Additional Transects 7 and 8
Rimba Raya Carbon Assessment Survey
August 5 – September 1, 2009

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1. Executive Summary

Ms. Leslie Bolick in cooperation with Orangutan Foundation International (OFI) conducted a field survey August 5 – September 1, 2009 of forest and peat in the proposed Rimba Raya restoration concession. This work was conducted as part of Ms. Bolick's independent research on orangutan and forest ecology, and was designed to extend the carbon assessment survey conducted June 22 – July 4 by Forest Carbon Consultants and OFI on behalf of InfiniteEARTH.

Survey methods for new transects T7 and T8 followed those used in the original carbon assessment (transects T1-T6). A total of 3,250 meters of transect were marked and surveyed with peat depth measured in 29 locations and biomass recorded across 8 plots representing two hectares of forest. Six plots were located in peat swamp forest and two in mixed-kerangas (non-peat) forest. Both sites T7 and T8 represent relatively inaccessible forest in the largest interior forest block of Rimba Raya. Together transects T1-T8 represent the primary forest types of the Rimba Raya carbon accounting area.

A preliminary review of survey data indicates that mixed-kerangas forest surveyed at T7 has relatively low biomass compared to peat swamp forest and is the first such forest documented for the carbon assessment. The peat swamp forest at T8 represents lightly logged forest with high biomass compared to other survey sites in the carbon accounting area. Peats were deep (>6 meters) in swamp forest on both sites, with depths consistently exceeding the reach of the new peat probe designed for this survey.

All survey data has been entered into an Excel workbook and provided to InfiniteEARTH, Forest Carbon and Orangutan Foundation International (OFI). These data provide detailed ground information on the condition and characteristics of forest and peat in the Rimba Raya carbon accounting area, which will be used to support biomass analysis and land cover mapping.

2. Introduction

Ms. Leslie Bolick, in partnership with Dr. Biruté Galdikas and Dr. Suwido Limin and with the assistance of Orangutan Foundation International (OFI) field staff, conducted a forest survey in the proposed Rimba Raya restoration concession July 17 – September 1, 2009. This survey is a component of Ms. Bolick's PhD research on orangutan and forest ecology in Bornean peatlands. The survey was conducted following protocols used in the carbon assessment fieldwork carried out by Forest Carbon Consultants and Orangutan Foundation International for Infinite Earth June 22 – July 4, 2009. The objective of the new survey (transects T7 and T8) was to augment the original dataset (transects T1-T6) by targeting previously unsurveyed areas in Rimba Raya's core forest (Figure 1A). This report documents the survey and the new dataset, in order to support use of these data by Rimba Raya project participants.

