.00	3.59	117.29	245.69
48-C9-A	907.16	29.85	155.66	145.80	7.56	0.18	153.54	34.26	0.63	3.28	10.81	14.09	117.96	320.48

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
48-C9-B	549.92	26.40	148.35	128.34	3.96	0.00	132.30	30.16	0.00	4.39	0.00	4.39	0.00	166.85
48-C9-C	2,008.80	36.22	143.33	136.63	17.35	0.00	153.98	32.11	0.00	0.00	0.00	0.00	0.00	186.09
48-C9-D	832.90	24.26	164.56	122.57	11.44	0.20	134.21	28.80	0.41	1.27	6.94	8.21	91.96	263.59
72-C1-A	2,348.34	33.25	148.54	128.16	17.02	0.45	145.63	30.12	1.43	5.51	3.79	9.30	38.65	225.13
72-C1-B	2,097.24	34.49	178.33	147.24	7.63	0.00	154.87	34.60	0.00	2.94	0.00	2.94	0.00	192.41
72-C1-C	1,325.32	36.10	184.02	158.69	1.89	0.00	160.58	37.29	0.00	1.10	3.10	4.20	0.00	202.07
72-C1-D	2,269.64	48.24	221.77	199.55	15.42	0.24	215.21	46.89	1.44	1.72	0.00	1.72	39.50	304.76
72-C10-A	2,394.32	49.32	291.99	231.12	15.50	0.21	246.83	54.31	1.93	10.19	0.00	10.19	27.49	340.75
72-C10-B	2,045.04	44.12	264.06	211.99	1.87	0.00	213.86	49.82	0.00	0.00	0.00	0.00	0.00	263.68
72-C10-C	2,229.88	37.67	181.51	147.27	17.93	0.00	165.20	34.61	0.00	0.00	0.00	0.00	0.00	199.81
72-C10-D	1,898.30	31.60	164.19	129.70	29.96	0.04	159.70	30.48	1.35	0.00	0.44	0.44	47.73	239.70
72-C11-A	1,550.80	22.45	91.19	86.19	13.57	0.26	100.02	20.25	1.74	0.00	1.06	1.06	23.28	146.35
72-C11-B	3,021.20	46.64	201.25	170.66	4.30	0.00	174.96	40.11	0.00	0.00	0.00	0.00	0.00	215.07
72-C11-C	1,725.02	33.95	151.12	135.47	29.29	0.00	164.76	31.84	0.00	0.00	3.06	3.06	0.00	199.66
72-C11-D	1,118.46	33.90	185.04	158.87	29.82	0.09	188.78	37.33	1.27	0.42	0.00	0.42	31.73	259.53
72-C2-A	3,246.64	52.41	259.35	207.37	18.91	0.07	226.35	48.73	1.37	8.40	0.00	8.40	64.17	349.02
72-C2-B	1,530.48	36.24	210.47	173.42	20.60	0.00	194.02	40.75	0.00	0.00	0.00	0.00	0.00	234.77
72-C2-C	2,121.12	38.95	172.46	151.29	3.96	0.00	155.25	35.55	0.00	7.12	0.77	7.89	0.00	198.69
72-C2-D	499.54	27.98	193.89	151.04	20.80	0.30	172.14	35.49	1.43	3.01	0.00	3.01	107.42	319.49
72-C3-A	2,773.66	52.72	278.24	222.01	9.76	0.15	231.92	52.17	1.69	3.65	0.00	3.65	31.92	321.35
72-C3-B	2,133.48	37.82	197.75	152.97	22.89	0.00	175.86	35.95	0.00	2.51	0.00	2.51	0.00	214.32
72-C3-C	1,351.86	27.59	122.20	113.66	17.45	0.00	131.11	26.71	0.00	4.86	4.38	9.24	0.00	167.06
72-C3-D	2,247.58	45.32	295.91	215.64	28.20	0.11	243.95	50.68	1.42	0.00	0.00	0.00	27.06	323.11
72-C4-A	2,205.96	31.80	128.61	110.04	11.44	0.09	121.57	25.86	0.78	2.80	2.64	5.44	30.64	184.29
72-C4-B	2,229.84	35.52	160.88	140.26	3.76	0.00	144.02	32.96	0.00	0.00	3.02	3.02	0.00	180.00
72-C4-C	1,405.80	35.94	187.25	151.73	15.62	0.00	167.35	35.66	0.00	5.04	1.41	6.45	0.00	209.46

