PAPUA LNG PROJECT

UPSTREAM ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2: ENVIRONMENTAL AND SOCIAL BASELINE STUDIES

Part 6: Upstream Terrestrial Biodiversity Baseline Report
Annex 1a: Upstream Flora Baseline Report

TOTAL E&P PNG LIMITED

December 2019
(Report No. 01215B_1-6_v5)

Upstream Flora Baseline Report
Papua LNG Project

Total E&P PNG Limited

August 2017

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Report reference number: 01215B_25-1-6_v5

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Acronyms and Abbreviations

Term	Definition
asl	above sea level
c.	approximately, about
cf.	confer, or compare to
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	centimeter
DBH	diameter at breast height
e.g.	for example
et al.	and others
FIMS	Forest Inventory Mapping System
i.e.	that is
IUCN	International Union for Conservation of Nature
km	kilometer
LAE	Index Herbarium acronym for the Papua New Guinea National Herbarium
m	meter
mm	millimeter
PNG	Papua New Guinea
sp.	species (singular)
spp.	species (plural)
subsp.	subspecies
syn.	synonym
var.	variety

Glossary

Term	Definition
abaxial	The side away from an axis
actinomorphous (actinomorphic)	Radially symmetrical; capable of being equally divided along many planes passing through the center of a structure
adaxial	The side facing the main axis
arborescent	Treelike
areolae	Area between veins on a leaf
axil	The angle formed by a structure and the axis from which it arises
bract	A leaf like or scale like structure on an inflorescence, usually subtending a flower or a branching point
calyx (calyces)	The sepals taken collectively, one of the two series comprising the perianth
catena	Lateral variation in soils over a hill slope
cauline	Arising from the main stem
chartaceous	Papery
coriaceous	Leathery
corolla	The petals taken collectively, one of the two series comprising the perianth
cosmopolitan	Worldwide, or of geographically extensive distribution
deciduous	Of parts falling at the end of a growing season or other period of development
epilithic	Growing on rocks
ericoid	Pertaining to a member of the family Ericaceae
gesnerid	A member of the family Gesneriaceae
hydrochory	The dispersal of seed by water
indumentum	Hair-covering
Inflorescence	Group or cluster of flowers arranged on a stem that is composed of a main branch or a complicated arrangement of branches
laciniate	Divided into deep narrow irregular segments
lycophyte	Lycopsid, a member of the *Lycopodium* group (Lycopsida)
macrophyllous	Large-leaved

Term	Definition
microphyllous	Small-leaved
monocaul (monocaulous)	Single-stemmed, generally referring to a plant without branches
pachycaulous	Possessing a thick or stout stem
panicle	An indeterminate branching raceme; an inflorescence in which pedicellate flowers are produced on branches of the primary axis
papillose	Provided with minute pimple-like protuberances (papillae)
Papuasia	The biogeographic region consisting of New Guinea, the Bismarck Archipelago, and the Solomon Islands
peltate	Shield-shaped
perianth	Collectively the calyx and the corolla.
pericarp	Tissues of a fruit that develop from the ovary wall.
petiole	The stalk of the leaf
phenology	Flowering and fruiting cycles
receptacle	The axis on which the floral parts are inserted.
riparian	Located on the bank of a natural watercourse, or of lakes or tidewater
scabrid	Rough hairs
sclerophyll	A hard- or tough-textured leaf
sensu	In the sense of (latin)
stipule	A leaf like appendage usually inserted at the base of a petiole
stellate	Star-shaped
tepal	A lobe from an undifferentiated perianth
umbelliform	Having the form of a cluster whose elements arise from a common point
undescribed	A taxon that has not been formally described in accordance with the International Code for Botanical Nomenclature
zoochory	Dispersal of seed by animals
zygomorphic	Bilaterally symmetrical; capable of division into two equal parts only along a single plane

Executive Summary

An intensive flora survey was conducted at 13 sites in the study area in the Purari River basin and the results are presented in this baseline report. The field survey was conducted in two phases to capture possible seasonal variations in flowering, fruiting and seeding behaviors of plant species in order to enhance identification of species present.
The objectives of the flora study component of the terrestrial biodiversity study are:

- To collate and assess existing information relevant to plant communities in the vicinity of the study area.
- To survey the plant communities present in the study area.
- To describe and discuss the composition, condition and conservation significance of native plant communities present within the study area, including:
  - Floristic and structural characteristics of major vegetation types present in surveyed areas.
  - The presence and status of species of conservation significance recorded or potentially present.
  - Habitats and other landscape features important to plant communities.
  - To summarize knowledge gaps in relation to plant communities present within the study area.

Thirteen vegetation formations (FIMS types; Swamp forest (Fsw), Swamp forest/Swamp grassland (Fsw/Gsw), Swamp forest/Swamp woodland (Fsw/Wsw), Hill forest (Hm), Small crowned hill forest (Hs), Herbaceous swamp (Hsw), Mangrove (M), Alluvial forest (Pl), Open alluvial forest (Po), Open alluvial forest/Swamp forest (Po/Fsw), Swamp woodland (Wsw), Swamp woodland/Swamp grassland (Wsw/Gsw) and Littoral forest (B) were characterized from field surveys at the eleven sampling sites.

A general checklist of plant taxa was compiled for the surveyed area, with a total of 812 plant species recorded.

Floristic diversity in the study area is high especially in the families Annonaceae (25 spp.), Araceae (23 spp.), Arecaceae (34 spp.), Euphorbiaceae (22 spp.), Fabaceae (27 spp.), Ferns (78 spp.), Melastomataceae (20 spp.), Meliaceae (21 spp.), Moraceae (28 spp.), Orchidaceae (52 spp. identified and many more species unidentified to species level) and Rubiaceae with 56 species.

Thirty-four (34) species new-to-science were discovered during the survey which are presently known only from within the study area. One additional undescribed species has been recorded previously from the Crater Mountain Wildlife Management Area north of the study area.

Twenty four IUCN listed species – three 'Critically Endangered', two 'Endangered', eight 'Vulnerable', eight 'Near Threatened' and three 'Data Deficient' – were recorded during the field surveys. Three additional IUCN listed species have been collected previously from the study area in the Purari River Delta—*Gluta papuana* (VU), *Brownlowia argentata* (DD) and *Pentaspadon motley* (DD). Therefore, a total of 27 IUCN listed species may occur in the study area based on current knowledge of their distribution and habitat preferences.

Forty-two (42) restricted-range species have been recorded in the study area, with a further five species potentially present that are restricted in distribution to Gulf Province below 1,000 m elevation, based on records from published literature, and specimens in Herbaria.

1 Introduction

1.1 Background

The following Project description is focused on the upstream components of the Papua LNG Project and aims at providing minimal but appropriate context for the baseline reports.

Joint venture partners are currently planning the development of the Elk-Antelope gas field, which is located within Petroleum Retention License 15 (PRL-15) in the Gulf Province, Papua New Guinea. Total E&P PNG Limited (TEP PNG), a wholly owned subsidiary of TOTAL S.A (TOTAL) has the largest interest in the Elk-Antelope gas field and is the operator of the Papua LNG Project (the Project) on behalf of the other joint venture partners.

The Elk-Antelope gas field is a significant gas discovery in Papua New Guinea consisting of a gas reservoir with several trillion cubic feet of gas reserves located approximately 120 km inland from the township of Kerema, and 340 km northwest of Port Moresby.

The Project will comprise upstream production well development and associated infrastructure at the gas field within PRL-15, construction of an upstream central processing facility (CPF) and delivery of gas and condensate via onshore and offshore export pipelines to a LNG Plant site at Caution Bay, Central Province, 20 km northwest of Port Moresby. The design life for the Project will be 25 years.

The Project area comprises the physical footprint of the various Project components and associated infrastructure as detailed below.

- Production, processing and related facilities (within PRL-15):
  - Wellpads and the associated gathering system (including flowlines and trunkline).
  - CPF.
  - Logistics base and river offloading facilities, accommodation camps, airstrip, roads and bridges.
  - Quarries, communications infrastructure.
  - Initial section of the onshore export pipeline.

- Onshore pipeline (outside PRL-15):
  - Remainder of the onshore export pipeline to landfall on the Gulf coast including valve stations.
  - Temporary laydown areas and camps.
  - Quarries, communications infrastructure.

- Transport (river) corridors:
  - River transport routes — the Purari, Urika-Ivo and Wame-Varoi rivers.

- Offshore pipeline:
  - Offshore section of the export pipeline to a LNG Plant site, Caution Bay.

As part of the Project environmental, social and health impact assessment (ESHIA), a terrestrial biodiversity baseline study has been commissioned to provide a baseline characterization of terrestrial biodiversity and conservation values present in the vicinity of the upstream Project area. This report presents the results of the technical study on flora conducted as part of the upstream terrestrial biodiversity baseline study. Description of vegetation communities and an inventory of weeds are reported separately (Booyong, 2017a and Booyong 2017b, respectively).

1.2 Upstream Terrestrial Biodiversity Study Area and Ecological Zones

The upstream terrestrial biodiversity study area (hereafter 'study area') covers approximately 7,290 km2 of the Gulf Province lowlands (to c. 600 m above sea level (asl)). The study area is divided into five ecological zones, each of which is expected to support a distinct assemblage of terrestrial biota.
The study area encompasses the upstream project area of influence (upstream PAOI), the area within which the Project may potentially and measurably impact biodiversity. The terrestrial biodiversity field surveys were focused at representative sites within the Upstream PAOI, hereafter referred to in this report as survey sites. Further description of the PAOI is provided in the main Upstream ESBS report and is no longer referred to in this report.[1]

The study area and its component ecological zones are shown in Figure 1. They are described in more detail in the Upstream Terrestrial Biodiversity Baseline Report.

1.3 Technical study objectives

The objectives of this technical study are:

- To collate and assess existing information relevant to plant communities in the vicinity of the study area.
- To survey the plant communities present in the study area, i.e., terrestrial biodiversity survey area.
- To describe and discuss the composition, condition and conservation significance of plant communities present within the study area, including:
  - Floristic and structural characteristics of major vegetation types present in surveyed areas.
  - The presence and status of species of conservation significance recorded or potentially present.
  - Habitats and other landscape features important to plant communities.
- To summarize knowledge gaps in relation to plant communities present within the study area.

2 Existing information

A limited number of botanical surveys have been conducted in the study area with most of these concentrated on the Purari Delta and the mangrove vegetation (Womersley 1975; White & White 1976; Floyd 1977; Liem & Haines 1977; Cragg 1983 & Ellison 1997). Paijmans (1983) gave a broad description of the plant communities throughout the Purari River catchment with some notes on dominant species in each habitat. The only survey conducted within the study area that was incorporated in Paijman's survey, was the 1966 CSIRO Land Research survey (Paijmans 1969; Ruxton *et al*. 1969). Information on collections made by other botanists who visited logging operations within this sector of the study area is provided in the collections of various herbaria, most notably the Papua New Guinea National Herbarium (LAE) at Lae.

During the 1970s, the Papua New Guinea Government conducted environmental studies for the proposed hydropower station near Wabo, but the studies have little botanical data of relevance to the current Project. During the same period a number of botanists from the former Papua New Guinea Department of Forests in Lae made a limited number of collections, mostly from the northern sector of the study area. These collections are kept at the Papua New Guinea National Herbarium, Australian National Herbarium in Canberra and the National Herbarium of New South Wales in Sydney. The Papua New Guinea National Herbarium and Australian National Herbarium in Canberra also contain a number of collections by Lyn Craven and Richard Schodde (labeled as being on behalf of CSIRO and dated 1966) in the Purari River catchment near the Crater Mountain Wildlife Management Area (WMA) with Craven concentrating on the families Ericaceae, Malvaceae and Myrtaceae. In 1977, Liem and Haines produced a report on the preliminary results of the vegetation in the proposed Wabo dam site for the Purari Hydroelectric Scheme, also with limited application to the current Project. An environmental impact statement (EIS) survey completed in 2008 by Douglas Environmental Services

[1] The boundary of the PAOI is shown in figures for context only.

for InterOil provided short descriptions of the various Papua New Guinea Forest Inventory Mapping System (FIMS) forest types with a short list of species recorded. The only species recorded by them that are listed as above Least Concern in the International Union for the Conservation of Nature's (IUCN) Red List of Threatened Species (see Section 3.3.1) were *Intsia bijuga* and *Pterocarpus indicus*. None of these reports describe vegetation in detail and are therefore of limited value for this study. An extensive flora and vegetation survey was undertaken by the principle author for the Purari Hydropower Project during 2011–12, however the information is not available to be incorporated into this report.

A number of vegetation surveys have been conducted in adjacent areas. To the east of the Purari River catchment a survey of the vegetation at Lakekamu River basin was conducted in 1998 as part of a Rapid Assessment Program (RAP) biodiversity study. Vegetation structure and floristic diversity were covered during this survey (Reich 1998; Takeuchi & Kulang 1998). Takeuchi and Kulang commented on the high species richness in the basin's lowland alluvial forest. North of the study area, an assessment of the Crater Mountain WMA flora was conducted by Takeuchi (1999), which spanned over two years. Unfortunately, the lowest area surveyed was at the Pie River area at elevations above those reached within the upstream terrestrial biodiversity study survey area (460–610 m elevation). Takeuchi noted that on a comparative percentage basis, the low elevation ecosystem at Crater Mountain are still unexplored and is likely to reward future botanical investigators with a disproportionate number of discoveries.

To the west of the study area, a number of floristic surveys have been conducted in the lowlands and hills of the Kikori catchment (Johns 1988), mostly as part of WWF's involvement with the KICDP/Kikori Basin Conservation Program. Habitats assessed included mangroves, freshwater swamps, alluvial forest and hill forest on karst terrain. A number of taxonomic inventories were produced from these field studies which resulted in several unpublished reports, many of which are available for reference.

Given the proximity of the Kikori River catchment and Purari River catchment lowlands, their similar habitats and occurrence within the same ecoregions (*sensu* Wikramanayake *et al*. 2002), such data might be useful in generating lists of species that may be expected to occur within the study area. Unfortunately, many of the WWF reports include records that are based on misidentification, limiting their value, but there were two credible surveys, one on palms by Baker *et al*. (2000) from Kew and the other on orchids of the Purari lowlands by Harris (2003) of the Queensland Herbarium.

The deltaic, swamp and lowland alluvial habitats of the Kikori–Purari region have been regarded as a 'Major Area of Biological Importance' (Beehler 1993; Johns 1993) with respect to the vegetation. Johns (1993) commented on the diversity of the mangrove and swamp vegetation and the forests on the isolated limestone hills that evidently support local endemics but are virtually uncollected from. Little or no relevant work has been conducted there since Johns' assessment, and when considered in conjunction with the statements of Takeuchi (1999), very little is known of the status and distribution of flora for any part of the study area, and that many rare, endemic and as yet undescribed plant species are expected to occur.

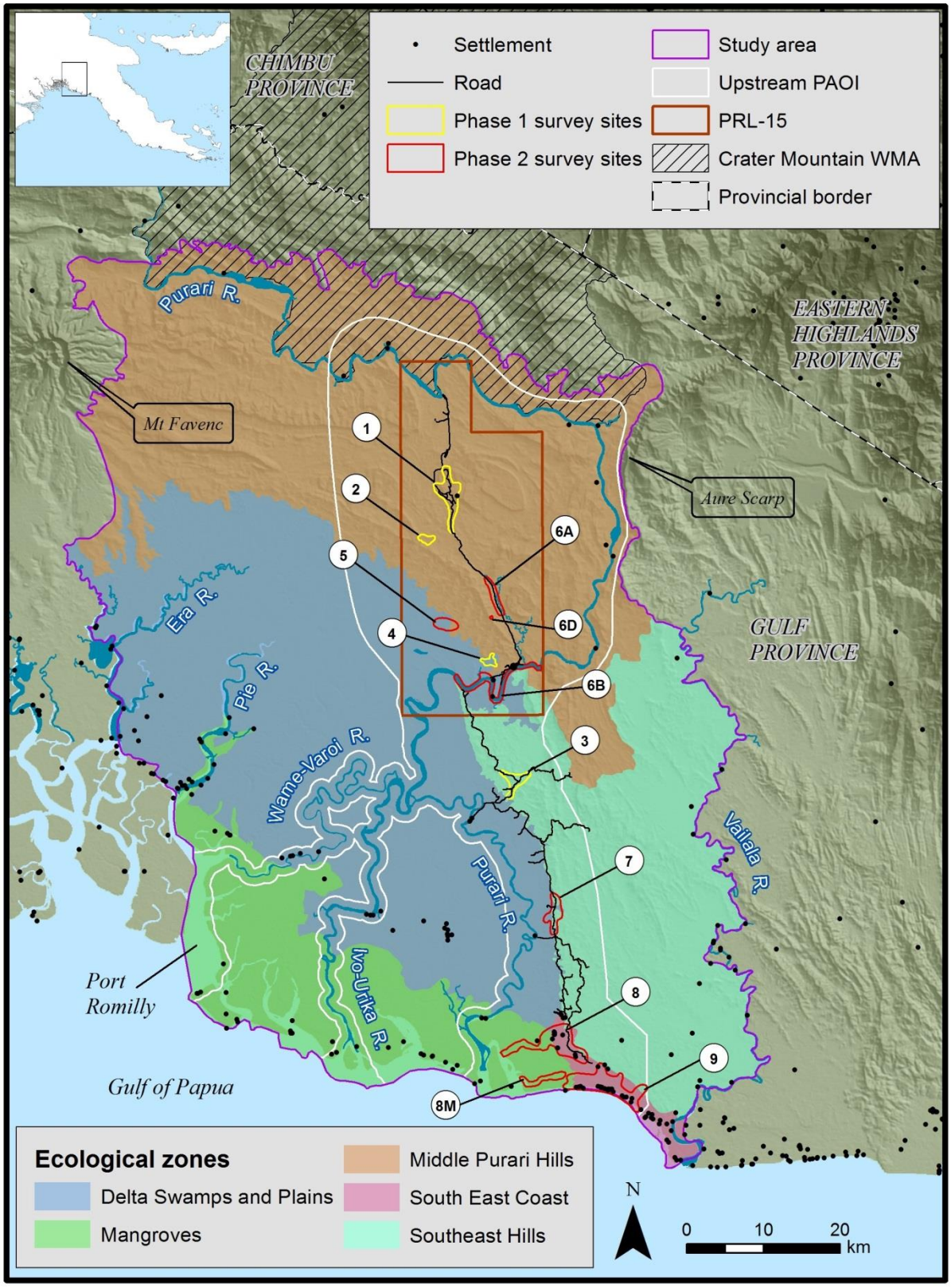

Figure 1. The Study Area
This map depicts the component ecological zones, the Upstream Direct PAOI and the location of Phase 1 and 2 upstream terrestrial biodiversity study survey sites.

3 Methods

3.1 Survey sites and schedule

The Phase 1 field surveys were conducted at four sites in the northern and central parts of the upstream terrestrial biodiversity study area, in January and February 2016 during the relatively dry 'northwest season'. The Phase 2 field surveys were conducted at nine sites in the north, center and south of the study area, in June and July 2016 during the 'southeast (tradewinds) season'.

Site 1 surveys were conducted in the forest surrounding the Antelope 3 Operations Camp, however Sites 2–5 and 7–9 consisted of a fly camp with a network of access tracks into the surrounding habitats. Sites 6A, 6B, 6D and 8M were covered in day visits by helicopter insertion and Site 6C was covered in a helicopter fly-over. Botanical collections and forest observations were made around these camps and day-visit ground insertion points.

Maps for each of the survey sites are presented in Figures 2–7. Geographic coordinates, elevations, survey dates, and survey duration (devoted to collecting by two surveyors) are provided for each survey site in Table 1. All GPS waypoints are expressed in UTM format, PNG94 datum.

Table 1 Survey Site summary

Location	UTM PNG94	Alt (m asl)	Arrival	Departure	Trail elevations:	
					Min	Max
Phase 1						
Site 1	294689 9209644	100	19 Jan, 14:30	27 Jan, 11:00	50	380
Site 2	291894 9202769	95	27 Jan, 11:15	2 Feb, 10:30	55	295
Site 3	303459 9171560	130	2 Feb, 10:45	9 Feb, 16:00	100	170
Site 4	300251 9186944	30	9 Feb, 14:20	16 Feb, 09:30	25	90
Phase 2						
Site 5	294432 9191260	20	21 Jun, 17:00	2 Jul, 10:45	15	45
Site 6A	300655 9195465	n/a	27 Jun, 09:20	27 Jun, 16:10	30	75
			28 Jun, 08:20	28 Jun, 15:00		
Site 6B	299876 9184880	n/a	25 Jun, 10:00	25 Jun, 15:00	5	30
Site 6C[1]	n/a	n/a	30 Jun, 11:00	30 Jun, 11:30	n/a	n/a
Site 6D	300280 9192765	n/a	26 Jun, 10:15	26 Jun, 16:00	185	310
Site 7	308305 9153930	15	2 Jul, 11:00	9 Jul, 12:25	5	120
Site 8	308835 9138610	5	9 Jul, 12:40	15 Jul, 09:20	0	60
Site 8M	309598 9133014	1	12 Jul, 9:00	12 Jul, 12:00	0	12
Site 9	315970 9131180	0	15 Jul, 09:30	19 Jul, 13:45	0	70

[1] Site 6C was surveyed by helicopter only so a GPS waypoint is not available.

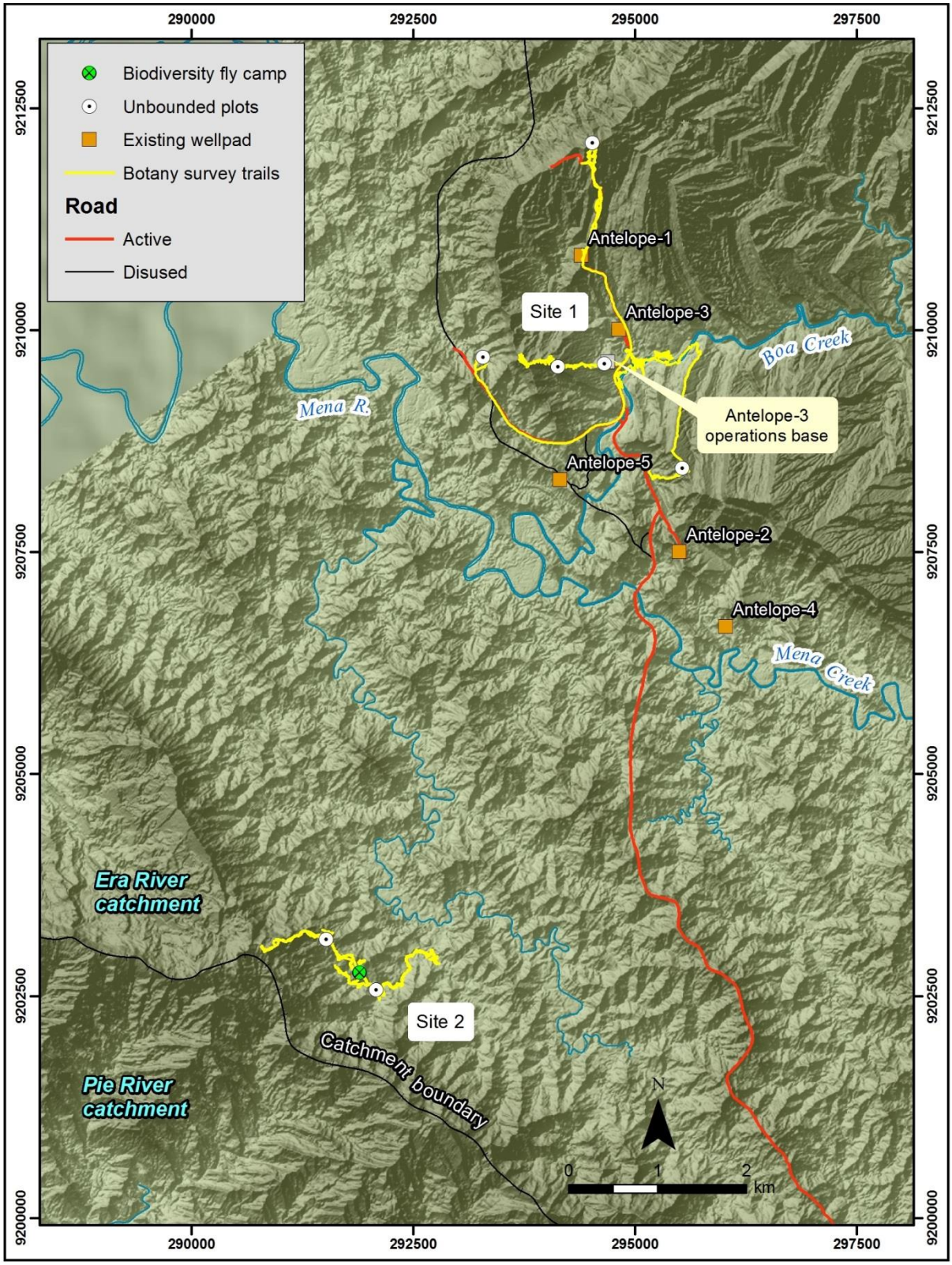

Figure 2. Botanical survey coverage for Sites 1 and 2. All vegetation within the mapped area is Hill forest (Hm).

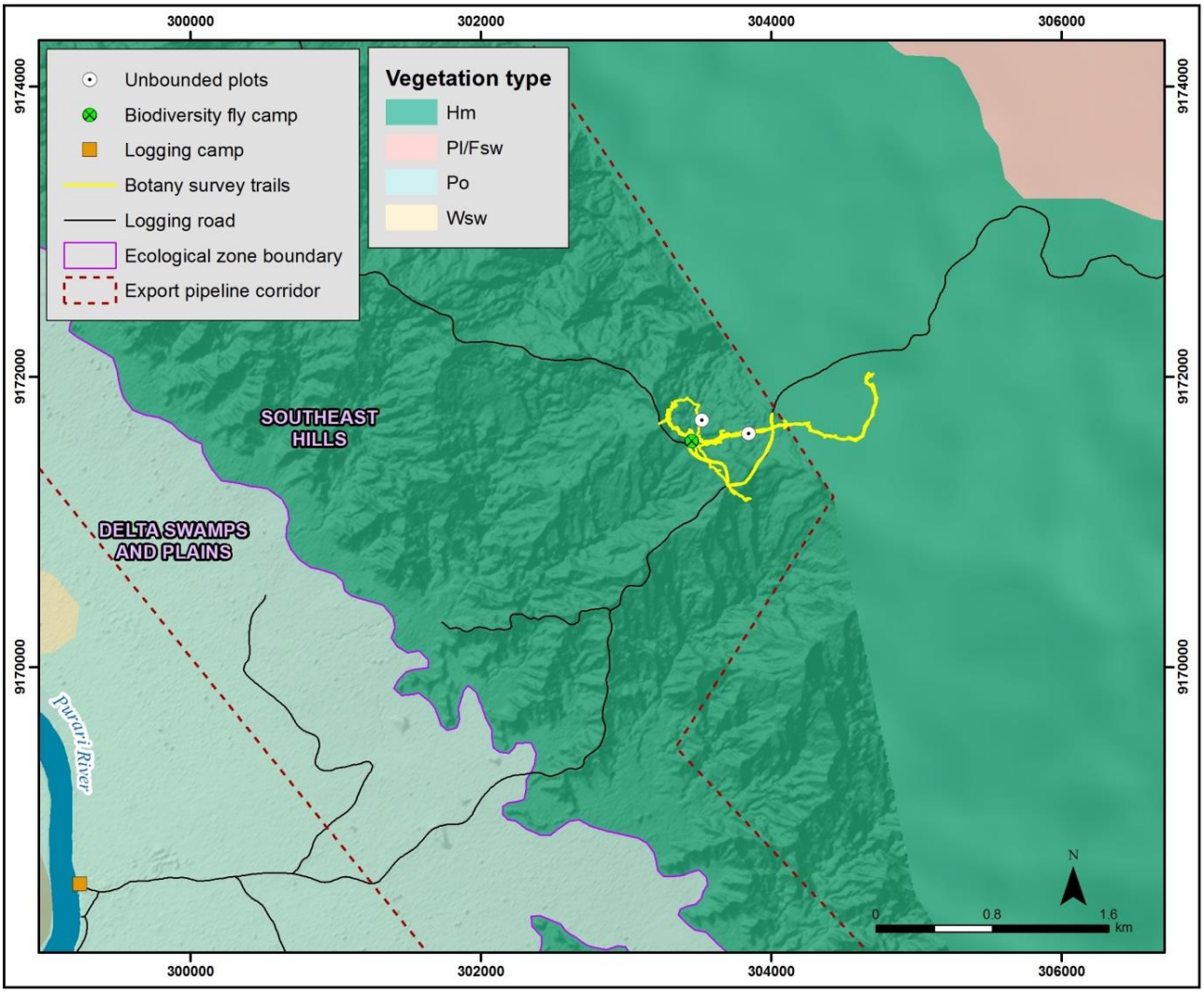

Figure 3. Botanical survey coverage for Site 3.

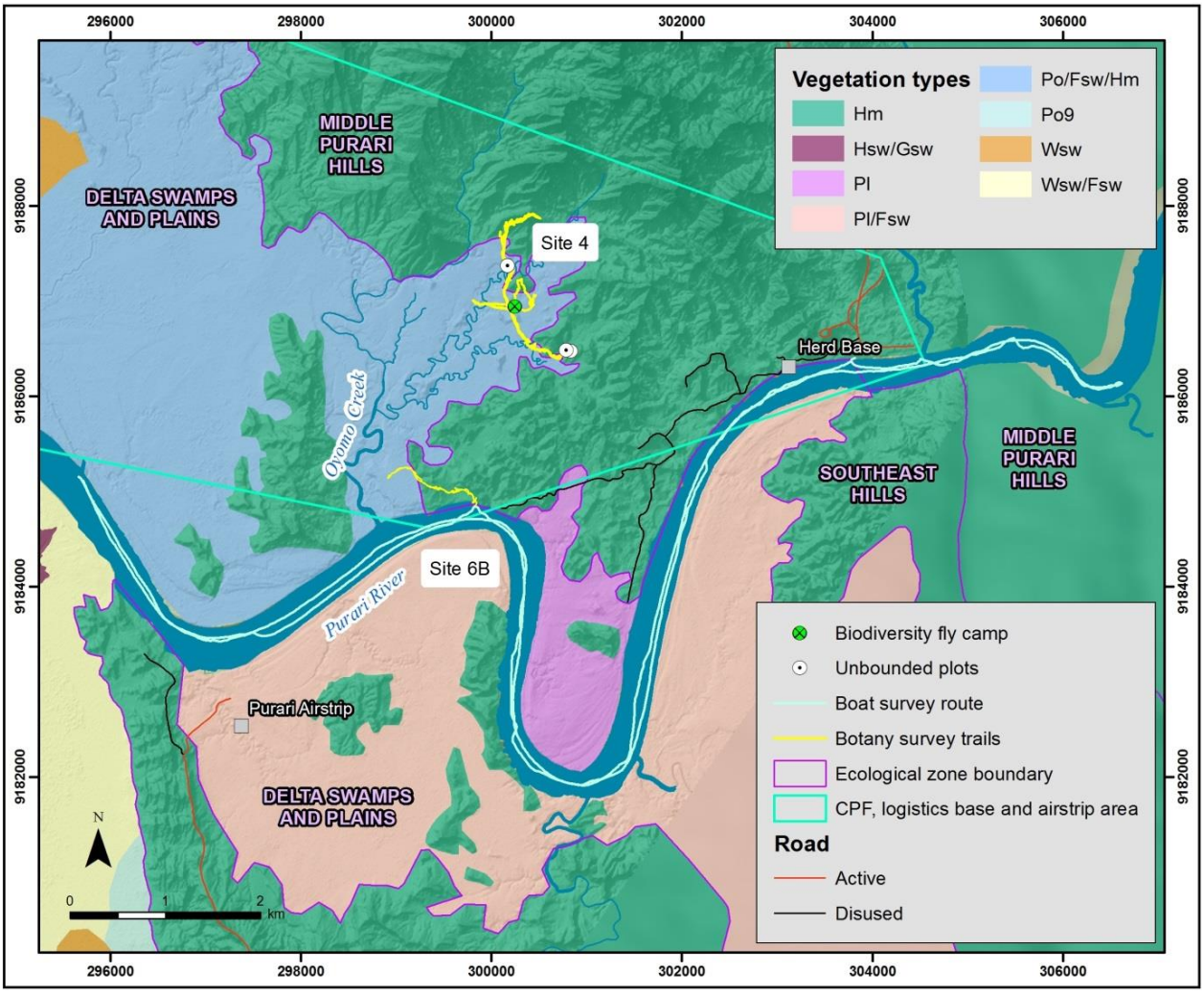

Figure 4. Botanical coverage for Sites 4 and 6B.

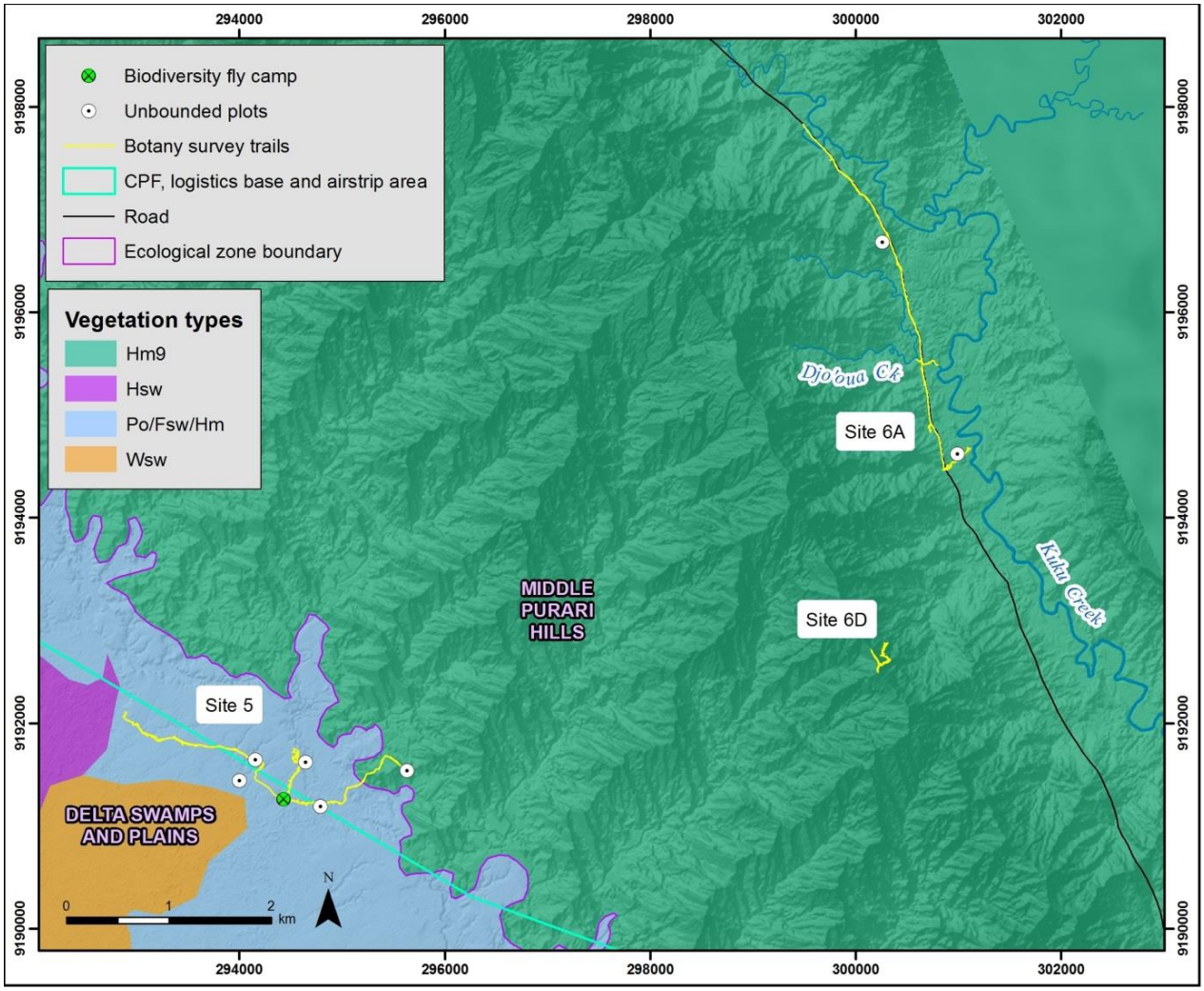

Figure 5. Botanical coverage for Sites 5, 6A and 6D.

