Rapid Ecological Assessment
Columbia River Forest Reserve
Past Hurricane Iris

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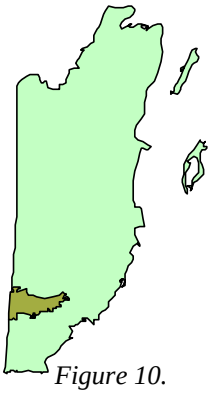

Figure 10. Location of CRFR within Belize

The Columbia River Forest Reserve (CRFR) is an approximately 60,000 hectare (148,357 acres) national protected area which is situated in the southern part of the country (Figure 1).

The CRFR is an area with a varied geology and ecosystems (Meerman & Matola, 2004, Meerman & Sabido 2001) and contains the headwaters of 6 watersheds of which the Rio Grande covers the largest area within the CRFR. To the north the CRFR is bordered by the Chiquibul National Park and the Bladen Nature Reserve. To the west lies Guatemala and to the south and east lies a densely inhabited area in which most of the natural vegetation has been converted to agricultural uses (Figure 2).

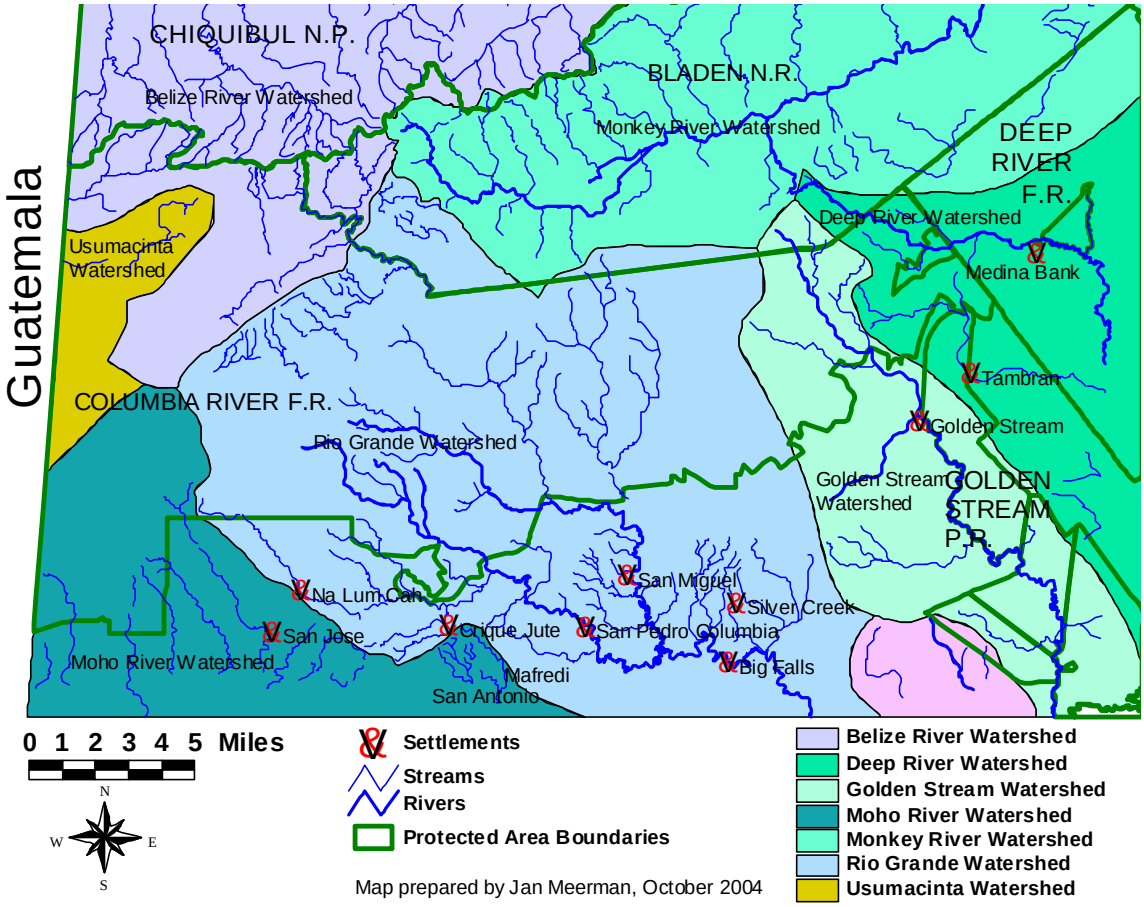

Figure 11. Map of the Columbia River Forest Reserve showing watersheds, protected areas, rivers, stream and settlements.

Perhaps due to its size, remote location and challenging terrain, the CRFR is relatively little documented. Also research has generally focused on discrete areas within the CRFR (Bird, 1994, 1998, Meerman & Holst. 1999, Meerman & Matola, 2004, Parker et al. 1993). Its significance as a location of globally-significant biodiversity has been nevertheless widely recognized as a result of the limited research conducted within its boundaries. As noted by Parker et. al, 1993:

Plant species found in the wet hill and low mountain forests in the CRFR are apparently among the unusual floristic elements of a once widespread lower montane type that now survives in widely separated and fast shrinking patches scattered along the Caribbean slope in Middle America. The extensive subtropical lower montane wet forest at 600-900m in the CRFR is undoubtedly one of the largest examples of its kind left in Central America.

These considerations led to an initial management plan including zonation of the CRFR (Bird, 1994), designed to create no-impact protection forests for the conservation of critical biodiversity and ecological services, and to regulate resource extractive activities within a ±65,000 acre forestry extraction zone. While logging in permitted areas was restricted to one out 40 compact 500 ha blocks per year (Figure 3).

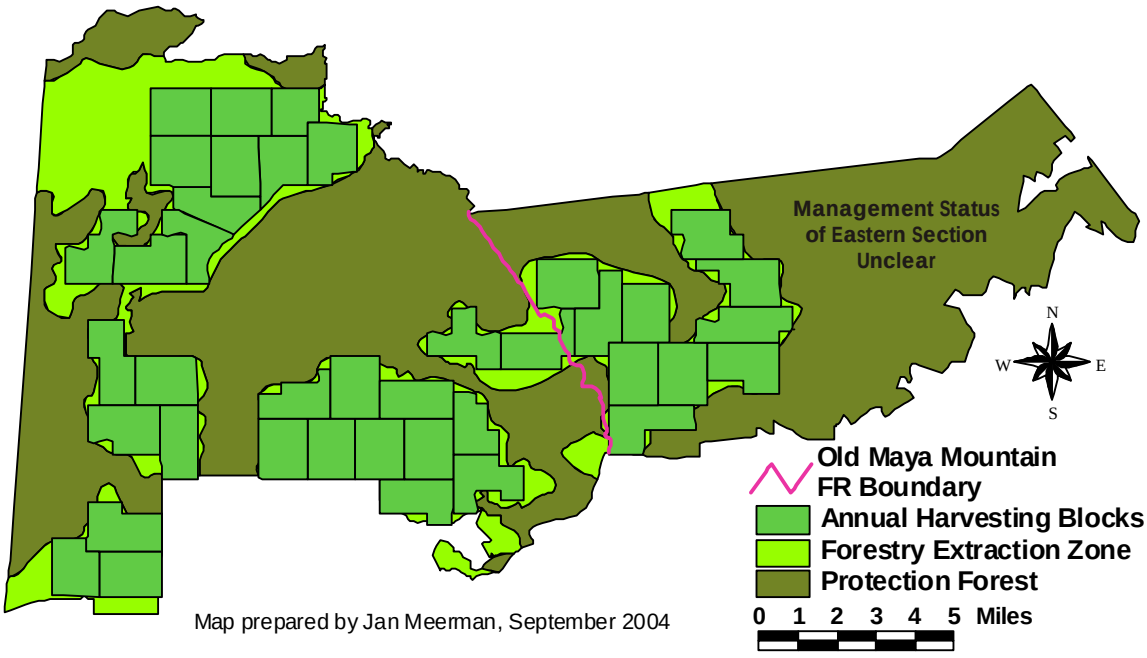

Figure 12. Harvesting Plan for the CRFR based on the 1994 management plan

Meanwhile, since the time of the publication of the CRFR draft management plan, certain conditions have changed in the reserve, which suggest a revision of these guidelines and management criteria might be in order. First there is the extension of the CRFR boundaries themselves, to include the Maya Mountain Forest Reserve - West (MMFRW) which was amalgamated within the CRFR under Statutory Instrument No. 115 in 1997. While the 1994 management plan incorporated the western section of the MMFRW, it did not specify the

Figure 13. Satellite image (May 9, 2004) showing two distinct smoke plumes originating from the CRFR

zonation of the eastern most part (i.e. the section towards Medina Bank). This omission is a complication factor in the establishment of a management regime of the CRFR.

In addition, the devastating blow inflicted upon the CRFR by Hurricane Iris in October 2001 (Meerman, 2001 and see figure 5 below) had doubtless affected considerable change in the integrity of its ecosystems; the impacts of which may have been further aggravated by manmade stresses upon the CRFR such as runaway Milpa Fires in the year 2003 (Figure 5). Fires raged through parts of the CRFR during early May 2003. The satellite image in figure 4 was taken on May 9, 2003, 16.45 hr local time. Two smoke plumes are clearly visible in the Golden Stream/Columbia River areas.

Following the Hurricane Iris impact, salvage permit licenses were issued to extract hurricane-felled lumber. These salvage licenses are subject to only minimal supervision or guidance over either their coverage or extractive practices and fears have been expressed that natural regeneration processes might be inhibited by these activities. This, in turn, could seriously affect the potential for sustainable management of the forests in the medium to long-term.

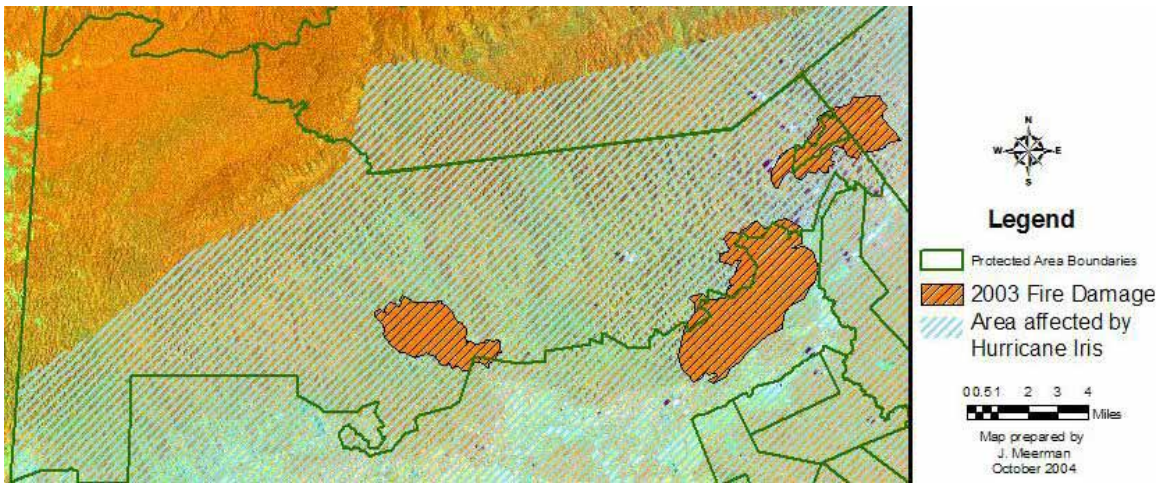

Figure 14. Areas affected by Hurricane Iris (2001) and by escaped milpa fires (2003).

Nevertheless, in the absence of any serious research within the CRFR to determine the conditions of the post-Iris forest, or to evaluate the location and possible impacts of the ongoing salvage logging operations, effective management recommendations cannot be devised or acted upon. In sum, there is clearly an urgent need to revisit the management conditions and zoning recommendations developed a decade ago for the CRFR, in light of new circumstances and the possible lack of enforcement of those previously defined.

From the perspective of landscape integrity and ecosystem interconnectivity, the CRFR and the Maya Mountain range in which it is situated also plays an extremely critical role in maintaining ecosystem health throughout the various watersheds that originate in the

mountains, disburse into the Port Honduras Marine Reserve, and impact the Belize Barrier Reef World Heritage Site beyond. As a result, the ecological implications of sustainable management for the CRFR reach far beyond the boundaries of the forest reserve itself, affect the entire spectrum of terrestrial and aquatic ecosystems in southern Belize. In a period when considerable attention is being paid to ensuring the relevance and effectiveness of Belize's protected areas system, with a revision and overhaul of the entire legislative system currently underway, the importance of ensuring that the respective, internal management systems for Belize's national protected areas are based upon relevant, current data is clearly consistent with existing trends in national protected areas management.

In light of the above, the goal of the current study was to establish a framework for increasing the likelihood of sustainable management of CRFR by providing post hurricane baseline data. This goal will be achieved through meeting several subsidiary objectives, namely:

1. Assessing the impacts occasioned by natural and man-made disasters upon forest ecosystem integrity in the CRFR during the 10-year interval;

2. Assess the occurrence and density of "Xate" (*Chamaedorea* spp.)

3. Evaluating the relevance of 1994 management zones in the 2004 context;

4. Developing management recommendations to promote sustainable, long-term management on the basis of the findings emerging from 1 & 2 above.

Methodology

Fieldwork was carried out between May and August 2004. The core of the research consisted of vegetation transects. No other groups such as birds or mammals were investigated. The reason for this limitation were mostly time and budget constraints. The methodology used for the vegetation transects has been adapted from the methodology used by the Forest Planning and Management Project (FPMP) in Belize (Shawe, 1997). This methodology involved the opening of a 200 meter long line through the vegetation under study. The actual transect consists of a 4 m wide band along this cut line. In this transect, all trees with a diameter at breast height (dbh) of more than 10 cm are counted, dbh measured and where possible identified. Although only trees with dbh > 10 cm were measured, other identifiable vegetation was noted down as well. Particular attention was paid to seedlings/saplings of timber trees and "Xate" palms (*Chamaedora* spp.). The results of the Xate count are presented in a separate report (Meerman, 2004). A total of 10 transects was established and thus a total area of 8000 m² (0.8 ha or 2 acres) was investigated.