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
72-C4-D	1,767.48	35.84	203.83	163.87	4.36	0.07	168.30	38.51	1.24	5.92	0.00	5.92	59.87	273.84
72-C5-A	3,459.72	44.75	163.11	146.81	21.25	0.14	168.20	34.50	1.09	3.35	4.38	7.73	33.17	244.69
72-C5-B	1,596.78	34.70	163.30	140.14	17.31	0.00	157.45	32.93	0.00	0.00	0.95	0.95	0.00	191.33
72-C5-C	2,501.30	36.00	192.63	147.90	26.25	0.00	174.15	34.76	0.00	5.54	2.20	7.74	0.00	216.65
72-C5-D	1,379.34	23.12	115.59	95.91	19.19	0.18	115.28	22.54	1.44	0.30	2.79	3.09	32.30	174.65
72-C6-A	4,183.00	50.96	189.03	163.71	9.62	0.36	173.69	38.47	0.87	0.75	3.28	4.03	29.36	246.42
72-C6-B	1,831.96	39.66	243.03	186.91	17.57	0.00	204.48	43.92	0.00	0.00	1.25	1.25	0.00	249.65
72-C6-C	1,984.92	32.08	168.73	132.49	7.49	0.00	139.98	31.14	0.00	5.54	0.00	5.54	0.00	176.66
72-C6-D	2,567.60	40.17	153.26	137.24	19.00	0.31	156.55	32.25	0.95	0.00	0.00	0.00	19.55	209.30
72-C7-A	3,499.56	47.42	202.75	169.26	3.79	0.12	173.17	39.78	1.51	0.00	0.00	0.00	37.46	251.92
72-C7-B	2,363.42	62.34	409.32	318.18	15.46	0.00	333.64	74.77	0.00	0.00	1.76	1.76	0.00	410.17
72-C7-C	3,964.58	41.02	135.94	123.53	24.46	0.00	147.99	29.03	0.00	4.54	0.00	4.54	0.00	181.56
72-C7-D	1,595.00	29.62	118.85	108.11	6.15	0.42	114.68	25.41	0.70	7.44	1.06	8.50	38.58	187.87
72-C8-A	1,811.60	36.59	164.79	149.55	10.07	0.13	159.75	35.14	1.35	1.02	1.19	2.21	27.58	226.03
72-C8-B	1,715.28	35.58	197.19	158.49	27.49	0.00	185.98	37.25	0.00	0.00	0.00	0.00	0.00	223.23
72-C8-C	2,229.84	39.60	169.87	150.60	31.42	0.00	182.02	35.39	0.00	30.26	0.00	30.26	0.00	247.67
72-C8-D	1,637.42	24.83	90.97	87.34	4.40	0.16	91.90	20.52	1.10	0.00	0.00	0.00	24.88	138.40
72-C9-A	3,101.64	58.23	291.49	242.81	5.83	0.20	248.84	57.06	1.57	3.26	4.38	7.64	47.78	362.89
72-C9-B	2,299.74	46.37	246.25	205.51	30.11	0.00	235.62	48.29	0.00	21.24	0.00	21.24	0.00	305.15
72-C9-C	2,058.34	48.66	267.69	217.11	5.83	0.00	222.94	51.02	0.00	0.62	0.00	0.62	0.00	274.58
72-C9-D	2,577.34	48.68	215.32	185.69	4.54	0.30	190.53	43.64	1.20	17.40	0.00	17.40	26.90	279.67
GELAM 2_A	714.56	15.31	49.82	50.35	5.61	0.17	56.13	10.32	3.02	20.37	2.04	22.41	0.00	91.88
GELAM 2_B	389.76	14.22	68.61	60.92	3.74	0.00	64.66	12.49	0.00	24.20	5.90	30.10	0.00	107.25
GELAM 2_C	779.52	25.44	98.16	97.26	9.35	0.66	107.27	22.86	7.25	19.27	3.50	22.77	0.00	160.15
GELAM 2_D	1,169.28	36.09	161.91	146.21	3.74	0.17	150.12	34.36	4.62	2.92	2.04	4.96	0.00	194.06
GELAM 2_E	1,039.36	40.19	148.22	163.18	3.74	0.17	167.09	38.35	4.62	20.37	2.04	22.41	0.00	232.47