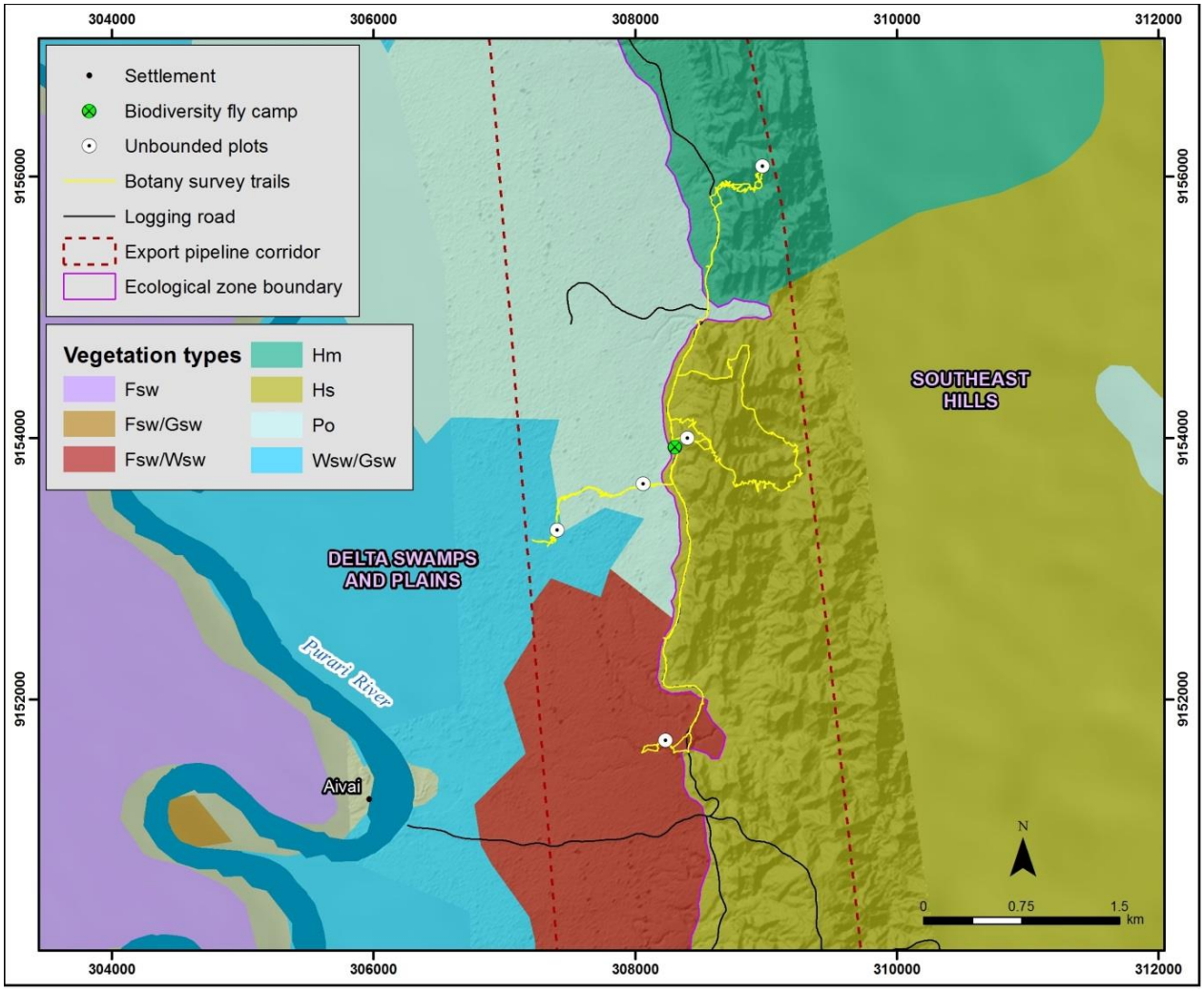

Figure 6. Botanical coverage for Site 7.

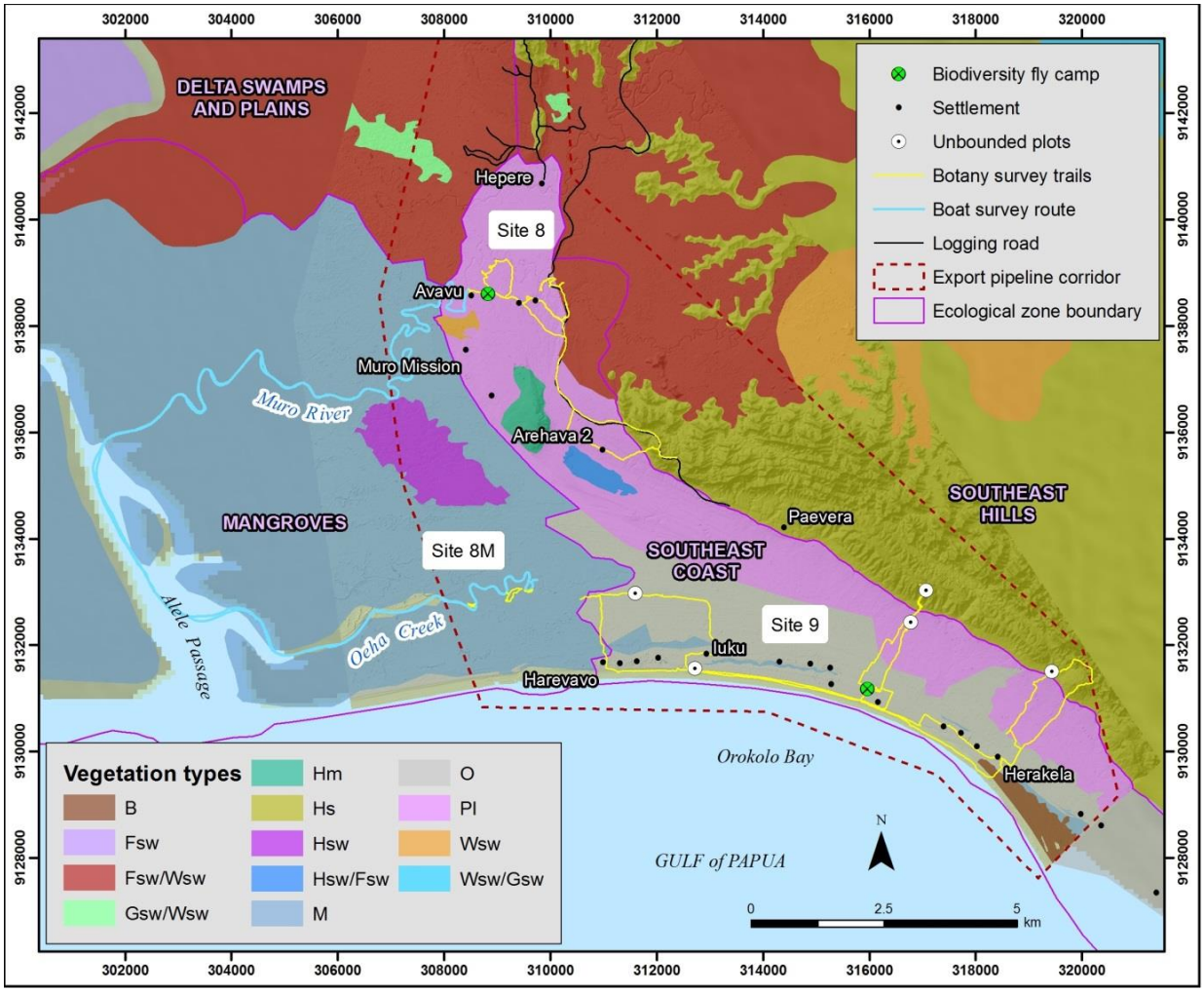

Figure 7. Botanical coverage of Sites 8, 8M and 9

3.2 Survey methods

For each site the vegetation survey team characterized representative vegetation types, compiled a botanical inventory, and conducted targeted searches for conservation listed and other botanically notable species.

To maximize the survey effort effectiveness at each site, the team stratified the survey by landform where practicable. Landform variation (ridgeline, hill face, gully and alluvial terrace) was used as an indication of habitat variation/potential changes in the vegetation, since a gradient of different soil types and drainage conditions (a catena) are typically associated with landform variation, which underlies floristic differences across forested landscapes. In addition, natural gaps and large fallen trees were surveyed. Natural gaps are favored by heliophytes that have adaptations to grow and reproduce in gaps and are therefore rare or absent in closed forest. Large fallen trees were assessed to identify epiphytic plants, including many orchids, which are typically confined to the forest canopy.

3.2.1 Flora Survey

Level 1: For each vegetation type encountered, including rare or sensitive vegetation communities, unbounded plots (generally 400 to 500 m^2) were used to record the plant species for the main plant life forms (e.g., trees, shrubs, palms, pandans, ferns, herbs, pitcher plants, grasses and sedges). For each plot, up to six physiognomic strata were recognized (ground layer, shrub layer, understory, subcanopy, canopy and emergent layer). For each stratum all the main vascular plants were recorded

for the main life forms. This survey method was used to rapidly characterize the vegetation communities but was not used to obtain a complete plant inventory. GPS coordinates were recorded for Level 1 survey only.

Level 2: Level 2 surveys involved a rapid visual check of the vegetation that primarily focused on the canopy species to determine similarity to the Level 1 survey records. The area assessed by the visual check was of similar size to the unbounded plots. This provided a rapid method to verify the FIMS mapping and determine more detailed plant community and landform/drainage/disturbance relationships not evident in the mapping.

Level 3: At each change in major vegetation type the vegetation survey team conducted searches for species of conservation significance, including species listed under the IUCN Red List of threatened species, taxa (genera) most likely to support species new-to-science/botanical novelties and restricted-range species (geographic range <50,000 km^2). Focal IUCN-listed species included species listed under the categories Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Data Deficient (DD). Additionally, potentially rare or sensitive vegetation communities were recorded at all levels of survey if present.

3.2.2 Data collection

The following data and specimen collection were undertaken at each site:

- General vegetation - a checklist of all vascular plant taxa (excluding liverworts, mosses and fungi) was compiled for the areas surveyed (Appendix 1).
- Restricted-range, IUCN and new-to-science/undescribed taxa - for each of the taxa the following data was recorded: GPS coordinates, elevation, number of individuals in the population, phenology, size and recruitment. In addition, photos were taken (Appendix 2).
- Unbounded vegetation plots as per the Level 1 survey description.
- Herbarium specimens of flowering and/or fruiting material of unknown and new taxa were collected for later identification. Collections were field-packed in 75% ethanol for subsequent processing at the Papua New Guinea National Herbarium.
- Photographs were also taken of all plant species in flower or in fruit with a Nikon D750 camera equipped with a 105-mm macro lens to assist with later identification.

3.2.3 Unidentified species

Voucher specimens of the less common fertile taxa and new plant discoveries were identified at the Papua New Guinea National Herbarium and the Australian Tropical Herbarium in Cairns.

Dr. Andre Schuiteman from Kew, head of Orchid Research and a specialist on Papua New Guinea orchids, and Dr. Ed de Vogel from Hortus Botanicus in Leiden assisted with identification of taxonomically difficult orchid groups. Dr. Axel Dalberg Poulsen from Oslo Botanic Gardens, a specialist on gingers of the world helped with identifications of all *Alpinia* and *Riedelia* species (Zingiberaceae). The Gesneriaceae research group at Kew in London and at The Royal Botanic Gardens Edinburgh assisted with the identification of Gesneriaceae.

3.2.4 GPS waypoints and tracks

GPS tracks were recorded throughout the survey and GPS points were recorded for the following only:

- All Level 1 survey locations.
- Conservation listed species, species potentially new-to-science and restricted-range species. Only one waypoint was recorded for populations of a particular species in the same locality.

3.2.5 Forest typing

To verify the FIMS mapping at each site the field data was compared to the FIMS descriptions. Where the species and composition was not consistent with the FIMS mapping the correct FIMS type was determined.

All forest communities in Papua New Guinea have been comprehensively mapped as part of FIMS, based on air photo interpretation from stereo pair photos taken from 1973 – 1974. The original photographs were black and white Skaipiksa series, which covered the whole country. Recognizable and distinctive patterns of natural vegetation were mapped at a scale of 1:100,000 from the photos (Saunders 1993a and b; Hammermaster and Saunders 1995a and b), and all forested areas were assigned a disturbance rating.

The output of this mapping now forms the basis for the GIS based Papua New Guinea FIMS spatial mapping layer, which provides the baseline vegetation mapping for the thirteen sites together with descriptions of the structure and species composition of each of the 63 typing codes employed by FIMS (Appendix 3).

3.3 Protocols used

3.3.1 Conservation listed species

Conservation listed species include those listed by the IUCN (International Union for Conservation of Nature) as Threatened (Critically Endangered—CR, Endangered—EN, Vulnerable—VU), Near Threatened (NT) or Data Deficient (DD), and those listed under Appendix I or II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and posted on the IUCN website (www.iucn.org). Most recorded plant species (>97%) are either categorized by the IUCN as Least Concern or are Not Evaluated. Given the large number of species involved, the IUCN status of these plants has not been distinguished in this report. No plant species are protected under Papua New Guinea law.

Description of the vegetation is based on the Forest Inventory Management System (FIMS) (Hammermaster & Saunders 1995 a and b). Assignment of species to plant families generally conforms to the following sources: ferns and lycophytes (Smith et al. 2006), gymnosperms (Laubenfels 1988) and angiosperms (Angiosperm Phylogeny Group 2009).

3.3.2 Restricted-range species

Species recorded within the study area (during Project and prior surveys), and a subset of potentially occurring additional species, were screened for restricted-range status.

Relevant information on the distribution and habitat associations of much of New Guinea's flora is scarce. The 'collections index' for Papua New Guinea is below the minimum considered to provide an 'adequate' floristic inventory and the distribution of collecting localities is unevenly spread (Takeuchi 2007). Accordingly, many species are known from only one or very few localities and large range extensions are a regular occurrence on most modern surveys even to previously sampled areas (e.g. Takeuchi 2009, 2010, 2012; Venter 2015).

With these restrictions, providing a comprehensive and accurate dataset of restricted-range plant taxa recorded or potentially occurring in the study area is not a feasible goal. Instead, focus has been placed on: (1) species recorded only from the study area; (2) taxa known from few (<10) sites located only in Gulf Province or from outside Gulf Province only at low elevation (<500 m asl) sites in catchments that overlap the Study Area.

In addition to published literary sources, the following databases were screened for distributional information on potential restricted-range species:

- The Papua New Guinea National Herbarium.
- The National Herbarium of New South Wales, Sydney, Australia.
- The Australian Tropical Herbarium, Cairns, Australia.
- The Australian National Herbarium, Canberra, Australia.

3.3.3 Taxonomic nomenclature

In some cases, it was not possible to assign an established name to a species encountered during surveys. Taxonomic research on Papua New Guinea flora is ongoing, and the taxonomic framework of many major plant groups remains incomplete. To account for various levels of uncertainty the following system of nomenclatural tags and abbreviations was applied in this baseline assessment.

- **'sp.'** (singular) or **'spp.'** (plural). These abbreviations are used in cases where one or more taxa were not able to be identified to species level, e.g., if a plant cannot be identified to species level (*Cyrtandra* sp.), or where reference is made to multiple species within a genus without the need for more specific information, e.g., where several different *Ficus* species occur in a specific vegetation type (*Ficus* spp.).
- **'cf.'**—for example: *Bulbophyllum* cf. *absconditum*. This abbreviation is used to refer to species that are clearly allied to a named taxon, but for which insufficient data are available to confidently assign specimens to any particular species. The taxon may be part of a known species complex, and/or may be scientifically undescribed (=unnamed), though further work is required to determine its identity.
- **'sp. 1', 'sp. 2', etc.**—for example: *Begonia* sp. 1, *Begonia* sp. 2, *Begonia* sp. 3. The numeric system is used where taxonomic identity is confidently resolved but the species is scientifically undescribed. Distinction is made between: (a) species newly discovered during the Project surveys (new-to-science) and therefore presently known only from within the upstream terrestrial biodiversity study survey area, and; (b) undescribed species known to occur more widely across New Guinea.

3.3.4 Vegetation terminology

Vegetation types are referred to in the text using a set of FIMS-equivalent terms developed specifically for the upstream terrestrial biodiversity study (Booyong 2017b). These closely follow the formal FIMS descriptors, which are based on the founding vegetation descriptions (Paijmans 1976; Hammermaster and Saunders 1995a), but are generally less cumbersome.

Where a specific vegetation type is referred to in the text it is capitalized and followed in brackets by its FIMS code. In this way reference is made to vegetation mapping units present in surveyed areas, for example 'Hill forest (Hm)' and 'Open alluvial forest/Swamp forest (Po/Fsw)'.

Where more general reference is made to broader vegetation types that include multiple possible variants within the study area (and more widely in Papua New Guinea) it appears without capitals or a FIMS code, for example 'hill forest' and 'alluvial forest'. These generic types closely follow the various basal FIMS vegetation types, which in these examples are coded 'H' and 'P' respectively.

A list of the FIMS vegetation types and equivalent upstream terrestrial biodiversity study terms used in this report is presented in Appendix 3. A full list of FIMS vegetation types present within the study area, and equivalent terms used in the biodiversity study, is presented in the Upstream Terrestrial Biodiversity Baseline Report.

4 Results

4.1 Forest typing and community description

For each site the forest typing and description was verified against the FIMS mapping and associated descriptions. Descriptive terminology follows Paijmans (1976) and Hammermaster and Saunders (1995a and 1995b).

4.1.1 Site 1

FIMS class Hm (Hill forest) Middle Purari Hills ecological zone.

The vegetation at Site 1 is mapped by FIMS as Hill forest (Hm). Field survey verified that the vegetation was consistent with this mapping unit based on its species composition and structural characteristics. The main difference from the FIMS mapping was the increase in disturbance and clearing associated with the Antelope 3 Operations Camp, roads, wellpads, laydown areas and some spoil deposition associated with their construction.

Where undisturbed, this relatively tall forest had a canopy height of approximately 20–30 m with a canopy cover of 70–80%, however emergent trees were uncommon. The forest assessed had a high occurrence of angiosperm trees from the Anacardiaceae (*Campnosperma brevipetiolatum*, *C. montana*), Apocynaceae (*Cerbera floribunda*), Burseraceae (*Canarium* spp.), Dilleniaceae (*Dillenia papuana*), Fagaceae (*Castanopsis acuminatissima*), Elaeocarpaceae (*Elaeocarpus* spp.), Moraceae (*Ficus* spp.), Sapotaceae (*Planchonella obovata*), Sapindaceae (*Pometia pinnata*), Lauraceae (*Cryptocarya* spp.) and Myrtaceae (*Syzygium* spp.). The relatively uniform canopy was broken by occasional canopy gaps, particularly across the steeper slopes where natural tree falls were typically more common. Unusually, these gaps were initially colonized by small trees and shrubs of the Urticaceae (*Dendrocnide longifolia*, *Elatostema novoguineensis*, *Pilea effusa* and *Procris frutescens*), vines from the Piperaceae (*Piper* spp.) and gingers from the Zingiberaceae (*Alpinia* spp., *Hornstaedtia scottiana*, *Riedelia corallina*).

Many of the canopy trees had diameters of 70 cm DBH (diameter at breast height) or larger with well-formed buttresses. These trees supported a heavy load of epiphytes in their crowns, which mainly consisted of various fern species (*Asplenium nidus*, Hymenophyllaceae, *Nephrolepis* spp.), *Medinilla* spp., orchid species (*Agrostophyllum* spp., *Bulbophyllum* spp., *Coelogyne asperata*, *Dendrobium* spp.) and *Hydnophytum* spp.

The subcanopy of the Hill forest (Hm) was well developed and was mostly dominated by Meliaceae (*Aglaia* spp.) and Myristicaceae (*Myristica* spp.). The pandan (*Pandanus lauterbachii*) was also present as a distinctive and an important element of the forest. The ground layer was relatively open except along creeks and other drainage lines, with taxa from the Urticaceae (*Elatostema novoguineensis, Procris frutescens*), Zingiberaceae (*Alpinia* spp. and *Riedelia corallina*) and Gesneriaceae (*Cyrtandra* spp.). Climbers were also well represented, especially the climbing pandans *Freycinetia* spp., which occurred from ground level up to and in excess of 18 m, sometimes covering the whole surface of individual tree trunks.
Vegetation on the ridges and areas above the cliffs was characterized by species that favor better-drained sites. The dominant families across these sites included Lauraceae (*Cryptocarya* spp.), Combretaceae (*Terminalia complanata*), Fagaceae (*Castanopsis acuminatissima*) and Melastomataceae (*Astronia papuana*).

Slightly different vegetation was present along the relatively small alluvial river terraces of Boa Creek where the forest canopy was characterized by Araliaceae (*Campnosperma montana*), Clusiaceae (*Garcinia* spp.), Combretaceae (*Terminalia complantata*), Dilleniaceae (*Dillenia papuana*) and Sapindaceae (*Pommetia pinnata*). The ground layer was well developed with aroids, gesnerids and gingers, i.e., Araceae (*Homalomena cordata, Schismatoglottis calyptrata*), Gesneriaceae (*Cyrtandra* spp.) and Zingiberaceae (*Alpinia* spp., *Amomum aculeatum, Hornstaedtia scottiana*).

These alluvial terraces supported somewhat different species from the typical Hill forest (Hm), however they are not unusual and are a normal part of the hill forest landscape and associated landforms. However, where the forest had been disturbed by infrastructure construction, numerous vines were present, particularly along roadsides, including the native vine *Merremia peltata*, which in places had covered the canopy of damaged and regenerating trees. An example of the Hill forest (Hm) at Site 1 is shown in Figure 8.

Figure 8. Hill forest (Hm) at Site 1

4.1.2 Site 2

FIMS class Hm. Middle Purari Hills ecological zone

The forest at Site 2 is mapped by FIMS as Hill forest/Scrub (Hm/Sc), however the species composition was consistent with Hill forest (Hm) only, and there was no evidence of Scrub (Sc) based on floristics. The widespread patches of regenerating forest that characterized much of the landscape around Site 2 appear to have been incorrectly classified as scrub in the original FIMS mapping. Scrub (Sc) is defined as a community of dense shrubs up to 6 m height, which would be difficult to differentiate from regenerating forest in the original black and white Skaipiksa photos.

The regenerating patches of forest occurred on slumps reflecting movement of a concave slope on unconsolidated mudstone a short distance downhill. The hills are formed from uplifted Pliocene mudstones of the Orubadi Formation (Dow 1977) and appeared to be susceptible to slumping across the hilly landscape. This is presumably facilitated by the relatively weak mudstone strata that is saturated in the high rainfall environment (Johns 1986). Slumps were frequent across the landscape but landslips were not. Landslips are a different geological process that results in loss of vegetation and soil exposing bedrock. The FIMS typing for this vegetation unit was therefore reclassified as Hill forest (Hm).

The regenerating vegetation was characterized by a relatively open canopy with a canopy cover as low as 40% to approximately 6–8 m height. The canopy was dominated by thorny climbing palms

(rattans), comprising *Korthalsia zippelii*, *Calamus distentus*, *C. heteracanthus* and *C. humboldtianus*. In the open areas, the native vine *Merremia peltata* had climbed over the low canopy and was present across large areas. Additional vine species were also present including vines belonging to the Convolvulaceae (Morning Glory family) and Vitaceae (grape family). Trees present in the canopy were mainly *Pometia pinnata, Terminalia* spp. and especially *T. complantata*. The understory and shrub layers were more species rich, particularly with the families Fabaceae (*Archidendron* spp., *Chisocheton* spp., *Ficus* spp., *Maniltoa* spp.). Vegetation on the ground layer was relatively sparse because the dense tangled canopy layer prevented much light from penetrating, except for the occasional sun flecks reaching the forest floor.

The species composition of the undisturbed hill forest at Site 2 was similar to the hill forest at Site 1, except for the presence of the trees *Chisocheton ceramicus, Dracontomelon dao, Endiandra globosa* and *Semecarpus* spp. (*S. cassuvium, S. papuana*). However, across the landscape at Site 2 there were only scattered pockets where mature forest similar to Site 1 was present. These sites were usually either close to the streams or more often higher up along stable ridgelines that had not slumped.

An example of Hill forest (Hm) at Site 2 is provided in Figure 9.

Figure 9. Hill forest– (Hm) at Site 2. Note the abundance of climbers.

4.1.3 Site 3

FIMS class Hm (Hill forest) Southeast Hills ecological zone.

The vegetation at Site 3 is mapped by FIMS as Hill forest (Hm), which was consistent with field observations. However, it had been extensively disturbed by commercial logging operations. Typical logging operations in Papua New Guinea harvest all the accessible commercial species > 50 cm DBH where trees are free of defects. In addition to disturbance to the canopy from harvesting, the logging had resulted in extensive linear disturbances that were created by large bulldozers skidding the logs

to the main log haulage road, resulting in a dense network of skid tracks through much of the forest. The main haulage road is still used to transport logs from further north to Evara logging camp.
Despite the logging the species composition was consistent with Hill forest (Hm). The angiosperms, *Pometia pinnata, Ficus* spp., *Terminalia* spp. and *Planchonella firma* were the dominant canopy species. The subcanopy was under developed showing a lack of diversity with only a small number of dominant species comprising *Cryptocarya* (*C. gigantocarpa, C. medicinalis*), *Horsfieldia subtilis* and the tall palm *Orania archboldtiana*. The shrub layer (*Saurauia* spp., *Goniothalamus* spp., *Celtis* spp. and *Garcinia* spp.) was well developed and species rich, reflecting regeneration in the canopy gaps created by logging and to a lesser extent along the compacted skid trails. An example of Hill forest (Hm) at Site 3 is provided in Figure 10.

Figure 10. Hill forest (Hm) at Site 3

4.1.4 Site 4

FIMS class Po/Fsw/Hm (Open alluvial forest/Swamp forest/Hill forest) Delta Swamps and Plains and Middle Purari Hills ecological zones.

The vegetation on the alluvial terrain around Site 4 was consistent with the FIMS definition for the Open alluvial forest/Swamp forest (Po/Fsw) complex (Figure 11), however Open alluvial forest (Po) was dominant. Open alluvial forest typically occurs in areas subject to prolonged wet-season inundation and areas with poor drainage which is consistent with the site. The Open alluvial forest had an irregular uneven canopy composed of mainly medium and small crowned trees. Common canopy species included *Planchonia papuana, Tijsmanniodendron bogoriense, Neonauclea acuminata* and *N. purpurata* (the more common of the two species) (Paijmans 1975, Hammermaster & Saunders 1995a).

There was an abundance of *Ficus* spp. (Ficus bernaysii, F. congesta, F. copiosa, F. nodosa, F. pungens, F. wassa), *Pongamia pinnata*, *Hydriastele costata*, *Litsea globosa*, Lamiaceae (Gmelina moluccana, Tijsmanniodendron bogoriense), Lauraceae (*Cryptocarya* spp.), Myrtaceae (*Syzygium* spp.), Dipterocarpaceae (Vatica papuana) and Combretaceae (*Terminalia* spp.) with some scattered

plants of Campnosperma brevipetiolatum and Myristica spp. in the canopy. The canopy was low (20-30 m) and open with a canopy cover of 60%.

The subcanopy and shrub layers were well developed and composed of the following dominant plant families: Actinidiaceae (*Saurauia novoguineensis, S. oligophlebia*), Arecaceae (*Licuala lauterbachii*), Burseraceae (*Canarium acutifolium, C. decomanum*), Meliaceae (*Aglaia euryanthera, A. sapindina, A. tomentosa*) and *Pandanus lauterbachiana*. The ground layer consisted of Asparagaceae (*Cordyline fruticosa*, *Dracaena angustifolia*), *Cycas scratchleyana* (common on the alluvial plains), Gesneriaceae (*Cyrtandra bracteata, C. scumanniana, C. wariana*), *Homalomena cordata, Phrynium pedunculatum* and Zingiberaceae (*Alpinia kiungensis, Hornstaedtia scottiana, Riedelia corallina, R. geluensis, R. grandiligula, R. longifolia*).

Most climbers occurred scattered throughout the forest but occasionally they formed dense colonies especially the rattans, *Calamus distentus, C. fertilis, C. humboldtianus* and *D. warburgii* and to a lesser extent *Flagellaria indica. Entada phaseoloides* and *Mucuna novae-guineensis*, which were more common along the streams. The epiphyte load on the upper branches of the trees was more developed here than at any of the other sites. The most common ferns in the canopy were *Asplenium nidus* and *Drynaria sparsisora* with *Stenochlaena palustris* a common element of the vegetation in the moister areas. Epiphytic orchids were more common in both Hill forest (H) and Alluvial forest (P) with higher species diversity at Site 4 than at any of the other sites. They occurred as low level and high-level epiphytes and were represented by the genera *Agrostophyllum, Appendicula, Bulbophyllum, Cadetia, Calymmanthera, Coelogyne, Cymbidium, Dendrobium, Dipodium, Podochilus* and *Pseuderia*.

The Open alluvial forest (Po) was also incised by many streams of various sizes, however the flora on the stream banks was similar to that of the surrounding area.

Smaller areas of vegetation that conformed to FIMS class Fsw (Swamp forest) also occurred in this area, albeit unevenly. The canopy was even and composed of trees with medium to small crowns up to 20 m tall. Common canopy species included *Campnosperma brevipetiolatum, Terminalia complanata* various *Syzygium* and *Myristica* spp. and *Neonauclea purpurata*. This forest type is more common in areas that experience prolonged inundation (Hammermaster & Saunders 1995a). *Ficus* spp. were far less common in this vegetation type compared to the Open alluvial forest (Po). Other common canopy species included *Cerbera floribunda, Celtis* spp. and *Dillenia schlechteri*. The shrub layer was not as well developed as it was in the Open alluvial forest (Po), with *Barringtonia, Garcinia, Sloanea* and *Maniltoa comprising* the dominant genera. Rattans (*Calamus distentus* and *C. humboldtianus*) sometimes formed small dense colonies on small drier areas. The fern *Stenochlaena palustris* was a common element of the vegetation, at times covering the stems of most trees (Paijmans 1975).
The vegetation to the north of the Site 4 fly camp (Fig. 11) on the low hills, was consistent with the FIMS class Hm (Hill forest) (Hammermaster & Saunders 1995). The forest canopy height was 20–30 m with a canopy cover of 70–80%. Occasional emergents were present which were mainly *Ficus* and *Syzygium* spp.

Common species in the canopy were *Dysoxylum parasiticum*, *Ficus* spp., the palm *Hydriastele costata*, *Pometia pinnata*, *and Syzygium* spp. A little further up the slopes dense dipterocarp populations of *Hopea iriana* and *Vatica papuana* occurred. The cycad *Cycas scratchleyana* was a common element of the flora on the ridges, with many very large and tall specimens, representing the densest stands of this species found during the survey.

The subcanopy comprised most of the canopy species and *Elaeocarpus* spp., *Lithocarpus celebicus*, *Myristica* spp., *Nagaia wallichiana* and the palm *Orania lauterbachiana*. The understory and shrub layers were well developed with *Cerbera floribunda*, *Cycas scratchleyana*, *Fagraia racemosa* and *Sterculia ampla* the most common species. The ground layer was poorly developed on the ridges but with a more prominent structure along the drainage lines. Frequently occurring genera were *Cyathea*, *Cyrtandra*, *Freycinetia*, *Holochlamys*, *Phrynium* and *Sphaerostephanos*.

Only a few climbers were present (*Dischidia* spp., *Flagellaria indica*, *Freycinetia* spp.) with epiphytes confined to the upper branches of the canopy (*Bulbophyllum* spp., *Drynaria sparsisora*, *Piper* spp. and *Schefflera dentata*).

Figure 11. Open alluvial forest/Swamp forest (Po/Fsw/Hm) in the foreground, Hill forest (Hm) in the background, at Site 4 (S. Richards)

4.1.5 Site 5

FIMS class Po/Fsw/Hm (Open alluvial forest/Swamp forest/Hill forest), Wsw (Swamp woodland), Hsw (Herbaceous swamp) and Hm (Hill forest) Delta Swamps and Plains and Middle Purari Hills ecological zones.

The vegetation at Site 5 was consistent with the FIMS class Open alluvial forest/Swamp forest (Po/Fsw), Swamp woodland (Wsw) and Hill forest (Hm). However, most of the vegetation around the fly camp was Open alluvial forest/Swamp forest (Po/Fsw) which was consistent with the FIMS description of an irregular open canopy forest composed of mainly medium and small crowned trees with the common canopy species *Campnosperma montana, Endospermum medullosum, Homalium foetidum, Sloanea sogerensis* and *Syzygium* spp. (Paijmans 1975, Hammermaster & Saunders 1995). This vegetation type reflected the alluvial site with areas of poor drainage which would be subject to prolonged wet-season inundation.

Prominent genera in the canopy were Combretaceae (*Terminalia complanata*), Lamiaceae (*Gmelina sessilis*, *Teijsmanniodendron bogoriense*), Euphorbiaceae (*Pimelodendron amboinicum*), and Myristicaceae (*Myristica* spp.) with some scattered plants of *Dysoxylum* spp., *Vatica rassak* and *Planchonella* spp. in the canopy. However, there was a noticeable absence of *Ficus* spp. with *Ficus bernaysii* the sole representative. The canopy was high (30–40 m) and open with a canopy cover of 70-80%. The subcanopy layer was well developed and species rich and composed of the following dominant plant families: Anacardiaceae (*Buchanania* spp. and *Semecarpus undulatus*) Arecaceae (*Arenga microcarpa*, *Calyptrocalyx albertisianus*, *Licuala lauterbachii* and *Ptychostachys loriae*),

Cannabaceae (*Celtis philippensis*), Meliaceae (*Aglaia sapindina* and *A. tomentosa, Dysoxylum* sp.), Myristicaceae (*Myristica* spp.), Myrtaceae (*Syzygium* spp.) and Sapindaceae (*Pometia pinnata*). The shrub layer was also well developed with the dominant plant families: Arecaceae (*Arenga microcarpa* and *Licuala lauterbachii*), Clusiaceae (*Garcinia* spp.), *Fabaceae* (*Archidendron* spp., *Maniltoa* spp.), Gesneriaceae (*Cyrtandra* spp.), Gnetaceae (*Gnetum gnemon*), Myristicaceae (*Myristica* spp.), Rubiaceae (*Ixora* spp.) and Zingiberaceae (*Alpinia* spp.). The ground layer consisted of scattered individuals of Araceae (*Holochlamys beccarii*, *Homalomena cordata*), Arecaceae (*Licuala lauterbachii*), Gesneriaceae (*Cyrtandra* spp.), Rubiaceae (*Maschalodesme arborea*) and Zingiberaceae (*Alpinia* spp. *Riedelia corallina*). Most of the climbers were scattered throughout the forest with only small dense stands of rattans (*Calamus* spp. and *Korthalsia zippelii*). Many *Freycinetia* climbing plants grew on tree trunks especially in more open areas where there was more light. In areas with denser shade, *Piper* spp. and *Pothos hellwigii* was more common. The most common ferns in the canopy were *Asplenium nidus* and *Drynaria sparsisora*. Epiphytic orchids were less common in this forest type and occurred as low-level epiphytes and were mostly represented by *Coelogyne fragrans*.

A small part of the surveyed area comprised Swamp woodland (Wsw) with an outlier present near fly camp 5. This outlier was surveyed as representative of the larger Swamp woodland (Wsw) area. It consisted of a dense canopy of sago palms with scattered *Campnosperma montana* and *Intsia palembanica*. Similarly, the subcanopy consisted of scattered *Campnosperma montana*, *Intsia palembanica* with the following additional species: *Pandanus lauterbachii* and *Terminalia complanata*. The understory was weakly developed with the pandan *Benstonea lauterbachii* the sole species. The shrub layer was more pronounced with *Myristica* spp., *Nauclea* sp., *Syzygium* spp. and *Vatica rassak*. The ground layer was well developed especially in the more open areas with *Alocasia aequiloba*, *Hanguana malayana*, *Holochlamys beccarii* and the fern *Sphaerostephanos unitus* the dominant species. *Freycinetia angustissima* and the fern *Stenochlaena palustris* were the dominant climbers with occasional plants of *Korthalsia zippelii*, *Piper* sp. and *Rhaphidiphora latevaginatum*. There was a noticeable lack of epiphytes with only a small number of the fern *Drynaria sparsisora* recorded in the moister areas.

Herbaceous swamp (Hsw) near Site 5 to the north of the Swamp woodland (Wsw) was also assessed, however this vegetation type could only be surveyed from the margins due to the waterlogged conditions. The vegetation was consistent with the FIMS description (Paijmans 1976, Hammermaster & Saunders 1995). Two of the major elements of the Herbaceous swamp, the sedge *Mapania sumatarana* and the herb *Hanguana malayana*, were conspicuous elements of the flora.