The transects were situated throughout the central and eastern half of the Columbia River Forest Reserve. Figure 6 gives a visual presentation of the location of the various transects. Access in the hurricane damaged CRFR is restricted to logging roads. Straying too far from these logging roads was inhibited by the dense tangle of fallen trees and disturbed vegetation. Siting of the transects was therefore dictated by access. Selection of transects was also based on landscape. Half of the transects was established on largely flat terrain, while the other half was established on steep slopes. One transect was established in an area affected by the 2003 wildfire and 3 transects showed signs of logging activities.

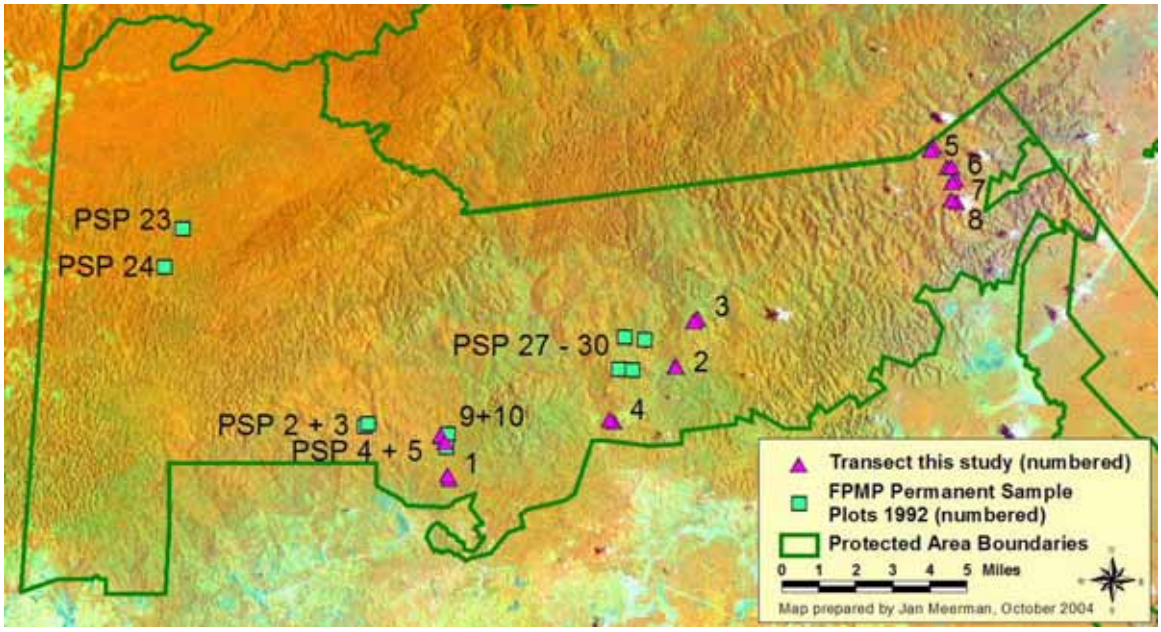

Figure 15. Satellite image (April 30, 2003, RGB: 354) of the Columbia River Forest Reserve with indicated Protected Area boundaries and locations of the current study's transects as well as the locations of the Permanent Sample Plots (PSP's) established by the Forest Planning and Management Project (FPMP) (Bird 1998). Note that PSP 23 + 24 do not geographically coincide with the current studies transects, and for this reason have not been incorporated in the analysis.

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The REA team was composed as follows:

Jan Meerman, Seven Miles, Cayo District. Principal consultant. Biodiversity specialist. The principal consultant has extensive experience in REA studies and protected area management and is author of various biodiversity papers. For example, the consultant is the principal author of the recent ecosystem map of Belize and co-author of the Central-American Ecosystems map. Presently consultant is working on the National Protected Areas Policy and Systems Plan (NPAPSP). On other fields consultant is the Belize contact person for MAYAMON anuran monitoring project. The office of the principal consultant has in-house GIS capacity. Specific fields of expertise: Flora, Reptiles, Amphibians and Butterflies.

Augustin Howe, San Antonio, Cayo District. Former Forest Planning and Management Project Employee. Tree Identification Specialist.

Assistance during the field work was received from YCT and TIDE staff. All YCT staff was introduced in the transect methodology and the majority of them exercised in the field. The following people participated: Marchilio Ack, Julio Chub, Anselmo Chaveria, Esteban Ak, Eugenio Ah.

Results

A total of 10 vegetation transects were established. Since each transect measured 4 x 200m, the total area investigated was 8000 m² or 0.8 ha or about 2 acres. While it was not possible to identify every single plant species encountered, an attempt was made to identify at least the tree species. In this the exercise was fairly successful since only 14 trees could not be identified to at least family level. In total 261 taxa were identified belonging to 87 families. The total results of the transect count can be found in the MS Excel file <transectdata_CRFR.xls> on the CD. A summary of the transect data can be found as an appendix to this document.

The actual analysis of the transect data is represented in table 1 on the following pages. In order to be able to put the transect data in context, the data were compared to pre-hurricane data collected by the FPMP in 1992 (Figure 7)(Bird, 1998). In 1992, the FPMP established a total of 30 "Permanent Sample Plots" (PSP) in forest extraction areas throughout Belize. 10 of these transects were located in the CRFR. Of these, two were located in the Little Quartz Ridge area, away from our study sites and subject to different geology and disturbance regimes. For this reason only the 8 transects (numbers 2-5 and 27-30) that geographically coincide (figure 6) with our research transects were used in the comparison. It should be noted that part of the PSP data was derived from Bird (1998), while additional information was obtained from the original data set that is housed at the Forest Department offices in Belmopan.

The analysis followed a standard procedure in which several biodiversity indices were calculated using Biodiversity Pro software. These variables are represented in table for comparison. The most important of these biodiversity indices is the Shannos's Index H' and this one will be discussed here in detail:

shannon's index, H'. The Shannon index (H') has probably been the most widely used index in community ecology. It is based on information theory and is a measure of the average degree of "uncertainty" in predicting to what species an individual chosen at random from a collection of S species and N individuals will belong. This average uncertainty increases as the number of species increases and as the distribution of individuals among the species becomes even. Thus, *H'* has two properties that have made it a popular measure of species diversity: (1)" $H' = 0$ if and only if there is one species in the sample, and (2) *H'* is maximum only when all *S* species are represented by the same number of individuals, that is, a perfectly even distribution of abundances. When all species in a sample are equally abundant, it seems intuitive that an evenness index should be maximum and decrease toward zero as the relative abundances of the species diverge away from evenness.

In our case, the biodiversity index expressed by H' comes out significantly lower than the pre-hurricane (1992) biodiversity figures for the same area. Two transects show a particularly low biodiversity index which includes the burned site # 4 near San Jose and a lowland site # 9 near Jimmycut. The latter had a wide logging road passing through the transect which clearly influenced the biodiversity values (increased disturbance, added "edge effect").

Table 3. Biodiversity indices compared between transects. FPMP sample plot data on the following page.

	1: Jimmycut	2: San Jose	3: San Jose	4 Burned San Jose	5 Medina Bank	6 Medina Bank	7 Medina Bank	8 Medina Bank	9 Jimmycut	10 Jimmycut
	Gently rolling	Steep	Steep	Gently rolling	Flat + steep	Gently rolling	Flat + steep	Steep	Steep	Gently rolling
N_0 = Number of species	22	20	14	9	27	14	17	21	13	14
Shannon H' Log Base 2.718	2.546	2.918	2.53	2.146	3.105	2.525	2.682	2.793	2.026	2.329
Evenness E1 (Shannon J')	0.836	0.974	0.959	0.977	0.942	0.957	0.947	0.917	0.815	0.883
Rarefraction at sample size of 10 trees	7.02	9.08	7.82	8.36	8.65	7.96	8.11	8.06	5.91	7.02
Rarefraction at sample size of 20 trees	11.38	16.35	12		15.09	12.48	13.32	13.68	9.13	11.34
Rarefraction at sample size of 30 trees	14.93				20.17		16.74	18.22	11.36	
Rarefraction at sample size of 40 trees	17.98				24.38					
Rarefraction at sample size of 50 trees	20.71									
Living stems > 10 cm dbh (incl. vines)	55	26	29	11	47	25	31	37	34	27
Average stem dbh in cm (living only)	17.4	25	16.9	27.4	19.9	23.4	19.3	18.7	17	18
Number of trees (non vines)	78	61	90	87	153	153	99	116	141	80
Total dbh living trees	958	651	489	301	934	584	599	691	577	487
Total dbh dead trees	294	482	754	446	389	447	125	239	498	360
Number of dead trees	10	16	30	17	16	17	8	7	15	8
Space per living tree in m^2	14.5	30.8	27.6	72.7	17	32	25.8	21.6	23.5	29.6
Total species	34	37	40	36	67	53	33	51	53	38
Dominant tree species (> 10% of total, >10cm dbh)	*Cestrum, Heliocarpus*	*Attalea cohune*	*Alseis yucatana, Cecropia, Sabal, Solanum sp. Trichospermum*	*Cecropia, Heliocarpus*	*Protium*	*Protium, Mosquitoloxylon jamaicense, Dialium guianense, Cordia*	*Cordia, Hirtella americana*	*Cordia, Hirtella americana, Laurel*	*Helicocarpus, Cestrum*	*Cecropia, Cestrum, Heliocarpus*
Dominant woody species	*Cestrum, Heliocarpus*	*None*	*Cecropia sp.*	*Cecropia*	*None*	*None*	*Hirtella americana*	*None*	*Helicocarpus, Cestrum*	*Cecropia*
Largest biomass	*Cestrum, Heliocarpus*	*Attalea cohune, Pouteria durlandii*	*Alseis yucatana, Sabal mauritiiformis*	*Cecropia, Ceiba pentandra*	*Vochysia hondurensis*	*Mosquitoloxylon jamaicense, Dialium guianense, Cordia*	*Cordia, Attalea cohune*	*Alseis, Cordia*	*Brosimum, Heliocarpus, Cestrum*	*Verbenaceae, Pouteria sp., Brosimum alicastrum, Cecropia*

	PSP 2	PSP 3	PSP 4	PSP 5	PSP 27	PSP 28	PSP 29	PSP 30
N_0 = Number of species								
Shannon H' Log Base 2.718	3.381	3.584	3.631	3.144	3.069	3.28	3.507	3.146
Evenness E1 (Shannon J')	0.84	0.875	0.858	0.765	0.811	0.83	0.837	0.751
Rarefraction at sample size of 10 trees	8.2	8.61	8.46	7.53	7.52	8	8.3	7.43
Rarefraction at sample size of 20 trees								
Rarefraction at sample size of 30 trees								
Rarefraction at sample size of 40 trees								
Rarefraction at sample size of 50 trees								
Living stems > 10 cm dbh (incl. vines)								
Average stem dbh in cm (living only)								
Number of trees (non vines)								
Total dbh living trees								
Total dbh dead trees								
Number of dead trees								
Space per living tree in m^2								
Total species								
Dominant tree species (> 10% of total, >10cm dbh)	*Pouteria sp.*	*None*	*Protium copal*	*Guarea granifolia, Lauraceae, Unknown species*	*Unknown species*	*Unknown species*	*Unknown species*	*Unknown species, Garcinia intermedia*

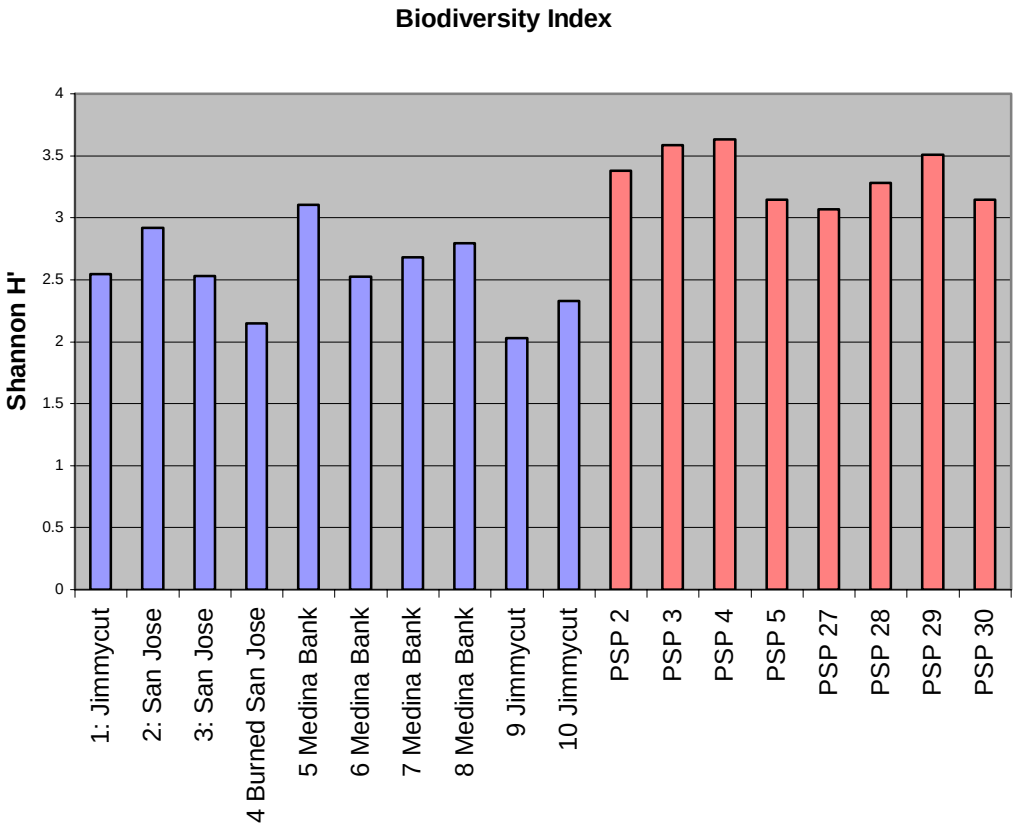

Figure 16. Shannon's Biodiversity Index H': Transects 1-10 refer to the current study. PSP transects refer to data collected by the FPMP (Bird 1998).