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
GELAM 2_F	129.92	1.75	5.70	4.86	3.74	0.17	8.77	1.00	4.62	20.37	2.04	22.41	0.00	36.80
LD (N1) A	654.28	24.24	140.72	117.56	7.48	0.25	125.29	27.63	0.92	1.17	2.04	3.21	0.00	157.05
LD (N1) B	717.06	11.88	50.64	45.30	5.61	0.00	50.91	9.29	0.00	2.27	5.90	8.17	0.00	68.37
LD (N1) C	494.24	7.47	26.64	24.79	5.61	0.00	30.40	5.08	0.00	1.49	3.50	4.99	0.00	40.47
LD (N1) D	875.32	22.44	103.01	90.20	7.48	0.17	97.85	21.20	4.62	2.50	2.04	4.54	0.00	128.21
LD10-A	397.00	28.70	247.06	173.65	0.00	0.00	173.65	40.81	0.00	0.00	3.52	3.52	0.00	217.98
LD10-B	488.96	30.22	191.79	160.32	0.00	0.00	160.32	37.68	0.00	3.52	5.71	9.23	0.00	207.23
LD10-C	726.80	18.19	90.10	81.70	0.00	0.00	81.70	19.20	0.00	0.89	0.00	0.89	0.00	101.79
LD10-D	704.66	21.95	110.69	97.06	0.00	0.00	97.06	22.81	0.00	0.00	0.21	0.21	0.00	120.08
LDNEW02(A)	442.98	25.73	164.39	135.02	0.00	0.00	135.02	31.73	0.00	0.00	0.00	0.00	0.00	166.75
LDNEW02(B)	344.84	29.83	254.00	190.94	0.00	0.00	190.94	44.87	0.00	0.00	0.00	0.00	0.00	235.81
LDNEW02(C)	153.86	13.54	78.43	69.64	0.00	0.00	69.64	16.37	0.00	0.76	0.00	0.76	0.00	86.77
LDNEW02(D)	294.42	29.31	203.62	166.52	8.36	0.00	174.88	39.13	0.00	0.00	0.00	0.00	0.00	214.01
M1 A	1,688.96	6.63	40.30	19.39	5.61	0.00	25.00	9.60	4.66	0.00	0.00	0.00	0.00	39.26
M1 B	844.48	18.03	110.35	87.19	3.74	0.00	90.93	32.69	0.00	6.67	5.90	12.57	0.00	136.19
M1 C	1,818.88	24.70	152.50	115.26	9.35	0.00	124.61	44.17	0.00	4.63	0.00	4.63	0.00	173.41
M1 D	1,753.92	17.40	107.04	66.99	3.74	0.17	70.90	28.60	4.62	20.37	2.04	22.41	0.00	126.53
M1 E	1,234.24	33.55	206.54	167.72	0.00	0.00	167.72	61.89	0.00	0.00	0.00	0.00	0.00	229.61
M1 F	1,104.32	13.48	81.77	51.57	0.00	0.00	51.57	21.93	0.00	0.00	0.00	0.00	0.00	73.50
M2 A	1,624.00	8.06	49.03	24.54	5.61	0.00	30.15	11.85	0.00	0.00	0.00	0.00	0.00	42.00
M2 B	1,753.92	6.36	38.63	17.54	3.74	0.00	21.28	8.94	0.00	6.67	5.90	12.57	0.00	42.79
M2 C	1,429.12	9.05	54.64	29.07	9.35	0.00	38.42	13.58	0.00	12.16	3.50	15.66	0.00	67.66
M2 D	1,883.84	18.65	113.73	67.08	0.00	0.00	67.08	29.66	0.00	0.00	0.00	0.00	0.00	96.74
M2 E	2,208.64	22.81	139.45	83.44	0.00	0.00	83.44	36.60	0.00	0.00	0.00	0.00	0.00	120.04
M2 F	2,728.32	36.75	225.34	145.52	0.00	0.00	145.52	61.06	0.00	0.00	0.00	0.00	0.00	206.58
M3 A	1,364.16	8.39	50.01	26.20	0.00	0.00	26.20	12.35	0.00	0.00	0.00	0.00	0.00	38.55

