Pre-clearing vegetation of the coastal lowlands of the Wet Tropics Bioregion, North Queensland

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***Abstract*:** A pre-clearing vegetation map and digital coverage at approximately 1:50 000 scale for the coastal lowlands (up to about 200 m elevation) of the Wet Tropics Bioregion, North Queensland is presented. The study area covers about 508 000 ha from Cooktown, 420 km south almost to Townsville (latitude 15° 30'–18° 20' longitude 144° 50'–146° 40'). Data sources included historical aerial photography, early surveyors' plans, explorers' journals, previous vegetation maps, and maps of soils and geology. The pre-clearing mapping was built around the remnant vegetation mapping of Stanton & Stanton (2005), and the vegetation classification of this latter work was adopted. Vegetation units were further classified into regional ecosystems compatible with the standard State-wide system used by Queensland government. The digital coverage is part of the current Queensland Herbarium regional ecosystem coverage (Queensland Herbarium and Wet Tropics Management Authority 2005). Coloured maps (1:100 000 scale) of the pre-clearing vegetation of the Herbert, Tully, Innisfail and Macalister/Daintree subregions are on an accompanying CD-ROM.

An evaluation of vegetation loss through clearing on the coastal lowlands of the Wet Tropics revealed several near-extinct vegetation communities and regional ecosystems, and many others that are drastically reduced in area. Even ecosystems occurring on poorly drained lands have suffered a surprisingly high level of loss due to the effectiveness of drainage operations. Grassland ecosystems were found to be widespread on the Herbert and Tully floodplains, but are now close to extinction. The lowlands vegetation of the Wet Tropics that remains today continues to be fragmented and degraded despite the introduction of State-wide broad-scale tree-clearing laws in 1999, and the cessation of broad-scale tree-clearing in December 2006.

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Introduction

Much of Australia has been cleared of native vegetation for agricultural and urban development since European settlement began in the 19th century, a relatively short time. The extent of clearing for each State is now estimated at 60% of Victoria, 30% of New South Wales, 18% of Queensland, 16% of Tasmania, 11% of South Australia, 7% of Western Australia, and 2% of the Northern Territory (National Land & Water Resources Audit 2001). In Queensland, most of the clearing has taken place in the 20th century, allowing reconstruction of the nature of the pre-clearing vegetation using a variety of documentation and aerial photography. The Wet Tropics Bioregion, in north-eastern Queensland has good aerial photo coverage, with the earliest taken in the 1940s (as early as 1937 in the Cairns city area) by the Royal Australian Air Force (R.A.A.F.), for military purposes. There are also detailed land survey plans drawn up in the 19th and early 20th centuries for all new land allocated for settlement. These plans often show major vegetation boundaries. Most of this land survey information is available today from the Queensland Department of Natural Resources and Water.

Indigenous people have lived in the Wet Tropics for many thousands of years. Radio-carbon data from Ngarrabullgan Cave at Mt Mulligan, 50 km west of the Wet Tropics, suggests this area was inhabited 35 000 years ago (Lorandos & David 2002). In the late 19th century, at the time of European settlement, the wet tropics supported at least 60 clan groups, and at least eight major language groups (Bottoms 2000). The rainforest clans had high population densities (Horsfall 1987), with large semi-permanent camps (Dalrymple 1873, Mulligan 1876, Birtles 1982, Anderson 1984). Permanent walking tracks were common and apparently impressive (*a broad hard-beaten path* (Dalrymple 1865); *splendid native tracks* (Mulligan 1876); *many large paths* (Palmerston 1885–1886); *the largest native path I have seen* (Palmerston 1887)), with major tracks connecting upland and lowland resources (Palmerston 1887, Bottoms 2000). Open areas in rainforest and sclerophyll forest, which were carefully maintained and kept open (and in many cases cleared from the forest), served as campsites and/or ceremonial areas (Palmerston 1885–1886, Palmerston 1887, Lumholtz 1889, Mjöberg 1918, Birtles 1982). The practice of regular burning, for reasons including driving (or attracting) game, improving ease of travel, and for ridding of pests such as leeches, was common (Lumholtz 1889, Tindale 1976, Anderson 1984, Bottoms 2000). Some authors caution that in the Mossman District, the use of fire may have become more common in early European contact days as a tool in frontier conflict, though they also concede it had previously been used to manipulate vegetation (Hill *et al*. 2000). Certain plant resources were maintained by encouraging regeneration after harvest (Bottoms 2000). From the evidence available it is clear that indigenous people were likely to have had substantial influence on the nature of vegetation communities, and the associated fauna.

From the 1840s Europeans were fishing and cutting timber from the Wet Tropics (Bottoms 2000), and from about 1870, small areas of land were taken up for sugarcane plantations, first near Cardwell, and then on the Herbert River delta (Frawley 1983, 2000). The area under sugarcane rapidly expanded during the 1880s; by this time, most of the useful Red Cedar timber, *Toona ciliata*, had been harvested from the lowlands (Frawley 1983, 2000). With support of a South Sea Islander workforce, agricultural expansion accelerated again in the 1890s and early 1900s. A state land development policy in the first decade of the 20th century saw large areas surveyed for cattle farming, and between Tully and Cooktown, large areas were subdivided and cleared in the 1920s (Frawley, 1983, 2000).