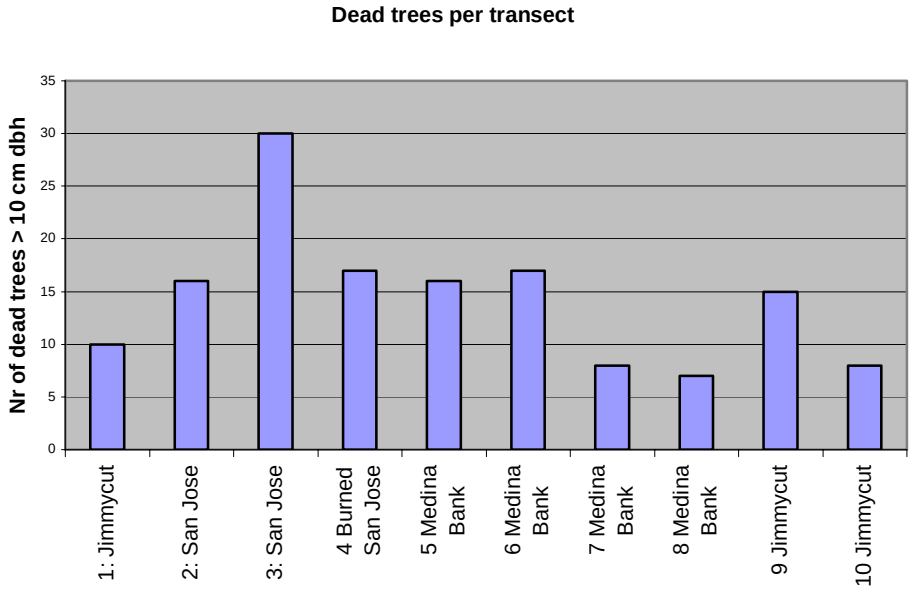

Figure 17. Number of dead trees on each transect

As part of the normal procedure for a vegetation transect, dead or downed trees are measured once the original base of the tree is in the 4 m wide swath of the transect. In the case of the CRFR transect this proved to be unexpectedly difficult. The tangle of dead trees and branches often made it difficult to find the original base of the downed trees. In the case of the burned transect #4, an unknown number stems had burned away. Also it is possible that some of the stems originally felled by the hurricane had already rotted away. Some species decompose very quickly.

The count errs on the safe side and it is probable that the actual count of dead trees for some transects should have been a little higher than the official count suggests. Nevertheless, and as expected, the count of dead trees per transect (figure 8) was very high and well above normal (in other locations I have noted dead tree counts between 0-5 per transect – personal database) Note that no dead tree figures were available for the FPMP PSP's).

The low biodiversity figure for burned transect # 4 must be attributed to the additional disturbance caused by the fire. The low biodiversity figure of the #9 Jimmycut transect must be attributed to the large logging road bisecting the transect. While the effect of logging roads may seem localized, the drop in biodiversity caused by logging roads should not be ignored. This particularly considering the local high density of logging roads in the area (see figure 10 to the left).

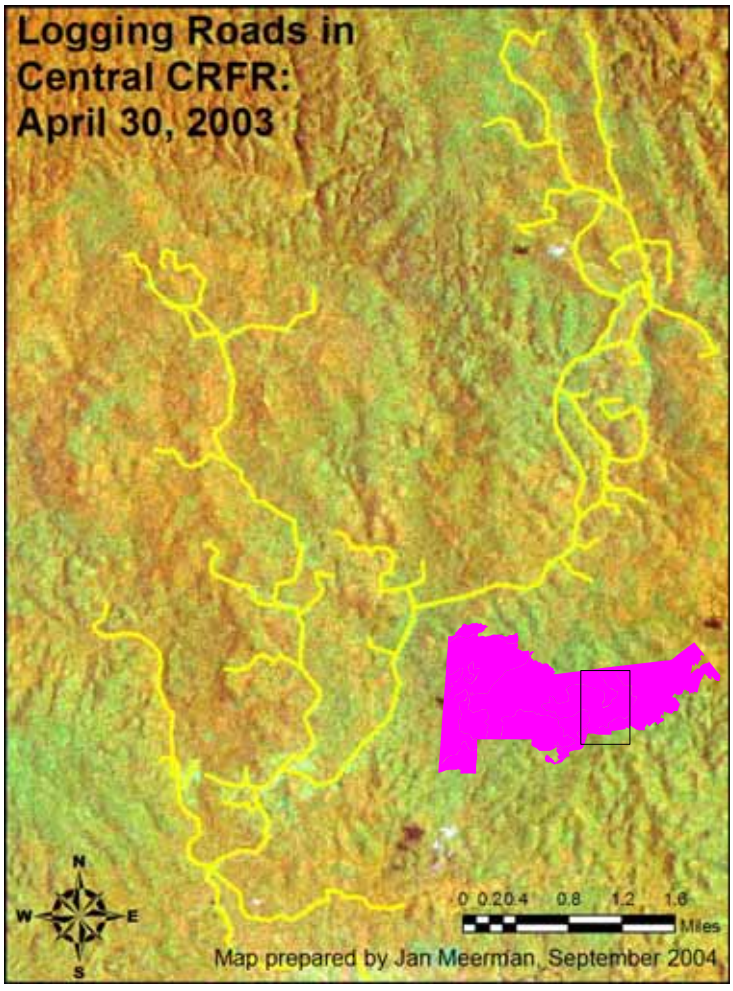

Figure 18. 2003 main logging roads in central CRFR indicated in yellow. Pink inset indicates location.

The roads indicated in figure 10 indicate only roads visible on Landsat Satelite image which has a pixel size of 30 x 30 meters, and thus must be wider than 30 m!. Smaller roads are not indicated but are no doubt more numerous than these major roads.

The risk of these roads is that the stumps and roots of the original vegetation is removed after which it will be recolonized by pioneer species which are capable of suppressing regeneration of the more desirable primary species (Finegan 1996), this apart from other risks such as soil compaction and erosion.

An important component of the study was tree species composition. The tree species composition on our transects was dominated by in total 14 species. Dominance was calculated for each individual transect as meaning species that make up more than 10 % of the total number of species measured (and thus >10 cm dbh) for that particular transect. These species combined for all transects are in alphabetic order:

- *Alseis yucatenensis* (Cacao Che, Wild Mamee),
- *Attalea cohune* (Cohune),
- *Cecropia* sp. (Trumpet Tree),
- *Cestrum* sp. (Night Bloom),
- *Cordia* sp. (Sombrerito),
- *Dialium guianense* (Ironwood),
- *Heliocarpus* sp. (Broadleaf Moho),
- *Hirtella americana* (Pigeon plum),
- "Laurel" (Lauraceae)
- *Mosquitoloxylum jamaicense* (Bastard Mahogany),
- *Protium copal* (Copal),
- *Sabal mauritiiformis* (Bayleaf),
- *Solanum sp.* and
- *Trichospermum grewiifolium* (Narrow Leaf Moho).

A number of these are secondary growth species. Indeed, within this section of 14 dominant species, 50 % of the total dominant individuals count was mad up by 4 pioneer species.

- (*Heliocarpus* (Broadleaf Moho),
- *Cordia sp. (Sombrerito),*
- *Cestrum sp. (Night Bloom)* and
- *Cecropia* (Trumpet Tree).

Another measure of dominance is the actual dominance of potential tree species. This does not only look at individuals above 10 cm dbh but takes into account smaller trees and even seedlings. This gives a good indication of the level of regeneration. The most dominant potential tree proved to be *Cecropia* sp (Trumpet Tree), followed by *Heliocarpus* sp. (Broadleaf Moho), *Cestrum* sp. (Night Bloom) and *Hirtella americana* (Pigeon Plum). Again (with the exception of *Hirtella americana* (Pigeon plum) these are typical pioneer species which seems to indicate that the pioneer species still have not reached their peak of abundance.

Taking into effect that pioneer species apparently still have not reach their peak abundance, it can be expected that biodiversity indices can be expected to decrease in the next few years as the pioneer species mature.

Looking at largest biomass (accumulative dbh), the picture does not change much:

- *Cordia* sp. (Sombrerito),
- *Heliocarpus* (Broadleaf Moho),
- *Cestrum* sp. (Night Bloom) and
- *Cecropia* sp. (Trumpet Tree)

These species are still responsible for the bulk of the biomass. At some distance follow the hurricane survivors:

- *Alseis yucatenensis* (Cacao Che, Wild Mamee),
- *Attalea cohune* (Cohune),
- *Brosimum alicastrum* (Breadnut, Ramon),
- *Ceiba pentandra* (Cotton Tree),
- *Dialium guianense* (Ironwood),
- *Mosquitoloxylum jamaicense* (Bastard Mahogany),
- *Pouteria durlandii* (Silion),
- *Pouteria sp.*(Silion),
- *Sabal mauritiiformis* (Bayleaf),
- Unidentified Verbenaceae and
- *Vochysia hondurensis (*Yemeri*)*

Unfortunately, during the FPMP project some of the dominant species are listed as "unidentified species" so that a good comparison is not possible. However, the following species featured heavily on these transects:

- *Cupania belizensis* (Grande Betty)
- *Garcinia intermedia*
- *Guarea grandifolia* (Cedrillo)
- "Laurel"
- *Poulsenia armata*
- *Pouteria sp.* (Silion)
- *Protium copal* (Copal)
- *Pseudolmedia sp.* (Cherry)

The only overlap between the two lists is from *Protium copal* and the *Pouteria* sp. Whether this difference is a result of differenced in site locations or difference in hurricane survivorship can not be explained at this stage.

Xate palms of the genus *Chamaedorea* were also surveyed (see separate report Meerman, 2004). The counts could be compared to the counts made during the FPMP permanent sample plot project (Bird, 1998, Forest Department Database). During the FPMP study, (in the 8 geographically coinciding transects) a total of 1480 *Chamaedorea* palms (unspecified species) were tallied, which translates to 74 palms per acre. During the present study, we counted 121 *Chamaedorea* palms per acre. Although *Chamaedorea* species don't seem to fare well in open, disturbed habitats (pers. obs.), these figures indicate that the *Chamaedorea* populations in the CRFR were not impacted by the hurricane induced damage. One can theorize that after the hurricane, the canopy closed quickly (with vines and other secondary vegetation) enough to prevent permanent damage to the *Chamaedorea* plants.

It should be noted that in the above analysis primary timber species don't make an appearance. Not a single live Mahogany (*Swietenia macrophylla*) or Ceder (*Cedrela odorata*) was

found. Either seedling, sapling or tree (1 logged Mahogany and one "naturally" dead Mahogany were found on the transects).

Wright (1959) reported primary hardwood densities for the forest types in the CRFR. He lists 1 mahogany and 1 Cedar per acre for the flatter terrains and 0.2 Mahogany and 1 Cedar per acre for the hilly terrain. These data are probably estimates and not based on actual data.

During the first half of the 1990'ies, the Forest Planning and Management Project (FPMP) established 30 permanent study plots of 1 ha in various forest reserves throughout Belize, 8 of which concern our study area (2-5 and 27-30) See map in figure 6 earlier in this report.

These older data give excellent opportunities to compare occurrence of timber species pre- and post- hurricane Iris. The comparison of primary and secondary timber species (the species selection of the latter based on Salazar, 1997) of older reports and those found on this study's transects are listed in table 2 below.

Table 4. Timber tree densities compared to two older studies (recalculated to 1 acre areas).

	Wright	**FPMP PSP's**	**This study**	
Species	1959	Total PSP 2,3,4,5,27, 28, 29, 30	Individuals only > 10 cm dbh	Nr of individuals (including seedlings)
*Aspidosperma cruentum (*Mylady*)*		2	1.5	6
Astronium graveolens (Jobillo)		0.1	1	3
*Callophyllum brasiliensis (*Santa Maria)		1	0	4
Cedrela odorata (Cedar)	1	0	0	0
Ceiba pentandra (Cotton Tree)		0.2	0.5	3
Cordia alliodora (Salmwood)		0	0	1
*Dialium guianense (*Ironwood*)*		2	2	5
Drypetes brownei (Bullhoof)		4	0	1
Jacaranda copaia		0	1	4
Lonchocarpus castilloi		0.2	0	0
*Manilkara sp.(*Chicle*)*		1.6	1	5
Simira salvadorensis (Redwood)		0.8	0.5	2
Swietenia macrophylla (Mahogany)	0.1 - 1	0.3	(1 logged specimen)	0
Terminalia amazonica (Nargusta)		0.6	1.5	3
Virola koschnyi. (Banak)		0.5	0.5	3
*Vochysia hondurensis (*Yemeri*)*		0.3	1	6

This table also shows the total number of individuals (Both above and below 10 cm dbh including conspicuous seedlings) found on this studies transects. The number of individuals < 10 cm dbh gives some indication of the regeneration of the species concerned. What appears clear from this comparison is that the current findings do not differ dramatically from the 1992-1994 FPMP data. The differences in densities are quite easily explained by normal differences between sites. This conclusion is somewhat surprising given the

destruction wrought by hurricane Iris (the data of the current study do not give any indication of the quality of the trees, crown damage etc.).