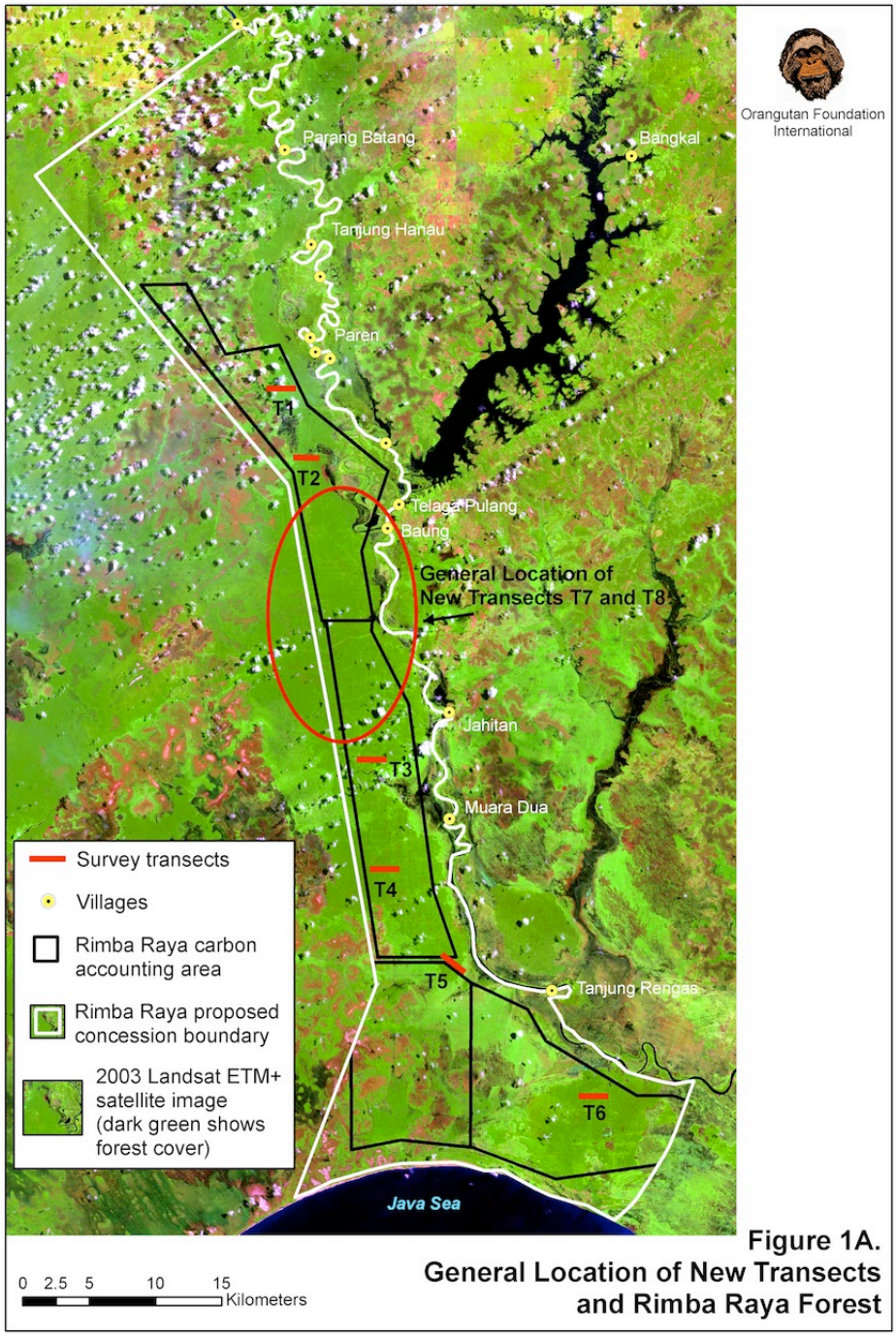


Figure 1A. General Location of New Transects and Rimba Raya Forest

3. Methods

3.1 Field Work Areas and Transect Locations

Transects T1-T6 of the original carbon assessment survey were distributed across a broad geographic area in the Rimba Raya accounting area to represent a range of forest conditions. Detailed descriptions and maps of transects 1-6 are part of the original field report for the carbon assessment (Bolick 2009). New transects T7 and T8 were located to better represent the central northern interior of Rimba Raya where the largest and most inaccessible forest blocks are located (Figure 1A). Transect T7 was located in an area that appeared to be a different forest type based on visual interpretation of satellite imagery. Transect T8 was located in an area that appeared to be dense swamp forest at some distance from logging rails which are prevalent throughout the study area. Together, these eight transects provide a broadly distributed representation of forest in Rimba Raya's Carbon Accounting Area (Figure 1B).

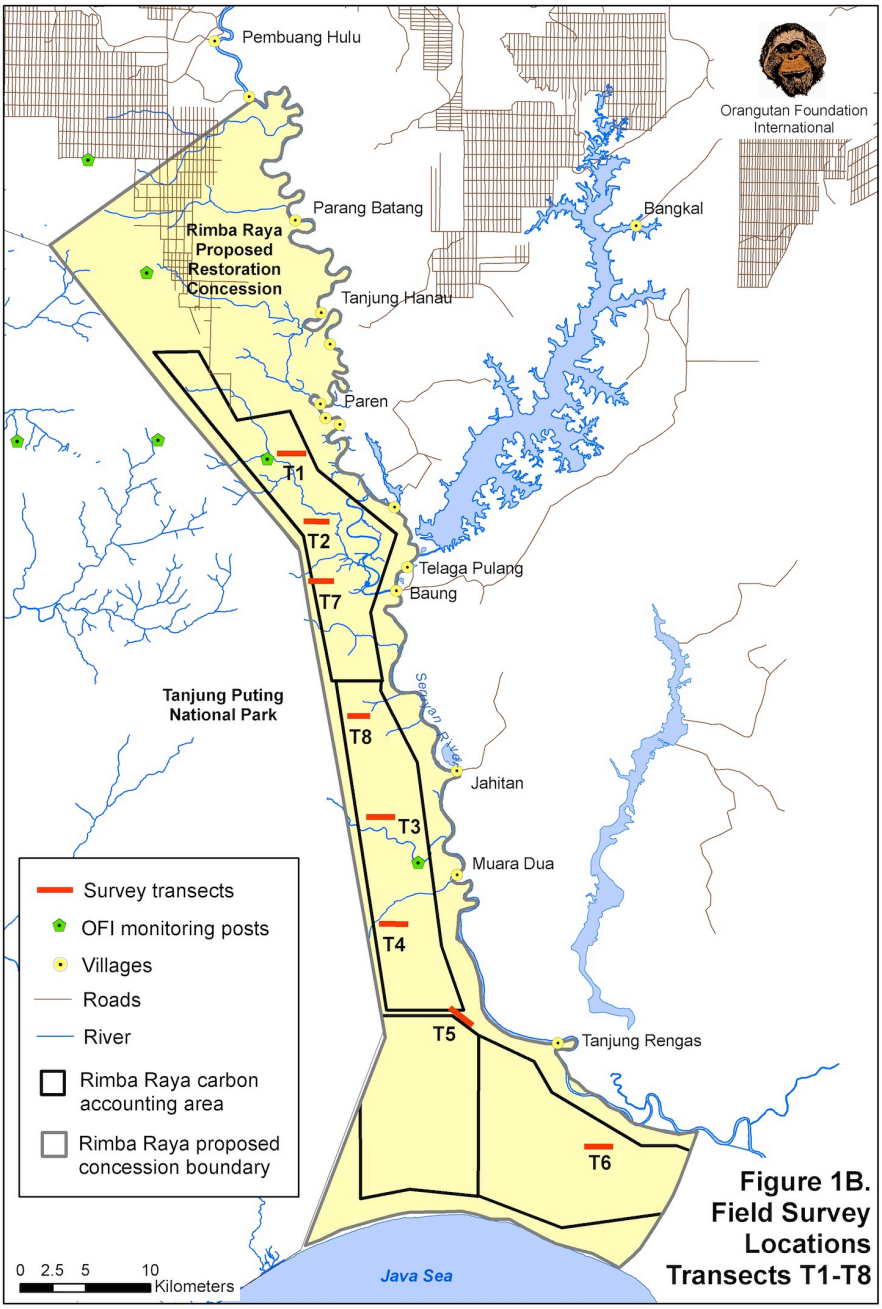


Figure 1B. Field Survey Locations Transects T1-T8

3.2 Transect and Plot Layout

Transects T7 and T8 were randomly located within target areas identified on Landsat ETM+ 2003 and 2008 satellite imagery (see maps, Figures 2A-2D in Appendix A). Transect and plot layout followed protocols established for transects T1-T6, which is described in more detail in the original field report. A brief summary follows.

Transects were 2.0km (T7) and 1.75km (T8) in length to accommodate 4 biomass plots and were oriented on an east-west bearing. Transect centerlines were marked every 10 meters with poles and flagging which provided orientation for biomass survey plots and measure locations for peat depth and tree counts.