In the 1950s there was some realisation that formerly plentiful resources were becoming scarce, but agricultural and pastoral development continued. In 1963 for example, the pastoral property King Ranch (21 000 ha in the Tully River Valley) was salvage-logged by the Forestry Department, and then cleared (Frawley 2000). Small areas of land continued to be cleared. In the late 1980s and early 1990s large areas of lowlands vegetation were clear-felled on State lands for the establishment of pine plantations, particularly in the Cardwell area and the Herbert floodplain (Abergowrie, Broadwater and Lannercost State Forests). At about this time (1989) a rare marsupial, the Mahogany Glider, *Petaurus gracilis*, previously not recorded since its original description in 1883, was re-discovered, clinging to the remnants of habitat confined to the Herbert and Tully lowlands, and critically endangered by clearing (Van Dyck 1993). A subsequent development rush was triggered, amid fears of impending clearing restrictions, and a large proportion of the remaining arable land in the Herbert and Tully lowlands (within the range of the Mahogany Glider) was cleared of timber.

Shortly before the introduction of State tree clearing laws in 2000 (Vegetation Management Act 1999), another minor clearing surge was initiated, but by this time most of the available land had been cleared, with the remainder either within reserves, or too swampy or saline to clear. The remnant native vegetation on the floodplain of the wet tropics is today (except for estuarine areas) severely depleted, with many of the remnants existing in various stages of weed invasion and structural alteration due to cessation of burning, timber harvesting and other activities.

This paper presents pre-clearing maps of the cleared areas of the coastal lowlands of the Wet Tropics, with vegetation patterns reconstructed following standard criteria for pre-clearing regional ecosystems coverage elsewhere in Queensland (Neldner *et al*. 2005). No previous project has attempted pre-clearing mapping of such a large proportion of the Wet Tropics at such a detailed vegetation community level. A second paper presenting pre-clearing mapping of the (higher elevation) Atherton tablelands of the Wet Tropics, is planned. These two areas, combined with the remnant vegetation and regional ecosystem mapping adapted from Stanton and Stanton (2005), form a bioregion-wide pre-clearing vegetation coverage of the Wet Tropics. This full coverage exists as a joint Wet Tropics Management Authority (WTMA) and Queensland Herbarium product (Queensland Herbarium & Wet Tropics Management Authority 2005), and is currently used by the Queensland Department of Natural Resources and Water (DNRW) for the administration of Queensland vegetation management legislation.

Methods

The coastal lowlands of the Wet Tropics study area

The study area covers the coastal lowlands area (508 044 ha) of the Wet Tropics bioregion, north-eastern Queensland (Goosem *et al*. 1999; Environmental Protection Agency 2003a), and extends from near Cooktown south 420 km, almost to Townsville (latitude 15° 30' to 18° 20' longitude 144° 50' to 146° 40') (Figure 1). Altitude ranges from sea level along the coast to approximately 200 m where the lowlands meet low foothills, or end abruptly at the bottom of steep mountainous terrain. Annual rainfall varies from approximately 1200 mm near Bluewater (at the southern end of the study area) to 4200 mm at Babinda (in the centre). The area has a tropical climate, and the natural vegetation includes eucalypt open forests, tea tree woodlands, dense tea tree swamps, sedgelands, grasslands and rainforest. Most of the original rainforest was confined to the fertile river and creek levees, with the exception of the highest rainfall areas where rainforest covered entire valleys. Approximately 10% of the study area today lies within the Wet Tropics World Heritage Area.

The Wet Tropics coastal lowlands are mainly within three subregions: Herbert (Herbert River valley), Tully (Tully and Murray River valleys) and Innisfail (valleys of the Barron, Mulgrave, Russell and Johnstone rivers, and Liverpool Creek), with minor areas in the Daintree-Bloomfield (Bloomfield, Daintree, Mossman River valleys and associated ranges and tablelands) and Macalister subregions (Macalister Range) (Goosem *et al*. 1999). Only minor pre-clearing areas were mapped in the Macalister subregion (these are included within the analysis and discussion of the Daintree-Bloomfield subregion).