Based on the number of young trees, it appears that the secondary timber species with Yemeri (*Vochysia hondurensis*), Mylady (*Aspidosperma cruentum*) and Chicle (*Manilkara* spp.) being the most successfully regenerating species.

Most concerning from the point of the timber industry would be the low level of Mahogany regeneration. Both Wright (1959), Bird (1998) reported on a very low Mahogany density. The fact that during the current survey we didn't find a single standing Mahogany tree on any of the 10 transects may have been caused by the indiscriminate removal of remaining Mahogany trees (we found one logged stump and one naturally dead Mahogany). As part of the salvage logging license, standing Mahogany trees can only be cut if they have little change of immediate survival (former Chief Forest Officer Sabido, pers. com.) such at the discretion of the local forest officer. In our experience, every standing tree in the project area (Mahogany or other) has sustained crown or stem damage and this has apparently been used as an excuse to remove every Mahogany tree that could be reached.

Even more concerning was the apparent absence of young Mahogany trees and Mahogany seedlings. Normally in suitable forest habitat (particularly after disturbances such as hurricanes and logging) in Belize it is common to find numerous Mahogany seedlings. We couldn't find a single one. Either on, or outside, the transects. This lack of seedlings raises the fear that regeneration of Mahogany to an economically interesting density will not be taking place.

Theoretically, it could be expected that after a hurricane, the remaining Mahogany trees, while freed from competing crowns would be able to set fruit in abundance. Apparently this did not happen. In this context it is interesting to mention the experience of foresters in the Programme for Belize lands in the North of Belize. For this area it was reported that both 2002 and 2004 were bad years for Mahogany in terms of seed production (Wilber Sabido, Programme for Belize, Pers. Com.). While the situation in the Programme for Belize lands (Northern Belize) may not be similar to those in CRFR, this example should demonstrate that it should not be expected that every year is a good reproduction year and a possible succession of "bad" seed years is a factor that needs to be considered. A succession of bad seed years combined with naturally low mahogany densities, a high seed tree mortality due to the hurricane and a high tree mortality due to unrestrained harvesting would all conspire to a dangerously low reproduction success.

Of the 10 transects established, 5 were on relatively flat terrain and 5 were on steep hill slopes. On 3 of the transects, signs of recent logging could be noted. All of these were in the flat transects and none on the steep slopes (even though some of the logging roads traverse exceedingly steep slopes) and as such it appears that the intent of the 1994 management plan (to avoid sensitive areas based on slope) is to a largely extend being adhered to (possibly by practical default). Outside the transects we noted only one felled tree on a very steep slope, but then it should be remembered that we did not investigate all the logged areas.

Unfortunately in the case of Mahogany, this species generally occurs most plentiful on flat terrain, which is exactly where the most intensive logging activities have been taking place. Thus exacerbating the reduction of the potential seed pool.

Meanwhile it should not be forgotten that the CRFR is not a prime Mahogany habitat. The densities are probably low for natural reasons. The good Mahogany are have to be sought in the flat lands of northern Belize. The FPMP (Bird, 1998) measured average Mahogany densities in the Fresh Water Creek Forest Reserve and in the Rio Bravo lands of 6.5 trees per acre!

Conclusions

Main findings can be summarized as follows:

- The transect method could not establish any clear differences in tree biodiversity values between steep, flat, logged or un-logged sites. The lowest biodiversity values were found in the one transect that was affected by the 2003 wildfire and in the transect that was traversed by a large logging road.

- Noticeable was that overall, the tree biodiversity indices of the CRFR sites has dropped compared with 1992 data. It should be remembered that forest disturbance normally leads to increase in biodiversity, but that this increase is typically caused by the increase in vines and herbaceous species. The biodiversity figures in the current study however, apply only to the tree flora. Taking this into account, part of the "new" tree biodiversity is now the result of secondary growth tree species.

- Biomass has shifted to pioneer species.

- In most areas the canopy has closed quickly (with vines and other secondary growth vegetation) which protected the soil and prevented permanent damage to understory shrub vegetation such as *Chamaedorea* palms.

- There is regeneration of secondary timber species but apparently not or very little of primary timber species (Mahogany and Cedar).

Careful conclusions from this all:

- Hurricane Iris has slightly lowered the general tree biodiversity levels.

- Although biodiversity indices have dropped, they are still sufficiently high to indicate that the importance of the CRFR for conservation has not diminished.

- Species composition has been dramatically altered and shifted towards pioneer species. However, the original "climax" species are still present in sufficient levels to allow good regeneration from an ecological point of view.

- The shift from "climax" species to pioneer species does seem to affect the ecological "value" of the affected part of the CRFR but pioneer species form an integral part of the recovery process and "biodiversity breeds biodiversity". Also the rapid closure of the canopy by secondary growth species has prevented soil erosion and protected certain sensitive understory species. Thus, a high level of secondary growth species biodiversity should have a positive effect on the recovery process. In essence it is a temporary phase since in extensive hurricane blow-downs regeneration is largely by tree species already present as suppressed plants in the understory or stumps capable of resprouting after damage (Boucher *et al*. 2001). Most natural regeneration tropical forests free from human disturbance comes from established plants, the species composition of which roughly reflects the pre-disturbance community.

- Fire affects the tree biodiversity more than just hurricane damage. The additional risk of areas damaged by fire is that such land is quickly occupied by one or a few early successional species, followed by what has been termed a 'pioneer desert' (Martinez-Garza &

Howe, 2003) of early and late pioneers that retards the influx of disperser-limited deep-forest trees for a century or more (Finegan 1996). Fire is also know to negatively affect the "regeneration" of the bird fauna (Lynch, 1991)

- Salvage logging as implemented in the CRFR may well be negatively affecting regeneration of primary timber species and thus affect the silvicultural value of the Forest Reserve on the long term. This raises concern for the economical future of the CRFR.

- Logging roads affect local biodiversity levels through removal of remnant vegetation and compaction. Given the density of logging roads in the project area, they may well influence the regeneration process of the hurricane affected area.

Management Recommendations

Based on the above findings and conclusions, the following important recommendations come forward:

- The 1994 management plan should still be adhered to in the extend that (salvage) logging only takes place in the harvest-blocks set aside in that plan and that areas set aside for conservation based on watershed properties and steepness of terrain remain off limits even for salvage logging.
- The eastern (Medina Bank) section should officially be incorporated in a management plan.
- While Mahogany levels in the CRFR are probably naturally low, the scarcity of Mahogany regeneration is of immediate concern. With depletion of the Mahogany stocks, the CRFR looses its future value as a forest (extractive) reserve for decades to come. Strict rules are to be established and implemented in order to protect remaining seed trees.
- To protect standing seed trees, a moratorium on the felling of any standing live tree in the hurricane affected areas should come in force. If this means that harvesting of naturally downed trees becomes uneconomic, the salvage licensing process should be reviewed.
- A complete return to the original management plan with rotating harvesting blocks should be considered.
- Martinez-Garza & Howe, 2003 report that planting disperser-limited trees that establish in open ground may bypass 30-70 years of species attrition in isolated remnants by attracting animals that encourage normal processes of seed dispersal into and out of the fragments.

  While this statement refers to biodiversity values in general and animal dispersed species in particular, it is also applicable to timber species and a carefully monitored –low density- mahogany replanting (enrichment) effort could help re-establish the presence of seed producing trees. This is an expensive option but should nevertheless be explored with the current concession holders.

Recommendations for further research

This study relied heavily upon the data collected by the FPMP in 1992. This demonstrates the value of establishing base line data. One of the recommendations for further research should therefore be to continue collecting base line data. This could be through:

- Establishing additional transects (including in burned areas)
- Maintaining and revisiting existing transects
- Find back the original FPMP transects
- Wildlife studies

For a number of reasons (time, budget) this study did not focus on wildlife. But during the fieldwork surprisingly few wildlife signs were noted. A similar lack of wild life signs was also noted in hurricane affected areas outside the project area. Equally, the number of hunter signs (shotgun shells on the trails) was lower than expected. On the Crique Jute transects a large number of hunters was noted following the logging trails. Some of these hunters were briefly interviewed and they conceded that the hunting effectiveness had dropped dramatically since the hurricane. They attributed that to the lack of access to the forest but personally I feel there is more to it than this.

Based on my observations in the CRFR and in other Hurricane affected areas in Toledo, it has the appearance that wildlife densities have collapsed after the hurricane. Based on these incomplete data, this observation can not be substantiated but needs following up upon. It is therefore recommended to establish some form of simple wildlife monitoring in the area. YCT is already experimenting with wildlife monitoring programs and these could be expanded into the CRFR.

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Columbia River Forest Reserve

Appendix 1: 2004 Rapid Ecological Assessment Flora Species List (Total)

Family	*Species*	Belizean Name	Habitus	Timber
Acanthaceae	*Acanthaceae*		Herb	
Acanthaceae	*Acanthaceae 2*		Herb	
Acanthaceae	*Louteridium donnell-smithii (?)*		Shrub	
Acanthaceae	*Odentonema sp.*		Herb	
Agavaceae	*Yucca guatemalensis*	Isote	Shrub	
Anacardiaceae	*Mosquitoxylon jamaicense*		Tree	
Anacardiaceae	*Spondias mombin*	Jobo	Tree	
Anacardiaceae	*Spondias radkofleri*	Jobo	Tree	
Annonaceae	*Annonaceae*		Tree	
Annonaceae	*Annona scleroderma*		Tree	
Annonaceae	*Cymbopetalum mayanum*		Tree	
Annonaceae	*Guatteria sp.*		Tree	
Annonaceae	*Xylopia frutescens*	Polewood	Tree	
Apocynaceae	*Aspidosperma cruentum*	Red Mylady	Tree	Yes
Apocynaceae	*Aspidosperma megalocarpon*	White Mylady	Tree	
Apocynaceae	*Stemmadenia donnell-smithii*	Cojoton	Tree	
Apocynaceae	*Thevetia ahouai*		Shrub/Tree	
Araceae	*Anthurium pentaphyllum*		Epiphyte	
Araceae	*Anthurium schlechtendahlii*	Pheasant tail	Herb	
Araceae	*Anthurium sp.*		Herb	
Araceae	*Araceae*		Herb	
Araceae	*Dieffenbachia sp.*	Wild Cane	Herb	
Araceae	*Monstera sp.*		Epiphyte	
Araceae	*Philodendron radiatum*		Epiphyte	
Araceae	*Philodendron sp.*		Epiphyte	
Araceae	*Syngonium sp.*		Epiphyte	
Araceae	*Xanthosma robustum*		Herb	
Araliaceae	*Dendropanax arboreus*	White Gombolimbo	Tree	
Araliaceae	*Oreopanax obtusifolius*		Tree	
Arecaceae	*Astrocaryum mexicanum*	Warree Cohune	Palm	
Arecaceae	*Attalea cohune*	Cohune	Palm	
Arecaceae	*Bactris major*	Pokenoboy	Palm	
Arecaceae	*Bactris mexicana*		Palm	
Arecaceae	*Calyptrogyne ghiesbrechtiana*		Palm	
Arecaceae	*Chamaedorea ernesti-augusti*	Xate	Palm	
Arecaceae	*Chamaedorea geonomiformis*		Palm	
Arecaceae	*Chamaedorea oblongata*	Jade	Palm	
Arecaceae	*Chamaedorea pinnatifrons*		Palm	
Arecaceae	*Chamaedorea tepejilote*	Pacaya	Palm	
Arecaceae	*Chrysophila stauracantha*	Give and Take	Palm	
Arecaceae	*Desmonchus orthocanthos*	Bayal, Basket Tietie	Palm	
Arecaceae	*Geonoma deversa*		Palm	
Arecaceae	*Sabal mauritiiformis*	Bayleaf	Palm	
Arecaceae	*Synechantus fibrosus*		Palm	
Aristolochiaceae	*Aristolochia schippii*		Vine	
Asclepiadaceae	*Gonolobus sp.*		Vine	
Asteraceae	*Neurolena lobata*	Jackass Bitters	Herb	
Ateraceae	*Asteraceae*		Herb	
Bignoniaceae	*Amphitecna breedlovei*	Calabash	Shrub	
Bignoniaceae	*Bignoniaceae*		Vine	
Bignoniaceae	*Bignoniaceae Vine*		Vine	
Bignoniaceae	*Jacaranda copaia*		Tree	Yes
Bignoniaceae	*Tabebuya rosea*	Mayflower	Tree	
Bombacaceae	*Ceiba pentandra*	Cotton Tree	Tree	Yes
Bombacaceae	*Ochroma pyramidale*	Polak, Balsa	Tree	
Bombacaceae	*Quararibea sp.*		Tree	
Boraginaceae	*Bourreria oxypylla*		Tree	

Columbia River Forest Reserve

Appendix 1: 2004 Rapid Ecological Assessment Flora Species List (Total)