The vegetation to the east of Site 5 on the low hills (Middle Purari Hills ecological zone) corresponded well with the FIMS class Hm (Hill forest) (Hammermaster & Saunders 1995). The forest canopy height was 30–40 m with a canopy cover of 60%. Occasional emergents were present, mostly of *Syzygium* spp. The canopy was speciose and common plant families in the canopy were Arecaceae (*Hydriastele costata*), Combretaceae (*Terminalia complanata*), Dipterocarpaceae (*Vatica rassak*), *Euphorbiaceae* (*Pimelodendron amboinicum*), Fagaceae (*Lithocarpus celebicus*), Lauraceae (*Cryptocarya* spp.), Meliaceae (*Toona ciliata*) and Myrtaceae (*Syzygium* spp.). The subcanopy was similarly speciose and well developed with the most prominent plant families Arecaceae (*Orania archboldiana*), Burseraceae (*Canarium* spp.), Combretaceae (*Terminalia complanata*), Dipterocarpaceae (*Vatica papuana* and *V. rassak*), *Euphorbiaceae* (*Pimelodendron amboinicum*), Gnetaceae (*Gnetum gnemon*), Lamiaceae (*Teijsmanniodendron bogoriense*) and Sapotaceae (*Pouteria* spp.). The understory was fairly open with *Aglaia tomentosa*, *Gnetum gnemon*, *Gynotroches axillaris*, *Licuala lauterbachii*, various *Myristica* spp., *Pandanus* sp. and *Pouteria* sp., the dominant species. The shrub layer was well developed and dense on the ridges and along drainage lines. Common plant families in the shrub layer were Annonaceae (*Goniothalamus aruensis*), Asparagaceae (*Dracaena angustifolia*), Clusiaceae (*Garcinia* spp.), Fabaceae (*Maniltoa psilogyne*), Malvaceae (*Microcos grandiflora*), Meliaceae (*Aglaia tomentosa*), Rubiaceae (*Mascalodesme arborea*) and Sapindaceae (*Harpulliua longipetala*). The ground layer was under developed and consisted of scattered plants of *Ardisia squarrosa*, *Holochlamys beccarii*, *Mapania cuspidata* and a few individuals of *Phrynium pedunculatum*. Climbers were also sparse with *Calamus humboldtianus* along the drainage lines and with *Piper* sp. and *Pothos rumphii* on the trunks of trees that grew on the ridges. The only common epiphytes were the fern *Nephrolepis lauterbachii* and the orchid *Coelogyne fragrans*. An example of the Hill forest (Hm) at Site 5 is shown in Figure 11.

Figure 12. Hill forest (Hm) at Site 5. Notice the well-developed shrub layer.

4.1.6 Site 6A

Kuku Creek. FIMS class Hm (Hill forest) Middle Purari Hills ecological zones.

The forest at Site 6A is mapped by FIMS as Hill forest/Scrub (Hm/Sc), however the species composition was consistent with Hill forest (Hm) only, and there was no evidence of Scrub (Sc) based on the floristics. The vegetation at Site 6A was typical of the FIMS class Hm (Hill forest), but disturbed to various degrees for the first 10-20 m either side of the road and along the creeks that were crossed by the road. The disturbed margins along the road were characterized by pioneer species with the vines *Merremia peltata* and *Pueraria montana* var. *lobata* abundant. These species grew directly on the sides of the road but also scrambling up into the canopy of the adjacent regenerating vegetation. *Calamus* spp., *Ficus pungens*, *Leukosyce capitellata*, *Macaranga aleuritoides*, *M. tanarius*, *Paraserianthes falcatari*, *Duabanga moluccana*, and *Trema orientalis* were the most common woody species with the gingers *Alpinia pulchra* and *Hornstaedtia scottiana* forming large populations along the road. The most common woody species was *Mastixiodendron pachyclados* that covered vast areas along the side of the road. The dense canopy of this species shaded out most other plants resulting in a low and weakly developed ground cover.

Construction of the road appeared to have caused a heavy loading of silt and soil that was still being washed down the creeks flowing into Kuku Creek. Much of the silt had been deposited as mud banks lining the creek, which had affected the vegetation. Creek areas above the road towards the hill tended to be without the heavy silt and mud load. The extensive mud banks had a high impact on the vegetation of the creek bank facilitating the regeneration of primarily pioneer species (*Macaranga* spp., *Calamus* spp., *Merremia peltata*, *Alpinia pulchra*, *Homalanthus novoguineensis*). Away from the creeks, the vegetation along the road was similar to that of Site 2 in structure and species composition with a high abundance of the rattan, *Korthalsia zippelii* that covered large areas. An example of the Hill forest (Hm) at Site 6A is shown in Figure 12.

Figure 13. Disturbed Hill forest (Hm) along the logging road close to Kuku Creek.

4.1.7 Site 6B

Proposed Logistics Base area along the Purari River. FIMS class Po/Fsw/Hm (Open alluvial forest/Swamp forest/Hill forest) Delta Swamps and Plains and Middle Purari Hills ecological zones.

There were two distinct vegetation communities present in this alluvial and mixed swamp forest site. The first community occupied the alluvial ridges and was situated in the Middle Purari ecological zone and the second community was located on low-lying frequently inundated or flooded areas situated in the Delta Swamps and Plains ecological zone. The alluvial ridges were characterized by Hill forest (Hm) with the canopy 30–40 m tall, with many buttressed trees (*Dracontomelon dao*, *Pometia pinnata*, *Ficus* spp. etc.) and trees with a DBH of 1–2 m, which was consistent with the FIMS description. The forest floor was characteristically open with some young woody plants, a few tree ferns (*Cyathea contaminans*, *Gymnosphaera hornei*) and gingers (*Alpinia* spp., *Riedelia corallina*) with a noticeable lack of other herbaceous plants. This plant community also had a high diversity of palm species (*Areca macrocalyx*, *Arenga pinnata*, *Calamus distentus*, *C. heteracanthus*, *Licuala* sp., *Livistona chocalatina*, *Orania lauterbachiana*).

The plant community on the low-lying area conforms to the FIMS Open alluvial forest/Swamp forest (Po/Fsw). The canopy was lower than that on the alluvial ridges at about 20 m height with some emergents up to 30 m. Most of the large trees had a DBH of up to 1 m. The fan palms, *Licuala lauterbachii* and *Licuala* sp. were prominent elements of this vegetation community. The forest floor had a dense growth of seedlings, young woody plants and a well-developed herbaceous layer (*Alocasia aequiloba*, *Alpinia kiungensis*, *Crinum asiaticum*, *Phrynium pedunculatum*) because of the more open canopy. Large areas were covered in rattan (*Calamus distentus*, *Korthalsia zippelii*) and vines. The vegetation in the low-lying area compared well with that of Site 5. An example of the Open alluvial forest/Swamp forest (Po/Fsw) at Site 6B is shown in Figure 14.

Figure 14. Area close to the proposed Logistics Base area along the Purari River.

4.1.8 Site 6C

Oxbow wetlands. FIMS class Wsw (Swamp woodland), Hsw (Herbaceous swamp) Delta Swamps and Plains ecological zone

Site 6C could not be assessed during the field survey due to logistical constraints caused by ground saturation, but was assessed by aerial survey. However, the Swamp woodland (Wsw) and Herbaceous swamp (Hsw) close to Site 5 were regarded as having very similar vegetation to the Oxbow wetlands based on the aerial survey and analysis of associated photos and has therefore been used to describe the vegetation. The Swamp woodland (Wsw) vegetation was dominated by *Metroxylon sagu* (Sago palm) that covered ± 40-50% of the crown area in permanently swampy areas. Other dominant genera included *Terminalia*, *Pandanus*, *Artocarpus* and *Myristica*. The slightly drier areas had plant associations that formed prominent vegetation zones. The treeless areas were consistent with the FIMS description of Herbaceous swamp (Hsw). Dominant plant associations included *Phragmitis karka* swamp, *Mapania sumatrana* swamp, *Scleria* swamp and *Hanguana malayana* swamp. Closer to the open water of the lake and into the open water there was a continual rim of the vine *Ipomoea aquatica* with stems trailing into the lake.

Drier areas in the swamp were indicated by the presence of *Nauclea orientalis*, *Neonauclea purpurea* and tall pandans. Forest bordering the swampy areas was covered in climbers primarily *Oxera splendida* indicating a possible history of wind damage. Examples of the Swamp woodland (Wsw) and Herbaceous swamp (Hsw) at Site 6C are shown in Figure 15 and Figure16.

Figure 15. Sago swamp (FIMS Swamp woodland - Wsw) at the Oxbow wetlands

Figure 16. Herbaceous swamp (Hsw) at the Oxbow wetlands

4.1.9 Site 6D

Ridgeline. FIMS class Hm (Hill forest) Middle Purari Hills ecological zone

The vegetation survey for Site 6D was undertaken along a ridgeline where the vegetation was consistent with the FIMS description for Hill forest (Hm). Vegetation to the east of the ridge was originally classed as FIMS Hm/Sc (Hill forest/scrub) but the vegetation is typical of Hill forest (Hm) only, but with abundant regeneration in slumped areas that had disturbed the forest (See Section 4.1.2). Regeneration across the slumps was dominated by pioneer species.

The closed canopy, undisturbed Hill forest (Hm) was 20-30 m high with a 70-80% closure with occasional emergents present. The dominant genera were *Canarium*, *Ficus*, *Hydriastele*, *Pometia*, *Syzygium* and *Terminalia*. The forest floor was covered in a dense growth of seedlings and young woody plants with the palm *Livistona* sp. 1 and various ferns of the genera *Asplenium*, *Cyathea*, *Bolbitis*, *Lygodium* and *Tectaria* that grew along the drainage lines. The crest of the hill was characterized by pioneer species with *Alphitonia incana* that grew on the old seismic line running along the crest of the hill. Many *Cycas scratchleyana* plants were present along the old seismic line which were a remnant of the original vegetation. Most of these plants were very old having stems 2–4 m tall but all had lost their tops it would seem during clearing for the historic seismic survey. About 90% of these old specimens had coppiced again from the top part of the cut stem, an unusual feature as most, if not all cycad genera coppice from the base of the stem if the head of the plant is removed.

The vegetation of Site 6D was very similar to that of Site 2 except that *Terminalia* and the tall palm *Hydriastele* were more prominent here, and the area covered in rattans (*Calamus* spp.) was much smaller. An example of the Hill forest (Hm) at Site 6D is shown in Figure 17.

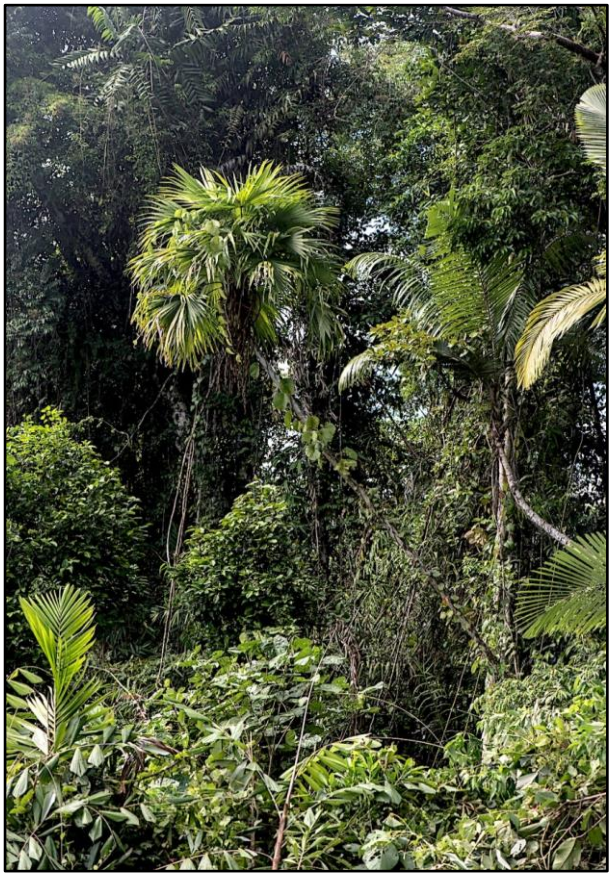

Figure 17. Hill forest (Hm) on the ridgeline showing the palm dominated vegetation in the undisturbed areas

4.1.10 Site 7

FIMS class Po (Open forest) and Wsw/Gsw (complex of Swamp woodland/Swamp grassland) and Fsw/Wsw (Swamp forest/Swamp woodland) in the Delta Swamps and Plains ecological zone and Hm (Hill forest) and Hs (Small crowned hill forest) Southeast Hills ecological zone.

4.1.10.1 Open forest (Po).

Open forest (Po) was present to the northeast of Site 7 which was partly consistent with the FIMS description (Hammermaster & Saunders 1995). The vegetation had an open (60%) to closed (80%) even canopy cover and was 30 m tall with occasional emergent *Ficus* with a height of up to 40 m. The floristic composition however was similar to that of Open alluvial forest/Swamp forest (Po/Fsw) and was dominated by the genera *Teijsmanniodendron*, *Terminalia*, *Syzygium* and *Myristica,* and was subject to short periods of inundation. Sago palms (*Metroxylon sago*) when present, occurred as small isolated populations in the understory. The canopy was speciose with the following common plant families in the canopy: Anacardiaceae (*Dracontomelon dao*), Apocynaceae (*Alstonia scholaris*), Burseraceae (*Canarium acutifolium*), Combretaceae (*Terminalia complanata*), Fabaceae (*Maniltoa megalocephala*, *Pterocarpus indicus*), Meliaceae (*Aglaia* spp.), Moraceae (*Ficus* spp.), Myrtaceae (*Syzygium* spp.), Rubiaceae (*Mastixiodendron pachyclados*) and Sapindaceae (*Pometia pinnata*). The subcanopy was well developed and diverse with the following common plant families: Arecaceae (*Hydriastele costata*, *Licuala* sp., *Orania archboldtiana*), Burseraceae (*Canarium acutifolium*), Combretaceae (*Terminalia complanata*), Euphorbiaceae (*Macaranga* sp., *Pimelodendron amboinicum*), Fabaceae (*Pterocarpus indicus*), Lamiaceae (*Gmelina moluccana*, *Teijsmanniodendron bogoriense*), Malvaceae (*Microcos grandifolia*, *Sterculia ampla*), Meliaceae (*Aglaia* spp.), Myristicaceae (*Myristica* spp.) and Sapindaceae (*Pometia pinnata*). Where present, the understory occurred as an open stand of Araliaceae (*Osmoxylon novoguineensis*), Arecaceae (*Arenga microcarpa*, *Licuala* sp.), Cannabaceae (*Celtis philippensis*), Gnetaceae (*Gnetum gnemon*), Lauraceae (*Cryptocarya* sp.), Meliaceae (*Aglaia* sp., *Dysoxlum* sp.) and Pandanaceae (*Benstonea lauterbachii*).

The shrub layer was not only well developed but was also dense and formed the most species rich layer of the forest. The shrub layer was represented by the following plant families: Anacardiaceae (*Semecarpus undulatus*), Annonaceae (*Popowia pisocarpa*, *Pseuduvaria* sp. 1), Arecaceae (*Licuala* sp.), Burseraceae (*Canarium acutifolium*), Cannabaceae (*Celtis phillippensis*), Euphorbiaceae (*Macaranga chrysotricha*), Fabaceae (*Maniltoa psilogyne*), Lauraceae (*Litsea* sp.), Meliaceae (*Chisocheton ceramicus*), Monimiaceae (*Kibara* spp.), Myristicaceae (*Horsfieldia* sp.) and Myrtaceae (*Syzygium stipulare*). The ground layer was sparse with occasional dense populations of *Pseudodiphasium volubile* with the remainder represented by the following plant families: Araceae (*Alocasia aequiloba**,** Holochlamys beccarii*), Cardiopteridaceae (*Gonocaryum litorale*), Gesneriaceae (*Cyrtandra wariana*), Orchidaceae (*Corymborkis veratrifolia*), Poaceae (*Leptaspis urceolata*), Xanthorrhoeaceae (*Dianella ensifolia*) and Zingiberaceae (*Riedelia corallina*, *R. subulocalyx*). An example of the Open forest (Po) at Site 7, showing the more open understory of a mature forest structure, is shown in Figure 18.

Figure 18. Interior of Primary Open Alluvial Forest (PO) at Site 7

4.1.10.2 Swamp woodland/Swamp grassland (Wsw/Gsw) (complex of) in the Delta Swamps and Plains ecological zone.

The area to the west of Site 7 is mapped as Swamp woodland/Swamp grassland. The vegetation was consistent with the FIMS mapping unit description. *Metroxylon sagu* (Sago palm) formed dense stands in shallow water together with the climbing fern *Stenochlaena palustris* and a few individuals of *Pandanus*. On the drier raised areas *Intsia bijuga* and *Neonauclea purpurea* trees dominated with an estimated height of 18 m. The vegetation changed with increase in water depth to more open Swamp grassland (Gsw) with dense stands of the native sugarcane *Saccharum spontanaeum* that gave way to various sedges (Cyperaceae) and grasses (Poaceae).

4.1.10.3 Swamp forest/swamp woodland (Fsw/Wsw) in the Delta Swamps and Plains ecological zone.

The area to the southwest of Site 7 is mapped as Swamp forest/Swamp woodland (Fsw/Wsw) and was consistent with the mapping, however the site appeared drier than normal for Swamp forest (Fsw). The forest had an open and irregular canopy with an estimated height of 30 m with a canopy cover of 60-70%. Emergent trees were uncommon with isolated *Ficus* sp. individuals having part to most of their crowns above the canopy. The following plant families were present in the canopy: *Canarium* (Burseraceae), *Dracontomelon* (Anacardiaceae), *Myristica* (Myristicaceae), Syzygium (Myrtaceae) and *Terminalia* (Combretaceae). The subcanopy and understory were well developed and composed of the following dominant plant families: Arecaceae (*Arenga microcarpa*, *Hydriastele costata*, *Licuala* spp., *Orania archboldtiana*), Combretaceae (*Terminalia* spp.), Meliaceae (*Aglaia* spp.), Myristicaceae (*Myristica* spp.) and Sapindaceae (*Pometia pinnata*). The forest floor was mostly open with the shrub layer well developed in areas with Annonaceae (*Popowia* spp., *Pseuduvaria* spp.), Burseraceae (*Canarium* spp.), Meliaceae (*Chisocheton* spp.) and Myrtaceae (*Syzygium* spp.) the dominant plant families. The ground layer was not well developed and was represented by the following plant families: Araceae (*Alocasia aequiloba*), Gesneriaceae (*Cyrtandra wariana*), (Orchidaceae (*Corymborkis veratrifolia*) and Zingiberaceae (*Riedelia* spp.). Occasionally the Swamp forest (Fsw) was replaced by more open vegetation that was consistent with the Swamp woodland (Wsw) mapping unit, characterized by dense stands of *Metroxylon sagu* (Sago palm).

4.1.10.4 Hill forest (Hm) – Southeast Hills Ecological Zone

The FIMS mapping shows Small crowned hill forest (Hs) directly east of the camp and Medium crowed hill forest (Hm) to the north. No major difference in floristics was observed between the two mapping units. The Hill forest on the low hills to the east of Site 7 had been logged with numerous roads traversing the ridges that are now characterized by regeneration of pioneer woody species. Vegetation along the drainage lines was undisturbed except where crossed by logging roads. Despite the logging, the species composition was consistent with Hill forest (Hm). Where undisturbed, this relatively tall forest had a canopy height that varied in height from 30–45 m on the slopes and along the drainage lines with a canopy cover of 70–80%. Emergent trees were uncommon. The following plant families were present in the canopy: Burseraceae (*Canarium acutifolium*, *C. decomanum*), Ebenaceae (*Diospyros* spp.), Fabaceae (*Maniltoa megalocephala*), Lamiaceae (*Vitex cofassus*), Moraceae (*Ficus* spp.) and Rubiaceae (*Mastixiodendron pachyclados*). The subcanopy and understory were well developed and composed of the following dominant plant families: Arecaceae (*Brassiophoenix schumannii*, *Licuala* sp.), Burseraceae (*Canarium acutifolium*), Cannabaceae (*Celtis latifolia*), Cardiopteridaceae (*Gonocaryum litorale*), Fabaceae (*Maniltoa megalocephala*), Lauraceae (*Cryptocarya* spp.), Malvaceae (*Sterculia ampla*), Meliaceae (*Aglaia* spp., *Dysoxylum micranthum*), Myristicaceae (*Myristica* spp.), Myrtaceae (*Syzygium* spp.), Rubiaceae (*Timonius grandifolius*), Sapindaceae (*Harpullia* sp.). A few scattered individuals of *Bambusa riparia* and *Cycas scratchleyana* were present on the undisturbed areas on the ridges. The shrub layer was well developed on the drier upper slopes with the most common plant families Annonaceae (*Haplostichanthus longirostris*, *Pseuduvaria filipes*), Fabaceae (*Maniltoa psilogyne*), Melastomataceae (*Memecylon amplexicaule*) and Myrtaceae (*Syzygium* spp.). The ground layer was poorly developed for Hill forest possibly because of the densely-shaded conditions with only three plant families that were common: Asparagaceae (*Cordyline minutiflora*), Marantaceae (*Phrynium pedunculatum*) and Orchidaceae (*Tropidia splendida*). The scarcity of climbers (*Pothos hellwigii* and *Strychnos minor*) and the absence of epiphytes were noticeable.

The forest canopy of the logged areas on the hills was much lower (25 m) than the surrounding forest with about 80% as regrowth. Common plant families making up the canopy species were Malvaceae (*Trichospermum pleostigma*), Rhamnaceae (*Alphitonia incana*), Rubiaceae (*Neonauclea purpurea*) and Tetramelaceae (*Octomeles sumatrana*). The subcanopy and understory was more diverse with Euphorbiaceae (*Macaranga* spp.), Malvaceae (*Talipariti archboldtianum*), Moraceae (*Ficus pungens*) and Urticaceae (*Leucosyke capitellata*). The shrub layer however was well developed but contained less pioneer species and was represented by Arecaceae (*Licuala lauterbachiana*), Elaeocarpaceae (*Elaeocarpus* spp.), Eupomatiaceae (*Eupomatia laurina*), Myrtaceae (*Tristaniopsis* sp.) and Rutaceae (*Melicope elleryana*). The open habit of the regrowth forest had stimulated the development of the ground herb layer which was represented by the plant families Araceae (*Holochlamys beccarri*, *Homalomena cordata*), Asparagaceae (*Cordyline fruticosa*), Commelinaceae (*Amischotolype mollissima*), Costaceae (*Cheilocostus speciosus*), Marantaceae (*Phrynium pedunculatum*), Poaceae (*Oplismenus undulatifolius*), Xanthorrhoeaceae (*Dianella ensifolia*) and Zingiberaceae (*Alpinia* spp., *Ammomum aculeatum*, *Riedelia corallina*). An example of logged small crowned Hill forest (Hs) and the interior of primary small crowned Hill forest (Hs) at Site 7 are shown in Figure 19 and Figure 20, respectively.

Figure 19. Logged Small Crowned Hill Forest (Hs) at Site 7

Figure 20. Remnant Primary Small Crowned Hill Forest (Hs) at Site 7

4.1.11 Site 8

FIMS class Fsw/Wsw (Swamp forest/Swamp woodland), Pl (Alluvial forest), Hs (Small crowned hill forest) - Southeast Coast and Southeast Hills ecological zones

The Swamp forest/Swamp woodland complex (Fsw/Wsw) assessed at Site 8 was located approximately 1.3 km to the east of the camp. The vegetation was consistent with the FIMS mapping and comprised a mosaic of the two vegetation types.

Most of the Swamp forest (Fsw) at Site 8 had been heavily logged 4–5 years ago with subsequent conversion to gardens. Signs of the logging operations were still visible throughout the area except along the streams and rivers where small remnants of the original Swamp forest (Fsw) remained. The forest canopy was uneven and up to 20 m tall with an overall canopy cover of 70%. Dominant plant families in the canopy and subcanopy were Combretaceae (*Terminalia* spp.), Fabaceae (*Pterocarpus indicus*), Moraceae (*Ficus* spp.), Myristicaceae (*Horsfieldia* spp., *Myristica* spp.),_Myrtaceae (*Syzygium* spp.), Rubiaceae (*Neonauclea* spp.) and Sapindaceae (*Pometia pinnata*). The understory and shrub layers were well developed with many native pioneer species present. Common plant families in this vegetation type were Apocynaceae (*Ochrosia citrodora*), Combretaceae (*Terminalia* spp.), Moraceae (*Ficus* spp.), Myristicaceae (*Myristica* spp.) and Phyllanthaceae (*Glochidion* spp.). The ground layer consisted mostly of Araceae (*Alocasia* spp.), Blechnaceae (*Stenoclaena palustris*), Cyperaceae (*Mapania* spp.), Marantaceae (*Phrynium pedunculatum*) and Pteridaceae (*Acrostichum speciosum*).

Areas of Swamp woodland were scattered throughout the Swamp forest and consisted mostly of pure Sago (*Metroxylon sagu*) stands with *Nauclea orientalis*, *Neonauclea* spp. and *Myristica* spp. colonizing the drier areas. Limited logging had occurred in the swamp woodland, possibly due to the unstable soil conditions for extracting logs. An example of the Swamp forest/Swamp woodland (Fsw/Wsw) at Site 8 is shown in Figure 21.

The central part of the surveyed area at Site 8 was typical of Alluvial forest (Pl) but it had been extensively logged about 4–5 years ago with the vegetation further altered by areas cleared for gardens. The remaining forest canopy was broken and uneven and varied in height from 20–30 m with many *Ficus* and *Canarium* trees as emergents. Common plant families in the canopy and subcanopy were Apocynaceae (*Alstonia scholaris*, *Cerbera floribunda*), Burseraceae (*Canarium* spp.), Combretaceae (*Terminalia* spp.), Fabaceae (*Pterocarpus indicus*), Lamiaceae (*Vitex cofassus*), Meliaceae (*Aglaia* spp.), Moraceae (*Artocarpus* spp., *Ficus* spp.), Myrtaceae (*Syzygium* spp.), Rutaceae (*Melicope* spp.) and Sapindaceae (*Pometia pinnata*). The understory and shrub layer were well developed because of logging activities and comprised the following plant families: Anacardiaceae (*Semecarpus* spp.), Myrtaceae (*Syzygium* spp.), Phyllanthaceae (*Glochidion* spp.) and Vitaceae (*Leea* spp.). Plant families that prefer dapple shaded conditions represented the ground layer with the dominant plant families comprising Araceae (*Amorphophallus galbra* and *Cyrtosperma* spp.), Costaceae (*Costus potierae*), and Zingiberaceae (*Amomum aculeatum*, *Curcuma longa*).

The vegetation on the low undulating hills towards the southeast of Site 8 (Southeast Hills ecological zone) was typical of Small crowned hill forest (Hs) with a closed uneven canopy (70–80%) 20–30 m high. The canopy and subcanopy was well developed and speciose and represented by the dominant plant families Anacardiaceae, Canabbaceae, Malvaceae, Rubiaceae and Sapotaceae. The understory and shrub layers were also well developed and speciose with Anacardiaceae, Arecaceae, Fabaceae, Lauraceae, Marantaceae and Myrtaceae the dominant plant families. Araceae, Costaceae, Orchidaceae, Xanthorrhoeaceae and Zingiberaceae dominated the ground layer, which was especially well developed near and along the small streams that flowed through the forest. Several logging roads traversed the area, which were covered in the native vine Merremia peltata, and several grasses (Poaceae). Some of the smaller (secondary) logging roads were characterized by secondary forest with a weakly developed ground layer of ferns, but shrubs were mostly absent. Most of the hill area was heavily logged with only a few pockets of unlogged forest.

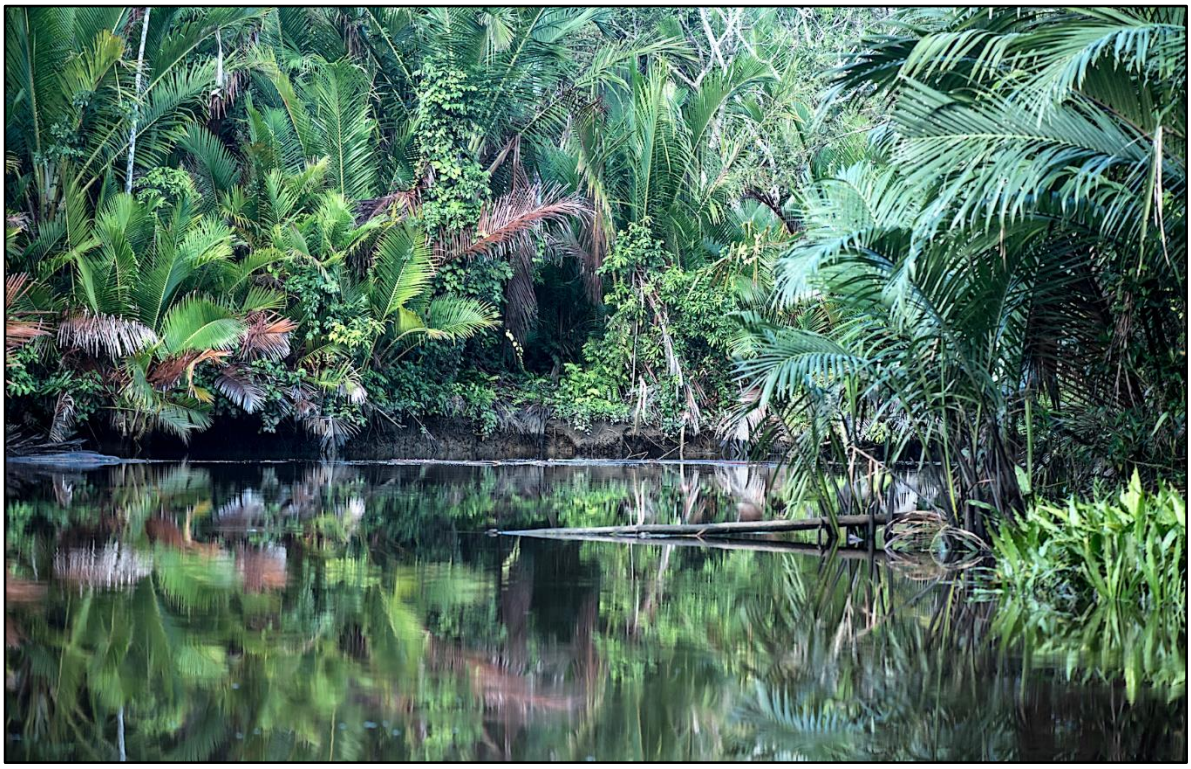

Figure 21. Swamp forest/Swamp woodland (Fsw/Wsw) at Site 8

4.1.12 Site 8M

FIMS class M (Mangrove) Mangroves ecological zone

The mangrove vegetation along the Purari River and its tributaries, including Oeha Creek at Site 8M in the southwest of the export pipeline corridor, was consistent with the FIMS mapping unit M (Mangroves). Two distinct mangrove communities occupied the delta area, (1) a *Nypa fruticans* (mangrove palm) dominated mangroves and (2), a tall tree and shrub-dominated mangrove community (Cragg 1983). The *Nypa fruticans* dominated mangroves occurred to the exclusion of all other plant species and occupied the fringing zone along tidal streams. Within the tree and shrub dominated mangroves, fringing mangroves were represented by *Sonneratia alba* and *S. lanceolata* (Lythraceae), *Avicennia marina* var. *eucalyptifolia* (Acanthaceae) and *Aegiceras corniculatum* (Primulaceae). The mangrove forest that occurred away from the water's edge had a canopy that varied in height from 5–15 m with a canopy cover of 80–100%. Adventitious roots and pneumatophores occupied most of the area below the canopy (Percival & Womersley 1975) with only some populations of the Mangrove fern (*Acrostichum speciosum*) that grew on the forest floor. The most common tree genera were *Bruguiera* (*B. gymnorrhiza* and *B. sexangula*) and *Rhizophora* (*R. stylosa*). The epiphyte flora was well developed with many orchids, primarily the genera *Bulbophyllum* and *Dendrobium*, ferns of the genera *Asplenium* and *Drynaria* and members of the families Apocynaceae and Fabaceae. An example of the Mangrove (M) vegetation at Site 8 is shown in Figure 22.

Figure 22. Mangrove vegetation on an island at the mouth of the Purari River

4.1.13 Site 9

FIMS class Hs (Small crowned hill forest), Pl (Alluvial forest), B (Littoral forest) and M (Mangroves) Southeast Coast, Southeast Hills and Mangroves ecological zones

The vegetation on the undulating hills (Southeast Hills ecological zone) 1.7 km to the northeast of the Site 9 fly camp is mapped as Small crowned hill forest (Hs) which was consistent with the FIMS description. The relatively even canopy was 20–30 m high with a canopy cover of 70% (Hammermaster & Saunders 1995). The vegetation of the upper slopes of the hills was disturbed from logging, with the existing old logging roads covered in secondary growth. The lower slopes were not logged and were characterized by undisturbed forest where many trees had a DBH of 1 m or more, especially *Dracontomelon dao* and *Octomeles sumatrana*. Dominant canopy plant families included Anacardiaceae (*Dracontomelon dao*), Cannabaceae (*Celtis latifolia*), Malvaceae (*Sterculia ampla*), Rubiaceae (*Neonauclea purpurea*), Sapotaceae (*Palaquim warburgiana*) and Tetramelaceae (*Octomeles sumatrana*). The subcanopy was well-developed and dense with Boraginaceae (*Cordia subcordata*), Malvaceae (*Sterculia ampla*), Moraceae (*Ficus variegata*), Myristicaceae (*Myristica* spp.) and Sapindaceae (*Pometia pinnata*) the dominant plant families. The understory layer of this forest was well developed and speciose especially on the lower slopes and along drainage lines with the most common plant families Arecaceae (*Brassiophoenix schumannii*, *Licuala* sp.), Burseraceae (*Canarium* spp.), Euphorbiaceae (*Pimelodendron amboinicum*), Gnetaceae (*Gnetum gnemon*), Malvaceae (*Microcos grandiflora*, *Sterculia ampla*) and Lauraceae (*Cryptocarya* spp.). The shrub layer consisted of typical plant families of Small crowned hill forest (Hs) including Asparagaceae (*Dracaena latifolia*), Marantaceae (*Donax caniiformis*, *Phrynium pedunculatum*) and Myrtaceae (*Syzygium* spp.). The ground layer was not well developed and represented by only a small number of plant families: Araceae (*Alocasia lanceolata*), Orchidaceae (*Corymborkis veratrifolia*), Xanthorrhoeaceae (*Dianella ensifolia*) and Zingiberaceae (*Alpinia* sp. and *Etlingera* spp.). In forest openings and along drainage lines where the vegetation is slightly more open, rattans (*Calamus* spp.) formed dense thickets. Common climbers in the more densely shaded areas were from the Araceae

(*Epipremnum papuanum*, *E. pinnatum* and *Pothos* sp.) with *Flagellaria gigantea* (Flagellariaceae), *Oxera splendida* (Lamiaceae) and *Tecomanthe dendrophila* (Bignoniaceae) that scrambled to the top of the forest canopy. There was a noticeable absence of epiphytes on the main trunks as well as on the canopy branches.

The vegetation on alluvial terrain between the Site 9 fly camp and the range of low hills forming part of Korela Hill was consistent with Alluvial forest (PI) FIMS description (Paijmans 1975, Hammermaster & Saunders 1995). The irregular uneven canopy had a height of 35 m and was composed of mainly large crowned trees. Many of the trees in this forest had a DBH of 1 m or more. Common canopy species includes *Alstonia scholaris*, *Artocarpus* spp., *Canarium* spp., *Cerbera floribunda*, *Elaeocarpus* spp., *Ficus* spp., *Pometia pinnata*, *Pterocarpus indicus*, *Syzygium* spp. and *Terminalia* spp. The subcanopy and the understory were even more speciose and represented by the following plant families: Anacardiaceae (*Semecarpus* spp.), Arecaceae (*Arenga microcarpa*, *Brassiophoenix schumannii*, *Caryota rumphii*, *Orania lauterbachii*, *Ptychosperma* sp.), Cannabaceae (*Celtis* spp.), Combretaceae (*Terminalia* spp.), Euphorbiaceae (*Pimelodendron amboinicum*), Lauraceae (*Cryptocarya* spp.), Myristicaceae (*Myristica fatua*), (Myrtaceae (*Syzygium* spp.) and Rubiaceae (*Neonauclea purpurea*). The forest floor was open; a sign of a mature forest, with a limited number of shrubs and herbs represented by the plant families Anacardiaceae (*Semecarpus undulatus*), Araceae (*Alocasia lanceolata*), Arecaceae (*Areca microcarpa*), Marantaceae (*Donax canniformis*, *Phrynium pedunculatum*), Pandanaceae (Pandanus *tectorius*), Rubiaceae (*Atractocarpus decorus*) and Zingiberaceae (*Etlingera* spp., *Riedelia corallina*, *R. subulocalyx*). Many climber species were recorded especially along the drainage lines that occasionally dissected the forest. Climbers were represented by the families Araceae (*Epipremnum papuanum*), Arecaceae (*Calamus longipinna*, *Korthalsia zippelii*), Blechnaceae (*Stenochlaena palustris*), Flagellariaceae (*Flagellaria indica*), Lamiaceae (*Oxera splendida*), Pandanaceae (*Freycinetia angustissima*), Piperaceae (*Piper* spp.) and Urticaceae (*Dendrocnide lanceolata*). Except for the fern *Asplenium nidus*, there was a noticeable absence of epiphytes. The forest was mostly free of disturbance apart from occasional food gardens and harvesting of smaller tree stems for village use.