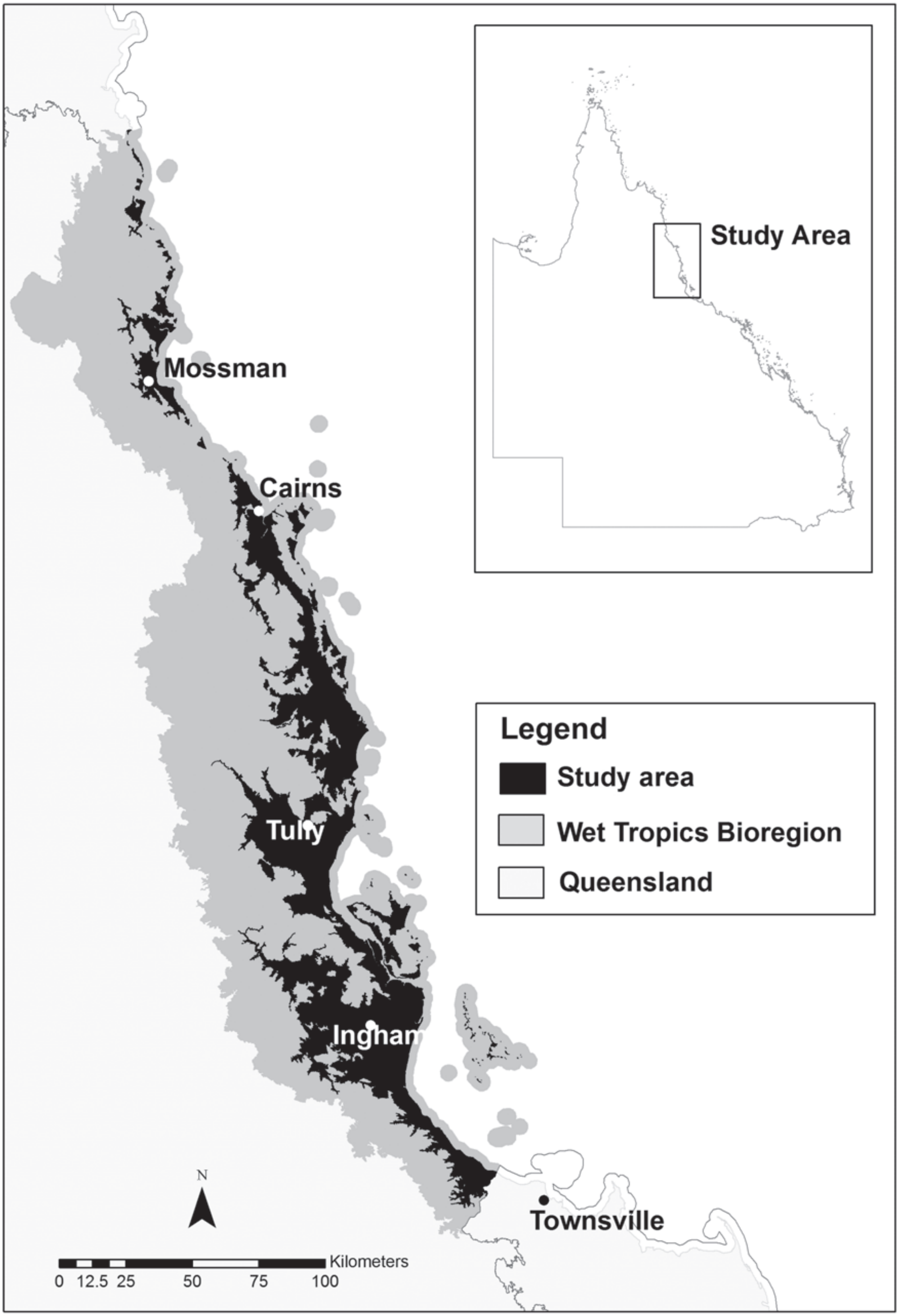

Fig. 1. The coastal lowlands of the Wet Tropics study area.

The Herbert is the driest subregion (annual rainfall 1200–2200 mm), with a very broad, alluvial plain, with fertile river levees and prior streams, and extensive poorly-drained plains. The vegetation consists of woodlands of *Eucalyptus platyphylla* and *Melaleuca viridiflora*, open forests and dense stands of *Melaleuca quinquenervia*, *Corymbia tessellaris* and *Eucalyptus tereticornis*, rainforests (along the Herbert River levee) and extensive mangrove systems.

The Tully subregion has a higher rainfall (annual rainfall 2200–3800 mm) and supports swampy *Eucalyptus* and *Melaleuca* forests, *Eucalyptus tereticornis* forests, grasslands, and rainforest (particularly in the upper Tully Valley, and along the Tully and Murray levees). It contains extensive coastal dune systems, including large areas of older dunes of Pleistocene age.

The Innisfail subregion has a similar, to slightly higher rainfall (annual rainfall 2000–4200 mm) than the Tully subregion, and has a greater area of well-drained, fertile soil (with large areas of basalt), supporting rainforest, or in swampier areas, palm swamps. Extensive dune systems and paperbark swamps are also a feature.

The near-coastal lowlands of the Daintree Bloomfield subregion are moderately wet (annual rainfall 1900–3500 mm) and fertile, and the alluvial plains are small and narrow, and usually backed by steep mountain ranges. Rainforest is common, and where swampy is often dominated by fan palms. *Eucalyptus* forests tend to be dense and dominated by species such as *Eucalyptus pellita*, *Eucalyptus leptophleba*, and *Eucalyptus tereticornis*, whilst drier, more northern areas, are dominated by more open forests of *Eucalyptus nesophila*. Swampy areas often support dense stands of *Melaleuca quinquenervia*.

The boundaries of the subregions in this study differ slightly from the current Queensland Herbarium subregional boundaries (Environmental Protection Agency 2003a) as boundaries were adjusted to match polygon boundaries of the new Wet Tropics mapping (Queensland Herbarium & Wet Tropics Management Authority 2005). Isolated hills in the floodplain were included if below 220 m altitude.