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
M3 B	1,299.20	8.02	48.62	25.94	0.00	0.00	25.94	12.11	0.00	0.00	0.00	0.00	0.00	38.05
M3 C	974.40	10.03	61.44	38.32	0.00	0.00	38.32	16.38	0.00	0.00	0.00	0.00	0.00	54.70
M3 D	974.40	7.05	42.27	24.31	3.74	0.00	28.05	10.88	0.00	0.00	0.00	0.00	0.00	38.93
M3 E	1,883.84	11.51	69.74	36.29	0.00	0.00	36.29	17.18	0.00	0.00	0.00	0.00	0.00	53.47
M3 F	2,793.28	22.59	136.39	78.43	0.00	0.00	78.43	35.06	0.00	0.00	0.00	0.00	0.00	113.49
P01 (A)	1,233.42	44.05	383.50	265.74	0.00	0.00	265.74	62.45	0.00	0.00	19.98	19.98	0.00	348.17
P01 (B)	1,957.56	62.66	439.30	336.97	0.00	0.00	336.97	79.19	0.00	0.00	0.00	0.00	0.00	416.16
P01 (C)	1,066.31	27.13	123.55	116.24	0.00	0.00	116.24	27.32	0.00	0.64	0.00	0.64	0.00	144.20
P01 (D)	875.33	84.94	899.83	629.04	0.00	0.00	629.04	147.82	0.00	1.28	0.00	1.28	0.00	778.14
P01 (E)	843.50	11.97	47.78	42.46	0.00	0.00	42.46	8.70	0.00	0.00	0.00	0.00	0.00	51.16
P01 (F)	572.94	10.76	43.04	36.43	0.00	0.00	36.43	7.47	0.00	0.00	0.00	0.00	0.00	43.90
P02 A	2,705.58	21.61	94.01	74.69	5.61	0.00	80.30	17.55	0.00	1.71	2.04	3.75	0.00	101.60
P02 B	509.28	28.29	259.86	168.04	3.74	0.00	171.78	39.49	0.00	0.00	0.00	0.00	0.00	211.27
P02 C	541.11	20.97	89.78	93.85	9.35	0.00	103.20	22.05	0.00	0.00	0.00	0.00	0.00	125.25
P02 D	318.30	10.19	33.11	39.24	3.74	0.17	43.15	8.04	4.62	3.91	0.00	3.91	0.00	59.72
P02 E	612.73	12.46	48.08	45.20	3.74	0.17	49.11	9.27	4.62	12.03	0.00	12.03	0.00	75.03
P02 F	413.79	13.68	66.21	63.04	3.74	0.17	66.95	14.81	4.62	9.98	0.00	9.98	0.00	96.36
P03 A	1,623.34	32.87	117.16	120.76	5.61	0.00	126.37	28.38	0.00	0.00	0.00	0.00	0.00	154.75
P03 B	923.08	13.68	71.79	68.25	3.74	0.00	71.99	16.04	0.00	2.42	0.00	2.42	0.00	90.45
P03 C	1,671.09	22.48	97.43	79.84	9.35	0.00	89.19	18.76	0.00	0.00	0.00	0.00	0.00	107.95
P03 D	477.45	20.05	91.86	85.45	3.74	0.17	89.36	20.08	4.62	0.00	0.00	0.00	0.00	114.06
P03 E	1,583.56	12.46	48.55	36.90	3.74	0.17	40.81	7.56	4.62	0.00	0.00	0.00	0.00	52.99
P03 F	835.54	20.49	83.04	80.21	3.74	0.17	84.12	18.85	4.62	0.00	0.00	0.00	0.00	107.59
P04 (A)	986.73	22.45	80.88	79.84	5.61	0.00	85.45	18.76	0.00	0.00	2.04	2.04	0.00	106.25
P04 (B)	795.75	25.97	119.69	110.34	0.00	0.00	110.34	25.93	0.00	1.34	0.00	1.34	0.00	137.61
P05 (A)	3,708.23	30.89	100.37	84.38	0.00	0.00	84.38	19.83	0.00	0.00	2.04	2.04	0.00	106.25