The vegetation to the northwest of Site 9 was originally mapped as FIMS class Po (Open alluvial forest). However, in this area, there were a multitude of swales that run parallel to the coast which were vegetated by planted sago (*Metroxylon sagu*), together with a mixture of freshwater mangroves, which are adapted to the low salinity in the water of the swales. The mangroves were represented by *Acanthus ebracteatus* (Acanthaceae), *Barringtonia racemosa* (Lecythidaceae), *Bruguiera gymnorrhiza* (Rhizophoraceae), *Excoecaria agallocha* (Euphorbiaceae) and *Hibiscus tiliaceus* (Malvaceae). There were a few small isolated areas of relatively undisturbed Open alluvial forest (Po) adjacent to the large mangrove area. The forest had an uneven canopy with a maximum height of 20 m and a canopy cover of 70%. The forest was not speciose, with a limited number of plant families that made up the canopy, sub canopy and shrub layers: Apocynaceae, Combretaceae, Fabaceae, Lamiaceae, Moraceae, Rubiaceae and Rutaceae. The anthropogenic disturbance on this forest was very evident as indicated by the multitude of gardens and sago processing sites, and the network of footpaths that dissected the area. Consequently, the vegetation in this area has been reclassified as Land use (O).

The mangrove area mapped as FIMS class M (Mangrove) corresponds directly with the FIMS mapping. The mangrove associations surveyed at Site 9 were different to the disturbed mangrove communities present in the subcoastal waterways near the villages. The mangroves had a low uneven canopy up to 15 m in height with a 60–70% canopy cover. Common plant families representing the canopy and subcanopy species were Euphorbiaceae (*Excoecaria agallocha*), Fabacaeae (*Pterocarpus indicus*), Lamiaceae (*Cordia subcordata*), Meliaceae (*Xylocarpus granatum*) and Rhizophoraceae (*Bruguiera gymnorrhiza*, *Rhizophora apiculata*). The understory was less well developed with Lecythidaceae (*Barringtonia racemosa*) and Malvaceae (*Heritiera littoralis*), but the shrub component was much better developed and represented by the families Acanthaceae (*Acanthus ebracteatus*), Cyperaceae (*Mapania macrocephala*), Lamiaceae (*Clerodendrum inerme*) and Sapindaceae (*Allophylus cobbe*). The herb layer varied from area to area and was represented by the families Acanthaceae (*Acanthus ebracteatus*), Amaryllidaceae (*Crinum asiaticum*) and Pteridaceae (*Acrostichum speciosum*). Because of the open habit of the vegetation there were several vines with a high light tolerance with most belonging to the families Apocynaceae (*Dischidia major*, *Finlaysonia obovata*), Blechnaceae (*Stenochlaena palustris*), Flagellariaceae (*Flagellaria*

gigantea), Fabaceae (*Abrus precatorius*, *Caesalpinia* sp.) and Vitaceae (*Cissus* sp.). Epiphytes were only common in the upper branches of the trees with *Asplenium nidus* (Aspleniaceae) and *Dendrobium* spp., *Cadetia* sp. and *Dendrochilum* spp. (Orchidaceae). Zonal growth of the vegetation along the drainage lines was mostly ill defined. An example of the mangroves is shown in Figure 23.

Figure 23. Upper reaches of the Mangrove vegetation
(At this site water has a low salinity level. The plants in the left of the photo are *Bruguiera hainesii*, an IUCN Critically Endangered species).

4.2 Summary of the Principle Characteristics of the Flora

Based on the assessment of Sites 1–9 some general characteristics of the flora can be stated as follows:

- Except for *Gnetum gnemon*, other conifers (*Nagaia wallacianus* and *Podocarpus neriifolius*) that would normally be present in Hill forest (Hm) were notably absent at Site 2 as was the common herb genera *Alocasia,* and the tree genera *Rhus, Trema, Mallotus, Cryptocarya, Memecylon, Pisonia* and *Phyllanthus.* This can perhaps be attributed to the lack of canopy cover that results in an increase in sunlight and a reduction of moisture, resulting in vegetation adapted to drier conditions, and the recent formation of the flora on the slumped areas. In addition, no conifers were recorded for Site 6C with only *Gnetum gnemon* recorded for Site 3 (Hill forest (Hm).

- There was a general absence of Cyperaceae (sedges) at Sites 3 (Hill forest (Hm)), Site 6B (Hill forest (Hm), Open forest (Po), Swamp forest (Fsw)), Site 6D (Hill forest (Hm)), and Poaceae (grasses), e.g. *Cyrtococcum oxyphyllum* and *Oplismenus* spp. at Sites 1, 2 and 4, with those present at Site 3 (*Imperata conferta, Bothriochloa pertusa, Paspalum conjugatum*) being indicative of anthropogenic disturbance. The exception to this was *Bambusa* (bamboo) that occurred naturally in the undisturbed Hill forest (Hm) vegetation on the surrounding hills at Sites 2, 4, 5, 6B, 6D, 7 and in Small crowned hill forest (Hs) at Site 9.

- The orchid flora at Site 3 (5 spp.) in Hill forest (Hm), 6B (6 spp.) in Open alluvial forest/Swamp forest/Hill forest (Po/Fsw/Hm), 6D (6 spp.) in Hill forest (Hm) and 7 (6 spp.) in Open alluvial

forest (Po), Swamp woodland/Swamp grassland (Wsw/Gsw), Swamp forest/Swamp woodland (Fsw/Wsw), Hill forest (Hm) and Small crowned hill forest (Hs) was depauperate compared to that of the other sites especially when compared to Site 1 (23 spp.) in Hill forest (Hm) and Site 4 (20 spp.) in Open alluvial forest/Swamp forest (Po/Fsw) and Hill forest (Hm). The forest at Site 3 and Site 8 was found to be disturbed in varying degrees because of commercial logging. The area left after being logged with its resultant regrowth, is much too dry for epiphytic orchids to survive, the exceptions being *Coelogyne asperata* and *Cadetia chionantha* that can cope with the hot and high light conditions.

- Dipterocarps (*Anisoptera, Hopea* and *Vatica*) were absent from Hill forest (Hm) at Sites 1–3, 6B, and 7 and from Small crowned forest (Hs) at Site 8. This appears to be unusual since Dipeterocarps, particularly *Vatica* occur in dense stands at low elevations (50 m ASL.) in the hill forests in Western Province across the Fly Platform geological region (Pers. Obs. Howard Rogers).

- The normally widespread and abundant genus *Ficus* was poorly represented in Hill forest (Hm) at Site 2. The reason for this is unclear.

- The fern flora in Hill forest (Hm) at Sites 3 (11 spp.) and 6D (15 spp.) were depauperate compared to that of the other sites. This can possibly be attributed to the degree of disturbance to the natural vegetation of the two sites. This resulted in drier conditions and much lower moisture levels, conditions that few fern genera can cope with.

- Several botanical surveys have been conducted in forests on limestone terrain below 500 m, especially to the west in the Kikori Basin (Crome 2008, Gillison *pers. comm.* 2016), however, there have been a very limited number of surveys conducted in lowland hill forest across mudstone/siltstone geology in this sector of southern New Guinea. Results suggest that the lowland flora of the mudstone/siltstone differs from that of hill forest on limestone near the Kikori River (Gillison *pers. comm.* 2016). There are differences in the dominant genera with *Buchanania* spp., *Rhus taitensis, Prunus* spp. and *Sloanea* spp. that occur on the limestones but not on the mudstone/siltstone areas, although the major plant families (Anacardiacea, Lauraceae, Meliaceae, Moraceae, Myrtaceae, Myristicaceae, Sapindaceae, Sapotaceae) are similar across both geologies.

  - Limestone areas in Papua New Guinea are well known for their high levels of endemism with plants having to adapt to alkaline conditions, thin soil layers, and desiccation on porous limestone bedrock (Clements et al. 2006, Crome 2008). Little is known about endemic plant species on the mudstone/siltstone areas because of insufficient vegetation surveys.

  - Hill forest on limestone has a well-represented herbaceous flora whereas in the mudstone/siltstone areas only a few herbaceous genera were common e.g. *Begonia* and *Alocasia.*

  - On limestone, there are several families that have endemics e.g., Actinidiaceae, Annonaceae, Begoniaceae, Elaeocarpaceae, Euphorbiaceae, Gesneriaceae, Melastomataceae, Myrtaceae, Phyllanthaceae, Primulaceae, Rubiaceae and Zingiberaceae. However, there is no evidence that the same families on the mudstone/siltstone substrates of the study area support a similar range of endemics.

  - Given these differences, distinct floristic communities may be expected to occur on limestone present in unsurveyed sectors of the Middle Purari Hills ecological zone outside of the upstream terrestrial biodiversity study survey area, such as on the Kereru Range and in discrete areas at the base of the central cordillera proper in the north of the study area.

4.3 Plant Diversity

A total of 812 plant species were recorded during the survey (Table 2; Appendix 1). A summary of the plant species richness recorded at each site is provided in Table 3. Dicots were the most speciose plant group followed by monocots, with gymnosperms being the least speciose plant group.

For terrestrial vegetation only, Site 5 had the highest plant diversity and Site 6D, which was located along a ridge which had been extensively disturbed from seismic survey activities, and which was surveyed for only a few hours, had the lowest plant diversity. However, the lowest diversity of all the plant communities was for the mangrove community, Site 8M. Mangroves typically have a low species diversity compared to forests, partly reflecting the more uniform mangrove habitat and the tidal, brackish water environment where a relatively small number of plants have adaptations to survive. The high diversity at Site 5 is attributed to survey coverage of a wide range of habitats including undulating hills, swamps, swamp forest, swamp woodland and stream banks. The low plant diversity at Site 3 possibly reflects the regenerating logging gaps that were dominated by a small number of heliophytes (pioneers). Moreover, the relatively high canopy cover of the regenerating gaps appeared to be limiting the amount of light reaching the forest floor resulting in a depauperate ground and shrub flora.

Table 2 Summary of plant species recorded during the survey.

Plant Group	Families	Genera	Species
Ferns	24	44	78
Gymnosperms	3	4	5
Monocots	21	97	173
Dicots	89	293	556

Table 3 Summary of plant species recorded at each Site.

Note that survey effort at Sites 6A, B, C and D and 8M was significantly less than at the remaining sites.

Plant Group	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
Ferns Families	19	16	10	14	18	12	13	12	18	13	3	15
Ferns Genera	27	15	11	19	27	19	17	14	28	17	3	20
Ferns species	31	19	11	25	38	22	20	15	36	22	3	25
Gymnosperm Families	3	3	2	3	3	2	2	2	2	1	-	2
Gymnosperm Genera	4	3	2	4	3	2	2	2	2	1	-	2
Gymnosperm species	4	3	2	5	4	2	2	2	3	2	-	2
Monocot Families	16	14	14	15	17	13	12	13	18	16	2	18
Monocot Genera	56	45	43	53	58	44	40	36	53	55	2	60
Monocot species	76	62	55	77	85	56	50	38	78	72	2	89
Dicot Families	68	63	46	64	56	38	40	45	57	52	9	51
Dicot Genera	75	137	94	143	130	75	69	78	139	135	13	145
Dicot species	237	198	132	211	196	99	91	91	184	171	16	178
Total species	**348**	**282**	**200**	**318**	**323**	**179**	**163**	**146**	**301**	**268**	**21**	**294**

4.4 Patterns of floristic discovery

Based on the number of previously recorded yet still undescribed taxa and completely new-to-science taxa Sites 1 (13 spp.), 2 (18 spp.), 4 (13 spp.) and 5 (13 spp.) were the most important of the twelve sites in terms of taxonomic discovery. This is attributed to the diverse habitats associated with the hill forest, alluvial forest and freshwater swamp vegetation types. Of these, the hill forests were the richest in undescribed and new-to-science species. This result is consistent with the number of undescribed taxa discovered in similar hill forests on karst terrain in Papua New Guinea (Takeuchi 2011, 2012). However, for Papua New Guinea, plant diversity appears to be at its highest in the speciose lowland-montane transition (Takeuchi 2011, 2012) rather than in the lowland areas of the study area.

Sites 6D (4 spp.), 8 (2 spp.) and 9 (2 spp.) were the least important sites in terms of taxonomic discovery. A low survey effort at Site 6D and the extensive disturbed areas at Sites 8 and 9 might have contributed to the low rate of floristic discovery at these sites.

4.5 Conservation listed species

A total of 18 IUCN listed species were recorded during the Phase 1 and 2 surveys, which included two Critically Endangered, two Endangered, five Vulnerable, six Near Threatened and three Data Deficient species. Three additional IUCN listed species, *Gluta papuana* (VU), *Brownlowia argentata* (DD) and *Pentaspadon motley* (DD) have been collected previously from within the study area and were not recorded during this survey. A brief account for each of these species is presented below (Sections 4.5.1–4.5.5). Spatial data on the location of IUCN threatened species (Critically Endangered, Endangered, Vulnerable) are provided in Appendix 2.

A total of 27 IUCN listed species may occur in the study area based on the current knowledge of their distribution and habitat preferences. Table 4 presents information on the locations (sites and ecological zones) where each conservation-listed species was recorded or is predicted to occur. Figures 24-27 present images of selected species.

All of the conservation-listed species are potentially threatened by destruction of forest and mangrove habitat. This can be the result of a catastrophic natural disturbance event[2] (e.g., cyclones, landslips, flooding and storm surges) or anthropogenic disturbance, including logging, and clearing for infrastructure construction, food gardens and settlements.

[2] A catastrophic natural disturbance event is a disturbance that occurs over large areas and causes severe damage.

Table 4 Conservation listed species recorded (Project surveys and prior studies) or potentially occurring in the study area

CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient, X = recorded during the Project or prior surveys, A = possible additional occurrence based on known distribution and habitat preferences (ecological zones only). Ecological Zones: MPH = Middle Purari Hills, SH = Southeast Hills, DSP = Delta Swamps and Plains, SEC = Southeast Coast, Mv = Mangroves.

Family	Scientific Name	IUCN	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9	Prior	MPH	SH	DSP	SEC	Mv
Anacardiaceae	*Gluta papuana*	VU													X		A	X	A	A
Anacardiaceae	*Pentaspadon motleyi*	DD													X		A	X	A	
Avicenniaceae	*Avicennia rumphiana*	VU																		A
Clusiaceae	*Mammea grandifolia*	VU			X	X	X		X		X					X	X	X	A	
Clusiaceae	*Mammea novoguineensis*	DD				X	X				X	X		X		X	X	X	X	
Cunoniaceae	*Ceratopetalum succirubrum*	VU									X					A	X	X		
Cycadaceae	*Cycas scratchleyana*	NT	X	X	X	X	X	X	X	X	X					X	X	X	A	
Ebenaceae	*Diospyros insularis*	EN							X							X	A	A		
Ebenaceae	*Diospyros lolinopsis*	CR									X					A	A	X		
Fabaceae	*Archidendron forbesii*	VU		X												X	A	A	A	
Fabaceae	*Intsia bijuga*	VU				X	X	X	X		X	X		X		X	A	X	X	
Fabaceae	*Koompassia grandiflora*	VU														A	A	A	A	
Fabaceae	*Pterocarpus indicus*	VU	X	X	X	X	X	X			X	X	X	X		X	X	X	X	X
Magnoliaceae	*Magnolia tsiampacca*	DD	X									X				X	X			
Malvaceae	*Brownlowia argentata*	DD													X			X		A
Meliaceae	*Aglaia cucullata*	DD							X		X						A	X	A	A
Meliaceae	*Aglaia euryanthera*	NT	X	X	X	X	X	X								X	X	X	A	
Meliaceae	*Aglaia rimosa*	NT									X					A	X			
Myristicaceae	*Myristica brachypoda*	VU														A	A	A	A	

Family	Scientific Name	IUCN	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9	Prior	MPH	SH	DSP	SEC	Mv
Myristicaceae	*Myristica globosa*	NT		X			X		X							X	A	X	A	
Proteaceae	*Helicia amplifolia*	NT		X												X	A			
Proteaceae	*Helicia latifolia*	NT		X												X	A			
Rhizophoraceae	*Bruguiera hainesii*	CR												X					X	A
Rutaceae	*Flindersia amboinensis*	NT														A	A	A	A	
Rutaceae	*Flindersia pimenteliana*	EN									X					A	X			
Rutaceae	*Flindersia schottiana*	NT														A	A	A	A	
Sapindaceae	*Guioa hospita*	CR														A	A			

4.5.1 Critically Endangered (CR)

Ebenaceae. *Diospyros lolinopsis*

A rare endemic species known only from the Madang and Morobe Provinces growing in hill forest and lowland rainforest and swamp (Kostermans 1977). Several semi-mature and mature specimens were recorded in the primary alluvial forest bordering the Sago swamps at Site 7 (Table 4). This species normally occurs as scattered individuals. Suitable habitat is widespread in the study area as alluvial forest and swamp forest in the Delta Swamps and Plains and hill forest in the Middle Purari Hills and Southeast Hills ecological zones. Major threats to this species are habitat degradation and logging of mature specimens. This is primarily a subcanopy species dependent on deep to light shaded conditions and degradation of the habitat will negatively impact on survival of mature specimens and especially recruitment. Logging companies target this species for the dense and fine-grained wood. This species may be more common based on suitable habitat present in the study area.

Rhizophoraceae. *Bruguiera hainesii*

This rare hybrid mangrove species has a wide geographic distribution extending from Myanmar and Thailand to the Malay Archipelago and Papua New Guinea (Tomlinson 1986, Sheue et al. 2005, Ono et al. 2016). According to Ono et al. (2016) only 250 mature individuals are currently known. The population of *B. hainesii* at Site 9 grew in full sun in low growing mangroves associated with low salinity of the upper limit of tidal streams. Most of the specimens were adult with flowers and fruit present. Suitable habitat is widespread across the landward margin of the Mangrove (M) FIMS mapping unit in the Mangroves ecological zone and to a lesser degree in the subcoastal mangrove strip parallel to the shorefront along Orokolo Bay in the Southeast Coast ecological zone. Opening up of the vegetation by local people to obtain firewood can pose a threat to the population.

Sapindaceae. Guioa hospita

This species is endemic to PNG and only known from the type specimen collected in 1890 in the Gulf Province (Adema et al. 1994). Habitat loss and habitat degradation are the major threats. May occur in hill forest in Middle Purari Hills and Southeast Hills ecological zones.

4.5.2 Endangered (EN)

Ebenaceae. *Diospyros insularis*

Mostly restricted to a few localities in the Solomon Islands also in the East and West New Britain Provinces (Bakhuizen van den Brink 1933) with two collections from Kiriwina Island in the Milne Bay Province (Oldfield et al. 1998) and threatened by habitat degradation and logging. This species normally occurs as scattered individuals in the above named localities. A single adult specimen with young fruit was recorded at Site 6B growing in deep shade in rocky clay loam covered in a deep layer of leaf litter along the track in hill forest in the Middle Purari Hills ecological zone. This is the first mainland New Guinea record of this Endangered tree. Suitable habitat occurs in the foothills of the Middle Purari Hills and Southeast Hills ecological zones, and on well drained alluvial soils on the Delta Swamps and Plains. There is a chance that there are more specimens growing in this habitat in other parts of the study area as bats and fruit pigeons disperse the seeds (Eddowes 1997).

Rutaceae. *Flindersia pimenteliana*

This species is widely distributed from Queensland, Australia to the northern and eastern areas of Papua New Guinea (Hartley 1969, Boland et al. 1992). It has been recorded growing over an elevational range of sea level to 2,700 m (Boland et al. 1992). A small population of five fruiting scattered individuals was recorded at Site 7 growing in hill forest of the Southeast Hills ecological

zone. Suitable habitat is widespread in the study area, including hill forest in the Middle Purari Hills and Southeast Hills ecological zones. Logging companies target this species for the dense and fine-grained wood marketing it as Maple Silkwood.

4.5.3 Vulnerable (VU)

Anacardiaceae. *Gluta papuana*.

This species is endemic to Papua New Guinea and known from Western and Gulf Provinces where it occurs in seasonally inundated freshwater swamp and alluvial forest habitats. This species was originally collected by Hart in March 1953 from the Romilly Sawmill Logging Area in the lower part of the study area (Specimen in Lae Herbarium; collection locality listed as S7° 40' E144° 55'). The precise collection locality is unknown, but based on this species' ecology it is likely to occur in alluvial or freshwater swamp forest environments in the Delta Swamps and Plains ecological zone. It may also occur in suitable habitat in any ecological zone other than the Middle Purari Hills. The type specimen represents 100% of the world population.

Avicenniaceae. *Avicennia rumphiana*

Occurs in Malaysia, the Philippines, Indonesia and widespread but sparingly along the coast and inland along rivers in the Central, Western, Morobe, Milne Bay and Northern Provinces. It grows in the upper part of intertidal zones and is thus vulnerable to habitat destruction. This taxon has not been recorded for the Gulf Province but suitable habitat is widespread in the Mangroves ecological zone.

Clusiaceae. *Mammea grandifolia*

A rare species known only from the type locality at Pinini Creek in Gulf Province, 7 km from Middletown. *Mammea grandifolia* is unique in the genus for its long, broad leaves and coarse areolae (Stevens 1974 and 1995). Seven mature specimens were recorded, one at Site 3 within a logged area of hill forest, two at Site 4 in alluvial and hill forest, two at Site 5 in foothill forest, and specimens in hill forest at Site 6B and in alluvial forest at Site 7 (Table 4). This rare and restricted-range species occurred in the Middle Purari Hills, Southeast Hills and Delta Swamps and Plains ecological zones. Suitable habitat is widespread in the study area as alluvial and hill forest in most ecological zones. Habitat destruction is the major threat to this species. The recorded specimens represent an estimated 80% of the world population.

Cunoniaceae. *Ceratopetalum succirubrum*

This rare species was first described from the Atherton Tablelands near Cairns, Australia and is widely distributed in Northern Queensland. In Papua New Guinea, it is previously known only from two separate areas in mountainous terrain in the Morobe Province, both of which are heavily logged (Lae Herbarium Database). At Site 7 a small population of five semi-mature and mature specimens was recorded along a drainage line in the low hills east of the fly camp and it was also recorded in alluvial forest west of the fly camp. Suitable habitat in the study area is widespread as Hill forest in the Southeast Hills and Middle Purari Hills ecological zones, and in areas of well-drained alluvial forest on the Delta Swamps and Plains.

Fabaceae. Koompassia grandiflora

Occurs naturally in West Papua and Papua New Guinea. Widely distributed in Morobe and Central Provinces (Verdcourt 1979). In Gulf Province, it has been recorded from the Saw Mountains and the western extension of the Rim Ridge between Malalana and Murua, growing on limestone slopes. This species is in high demand with logging companies (Eddowes 1997). Suitable habitat is widespread in the Study Area as hill and alluvial forest in the Middle Purari Hills, Southeast Hills, and Southeast Coast ecological zones

Fabaceae. *Archidendron forbesii*

A rare species (De Wit 1952; Nielsen et al.1984) known from Central Province with a single record from Oro Province (Verdcourt 1979). A single fruiting specimen c. 7 m tall was recorded for the first time in Gulf Province from the top of a ridge at c. 310 m elevation at Site 2 (Table 4). This species normally occurs in low densities as scattered individuals. Suitable habitat is widespread in the study area, including hill and alluvial forest in the Middle Purari Hills, Southeast Hills, Delta Swamps and Plains and Southeast Coast ecological zones.

Fabaceae. *Intsia bijuga*

This species is a primary commercial timber tree (Kwila/Merbau) that is widespread from East Africa, India, Indo-China, and Malesia to the Philippines (Verdcourt 1979). Papua New Guinea (mainly Sepik and Madang Provinces) and Indonesia still harbor relatively large reserves of this species (Oldfield 1991). Wherever there are millable size trees, there is high pressure from logging companies. Two individual trees with DBH 30 cm and in fruit were recorded in Open alluvial forest (Po) at Site 4, single mature specimens were recorded in alluvial forest at Site 5 and in hill forest at Site 6A, present in hill forest at Site 6B, and with 10 mature specimens recorded in alluvial forest at Site 7 where the tallest (20 m height) individual was present in the unlogged part of the forest. Three mature specimens were recorded in alluvial forest at Site 8 and nine semi-mature specimens were recorded in littoral forest at Site 9, where this species was also present in alluvial forest north of the fly camp. This species is likely to occur in hill forest in the Middle Purari Hills and Southeast Hills ecological zones and especially in alluvial forest in the Delta Swamps and Plains ecological zone with more restricted occurrences in the South East Coast ecological zone. The recorded specimens represent less than 1% of the world population.

Fabaceae. *Pterocarpus indicus*

A much sought after hardwood timber species that occurs from Southeast Asia, Indo-China and the Pacific Islands throughout Malesia to the Santa Cruz Islands and is widely distributed in Papua New Guinea. One of the most important timber trees in Papua New Guinea and heavily exploited (Verdcourt 1979). It is widespread within the study area. A single very old specimen was recorded on a high ridge at Site 1 growing in hill forest, with the largest population recorded during the survey at Site 2, also in hill forest though with large numbers in alluvial terrain along the unnamed creek east of the fly camp. The second largest population was recorded at Site 3, also in hill forest, where nearly all the mature specimens have been logged, with only individuals that have originated from suckers remaining. Five semi-mature trees were recorded at Site 6A growing in hill forest along Kuku Creek. It was found growing in alluvial forest at Sites 4 and 5. Thirty-nine specimens of suckering and semi-mature trees were recorded in alluvial and hill forest at Site 7 and 11 mature specimens were recorded in swamp forest at Site 8, presumably left by the loggers because of the twisted main stems. At Site 9 nine specimens were recorded in littoral forest close to the beach, all of which were suckering from cut stumps, and the species was also observed in hill and alluvial forest north of the fly camp (Table 4). A single specimen was recorded growing on a raised area in mangroves at Site 8M, the only specimen recorded for this vegetation type and ecological zone. Suitable habitat is widespread in the study area. *Pterocarpus indicus* occurred in all the ecological zones. The recorded specimens represent less than 1% of the world population.

Myristicaceae. *Myristica brachypoda*

This species is endemic to Papua New Guinea and is only known from the type collection made at the A.P.C. Logging Area, Seribi River near Middletown (De Wilde 1995, 2000). It was collected at near sea level in alluvial or freshwater swamp forest environments in the Delta Swamps and Plains ecological zone.

4.5.4 Near Threatened (NT)

Meliaceae. *Aglaia euryanthera*

Distributed from Australia and Indonesia to Papua New Guinea. It is widely distributed in Papua New Guinea and well represented in the Gulf Province. It is a small tree 6-12 m tall with a rusty indumentum on the younger parts and peltate scales on the inflorescence (Harms 1942; Pannell 1995). This species has a wide altitudinal range from near the coast upwards to 1,300 m elevation. It appears to be locally common and was recorded in hill forest at Sites 1- 6A and alluvial forest at Sites 4. It was recorded in the Middle Purari Hills, Delta Swamps and Plains, and Southeast Hills ecological zones. Intact hill forest is extensive across the Middle Purari Hills and Southeast Hills ecological zones and intact alluvial forest across the Delta Swamps and Plains ecological zone. Destruction of the habitat is the major threat. The recorded specimens represent less than 1% of the world population.

Meliaceae. *Aglaia rimosa*

Widely distributed in Taiwan, Indonesia, Philippines, Sulawesi, Maluku Islands and most provinces in Papua New Guinea (Pannell 1992, Mabberley et al. 1995, Oldfield et al.1998), but it is generally an uncommon species. It is a small tree 6-10 m tall with dark green glossy leaves and small deep yellow flowers. Male and female flowers on separate trees. A few scattered semi-mature specimens were recorded growing in hill forest along drainage lines on the low hills at Site 7 in the Southeast Hills ecological zone. Suitable habitat (hill forest) for this species is widespread in the study area in the Middle Purari Hills and particularly in the Southeast Hills ecological zone. Destruction of the habitat is the major threat.

Cycadaceae. *Cycas scratchleyana*

A New Guinea endemic distributed from Indonesia (Papua, Maluku, Papua Barat) to Papua New Guinea (Central, Gulf, Milne Bay, Western Provinces) with most populations restricted to the Gulf Province (Hill 1994). *Cycas scratchleyana* was recorded as common at all sites surveyed except sites 8, 8M and 9. It was mostly present as scattered individual except along ridges in hill forest where larger populations were present. The largest population (27 individuals) was located in hill forest at Site 4. Tall specimens (up to 12 m height) with good recruitment were recorded on the ridges in hill forest at this site. *Cycas scratchleyana* was recorded growing in hill forest at all sites and in alluvial forest at sites 4 and 7 and in the Middle Purari Hills, Southeast Hills and Delta Swamps and Plains ecological zones. Seedlings were recorded underneath or close to adult specimens throughout the survey area. Suitable habitat (hill forest and alluvial forest) is widespread in the study area. *Cycas scratchleyana* seems to survive better than other plants in disturbed habitats e.g. on the ridge at site 6D that despite long periods exposed to full sun and the tops of the large plants being slashed off, they still survived. The recorded specimens represent less than 5% of the world population.

Proteaceae. *Helicia amplifolia*

This species is widespread in Papua New Guinea and known from the Eastern, Western and Southern Highlands, Madang and Morobe Provinces. It occurs in forest at elevations of 600–1300 m asl. The specimen at Site 2 was at the lowest elevation (310 m asl) recorded for the species. The single mature flowering and fruiting specimen grew on a high ridge in hill forest in the Middle Purari Hills ecological zone. Potential hill forest habitat for this species occurs widely in the study area in the Middle Purari Hills and Southeast Hills ecological zones. Destruction of the habitat by logging and wood harvesting are the major threats.

Proteaceae. *Helicia latifolia*

This species is endemic to Papua New Guinea, and occurs in the mainland provinces of Gulf, Central, Milne Bay and Northern Province, and on the island of New Britain in the Bismarck Archipelago (Conn 1995). *Helicia latifolia* normally occurs as scattered individuals. A single large flowering specimen of *H. latifolia* was recorded in hill forest on a ridge at Site 2 growing in a fairly open area in full sun. Suitable hill forest is widespread in the Middle Purari Hills and Southeast Hills ecological zones and can potentially occur throughout these ecological zones. It is threatened mostly by habitat loss. The recorded specimens represent less than 1% of the world population.

Rutaceae. *Flindersia amboinensis*

Widespread but sporadic on mainland PNG, Seram Island and Tanimbar Islands (Moluccas), with a number of collections from Gulf Province (Hartley 1969). Occurs from lowlands to sub-montane forest. The main threat is logging and habitat loss. Sufficient Hill and alluvial forest habitat is available in all ecological zones except Mangroves.

Rutaceae. *Flindersia schottiana*

Widespread in New Guinea and eastern Australia in lowland, hill and lower montane forest (Hartley 1969). The main threat is logging and habitat loss. Sufficient Hill and alluvial forest habitat is available in all ecological zones except Mangroves.

Myristicaceae. *Myristica globosa*

A widespread species that occurs in West Papua, Papua New Guinea, the Solomon Islands and the northeastern part of Australia. It is a variable species with three subspecies having much overlap in the different subspecies, making it difficult to place many of the specimens (De Wilde 1994). This species prefers to grow in lowland forest at elevations of 30–1,500 m asl (De Wilde 2000). *Myristica globosa* was recorded growing as scattered individuals at Site 2 (3 mature specimens) in hill forest in the Middle Purari Hills ecological zone, at Site 5 (2 mature specimens) in alluvial forest in the Delta Swamps and Plains ecological zone and at Site 6B (a single mature specimen) in alluvial forest in the Delta Swamps and Plains ecological zone. Suitable hill forest and alluvial forest habitat occurs widely in the study area. The major threat to this species is habitat destruction.

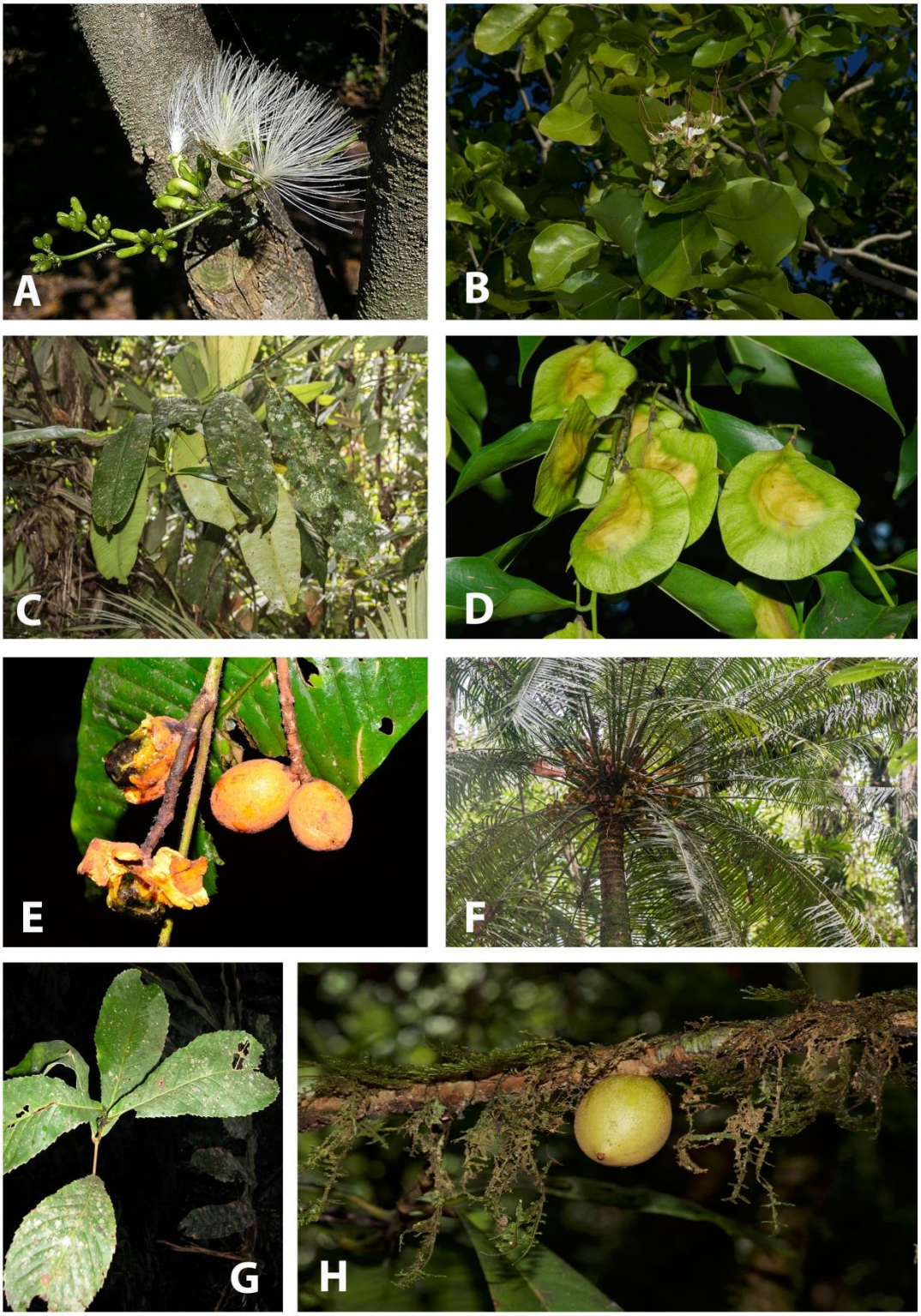

Figure 24. A selection of the IUCN listed species
A. *Archidendron forbesii* (IUCN = VU); B. *Intsia bijuga* (IUCN = VU); C. *Mammea grandifolia* (IUCN = VU); D. *Pterocarpus indicus* (IUCN = VU); E. *Aglaia euryanthera* (IUCN = NT); F. *Cycas scratchleyana* (IUCN = NT); G. *Helicia latifolia* (IUCN = NT); H. *Mammea novoguineensis* (IUCN = DD).