Within the subregional boundaries described above, the coverage of Queensland Herbarium and Wet Tropics Management Authority (2005) was used for area calculations in this paper. This coverage consists of original pre-clearing mapping produced by the authors, joined to the remnant vegetation mapping of Stanton and Stanton (2005). The colour map series on CDROM accompanying this paper (Maps 1 to 4) were generated to show only major areas of original pre-clearing work (the relatively intact (i.e. not cleared today) section from Rollingstone to Bluewater, for example, is not included on the colour maps).

Previous pre-clearing studies of the Wet Tropics Bioregion

Previous work describing or mapping pre-clearing vegetation in the Wet Tropics bioregion include pre-European mapping done by CSIRO for the Herbert River Valley (Johnson *et al*. 2000; Johnson & Murray 1997). Johnson *et al*. (2000) used a series of different aged aerial photos including the oldest aerial photos available, to map structural vegetation types, though it was limited to a small number of vegetation classes (8 natural vegetation patterns).

Accad (2003) showed that vegetation distribution in the Wet Tropics (including prediction over cleared areas) can be modelled by integrating a data model, a statistical model, and an ecological model using sophisticated GIS techniques and rule-based systems. Accad presented a pre-clearing vegetation map for the Innisfail lowlands, at a scale of approximately 1:50 000 to 1:70 000 (scale estimated by Accad (2003)) using a pre-release version of the Stanton and Stanton (2005) remnant vegetation coverage, with vegetation types grouped into twenty Tracey (1975) floristic associations. The results of this work present a more rapid, and less subjective alternative to traditional methods, as that used in this study, and may in the future be used as an alternative or in combination with these methods.

Hilbert and Ostendorf (2001) modelled vegetation using artificial neural networks, which use climate variables, terrain variables and soil classes, to predict relative suitability of environments for particular forest types. The models used simple structural types (rainforest versus sclerophyll) and attempted to predict up to 15 forest classes. As a tool to predict pre-clearing vegetation, this method was found to be 88% accurate on the Atherton Tablelands (accuracy determined by comparison with existing vegetation remnants), though predictions for the coastal lowlands proved much less accurate, due to the poorer resolution of soil parent material data for this area.

To estimate the pre-clearing extent of land types in the Herbert and Tully subregions, Kemp and Morgan (1999) and Kemp *et al*. (1999) created remnant land type mapping, and extrapolated this using soils and land-system coverages, This work provided useful rapid estimates, but was limited to the Herbert and Tully subregions, and is not as accurate as detailed mapping work from historical aerial photography.

Hill *et al*. (2000) created an 1890 vegetation map of the Mossman District using surveyor's plans, resulting in a map of four major vegetation classes. This work was a part of a project designed to establish whether fire regimes in the wet tropics have been responsible for rainforest decline, in the context of changes brought about by European occupation.

Vegetation classification and scale

The classification and scale used for the project was strongly influenced by the current-day Wet Tropics Bioregion vegetation mapping of Stanton and Stanton (2005). This coverage, adapted by the Queensland Herbarium to include regional ecosystems (Queensland Herbarium & Wet Tropics Management Authority 2005), formed a framework for the pre-clearing mapping. Pre-clearing interpretation commenced at the boundaries of this current-day mapping, and proceeded outwards into cleared areas; the same vegetation units were adopted to ensure a seamless coverage. The Queensland Herbarium & Wet Tropics Management Authority (2005) “pre-clearing” coverage of the Wet Tropics Bioregion is therefore a combination of current vegetation and pre-clearing vegetation. This closely approximates a true pre-clearing map except where there have been dramatic changes in vegetation structure since the middle of the century (e.g. tracts of vegetation undergoing rainforest invasion).

The Stanton and Stanton (2005) units were defined by distinct aerial photo-patterns, which represent a unique combination of canopy dominance and structure, and sometimes, distinct landforms. Each vegetation polygon was assigned a prefix code which represents one of 14 geological classes (Stanton & Stanton 2005). The combination of this prefix class and the vegetation code provided a unit which reflects a combination of vegetation and geology, and which is a suitable building block for construction of regional ecosystems (Goosem *et al.*, 1999). To create a regional ecosystem coverage (Queensland Herbarium & Wet Tropics Management Authority 2005), each of the geological/vegetation combinations were assembled into related groups and assigned regional ecosystems according to the Queensland Herbarium’s current criteria (Neldner et al. 2005).

In order to simplify some components of the analysis and discussion, and for comparison with other pre-European vegetation mapping projects, regional ecosystems were further grouped into broader vegetation groups for this paper. These groups are based on dominant taxa and landform, and differ slightly to the Broad Vegetation Groups used by Queensland Herbarium & Wet Tropics Management Authority (2005). For non-rainforest vegetation, the vegetation community and regional ecosystem descriptions utilise the structural classes from Neldner (1984), which are based on Specht (1970) (refer also to Neldner *et al.,* 2005). Rainforest is classified and described using Webb’s classification. (Webb 1978, Tracey 1982). Plant scientific names follow Bostock and Holland (2007). Common names are listed in Table 1, and were chosen from local texts, or from those commonly used by botanists and landowners in the area.