Biomass plots 250m x 10m (¼ hectare), were located at 250 meter intervals on each transect. Biomass plots consisted of five 50m subplots within which large trees (>20cm DBH, diameter at breast height) were measured plus two nested 20m subplots within which small trees (10-20cm DBH) were measured.

3.3 Field Team Organization

Field team organization followed the same protocol as the original carbon assessment survey, with seven people divided among three subteams to facilitate workflow. All team members had participated in the original surveys on transects T1-T6, therefore had substantial experience in survey protocols and subteam position responsibilities. Team positions are listed below and described in the original field report.

Transect Subteam (2)
- Compass person/distance measurer
- Trail cutter

Peat Subteam (2)
- Note taker/tree volume measurer
- Peat measurer

Biomass Subteam (3)
- Note taker/biomass team leader
- Tree canopy measurer (clinometer and laser)
- Tree identifier and diameter measurer

3.4 Field Team Workflow, Equipment and Survey Protocols

Survey methods follow those described for transects T1-T6. The transect subteam led the survey by cutting the transect on a fixed bearing and marking the transect centerline with a flagged pole every 10 meters. The peat subteam followed behind the transect subteam, measuring and recording peat depths at 100-meter intervals on T7 and T8 transect centerlines. On T8, tree counts were recorded at 50-meter intervals in point-centered variable plots using a 20 BAF (Basal Area Factor) prism. Tree counts were not carried out on transect T7, as the prism tool was not available.

On transects T7 and T8, a new peat probe was used which was able to record depths of six meters. The new tool followed the design of the original peat probe but with six, 1-meter threaded, attachable pipe units made from heavier gauge steel and two inches of threading at the ends. This tool was somewhat heavier to carry than the original unit and the deeper threads sometimes required two people to detach, but team members chose this design to ensure the tool would be strong enough to measure moderately deep peats.

In the peat swamp forest on T7 and T8, peat depths consistently exceeded the six-meter maximum depth of the new peat tool. Such peat depths proved somewhat challenging to measure as the longer peat probe often hit undecomposed logs below the surface. In such areas, 10-20 attempts had to be made before a clean measurement could be obtained. Deep peats and abundant wood on these sites also required two people to remove the probe. Using this design, it is expected that 7 or perhaps 8 meters would be the maximum peat probe length that a two-person subteam could manage.

Measuring peat depth and using the prism to sample basal area

The biomass subteam worked in nested subplots to manage workflow across 250m x 10m (¼ hectare) plots. The transect centerline and 10-meter marks were used to define subplot boundaries within which tree measurements were recorded on separate subplot tally sheets. A laser range finder was used to determine exact distances from transect centerline for borderline trees. The note taker played a key role in managing data collection, keeping track of subplot boundaries and directing biomass sub-team members to specific trees for measurement.

Within each subplot, two tree identifiers searched for trees meeting the diameter requirements, identified species using local names and measured diameter at breast height (DBH). At the same time, the note taker directed the canopy measurer to selected trees (2 per subplot) to measure crown dimension, canopy class and tree height. Crown dimension was measured at the broadest radius and the radius perpendicular to the first measurement using a laser range finder to record distance from canopy edge to the tree stem. Canopy class was visually estimated following the original peat survey protocols where class 5 was assigned to an understory tree receiving no direct sunlight and class 1 was assigned to a canopy emergent receiving full sunlight. Tree height measures (observer distance and angle to the tree) were also recorded for the selected crown measure trees. Distance was measured using the laser range finder and angles to tree base and tree crown apex were made using a clinometer. An equipment list for the peat survey is included in the original field report.

DBH measurements of subplot trees

3.5 Data Recording - Tally Sheets

Survey data were recorded on hardcopy tally sheets carried on clipboards. The same tally sheet design was used for all transects T1-T8. One peat tally sheet was used per survey session to record peat depths and tree counts at 50 and 100-meter intervals. Transects T7 and T8 had a mid-transect start point so the survey proceeded in two sections on opposite bearings (90° and 270°). Direction of travel along the transect was

recorded at the top of the tally sheet to indicate which section of the transect was being recorded. A total of 2 or 3 peat tally sheets were used for each transect.

Seven tally sheets were used to record biomass plot data, with one sheet for each subplot. Each plot started with a small tree subplot (20x10m), proceeded by five large tree subplots (50x10m) and ending with a second small tree subplot (20x10m). Plot and subplot numbers progressed west to east on each transect regardless of the order in which they were surveyed, following protocol of the original survey. A total of 28 tally sheets, representing 4 plots, were recorded for each transect.

3.6 Field Work Schedule

Peat transect surveys were conducted August 5 - September 1 during which time orangutan nest surveys were also carried out. Both T7 and T8 were sufficiently remote that three days were required to move teams from Pangkalan Bun and the Seruyan River to the survey site by way of OFI monitoring posts, Seruyan villages and overnight forest camps. Survey camps were then established at the sites and used for 5-7 nights while transects were cut and surveys conducted.

3.7 Transport, Logistics and Camps

Small kelotoks (ces) transported the team to staging camps where gear was packed in on foot

Team members met at initial staging areas on the Baung River (T7) or Seruyan River (T8) and then moved gear to the closest river or canal access point to the field site via ces (small kelotok). Because the survey was conducted during the height of dry season, low water in rivers and canals made interior access by ces very limited. Therefore, sites were reached on foot.

Team logistics, purchased in Pangkalan Bun and Seruyan villages were reorganized at river-based staging camps. Some supplies were left at these camps to minimize pack weight. Remaining logistics were divided among team members and packed into survey sites. Both sites were located by trail cutting on a fixed bearing to the GPS target established from satellite image review. Hardcopy maps of imagery, rivers and interpreted logging canals were used for orientation on the initial hike to the site. Figure 2D in Appendix A shows detailed site maps of trails, camps and transects.