4.5.5 Data Deficient (DD)

Meliaceae. *Aglaia cucullata*

Widely distributed from Bangladesh, Thailand, Vietnam, Sumatra, Malaysia, Singapore, Borneo, Java, Philippines, Solomon Islands and New Guinea. It occurs widely in Papua New Guinea with most records from the Morobe Province and mostly from lowland forests associated with mangroves but there are a few records from alluvial forest. Three scattered individual specimens were recorded in alluvial forest at Site 6B in the Delta Swamps and Plains ecological zone. Two specimens were young plants but the third was flowering making a positive identification possible. Two adult flowering specimens were recorded from alluvial forest at site 7 also in the Delta Swamps and Plains ecological zone. Potential alluvial forest occurs widely in the Delta Swamps and Plains and Southeast Coast ecological zones.

Malvaceae. *Brownlowia argentata*

This species occurs in the landward margin of mangrove ecosystems at the interface with freshwater swamp forest environments. Its distribution is poorly known but it is thought to occur widely from Southeast Asia to New Guinea. Widely distributed in Papua New Guinea with several collections from Ravikivau and the Pie River in the Purari Delta (Papua New Guinea National Herbarium, Lae). Precise localities are unknown but are here attributed to the Delta Swamps and Plains ecological zone within the study area. It may also occur in the Mangroves ecological zone. This species is threatened by habitat destruction and rising sea levels.

Magnoliaceae. *Magnolia tsiampacca*

A widespread species occurring in Sumatra, Borneo, Sulawesi, Maluku Islands and the whole island of New Guinea growing at elevations from sea level to 1,800 m asl (Nooteboom 1988, Croft 1995). *Magnolia tsiampacca* was recorded as scattered individuals in hill forest at Site 1 in the Middle Purari Hills ecological zone and at Site 8 in the Southeast Hills ecological zones. Suitable habitat occurs widely in the study area in these ecological zones. A major hardwood timber species targeted by the logging companies throughout its range. It is threatened by deforestation and forest degradation.

Clusiaceae. *Mammea novoguineensis*

This small tree (to 15 m high) is known from a few scattered localities in West Papua and the Oro Province in Papua New Guinea (Stevens 1995) where it occurs in hill forest between 60 and 420 m asl. The record from near Site 9 is the lowest elevation recorded for the species (12 m ASL). It was recorded in hill forest at Sites 4, 5 and 7 in the Middle Purari Hills and Southeast Hills ecological zones and also in alluvial forest at Site 7 in the Delta Swamps and Plains and Site 9 in the South-East Coast ecological zone growing as scattered individuals. Suitable hill forest occurs widely in the Middle Purari Hills and Southeast Hills and alluvial forest in the Delta Swamps and Plains and South East Coast ecological zones.

Anacardiaceae. *Pentaspadon motleyi*

This tall (to 50 m) deciduous tree is distributed widely form Southeast Asia through New Guinea to the Solomon Islands where it occurs mainly in primary forest along streams and rivers near the coast. This species has been collected previously from the Romilly Sawmill Logging Area in the lower part of the study area (Specimen in Lae Herbarium; collection locality listed as S7° 40’ E144° 55’). The precise collection locality is unknown, but based on this species’ ecology it has been allocated to alluvial or freshwater swamp forest environments in the Delta Swamps and Plains ecological zone. It may also occur in the Southeast Hills and Southeast Coast ecological zones.

4.6 New to science and undescribed taxa

Thirty-five undescribed taxa were recorded during the survey (Table 5). Thirty-four of these species are new-to-science, discovered for the first time during Project surveys and at present known only from the study area. Also recorded was a single species (*Memecylon* sp. 1) that is also known from the Crater Mountain WMA north of the study area but remains scientifically undescribed (Table 5). These taxa are illustrated in Figures 25–27 and brief accounts are given below. Spatial data on the location of select occurrences of new-to-science and undescribed plant species are provided in Appendix 2.

Table 5 New-to-science and undescribed plant species from the study area
New-to-science = N; Undescribed = U.

Family	Scientific Name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6 B	Site 6D	Site 7	Site 8	Site 8M	Site 9	Geographic Range
Annonaceae	Orophaea sp. 1		N					N						Known only from study area
Annonaceae	Pseuduvaria sp. 1									N				Known only from Study Area
Arecaceae	Livistona sp. 1				N	N		N	N					Known only from Study Area
Begoniaceae	Begonia sp. 1	N	N		N									Known only from Study Area
Begoniaceae	Begonia sp. 2	N	N											Known only from Study Area
Begoniaceae	Begonia sp. 3		N											Known only from Study Area
Begoniaceae	Begonia sp. 4		N											Known only from Study Area
Begoniaceae	Begonia sp. 5				N									Known only from Study Area
Fabaceae	Archidendron sp. 1				N									Known only from Study Area
Gesnertiaceae	Cyrtandra sp. 1		N	N										Known only from Study Area
Gesnertiaceae	Cyrtandra sp. 2	N	N	N		N		N						Known only from Study Area
Gesnertiaceae	Cyrtandra sp. 3	N	N		N	N								Known only from Study Area
Lecythidaceae	Barringtonia sp. 1	N	N			N								Known only from Study Area
Lecythidaceae	Barringtonia sp. 2		N		N	N		N		N				Known only from Study Area
Melastomataceae	Medinilla sp. 1	N	N											Known only from Study Area
Melastomataceae	Memecylon sp. 1	U				U		U						North to Crater Mountain WMA
Moraceae	Ficus sp.1			N										Known only from Study Area
Myrtaceae	Syzygium sp. 1				N									Known only from Study Area
Myrtaceae	Syzygium sp. 2					N		N	N	N				Known only from Study Area
Myrtaceae	Syzygium sp. 3									N				Known only from Study Area
Myrtaceae	Syzygium sp. 4									N				Known only from Study Area
Myrtaceae	Syzygium sp. 5					N								Known only from Study Area

Family	Scientific Name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6 B	Site 6D	Site 7	Site 8	Site 8M	Site 9	Geographic Range
Orchidaceae	Bulbophyllum sp. 1				N									Known only from Study Area
Orchidaceae	Bulbophyllum sp. 2											N		Known only from Study Area
Orchidaceae	Oberonia sp. 1				N									Known only from Study Area
Phyllanthaceae	Glochidion sp. 1	N												Known only from Study Area
Primulaceae	Discocalyx sp. 1		N	N										Known only from Study Area
Rubiaceae	Ixora sp. 1	N	N	N	N	N				N				Known only from Study Area
Rubiaceae	Ixora sp. 2	N	N		N				N					Known only from Study Area
Rubiaceae	Ixora sp. 3	N	N	N		N				N			N	Known only from Study Area
Rubiaceae	Lasianthus sp. 1	N												Known only from Study Area
Rubiaceae	Maschalodesme sp. 1		N		N	N								Known only from Study Area
Rubiaceae	Genus 1 sp. 1	N	N		N	N				N	N			Known only from Study Area
Rubiaceae	Genus 1 sp. 2		N											Known only from Study Area
Rubiaceae	Genus 1 sp. 3				N	N		N	N	N			N	Known only from Study Area

Annonaceae. *Orophaea* sp. 1

A shrub to small tree 3 m tall with smooth dark greyish brown bark. The bright green leaves are held in the same plane. The venation is prominently sunken on the adaxial surface. The fleshy fruit is slightly rough when green but bright orange and covered in dense short and fine hairs. This taxon is known from Site 2 where it occurred as scattered individuals in hill forest in deep shade and in places where there was a thick layer of leaf litter and in light shade in hill forest at site 6B in the Middle Purari Hills ecological zone. Birds and mammals disperse the fruit of Annonaceae. Potentially suitable undisturbed hill forest is widespread in the Middle Purari Hills and to a lesser extent the Southeast Hills. The recorded specimens represent 100% of the world population. Status of EN at present.

Annonaceae. *Pseuduvaria* sp. 1

A shrub to small tree up to 4 m tall with drooping branches and smooth, dark grey bark. The leaves are pendulous, glossy dark green and narrowly pointed. The inflorescence consists of a single flower on a very short pedicel and resting on the base of the lamina. The flower is purplish and without any scent. The fruit is a pendulous bright orange berry with a wrinkled surface. Most plants were in flower with about 20% in fruit. The single flower on a very short pedicel and resting on the base of the leaf distinguishes this taxon from all other *Pseuduvaria* taxa (Su & Saunders 2006). The taxon is only known from Site 7 where it occurred as scattered individuals in alluvial forest in the Delta Swamps and Plains ecological zone in deep shade areas with a deep layer of leaf litter, and in hill forest east of the fly camp in the foothills of the Southeast Hills ecological zone. Birds and mammals are the dispersing agents of Annonaceae seed. Potentially suitable habitat is widespread in the Delta Swamps and Plains ecological zone.

Arecaceae. *Livistona* sp. 1

The long petioles of this palm, without a covering of white waxy powder and with dense spines on the margins, lack of brown indumentum on the inflorescence and very long infructescences with relatively large fruit, distinguishes this taxon from its closest relative *Livistona chocolatina*, which occurs in the Kuriva area of Gulf Province (John Dowe, pers. comm., 2016). This palm grows in small populations of up to 20 individuals along drainage lines in hill forest at Sites 4 and 5, and on low foothill forest terraces at Site 6B, and in hill forest on the slopes of the ridges at site 6D. Soils were well drained at all these sites. Birds especially hornbills act as dispersal agents for *Livistona* seed (Datta & Rawat 2003). Potentially suitable habitat is widespread in the Middle Purari Hills ecological zone.

Begoniaceae. *Begonia* sp. 1

The large leaves covered in scattered thick scabrid purple hairs, purple petiole, purple veins on the abaxial lamina surface, large red-veined flower bracts with apical teeth and large pink bimerous flowers distinguishes this taxon from all other *Begonia* species (Sosef 1994). Its fruit are wind dispersed which have three large wings. This species was recorded in hill forest at sites 1 and 2 where it was common on the forest floor in areas with permanent shade and a thick layer of moist leaf litter. The populations at Site 4 were recorded growing in alluvial forest in the Delta Swamps and Plains ecological zone. Populations varied in size from a few individuals to 200+. All populations included good regeneration as indicated by the presence of abundant seedlings and saplings. Four hundred and ninety-three (493) plants were recorded during the field work. The species preferentially establishes in the shaded forest understory where it is susceptible to habitat disturbance. The only disturbance recorded was from pig damage to two of the populations at site 2. The recorded specimens represent an estimated 90% of the world population. Four more populations known from the Mt. Bosavi area.

Begoniaceae. *Begonia* sp. 2

A fleshy herb with a combination of inflorescence bracts with awl-shaped apices, paired large pink flowers, glossy dark green adaxial lamina surface with silver blotches and prominent asymmetrical lamina base distinguishes this taxon from all other *Begonia* species. This new taxon was recorded in hill forest at Sites 1 and 2 in the Middle Purari Hills ecological zone where it was localized and uncommon, occurring as scattered populations in deep shade on the sides of drainage lines where

the soil was permanently moist, and where there was either a thin layer of leaf litter or none. It only occurred in dense shade. The fruit is dispersed by water, which accounts for the plants growing on stream banks. It is susceptible to habitat disturbance, which results in more light, higher temperatures and drier soils. Potentially suitable undisturbed stream bank forest habitat is widespread in the Middle Purari Hills and to a lesser extent in the Southeast Hills. At present this species is known only from the Era River catchment. The recorded specimens represent an estimated 70% of the world population.

Begoniaceae. *Begonia* sp. 3

The lamina is covered in long hairs with a bulbous base and the laciniate lamina margin immediately separates this taxon from all the other species of *Begonia*. It was recorded from two isolated populations (30+ individuals including many young plants and seedlings) at Site 2 where it was growing on the forest floor on a high ridge at 90–115 m asl. This taxon prefers to grow on the forest floor where there is permanent shade and a thick layer of moist leaf litter. It prefers deep shade but will survive under higher light conditions which causes the under surface of the leaves to turn reddish green. The fruit has three prominent wings and is distributed by wind. This taxon is susceptible to habitat disturbance (more light, higher temperatures, drier soils). Potentially suitable undisturbed hill forest is widespread in the Middle Purari Hills and (to a lesser degree) the Southeast Hills, though at present the species is known only from a very small area in the Era River catchment. The recorded specimens represent 100% of the world population. Status of EN at the moment.

Begoniaceae. *Begonia* sp. 4

This new-to-science *Begonia* taxon has purple leaves on the abaxial surface and dark green with reddish purple spots on the adaxial surface. The flowers are unusually large. This taxon prefers to grow where the forest floor is open and where there is permanent deep shade and a thick layer of moist leaf litter. It was recorded as an isolated flowering specimen on a steep slope in somewhat dry conditions in dense forest at Site 2 at an elevation of c. 120 m asl in the Middle Purari Hills ecological zone. This taxon is susceptible to habitat disturbance (more light, higher temperatures, drier soils). Potentially suitable undisturbed hill forest is widespread in the Middle Purari Hills and to a lesser extent the Southeast Hills, though at present the species is known only from a small area in the Era River catchment. The recorded specimens represent an estimated 50% of the world population. The other populations are in the Mt. Bosavi area.

Begoniaceae. *Begonia* sp. 5

The tall stature, up to 50 cm, lamina with widely scattered purple scabrid hairs, many branched inflorescence and small pink flowers separate this taxon from all other *Begonia* species. This new-to-science taxon was found growing on the banks of a seasonal stream in palm dominated Hill forest (Hm) at Site 4, and is only known from two isolated populations consisting of only five (5) flowering and fruiting specimens. The fruit is dispersed by water, hence the plants growing on stream banks. This taxon is susceptible to habitat disturbance (more light, higher temperatures and especially drier soils). Potentially suitable intact stream bank habitat is widespread in the Middle Purari Hills and (to a lesser degree) the Southeast Hills. However, at present the species is known only from a small area in the Purari River (Oyomo Creek) catchment, and it is not known if this species is replaced by the ecologically similar *Begonia* sp. 2 in some nearby areas. The recorded specimens represent 100% of the world population. Status of EN at present.

Fabaceae. *Archidendron* sp. 1

A single-stemmed shrub 3 m tall with a few short branches, smooth grey bark and dull green leaves. The fruit is a strongly curled semi-fleshy deep orange red pod and does not conform to any known species (Verdcourt 1979). This taxon is rare and only three widely scattered fruiting plants were recorded at Site 4, where it occurred in alluvial forest in the Delta Swamps and Plains ecological zone. The seed of *Archidendron* is primarily distributed by birds (Nielsen et al. 1984). Potentially suitable intact alluvial forest habitat occurs more widely in the Delta Swamps and Plains, but large areas have been intensively logged, it was not recorded in similar habitat at Site 5, and at present the species is known only from a small area in the Oyomo Creek catchment.

Gesneriaceae. *Cyrtandra* sp. 1

The large leaves of this new-to-science taxon are covered in dark brown bristly hairs particularly on the petiole. A glabrous abaxial lamina surface, leafy bracts, and fleshy pink to red hairy calyx, and short-tubed deep pink corolla are unique to this taxon. It was uncommon and favored steep well-shaded moist stream banks along perennial streams in hill forest at Site 2, where it co-occurred with many plants of the IUCN Vulnerable *Pterocarpus indicus* (Rosewood). Three plants of this taxon were recorded from hill forest at Site 3 in similar habitat in the Southeast Hills ecological zone. Birds that move up and down along the streams presumably distribute the fleshy fruit. The stream bank habitat is vulnerable to disturbance especially the opening of the forest canopy that will lead to drier conditions. Potentially suitable intact stream bank habitat is widespread in the Middle Purari Hills and the Southeast Hills. The recorded specimens represent 100% of the world population. Status of EN at present.

Gesneriaceae. *Cyrtandra sp. 2*

The large leaves with widely spaced hairs on the lamina margin, pendulous flowers with long filamentous calyx lobes covered in long purple hairs, hairy red outer corolla tube covered in long purple hairs and white inner corolla with the corolla lobes covered on the abaxial surface in glandular hairs, distinguish this taxon from all other *Cyrtandra* species. This taxon is known from several scattered specimens growing in deep shade of hill forest on slopes and on ridges at Sites 1, 2, 5 and 6B in the Middle Purari Hills ecological zone and Site 3 in the Southeast Hills ecological zone. It occurs across an elevational range of 40–260 m asl. Most of the plants were in full flower with a number having young fruit. The fleshy fruit is probably distributed by birds and small animals hence the scattered occurrence of the taxon. The species is likely to be susceptible to prolonged dry conditions. Potentially suitable undisturbed hill forest and alluvial forest is widespread in the Middle Purari Hills and to a lesser extent the Southeast Hills and the Delta Swamps and Plains. The recorded specimens represent 100% of the world population. Status of EN at present.

Gesneriaceae. *Cyrtandra* sp. 3

This new taxon is a common floral element of the drainage line banks in the forest around Sites 1–2 and 4–5. This small fleshy herb has leaves with all the veins immersed on the dark green adaxial lamina surface and with prominent silver blotches. The inflorescence, with pure white flowers is borne below the leaves. There are occasional populations without the silver markings on the leaves but apart from this, there is no difference between the two forms. This taxon prefers deeply shaded and moist conditions where there is a substantial amount of leaf litter. It appears to be widely distributed in the study area being found as scattered individuals or as small dense populations growing along stream banks in hill forest in the Middle Purari Hills ecological zone, and in well drained alluvial forest near the foothill base in the Delta Swamps and Plains (Site 4). The seed is washed down the drainage line banks by rain and then dispersed further by flowing water in the drainage lines. The species will be susceptible to mortality from prolonged dry and high light conditions. Potentially suitable habitat is widespread in the Middle Purari Hills and the Southeast Hills ecological zones where it was recorded in the Era and Purari River catchments. The recorded specimens represent an estimated 50% of the world population. A number of populations from the Aure River and from the Mt. Pirora areas.

Lecythidaceae. *Barringtonia* sp. 1

A monocaulos plant up to 3 m tall with a feather duster shaped head of glossy leaves and white fruit. This combination of features immediately separates this taxon from all other species of *Barringtonia* (Payens 1967, Prance & Kartawinata 2013). This taxon was locally uncommon and was distributed as widely scattered individuals at elevations of 60–157 m. It grew in shaded conditions in forest on well-drained alluvium next to Boa Creek and a Mena Creek tributary at Site 1 where there was a thick layer of leaf litter. A single fruiting specimen was recorded growing next to a small stream at Site 2 and a fruiting specimen grew on the low hills at Site 5, all in the Middle Purari Hills ecological zone.

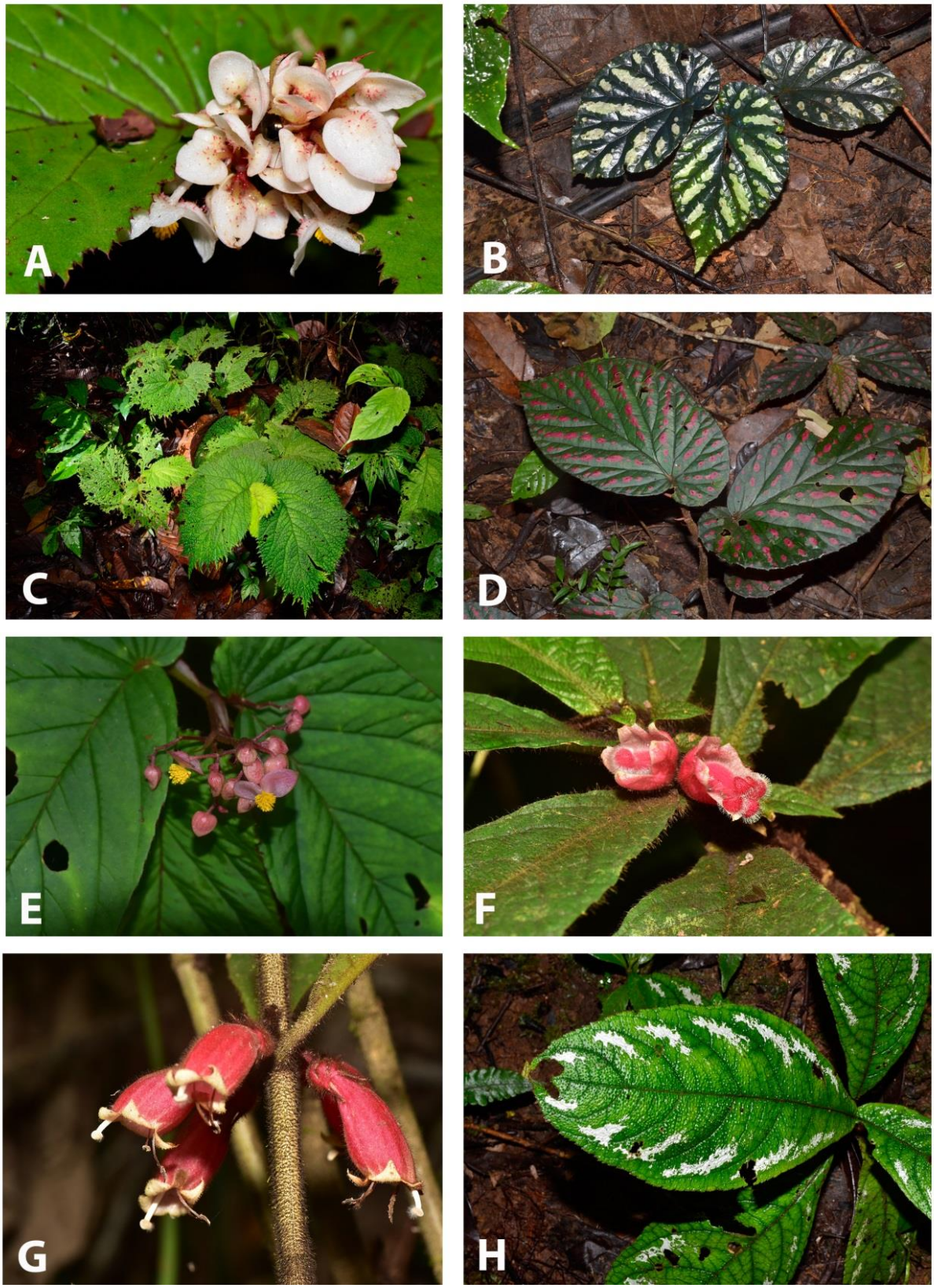

Figure 25. New and undescribed species
A, *Begonia* sp. 1; B, *Begonia* sp. 2; C, *Begonia* sp. 3; D, *Begonia* sp. 4; E, *Begonia* sp. 5; F, *Cyrtandra* sp. 1; G, *Cyrtandra* sp. 2; H, *Cyrtandra* sp. 3.

The large white fruit drops to the ground when ripe and is most probably dispersed by cassowary and other animals. Potentially suitable hill forest habitat occurs widely in the study area in the Middle Purari Hills and the Southeast Hills ecological zones. The recorded specimens represent an estimated 70% of the world population. Other populations are known from Mt. Pirora area.

Lecythidaceae. *Barringtonia* sp. 2

The very large leaves (up to 1 x 0.5 m), small cauliflorous bunches of pink flowers and sessile glossy bright red fruit are all unique for this genus (Payens 1967, Prance & Kartawinata 2013). This taxon is known from several small populations in alluvial forest at Sites 4, 5, 6B and at Site 7 in the Delta Swamps and Plains ecological zone and in forest on alluvial terraces adjacent to the unnamed creek at Site 2 (amid broader hill forest area) in the Middle Purari Hills ecological zone. It grows in areas where water collects during heavy rain and prefers areas of dappled shade with a few individuals in dense shade and always under very moist conditions. Nothing is known about the dispersal of this taxon but it is assumed that the fleshy red fruit might be attractive to cassowaries. These plants are susceptible to disturbance (drier soil conditions and higher light levels). Potentially suitable intact alluvial forest habitat occurs more widely in the Delta Swamps and Plains, though large areas have been intensively logged. The recorded specimens represent 100% of the world population. Status of EN at present.

Melastomataceae. *Medinilla* sp. 1

The small leaves with purple primary veins; deeply grooved petiole, small white flowers, long pedicel and small white fruit are unique to this taxon. This interesting miniature epiphytic *Medinilla* species is known from several small populations in two small areas in alluvial terrain alongside watercourses amid broader hill forest areas in the Middle Purari Hills ecological zone, one along Boa Creek near Site 1 and the other along the unnamed creek at Site 2. It is also potentially present along the larger streams. Being a low level epiphyte close to streams, this taxon experiences high level of moisture throughout the year. The stems of the host tree are normally covered in a dense growth of moss, ferns and other epiphytes. It prefers deep shaded conditions. This taxon is highly susceptible to habitat disturbance (lowering of shade, higher temperatures and drier conditions). Seeds of the genus *Medinilla* are bird dispersed (Styles and Roselli 1993). Potentially suitable intact streamside hill forest habitat is widespread in the Middle Purari Hills and (to a lesser extent) the Southeast Hills, though at present this species is known only from the Era River catchment. The recorded specimens represent an estimated 90% of the world population. Two other populations are known from the Aure River area. Status of EN at present.

Melastomataceae. *Memecylon* sp. 1

Jensen first collected this undescribed taxon at 1,442 m asl at Crater Mountain WMA in January 1999 (Papua New Guinea National Herbarium collection, Lae). The large sessile leaves held in the same plane and the dense contracted inflorescence of purplish blue flowers characterize this taxon. Within the study area it was locally common in several small populations growing on ridges covered in hill forest at Sites 1, 5 and at Site 6B in the Middle Purari Hills ecological zone. It grows at an elevational range of 40–1,215 m asl. It favors shallow soil with a thin layer of leaf litter and in light to dense shade. This taxon prefers the drier conditions of the ridges where the forest floor is moderately open and the layer of leaf litter is weakly developed. The fruit of *Memecylon* is bird dispersed (Gonzales et al. 2009). *Memecylon* sp. 1 is vulnerable to high light conditions and even though it grows on the dry ridges, prolonged dry conditions will be detrimental. Potentially suitable intact hill forest habitat is widespread in the Middle Purari Hills and the Southeast Hills. Despite being distributed across a broad elevational range it is currently known only from the Purari River catchment. The recorded specimens represent an estimated 90% of the world population. More populations are known from the Crater Mountain WMA area.

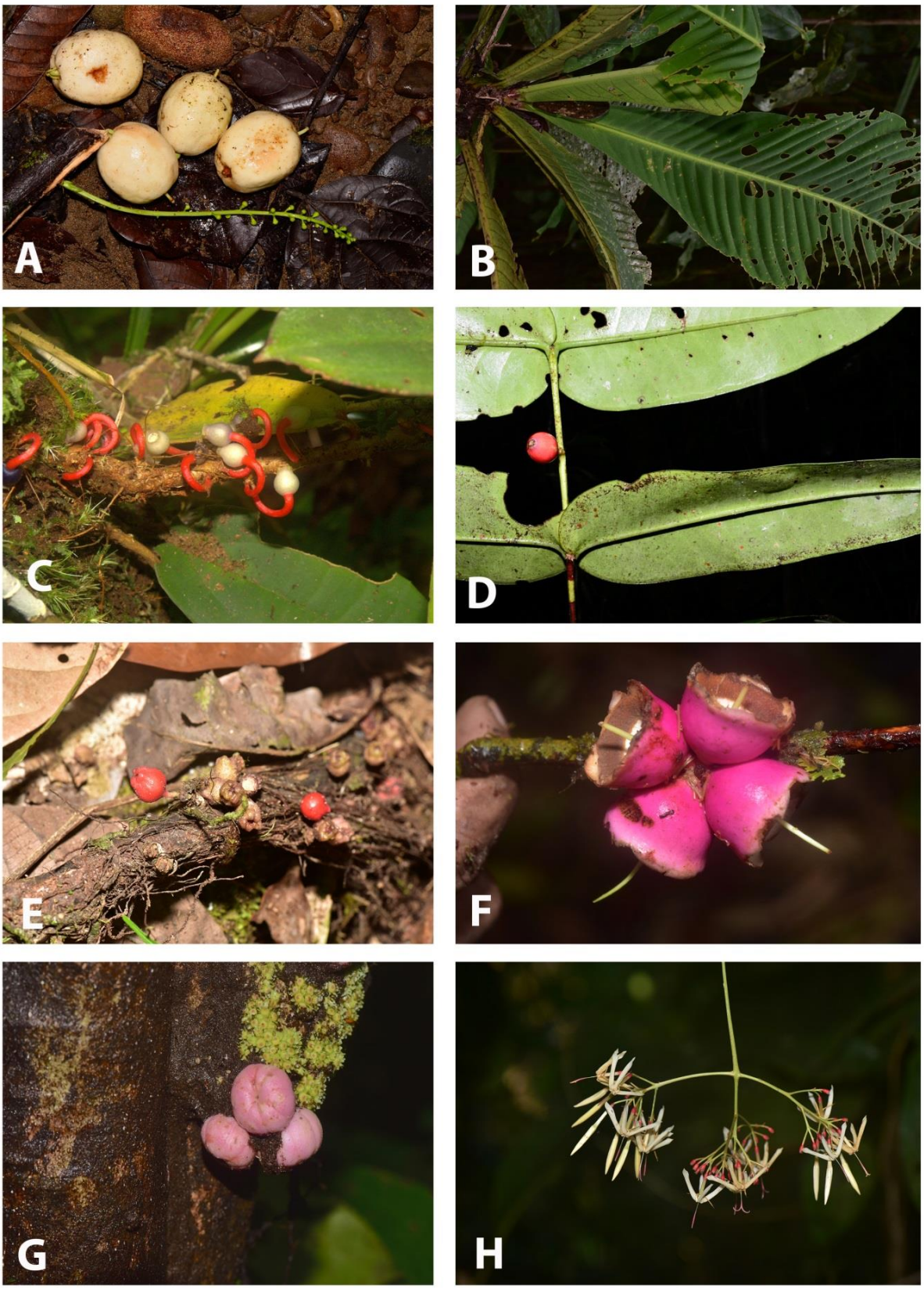

Figure 26. New and undescribed species
A. *Barringtonia* sp. 1 (N); B. *Barringtonia* sp. 2 (N); C. *Medinilla* sp. 1 (N); D. *Memecylon* sp. 1 (U); E. *Ficus* sp. 1 (N); F. *Syzygium* sp. 1 (N); G. *Glochidion* sp. 1 (N); H. *Ixora* sp. 1 (N).

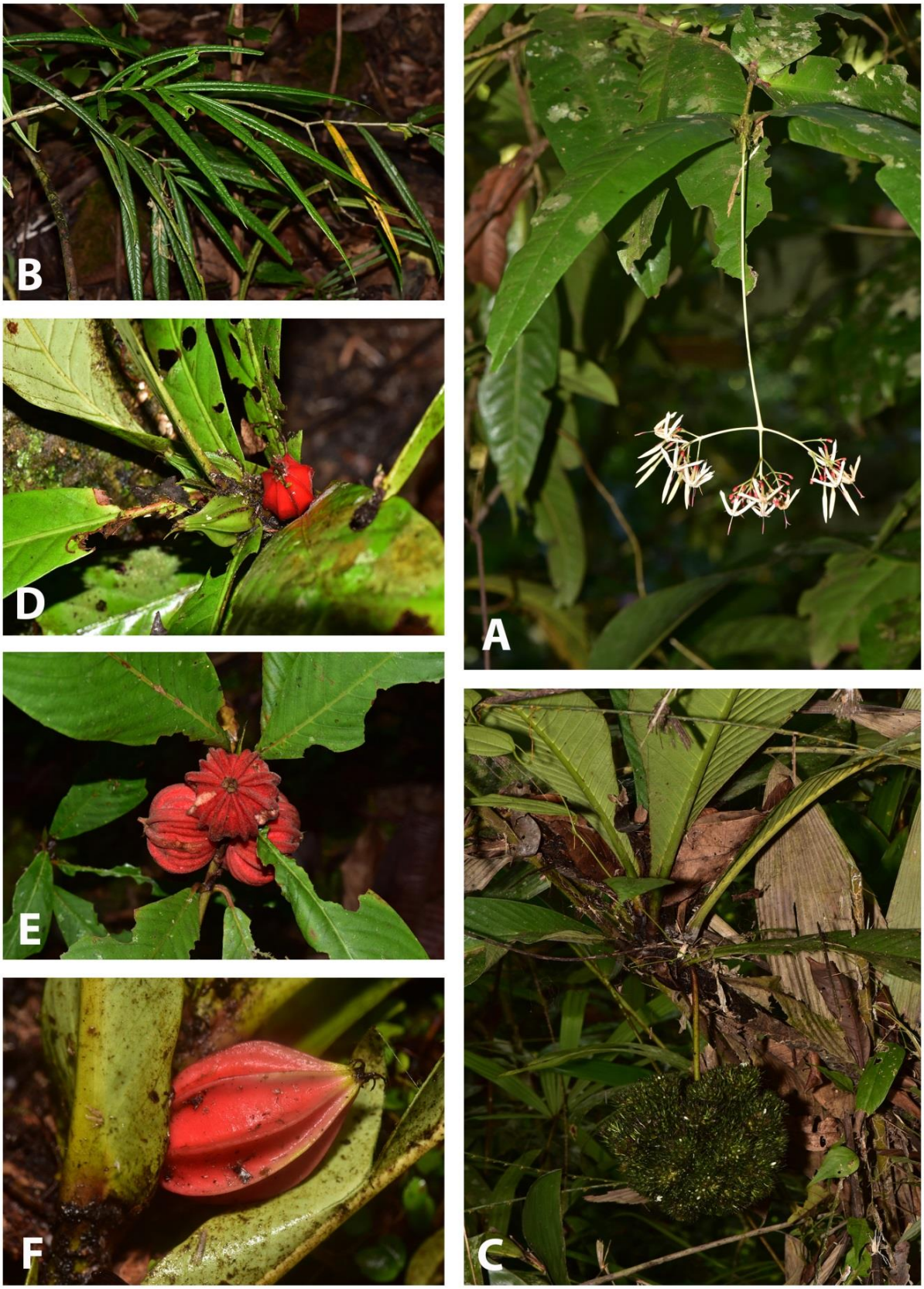

Figure 27. New and undescribed species
A. *Ixora* sp. 1 (N); B. *Ixora* sp. 2 (N); C. *Maschalodesme* sp. 1 (N); D. Genus 1 sp. 1 (N); E. Genus 1 sp. 2 (N); F, Genus 1 sp. 3 (N).

Moraceae. *Ficus* sp. 1

An unusual species of *Ficus* in the small monocaulous growth habit, not being taller than 70 cm and bearing bright red syconia (figs) low down the stem just above ground level. The species is known only from a few small and scattered populations in logged hill forest at Site 3 in the Southeast Hills ecological zone, where it was found growing in moist, shaded conditions on flat to slightly sloping areas covered in a thin layer of leaf litter in places where the canopy of the logged forest was still intact. The red fleshy fruit is situated low down on the stems just above ground level suggesting that animals such as bandicoots and rats (Shanahan 2000; Shanahan et al. 2001) disperse the seed. Potentially suitable hill forest habitat is widespread in the Southeast Hills and potentially the Middle Purari Hills ecological zones, but at present the species is known only from a small area in the lower Purari River catchment in the northern sector of the Southeast Hills. The recorded specimens represent 100% of the world population. Status of CR at present.

Myrtaceae. *Syzygium* sp. 1

A tree 3 m tall with sparse branching, reddish brown bark and the fruit arranged in the shape of a Maltese cross with the hypanthium bright pink. This taxon is known from a single specimen collected about 400 m southeast of fly camp 4 on the banks of a small creek at c. 50 m asl in alluvial forest in an area with a well-developed layer of leaf litter and permanent shade. This is a locally rare species; although its habitat is common in this forest type in the study area it was not found in survey of comparable forest types at Sites 5 or 7. The fruit of *Syzygium* species are primarily dispersed on the plant by frugivorous birds and by arboreal animals. The thin branches of this plant favor the suggestion that birds disperse the fruit. Opening of the forest canopy with the resultant higher light levels and drier conditions is likely to negatively impact this taxon. Potentially suitable intact alluvial forest habitat occurs more widely in the Delta Swamps and Plains, however large areas have been intensively logged. At present the species is known only from a very small area in the Oyomo Creek catchment. The recorded specimens represent 100% of the world population. Status of CR at present.