The approximate scale of the Stanton & Stanton (2005) remnant vegetation mapping was 1:25 000. Though we attempted to map at a similar scale, for some areas we only had 1:80 000 aerial photos; therefore less detail is shown in these areas. Overall the average scale of the pre-clearing work is approximately 1:50 000.

Table 1. List of plant scientific and common names.

Names are from local texts, or are those commonly used in the area.

Scientific name	**Common name**
Acacia celsa	brown salwood
Acacia crassicarpa	beach wattle
Acacia mangium	black wattle
Allocasuarina spp.	sheoaks
Allocasuarina littoralis	black sheoak
Annona glabra	pond apple
Archontophoenix alexandrae	feather palm
Chrysopogon aciculatus	Mackie's pest
Corymbia clarksoniana	Clarkson's bloodwood
Corymbia intermedia	pink bloodwood
Corymbia tessellaris	Moreton Bay ash
Corymbia torelliana	cadaghi
Cynodon dactylon	couch
Eucalyptus cloeziana	Gympie messmate
Eucalyptus drepanophylla	ironbark
Eucalyptus leptophleba	Molloy red box
Eucalyptus nesophila	Melville Island bloodwood
Eucalyptus pellita	red mahogany
Eucalyptus platyphylla	poplar gum
Eucalyptus portuensis	white mahogany
Eucalyptus tereticornis	forest red gum
Heteropogon triticeus	giant spear grass
Imperata cylindrica	blady grass
Licuala ramsayi	fan palm
Lophostemon suaveolens	swamp mahogany
Melaleuca dealbata	cloudy tea-tree
Melaleuca leucadendra	weeping paperbark
Melaleuca viridiflora	broad leaf tea-tree
Melaleuca quinquenervia	swamp paperbark
Mimosa pudica	sensitive weed
Mnesithea rottboelloides	northern canegrass
Myrmecodia beccarii	ant plant
Schoenoplectus litoralis	bulrush
Sorghum nitidum	brown Sorghum
Sorghum spp.	native Sorghum
Sporobolus virginicus	saltwater couch
Syncarpia glomulifera	turpentine
Toona ciliata	red cedar
Urochloa mutica	para grass

Mapping process

The pre-clearing mapping was based on a number of key sources of varying detail, mostly in digital coverage form, and displayed as layers in the Arcview 3 GIS application. Colour 1:25 000 scale aerial photos (from years 1992 to 2002) were rectified and stitched together to create a mosaic, which formed the mapping base (done by the Wet Tropics Management Authority with some assistance from the Queensland Herbarium). This mosaic was, for the majority of the study area, registered to the 1:50 000 geodata drainage layer. Towards the end of the project, Landsat satellite imagery produced by the Queensland Department of Natural Resources for their Statewide Landcover and Trees Study (SLATS) project, was considered to be a more accurately registered base, and therefore the remaining study area was aligned to this. Future releases of the coverage will involve a progressive updating of the remaining area to match this satellite imagery.

Black and white aerial photos showing pre-clearing natural vegetation were considered the most reliable depiction of pre-clearing vegetation and were used stereoscopically for direct vegetation interpretation wherever possible. The earliest aerial photos that provide full coverage of the Wet Tropics are the 1960–61 1:80 000 scale series; these were used for areas that appeared to be uncleared at that time (such as the lower Herbert subregion). For those areas already cleared on 1960–61 series, older photographs were used. Aerial photos used included 1937 1:7000 scale photos from the Cairns city area, and 1943 1:23 000 for the Herbert floodplain (Table 2, Appendix 1).

Although a range of different aged aerial photos were often used for a given area, a record of the oldest photos used was kept, so that further discoveries of older aerial photographs can be used for map updates. Line-work on recent colour aerial photography used for the adjacent remnant vegetation (Stanton & Stanton 2005) was frequently consulted to ensure consistency of photo-pattern interpretation between the two projects.

Whilst the older series (limited area) photographs were viewed stereoscopically for identification of patterns, the line-work itself was drawn on 1960–61, 1:80 000 series (using overlays). In some areas (e.g. Cairns city) line-work was first drawn on the older series photographs (1937, 1:7000 scale) and then transferred by eye to the 1960–61, 1:80 000 series. Every effort was made to retain the detail of the finer scale photos. All overlays have been kept by the Queensland Herbarium.

Vegetation patterns for areas already shown as cleared on the oldest aerial photos were re-constructed using other sources including original surveyors' plans (e.g. Figure 6) (archived

Table 2. Pre-1970s aerial photos utilised (refer also to Appendix 1).