Family	*Species*	Belizean Name	Habitus	Timber
Boraginaceae	*Cordia alliodora*	Salmwood	Tree	Yes
Boraginaceae	*Cordia bicolor (?)*	Sombrerito	Tree	
Bromeliaceae	*Bromeliad*		Epiphyte	
Burseraceae	*Bursera simaruba*	Gumbo Limbo	Tree	
Burseraceae	*Protium*	Copal	Tree	
Burseraceae	*Protium copal*	Copal	Tree	
Cactaceae	*Epiphyllum sp.*		Epiphyte	
Caesalpinoideae	*Bauhinia sp.*	Bullhoof	Vine	
Caesalpinoideae	*Dialium guianense*	Ironwood	Tree	Yes
Caesalpinoideae	*Schizolobium parahyba*	Quamwood	Tree	
Caesalpinoideae	*Swartzia simplex*	Bastard Rosewood	Tree	
Cannaceae	*Canna indica*		Herb	
Capparaceae	*Crateva tapia*		Tree	
Caricaceae	*Carica papaya*	Papaya	Herb	
Cecropiaceae	*Cecropia obtusifolia*	Trumpet Tree	Tree	
Cecropiaceae	*Pourouma bicolor*	Mountain Trumpet	Tree	
Chrysobalanaceae	*Hirtella americana*		Tree	
Chrysobalanaceae	*Hirtella racemosa*		Tree	
Chrysobalanaceae	*Licania hypoleuca*		Tree	
Chrysobalanaceae	*Licania sparsipilis*		Tree	
Clusiaceae	*Callophyllum brasiliensis*	Santa Maria	Tree	Yes
Clusiaceae	*Clusia sp.*		Tree	
Clusiaceae	*Garcinia sp.*		Tree	
Clusiaceae	*Symphonia globulifera*		Tree	
Clusiaceae	*Vismia sp.*	Ringworm stick	Tree	
Combretaceae	*Combretum sp.*		Vine	
Combretaceae	*Terminalia amazonica*	Nargusta	Tree	Yes
Commelinaceae	*Tradescantia sp.*		Herb	
Commelinaceae	*Tradescantia zanonia*		Herb	
Convolvulaceae	*Ipomoea setosa*		Vine	
Costaceae	*Costus sp.*		Herb	
Cucurbitaceae	*Momordia charantia*	Sorosi	Vine	
Cucurbitaceae	*Psiguria triphylla*		Vine	
Cucurbitaceae	*Psiguria warscewickii*		Vine	
Cyclanthaceae	*Asplundia sp.*		Epiphyte	
Cyperaceae	*Scleria bracteata*	Cutting Grass	Herb	
Dilleniaceae	*Davila sp.*		Vine	
Dioscoreacea	*Dioscorea*	Wild Yam	Vine	
Eleocarpaceae	*Sloanea sp.*		Tree	
Eleocarpaceae	*Sloanea tuerkheimii*	Wild Anatto	Tree	
Euphorbiaceae	*Acalypha herbaceous*		Herb	
Euphorbiaceae	*Acalypha shrub*		Shrub	
Euphorbiaceae	*Acalypha sp.*		Shrub	
Euphorbiaceae	*Alchornea latifolia*		Tree	
Euphorbiaceae	*Croton sp.*		Tree	
Euphorbiaceae	*Dalechampia sp.*		Vine	
Euphorbiaceae	*Drypetes brownei*	Bullhoof	Tree	Yes
Euphorbiaceae	*Hieronima alchorneoides*		Tree	
Euphorbiaceae	*Pera barbelata*		Tree	
Euphorbiaceae	*Plukenetia penninervia*		Vine	
Euphorbiaceae	*Sapium sp.*		Tree	
Euphorbiaceae	*Sebastiana tuerckheimiana*	White Poisonwood	Tree	
Flacourtiaceae	*Casearia sp.*		Tree	
Flacourtiaceae	*Casearia sylvestris*		Tree	
Flacourtiaceae	*Flacourtiaceae*		Tree	
Flacourtiaceae	*Laetia thamnia*		Tree	
Flacourtiaceae	*Xylosma sp.*		Tree	

Columbia River Forest Reserve

Appendix 1: 2004 Rapid Ecological Assessment Flora Species List (Total)

Family	*Species*	Belizean Name	Habitus	Timber
Haemadoraceae	*Xiphidium caeruleum*		Herb	
Heliconiaceae	*Heliconia aurantiaca*		Herb	
Heliconiaceae	*Heliconia bourgeana*		Herb	
Heliconiaceae	*Heliconia vaginalis*		Herb	
Heliconiaceae	*Heliconia wagneriana*		Herb	
Lacistemataceae	*Lacistema aggregatum*		Tree	
Lauraceae	*Lauraceae*	Laurel	Tree	
Lauraceae	*Nectandra*	Laurel	Tree	
Loganiaceae	*Strychnos sp.*		Vine	
Malvaceae	*Malvaviscus arboreus*		Shrub	
Marantaceae	*Calathea lutea*	Waha	Herb	
Marantaceae	*Calathea sp*	Waha	Herb	
Melastomataceae	*Belotia sp.*		Tree	
Melastomataceae	*Clidemia sp.*	Sirin	Shrub	
Melastomataceae	*Melastomataceaeae*	Sirin	Shrub	
Melastomataceae	*Miconia impetiolaris*		Shrub	
Melastomataceae	*Miconia sp.*	Maya, Sirin	Tree	
Melastomataceae	*Miconia sp.*	Maya, Sirin	Tree	
Melastomataceae	*Mouriri exilis*		Tree	
Melastomataceae	*Mouriri myrtiloides*		Tree	
Meliaceae	*Carapa guianensis*		Tree	
Meliaceae	*Guarea glabra*	Cedrillo	Tree	
Meliaceae	*Guarea grandiflora*	Cedrillo	Tree	
Meliaceae	*Meliaceae?*		Tree	
Meliaceae	*Trichilia minutiflora*		Tree	
Meliaceae	*Trichilia sp.*		Tree	
Menispermaceae	*Abuta sp.*		Vine	
Menispermaceae	*Menispermaceae*		Vine	
Mimosoideae	*Acacia dolichostachya*		Tree	
Mimosoideae	*Acacia glomerosa*		Tree	
Mimosoideae	*Acacia sp.*	Cockspur	Tree	
Mimosoideae	*Cojoba arborea*		Tree	
Mimosoideae	*Inga 2*	Bribri	Tree	
Mimosoideae	*Inga 3*	Bribri	Tree	
Mimosoideae	*Inga nr pavoniana*	Bribri	Tree	
Mimosoideae	*Inga sp.*	Bribri	Tree	
Mimosoideae	*Mimosa cf hondurana*	Haulback	Vine	
Mimosoideae	*Pithecellobium sp.*		Shrub	
Monimiaceae	*Siparuna thecaphora*		Shrub	
Moraceae	*Brosimum alicastrum*	Breadnut, Ramon	Tree	
Moraceae	*Ficus sp.*	Matapalo	Tree	
Moraceae	*Poulsenia armata*		Tree	
Moraceae	*Pseudolmedia sp.*	Cherry	Tree	
Moraceae	*Trophis racemosa*	Ramon blanco	Tree	
Moraceae	*Trophis sp.*		Tree	
Myristicaceae	*Virola sp.*	Banak	Tree	Yes
Myrsinaceae	*Ardisia sp.*		Shrub	
Myrtaceae	*Eugenia sp.*		Tree	
Myrtaceae	*Myrtaceae*		Tree	
Myrtaceae	*Myrtaceae (strong smell)*		Tree	
Myrtaceae	*Pimenta dioica*	Pimenta, Allspice	Tree	
Nyctaginaceae	*Pisonia sp.*	Tiger Nail	Vine	
Ochnaceae	*Ouratea sp.*		Shrub	
Olacaceae	*Heisteria media*	Quero de sapo	Tree	
Orchidaceae	*Encyclia cochleata*	Black Orchid	Epiphyte	
Orchidaceae	*Oeceoclades maculata*		Herb	
Orchidaceae	*Oncidium ascendens*	Rat Tail Orchid	Epiphyte	

Columbia River Forest Reserve

Appendix 1: 2004 Rapid Ecological Assessment Flora Species List (Total)

Family	*Species*	Belizean Name	Habitus	Timber
Papilionoideae	*Lonchocarpus sp.*		Tree	
Papilionoideae	*Machaerium sp.*		Vine	
Papilionoideae	*Platymiscium dimorphandrum*		Tree	
Papilionoideae	*Pterocarpus rohrii*	Mountain Kaway	Tree	
Papilionoideae	*Vatairea lundelli*		Tree	
Passifloraceae	*Passiflora ambigua*	Umbats	Vine	
Passifloraceae	*Passiflora biflora*		Vine	
Passifloraceae	*Passiflora cobanensis*		Vine	
Passifloraceae	*Passiflora guatemalensis*		Vine	
Passifloraceae	*Passiflora helleri*		Vine	
Passifloraceae	*Passiflora lancetillensis*		Vine	
Passifloraceae	*Passiflora oerstedii*		Vine	
Passifloraceae	*Passiflora serratifolia*		Vine	
Piperaceae	*Piper auritum*	Obel	Herb	
Piperaceae	*Piper peltatum*		Herb	
Piperaceae	*Piper spp.*		Herb	
Poaceae	*Bamboo small*		Shrub	
Poaceae	*Hyparrhenia rufa*		Herb	
Poaceae	*Rottboelia cochinchinensis*		Herb	
Polygalaceae	*Securidaca diversifolia*	Man vine	Vine	
Polygonaceae	*Coccoloba belizensis*	Wild Grape	Tree	
Polygonaceae	*Coccoloba sp.*		Tree	
Polypodiaceae	*Ferns*		Herb	
Polypodiaceae	*Treefern*		Tree	
Polypodiaceae	*Pteridium caudatum*	Bracken, Tiger bush	Herb	
Rhamnaceae	*Gouannia sp.*		Vine	
Rhizophoraceae	*Cassipourea guianensis*	Waterwood	Tree	
Rubiaceae	*Alseis yucatana*	Zon	Tree	
Rubiaceae	*Amaioua corymbosa*		*Tree*	
Rubiaceae	*Astronium graveolens*	Jobillo	Tree	Yes
Rubiaceae	*Faramea sp.*		Tree	
Rubiaceae	*Guettarda combsii*	Glassywood	Tree	
Rubiaceae	*Hamelia patens*	Firebush	Shrub	
Rubiaceae	*Morinda sp.*		Shrub	
Rubiaceae	*Psychotria poeppigiana*	Hotlips	Herb	
Rubiaceae	*Psychotria sp.*		Shrub	
Rubiaceae	*Randia sp*		Shrub	
Rubiaceae	*Rubiaceae*		Tree	
Rubiaceae	*Rubiaceae 2*		Tree	
Rubiaceae	*Simira salvadorensis*	Redwood	Tree	Yes
Rutaceae	*Zanthoxylum sp.*	Prickly Yellow	Tree	
Sapindaceae	*Allophyllus sp.*		Tree	
Sapindaceae	*Cupania belizensis*	Grande Betty	Tree	
Sapindaceae	*Cupania sp.*		Tree	
Sapindaceae	*Matayba sp.*		Tree	
Sapindaceae	*Paullinea sp.*		Vine	
Sapindaceae	*Serjania sp.*		Vine	
Sapindaceae	*Thouinia paucidentata*		Tree	
Sapotaceae	*Manilkara sp.*	Sapodilla, Chicle	Tree	Yes
Sapotaceae	*Pouteria amygdalina*		Tree	
Sapotaceae	*Pouteria campechiana*	Mamey ciruela	Tree	
Sapotaceae	*Pouteria durlandii*		Tree	
Sapotaceae	*Pouteria reticulata*		Tree	
Sapotaceae	*Pouteria sapota*	Mamey, Mamee	Tree	
Sapotaceae	*Pouteria sp.*		Tree	
Sapotaceae	*Sideroxylon sp.*		Tree	
Selaginellaceae	*Selaginella sp.*		Herb	

Columbia River Forest Reserve

Appendix 1: 2004 Rapid Ecological Assessment Flora Species List (Total)

Family	*Species*	Belizean Name	Habitus	Timber
Simaroubaceae	*Picramnia antidesma*		Tree	
Simaroubaceae	*Simarouba glauca*	Negrito	Tree	
Smilacaceae	*Smilax sp.*		Vine	
Solanaceae	*Cestrum sp.*	Dama de Noche	Tree	
Solanaceae	*Solanaceae*		Shrub	
Solanaceae	*Solanum sp.*		Shrub	
Solanaceae	*Solanum torvum*		Herb	
Sterculiaceae	*Byttneria aculeata*	Haulback	Vine	
Theophrastaceae	*Deheraina smaragdina*		Shrub	
Tiliaceae	*Heliocarpus americanus*	Broadleaf Moho	Tree	
Tiliaceae	*Luhea sp.*		Tree	
Tiliaceae	*Mortoniodendron guatemalensis*		Tree	
Tiliaceae	*Trichospermum grewiifolium*	Narrowleaf Moho	Tree	
Turneraceae	*Erblichia odorata*		Tree	
Ulmaceae	*Ampelocera hottlei*	Luin	Tree	
Ulmaceae	*Celtis iguanae*		Tree	
Ulmaceae	*Trema micrantha*		Shrub	
Unknown	*Unknown*		Tree	
Urticaceae	*Myriocarpa obovata*		Shrub	
Urticaceae	*Urera sp.*		Shrub	
Verbenaceae	*Aegephyla monstrosa*		Tree	
Verbenaceae	*Square stem*		Tree	
Verbenaceae	*Stachytarpheta sp.*		Herb	
Verbenaceae	*Verbenaceae*		Tree	
Verbenaceae	*Vitex gaumeri*	Fiddlewood, Florazul, Yaxnik	Tree	
Violaceae	*Rinorea sp.*	Wild coffee	Shrub	
Vitaceae	*Vitaceae*		Vine	
Vitaceae	*Vitis tiliifolia*	Watervine	Vine	
Vochysiaceae	*Vochysia hondurensis*	Yemeri	Tree	Yes
Zamiaceae	*Zamia variegata*		Herb	
Zingiberaceae	*Renealmia sp.*	Wild Ginger	Herb	