Myrtaceae. *Syzygium* sp. 2

This new-to-science taxon belongs to the cauliflorous group of *Syzygium*. The large leaves, large flowers with bright red hypanthium, lime green persistent petals, long and widely spreading stamens and the cricket ball sized bright red fruit immediately distinguishes this taxon from all other species of *Syzygium* (Hartley & Perry 1973). This taxon is known from several specimens growing scattered in alluvial forest at Sites 5 and 7 in the Delta Swamps and Plains ecological zone and in hill forest at Sites 6B and 6D in the Middle Purari Hills ecological zone and Site 7 in the Southeast Hills ecological zone. The species grows in areas with a well-developed layer of leaf litter and permanent shade. The fruit of *Syzygium* species are primarily dispersed on the plant by frugivorous birds, fruit bats and by arboreal animals. The large, fleshy and red fruit on the main stem suggests that arboreal animals play an important part in the distribution of seed. Opening up of the forest canopy with the resultant higher light levels and drier conditions will negatively impact this taxon. Potentially suitable intact alluvial forest habitat occurs more widely in the Delta Swamps and Plains, however large areas have been intensively logged. Suitable hill forest habitat occurs widely in the Southeast Hills and Middle Purari Hills ecological zones.

Myrtaceae. *Syzygium* sp. 3

This new taxon grows as a shrub 2-3 m tall with only a few branches and large leaves that are held in the same plane. The bark is smooth and yellowish grey. The fleshy glossy bright red fruit hanging from a 20–50 cm long, and very thin infructescence is unique for the genus *Syzygium* (Hartley & Perry 1973). This potentially rare taxon was recorded only in undisturbed forest fringing small streams in hill forest in the foothills at Site 7. Although the area was heavily logged in the past the vegetation along the small streams are undisturbed. A total of five mature and two young plants were recorded growing in light to deep shade in well-drained soil covered in a deep layer of leaf litter. For the study area, this taxon's habitat appears to be restricted to the Southeast Hills ecological zone. It is potentially susceptible to high light levels and dry conditions resulting from the opening up of the canopy. Areas of suitable habitat occur in many places across the Southeast Hills ecological zone.

Myrtaceae. *Syzygium* sp. 4

A tree eight meters tall with thinly flaking reddish brown bark on the main stem. The leaves are hard, leathery and much lighter below with the secondary veins prominently raised on the abaxial lamina surface. The fruit is cauliflorous, sessile, dull brownish red and fleshy with eight prominent five millimeter high parallel ridges. This rare new taxon is known only from a single specimen at Site 7 that was growing in a very moist area in light shade of unlogged alluvial forest. The only other *Syzygium* species with a similar fruit is *S. kipidamasii* but this is a shrub 3–4 m tall with smaller leaves and with the fruit situated near the ground (Takeuchi 2002). The cauliflorous habit of the fruit suggests dispersal of seed by arboreal mammals and birds. This is a locally rare species although its habitat is common in the study area. Potentially suitable habitat for this taxon occurs in many places as alluvial forest in the Delta Swamps and Plains ecological zone.

Myrtaceae. *Syzygium* sp. 5

This new-to-science taxon is an 18 m tall tree with smooth bark. The leaves are held in the same plane, glossy green and much lighter on the abaxial surface. The surface of the fleshy bright red fruit is strongly pustulate, a unique character in the genus *Syzygium* (Hartley & Perry 1973). It is known only from a single mature fruiting specimen at Site 5 growing in alluvial forest between the helipad and the camp of the local assistants. As with most *Syzygium* species, the fruit is eaten by frugivorous birds and arboreal animals. Local people in the camp were witnessed eating the fruit too. This is a locally rare species although its habitat is common in the study area. Potentially suitable habitat for this taxon is widespread in the Delta Swamps and Plains ecological zone.

Orchidaceae. *Bulbophyllum* sp. 1.

This new-to-science taxon is ranked as one of the smallest members of the genus *Bulbophyllum* and belongs to the section *Monanthes*. It is epiphytic and grows high up on the outer branches of trees. The leaves are thick with a leathery texture. The solitary flower is flesh-colored with the sepals curving backwards and the purple lip is covered in long white hairs. This is one of the taxa that is only noticed when a fallen branch from the canopy is inspected. It is known only from one hill forest locality in the foothills near Site 4. The thick leathery leaves suggest this species thrives in high light conditions. As with all orchid species, seed is distributed by wind. Potentially suitable intact hill forest habitat is widespread in the Middle Purari Hills ecological zone and to a lesser extent, the Southeast Hills ecological zone.

Orchidaceae. *Bulbophyllum* sp. 2.

This new-to-science *Bulbophyllum* belongs to section *Codonosiphon,* which is characterized by a thickened lip that resembles a tongue. It is a mid-level epiphyte growing on the trunks of the mangrove *Bruguiera gymnorrhiza* (Large-leaved Orange Mangrove). This is one of the few *Bulbophyllum* species associated with mangrove vegetation. This new taxon has stems that run on the surface of the tree trunk with a pseudobulb spaced every five centimeters. The pseudobulb is pear-shaped bearing a single thickly leathery leaf with a prominent depressed midrib. The solitary flower arises from the base of the pseudobulb. The sepals are widely spreading and white with the basal part maroon colored with a pink swollen lip and maroon tip. As with all orchid species, seed is distributed by wind. Potentially suitable intact Mangrove forest habitat is widespread in the survey area at the mouth of the Purari River.

Orchidaceae. *Oberonia* sp. 1.

This new-to-science *Oberonia* belongs to section *Labidous*, which is characterized by the well-developed lip. This is a high level epiphyte that grows on small branches of trees in the canopy of alluvial forest (near the hill-foot boundary) in the Delta Swamps and Plains ecological zone at Site 4. This is another taxon that specimens are only available from dropped canopy branches. The light green leathery leaves are an adaptation to survival under high light conditions. The inflorescence is very compact and tapers to the apex and is covered in 4–5 mm wide yellow flowers that have a strong musty smell, indicating beetles as the possible pollinator. Seeds of this orchid are distributed by wind.

This is a locally rare species although its alluvial forest habitat is common in the Delta Swamps and Plains ecological zone in study area.

Phyllanthaceae. *Glochidion* sp. 1

This new-to-science taxon is closely related to *Glochidion beehleri* (Takeuchi 1999), which is the only other cauliflorous species of *Glochidion*, but differs in the glabrous branchlets and leaves and the sessile fruit. It is known from three mature plants growing in deep shade on the banks of a small creek at 90 m asl in hill forest at Site 1 situated in the Middle Purari Hills ecological zone. The soil was deep with a well-developed layer of leaf litter. The cauliflorous habit of the fruit suggests seed dispersal by arboreal mammals and birds. This is a locally rare species although its habitat is common in the study area. It is susceptible to high light levels and dry conditions created by the opening of the canopy. Potentially suitable intact hill forest habitat is widespread in the Middle Purari Hills and to a lesser extent the Southeast Hills. However, at present the species is known only from a very small area in the Era River catchment. The recorded specimens represent 100% of the world population. Status of CR at present.

Primulaceae. *Discocalyx* sp. 1.

This new-to-science taxon is a shrub 1–2 m tall with few branches. The leaves are thickly leathery and dark green with a depressed midrib on the adaxial surface and prominently raised on the abaxial surface. The secondary venation is obscure. The drooping fruit is very succulent, slightly flattened off and glossy bright red, resembling a cherry. This combination of characters immediately separates it from all other *Discocalyx* species (Sleumer 1988). Plants (five fruiting individuals) occur as scattered individuals in hill forest in the Middle Purari Hills ecological zone at Site 2 and three flowering and fruiting individuals were growing in hill forest in the Southeast Hills ecological zone at Site 3. Plants grew in areas with a thick layer of leaf litter and in deep shade. Potentially suitable intact hill forest habitat is widespread in the Middle Purari Hills and to a lesser extent in the Southeast Hills.

Rubiaceae. *Ixora* sp. 1 'broad leaf'

This new-to-science species is a small tree with a maximum height of 3 m, smooth brown bark, broad leaves that are held in the same plane, and a long pendulous cream-colored inflorescence with large highly fragrant flowers with a diagnostic pink stigma and style. This taxon was locally common in undisturbed hill forest on the high ridges surrounding the Antelope 3 operations base at Site 1 and on a high ridge near Site 2 in the Middle Purari Hills ecological zone, in logged hill forest at Site 3 in the Southeast Hills ecological zone, also in alluvial forest in the Delta Swamps and Plains ecological zone at Sites 4, 5 and 7. Records are from an elevational range of 40–210 m asl. It was more common on gentle slopes with a well-developed layer of leaf litter and under well-shaded conditions. Fruits of the genus *Ixora* are typically dispersed by birds that scatter the seed in droppings far from the parent plant. Mammals are also important seed disperses (Fall et al. 2007). This taxon's habitat is common throughout the study area but it is susceptible to high light levels and dry conditions because of opening of the canopy. Potentially suitable intact hill forest habitat is widespread in the Middle Purari Hills and (to a lesser extent) the Southeast Hills, where it has been recorded in the Era and Purari River catchments. The recorded specimens represent 100% of the world population. Status of EN at present.

Rubiaceae. *Ixora* sp. 2

This new-to-science taxon has a very diagnostic drooping habit with smooth grey bark, long and narrow glossy dark green sessile auriculate leaves, with drawn-out apices, deeply sunken midvein, large pendulous inflorescence with fragrant white flowers, and fleshy glossy red fruit that are white inside. This taxon was locally common on hill forest ridges in the Middle Purari Hills ecological zone at Sites 1, 2, 4 and 6D with an elevational range of c. 100–350 m asl. This taxon prefers the drier conditions and shallower soils of the ridges where the forest floor is moderately open and the layer of leaf litter is weakly developed. Potentially suitable habitat for this taxon is widespread in low hill terrain in the Middle Purari Hills and (to a lesser extent) the Southeast Hills. The recorded specimens represent an estimated 90% of the world population. Two other populations are known from the Aure River area.

Rubiaceae. *Ixora* sp. 3

This remarkable new-to-science taxon grows into a tree up to 12 m tall with smooth bark, large leaves that are held in the same plane and large highly fragrant pendulous inflorescences with white to cream colored flowers. It was found as occasional scattered individual specimens on ridges in hill forest over an elevational range of 30–315 m asl, at Sites 1, 2 and 5 in the Middle Purari Hills ecological zone and Sites 3 and 7 in the Southeast Hills ecological zone. It was also recorded from alluvial forest at Site 9 in the Southeast Coast ecological zone. It prefers densely shaded conditions and sites where the shrub layer is prominent and the layer of leaf litter is well developed. The habitat for this taxon is common in low hilly terrain in the study area. It is susceptible to high light levels and dry conditions because of opening of the canopy. Potentially suitable intact hill forest habitat is widespread in the Middle Purari Hills and the Southeast Hills, where it has been recorded in the Era and Purari River catchments. The plant recorded in alluvial forest in the Southeast Coast ecological zone is possibly an isolated distribution record. The recorded specimens represent 100% of the world population. Status of EN at present.

Rubiaceae. *Lasianthus* sp. 1.

This new-to-science *Lasianthus* taxon is a shrub 1 m tall with horizontally spreading branches. The leaves are light green and thinly textured. The fleshy blue fruit is on the underside and obscured by the leaves. This combination of characters immediately separates this taxon from all the other species of *Lasianthus* (Zhu et al. 2012). This taxon grows in deep shade in hill forest where soils are well-drained with a thick layer of leaf litter. Frugivorous birds distribute the fleshy fruit of *Lasianthus*. Potentially suitable intact hill forest habitat is widespread in the Middle Purari Hills and the Southeast Hills, where it has been recorded in the Era River catchment.

Rubiaceae. *Maschalodesme* sp. 1

This new taxon differs from all other *Maschalodesme* species in the pendulous spherical-shaped inflorescence and much larger leaves. It was found as scattered individuals across an elevational range of c. 45–155 m asl in hill forest on hill slopes alongside streams at Site 2 in the Middle Purari Hills ecological zone and in alluvial forest at Sites 4 and 5 in the Delta Swamps and Plains ecological zone. This taxon grows in deep shaded and moist areas on stream banks where the leaf litter layer is well developed. Nothing is known about the dispersal of seed in the genus *Maschalodesme*. It is susceptible to high light and dry soil conditions resulting from opening of the canopy. Potentially suitable hill forest is extensive in the Middle Purari Hills and to a lesser extent in the Southeast Hills ecological zones with streamside forest habitat that occurs more widely in the Delta Swamps and Plains ecological zone, however large areas have been intensively logged. It is also likely to have a more restricted distribution alongside watercourses in the Middle Purari Hills and Southeast Hills. The recorded specimens represent an estimated 90% of the world population. Two other populations are known from the Mt. Pirora area. Status of EN at present.

Rubiaceae. *Genus* 1 sp. 1

This new Rubiaceous genus is unique in having the fruit with diagnostic parallel ridges from the base of the fruit to the apex. It is closely related to the genus *Ixora* (=*Versteegia*) but differs in the flower orientation not being erect, very small flowers, fruit large and with parallel ridges and the pyrenes not being disciform. This taxon has completely glabrous and glossy bright red fruit that is white and spongy inside. It formed a common element of the forest floor vegetation as scattered small populations in hill forest in the Middle Purari Hills ecological zone at Sites 1 and 2 and at Site 8 in the Southeast Hills ecological zone. It was also recorded in alluvial forest in the Delta Swamps and Plains ecological zone at Sites 4, 5 and 7. It prefers deep shade in flat areas where the layer of leaf litter is well developed. The bright red fruit of this genus grows close to the ground in the axils of the leaves, which suggests seed dispersal by cassowary, other birds, and possibly by mammals. Potentially suitable intact hill and alluvial forest habitat occurs extensively in the Middle Purari Hills, Southeast Hills and the Delta Swamps and Plains. The recorded specimens represent an estimated 70% of the world population. Other populations are known from Mt. Pirora area.

Rubiaceae. *Genus* 1 sp. 2

The whole plant is either glabrous or covered in various types of hairs. The dull red fruit is covered in prominent parallel ridges, and covered in dense short hairs (tomentose) and has spongy white flesh. This new taxon was found in undisturbed hill forest on a high ridge west of the fly camp at Site 2. It is known only from a single small population in dappled shade, on a steep slope under moist conditions with little leaf litter present. Potentially suitable intact hill forest habitat is widespread in the Middle Purari Hills and to a lesser extent the Southeast Hills ecological zones, however, at present this species is known only from the Era River catchment. The recorded specimens represent an estimated 50% of the world population. Other populations are known from the Aure River area. Status of CR at present.

Rubiaceae. *Genus* 1 sp. 3

This taxon grows up to a meter tall with large leaves that spread horizontally, with sessile fruit situated in the upper leaf axils. The flowers and fruit is similar to that of 'Rubiaceae *Genus* 1 sp. 1' but larger and the fruit more pointed. This taxon occurs in moist areas in alluvial forest at Sites 4 and 7 in the Delta Swamps and Plains ecological zone and at Site 9 in the Southeast Coast ecological zone. It was also recorded in hill forest at Sites 5, 6B and 6D in the Middle Purari Hills ecological zone and at Site 7 in the Southeast Hills. This taxon prefers to grow in dense shade in areas where the forest floor is fairly open and the layer of leaf litter is well developed. It also occurs occasionally on stream banks. Potentially suitable intact alluvial forest habitat occurs more widely in the Delta Swamps and Plains and Middle Purari Hills ecological zones, however, large areas have been intensively logged and at present the species is known only from the Purari River catchment. The recorded specimens represent an estimated 70% of the world population. Other populations are known from Mt. Pirora area. Status of EN at present.

4.7 Restricted-range species

4.7.1 New-to-science species known only from the study area

All 35 of the new-to-science taxa are currently known only from the study area (Section 4.6) and are therefore regarded as strong candidates for restricted-range status. Their known distribution, habitat preferences and relevant ecological traits (including dispersal modes) are outlined in Section 4.6.

4.7.2 Other restricted-range species recorded within the study area

Other species recorded in the Gulf Province that occur below 1,000 m asl were screened for restricted-range status based on the known distribution and habitat preferences.

Annonaceae. *Cyathocalyx lucidus*

Known only from the original collection from hill forest at Hewa near the Vailala River at 280 m asl in the Southeast Hills ecological zone. Potential distribution within the study area includes forested ridges in the Southeast Hills and Middle Purari Hills ecological zones. Birds and fruit bats are responsible for seed dispersal in *Cyathocalyx* (Wang & Saunders 2006).

Annonaceae. *Pseuduvaria filipes*

This is a rare species known from the Purari River catchment in the southwestern part of the Eastern Highlands Province and the Purari River area. It prefers to grow on the drier ridges in hill forest and is never common. Occurs at 50–350 m asl. Potential distribution within the study area includes ridges in the Middle Purari Hills and Southeast Hills ecological zones. The seed is likely to be distributed by birds. Five mature specimens were recorded in logged hill forest on ridges at Site 3 and 14 individuals at Site 7. Conservatively considering an expanded potential range of occurrence from the Kikori Basin east to the Kerema/Kukukuku lobe, the total area of potentially suitable habitat amounts to less than 15,000 km^2.

Apocynaceae. *Marsdenia venusta*

Known only from the type collection made near Ihu in the Gulf Province, growing at 40 m elevation in 'primary lowland rainforest' (Forster 1995). The precise vegetation type and locality are unknown, though it may have been collected from alluvial forest within the study area in the Southeast Coast ecological zone. Seed dispersal in the genus *Marsdenia* is by wind. Not recorded during the Project surveys, but potential distribution within the study area includes hill and/or alluvial forests along the Vailala River in the Southeast Coast and Southeast Hills ecological zones, and potentially in the Middle Purari Hills and on the Delta Swamps and Plains.

Clusiaceae. *Mammea grandifolia*

This IUCN Vulnerable species (Section 4.5.1) was known only from the lower Kikori basin in Gulf Province at 50-150 m elevation, from the type locality at Pinini Creek, 7 km from Middletown (Stevens 1995, 1997, 1998). Further collections were made during Project surveys (see Section 4.5.3). Nothing is known about the dispersal ecology of the genus and it is assumed to be the same as for the closely related genus *Garcinia* that is primarily distributed by birds. The total area of potentially suitable low elevation hill forest (below 500 m) and alluvial forest present within Gulf Province between the Kikori Basin and the Kukukuku lobe amounts to less than 15,000 km^2.

Gesneriaceae. *Cyrtandra externata*

This species is known only from the type gathering made in 1926 in an unspecified forest type in the area around Hohoro, located in the Southeast Coast ecological zone[3] close to the Vailala River at an elevation of 80 m (Moore 1929). Potential distribution within the study area includes alluvial and/or swamp forests in the Southeast Coast, Southeast Hills and Delta Swamps and Plains ecological zones. The seed of *Cyrtandra* is adapted to germinate in a permanently moist substrate (Cronk et al. 2005).

Myristicaceae. *Myristica brachypoda*

This IUCN Vulnerable species is known only from the type specimens collected in 1955 from a logging area ('A.P.C. Logging Area' on specimen data label) close to sea level near Middletown at the Seribi River, Kikori Basin, in the Gulf Province (De Wilde 1995). Its ecology is poorly known. Not recorded in the study area, but suitable habitat potentially includes hill, alluvial and/or swamp forest in all ecological zones except Mangroves. Birds and mammals disperse the seed of *Myristica*.

Phyllanthaceae. *Glochidion delticola*

This tree (18 m) is known only from the type collection that was made c. 24 km inland from the mouth of the eastern channel of the Purari River at 10 m elevation, and was growing in an alluvial-freshwater tidal forest ecotone in the Delta Swamps and Plains ecological zone (Airy Shaw 1974). Birds disperse the seed of *Glochidion* (Galetti 2002). Suitable habitat potentially includes alluvial and swamp forest in the Delta Swamps and Plains ecological zone.

Rubiaceae. Ixora whitei

A rare species known only from the area 'between Ihu and Vailala' at 10–15 m asl. It may potentially occur in forested areas of the Southeast Coast ecological zone, including alluvial and freshwater swamp forests along the Vailala River and in the Purari delta. Birds disperse the fleshy seed of *Ixora* (Fall et al. 2007). Most *Ixora* species occur as scattered individuals in the forest.

[3] Based on the Australian Army Map Service Kikori map sheet SB 55-13.

Rubiaceae. *Psychotria diplococca* var. *tauriensis*

Known localities are from Gulf Province at 10-200 m asl, at the junction of the Kapau and Tauri Rivers (between the Lakekamu and Purari basins), at 'Baimuru S. P.' and 'Kerenga S. P.' and the Vailala River (Sohmer 1988). Precise collecting localities are unknown but Baimuru and the Vailala River are located at the western and eastern boundaries of the southern study area respectively. This species is conservatively placed in these areas and is therefore considered to have been recorded within the study area (Delta Swamps and Plains, Southeast Hills and/or Southeast Coast ecological zones). The original collections were made from a range of forest types including mangroves and hill forest. Potential distribution within the study area includes hill, alluvial, swamp and mangrove forests in all ecological zones.

Rubiaceae. *Psychotria heterophylla*

Known only from the type collection made on 09 February 1926 near Ihu along the Vailala River in the Gulf Province, growing at 10 m elevation in mangrove forest (Sohmer 1988). The precise collecting locality is unknown but this species was probably collected in the Southeast Coast ecological zone within the study area. Its potential distribution within the study area includes alluvial, swamp and/or mangrove forests along the Vailala River and in the Purari Delta, in the Southeast Coast, Delta Swamps and Plains and Mangroves ecological zones, and potentially the Southeast Hills.

Rubiaceae. *Psychotria purariensis*

Known from several localities in Gulf Province only, which includes the Kikori basin 52 km west of Baimuru, in swamp forest subject to flooding, and within the study area in alluvial forest near Wabo and the Pide River. It occurs at elevations of 0-80 m asl (Sohmer 1988). Potential distribution within the study area includes freshwater swamps and alluvial forests in all ecological zones except the Mangroves.

4.8 Other notable finds

Annonaceae. *Friesodielsia bakeri*

The records from Sites 6D and 9 represents the first records for this species for the Gulf Province. Previously known only from two gatherings at Mt. Sibium in Oro Province.

Annonaceae. *Pseuduvaria beccarii*

This species was previously known from five localities in New Guinea (Su & Saunders 2006). The collection made at Site 2 represents the first record of this species for Papua New Guinea.

Apocynaceae. *Marsdenia argentata*

Distributed in Central, Morobe, West Sepik and Western Highlands Provinces. The specimen collected along Boa Creek in hill forest at Site 1 represents the first record of this species for Gulf Province and is the lowest elevation recorded for the species (90 m asl compared to 250-300 m asl) (Forster 1991).

Araceae. *Homalomena peekelii*

This species was previously known from the Kiunga area of Western Province. The records from Sites 8 and 9 represent the first records for Gulf Province making it a significant range extension for the species.

Arecaceae. *Calamus longipinna*

The records from Sites 2 and 9 in hill forest represent the first record for the Gulf Province. This species was previously known only from several localities from the Madang and Morobe Provinces.

Araliaceae. *Osmoxylon tetrandrum*

This species was previously known from the Solomon Islands. The collection made in hill forest in the hills near Site 4 is the first record of this species for Papua New Guinea.

Asparagaceae. *Cordyline minutiflora*

Previously known only from Indonesian New Guinea. The record from Site 5 represents the first record of this species for Papua New Guinea making it a significant range extension for the species.

Ebenaceae. *Diospyros pilosanthera*

This species was previously only known from a few localities in Morobe Province. The specimens collected in hill forest at Sites 3, 4 and 7 are the first records for Gulf Province.

Euphorbiaceae. *Codiaeum finisterrae*

Prior known localities for this species are all from West Sepik Province. The specimens from hill forest at sites 2, 5 and 7 and in alluvial forest at site 4 are therefore a new range extension for the species, and the first for south of the central cordillera.

Fabaceae. *Maniltoa megalocephala*

Previously known from the East Sepik and Madang Provinces (Hou 1996). The records from hill forest at Site 3 appears to be the first record of this species in Gulf Province and south of the central cordillera. Also, recorded from hill forest during the survey at Sites 6A, 7, 8 and 9.

Fabaceae. *Oxyrhynchus papuanus*

A rare species mostly restricted in distribution to New Ireland and Western Province. The new record from hill forest at Sites 2, 5, 6B and 6D represents a notable range extension.

Gesneriaceae. *Cyrtandra filibracteata*

A rare species restricted to the Solomon Islands and Bougainville. The collection made in alluvial forest at Site 5 represents the first record of this species for mainland Papua New Guinea.

Lauraceae. *Cryptocarya idenburgensis*

A species that is common in Indonesian New Guinea with a few records from Papua New Guinea in Madang Province. The record from hill forest at Site 1 is a first, both for the Gulf Province and south of the central cordillera.

Melastomataceae. *Memecylon amplexicaule*

A species that commonly occurs in Peninsular Malaysia. It is likely that the records from hill forest at Sites 3, 4, 6D and 7 are the first records for New Guinea.

Myristicaceae. *Myristica cylindrocarpa*

The collection of this species made at Site 5 is the first record for Gulf Province, otherwise it is only known from Madang Province (De Wilde 2000).

Orchidaceae. *Agrostophyllum parviflorum*

The record of this low level epiphytic orchid from hill forest at Sites 1 and 5 is the first collection of this species for Gulf Province. It is also known from East Sepik, Morobe and Western Provinces.

Orchidaceae. *Brachypeza indusiata*

This small epiphytic orchid has a wide distribution and is known from Peninsular Malaysia, Sumatra, Borneo, and Sulawesi to Indonesian New Guinea. The single specimen recorded from Site 5 represents the first record for Papua New Guinea.

Orchidaceae. *Cadetia lucida*

The record from hill forest of this small low level epiphytic orchid at Site 1 is the first record for Gulf Province otherwise it is only known from two collections, one from the Morobe Province and the other from Madang Province.

Orchidaceae. *Calymmanthera montana*

The specimens of this low level epiphytic orchid collected in alluvial forest at Sites 4 and 5 are the first records for the Gulf Province also the lowest elevation recorded for the species (76 m). Other records are from Madang and Enga Provinces, all above 600 m elevation.

Orchidaceae. *Dendrobium ingratum*

This low level epiphytic orchid with erect stems occurs in Madang, Morobe and Central Provinces making the specimens collected in Open alluvial forest at Sites 4 and 5 the first records for Gulf Province.

Orchidaceae. *Oberonia bifida*

The specimen of this small high level epiphytic orchid collected along the unnamed stream in hill forest at Site 2 represents the first record of this species for Gulf Province. Other records are from Central Province.

Orchidaceae. *Oberonia oblonga*

The specimens of this small high level epiphytic orchid collected in hill forest along Boa Creek at Site 1 and along a small stream at Site 2 represent the first records of this species for Gulf Province. It is also known from Oro and Southern Highlands Provinces.

Orchidaceae. *Pseuderia floribunda*

The record of this large medium level epiphytic orchid from hill forest at Site 4 represents the first record of this species for Gulf Province. It is also known from Oro Province.

Orchidaceae. *Spathoglottis papuana*

The specimens of this terrestrial orchid recorded in hill forest at Sites 1, 3, 6A and 6D represent the first records for Gulf Province. Otherwise it is known from the Eastern Highlands, Morobe, Southern Highlands and Western Province.

Orchidaceae. *Tropidia acuminata*

This small terrestrial orchid is known from two widely different areas, one from the Vogelkop Peninsula of West Papua, and the other from the southern end of Morobe Province. The records from alluvial forest at Sites 7 and 9 are the first records for Gulf Province.

Pandanaceae. *Benstonea odoardii*

The specimens of this small pandan from hill forest at Sites 1, 5 and 7 represent the first records for Gulf Province. It is also known from Palmer River in Western Province.

Primulaceae. *Myrsine warrae*

Known only from the Kamiali WMA in Morobe Province. The collections from hill forest at Sites 1, 2 and 6B are a range extension for the species and the first record for Gulf Province.

Proteaceae. *Helicia saruwagedica*

This rare species is known from Morobe, Eastern Highlands and Western Highlands Provinces at elevations of 1,200–2,700 m asl (Foreman 1995). The collection made in alluvial forest at Site 4 was the first record for Gulf Province and was made at a much lower elevation of 90 m asl.

Pteridaceae. *Vittaria ledermannii*

This rare species is known from the Kwagira River area in Milne Bay Province. The records from hill forest at Sites 2, 4, and 7 are the first records of the species for Gulf Province.

Rubiaceae. *Ixora dolichothyrsa*

This species was known previously only from north of the Cordillera in East Sepik and Madang. The collection made in hill forest at Site 4 is the first record for Gulf Province and the first known locality south of the central cordillera.

Rubiaceae. Ixora ysabellae

This species is widespread in the Solomon Islands. The specimens collected in hill forest at Sites 2, 4, 7 and 8 are the first records of this species for Papua New Guinea.

Rubiaceae. *Psychotria pseudomaschalodesme*

Previously known only from a small area in West Sepik Province. The collection made in hill forest at Site 7 is a large extension of its distribution but is also the first record south of the cordillera and for the Gulf Province.

Zingiberaceae. *Riedelia subulocalyx*

Previously known from the Southern Highlands Province and from New Britain. The records from hill forest at Sites 7 and 8 and in alluvial forest at Site 9 are the first records for Gulf Province.

4.9 Important habitats and landscape features for plant conservation

4.9.1 Riparian zone

Riparian forests are forests growing adjacent to a stream or river between the low and high water marks, and above the high water where the vegetation may be influenced by elevated water tables or flooding (Naiman & Decamps 1997). Collectively these sites are known as the riparian zone. The riparian zone usually comprises a narrow band of forest on the stream or riverbank with species that have adaptations to periodic inundation and play a crucial role as a corridor for the movement of flora (Molles 2008). However, Open forest (Po) is also included in this definition since it is subject to periodic inundation.

The typically narrow band of riparian vegetation that occurs across forested landscapes plays a crucial role as a corridor for the movement of flora (Molles 2008), which includes the banks of larger rivers and streams and the steep banks of the smaller streams that typically dissect hill forest, which are equally important. A number of plant species are restricted to this habitat. The high number of plant species closely associated or in some cases restricted to this habitat, and the fact that these areas are not resilient to disturbance makes them ecologically sensitive.

Many of the plant species of the riparian zone are well adapted to cope with flooding, sediment deposition, physical abrasion and stem breakage (Malansson 1993). For example, some of the plants display hydrochary, seed dispersal by water (Nilsson et al. 2010), with seed and fruit commonly being

washed downstream. Consequently, plant communities downstream tend to be more speciose because of the germination of seeds transported from upstream (Malanson 1993; Johansson et al. 1996). Moreover, one particular riparian habitat, Open alluvial forest (Po) is floristically and structurally very rich (Paijmans 1976) with a high number of endemics that are adapted to periods of inundation (Chapter 4.9.4.).

Plants restricted to the riparian zone include the fern Phlegmariurus brassii, the monocots Bulbophyllum digoelense, B. fractiflexum, Oberonia falcata and the dicots Diospyros pilosanthera, Medinilla sp. 1 and Phyllanthus rheophilus. The Near Threatened (NT) IUCN conservation listed species Aglaia euryanthera and Myristica globosa occurred in the riparian forest but they also occur in other forest types.

4.9.2 Smaller stream banks

Small streams draining from the forest normally have steep banks that are mostly vegetated by ferns, herbaceous plants and shrubs. These areas are distinguished from the riparian zones of larger rivers (Section 4.9.1) as they are not subject to regular flooding. The steep stream-bank vegetation tends to be more open except where fallen branches create gaps in the canopy, resulting in more light penetrating the canopy and encouraging denser growth. Many of the plant species growing on these stream banks are dispersed either up or downstream by birds and animals, and tend to be restricted to the stream banks. Seeds of these plants may be dispersed into the wider forested environment but will not germinate there. The species will only germinate and survive in the streambank environment. Plants that commonly occur in this habitat include various ferns, *Begonia* spp., *Cyrtandra* spp., and various Araceae (Arum Family) and Zingiberaceae (Gingers). Several new-to-science species (*Begonia* sp. 2, *Begonia* sp. 5, *Cyrtandra* sp. 1, *Cyrtandra* sp. 3 and *Glochidion* sp. 1) were recorded in and may be restricted to this habitat. The high number of plant species closely associated with or in some cases restricted to this habitat, and the fact that these areas are not resilient to disturbance makes them ecologically sensitive.

4.9.3 Alluvial forest

Alluvial forests all over the world but especially in the Indo-Pacific region are under pressure from commercial logging (Wikramanayake et al. 2002). Many areas that support alluvial forests in Papua New Guinea have been logged or are in the process of being logged. Several commercial timber species (*Alstonia scholaris*, *Anisoptera thurifera*, *Buchanania macrocarpa*, *Calophyllum papuanum*, *Campnosperma brevipetiolatum, Dillenia papuana*, *Elaeocarpus culminicola* etc.) occur in alluvial forest at Sites 4, 5, 6B and 9 making these areas a possible target for logging.

Several IUCN listed species (10 spp.) were recorded in this vegetation type: Diospyros lolinopsis - CR, D. insularis - EN, Intsia bijuga - VU, Mammea grandifolia - VU, Pterocarpus indicus - VU, Aglaia euryanthera - NT, Cycas scratchleyana - NT, Myristica globosa - NT, Aglaia cucullata - DD and Mammea novoguineensis - DD with Aglaia erianthera, Cycas scratchleyana and Pterocarpus indicus as common elements of the alluvial forest. Several plant species new-to-science that also qualify as restricted-range species (14 spp.) were recorded in alluvial forest: Barringtonia sp. 2, Begonia sp. 1, Cyrtandra sp. 2, Genus 1 sp. 1, Genus 1 sp. 3, Ixora sp. 1, Ixora sp. 3, Maschalodesme sp. 1, Oberonia sp. 1 and Syzygium sp. 1, Syzygium sp. 2, Syzygium sp. 3, Syzygium sp. 4 and Syzygium sp. 5. This forest is also the habitat of Mammea grandifolia a restricted-range species.

4.10 Knowledge gaps

4.10.1 Phenological limitations

Phenology in tropical rainforests conforms less to climatic rhythms of the habitat than forests in temperate and sub-tropical climates (Daubenmire 1968; Willmer 2011). The only areas where there were a high number of plants in flower or in fruit were on the upper ridges of the hills with very few in flower/fruit in the low-lying areas, especially along the rivers and larger streams. The area around Sites 4 and 7 in the alluvial forest produced the highest number of flowering/fruiting material.

No seasonal differences were observed in the phenology of the plant taxa in the study area. Fruiting/flowering phenology is complex in the lowlands of Papua New Guinea and appears unpredictable. Moreover, the data is insufficient to provide a detailed analysis of the phenology of the plant taxa within study area which would require repeat assessment over several years to obtain a good understanding.

4.10.2 Taxonomic uncertainties

The taxonomic status of several plant genera present in the survey area is uncertain. The taxonomic revisions of many Papua New Guinea genera are older than 10 years with some being older than 50 years. In the meantime, many new and undescribed species have been recorded in these genera making it difficult to assign specific names to specimens. Examples are the genera *Spathoglottis* with at least six undescribed taxa (last revision 1986), *Syzygium* with at least 70 new and undescribed species (last nominal revision for Papua New Guinea 1973), and *Apostasia* with at least 10 undescribed species (last revision 1969). Due to this situation, a number of specimens of the genera *Alpinia*, *Cyrtandra*, *Etlingera*, *Hoya, Liparis*, *Maschalodesme*, *Memecylon* and *Syzygium* collected during this survey must await taxonomic revisions before names can be affixed to them.

4.10.3 Status and distribution of new-to science and unnamed taxa

There is insufficent information available to estimate broader status and distribution of new-to-science and unnamed taxa. The information required to underpin threatened status is rarely available in this context, given the paucity of knowledge of rare plant distributions in New Guinea and for example the high frequency with which large range extensions, regularly in the order of >1,000 km, are recorded. Consequently new-to science and unnamed taxa are more likely to be Data Deficient than Threatened.

5 Conservation value of the study area and its flora

Except for the areas subject to anthropogenic disturbance, most of the forest is still in a good and balanced ecological condition with high conservation values. The high number of new and undescribed flora taxa, restricted-range species, and the high number of IUCN listed species is indicative of this.

Other important points include:

- There were several new species recorded from the banks of streams in the study area (*Begonia* sp. 5, *Cyrtandra* sp. 3 and *Glochidion* sp. 1). The vegetation along streams in the forest is particularly sensitive to disturbance.
- The hills around Sites 1, 2, 4, 5 and 6B are still to a large degree undisturbed.
- The alluvial forest around Sites 4 and 5 and the tall alluvial forest at Site 9 are still in a relatively undisturbed condition apart from minor disturbance from a few gardens (Site 9), seismic lines and helipad construction (Sites 4 and 5).

6 Conclusion

The flora study has achieved all of the baseline objective as follows:

- Collating and assessing existing information relevant to plant communities in the vicinity of the study area.
- The survey of the plant communities present in the study area.
- The description and discussion of the composition, condition and conservation significance of plant communities present within the study area, including:
  - Description of the floristic and structural characteristics of major vegetation types present in surveyed areas.
  - Assessment of the presence and status of species of conservation significance recorded or potentially present.
  - Assessment of habitats and other landscape features important to plant communities.
  - A summary of the knowledge gaps in relation to plant communities present within the study area.