Mapsheet (1:100 000)	Set name	Scale	Year	Runs
Ingham Cardwell, Kirrama, Kangaroo Hills	Ingham Program Aerial Photography	1:80 000	1961	1-10
Ingham, Kangaroo Hills	Ingham RAAF	1:23 000	1943	1-11, west key, east key
Ingham	Ingham Tri-met (Ingham to Townsville Vertical (Eastman Topographic safety), Cairns to Townsville	1:44 000	1942	ctot 1_165v-262v
Kirrama	Mt Graham 43 Project Aerial photography	1:34 000	1943	5-6
Kangaroo Hills	Oak Hills 43 Program Aerial photography	1:25 000	1943	1-10
Tully, Innisfail, Cooper Point, Bartle Frere	Innisfail Program Aerial Photography	1:80 000	1961	1-10
Tully	R.A.A.F. Tully Area "A"	1:15 000	1937	1-13
Tully	R.A.A.F. Tully Area "C"	1:15 000	1937	1
Tully	Clump Point-Tully 51 Program Aerial Photography	1:24 000	1951	8
Innisfail	Palmerston-Innisfail 43 Program Aerial Photography (K. D. 817 & 819)	1:24 000	1943	1-10
Cooper Point, Bartle Frere	Cairns - Innisfail Transmission Line	1:23 000	1949	3-6
Bartle Frere	Bartle Frere 43 Program Aerial Photography	1:23 000	1943	1-10
Bartle Frere, Cairns	8th Photo Sqdn; U.S.A.A.F. Macalister Range, Cairns, Gordonvale	1:40 000	1942	A - G
Bartle Frere, Cairns	Cairns City 37 Project Aerial Photography	1:7 000	1937	1-8
Tully, Innisfail	Palmerston-Innisfail 43 Program Aerial Photography	1:24 000	1943	1-10
Cairns, Rumula, Mossman	Mossman-Cairns Program aerial photography	1:80 000	1960	2-7
Mossman	Mossman Area	1:24 500	1944	E-Tie, Q 6-10
Rumula	Rumula-Macalister	1:11 000	1969	Coast Tie

by the Department of Natural Resources & Mines). Appendix 2 shows the area for which surveyors' plans were used.

Fensham (1989) pioneered the use of historical records for detailed information on the nature of early-European vegetation, and created maps with complex vegetation boundaries largely sourced from historical surveyors' plans (Fensham & Fairfax1997). The use of this historical resource is now standard Queensland Herbarium practice (Neldner et al. 2005). For this work we also created a digital representation of the plans to view with other layers in Arcview 3.

Identification of pre-clearing vegetation also required interpretation of landform patterns on cleared parts of aerial photos, using a stereoscope. We also used field knowledge of the ecological requirements of each vegetation unit as well as evidence from any surrounding remnant patches (both from field inspection, and from Stanton & Stanton 2005) to assist with this process. Field checking involved two short field trips, mainly aimed at examining very small remnant stands of trees, to assist with type allocation in areas with minimal information.

Soil coverage patterns (Murtha 1986, Murtha 1989, Wilson & Baker, 1990, Canon *et al*. 1992, Murtha et al. 1996) assisted classification and location of some vegetation types - particularly those now close to extinction. Soil boundaries were generally re-interpreted using stereoscopic aerial photo interpretation. Quaternary geological mapping (Holmes *et al*. 1991) was particularly useful for locating obscure Pleistocene-age dune systems (as were the soils coverages), and some of the more recent geology coverage (from Department of Natural Resources & Water) was also useful. Previous vegetation maps for particular areas (eg. Tait 1994) were also consulted since they often included vegetation that is now cleared. Internal reports on file at the Environmental Protection Agency, Townsville (Cumming 1992a, 1992b, 1993, 1995a, 1995b, and Kemp 1996) and Department of Primary Industries, Mareeba (Perry 1995) were also consulted for the same purpose. Vegetation site data collected by the Queensland Herbarium and EPA, Townsville was also used - particularly for those areas that have subsequently been cleared. The majority of this vegetation data is held in the Queensland Herbarium's CORVEG database (Queensland Herbarium, Brisbane).

The aerial photos (along with their pre-clearing line-work on overlays) were scanned and registered to the Wet Tropics Management Authority aerial photo mosaic (described previously) using either ArcGIS 8 or ERDAS Imagine 8. The line-work was then digitised by tracing the pre-clear lines in Arcview 3 or ArcGIS 8 (depending on the user), creating shapefiles. While digitising the pre-clear lines it was necessary to take care that the linework aligned with features on the aerial photograph mosaic. The vegetation community for each polygon was entered into point shapefiles. Conversion to polygon coverages and any final cleaning and editing was carried out in ArcInfo Workstation 8.

Several checks of the coverage were carried out by colouring the coverage (on screen) in a logical manner (eg. colours reminiscent of the shading of the photo-patterns) enabling rapid identification of geological or vegetation labelling errors. Visual comparisons were made with previous vegetation, soils and geological coverages. A comparison of the resulting coverage of pre-clearing vegetation communities with the soils coverages was made to assist with explanations on the distribution of some of the vegetation communities. The soils coverages were intersected with pre-clearing vegetation coverage to provide statistics of area of each soil type by vegetation community.

In addition, each vegetation community was displayed individually on screen, in order to check polygons in unexpected locations or habitats. Finally the coverage was joined to the remnant vegetation version of the coverage (adapted from Stanton and Stanton 2005) resulting in a combined coverage with both pre-clearing and remnant attributes that can by displayed either as a pre-clearing or a remnant vegetation map.