Columbia River Forest Reserve

Appendix 2: 2004 Rapid Ecological Assessment

Tree Species Per Transect

Northing y	1804315	1809233	1811257	1806895	1818571	1817866	1817166	1816404	1806131	1805907
Easting x	283183	293003	293802	290152	304044	304951	305018	304980	282824	282974
Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Acacia cockspur					1					
Acacia dolichostachya		1								
Allophyllus	1									
Alseis yucatana			3					2		
Ampellocera hotlei	1									
Ampelocera hottlei									1	
Aspidosperma red		1						2		
Aspidosperma white		1								
Astronium graveolens			1					1		
Attalea cohune		3			1		2			1
Bourreria sp.		1			1			1		
Brosimum alicastrum									2	1
Carica papaya				1						
Casearia								1		
Cecropia obtusifolia	4		3	2					2	7
Ceiba pentandra				1						
Cestrum	13								6	4
Coccoloba								2		
Cordia bicolor					1	3	4	7	1	
Crateva tapia	3								2	
Cupania sp.					1	1		1		
Cymbopetalum mayanum							1			
Dendropanax arboreus	1								1	1
Dialium guianense						3				1
Drypetes brownei	1	2			1					
Faramea						1				
Fern:Treefern							1			
Ficus sp.					1					
Flacourtiaceae		1								
Garcinia						1				
Guarea grandifolia	2	2					2	1	1	
Guatteria sp.					1					
Guettarda							1			
Heisteria media					2			1		
Heliocarpus	11			2					13	4
Hieronyma						1				
Hirtella americana					1	2	5	4		
Inga							2	1		
Inga nr pavoniana	1									
Jacaranda copaia							2			
Lauraceae					1		1	4	2	
Licania hypoleuca					1	2		1		
Licania sparsipilis							1			
Louteridium?										2
Manilkara		1			1	1				
Morinda		1								
Mortoniodendron guatemalense			1							
Mosquitoxylon jamaicense						3	1			
Myrtaceae					3					
Pimenta dioica								1		
Pouteria amygdalina	1	1	1							
Pouteria campechiana	3			1	1		1	1		
Pouteria durlandi		2	2							
Pouteria mammosa		1		1						

Columbia River Forest Reserve

Appendix 2: 2004 Rapid Ecological Assessment

Tree Species Per Transect

Northing y	1804315	1809233	1811257	1806895	1818571	1817866	1817166	1816404	1806131	1805907
Easting x	283183	293003	293802	290152	304044	304951	305018	304980	282824	282974
Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Pouteria reticulata					3			1		
Pouteria reticulata										
Pouteria sp.	1	1	1							1
Protium copal		1			6	3	2	1	2	1
Pseudolmedia		2	2		3					1
Pterocarpus rohrii	1	1						2		
Quararibea sp.	1									
Randia			1							
Rubiaceae	1	1	2			1				
Rubiaceae 2	1									
Sabal mauritiiformis		1	3		2				1	
Schizolobium parahyba	3									
Sebastiana					2					
Sideroxylon					1					
Simira salvadorensis					1					
Sloanea tuerkheimii					1		2			1
Solanaceae		1								
Solanum			4	1						
Spiny tree, sap, small leaves	1									
Stemmadenia donnell-smithii					1					
Symphonia globulifera							2			
Terminalia amazonia					3		1			
Thouinia				1						
Trichospermum grewiifolium			3							
Unknown	1		2	1	4	2				1
Vatairea lundelli								1		
Verbenaceae										1
Virola						1				
Vochysia hondurensis					2					
Xylopia frutescens								1		
Zanthoxylum sp.	2									
Chamaedorea species										
Chamaedorea oblongata	1									
Chamaedorea ernesti-augusti		8	4		10	6		10		
Chamaedorea tepejilote	13			3					10	6
Chamaedorea pinnatifrons		3	4	3	47	1	3	15	9	12
Chamaedorea geonomiformis	17								1	

Xate hembra (Chamaedora elegans)
- Xate macho o Jade (Ch. oblongata)
- Cambray (Ch. erumpens)
- Tepejilote (Ch. tepejilote)
- Cola de pez (Caryota mitis)

Columbia River Forest Reserve

2004 Rapid Ecological Assessment. Appendix 3 Transect Summaries

WP 81, 82. JimmyCut Transect in gently sloping terrain

UTM 1804315/283183 to 1804485/283091

Date: May 31, 2004

	total dbh	Potential Trees only	> 10cm dbh
Acalypha sp.			
Aegephylla monstrosus		1	
Allophyllus	18	1	1
Ampellocera hotlei	15	1	1
Anthurium schlechtendahlii			
Asterogyne martiana			
Astrocaryum mexicanum			
Attlea cohune		5	
Bactris grandis			
Bignoniaceae Vine			
Calathea lutea			
Cecropia	49	7	4
Cestrum sp.	139	16	13
Chamaedorea oblongata			
Chamaedorea tepejilote			
Chrysophila stauracantha			
Cojoba arborea			
Combretum sp.			
Costus sp.			
Crateva tapia	74	3	3
Croton sp.		1	
Dead			
Dead: Swietenia macrophylla			
Dendropanax arborea	28	1	1
Drypetes brownei	84	1	1
Epiphyllum sp.			
Faramea			
Guarea big leaf	73	2	2
Guarea small leaf		1	
Heisteria media		1	
Heliconia aurantiaca			
Heliconia bourgeana			
Heliocarpus sp	150	11	11
Inga nr pavoniana	23	2	1
Mourriri myrtiloides		1	
Ochroma pyramidale	10	1	1
Passiflora biflora			
Passiflora lancetillensis			
Passiflora oerstedii			
Passiflora serratifolia			
Piper sp.			
Piper auritum			
Pisonia sp.			
Poulsenia armata		1	
Pouteria amygdalina	41	1	1
Pouteria campechiana	66	3	3
Pouteria sp.	33	1	1

Columbia River Forest Reserve

2004 Rapid Ecological Assessment. Appendix 3 Transect Summaries

WP 81, 82. JimmyCut Transect in gently sloping terrain

UTM 1804315/283183 to 1804485/283091

Date: May 31, 2004

	total dbh	Potential Trees only	> 10cm dbh
Psiguria warscewickii			
Pterocarpus rohrii	20	1	1
Quararibea sp.	17	1	1
Rubiaceae	14	1	1
Rubiaceae 2	15	1	1
Sabal mauritiiformis		1	
Sapium sp.		1	
Schizolobium parahyba	34	3	3
Sloanea sp?		1	
Spiny tree, sap, small leaves	14	1	1
Spondias radkofleri		1	
Dead Stump			
Dead Stump: Pouteria			
Tradescantia zanonia			
Unknown	11	1	1
Urera sp.			
Xanthosma robustum			
Zanthoxylum sp.	30	3	2
	958	78	55

Soil brown clay
Some limestone protuding
Slope < 5 degrees
Canopy of shrubs and vines, approx 4 m high. Some emergent stumps
Massive hurricane damage
Understory dense of vines, Piper etc.

N_0 **= *Number of species***	22
Shannon H' Log Base 2.718	2.546
Evenness E1 (Shannon J')	0.836
Rarefraction at sample size of 10 trees	7.02
Rarefraction at sample size of 20 trees	11.38
Rarefraction at sample size of 30 trees	14.93
Rarefraction at sample size of 40 trees	17.98
Rarefraction at sample size of 50 trees	20.71
Living stems > 10 cm dbh (incl. vines)	55
Average stem dbh in cm (living only)	17.4
Number of trees (non vines)	78
Total dbh living trees	958
Total dbh dead trees	294
Number of dead trees	10
Space per living tree in m^2	14.5
Total species	34
Dominant tree species (> 10% of total, >10cm dbh)	*Cestrum, Heliocarpus*
Dominant woody species	*Cestrum, Heliocarpus*
Largest biomass	*Cestrum, Heliocarpus*

Columbia River Forest Reserve

Appendix 4. 2004 REA Transect Summary

WP 85. + UTM 293003/1809233
Steep slope 40 - 45 degrees. Last section top of hill (plateau like)
Date: June 1, 2004
Hurricane Damage, no erosion, some rock. Much leaflitter
Canopy 1 - 25 m. closed.

	Total dbh	Potential trees	Stems > 10 cm
Abuta			
Acacia dolichostachya	38	1	1
Acacia glomerosa		1	
Alchornea latifolia		5	
Alseis yucatenensis		1	
Aspidosperma red	16	1	1
Aspidosperma white	25	1	1
Asterogyne martiana			
Astrocaryum mexicana			
Attalea cohune	114	5	3
Bactris grandis			
Bactris mexicana			
Bignoniaceae			
Bourreria	17	1	1
Caseria		1	
Cecropia		3	
Cestrum		1	
Chamaedorea ernesti augusti			
Chamaedorea pinnatifrons			
Chrysophila stauracanta			
Combretum			
Cordia bicolor		1	
Cymbopetalum		1	
Dead			
Deheraina smaragdina			
Desmonchus orthocanthos			
Dialium guianense	38	1	
Dioscorea			
Drypetes	29	2	2
Faramea			
Fern			
Flacourtiaceae	19	2	1
Guarea glabra		1	
Guarea grandifolia	40	2	2
Heliconia bourgeana			
Ipomoea setosa			
Manilkara	13	2	1
Monstera			
Morinda	20	1	1
Neurolena lobata			
Passiflora guatemalensis			
Passiflora serratifolia			
Piper			
Piper auritum			
Pouteria amygdalina	16	1	1

Columbia River Forest Reserve

Appendix 4. 2004 REA Transect Summary

WP 85. + UTM 293003/1809233
Steep slope 40 - 45 degrees. Last section top of hill (plateau like)
Date: June 1, 2004
Hurricane Damage, no erosion, some rock. Much leaflitter
Canopy 1 - 25 m. closed.

	Total dbh	Potential trees	Stems > 10 cm
Pouteria durlandi	25	2	2
Pouteria mammosa	66	1	1
Pouteria reticulta		1	
Pouteria sp.	11	2	1
Protium	18	2	1
Pseudolmedia	32	2	2
Pterocarpus rohrii	33	1	1
Rubiaceae	45	2	1
Sabal mauritiiformis	23	4	1
Simira salvadorensis		1	
Siparuna			
Solanaceae	13	2	1
Spondias radkofleri		1	
Thevetia ahouai		1	
Trichilia minutiflora		1	
Trichospermum grewiifolium		2	
Urera			
Zanthoxylum		1	
	651	61	26

N_0 = ***Number of species***	20
Shannon H' Log Base 2.718	2.92
Evenness E1 (Shannon J')	0.97
Rarefraction at sample size of 10 trees	9.08
Rarefraction at sample size of 20 trees	16.4
Living stems > 10 cm dbh (incl. vines)	26
Average stem dbh in cm (living only)	25
Number of trees (non vines)	61
Total dbh living trees	651
Total dbh dead trees	482
Number of dead trees	16
Space per living tree in m^2	30.8
Total species	37
Dominant tree species (> 10% of total, >10cm dbh)	Attalea cohune
Dominant woody species	None
Largest biomass	Attalea cohune, Pouteria durlandii

Columbia River Forest Reserve

Appendix 5: 2004 REA, Transect 3 summary

WP 86 - 87 293802/1811257. June 1, 2004
Steep slope, 45 degrees or steeper but crosses crest and then goes gently down agai
Brown Clay. Very stony. Last 50 m going down again. Canopy 1-20 m. mostly closed.

	Total DBH	no of stems	Trees > 10 cm dt
Abuta			
Aegephyla monstrosa		1	
Alchornea		4	
Alseis yucatana	50	3	3
Ampelocera		1	
Anthurium slechtendahli			
Anthurium sp.			
Aspidosperma white		1	
Astrocarium mexicana			
Astronium graveolens	13	5	1
Attalea cohune		4	
Carica papaya			
Cecropia	33	11	3
Ceiba pentandra		2	
Chamaedorea ernesti-augusti			
Chamaedorea pinnatifrons			
Costus			
Crateva tapia		1	
Crysophila stauracantha			
Dead			
Dendropanax arboreus		1	
Desmonchus orthocanthos			
Dioscorea			
Epiphyllum sp.			
Faramea			
Ficus		4	
Gouannia			
Heisteria media		1	
Heliconia aurantiaca			
Heliconia bourgeana			
Inga		1	
Ipomoea setosa			
Lauraceae		2	
Manilkara		1	
Menispermaceae		1	
Mortoniodendron guatemalense	34	1	1
Mouriri mytiloides		1	
Myriocarpa obovata		4	
Odentonema			
Oeceoclades maculata			
Passiflora biflora			
Passiflora guatemalensis			
Passiflora lancetillensis			
Philodendron			
Piper			
Piper auritum			

Columbia River Forest Reserve

Appendix 5: 2004 REA, Transect 3 summary

WP 86 - 87 293802/1811257. June 1, 2004
Steep slope, 45 degrees or steeper but crosses crest and then goes gently down agai
Brown Clay. Very stony. Last 50 m going down again. Canopy 1-20 m. mostly closed.