The key finding of the study are:

- The study area supports important major habitats (landscape level vegetation communities) which include hill forest and alluvial forest. Within these major habitats other important habitats are present, including riparian zones in hill forest and alluvial forest, Open alluvial forest (Po) in alluvial forest, and small streams in hill forest.
- The study area supports areas of alluvial forest in relatively good condition at Sites 4, 5 and 9, although more disturbed at Site 9. Alluvial forest is typically some of the first forest to be impacted by logging and conversion to food gardens where accessible, throughout Papua New Guinea. Consequently, this forest habitat is a conservation priority.
- The vegetation communities of the study area have high conservation values apart from where heavily disturbed. These conservation values include:
  - A substantial number of endemic plant species indicating the uniqueness of the Papua New Guinea flora.
  - A high orchid species diversity which was highest in the riparian forest and on the hill ridges.
  - A high number of new species to science indicating the floristic richness of the study area.

The investigations undertaken have provided a baseline on which the Papua LNG environmental impact assessment can be completed.

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Appendix 1

List of vascular plants recorded during the survey

List of vascular plant species recorded during the survey are indicated by the symbol 'X'. IUCN indicates those species listed as threatened (Critically Endangered – “CR”, Endangered – “EN”, Vulnerable – “VU”), Near Threatened (“NT”) or Data Deficient (“DD”) by the IUCN. Species not listed with an IUCN category are either Not Evaluated or Least Concern. CITES indicates species listed under CITES Appendix II whose trade must be controlled to avoid utilization incompatible with their survival (e.g. all orchids). Species are arranged according to their belonging to one of four major plant groups: ferns and lycophytes, gymnosperms (conifers and cycads), monocots (monocotyledonous flowering plants – including grasses, sedges, palms and orchids) and dicots (dicotyledonous flowering plants – all other flowering taxa).

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
FERNS & LYCOPODS																
1	Adiantaceae	Adiantum diaphanum							X	X			X			
2	Adiantaceae	Adiantum caudatum							X							
3	Aspleniaceae	Asplenium acrobryum			X			X	X		X			X		
4	Aspleniaceae	Asplenium amboinense						X	X	X			X	X		
5	Aspleniaceae	Asplenium bipinnatifidum				X			X	X	X		X			
6	Aspleniaceae	Asplenium laserpitifolium														X
7	Aspleniaceae	Asplenium marattoides											X			X
8	Aspleniaceae	Asplenium nidus			X	X	X	X	X	X	X	X	X	X		X
9	Aspleniaceae	Asplenium sancti-christophori											X			
10	Aspleniaceae	Asplenium scolopendropsis						X	X		X	X	X	X		X
11	Athyriaceae	Diplazium cordifolium			X			X								
12	Athyriaceae	Diplazium esculentum			X		X	X	X				X			
13	Athyriaceae	Diplazium silvaticum							X							
14	Blechnaceae	Blechnum orientale											X			
15	Blechnaceae	Blechnum vittatum			X											

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
16	Blechnaceae	Stenochlaena palustris				X	X	X	X		X	X	X	X	X	X
17	Cyatheaceae	Cyathea brackenridgei		II										X		
18	Cyatheaceae	Cyathea contaminans		II			X	X	X	X	X	X	X			
19	Cyatheaceae	Gymnosphaera hornei		II				X	X		X					
20	Davalliaceae	Davallia epiphylla							X				X			X
21	Davalliaceae	Leucostegia pallida														X
22	Dryopteridaceae	Bolbitis quoyana						X		X		X				X
23	Dryopteridaceae	Bolbitis rivularis						X	X		X		X			
24	Dryopteridaceae	Ctenitis hypolepioides			X		X		X	X			X	X		X
25	Dryopteridaceae	Lomagramma articulata							X				X			
26	Dryopteridaceae	Lomagramma guianensis												X		
27	Dryopteridaceae	Lomagramma sinuata			X	X		X	X	X						
28	Dipteridaceae	Dipteris conjugata			X											
29	Gleicheniaceae	Dicranopteris linearis			X	X					X					
30	Hymenophyllaceae	Abrodyctium obscurum							X				X			
31	Hymenophyllaceae	Cephalomanes atrovirens						X	X				X			
32	Hymenophyllaceae	Cephalomanes obscurum			X											
33	Hymenophyllaceae	Crepidomanes aphlebioides			X				X		X	X	X			
34	Lindsaeaceae	Lindsaea obtusa			X				X							
35	Lindsaeaceae	Odontoloma tenuifolium			X											
36	Lomariopsidaceae	Lomariopsis intermedia							X							X
37	Lycopodiaceae	Phlegmariurus carinatus												X		
38	Lycopodiaceae	Lycopodium clavatum														X
39	Lycopodiaceae	Phlegmariurus brassii				X										
40	Lycopodiaceae	Phlegmariurus nummulariifolius												X		

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
41	Lycopodiaceae	Phlegmariurus squarrosus			X	X		X	X			X		X		
42	Lycopodiaceae	Lycopodium clavatum			X					X						
43	Lycopodiaceae	Pseudodiphasium volubile			X		X	X	X	X	X	X	X	X		X
44	Lygodiaceae	Lygodium circinatum			X	X		X	X	X		X	X			X
45	Lygodiaceae	Lygodium microphyllum								X			X	X		X
46	Lygodiaceae	Lygodium trifurcatum							X		X		X			
47	Marattiaceae	Angiopteris evecta			X	X		X	X	X	X	X	X	X		X
48	Nephrolepidaceae	Nephrolepis hirsutula														X
49	Nephrolepidaceae	Nephrolepis lauterbachii			X	X	X	X	X		X	X	X	X		X
50	Nephrolepidaceae	Nephrolepis obtusifolia			X					X						
51	Ophioglossaceae	Helminthostachys zeylanica												X		
52	Ophioglossaceae	Ophioglossum pendulum					X						X			X
53	Polypodiaceae	Antrophyum alatum							X	X	X		X	X		
54	Polypodiaceae	Drynaria sparsisora			X	X	X	X	X	X	X	X	X	X	X	X
55	Polypodiaceae	Lecanopteris sinuosa											X	X		X
56	Polypodiaceae	Microsorum commutatum			X			X								
57	Polypodiaceae	Microsorum linguiforme					X	X	X	X	X	X				
58	Polypodiaceae	Microsorum punctatum							X							
59	Polypodiaceae	Microsorum rampans							X							
60	Psilotaceae	Psilotum nudum			X	X			X			X	X			
61	Pteridaceae	Acrostichum aureum											X			
62	Pteridaceae	Acrostichum speciosum												X	X	X
63	Pteridaceae	Taenitis blechnoides			X		X	X		X						
64	Pteridaceae	Vittaria ledermannii				X		X					X			
65	Pteridaceae	Vittaria elongata				X										

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
66	Schizaeaceae	Schizaea dichotoma				X			X				X			X
67	Selaginellaceae	Selaginella anceps			X	X		X	X							
68	Selaginellaceae	Selaginella velutina			X	X			X	X	X		X	X		X
69	Tectariaceae	Aspnidium preslianum			X											
70	Tectariaceae	Pleocnemia cumingiana									X		X			
71	Tectraiaceae	Pleocnemia dimidiolobata			X	X										
72	Tectraiaceae	Pleocnemia irregularis											X	X		
73	Tectariaceae	Tectaria decurrens			X					X	X					
74	Tectariaceae	Tectaria menyanthidis						X								
75	Thelypteridaceae	Christella dentata								X						
76	Thelypteridaceae	Pneumatopteris costata			X											X
77	Thelypteridaceae	Sphaerostephanos adenostegius							X							
78	Thelypteridaceae	Sphaerostephanos unitus			X	X				X		X	X			X
CONIFERS																
79	Cycadaceae	Cycas scratchleyana	NT	II	X	X	X	X	X	X	X	X	X			
80	Gnetaceae	Gnetum gnemon var. gnemon			X	X	X	X	X	X	X	X	X	X		X
81	Gnetaceae	Gnetum latifolium						X	X				X	X		
82	Podocarpaceae	Nagaia wallacianus			X			X								X
83	Podocarpaceae	Podocarpus neriifolius		III	X	X		X	X							
MONOCOTS																
84	Amaryllidaceae	Crinum asiaticum var. asiaticum				X			X		X		X	X		X
85	Araceae	Aglaonema marantifolium					X	X					X	X		
86	Araceae	Alocasia aequiloba							X		X	X	X	X		X
87	Araceae	Alocasia hollrungii					X							X		

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
88	Araceae	Alocasia lancifolia			X		X	X	X				X	X		X
89	Araceae	Alocasia lauterbachiana			X			X	X		X			X		
90	Araceae	Alocasia macrorrhiza														X
91	Araceae	Amorphophallus galbra					X	X	X	X			X	X		X
92	Araceae	Amydrium magnificum				X	X	X	X	X	X			X		X
93	Araceae	Cyrtosperma cuspidatum							X			X		X		X
94	Araceae	Cyrtosperma macrotum							X					X		
95	Araceae	Epipremnum aureum					X	X								
96	Araceae	Epipremnum papuanum			X	X	X	X	X	X	X	X	X	X		X
97	Araceae	Epipremnum pinnatum			X	X	X	X	X	X	X	X	X	X		X
98	Araceae	Holochlamys beccarii			X	X	X	X	X		X	X	X	X		X
99	Araceae	Homalomena cordata			X	X	X	X	X	X	X	X	X	X		X
100	Araceae	Homalomena peekelii												X		X
101	Araceae	Homalomena schlechteri			X	X		X	X		X		X			X
102	Araceae	Pothos hellwigii					X	X	X	X	X	X	X			X
103	Araceae	Pothos papuanus			X	X		X		X						
104	Araceae	Pothos tener												X		X
105	Araceae	Rhaphidophora latevaginatum							X				X			
106	Araceae	Rhaphidophora pachyphylla						X	X	X		X	X			X
107	Araceae	Schismatoglottis calyptrata							X	X			X	X		X
108	Arecaceae	Actinorhytis calapparia												X		X
109	Arecaceae	Areca catechu												X		X
110	Arecaceae	Areca macrocalyx			X	X	X	X		X	X	X	X	X		X
111	Arecaceae	Arenga microcarpa			X	X	X	X	X	X	X	X	X	X		X
112	Arecaceae	Arenga pinnata					X	X		X	X	X	X			X

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
113	Arecaceae	Brassiophoenix schumannii						X	X				X			X
114	Arecaceae	Calamus aruensis			X	X	X		X	X			X	X		X
115	Arecaceae	Calamus distentus			X		X	X	X	X	X	X	X			X
116	Arecaceae	Calamus fertilis						X	X	X			X			X
117	Arecaceae	Calamus heteracanthus			X	X					X		X			
118	Arecaceae	Calamus humboldtianus			X	X		X	X	X			X			X
119	Arecaceae	Calamus longipinna				X										X
120	Arecaceae	Calamus pinnatifida											X			
121	Arecaceae	Calamus vitiensis							X	X			X	X		
122	Arecaceae	Calamus warburgii				X		X	X		X					
123	Arecaceae	Calamus zieckii					X						X			
124	Arecaceae	Calyptrocalyx albertisianus				X		X	X	X						
125	Arecaceae	Caryota rumphiana			X	X	X	X	X		X	X	X	X		X
126	Arecaceae	Cocos nucifera									X			X		X
127	Arecaceae	Gronophyllum rhopalocarpum								X						
128	Arecaceae	Heterospathe elegans				X										
129	Arecaceae	Hydriastele costata			X	X	X	X	X	X	X		X	X		X
130	Arecaceae	Hydriastele rhopalocarpa			X	X				X			X			X
131	Arecaceae	Korthalsia zippelii			X	X	X	X	X	X	X	X	X	X		X
132	Arecaceae	Licuala lauterbachii			X	X	X	X	X	X	X	X	X	X		X
133	Arecaceae	Licuala montana				X										
134	Arecaceae	*Licuala* sp. Camp 5							X		X		X	X		X
135	Arecaceae	Livistona chocolatina							X							
136	Arecaceae	Livistona sp. 1	NE					X	X		X	X				
137	Arecaceae	Metroxylon sagu							X		X		X	X		X

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
138	Arecaceae	Metroxylon warburgii					X		X			X	X			
139	Arecaceae	Nypa fruticans												X	X	X
140	Arecaceae	Orania archboldiana			X	X	X					X	X	X		
141	Arecaceae	Orania lauterbachiana				X		X	X		X			X		X
142	Asparagaceae	Dracaena angustifolia #30#			X	X		X	X	X	X	X	X	X		X
143	Asparagaceae	Cordyline canniifolia			X			X	X							
144	Asparagaceae	Cordyline fruticosa			X	X	X	X	X	X	X	X	X	X		X
145	Asparagaceae	Cordyline minutiflora							X							
146	Commelinaceae	Amischotolype hispida					X		X				X			
147	Commelinaceae	Floscopa scandens														X
148	Commelinaceae	Pollia thyrsiflora			X		X	X	X	X		X	X			
149	Costaceae	Costus potierae											X	X		X
150	Costaceae	Tapeinochilos ananassae			X	X	X		X		X		X	X		X
151	Costaceae	Tapeinochilos pubescens			X	X		X					X	X		X
152	Cyperaceae	Cyperus digitatus												X		X
153	Cyperaceae	Gahnia javanica												X		
154	Cyperaceae	Mapania cuspidata			X			X	X	X						
155	Cyperaceae	Mapania macrocephala				X			X				X	X		X
156	Cyperaceae	Scleria polycarpha												X		X
157	Dioscoreaceae	Dioscorea nummularia					X						X			X
158	Flagellariaceae	Flagellaria indica var. bifurcata						X					X			
159	Flagellariaceae	Flagellaria indica var. indica			X	X	X	X	X	X	X	X	X	X		X
160	Flagellariaceae	Flagellaria gigantea							X				X	X		X
161	Hanguanaceae	Hanguana malayana							X	X			X	X		
162	Heliconiaceae	Heliconia papuana			X		X							X		

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
163	Hypoxidaceae	Molineria capitulata			X			X	X	X		X	X	X		X
164	Marantaceae	Cominsia gigantea					X	X	X				X			X
165	Marantaceae	Donax canniformis			X	X	X	X	X	X	X	X	X	X		X
166	Marantaceae	Phrynium macrocephalum			X	X	X	X	X	X			X			X
167	Marantaceae	Phrynium pedunculatum			X		X	X	X	X	X		X	X		X
168	Orchidaceae	Acanthephippium splendidum		II	X											
169	Orchidaceae	Agrostophyllum elongatum		II	X			X								
170	Orchidaceae	Agrostophyllum cf. parviflorum		II	X				X							
171	Orchidaceae	Appendicula reflexa var. reflexa		II	X	X		X	X	X	X					
172	Orchidaceae	Brachypeza indusiata		II					X							
173	Orchidaceae	Bulbophyllum cf. absconditum		II	X	X										
174	Orchidaceae	Bulbophyllum digolense		II	X			X								
175	Orchidaceae	Bulbophyllum fractiflexum		II	X											
176	Orchidaceae	Bulbophyllum nasica		II				X								
177	Orchidaceae	Bulbophyllum quadrangulare		II		X										
178	Orchidaceae	Bulbophyllum sp. 1	NE	II				X								
179	Orchidaceae	Bulbophyllum sp. 2	NE	II											X	
180	Orchidaceae	Cadetia chionantha		II			X	X								X
181	Orchidaceae	Cadetia lucida		II	X											
182	Orchidaceae	Calanthe triplicata		II	X	X										
183	Orchidaceae	Calymmanthera montana		II				X	X							
184	Orchidaceae	Ceratostylis sp.		II	X						X					
185	Orchidaceae	Coelogyne asperata		II	X	X	X	X	X	X	X		X			
186	Orchidaceae	Coelogyne beccarii		II					X							
187	Orchidaceae	Corymborkis veratrifolia		II	X	X	X	X	X	X	X	X	X	X		X

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
188	Orchidaceae	Crepidium cupuliflorum #60#		II	X											
189	Orchidaceae	Crepidium lowii		II	X					X		X				
190	Orchidaceae	Cymbidium ensifolium		II				X								X
191	Orchidaceae	Dendrobium antennatum		II												X
192	Orchidaceae	Dendrobium bifalce		II						X				X		X
193	Orchidaceae	Dendrobium ingratum		II				X	X							
194	Orchidaceae	Dendrobium lawesii		II		X										
195	Orchidaceae	Dendrobium macfarlanei		II										X		
196	Orchidaceae	Dendrobium nitidissimum		II				X								
197	Orchidaceae	Dendrobium rumphiae		II	X											
198	Orchidaceae	Dendrobium spectabile		II						X				X		X
199	Orchidaceae	Dendrochilum graminifolium		II										X		
200	Orchidaceae	Dipodium scandens		II	X			X	X				X			X
201	Orchidaceae	Eurycentrum sp.		II								X				
202	Orchidaceae	Glomera hamadryas		II		X										
203	Orchidaceae	Liparis condylobulbon		II	X				X	X				X		X
204	Orchidaceae	Macodes sanderiana		II	X	X						X				
205	Orchidaceae	Microptera fasciculata		II	X											
206	Orchidaceae	Oberonia bifida		II		X										
207	Orchidaceae	Oberonia falcata		II		X										
208	Orchidaceae	Oberonia oblonga		II	X	X										
209	Orchidaceae	Oberonia sp. 1	NE	II				X								
210	Orchidaceae	Peristylus tradescantiifolius		II	X			X	X							
211	Orchidaceae	Plocoglottis lowii		II				X								
212	Orchidaceae	Plocoglottis moluccana		II	X	X		X	X							

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
213	Orchidaceae	Podochilus scalpelliformis		II				X	X		X					
214	Orchidaceae	Pseuderia floribunda		II				X								
215	Orchidaceae	Pseuderia frutex		II	X											
216	Orchidaceae	Spathoglottis papuana		II	X		X			X		X				X
217	Orchidaceae	Taeniophyllum sp.		II					X				X			
218	Orchidaceae	Tropidia acuminata		II									X			X
219	Orchidaceae	Tropidia disticha		II	X	X	X	X	X	X	X	X	X			X
220	Orchidaceae	Vanilla sp.		II										X		
221	Pandanaceae	Benstonea odoardii			X				X				X			
222	Pandanaceae	Benstonea lauterbachii						X	X	X	X	X	X	X		
223	Pandanaceae	Freycinetia angustissima			X	X		X	X	X	X	X	X	X		X
224	Pandanaceae	Freycinetia archboldiana							X				X	X		X
225	Pandanaceae	Freycinetia beccarii														X
226	Pandanaceae	Freycinetia decipiens			X		X	X	X				X			X
227	Pandanaceae	Freycinetia divaricata			X			X	X			X				
228	Pandanaceae	Freycinetia filiformis			X	X	X			X	X					
229	Pandanaceae	Freycinetia linearis			X								X			
230	Pandanaceae	Pandanus hollrungii														X
231	Pandanaceae	Pandanus tectorius			X	X	X	X	X	X	X					X
232	Pandanaceae	Pandanus sp.														X
233	Poaceae	Bambusa riparia				X		X	X	X	X	X	X			X
234	Poaceae	Imperata conferta					X			X				X		X
235	Poaceae	Leptaspis urceolata					X				X		X	X		X
236	Poaceae	Oplismenus compositus														X
237	Poaceae	Oplismenus deflexa								X	X		X	X		X

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
238	Poaceae	Paspalum conjugatum								X			X	X		X
239	Poaceae	Saccharum spontaneum					X			X			X	X		
240	Smilacaceae	Smilax calophylla			X			X	X	X		X	X	X		X
241	Taccaceae	Tacca leontopetaloides														X
242	Triuridaceae	Sciaphila secundiflora			X	X										
243	Xanthorrhoeaceae	Dianella ensifolia			X	X	X	X	X		X	X	X			X
244	Zingiberaceae	Alpinia kiungensis			X		X	X	X		X					
245	Zingiberaceae	Alpinia longifolia					X	X	X	X			X			
246	Zingiberaceae	Alpinia pulchra			X	X				X				X		
247	Zingiberaceae	Amomum aculeatum			X	X	X		X				X	X		X
248	Zingiberaceae	Curcuma longa			X	X								X		X
249	Zingiberaceae	Hornstedtia scottiana			X	X	X	X	X	X	X	X	X	X		X
250	Zingiberaceae	Pleuranthodium floribundum			X	X										
251	Zingiberaceae	Pleuranthodium tephrochlamys				X	X				X		X			
252	Zingiberaceae	Riedelia corallina			X	X	X	X	X	X	X	X	X	X		X
253	Zingiberaceae	Riedelia geluensis				X	X	X	X							X
254	Zingiberaceae	Riedelia grandiligula			X	X	X	X	X		X			X		X
255	Zingiberaceae	Riedelia longifolia					X	X								
256	Zingiberaceae	Riedelia subulocalyx											X	X		X
DICOTS																
257	Acanthaceae	Acanthus ebracteatus												X	X	X
258	Acanthaceae	Avicennia marina													X	
259	Acanthaceae	Calycanthus magnusianus														X
260	Acanthaceae	Hemigraphis repens			X	X		X	X				X			
261	Acanthaceae	Justicia zollingeriana			X											

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
262	Acanthaceae	Lepidigathis royeni				X							X			
263	Acanthaceae	Ptyssiglottis cyrtandroides														X
264	Achariaceae	Erythrospermum candidum										X				
265	Achariaceae	Pangium edule						X	X	X		X	X	X		
266	Achariaceae	Ryparosa maculata			X	X	X		X							
267	Actinidiaceae	Saurauia conferta			X	X	X									
268	Actinidiaceae	Sauruaia congestiflora			X		X			X						
269	Actinidiaceae	Saurauia novoguineensis			X	X		X	X	X	X					
270	Actinidiaceae	Saurauia oligophlebia			X	X		X	X			X	X	X		X
271	Actinidiaceae	Saurauia pleurolocularis					X									
272	Actinidiaceae	Saurauia purgans							X		X	X				
273	Anacardiaceae	Buchanania macrocarpa							X		X	X				
274	Anacardiaceae	Buchanania merrillii							X							
275	Anacardiaceae	Campnosperma brevipetiolatum			X	X		X	X	X	X					
276	Anacardiaceae	Campnosperma montana			X							X				
277	Anacardiaceae	Dracontomelon dao				X	X	X	X	X	X	X	X	X		X
278	Anacardiaceae	Euroschinus papuanus			X											
279	Anacardiaceae	Mangifera minor												X		X
280	Anacardiaceae	Rhus taitensis						X	X			X	X			
281	Anacardiaceae	Semecarpus cassuvium			X	X		X								
282	Anacardiaceae	Semecarpus forstenii			X											
283	Anacardiaceae	Semecarpus magnifica			X			X	X				X			X
284	Anacardiaceae	Semecarpus papuana				X		X								
285	Anacardiaceae	Semecarpus rostrata					X		X							
286	Anacardiaceae	Semecarpus undulatus			X	X	X	X	X	X	X	X	X	X		X

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
287	Anacardiaceae	Spondias dulcis												X		X
288	Annonaceae	Cananga odorata			X	X	X		X	X	X		X	X		X
289	Annonaceae	Cyathocalyx polycarpa							X		X					
290	Annonaceae	Friesodielsia bakeri										X				X
291	Annonaceae	Goniothalamus amplifolius			X	X										
292	Annonaceae	Goniothalamus aruensis						X	X				X	X		
293	Annonaceae	Goniothalamus grandiflorus			X	X	X	X	X							X
294	Annonaceae	Goniothalamus imbricatus			X	X	X	X	X	X	X		X			
295	Annonaceae	Haplostichanthus longirostris			X	X	X	X	X	X			X			
296	Annonaceae	Meiogyne cylindrocarpa				X		X								
297	Annonaceae	Orophaea sp. 1				X					X					
298	Annonaceae	Papualthia auriculata				X										
299	Annonaceae	Petalolophus megalopus														X
300	Annonaceae	Polyalthia glauca							X							
301	Annonaceae	Polyalthia oblongifolia			X	X										X
302	Annonaceae	Polyalthia rumphii			X											
303	Annonaceae	Popowia beccarii				X										
304	Annonaceae	Popowia pisocarpa			X			X	X	X			X	X		X
305	Annonaceae	Pseuduvaria beccarii				X										
306	Annonaceae	Pseuduvaria brachyantha			X	X	X		X				X			X
307	Annonaceae	Pseuduvaria filipes					X						X			
308	Annonaceae	Pseuduvaria megalopus			X	X		X								
309	Annonaceae	Pseudovaria mollis							X				X			
310	Annonaceae	Pseuduvaria sp. 1	NE										X			
311	Annonaceae	Pseudvaria versteegii							X				X			

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312	Annonaceae	Xylopia peekelii				X										
313	Apocynaceae	Alstonia scholaris			X	X		X	X	X	X	X	X	X		X
314	Apocynaceae	Alstonia spectabilis					X	X		X						
315	Apocynaceae	Alyxia composita			X			X					X			X
316	Apocynaceae	Cerbera floribunda			X	X		X	X	X	X	X	X	X		X
317	Apocynaceae	Cerbera mangas														X
318	Apocynaceae	Dischidia benghalensis				X			X	X	X		X	X		X
319	Apocynaceae	Dischidia major						X						X		X
320	Apocynaceae	Dischidia nummularia												X		X
321	Apocynaceae	Dischidia ovata												X		X
322	Apocynaceae	Dischidia sp. 1						X	X							
323	Apocynaceae	Finlaysonia obovata												X	X	
324	Apocynaceae	Hoya gigas						X	X				X			
325	Apocynaceae	Hoya pottsii				X								X		X
326	Apocynaceae	Hoya sp.			X									X		
327	Apocynaceae	Ischnocarpus frutescens					X									X
328	Apocynaceae	Lepiniopsis ternatensis			X			X								
329	Apocynaceae	Marsdenia argentata			X											
330	Apocynaceae	Melodinus forbesii					X		X		X					X
331	Apocynaceae	Ochrosia citrodora												X		X
332	Apocynaceae	Ochrosia ficifolia											X	X		X
333	Apocynaceae	Papuechites aambe					X						X			
334	Apocynaceae	Tabernaemontana pandacaqui			X	X	X	X		X	X					
335	Araliaceae	Arthrophyllum macranthum														X
336	Araliaceae	Gastonia spectabilis			X									X		

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337	Araliaceae	Mackinlaya schlechteri					X		X							
338	Araliaceae	Osmoxylon boerlagei			X	X			X				X			
339	Araliaceae	Osmoxylon ledermannii					X							X		
340	Araliaceae	Osmoxylon micranthum												X		X
341	Araliaceae	Osmoxylon novoguineensis			X			X	X	X	X	X	X	X		X
342	Araliaceae	Osmoxylon tetrandrum						X								
343	Araliaceae	Polyscias cumingiana			X	X		X	X	X			X			
344	Araliaceae	Polyscias ledermannii														X
345	Araliaceae	Schefflera actinophylla					X						X	X		
346	Araliaceae	Schefflera dentata			X	X		X					X			X
347	Araliaceae	Schefflera pachystyla						X	X	X		X		X		X
348	Aristolochiaceae	Aristolochia dielsiana				X	X	X	X		X					X
349	Aristolochiaceae	Aristolochia schlechteri										X				
350	Asteraceae	Adenostemma lavenia				X										
351	Asteraceae	Blumea arfakiana										X				
352	Begoniaceae	Begonia augustae			X	X	X	X		X	X	X				
353	Begoniaceae	Begonia brevirimosa			X											
354	Begoniaceae	Begonia calliantha			X											
355	Begoniaceae	Begonia pediophylla			X	X		X		X						
356	Begoniaceae	Begonia pinnatifida			X											
357	Begoniaceae	Begonia randiana			X	X		X								
358	Begoniaceae	Begonia serratipetala				X										
359	Begoniaceae	Begonia sp. 1	NE		X	X		X								
360	Begoniaceae	Begonia sp. 2	NE		X	X										
361	Begoniaceae	Begonia sp. 3	NE			X										

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362	Begoniaceae	Begonia sp. 4	NE			X										
363	Begoniaceae	Begonia sp. 5	NE					X								
364	Bignoniaceae	Dolichandrone spathacea												X		X
365	Bignoniaceae	Pandorea montana			X	X		X	X			X	X			X
366	Bignoniaceae	Tecomanthe dendrophila			X			X	X	X				X		X
367	Boraginaceae	Cordia subcordata											X			X
368	Burseraceae	Canarium acutifolium				X		X	X			X	X			X
369	Burseraceae	Canarium decomanum						X	X	X			X	X		
370	Burseraceae	Canarium lamii												X		
371	Burseraceae	Canarium maluense						X								
372	Burseraceae	Haplolobus floribundus			X			X	X				X			
373	Calophyllaceae	Calophyllum inophyllum														X
374	Calophyllaceae	Calophyllum papuanum					X	X			X	X				
375	Calophyllaceae	Calophyllum soulattri			X	X	X	X	X				X			X
376	Calophyllaceae	Calophyllum vexans							X							
377	Cannabaceae	Celtis latifolia			X	X	X	X	X		X	X	X	X		X
378	Cannabaceae	Celtis philippensis			X	X	X	X	X	X	X		X	X		X
379	Cannabaceae	Celtis rigescens					X	X								
380	Cannabaceae	Gironniera celtidifolia					X				X	X	X			
381	Cannabaceae	Trema orientalis			X					X		X	X	X		X
382	Cannabaceae	Trema tomentosa					X									
383	Capparaceae	Crateva religiosa				X										
384	Cardiopteridaceae	Gonocaryum litorale						X								
385	Chloranthaceae	Chloranthus elatior						X	X					X		
386	Chrysobalanaceae	Parastemon versteeghii						X								

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387	Chrysobalanaceae	Parinari nonda						X								
388	Clusiaceae	Garcinia assugu						X	X		X					
389	Clusiaceae	Garcinia latissima			X	X	X	X	X		X					X
390	Clusiaceae	Garcinia ledermannii											X			
391	Clusiaceae	Garcinia maluensis			X		X		X		X					
392	Clusiaceae	Mammea grandifolia	VU		Deleted		X	X	X		X		X			
393	Clusiaceae	Mammea novoguineensis	DD					X	X				X	X		X
394	Combretaceae	Combretum indicum							X							
395	Combretaceae	Terminalia catappa														X
396	Combretaceae	Terminalia complanata			X	X	X	X	X	X	X	X	X	X		X
397	Combretaceae	Terminalia impediens					X									
398	Combretaceae	Terminalia kaernbachii					X		X	X	X	X	X	X		X
399	Convolvulaceae	Ipomoea aquatica														X
400	Convolvulaceae	Ipomoea pes-caprae subsp. brasiliensis														X
401	Convolvulaceae	Merremia peltata			X	X	X	X	X	X	X	X	X	X		X
402	Cornaceae	Alangium javanicum				X										
403	Cunoniaceae	Caldcluvia celebica			X			X	X							
404	Cunoniaceae	Ceratopetalum succirubrum	VU										X			
405	Datiscaceae	Octomeles sumatrana			X	X	X	X	X		X	X	X	X		X
406	Dilleniaceae	Dillenia papuana			X	X	X	X	X	X			X			X
407	Dilleniaceae	Dillenia schlechteri			X			X	X	X			X			
408	Dilleniaceae	Tetracera nordtiana			X		X	X	X			X				
409	Dipterocarpaceae	Anisoptera thurifera						X	X			X				

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410	Dipterocarpaceae	Hopea iriana						X		X						
411	Dipterocarpaceae	Vatica papuana						X				X				
412	Ebenaceae	Diospyros insularis	EN								X					
413	Ebenaceae	Diospyros lolinopsis	CR										X			
414	Ebenaceae	Diospyros maritima												X		
415	Ebenaceae	Diospyros nummularia												X		
416	Ebenaceae	Diospyros papuana			X	X	X		X	X	X		X			
417	Ebenaceae	Diospyros pilosanthera					X	X					X			
418	Elaeocarpaceae	Aceratium ledermannii					X		X			X				
419	Elaeocarpaceae	Elaeocarpus culminicola			X	X					X	X				
420	Elaeocarpaceae	Elaeocarpus dolichodactylis							X							
421	Elaeocarpaceae	Elaeocarpus sphaericus						X	X					X		X
422	Elaeocarpaceae	Elaeocarpus serratus			X			X								
423	Elaeocarpaceae	Sloanea sogerensis			X	X	X	X					X	X		X
424	Ericaceae	Dimorphanthera sp.				X										
425	Ericaceae	Paphia sp.			X											
426	Escalloniaceae	Polyosma integrifolia			X	X										
427	Euphorbiaceae	Acalypha caturus				X				X		X				
428	Euphorbiaceae	Acalypha hellwigii				X				X		X		X		
429	Euphorbiaceae	Acalypha insulana			X											
430	Euphorbiaceae	Bischoffia javanica											X			X
431	Euphorbiaceae	Claoxylon indicum			X											X
432	Euphorbiaceae	Codiaeum finnisterae				X		X	X				X			
433	Euphorbiaceae	Codiaeum variegatum							X				X	X		X
434	Euphorbiaceae	Endospermum medullosum				X	X		X	X				X		X
435	Euphorbiaceae	Endospermum moluccanum			X						X					X

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436	Euphorbiaceae	Excoecaria agallocha												X	X	X
437	Euphorbiaceae	Homalanthus novoguineensis			X	X	X	X	X	X		X	X	X		X
438	Euphorbiaceae	Homonoia riparia											X			
439	Euphorbiaceae	Macaranga aleutoroides							X	X		X	X	X		X
440	Euphorbiaceae	Macaranga chrysotricha				X			X	X			X			
441	Euphorbiaceae	Macaranga pulchra										X				
442	Euphorbiaceae	Macaranga punctata			X							X				
443	Euphorbiaceae	Macaranga quadriglandulosa						X								
444	Euphorbiaceae	Macaranga tanarius			X	X		X		X		X	X			
445	Euphorbiaceae	Mallotus peltatus						X	X			X	X	X		X
446	Euphorbiaceae	Mallotus penangensis			X											
447	Euphorbiaceae	Pimelodendron amboinicum			X	X			X				X	X		
448	Eupomatiaceae	Eupomatia laurina			X	X		X					X	X		X
449	Fabaceae	Abrus precatorius				X			X					X		
450	Fabaceae	Adenanthera pavonina						X								X
451	Fabaceae	Albizia procera				X										
452	Fabaceae	Archidendron forbesii	VU			X										
453	Fabaceae	Archidendron glabrum			X	X	X	X	X	X	X		X	X		X
454	Fabaceae	Archidendron lucyi				X										
455	Fabaceae	Archidendron sp. 1						X								
456	Fabaceae	Caesalpinia crista				X								X		
457	Fabaceae	Canavalia rosea														X
458	Fabaceae	Cassia grandis												X		
459	Fabaceae	Cynometra ramiflora			X									X		
460	Fabaceae	Derris pinnata														X

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461	Fabaceae	Derris trifoliata			X	X		X						X	X	X
462	Fabaceae	Entada persuetha			X				X				X	X		X
463	Fabaceae	Inocarpus fagifer						X	X					X		X
464	Fabaceae	Intsia bijuga	VU					X	X	X	X		X	X		X
465	Fabaceae	Maniltoa fortuna-tironis			X	X		X	X		X					
466	Fabaceae	Maniltoa megalocephala					X			X			X	X		X
467	Fabaceae	Maniltoa psilogyne			X		X	X	X	X	X		X	X		X
468	Fabaceae	Mucuna brachycarpa					X		X	X			X			
469	Fabaceae	Mucuna novoguineensis				X	X	X		X	X		X	X		X
470	Fabaceae	Oxyrhynchus papuanus				X			X		X	X				
471	Fabaceae	Paraserianthus falcataria			X		X	X	X	X	X	X	X	X		X
472	Fabaceae	Pterocarpus indicus	VU		X	X	X	X	X	X			X	X	X	X
473	Fabaceae	Pueraria montana var. lobata				X		X		X		X	X	X		X
474	Fabaceae	Strongyledon archbodianus											X	X		
475	Fagaceae	Lithocarpus celebicus			X			X				X				
476	Gentianaceae	Exacum tenue									X		X			
477	Gentianaceae	Fagraea racemosa			X	X		X	X				X			
478	Gesneriaceae	Aeschynanthus nummularius			X			X								
479	Gesneriaceae	Cyrtandra bracteata			X	X	X	X	X				X			
480	Gesneriaceae	Cyrtandra elata					X									
481	Gesneriaceae	Cyrtandra filibracteata							X							
482	Gesneriaceae	Cyrtandra hispidissima							X					X		
483	Gesneriaceae	Cyrtandra schumanniana			X			X	X							
484	Gesneriaceae	Cyrtandra sp. 1	NE			X	X									
485	Gesneriaceae	Cyrtandra sp. 2	NE		X	X	X		X		X					