Confidence in accuracy of the pre-clearing mapping

The accuracy across the pre-clearing coverage varies according to the variety and quality of source data available, and the confidence in interpretation. The Stanton and Stanton (2005) current-day mapping was considered an accurate data source as it is based on standing vegetation visible on recent, large scale (1:25 000) colour aerial photography, and supported by a field sampling component. Old aerial photography was also considered a very useful data source, and the older the better, although the quality (often dependent on the time of day flown, as well as other factors) was also extremely important. The presence of land survey plan information was usually beneficial, although some plans were more useful than others, due to differences in detail of surveyor's notes. Also, on aerial photos some vegetation communities have a very distinct and unique pattern, whilst others are more difficult to distinguish from other similar types.

Separate qualitative reliability codes were assigned for the accuracy of the line-work (boundaries) and polygon attributes based on the above factors. These codes are assigned to each polygon, and are recorded within the map coverage attributes "L" (accuracy of polygon boundary) and "V" (accuracy of vegetation code). The rules and codes used are described in Neldner *et al*. (2005). To create a map of accuracy for the Wet Tropics lowlands, the attributes within "L" and "V" were assigned the scores A=3, B=2, and C=1, then the scores for "L" and "V" for each polygon were combined to produce a score from 2 to 6.

Comparison with previous pre-clearing vegetation coverages

The pre-clearing coverage of the current study was compared with the results of two previous pre-European mapping coverages, Accad (2003), and Johnson *et al*. (2000). The vegetation communities of the current study were grouped to match the groupings used in these studies, and the resulting coverage were compared to each of the previous coverages in turn. The comparison was made by first intersecting the current coverage with the previous coverage (and excluding areas not common to both). Then for each vegetation group a percent similarity was calculated (area of vegetation type "a" where both coverages agree/area of vegetation type "a" in either coverage) X100). Possible reasons for differences between the coverages of the three studies were briefly investigated by examination of the respective project methodologies.

Table 3. Relative proportion of pre-clearing vegetation groups in the Wet Tropics coastal lowlands.

(Vegetation groups occur on alluvium unless specified. "Open forest" and "woodland" here means eucalypt and *Lophostemon* dominated open forest and woodland respectively.)

Vegetation Group	No. of Regional Ecosystems	Area (ha)	% of coastal lowlands
open forests	15	124 450	25
rainforest	11	124 356	24
estuarine	5	55 806	11
teatree	1	38 069	7
woodland	4	37 842	7
paperbark forests	5	37 607	7
grassland and sedgeland	4	28 327	6
dune open forests	2	17 229	3
dune paperbark forests	3	8 580	2
palm swamps	2	7 439	1
open forests on hills	18	7 107	1
rainforest on hills	7	5 438	1
stream beds	1	5 013	<1
dune rainforests vinescrubs	3	4 189	<1
woodland on hills	3	1 356	<1
casuarina	1	1 341	<1
dune casuarina	1	1 323	<1
acacia	1	1 043	<1
dune shrublands and heathlands	2	803	<1
fernland	1	462	<1
teatree on hills	1	174	<1
shrubland on hills	4	46	<1
acacia on hills	2	31	<1
grassland and sedgeland on hills	1	12	0
TOTAL		**508 044**	**100**

Evidence of vegetation manipulation by indigenous inhabitants

Though not a primary aim of this project, some evidence for pre-European manipulation of the environment by the aboriginal inhabitants was noted by the authors, from explorers journals and diaries, and indirectly by visual comparison of the wet tropics pre-clearing vegetation mapping with soils mapping. Some support for this evidence was drawn from the vegetation of the Goorganga Plains of the Central Queensland Coast bioregion (Kemp *et al*. 2001).

Conservation value of vegetation communities and regional ecosystems

An indication of the reduction in area of each vegetation community since pre-clearing times was derived from the vegetation coverage of the current project by comparison of area figures within the pre-clearing attribute and remnant 2003 attribute. This was further broken down into subregions to provide an accurate picture of natural vegetation loss at a subregional level.

Results

Pre-clearing vegetation types and regional ecosystems of the Wet Tropics coastal lowlands

257 vegetation communities, grouped into 98 regional ecosystems, and 24 broad vegetation groups, were mapped in the Wet Tropics coastal lowlands pre-clearing coverage. These are all listed in Appendix 3. The following coloured maps are on the accompanying CD-ROM

Map 1 – Pre-clearing vegetation of the lowlands of the Herbert Subregion, Wet Tropics Bioregion (1:100 000 scale).

Map 2 – Pre-clearing vegetation of the lowlands of the Tully Subregion, Wet Tropics Bioregion (1:100 000 scale).

Map 3 – Pre-clearing vegetation of the lowlands of the Innisfail Subregion, Wet Tropics Bioregion (1:100 000 scale).

Map 4 – Pre-clearing vegetation of the lowlands of the Macalister and Daintree-Bloomfield Subregions, Wet Tropics Bioregion (1:100 000 scale).

The regional ecosystem attribute was chosen for map display, and only the larger pre-clearing mapping areas are shown (minor areas surrounded by remnant vegetation are not included). The full coverage (including both pre-clearing and remnant mapping and both vegetation community and regional ecosystem attributes) can be obtained from the Queensland Herbarium, Environmental Protection Agency, Brisbane.