Plot ID	TPH	BA	VOL	AG TREE	SAPLING	CLIP PLOT	TOTAL AGC	BG TREE	LITTER	DW STAND	DW LYING	DW TOTAL	SOIL	TOTAL CARBON
P05 (B)	2,228.12	26.17	97.87	86.45	0.00	0.00	86.45	20.32	0.00	0.00	0.00	0.00	0.00	106.77
P06 (A)	1,257.29	23.19	84.63	77.77	0.00	0.00	77.77	18.28	0.00	13.29	0.00	13.29	0.00	109.34
P06 (B)	931.03	18.96	84.74	72.58	0.00	0.00	72.58	17.06	0.00	5.27	0.00	5.27	0.00	94.91
P06 (C)	572.94	29.43	150.73	135.18	0.00	0.00	135.18	31.77	0.00	14.83	0.00	14.83	0.00	181.78
P06 (D)	867.37	15.47	64.93	57.67	0.00	0.00	57.67	11.82	0.00	0.00	0.00	0.00	0.00	69.49
P06 (E)	700.26	28.23	139.12	122.07	0.00	0.00	122.07	28.69	0.00	1.87	0.00	1.87	0.00	152.63
P06 (F)	413.79	14.56	57.51	59.43	0.00	0.00	59.43	12.18	0.00	3.40	0.00	3.40	0.00	75.01
P10 A	1,503.98	21.49	103.70	85.85	5.61	0.00	91.46	20.17	0.00	0.00	0.00	0.00	0.00	111.63
P10 B	1,273.21	26.15	134.79	119.20	3.78	0.00	122.98	28.01	0.00	0.00	0.00	0.00	0.00	150.99
P10 C	1,074.27	21.24	95.81	94.77	9.45	0.00	104.22	22.27	0.00	3.79	0.00	3.79	0.00	130.28
P10 D	803.71	26.95	121.43	114.82	3.74	0.17	118.73	26.98	4.62	0.00	0.00	0.00	0.00	150.33
P10 E	644.56	14.92	76.09	59.27	3.74	0.17	63.18	12.15	4.62	5.11	0.00	5.11	0.00	85.06
P10 F	1,137.93	44.03	276.58	227.69	3.74	0.17	231.60	53.51	4.62	9.98	0.00	9.98	0.00	299.71
PO4 (C)	795.75	29.06	133.23	121.03	0.00	0.00	121.03	28.44	0.00	1.89	0.00	1.89	0.00	151.36
PO4 (D)	1,010.61	13.66	54.40	45.99	0.00	0.00	45.99	9.43	0.00	1.58	0.00	1.58	0.00	57.00
PO4 (E)	827.58	36.27	218.45	180.15	0.00	0.00	180.15	42.34	0.00	0.00	0.00	0.00	0.00	222.49
PO4 (F)	127.32	13.74	125.37	90.93	0.00	0.00	90.93	21.37	0.00	0.40	0.00	0.40	0.00	112.70
PO5 (C)	795.75	19.46	82.13	73.11	0.00	0.00	73.11	17.18	0.00	0.00	0.00	0.00	0.00	90.29
PO5 (D)	740.05	11.85	38.56	36.30	0.00	0.00	36.30	7.44	0.00	0.00	0.00	0.00	0.00	43.74
PO5 (E)	1,225.46	29.40	171.06	130.00	0.00	0.00	130.00	30.55	0.00	0.00	6.64	6.64	0.00	167.19
PO5 (F)	827.58	16.18	52.66	54.34	0.00	0.00	54.34	11.14	0.00	0.83	0.00	0.83	0.00	66.31

Sibu,Mukah Kapit & Sarikei
Regional Forest Office.

Bintulu Regional Forest Office.

Kuching Regional Forest Office.

Miri & Limbang Regional Forest Office.

FOREST RESOURCE INVENTORY

IN THE HEART OF BORNEO (HoB) SARAWAK

(2016-2020)

FOREST DEPARTMENT SARAWAK

Forest Department Sarawak Headquarters
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FOREST RESOURCE INVENTORY IN THE HEART OF BORNEO (HoB) SARAWAK (2016-2020)