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
486	Gesneriaceae	Cyrtandra sp. 3	NE		X	X		X	X							
487	Gesneriaceae	Cyrtandra wariana			X	X	X	X	X	X			X			
488	Hernandiaceae	Hernandia ovigera			X			X					X			X
489	Hernandiaceae	Hernandia sonora			X											
490	Himatandraceae	Galbulimima belgraveana						X								
491	Icacinaceae	Platea excelsa			X	X										
492	Icacinaceae	Gonocaryum littorale											X			
493	Lamiaceae	Callicarpa pentandra			X	X				X			X	X		
494	Lamiaceae	Clerodendrum brassii			X		X	X			X					
495	Lamiaceae	Clerodendrum inerme												X		
496	Lamiaceae	Clerodendrum traceyi										X		X		X
497	Lamiaceae	Gmelina moluccana			X	X		X				X	X	X		
498	Lamiaceae	Oxera splendida			X	X		X	X	X		X	X	X		X
499	Lamiaceae	Premna serratifolia				X	X			X				X		X
500	Lamiaceae	Teijsmanniodendron bogoriense			X		X	X	X	X		X	X			X
501	Lamiaceae	Vitex cofassus			X								X	X		X
502	Lauraceae	Cinnamomum culilaban			X	X			X							
503	Lauraceae	Cryptocarya gigantocarpa			X		X	X	X				X			
504	Lauraceae	Cryptocarya idenburgensis			X											
505	Lauraceae	Cryptocarya medicinalis			X		X									X
506	Lauraceae	Cryptocarya multipaniculata				X										
507	Lauraceae	Endiandra brassii			X	X										
508	Lauraceae	Endiandra globosa			X											
509	Lauraceae	Litsea firma			X			X					X	X		
510	Lauraceae	Litsea globosa			X											

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
511	Lecythidaceae	Barringtonia asiatica														X
512	Lecythidaceae	Barringtonia calyptrocalyx			X				X		X	X	X			
513	Lecythidaceae	Barringtonia papuana				X										X
514	Lecythidaceae	Barringtonia procera			X	X		X						X		
515	Lecythidaceae	Barringtonia racemosa												X		
516	Lecythidaceae	Barringtonia sp. 1	NE		X	X			X							
517	Lecythidaceae	Barringtonia sp. 2	NE			X		X	X		X		X			
518	Lecythidaceae	Planchonia papuana				X		X		X			X	X		X
519	Loganiaceae	Geniostema weinlandii					X	X				X				
520	Loganiaceae	Neuburgia celebica			X				X							
521	Loganiaceae	Neuburgia corynocarpa			X	X		X	X			X		X		
522	Loganiaceae	Neuburgia kochii			X	X							X			
523	Loranthaceae	Amyema friesiana						X								
524	Loranthaceae	Decaisnina hollrungii				X		X			X		X	X		
525	Lythraceae	Duabanga moluccana			X											
526	Lythraceae	Sonneratia alba													X	
527	Lythraceae	Sonneratia lanceolata													X	
528	Magnoliaceae	Magnolia tsiampacca	DD		X									X		
529	Malvaceae	Bombax ceiba												X		
530	Malvaceae	Brownlowia lepidota												X	X	
531	Malvaceae	Commersonia bertramia					X						X			
532	Malvaceae	Heritiera littoralis			X									X	X	X
533	Malvaceae	Hibiscus tiliaceus												X	X	X
534	Malvaceae	Kleinhovia hospita							X					X		
535	Malvaceae	Microcos grandiflora			X	X		X					X			X

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
536	Malvaceae	Microcos tetrasperma						X								
537	Malvaceae	Sterculia ampla			X	X	X	X	X	X		X	X	X		X
538	Malvaceae	Sterculia conwentzii				X										
539	Malvaceae	Sterculia macrostemon							X							
540	Malvaceae	Sterculia schumanniana?				X	X									
541	Malvaceae	Talipariti archboldtianum			X	X		X	X	X	X		X	X		X
542	Malvaceae	Trichospermum pleostigma											X	X		X
543	Melastomataceae	Astronia hollrungii					X	X	X				X	X		
544	Melastomataceae	Astronia papuana								X						
545	Melastomataceae	Astronia rostrata										X				
546	Melastomataceae	Astronidium montanum			X	X		X								
547	Melastomataceae	Dissochaeta angiensis						X								
548	Melastomataceae	Medinilla brassii			X									X		
549	Melastomataceae	Medinilla crassinervia						X		X		X	X			
550	Melastomataceae	Medinilla sogerensis							X							
551	Melastomataceae	Medinilla sp. 1	NE		X	X										
552	Melastomataceae	Melastoma cyanoides				X	X	X		X						
553	Melastomataceae	Melastoma malabathricum			X	X				X		X	X	X		X
554	Melastomataceae	Memecylon amplexicaule					X	X				X	X			
555	Melastomataceae	Memecylon fruticosum							X							
556	Melastomataceae	Memecylon hepaticum							X							
557	Melastomataceae	Memecylon heteropleurum			X			X					X			
558	Melastomataceae	Memecylon sp. 1	NE		X				X		X					
559	Melastomataceae	Memecylon torricellense							X							
560	Melastomataceae	Poikilogyne cordifolia			X							X				

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
561	Melastomataceae	Pternandra caerulescens						X								
562	Melastomataceae	Pternandra rostrata					X									
563	Meliaceae	Aglaia argentea			X											
564	Meliaceae	Aglaia cucullata	DD				Deleted				X	Deleted	X			
565	Meliaceae	Aglaia elaeagnoidea				X										
566	Meliaceae	Aglaia euryanthera	NT		X	X	X	X	X	X						
567	Meliaceae	Aglaia littoralis				X							X			X
568	Meliaceae	Aglaia parviflora			X											
569	Meliaceae	Aglaia rimosa	NT										X			
570	Meliaceae	Aglaia sapindina				X		X	X					X		X
571	Meliaceae	Aglaia tomentosa subsp. tomentosa			X	X	X	X	X		X					
572	Meliaceae	Aphanamixis polystachya			X											
573	Meliaceae	Chisocheton ceramicus			X	X		X	X	X	X		X			X
574	Meliaceae	Chisocheton cumingianus subsp. cumingianus			X		X	X	X		X			X		
575	Meliaceae	Chisocheton lasiocarpus						X	X							
576	Meliaceae	Dysoxylum alliaceum			X											
577	Meliaceae	Dysoxylum gaudichaudianum									X					
578	Meliaceae	Dysoxylum micranthum											X	X		
579	Meliaceae	Dysoxylum parasiticum			X	X	X	X								X
580	Meliaceae	Dysoxylum variabile				X	X		X	X	X	X				X
581	Meliaceae	Vatica papuana			X			X	X	X	X					
582	Meliaceae	Xylocarpus granatum												X		
583	Meliaceae	Xylocarpus mekongensis												X	X	

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
584	Menispermaceae	Chlaenandra ovata					X		X							X
585	Menispermaceae	Parabaena tuberculata					X						X			X
586	Menispermaceae	Stephania japonica var. japonica			X	X	X	X				X	X			
587	Monimiaceae	Kibara archboldtiana			X					X						
588	Monimiaceae	Kibara grandifolia			X	X			X	X			X			
589	Monimiaceae	Steganthera hospitans			X				X							
590	Moraceae	Antiaris toxicaria											X	X		X
591	Moraceae	Artocarpus altilis												X		X
592	Moraceae	Artocarpus communis									X			X		
593	Moraceae	Artocarpus incisa														X
594	Moraceae	Ficus arfakensis			X	X	X		X			X	X			X
595	Moraceae	Ficus benjamina					X									
596	Moraceae	Ficus bernaysii			X	X	X	X	X				X			X
597	Moraceae	Ficus botryocarpa					X									
598	Moraceae	Ficus caulocarpa								X						
599	Moraceae	Ficus congesta					X	X		X			X			X
600	Moraceae	Ficus copiosa			X			X								X
601	Moraceae	Ficus crassiramea						X								
602	Moraceae	Ficus dammaropsis			X						X	X	X			
603	Moraceae	Ficus glaberrima			X											
604	Moraceae	Ficus iodotricha												X		X
605	Moraceae	Ficus itoana			X		X				X	X				
606	Moraceae	Ficus molior								X						
607	Moraceae	Ficus nodosa					X	X		X	X	X				
608	Moraceae	Ficus odoardii						X								

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609	Moraceae	Ficus primaria					X									
610	Moraceae	Ficus pungens			X		X	X		X	X	X	X			X
611	Moraceae	Ficus septica												X		
612	Moraceae	Ficus sp. 1	NE				X									
613	Moraceae	Ficus subcongesta					X						X			
614	Moraceae	Ficus subulata			X	X			X		X			X		
615	Moraceae	Ficus variegata										X	X	X		X
616	Moraceae	Ficus wassa			X			X	X			X	X	X		X
617	Moraceae	Maclura amboinensis							X				X	X		X
618	Myristicaceae	Endocomia macrocoma				X		X								
619	Myristicaceae	Gymnacranthera paniculata			X	X				X	X			X		X
620	Myristicaceae	Horsfieldia coryandra							X							
621	Myristicaceae	Horsfieldia hellwigii							X				X			
622	Myristicaceae	Horsfieldia subtilis			X	X	X	X	X							X
623	Myristicaceae	Myristica cylindrocarpa							X							
624	Myristicaceae	Myristica fatua											X			X
625	Myristicaceae	Myristica globosa	NT			X			X		X					
626	Myristicaceae	Myristica ingrata			X	X					X		X			
627	Myristicaceae	Myristica schleinitzii			X			X				X		X		
628	Myristicaceae	Myristica subalulata			X			X		X			X			
629	Myrsinaceae	Aegiceras corniculatum												X		
630	Myrtaceae	Octamyrtus behrmannii					X						X			X
631	Myrtaceae	Syzygium branderhorstii			X				X							
632	Myrtaceae	Syzygium buettnerianum			X				X			X				
633	Myrtaceae	Syzygium coalitum			X											

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634	Myrtaceae	Syzygium cratermontensis				X										
635	Myrtaceae	Syzygium cf. leonhardii			X	X		X		X						
636	Myrtaceae	Syzygium nemorale			X											
637	Myrtaceae	Syzygium nutans			X		X						X			
638	Myrtaceae	Syzygium sp. 1	NE					X								
639	Myrtaceae	Syzygium sp. 2	NE						X		X	X	X			
640	Myrtaceae	Syzygium sp. 3	NE										X			
641	Myrtaceae	Syzygium sp. 4	NE										X			
642	Myrtaceae	Syzygium sp. 5	NE						X							
643	Myrtaceae	Syzygium stipulare			X	X	X	X	X	X	X	X	X			X
644	Myrtaceae	Syzygium tiernyanum				X										
645	Myrtaceae	Syzygium versteegii						X	X	X			X	X		
646	Nyctaginaceae	Pisonia longirostris					X	X					X	X		X
647	Nyctaginaceae	Pisonia umbellata					X									
648	Ochnaceae	Schuurmansia henningsii			X	X		X	X	X				X		X
649	Opiliaceae	Cansjera leptostachya					X							X		X
650	Oxalidaceae	Averrhoea bilimbi											X			X
651	Pandaceae	Galearia celebica			X	X			X							
652	Pentaphragmaceae	Pentaphragma grandiflora				X										
653	Pentaphyllaceae	Eurya tigang			X											
654	Phyllanthaceae	Antidesma contractum			X	X		X					X			
655	Phyllanthaceae	Antidesma excavatum var. indutum			X	X		X								X
656	Phyllanthaceae	Aporosa papuanum			X	X										X
657	Phyllanthaceae	Baccaurea nesophila				X										
658	Phyllanthaceae	Breynia cernua			X		X	X	X			X	X	X		

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659	Phyllanthaceae	Bridelia macrocarpa			X	X		X				X	X			
660	Phyllanthaceae	Cleistanthus oblongifolia							X							
661	Phyllanthaceae	Glochidion insectum												X		X
662	Phyllanthaceae	Glochidion philippicum			X									X		
663	Phyllanthaceae	Glochidion sp. 1	NE		X											
664	Phyllanthaceae	Phyllanthus archboldtianus			X											
665	Phyllanthaceae	Phyllanthus clamboides				X										
666	Phyllanthaceae	Phyllanthus lamprophyllus			X											
667	Phyllanthaceae	Phyllanthus rheophilus			X											
668	Piperaceae	Piper betle				X		X								
669	Piperaceae	Piper caninum							X	X	X	X				
670	Piperaceae	Piper macropiper			X	X		X	X	X				X		
671	Piperaceae	Piper mestonii			X	X	X		X	X	X		X			
672	Piperaceae	Piper rodatzii												X		
673	Pittosporaceae	Pittosporum sinuatum			X	X	X	X	X	X	X	X	X	X		X
674	Polygonaceae	Xanthophyllum papuanum						X								
675	Portulacaceae	Sesuvium portulacastrum														X
676	Primulaceae	Aegiceras corniculatum													X	
677	Primulaceae	Ardisia imperialis					X	X								
678	Primulaceae	Ardisia squarrosa			X	X			X							
679	Primulaceae	Conandrium polyanthum					X	X	X							
680	Primulaceae	Discocalyx sp. 1	NE			X	X									
681	Primulaceae	Fittingia tubiflora			X			X								
682	Primulaceae	Loheria reiniana						X	X							
683	Primulaceae	Myrsine fatua				X	X									

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684	Primulaceae	Myrsine warae			X	X					X					
685	Proteaceae	Helicia amplifolia	NT			X										
686	Proteaceae	Helicia latifolia	NT			X										
687	Proteaceae	Helicia macrostachya											X			
688	Proteaceae	Helicia oreadum						X								
689	Proteaceae	Helicia saruwagedica						X								
690	Ranunculaceae	Clematis zeylanica			X					X				X		
691	Rhamnaceae	Alphitonia incana					X				X	X	X	X		
692	Rhamnaceae	Gouania microcarpa							X				X			X
693	Rhamnaceae	Ziziphus angustifolia			X	X	X	X					X	X		X
694	Rhizophoraceae	Bruguiera gymnorrhiza												X	X	X
695	Rhizophoraceae	Bruguiera hainesii	CR													X
696	Rhizophoraceae	Bruguiera sexangula												X	X	
697	Rhizophoraceae	Gynotroches axillaris			X	X		X	X							X
698	Rhizophoraceae	Rhizophora stylosa												X	X	X
699	Rosaceae	Rubus moluccanus			X				X	X						X
700	Rubiaceae	Amaracarpus grandifolius var. humilis			X	X										X
701	Rubiaceae	Anthocephalus chinensis											X	X		X
702	Rubiaceae	Argostemma bryophilum				X								X		
703	Rubiaceae	Atractocarpus decorus			X	X		X	X	X	X	X				X
704	Rubiaceae	Calycosia kajewskii						X					X			
705	Rubiaceae	Cyclophyllum longiflorum			X											
706	Rubiaceae	Dolicholobium acuminatum												X		X
707	Rubiaceae	Gardenia lamingtonii						X								X
708	Rubiaceae	Gardenia pallens						X								

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709	Rubiaceae	Hydnophytum dipteropodum					X									
710	Rubiaceae	Hydnophytum moseleyanum			X	X		X	X	X	X	X		X		
711	Rubiaceae	Hydnophytum parvifolium				X		X								
712	Rubiaceae	Hydnophytum radicans			X	X		X					X	X		X
713	Rubiaceae	Ixora amplexifolia			X	X	X	X								
714	Rubiaceae	Ixora cauliflora				X								X		
715	Rubiaceae	Ixora dolichothyrsa						X								
716	Rubiaceae	Ixora minor			X	X		X	X		X		X			
717	Rubiaceae	Ixora moszkowskii			X	X										X
718	Rubiaceae	Ixora sp. 1	NE		X	X	X	X	X				X			
719	Rubiaceae	Ixora sp. 2	NE		X	X		X				X				
720	Rubiaceae	Ixora sp. 3	NE		X	X	X		X				X			X
721	Rubiaceae	Ixora ysabellae				X		X					X	X		
722	Rubiaceae	Lasianthus chlorocarpus				X			X					X		
723	Rubiaceae	Lasianthus cyanocarpoides			X				X					X		
724	Rubiaceae	Lasianthus sp. 1	NE		X											
725	Rubiaceae	Lasianthus strigosus			X	X		X								
726	Rubiaceae	Maschalodesme arborea				X		X	X		X			X		
727	Rubiaceae	Maschalodesme simplex					X	X	X							
728	Rubiaceae	Maschalodesme sp. 1	NE			X		X	X							
729	Rubiaceae	Mastixiodendron pachyclados			X				X		X	X	X	X		X
730	Rubiaceae	Morinda citrifolia												X		
731	Rubiaceae	Mussaenda scratchleyi			X	X		X	X	X	X	X	X	X		X
732	Rubiaceae	Mycetia javanica				X		X					X			
733	Rubiaceae	Myrmecodia tuberosa			X	X			X	X				X		X

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734	Rubiaceae	Nauclea orientalis											X			X
735	Rubiaceae	Neonauclea acuminata?						X						X		
736	Rubiaceae	Neonauclea purpurea			X	X	X	X	X				X	X		X
737	Rubiaceae	Ophiorrhiza rupestris			X	X			X							
738	Rubiaceae	Pachystylis zippelianus							X				X	X		X
739	Rubiaceae	Pertusadina multifolia			X											
740	Rubiaceae	Genus 1 sp. 1	NE		X	X		X	X				X	X		
741	Rubiaceae	Genus 1 sp. 2	NE			X										
742	Rubiaceae	Genus 1 sp. 3	NE					X	X		X	X	X			X
743	Rubiaceae	Psychotria aquatilis												X		
744	Rubiaceae	Psychotria dieniensis			X											
745	Rubiaceae	Psychotria leptothyrsa						X	X							
746	Rubiaceae	Psychotria micrococca			X											
747	Rubiaceae	Psychotria microlablasta			X											
748	Rubiaceae	Psychotria morobensis			X											
749	Rubiaceae	Psychotria pseudomaschalodesme											X			
750	Rubiaceae	Psychotria versteegii												X		
751	Rubiaceae	Tarenna sambucina var. buruensis			X	X		X								
752	Rubiaceae	Timonius carrii						X								
753	Rubiaceae	Timonius grandifolius							X	X			X	X		
754	Rubiaceae	Timonius timon				X				X			X	X		X
755	Rubiaceae	Uncaria cordata			X	X	X	X	X		X	X	X	X		X
756	Rubiaceae	Urophyllum glaucescens				X										
757	Rutaceae	Acronychia pedunculata										X				

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758	Rutaceae	Flindersia pimenteliana	VU										X			
759	Rutaceae	Melicope elleryana			X	X		X	X				X	X		X
760	Rutaceae	Melicope novoguineensis												X		
761	Rutaceae	Melicope rubra				X			X							X
762	Sabiaceae	Meliosma sp.			X											
763	Sabiaceae	Sabia pauciflora				X										
764	Salicaceae	Casearia clutiifolia			X				X		X					X
765	Salicaceae	Homalium foetidum			X		X	X		X		X		X		
766	Sapindaceae	Allophyllus cobbe					X						X			X
767	Sapindaceae	Dodonaea viscosa														X
768	Sapindaceae	Ganophyllum falcatum			X											
769	Sapindaceae	Harpullia camptoneura			X				X	X				X		
770	Sapindaceae	Harpullia cupanioides												X		X
771	Sapindaceae	Harpullia longipetalata								X						
772	Sapindaceae	Harpullia petiolaris			X											
773	Sapindaceae	Lepisanthes senegalensis					X									
774	Sapindaceae	Pometia pinnata			X	X	X	X	X	X	X	X	X	X		X
775	Sapindaceae	Tristiropsis acutangula											X			
776	Sapotaceae	Burckella obovata							X							
777	Sapotaceae	Burckella polymera											X			
778	Sapotaceae	Palaquium morobense						X								
779	Sapotaceae	Palaquium warburgianum						X								X
780	Sapotaceae	Planchonella firma					X	X	X							
781	Sapotaceae	Planchonella obovata			X	X										X
782	Smilacaceae	Smilax zeylanica			X	X	X	X	X			X	X	X		X

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783	Sonneratiaceae	Sonneratia alba												X		X
784	Stemonuraceae	Medusanthera laxiflora							X		X		X	X		X
785	Strychnaceae	Strychnos minor						X	X				X	X		
786	Symplocaceae	Symplocos cochinchinensis			X											
787	Tetramelaceae	Octomeles sumatrana			X		X		X	X		X	X	X		X
788	Thymelaeaceae	Aquilaria filaria					X									
789	Thymelaeaceae	Gyrinops caudata					X									
790	Thymelaeaceae	Phaleria coccinea						X								
791	Thymelaeaceae	Phaleria macrocarpa			X			X			X		X	X		
792	Thymelaeaceae	Wikstroemia androsaefolia											X			
793	Triuridaceae	Sciaphila secundiflora			X	X										
794	Urticaceae	Dendrocnide carriana					X		X							
795	Urticaceae	Dendrocnide longifolia			X	X	X	X	X		X	X	X	X		X
796	Urticaceae	Dendrocnide peltata												X		
797	Urticaceae	Dendrocnide ternatensis							X							X
798	Urticaceae	Elatostema macrophyllum					X	X	X	X	X					X
799	Urticaceae	Elatostema novoguineense			X	X		X			X	X	X			X
800	Urticaceae	Leucosyke capitellata			X	X		X		X			X	X		X
801	Urticaceae	Pilea effusa			X	X	X									
802	Urticaceae	Pipturus argenteus			X	X	X			X		X	X	X		X
803	Urticaceae	Procris frutescens			X		X	X	X	X	X		X			
804	Urticaceae	Procris grueningii							X		X					
805	Violaceae	Rinorea bengalensis			X											
806	Violaceae	Rinorea horneri					X									
807	Vitaceae	Cayratia geniculata					X		X				X	X		X

No.	Family	Scientific Name	IUCN	CITES	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6A	Site 6B	Site 6D	Site 7	Site 8	Site 8M	Site 9
808	Vitaceae	Cissus aristata							X				X	X		
809	Vitaceae	Leea coryphantha			X											
810	Vitaceae	Leea heterodoxa			X	X	X	X	X	X	X		X	X		X
811	Vitaceae	Leea indica			X	X		X	X	X	X	X	X	X		X
812	Vitaceae	Leea zippeliana			X		X	X	X							

Appendix 2

Select survey results of IUCN threatened and new-to-science/undescribed species for Sites 1–9

IUCN: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NE= Not Evaluated (IUCN). New-to-science and undescribed species are indicated by the suffix ‘sp. 1’, ‘sp. 2’, etc.

UTM PNG94		Species	No. individuals	Status	IUCN
290848	9203022	Archidendron forbesii	1	Fruiting	VU
295551	9191605	Barringtonia sp. 1	1	Fruiting	NE
295075	9209687	Barringtonia sp. 1	2	Fruiting	NE
293285	9209695	Barringtonia sp. 1	1	Fruiting	NE
291550	9203105	Barringtonia sp. 1	1	Fruiting	NE
291225	9203204	Barringtonia sp. 1	–	–	NE
292458	9202947	Barringtonia sp. 2	18	Flowering/fruiting	NE
299215	9185135	Barringtonia sp. 2	1	Fruiting	NE
307784	9153565	Barringtonia sp. 2	1	Sterile	NE
308083	9151649	Barringtonia sp. 2	1	Sterile	NE
295048	9209612	Begonia sp. 1	6	Some flowering	NE
295048	9209612	Begonia sp. 1	5	Flowering	NE
295055	9209663	Begonia sp. 1	75	Some flowering	NE
294459	9211970	Begonia sp. 1	56	Sterile	NE
293494	9209022	Begonia sp. 1	20	Some flowering	NE
293266	9209573	Begonia sp. 1	78	Some flowering	NE
293285	9209695	Begonia sp. 1	200+	Some flowering	NE
291511	9203138	Begonia sp. 1	13	Sterile	NE
291486	9203115	Begonia sp. 1	20	Sterile	NE
300445	9186508	Begonia sp. 1	20	Some flowering	NE

UTM PNG94		Species	No. individuals	Status	IUCN
292458	9202947	Begonia sp. 2	35	Sterile	NE
293706	9209674	Begonia sp. 2	–	–	NE
291799	9202913	Begonia sp. 3	30+	Some fruiting	NE
292458	9202947	Begonia sp. 3	30+	Some fruiting	NE
291486	9203115	Begonia sp. 4	1	Sterile	NE
300208	9186876	Begonia sp. 5	9	Some flowering	NE
300085	9187686	Begonia sp. 5	8	Flowering & fruiting	NE
300443	9187903	Bulbophyllum sp. 1	11	Flowering & fruiting	NE
308488	9154030	Ceratopetalum succirubrum	5	Sterile	VU
307939	9153603	Ceratopetalum succirubrum	5	Sterile	VU
291946	9202623	Cyrtandra sp. 1	1	Flowering	NE
303314	9171788	Cyrtandra sp. 1	7	Some flowering	NE
291799	9202913	Cyrtandra sp. 2	1	Flowering	NE
291486	9203115	Cyrtandra sp. 2	1	Flowering	NE
291087	9203132	Cyrtandra sp. 2	1	Flowering	NE
303296	9171782	Cyrtandra sp. 2	1	Flowering	NE
299661	9185012	Cyrtandra sp. 2	1	Flowering	NE
295501	9191647	Cyrtandra sp. 2	1	Flowering	NE
295075	9209687	Cyrtandra sp. 3	9	Flowering/fruiting	NE
291799	9202913	Cyrtandra sp. 3	18	Some flowering	NE
300132	9187438	Cyrtandra sp. 3	18	Some flowering	NE
295462	9191670	Cyrtandra sp. 3	14	Some flowering	NE
299660	9185012	Diospyros insularis	1	Fruiting	EN
307379	9153234	Diospyros lolinopsis	7	Sterile	CR
292146	9202567	Discocalyx sp. 1	5	Flowering	NE
303296	9171782	Discocalyx sp. 1	3	Flowering/fruiting	NE

UTM PNG94		Species	No. individuals	Status	IUCN
304636	9171627	Ficus sp. 1	18	Flowering/fruiting	NE
309115	9153999	Flindersia pimenteliana	1	Fuiting	VU
291604	9203025	Genus 1 sp. 1	18	Some fruiting	NE
295055	9209663	Genus 1 sp. 1	64	Some fruiting	NE
294305	9209604	Genus 1 sp. 1	5	Fruiting	NE
293374	9209215	Genus 1 sp. 1	7	Some flowering	NE
293232	9209554	Genus 1 sp. 1	50+	Some fruiting	NE
300674	9186890	Genus 1 sp. 1	18	Some fruiting	NE
307905	9153585	Genus 1 sp. 1	2	Flowering & fruiting	NE
311674	9135635	Genus 1 sp. 1	1	Fruiting	NE
291486	9203115	Genus 1 sp. 2	5	Some fruiting	NE
300271	9187214	Genus 1 sp. 3	2	Fruiting	NE
299814	9184939	Genus 1 sp. 3	1	Fruiting	NE
295476	9191660	Genus 1 sp. 3	1	Fruiting	NE
307894	9153583	Genus 1 sp. 3	1	Fruiting	NE
308770	9153633	Genus 1 sp. 3	1	Fuiting	NE
316887	9132609	Genus 1 sp. 3	1	Flowering	NE
295349	9209928	Glochidion sp. 1	3	Flowering/fruiting	NE
300282	9186679	Intsia bijuga	2	Fruiting	VU
299661	9185012	Intsia bijuga	8	Sterile	VU
300863	9194457	Intsia bijuga	1	Fruiting	VU
307598	9153624	Intsia bijuga	1	Sterile	VU
307223	9153218	Intsia bijuga	1	Sterile	VU
308874	9139085	Intsia bijuga	1	Sterile	VU
316649	9132241	Intsia bijuga	9	Sterile	VU
295075	9209687	Ixora sp. 1	3	Flowering/fruiting	NE

UTM PNG94		Species	No. individuals	Status	IUCN
294516	9211177	Ixora sp. 1	1	Flowering	NE
295075	9209687	Ixora sp. 1	2	Flowering/fruiting	NE
293285	9209695	Ixora sp. 1	1	Flowering	NE
291225	9203204	Ixora sp. 1	9	Flowering	NE
304633	9171621	Ixora sp. 1	1	Flowering	NE
300125	9187588	Ixora sp. 1	5	Fruiting	NE
299661	9185012	Ixora sp. 1	2	Fruiting	NE
308270	9151635	Ixora sp. 1	1	Sterile	NE
300372	9187872	Ixora sp. 2	5	Sterile	NE
294536	9212066	Ixora sp. 2	1	Sterile	NE
294193	9209578	Ixora sp. 2	18	Sterile	NE
293754	9209616	Ixora sp. 2	129	Sterile	NE
293706	9209674	Ixora sp. 2	53	Some fruiting	NE
295474	9208566	Ixora sp. 2	1	Sterile	NE
293411	9209083	Ixora sp. 2	1	Sterile	NE
293266	9209573	Ixora sp. 2	2	Sterile	NE
291666	9202920	Ixora sp. 2	2	Fruiting	NE
291550	9203105	Ixora sp. 2	10	Sterile	NE
291322	9203209	Ixora sp. 2	3	Sterile	NE
291486	9203115	Ixora sp. 2	4	Sterile	NE
300280	9192765	Ixora sp. 2	2	Sterile	NE
293232	9209554	Ixora sp. 3	1	Flowering	NE
291511	9203138	Ixora sp. 3	1	Flowering	NE
291322	9203209	Ixora sp. 3	1	Flowering	NE
291486	9203115	Ixora sp. 3	1	Flowering	NE
290848	9203022	Ixora sp. 3	2	Flowering	NE

UTM PNG94		Species	No. individuals	Status	IUCN
304241	9171678	Ixora sp. 3	1	Flowering	NE
295632	9191535	Ixora sp. 3	1	Flowering	NE
308512	9154026	Ixora sp. 3	1	Flowering	NE
316687	9132302	Ixora sp. 3	1	Flowering	NE
293706	9209674	Lasianthus sp. 1	5	Fruiting	NE
295472	9191666	Livistona sp. 1	1	Sterile	NE
303314	9171788	Mammea grandifolia	1	Sterile	VU
300445	9186508	Mammea grandifolia	2	Sterile	VU
300170	9187794	Mammea grandifolia	1	Sterile	VU
299814	9184939	Mammea grandifolia	1	Sterile	VU
299533	9184984	Mammea grandifolia	1	Sterile	VU
295501	9191647	Mammea grandifolia	1	Sterile	VU
308181	9151659	Mammea grandifolia	1	Sterile	VU
294156	9191643	Maschalodesme sp. 1	5	Flowering/fruiting	NE
300283	9187180	Maschalodesme sp. 1	3	Flowering & fruiting	NE
291946	9202623	Maschalodesme sp. 1	1	Flowering/fruiting	NE
291799	9202913	Maschalodesme sp. 1	–	–	NE
291799	9202913	Medinilla sp. 1	9	Some fruiting	NE
294809	9209402	Medinilla sp.1	11	Fruiting	NE
294809	9209402	Medinilla sp.1	4	Fruiting	NE
295106	9209669	Medinilla sp.1	4	Fruiting	NE
294578	9211336	Memecylon sp. 1	18	Fruiting	NE
294581	9211445	Memecylon sp. 1	5	Fruiting	NE
299295	9185093	Memecylon sp. 1	1	Sterile	NE
295501	9191647	Memecylon sp. 1	1	Flowering	NE
300152	9187668	Oberonia sp. 1	3	Flowering & fruiting	NE

UTM PNG94		Species	No. individuals	Status	IUCN
308488	9154030	Pseuduvaria sp. 1	2	Some flowering	NE
308181	9151659	Pseuduvaria sp. 1	1	Flowering	NE
309230	9153902	Pseuduvaria sp. 1	1	Flowering	NE
291946	9202623	Pterocarpus indicus	7	Sterile	VU
291858	9202629	Pterocarpus indicus	26	Sterile	VU
292146	9202567	Pterocarpus indicus	83	Some fruiting	VU
292425	9202869	Pterocarpus indicus	100	Some fruiting	VU
292458	9202947	Pterocarpus indicus	133	Some fruiting	VU
303462	9171570	Pterocarpus indicus	10	Sterile	VU
303619	9171365	Pterocarpus indicus	4	Sterile	VU
303650	9171350	Pterocarpus indicus	8	Sterile	VU
303656	9171319	Pterocarpus indicus	14	Sterile	VU
308612	9153858	Pterocarpus indicus	1	Fuiting	VU
293706	9209674	Pterocarpus indicus	1	Sterile	VU
308565	9153986	Pterocarpus indicus	6	Some fruiting	VU
308247	9153645	Pterocarpus indicus	1	Sterile	VU
307950	9153604	Pterocarpus indicus	2	Sterile	VU
307609	9153622	Pterocarpus indicus	1	Sterile	VU
308345	9152837	Pterocarpus indicus	1	Sterile	VU
308275	9152521	Pterocarpus indicus	18	Fruiting	VU
308226	9151696	Pterocarpus indicus	1	Sterile	VU
307387	9153302	Pterocarpus indicus	1	Sterile	VU
308803	9153645	Pterocarpus indicus	1	Fuiting	VU
309068	9153644	Pterocarpus indicus	1	Sterile	VU
309181	9153637	Pterocarpus indicus	1	Fuiting	VU
309231	9153714	Pterocarpus indicus	1	Fruiting	VU

UTM PNG94		Species	No. individuals	Status	IUCN
308932	9154151	Pterocarpus indicus	1	Fruiting	VU
308878	9155920	Pterocarpus indicus	1	Sterile	VU
308929	9155990	Pterocarpus indicus	1	Fruiting	VU
309603	9133014	Pterocarpus indicus	1	Fuiting	VU
309648	9133045	Pterocarpus indicus	1	Fuiting	VU
309616	9133026	Pterocarpus indicus	2	Fuiting	VU
309589	9133002	Pterocarpus indicus	1	Fuiting	VU
309514	9133038	Pterocarpus indicus	1	Fuiting	VU
309192	9132818	Pterocarpus indicus	1	Fuiting	VU
309228	9132823	Pterocarpus indicus	1	Fuiting	VU
308889	9139039	Pterocarpus indicus	1	Sterile	VU
308874	9139085	Pterocarpus indicus	1	Fruiting	VU
316770	9132454	Pterocarpus indicus	1	Fruiting	VU
316793	9132540	Pterocarpus indicus	1	Fruiting	VU
316887	9132609	Pterocarpus indicus	1	Sterile	VU
316958	9132676	Pterocarpus indicus	1	Sterile	VU
316992	9132729	Pterocarpus indicus	1	Fruiting	VU
319296	9130465	Pterocarpus indicus	1	Fuiting	VU
319105	9131313	Pterocarpus indicus	1	Fuiting	VU
318937	9130851	Pterocarpus indicus	1	Fuiting	VU
318846	9130705	Pterocarpus indicus	1	Fuiting	VU
300674	9186890	Syzygium sp. 1	1	Fruiting	NE
299273	9185105	Syzygium sp. 2	9	Flowering/fruiting	NE
300210	9192861	Syzygium sp. 2	3	Some in flower	NE
307784	9153565	Syzygium sp. 2	1	Flowering	NE
309230	9153902	Syzygium sp. 2	1	Flowering	NE

UTM PNG94		Species	No. individuals	Status	IUCN
308488	9154030	Syzygium sp. 3	1	Fruiting	NE
307440	9153572	Syzygium sp. 4	2	Fruiting	NE
294580	9191245	Syzygium sp. 5	1	Fruiting	NE

Appendix 3

FIMS vegetation descriptions and the equivalent terminology used in this report

Major vegetation group/FIMS code	FIMS Group/Description	Biodiversity Study term
Natural vegetation types		
Hill forest		
Hm	Medium crowned forest	Hill forest
Hm/Sc	Complex: Medium crowned forest/Scrub	Hill forest/Scrub
Hs	Small crowned forest	Small crowned hill forest
Alluvial forest		
Pl	Large to medium crowned forest	Alluvial forest
Po	Open forest	Open alluvial forest
Po/Fsw	Complex: Open forest/Mixed swamp forest	Open alluvial forest/Swamp forest
Po/Fsw/Hm	Complex: Open forest/Mixed swamp forest/Medium crowned forest	Open alluvial forest/Swamp forest/Hill forest
Freshwater swamp habitats		
Fsw	Mixed swamp forest	Swamp forest
Fsw/Gsw	Complex: Mixed swamp forest/Swamp grassland	Swamp forest/Swamp grassland
Fsw/Wsw	Complex: Mixed swamp forest/Swamp woodland	Swamp forest/Swamp woodland
Wsw	Swamp woodland	Swamp woodland
Hsw	Herbaceous swamp	Herbaceous swamp
Littoral forest		
B	Mixed forest	Littoral forest
Marine tidal		
M	Mangrove	Mangrove