	Total DBH	no of stems	Trees > 10 cm dbh
Pouteria amygdaloides	24	1	1
Pouteria durlandii	43	2	2
Pouteria sp.	45	1	1
Protium		5	
Pseudolmedia	27	3	2
Randia	11	1	1
Rinorea			
Rubiaceae	33	2	2
Sabal mauritiiformis	63	5	3
Schizolobium parahyba		1	
Sebastiana		1	
Simarouba glauca		1	
Simira salvadorensis		1	
Spondias radkofleri		1	
Solanum	40	6	4
Tradescantia zanonia			
Trema micrantha		1	
Trichospermum grewiifolium	45	3	3
Unknown	28	2	2
Urera			
Vitex gaumeri		1	
Xylosma		1	
Yuca guatemalensis			
Zanthoxylum		1	
	489	90	29

N_0 = Number of species	14
Shannon H' Log Base 2.718	2.53
Evenness E1 (Shannon J')	0.96
Rarefraction at sample size of 10 trees	7.82
Rarefraction at sample size of 20 trees	12
Living stems > 10 cm dbh (incl. vines)	29
Average stem dbh in cm (living only)	16.9
Number of trees (non vines)	90
Total dbh living trees	489
Total dbh dead trees	754
Number of dead trees	30
Space per living tree in m^2	27.6
Total species	40
Dominant tree species (> 10% of total, >10cm dbh)	*Alseis yucatana, Cecropia, Sabal*
Dominant woody species	*Cecropia sp.*
Largest biomass	*Alseis yucatana,*

Columbia River Forest Reserve

Appendix 6: 2004 REA Summary Transect 4

WP 89 - 90. 2 June 2004
Burned in 2003, Canopy 3 m. very broken. Terrain gently roling. 2% slope. Some erosion visible. S
Soil brown clay covered by thin layer of ashes, litle leaflitter and then only fresh. Very wet
1806895
290152

		total dbh	(potential trees only)	> 10 cm DBH
Acacia glomerosa			1	
Acacia cockspur			1	
Acalypha herb	x			
Acalypha shrub	x			
Aegephylla monstrosa			2	
Araceae				
Attalea cohune			5	
Asteraceae				
Astrocaryum mexicana	x			
Calathea	x		1	
Canna indica			1	
Carica papaya		12		1
Cecropia		33	9	2
Ceiba pentandra		150	2	1
Cestrum			5	
Coccoloba			1	
Cordia alliodora			1	
Chamaedorea tepejilote				
Chamaedorea pinnatifroms				
Crysophila stauracantha				
Cymbopetalum mayanum			1	
Croton			4	
Costus	x			
Dalechampia				
Dead				
Desmonchus orthocanthos	x			
Diefenbachia	x			
Ficus				
Garcinia	x		1	
Gonolobus sp.				
Heliconia aurantiaca				
Heliconia bourgeana	x			
Heliconia wagneriana	x			
Heliocarpus		34	4	2
Hyparrhenia rufa				
Inga			2	
Luhea			1	
Lonchocarpus sp.			1	
Miconia impetiolaris				
Momordia charantia				
Neurolena lobata	x			
Ochroma pyramidale	x		4	
Passiflora ambigua				
Passiflora seratifolia				
Passiflora guatemalensis				
Piper	x			
Piper auritum				
Piper peltatum				
Poulsenia armata	x		1	

Columbia River Forest Reserve

Appendix 6: 2004 REA Summary Transect 4

WP 89 - 90. 2 June 2004
Burned in 2003, Canopy 3 m. very broken. Terrain gently roling. 2% slope. Some erosion visible. S
Soil brown clay covered by thin layer of ashes, litle leaflitter and then only fresh. Very wet
1806895
290152

		total dbh	(potential trees only)	> 10 cm DBH
Pouteria mamosum		19	1	1
Pouteria campechiana		17	1	1
Protium	x		2	
Platymiscium dimorphandrum			1	
Pteridium caudatum				
Rinorea				
Rottboelia cochinensis				
Sapium	x		5	
Schizolobium parhyba	x		5	
Solanum sp.			3	1
Solanum torvum				
Spondias mombin	x		1	
Spondias radkofleri	x		4	
Stachytarpheta				
Stemmadenia donnell-smithii	x		4	
Swartzia simplex				
Tabebuya rosea			3	
Trichospermum grewiifolium			1	
Thouinia		17	1	1
Trema micrantha			4	
Unknown		19	1	1
Urera	x			
Vitaceae				
Zanthoxylum			3	
		301	88	11

	9
N_0 = Number of species	2.15
Shannon H' Log Base 2.718	0.98
Evenness E1 (Shannon J')	8.36
Rarefraction at sample size of 10 trees	NA
Rarefraction at sample size of 20 trees	11
Living stems > 10 cm dbh (incl. vines)	27.4
Average stem dbh in cm	87
Number of trees (non vines)	301
Total dbh living trees	446
Total dbh dead trees	17
Number of dead trees	72.7
Space per living tree in m^2	36
Total species	*Cecropia,*
Dominant tree species (> 10% of total, >10cm dbh)	*Cecropia*
Dominant woody species	*Cecropia, Ceiba*
Largest biomass	

Columbia River Forest Reserve

Appendix 7: 2004 REA summary Transect 5.

WP 96 - 97 7-Jun-04 Steep/flat 1818571 304044	Total DBH	Potential trees	Trees > 10 cm dbh
Abuta sp.			
Acacia cockspur	13	4	1
Acalypha herbaceous			
Acanthaceae			
Alchornea latifolia		1	
Allophylus		3	
Alseis yucatana		1	
Ampelocera		1	
Amphitecna breedlovei			
Anthurium pentaphyllum			
Anthurium sp.			
Ardisia sp.			
Aspidosperma (red)		3	
Aspidosperma (white)		1	
Astrocaryum mexicanum			
Attalea cohune	39	3	1
Bactris grandis			
Bauhinia sp.			
Bourreria sp.	38	2	1
Callophyllum brasiliensis		7	
Carapa guianensis		1	
Cassipourea guianensis			
Cecropia sp.		2	
Chamaedorea ernesti-augusti			
Chamaedorea pinnatifrons			
Chrysophila stauracantha			
Chrysophyllum mexicanum			
Clidemia sp.			
Coccoloba		1	
Cordia sp.	21	2	1
Costus sp.			
Croton			
Cupania sp.	13	2	1
Cymbopetalum		2	
Dead			
Dendropanax arboreum		1	
Desmoncus orthocanthus			
Dialium guianense		1	
Dioscorea			
Drypetes	44	1	1
Erblichia		1	
Faramea			
Ficus sp.	11	1	1
Garcinia sp.		1	
Guarea sp.		1	
Guatteria sp.	12	2	1

Columbia River Forest Reserve

Appendix 7: 2004 REA summary Transect 5.

WP 96 - 97 7-Jun-04 Steep/flat 1818571 304044	Total DBH	Potential trees	Trees > 10 cm dbh
Heisteria media	32	2	2
Heliconia aurantiaca			
Heliconia vaginalis			
Hirtella americana	18	6	1
Hirtella racemosa			
Inga sp.		4	
Laccistema aggregatum		3	
Laetia thamnia		3	
Lauraceae	17	1	1
Licania sparsipilis		1	
Lycania hypoleuca	30	1	1
Malvaviscus			
Manilkara sp.	16	4	1
Matayba		1	
Melastomataceaeae		1	
Miconia sp.		1	
Mosquitoxylum jaimaicense		1	
Mouriri exilis		2	
Mouriri myrtiloides		1	
Myriocarpa obovata		1	
Myrtaceae	54	8	3
Nectandra		1	
Ouratea			
Passiflora cobanensis			
Passiflora serratifolia			
Philodendron			
Philodendron radiatum			
Picramnia antidesma		1	
Pimenta dioica		1	
Piper sp.			
Plukenetia penninervia			
Pouteria campechiana	15	3	1
Pouteria reticulata	40	5	3
Pouteria sp.		1	
Protium	75	9	6
Pseudolmedia	40	4	3
Psychotria			
Psychotria poeppigiana			
Pterocarpus rohrii		1	
Renealmia sp.			
Rinorea sp.			
Sabal mauritiiformis	45	3	2
Sebastiana	32	6	2
Sideroxylon	43	1	1
Simarouba glauca		2	
Simira salvadorensis	10	1	1

Columbia River Forest Reserve

Appendix 7: 2004 REA summary Transect 5.

WP 96 - 97 7-Jun-04 Steep/flat 1818571 304044	Total DBH	Potential trees	Trees > 10 cm dbh
Siparuna thecaphora			
Sloanea sp.		1	
Sloanea tuerkheimii	13	2	1
Solanaceae			
Stemmadenia donnell-smithii	19	1	1
Strychnos			
Symphonia globulifera		1	
Synechantus fibrosus			
Terminalia amazonia	89	4	3
Thevetia ahouai		4	
Trophis racemosa		1	
Unknown	48	4	4
Virola		4	
Vitex gaumeri		2	
Vochysia hondurensis	107	3	2
Xylopia frutescens		1	
Yucca guatemalensis			
	934	153	47

N_0 = ***Number of species***	27
Shannon H' Log Base 2.718	3.11
Evenness E1 (Shannon J')	0.94
Rarefraction at sample size of 10 trees	8.65
Rarefraction at sample size of 20 trees	15.1
Rarefraction at sample size of 30 trees	20.2
Rarefraction at sample size of 40 trees	24.4
Living stems > 10 cm dbh (incl. vines)	47
Average stem dbh in cm (living only)	19.9
Number of trees (non vines)	153
Total dbh living trees	934
Total dbh dead trees	389
Number of dead trees	16
Space per living tree in m^2	17
Total species	67
Dominant tree species (> 10% of total, >10cm dbh)	*Protium*
Dominant woody species	*None*
Largest biomass	*Vochysia hondurensis*

Columbia River Forest Reserve

Appendix 8: 2004 REA; Summary Transect 6

WP 98 -100, June 7, 2004, Canopy 4 m. , brown clay., no rocks
Relatively Flat, Starting in relatively flat terrain. High Damage!
Nr. Medina Bank UTM 1817866/304951

	Total DBH	Potential tı	Trees > 1(
Acacia Bullhorn		1	
Alchornea latifolia		1	
Ampelocera		1	
Annona squamosa		1	
Apocynaceae vine			
Aspidosperma red		1	
Astrocaryum mexicanum			
Attalea cohune		7	
Bactris mexicana			
Bauhinia			
Belotia		1	
Black Orchid			
Casearia sylvestris		1	
Cassipourea guianensis		2	
Cecropia sp.		6	
Cestrum		1	
Chamaedorea ernesti augusti			
Chamaedorea pinnatifrons			
Chrysophila stauracantha			
Clusia		1	
Coccoloba belizensis		1	
Cordia	82	6	3
Cordia alliodora		1	
Costus			
Cupania sp.	16	12	1
Cut stump			
Cutgrass			
Dalechampia sp.			
Davila sp.			
Dead			
Dendropanax arboreus		1	
Desmonchus orthocanthos			
Dialium guianense	108	4	3
Diocorea			
Faramea	13	2	1
Ferns			
Garcinia	10	1	1
Geonoma			
Guarea glabra		1	
Guatteria		2	
Guettarda combsii		1	
Hieronyma	35	3	1
Hirtella americana	24	6	2
Inga		7	
Inga 2		2	
Inga 3		3	
Jacaranda copaia		3	
Lacistema aggregatum		1	

Columbia River Forest Reserve

Appendix 8: 2004 REA; Summary Transect 6

WP 98 -100, June 7, 2004, Canopy 4 m. , brown clay., no rocks Relatively Flat, Starting in relatively flat terrain. High Damage! Nr. Medina Bank UTM 1817866/304951	Total DBH	Potential tı	Trees > 1(
Lauraceae		1	
Licania hypoleuca	36	9	2
Licania sparsipilis		2	
Machaerium			
Manilkara	10	1	1
Melastomataceae		4	
Miconia		9	
Mimosa cf adhaerens			
Mosquitoxylon jamaicense	127	4	3
Mouriri exilis		1	
Ouratea			
Passiflora ambigua			
Paullinea			
Pera barbelata		1	
Philodendron radiatum			
Philodendron sp.			
Piper			
Pourouma bicolor		3	
Pouteria campechiana		2	
Protium	44	4	3
Pseudolmedia		1	
Psiguria triphylla			
Psychotria			
Psychotria poeppigiana			
Rat Tail Orchid			
Renealmia			
Rinorea			
Rubiaceae	13	3	1
Securidaca diversifolia			
Sideroxylon		4	
Siparuna			
Sloanea tuerkheimii		4	
Small Bamboo			
Strychnos			
Synechantus fibrosus			
Trichospermum		4	
Unknown	29	2	2
Virola	37	1	1
Vismia sp.		1	
Vitis tilaefolia			
Vochysia hondurensis		6	
Xylopia frutescens		4	
Zanthoxylum		1	
	584	153	25

Columbia River Forest Reserve

Appendix 8: 2004 REA; Summary Transect 6

WP 98 -100, June 7, 2004, Canopy 4 m. , brown clay., no rocks
Relatively Flat, Starting in relatively flat terrain. High Damage!
Nr. Medina Bank UTM 1817866/304951

	Total DBH	Potential tı	Trees > 1(
N_0 = ***Number of species***	14		
Shannon H' Log Base 2.718	2.53		
Evenness E1 (Shannon J')	0.96		
Rarefraction at sample size of 10 trees	7.96		
Rarefraction at sample size of 20 trees	12.5		
Living stems > 10 cm dbh (incl. vines)	25		
Average stem dbh in cm (living only)	23.4		
Number of trees (non vines)	153		
Total dbh living trees	584		
Total dbh dead trees	447		
Number of dead trees	17		
Space per living tree in m^2	32		
Total species	53		
Dominant tree species (> 10% of total, >10cm dbh)	*Protium, Mosquitoloxylon jamaicense, Dialium guianense,*		
Dominant woody species	*None*		
Largest biomass	*Mosquitoloxylon jamaicense, Dialium guianense, Cordia*		

Columbia River Forest Reserve

Appendix 9: 2004 REA summary of Transect 7

WP 102 - 103, UTM 1817166/305018
8-Jun-04
part steep, part flat, Canopy broken, 5-20 m. closed. Soil brownish/yellow clay.