A small amount of drinking water was carried during initial hikes as the team relied on water at the campsites. Swamps were dry at both sites so 1-1.5 meter deep wells were dug on site upon arrival to supply rationed water for drinking and cooking.

4. Results

4.1 Description of the Survey Transects

Like previously surveyed transects, T7 and T8 were predominated by selectively hand-logged peat swamp forest within a short distance of logging rails. These sites exhibited slight variation in forest conditions compared to transects T1-T6 as predicted by pre-survey satellite image review. The effect of this variation on biomass and the ability to delineate important variation in satellite imagery will be assessed in upcoming work for the Rimba Raya carbon assessment.

4.2 Transect T7 Overview

Transect T7 is located in the southern region of the Baung River, 4.5 km south of T2 and 2.5 km southwest of the Baung River within 3 km of its confluence with the Seruyan River (Figures 2A-D, Appendix A). Based on satellite image interpretation, this site was selected as a less-accessible and possibly less-degraded site compared to other Baung River sites. Additionally, this site was selected for its unique spectral signature on satellite imagery. In the field, the team encountered lightly logged peat swamp and mixed-kerangas (non-peat) forest at the site and established the T7 transect to survey both forest types.

4.3 Transect T7 Mixed-Kerangas Plots

The mixed-kerangas portion of the T7 site, including biomass plots 1 and 2, extended from 750 to 1500 west on the transect, and continued west beyond the Rimba Raya project boundary. This forest on a mix of sand and mineral soils (locally "pasir" and "tanah liat") represents a new type for the carbon assessment survey. A total of 93 trees >20cm DBH were recorded in the mixed-kerangas plots representing 35 species. All species occur at very low frequency, with only about half (18 of 35 species) encountered more than once during the survey (Table 1).

There is some overlap in species composition between mixed-kerangas (Table 1) and peat swamp forest surveyed on transects T1-T6 (Table B1, Appendix B) but species frequencies vary. For example ketiau is the most common species in peat swamp forest, (8.7% frequency), but uncommon (2.2% frequency) in mixed-kerangas forest at T7. The genus *Eugenia*, known locally as ubar, represents at least four species and is prevalent in mixed-kerangas (20.4%) but relatively rare in peat swamp (2.3%).

Two species characteristic of dry ground forest, bawang-bawang and kempas occurred with a frequency of 11.8% and 5.4% respectively. These two plus at least one species of *Eugenia* (shown in photo above left) were some of the largest individuals recorded (e.g. 40-60cm DBH) and probably contribute substantially to site biomass in mixed-kerangas plots.

Table 1. Frequency of most common tree species on transect T7 mixed-kerangas plots 1 and 2, representing 0.5 hectares

Species (Local Name)	Number of occurrences (of 93 large trees measured)	Frequency (%)
Ubar[1]	19	20.4
Bawang-bawang	11	11.8
Medang[2]	6	6.5
Kempas	5	5.4
Asam-asam[2]	4	4.3
Bekepas[2]	4	4.3
Garu tengang	3	3.2
Mentabuan	3	3.2
Poga	3	3.2
Jampang	2	2.2
Ketiau[2]	2	2.2
Kumpang darah	2	2.2
Luing	2	2.2
Merang	2	2.2
Pempaning[2]	2	2.2
Pikal	2	2.2
Sundi	2	2.2
Tembaras	2	2.2

[1] local name ”ubar” represents multiple species in the genus *Eugenia*
[2] species also occurs with >2% frequency in peat swamp forest

Mixed-kerangas forest is generally characterized by fewer and smaller trees compared to peat swamp forest. This translates to comparatively lower biomass. On the T7 transect, mixed-kerangas plots had 27% fewer small trees and 36% fewer large trees compared to peat swamp plots.

Large tree density for mixed-kerangas plots (186 trees/ha) was much lower than large tree density for peat swamp plots (282 trees/ha) but still slightly higher than large tree density across all other T1-T6 plots (155 trees/ha) indicating the site at T7 may represent more lightly-logged forest compared to some other survey sites.

Biomass will be quantified and compared for forest types from plot and transect survey data in the carbon assessment.

4.4 Transect T7 Peat Swamp Forest Plots

The peat swamp forest at T7 extended from 750 west to 250 east on the transect, including biomass plots 3 and 4, and continued east to the Baung River. A total of 147 trees >20cm DBH were recorded in these plots representing 30 species. All species occur at low frequency. Ketiau (15.6% frequency) and perapat (10.2% frequency) were more

common. Thirteen other species of trees > 20cm DBH occurred with a frequency of 2.0% - 6.1% (Table 2). Fifty percent of species were recorded only once or twice during the survey of biomass plots covering 0.5 hectares.

The peat swamp forest on T7 is similar in species composition and abundance to forests on Transects 1-6 (Table x Appendix B), with biomass plots dominated by ketiau and including important timber species ramin and lanan at low frequencies. An important difference in the T7 site is the presence of co-dominant perapat (10.2% frequency) and the absence of swamp forest species lamanaduk, which is a co-dominant on T1-T6 swamp forest sites. Presence of dry ground species kempas and rasak are also unique to T7 swamp forest biomass plots indicating the heterogeneous nature of species composition in this swamp forest adjacent to kerangas.

The T7 swamp forest also has a substantially higher density of trees > 20cm DBH (292 trees/ha) compared to T1-T6 swamp forest on average (151 trees/ha), despite the presence of a logging rail in plot 4 (shown in photo right). Tree density and biomass will be further analyzed in the carbon assessment.

Table 2. Frequency of most common tree species on transect T7 peat swamp forest plots 3 and 4, representing 0.5 hectares

Species (local name)	Number of occurrences (of 147 large trees measured)	Frequency (%)
Ketiau[1]	23	15.6
Perapat	15	10.2
Jelutung[1]	9	6.1
Idat[1]	8	5.4
Nyatuh rawa	7	4.8
Ramin[1]	7	4.8
Banitan[1]	6	4.1
Jangkang	6	4.1
Bentuka	5	3.4
Kumpang[1]	5	3.4
Lanan[1]	5	3.4
Mertibu	5	3.4
Penampalaan[1]	5	3.4
Bekepas	4	2.7
Ubar[1]	4	2.7
Bekunyit[1]	3	2.0
Jampang	3	2.0
Kempas	3	2.0
Papung[1]	3	2.0
Rasak	3	2.0
Tempalaan	3	2.0

[1] species shared with peat swamp forest biomass plots T1-T6

4.5 Transect T8

Transect T8 is located 3km southwest of the Seruyan River, 10.5 km south of T7 and 1.5km south of the logging canal "Tatah Slamat", which bisects the primary forest block of Rimba Raya (Figure 2B, 2D Appendix A). A total of 272 trees >20cm DBH, representing 38 species were recorded in four biomass plots.

Like all other sites, species occur at low frequency, but there is higher evenness at T8 compared to other sites (Table 3). This is the only site where mertibu is dominant (8.8% frequency) with co-dominant lamanaduk (7.3% frequency). Five other species occurred with >5% frequency. Relatively common species ulin paya, pelawan and jungkung differentiate T8 from other swamp forest transects in terms of species composition. Lanan is important at T8 (7.0% frequency) and may contribute to comparatively high biomass at this site.

The T8 site represents lightly logged peat swamp forest. Like the peat swamp forest at T7, the T8 site has high tree density (272 trees/ha) compared to other surveyed swamp forest on average (151 trees/ha). Higher biomass was predicted for this site based on pre-survey satellite image interpretation and will be further explored in the quantitative assessment of aboveground carbon.

Table 3. Frequency of most common tree species on transect T8 peat swamp forest plots 1,2,3,4 representing 1.0 hectares

Species (Local Name)	Number of occurrences (of 272 large trees measured)	Frequency (%)
Mertibu	24	8.8
Lamanaduk[1]	20	7.4
Banitan[1]	19	7.0
Lanan[1]	19	7.0
Nyatuh	18	6.6
Perapat	16	5.9
Medang	15	5.5
Ketiau[1]	13	4.8
Jelutung[1]	12	4.4
Ubar[1]	12	4.4
Ulin paya	11	4.0
Pelawan	9	3.3
Ramin[1]	7	2.6
Asam-asam[1]	6	2.2
Jungkung	6	2.2

[1] species shared with peat swamp forest biomass plots T1-T6

4.6 Data Entry, Description and Summary

For new transects T7 and T8, a total of 3,250 meters of transect were marked and surveyed with biomass data recorded in 8 plots and 56 subplots representing 2.0 hectares of forest. T7 and T8 data records for this survey include: 29 peat measures, 36 tree volume counts, 140 small tree diameter measurements, 511 large tree diameter measurements and 112 tree crown measurements.

The Excel workbook for transects T1-T6 was used to compile data for new transects 7-8 from 61 hardcopy tally sheets recorded by day, transect, plot and subplot. Three separate Excel worksheets were used to store records for: 1) peat and tree volume counts, 2) biomass subplot data for small trees and 3) biomass subplot data for large trees. The data validation tool in Excel was used to constrain data entry and provide one data accuracy check. Data for each tally sheet was entered and reviewed one sheet at a time as a second accuracy check. Leslie conducted all data entry for transects T1-T8.

Hardcopy datasheets were photocopied with one set stored at the OFI office. Digital copies of Excel data have been sent to project participants at InfiniteEARTH, Forest Carbon and OFI.

5. Planned Analysis: Biomass and Land Cover

Data from transects T7 and T8 will be used to support analysis for the carbon assessment. Data analysis will include relating biomass measures on the ground (biomass plot data and basal area point counts) to aerial imagery from July 2009 over-flights of the transect sites and to satellite imagery. Survey data will also be used to develop allometric relationships of tree crown measurements to tree stem diameter, which can be used to predict tree biomass from tree crown measurements obtained from aerial imagery in Rimba Raya forests.

A key component of the carbon assessment will be extrapolating biomass estimates across the carbon accounting area based on land cover mapping. Existing land cover mapping for Rimba Raya is currently being updated using satellite image analysis techniques and field data collected during carbon assessment surveys. Data from the T7 and T8 surveys will provide important new ground verification for the land cover analysis. Image classification and delineation methods for kerangas and lightly logged, high biomass forest represented by T7 and T8, as well as swamp and dry ground forest surveyed on transects T1-T6 will be investigated in the land cover analysis.

It is expected that significant variation in forest-specific tree biomass can be detected on satellite imagery, which would enable biomass and carbon stocks to be systematically predicted across the landscape at Rimba Raya. Therefore survey data will also be used to train and test biomass mapping using remote sensing analysis techniques.

Acknowledgements

I thank the team members who helped carry out the survey: Pak Hadeli, Pak Rano, Pak Ajo, Pak Yuti of Orangutan Foundation International (OFI) and Pak Ikhas and Pak Nanar of Muara Dua village. I also thank Pak Fajar, Pak Tumin and OFI office staff who assisted with organizing personnel, logistics and transport for this fieldwork.

References Cited

Bolick, L. 2009. Field Report to InfiniteEARTH: Rimba Raya Carbon Assessment Survey June 22 – July 4, 2009. Technical Report July 18, 2009. Orangutan Foundation International. Pangkalan Bun Central Kalimantan, Indonesia.