	Total DBH	Potential trees	Trees > 10 cm dbh
Amaouia		1	
Abuta			
Aristolochia schippii			
Asplundia sp.			
Astrocaryum mexicanum			
Attalea cohune	63	7	2
Bactris sp.			
Bauhinia			
Calyptrogyne ghiesbrechtiana			
Cassipourea guianensis		1	
Chamaedorea pinatifrons			
Clusia		2	
Cordia	88	4	4
Costus			
Cupania		1	
Cut grass			
Cymbopetalum mayanum	10	1	1
Davilla			
Dead			
Dendropanax arboreus		2	
Desmonchus orthocantos			
Faramea			
Fern:Treefern	13	4	1
Ferns			
Garcinia		1	
Guarea grandifolia	35	2	2
Guettarda	21	3	1
Heliconia vaginalis			
Hirtella americana	70	10	5
Inga	52	6	2
Jacaranda copaia	58	4	2
Lacistema aggregatum		1	
Lauraceae	20	3	1
Licania hypoleuca		2	
Licania sparsipilis	13	5	1
Machaerium			
Melastomataceae		2	
Miconia		5	
Mimosa cf adhaerens			
Mouriri exilis		3	
Mosquitoxylon jamaicensis	14	3	1
Passiflora biflora			
Pera barbelata		1	
Philodendron			
Piper			
Pourouma bicolor		3	
Pouteria campechiana	13	1	1
Protium	22	5	2

Columbia River Forest Reserve

Appendix 9: 2004 REA summary of Transect 7

WP 102 - 103, UTM 1817166/305018
8-Jun-04
part steep, part flat, Canopy broken, 5-20 m. closed. Soil brownish/yellow clay.

	Total DBH	Potential trees	Trees > 10 cm dbh
Psiguria warczewickii			
Psychotria			
Psychotria poeppigiana			
Rinorea			
Sideroxylon		3	
Siparuna			
Sloanea tuerkheimii	53	5	2
Syngonium			
Symphonia globulifera	37	4	2
Synechantus fibrosus			
Terminalia amazonia	17	2	1
Tradescantia zanonia			
Trichospermum grewiifolium		1	
Vismia sp.		1	
Vitis tiliaefolia			
	599	99	31

N_0 = Number of species	17
Shannon H' Log Base 2.718	2.682
Evenness E1 (Shannon J')	0.947
Rarefraction at sample size of 10 trees	8.11
Rarefraction at sample size of 20 trees	13.32
Rarefraction at sample size of 30 trees	16.74
Living stems > 10 cm dbh (incl. vines)	31
Average stem dbh in cm (living only)	19.3
Number of trees (non vines)	99
Total dbh living trees	599
Total dbh dead trees	125
Number of dead trees	8
Space per living tree in m^2	25.8
Total species	33
Dominant tree species (> 10% of total, >10cm dbh)	*Cordia, Hirtella americana*
Dominant woody species	*Hirtella americana*
Largest biomass	*Cordia, Attalea cohune*

Columbia River Forest Reserve

Appendix 10: 2004 REA; Summary Transect 8

WP 104-105, UTM 1816404/304980
6/8/2004 Little damage, canopy 15 m. semi-broken.
Half flat half steep, Brown Clay, no visible rocks. Understory ferns etc.

	Total DBH	Potential trees	Trees > 10 cm dbh
Ampelocera		1	
Alseis	79	2	2
Astrocaryum mexicanum			
Astronium graveolens	18	1	1
Aspidosperma white		1	
Aspidosperma red	30	6	2
Attalea cohune		3	
Bactris			
Bauhinia			
Bourreria	17	1	1
Calyptrogyne ghiesbrechtiana			
Callophylum brasiliensis		2	
Casearia	12	1	1
Cecropia		1	
Chamaedorea ernesti-augusti			
Chamaedorea pinnatifrons			
Chrysophila stauracantha			
Coccoloba	49	3	2
Cordia	142	7	7
Costus			
Cupania	11	2	1
Dead			
Dendropanax arboreus		4	
Desmoncus orthocanthos			
Dialium		1	
Dioscorea			
Faramea		3	
Ferns			
Ficus sp.		1	
Guarea grandiflora	13	3	1
Guarea glabra		2	
Heisteria media	17	2	1
Heliconia bourgeana			
Heliconia vaginalis			
Hieronyma		2	
Hirtella americana	60	6	4
Inga	14	2	1
Laurel	64	5	4
Licania hypoleuca	20	9	1
Licania sparsipilis		1	
Manilkara		4	
Machaerium			
Melastomataceae		2	
Mimosa cf adhaerens			
Mouriri exilis		2	
Neurolena lobata			
Pera barbelata		1	
Pithecellobium sp.		1	

Columbia River Forest Reserve

Appendix 10: 2004 REA; Summary Transect 8

WP 104-105, UTM 1816404/304980
6/8/2004 Little damage, canopy 15 m. semi-broken.
Half flat half steep, Brown Clay, no visible rocks. Understory ferns etc.

	Total DBH	Potential trees	Trees > 10 cm dbh
Pimenta dioica	26	1	1
Picramnia antidesma		1	
Piper			
Poulsenia armata		1	
Pourouma bicolor		1	
Pouteria campechiana	13	4	1
Pouteria mamosum		1	
Pouteria reticulata	19	2	1
Protium	10	3	1
Pseudolmedia		1	
Psiguria triphylla			
Psychotria			
Pterocarpus rohrii	46	2	2
Quararibea		2	
Rinorea			
Sabal mauritiiformis		2	
Sideroxylon		1	
Sloanea tuerkheimii		2	
Smilax			
Stemmadenia donnell-smithii		1	
Strychnos			
Synechantus fibrosus			
Terminalia amazonica		1	
Trophis racemosa		2	
Vatairea lundelli	12	1	1
Vochysia hondurensis		3	
Xylopia frutescens	19	2	1
	691	116	37

N_0 = Number of species	21
Shannon H' Log Base 2.718	2.793
Evenness E1 (Shannon J')	0.917
Rarefraction at sample size of 10 trees	8.06
Rarefraction at sample size of 20 trees	13.68
Rarefraction at sample size of 30 trees	18.22
Living stems > 10 cm dbh (incl. vines)	37
Average stem dbh in cm (living only)	18.7
Number of trees (non vines)	116
Total dbh living trees	691
Total dbh dead trees	239
Number of dead trees	7
Space per living tree in m^2	21.6
Total species	51
Dominant tree species (> 10% of total, >10cm dbh)	*Cordia, Hirtella americana, Laurel*
Dominant woody species	*None*
Largest biomass	*Alseis, Cordia*

Columbia River Forest Reserve

Appendix 11: 2004 REA summary transect 9

WP 136, 137, 138. JimmyCut Transect on slight hill
WP 136, 137, 138. JimmyCut Transect on slight hill, August 3, 2004
From loggingroad downhill on both sides. Small hill over limestone. Fairly steep slopes
UTM 1806131/282824

	Total DBH	Potential trees	Trees > 10 cm dbh
Abuta sp.			
Acacia glomerosa		1	
Acalypha			
Acanthaceae 2			
Aegephylla sp.		5	
Aegephylla square stem		1	
Alchornea latifolia		1	
Ampelocera hottlei	11	1	1
Annonaceae		1	
Anthurium pentaphyllum			
Anthurium schlechtendali			
Ardisia sp.			
Aspidosperma megalocarpon		1	
Asteraceae			
Astrocaryum mexicanum			
Attalea cohune		10	
Bactris major			
Bamboo small			
Bromeliad			
Brosimum alicastrum	122	2	2
Bursera simaruba		1	
Calathea sp			
Casearia sp.		1	
Cecropia obtusifolia	27	6	2
Celtis iguanae		4	
Cestrum	70	14	6
Chamaedorea geonomiformis			
Chamaedorea pinnatifrons			
Chamaedorea tepejilote			
Chrysophyla stauracanta			
Coccoloba sp.		1	
Cordia bicolor	10	2	1
Costus sp.			
Crateva tapia	31	5	2
Croton sp.		3	
Cupania belizensis		2	
Cymbopetalum mayanum		2	
Dead			
Dendropanax arboreus	15	2	1
Desmoncus orthacanthos			
Drypetes brownei		1	
Eugenia sp.		1	
Faramea			
Ferns			
Ficus sp.		1	
Geonoma tall			
Gouannia			
Guarea sp. Large	19	1	1
Hamelia patens			
Heliconia bourgeana			
Heliocarpus sp.	175	14	13

Columbia River Forest Reserve

Appendix 11: 2004 REA summary transect 9

WP 136, 137, 138. JimmyCut Transect on slight hill, August 3, 2004
From loggingroad downhill on both sides. Small hill over limestone. Fairly steep slopes
UTM 1806131/282824

	Total DBH	Potential trees	Trees > 10 cm dbh
Inga sp. Hairy		2	
Lauraceae	32	4	2
Lonchocarpus sp.		2	
Luhea sp.		3	
Manilkara chicle		2	
Miconia impetiolaris			
Miconia sp.		2	
Mimosa (tearcoat)			
Monstera sp.			
Myrtaceae (strong smell)		2	
Neurolena lobata			
Ochroma pyramidale		1	
Odentonema sp.			
Ouratea sp.			
Passiflora helleri			
Passiflora lancetillensis			
Passiflora serratifolia			
Philodendron sp.			
Picramnia antidesma		1	
Piper peltatum			
Piper spp.			
Pithecellobium arboreum		2	
Platymiscium dimorphandrum		1	
Poulsenia armata		1	
Pouteria campechiana		2	
Protium copal	38	6	2
Psiguria warczewicki			
Randia sp		1	
Rinorea sp			
Rubiaceae			
Sabal mauritiiformis	27	2	1
Sapium sp		3	
Sebastiana tuerkheimiana		1	
Selaginella			
Serjania			
Sideroxylon sp.		1	
Solanum sp.		1	
Solanum torvum			
Spondias radkofleri		7	
Stemmadenia donell-smithii		3	
Strychnos			
Syngonium sp.			
Tradescantia sp			
Trichilia sp.		2	
Trophis sp.		1	
Urticaceae			
Vitex gaumeri		1	
Xiphidium caeruleum			
Zanthoxylum sp.		3	
	577	141	34

Columbia River Forest Reserve

Appendix 11: 2004 REA summary transect 9

WP 136, 137, 138. JimmyCut Transect on slight hill, August 3, 2004
From loggingroad downhill on both sides. Small hill over limestone. Fairly steep slopes
UTM 1806131/282824

	Total DBH	Potential trees	Trees > 10 cm dbh
N_0 **= *Number of species***	13		
Shannon H' Log Base 2.718	2.026		
Evenness E1 (Shannon J')	0.815		
Rarefraction at sample size of 10 trees	5.91		
Rarefraction at sample size of 20 trees	9.13		
Rarefraction at sample size of 30 trees	11.36		
Living stems > 10 cm dbh (incl. vines)	34		
Average stem dbh in cm (living only)	17		
Number of trees (non vines)	141		
total dbh living trees	577		
total dbh dead trees	498		
Number of dead trees	15		
Space per living tree in m^2	23.5		
Total species	53		
Dominant tree species (> 10% of total, >10cm dbh)	Helicocarpus, Cestrum		
Dominant woody species	Helicocarpus, Cestrum		
Largest biomass	Brosimum,		

Columbia River Forest Reserve

Appendix 12: 2004 REA summary transect 10

WP 136, 137, 138. JimmyCut Transect on slight hill, August 3, 2004
From loggingroad downhill on both sides of a small hill over limestone. Flat
UTM 1805907/282974

	Total DBH	Potential trees	Trees > 10 cm dbh
Abuta			
Acalypha shrub			
Aegephylla monstrosa		1	
Alchornea latifolia		2	
Ampelocera		1	
Annonaceae		1	
Anthurium schlechtendali			
Ardisia			
Aroid			
Aspidosperma red		1	
Asterogyne martiana			
Astocaryum mexicanum			
Attalea cohune	32	5	1
Brosimum alicastrum	90	1	1
Byttneria aculeata			
Calathea			
Carapa guianensis		2	
Cecropia	84	8	7
Ceiba pentandra		1	
Celtis iguanae		1	
Cestrum	11	5	4
Chamaedorea pinnatifrons			
Chamaedorea tepejilote			
Chrysophila stauracanthos			
Coccoloba		1	
Cordia bicolor		2	
Costus			
Croton		3	
Dead			
Dendropanax arboreus	33	1	1
Desmonchus orthocanthos			
Dialium guianense	10	2	1
Faramea			
Ferns			
Geonoma			
Guarea grandifolia		1	
Heisteria media		1	
Heliconia aurantiaca			
Heliconia bourgeana			
Heliconia vaginalis			
Heliocarpus	51	5	4
Inga		2	
Lauraceae		2	
Louteridium?	22	7	2
Luhea		1	
Manilkara		1	
Meliaceae?		1	
Mortoniodendron guatemalensis		1	
Mouriri myrityloides		1	
Odentonema			
Oreopanax		1	
Ouratea			

Columbia River Forest Reserve

Appendix 12: 2004 REA summary transect 10

WP 136, 137, 138. JimmyCut Transect on slight hill, August 3, 2004
From loggingroad downhill on both sides of a small hill over limestone. Flat
UTM 1805907/282974

	Total DBH	Potential trees	Trees > 10 cm dbh
Passiflora lancetillensis			
Piper auritum			
Piper sp.			
Pisonia		1	
Pitehecellobium arboreum		1	
Pouteria sp.	52	2	1
Protium	12	4	1
Pseudolmedia			1
Psychotria			
Rinorea			
Sapium		3	
Siparuna			
Sloanea tuerkheimii	14	1	1
Solanum torvum			
Spondias radkofleri		3	
Strychnos			
Unknown	24	1	1
Urera			
Verbenaceae	52	2	1
Zamia variegata			
	487	80	27

N_0 = Number of species	14
Shannon H' Log Base 2.718	2.329
Evenness E1 (Shannon J')	0.883
Rarefraction at sample size of 10 trees	7.02
Rarefraction at sample size of 20 trees	11.34
Living stems > 10 cm dbh (incl. vines)	27
Average stem dbh in cm (living only)	18
Number of trees (non vines)	80
Total dbh living trees	487
Total dbh dead trees	360
Number of dead trees	8
Space per living tree in m^2	29.6
Total species	38
Dominant tree species (> 10% of total, >10cm dbh)	*Cecropia, Cestrum, Heliocarpus*
Dominant woody species	*Cecropia*
Largest biomass	*Verbenaceae, Pouteria sp., Brosimum alicastrum, Cecropia sp.*