Appendix A. Detailed Maps of Transect T7 and T8

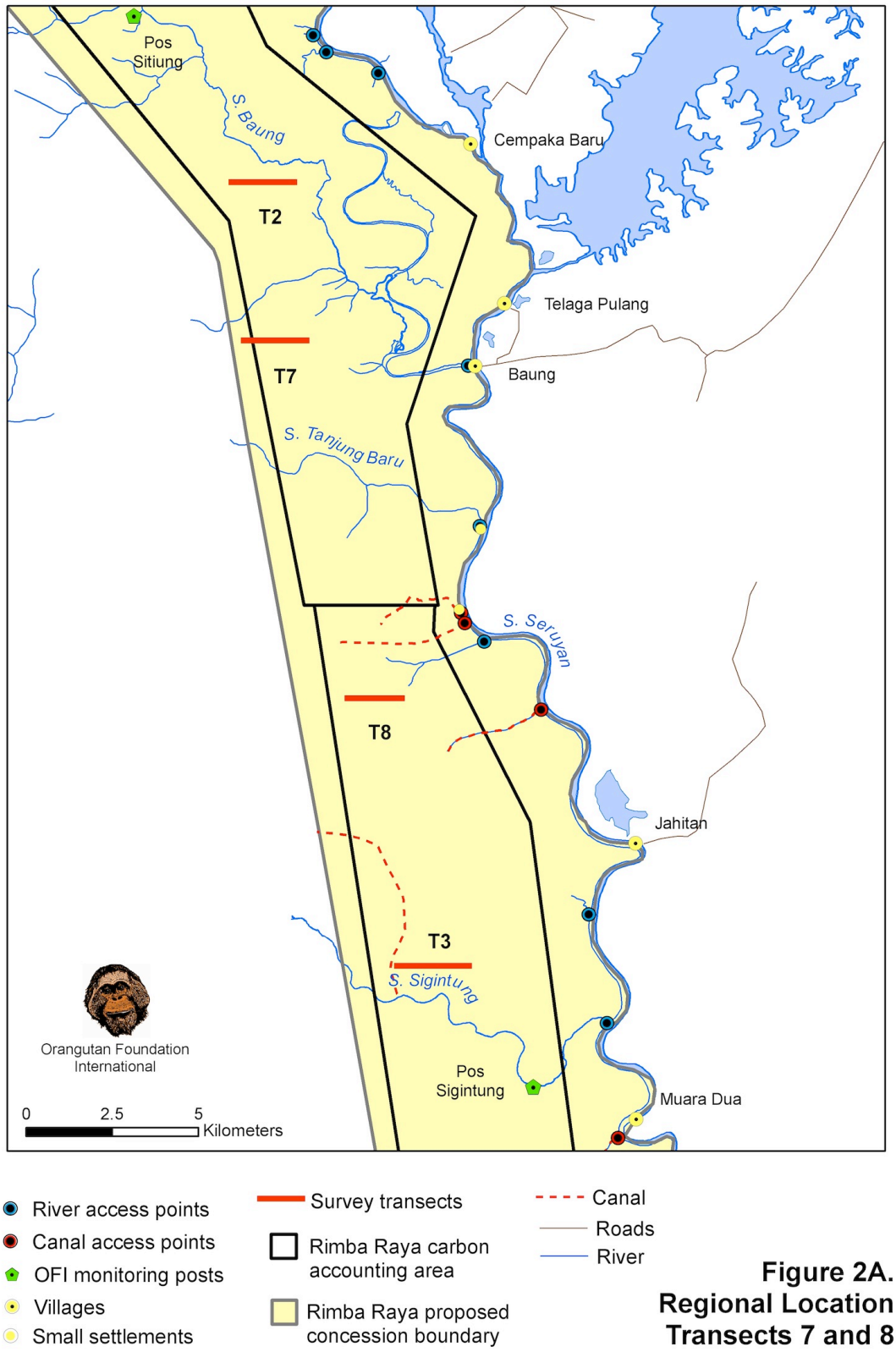


Figure 2A.
Regional Location
Transects 7 and 8

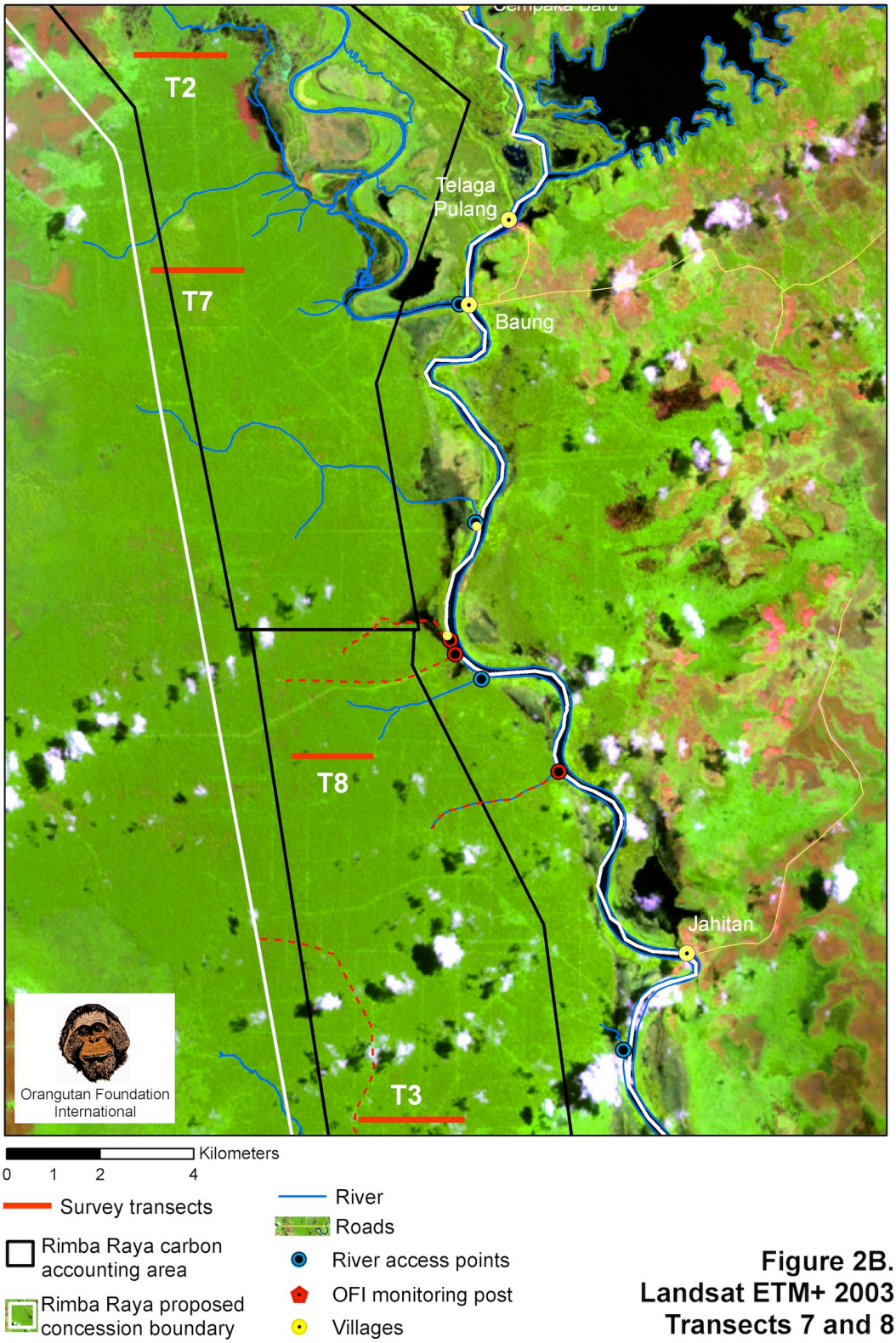


Figure 2B.
Landsat ETM+ 2003
Transects 7 and 8

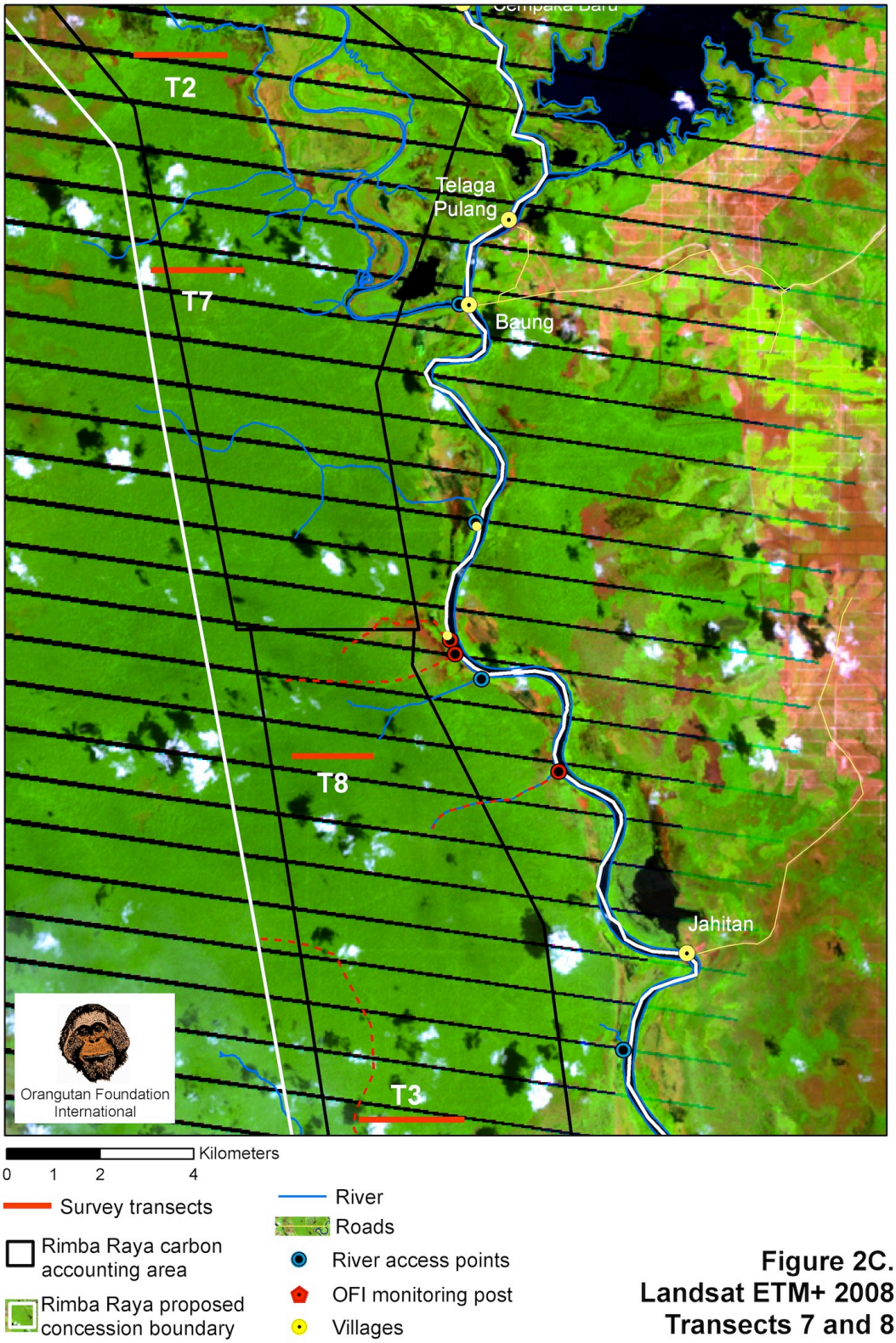
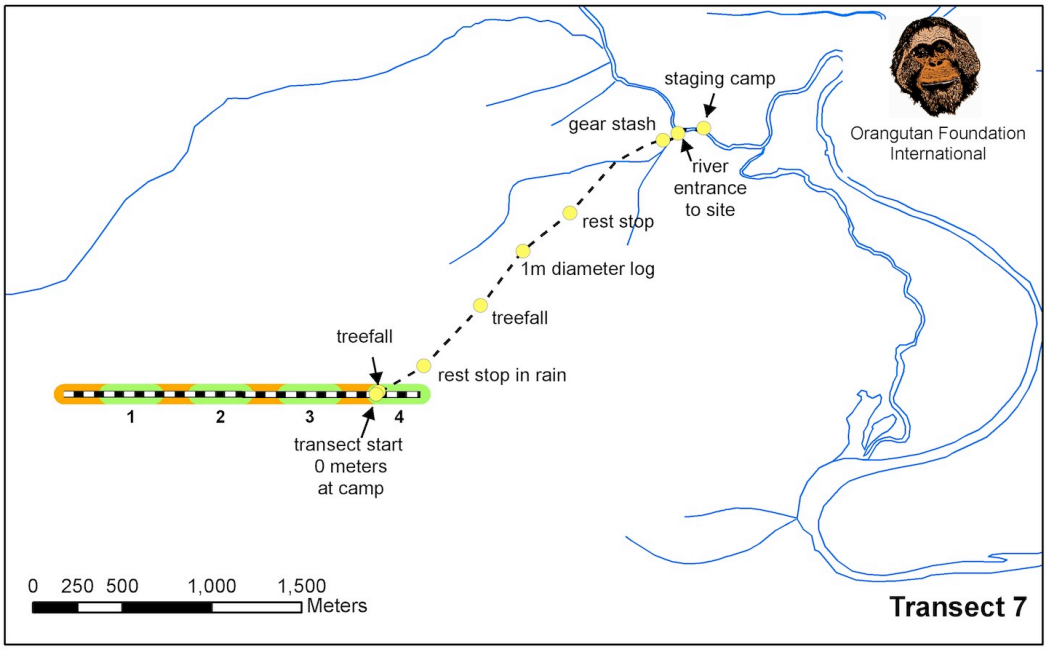
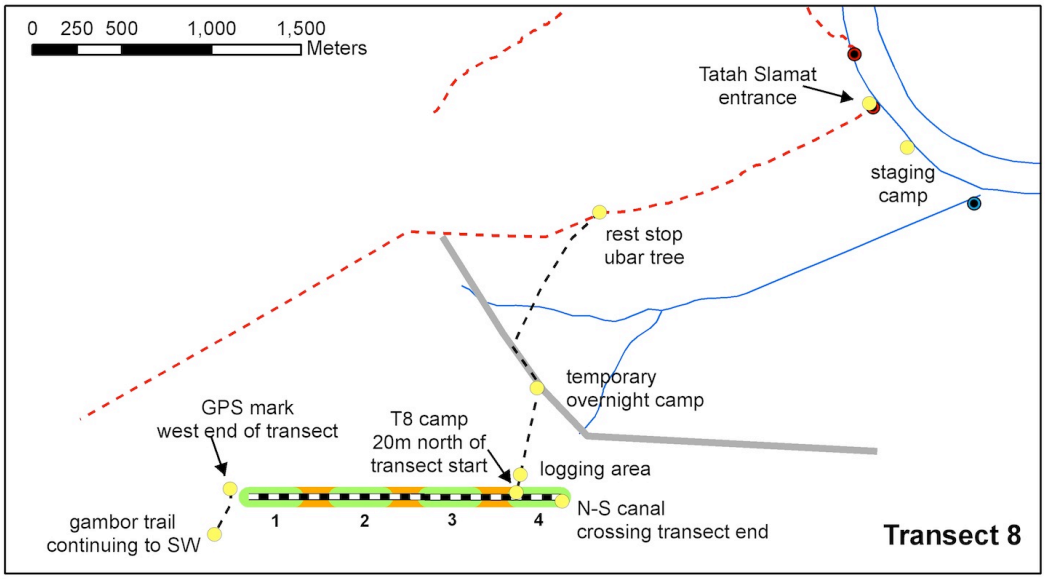


Figure 2C.
Landsat ETM+ 2008
Transects 7 and 8





site locations (edited from GPS data)

track walked/cut by survey team

transect marked and surveyed

Survey Type

peat, tree volume, biomass plot

peat, tree volume

logging rail

river

logging canal

river entrance

canal entrance

Figure 2D.
Survey Sites
Transects 7 and 8

Appendix B. Frequency of peat swamp forest species T1-T6

Table B1. Frequency of most common tree species on transects T1-T6 26 peat swamp forest plots, 6.5 ha

Species (Local Name)	Number of occurrences (of 1010 large trees measured)	Frequency (%)
Ketiau	92	9.2
Lamanaduk	68	6.7
Asam asam	40	4.0
Medang	40	4.0
Bentan	39	3.9
Idat	34	3.4
Lanan	33	3.3
Bekunyit	32	3.2
Banitan	31	3.1
Kumpang	30	3.0
Ramin	30	3.0
Pempaning	29	2.8
Jangkang	28	2.8
Jelutung	27	2.7
Penemplaan	27	2.6
Bekepas	26	2.5
Terantang	24	2.4
Ubar	24	2.3
Papung	23	2.3
Puak	21	2.1

This table and the tree density calculations for T1-T6 peat swamp forest exclude plot 1 on Transect 1 which was located in dry ground lowland forest and plot 1 on Transect 5 which was located in highly degraded swamp forest and had no measurable trees. Remaining plots are on transects T1 (3), T2 (4), T3 (5), T4 (5), T5 (4), T6 (5). Average large tree density for 26 peat swamp forest plots is 155 tree/ha.