A summary of the pre-clearing broad vegetation groups across the coastal lowlands is given in Table 3. The most common ecosystems were eucalypt and *Lophostemon* open forests (15 ecosystems; totalling 25% of the coastal lowlands), rainforests (11 ecosystems; 24%) and estuarine systems (5 ecosystems, 11%) (Table 3). Also common were tea-tree woodlands/open forests (1 ecosystem; 7%) eucalypt woodlands (4 ecosystems; 7%), and paperbark open forests (5 ecosystems 7%). Moderately common were grasslands (4 ecosystems; 6%), dune eucalypt forests (2 ecosystems; 3%) dune paperbark open forests (3 ecosystems; 2%) and palm swamps (2 ecosystems 1%) (Table 3). The predominant vegetation on the isolated low hills was eucalypt open forest (18 ecosystems; 1%) and rainforest (7 ecosystems; 1%). A further 12 vegetation groups (21 regional ecosystems) covered the remaining 3% of the lowlands. The dominant soil types found to be associated with each of the most widespread vegetation communities are provided in Table 4.

Lowland pre-clearing vegetation: Herbert subregion

The most common vegetation groups in the Herbert subregion were the eucalypt open forests (11 regional ecosystems, 34% of the subregion), eucalypt woodlands (2 ecosystems, 19%), tea-tree woodlands (1 ecosystem, 12%), grasslands and sedgelands (3 ecosystems 11%) and estuarine systems (5 ecosystems 9%) (Table 5). Dense paperbark forests (5 ecosystems 6%) and rainforests (4 ecosystems 4%) were moderately common to uncommon (Table 5). A further 13 vegetation groups (29 regional ecosystems) made up the remaining 5% of the subregion (each vegetation group around 1% or less).

The fertile lower Herbert River levee and its former courses (including Palm Creek, Trebonne Creek and Cattle Creek), were densely vegetated with forests of *Corymbia tessellaris*, *Melaleuca dealbata*, *Lophostemon suaveolens*, and *Eucalyptus tereticornis* (regional ecosystem (RE) 7.3.9). These were interspersed with poorly drained areas dominated by stands of *Melaleuca leucadendra* and/or *Melaleuca quinquenervia* (REs 7.3.6, and 7.3.5). Rainforest was generally restricted to the best-drained and most fertile soils; (usually narrow creek and river levees), and took the form of a semi-deciduous notophyll to mesophyll vine forest (RE 7.3.23), or more commonly, a vine forest with emergent *Melaleuca leucadendra* (RE 7.3.25). In a few places, rainforest (RE 7.3.23) covered wider areas such as at the junction of the Stone and Herbert Rivers (approximately 300 Ha), and Gowrie Creek (400Ha), and also the mouth of the Herbert River in the Macknade/Halifax area where broad expanses of rainforest (approx 1700Ha) were interspersed with pockets of *Eucalyptus tereticornis* open forest.

The swampy, seasonally inundated back-plains of the main central and eastern Herbert River floodplain supported large expanses of open grassy plains, sedge-swamps, and lagoons. These included tongues of better-drained soils supporting

Table 4. List of vegetation communities and their dominant soil types. Only vegetation communities > 1000 ha in the soils/vegetation intersect coverage are shown.

The four soil types covering the greatest percent area of the vegetation community are listed (only soils > 5% are shown). Full names and descriptions of soil types are in Canon et al. (1992), Murtha (1986), Murtha (1989), Murtha et al. (1996), and Wilson & Baker (1990).

Vegetation Community	Soil type (% area of vegetation community)
7.1.1	UCG (72), Mg (16)
7.1.2a	UCG (67), Mg (12), ML (10)
7.2.1a	Br (74), Hu (12)
7.2.3a	Hu (63), Cs (10), DLU (7), UCG (6)
7.2.3d	Hu (61), Dt (15), Tk (6)
7.2.3e	Hu (36), Br (26), Ta (13)
7.2.3f	Hu (47), Ka (17), Ku (10), Cs (8)
7.2.4a	Sp (33), Hu 16, Ku (11), Br (11)
7.2.4b	Hu (36), Sp (33), H3 (6)
7.2.8	Hu (50), UCG (13), CS (9)
7.2.9a	Ne (25), Hu (15), He (15), Ku (8)
7.3.1a	He (24), Co (17), Bg (15), He Dv (12)
7.3.1b	Hl (64), Tb (17), Ih (6)
7.3.3a	Ti (30), Tu (13), Co (12)
7.3.4	Co (37), Tu (20), Ti (10), Th (6)
7.3.5a	He (20), Nd (13), Bu (13), Co (7)
7.3.6a	DLU (30), Hl (15), Tb (15), Tr (11)
7.3.7a	Tu (14), Bg (13), Th (12), Ma (8)
7.3.7b	Tu (27), Co (11), Ct (8), Ma (7)
7.3.8a	Lu (14), Cm (12), Pt (11), Th (7)
7.3.8b	As (14), Ln (14), Yr (9), Hl (9)
7.3.8c	Th (28), Lu (11), He (8), Co (7)
7.3.9a	Tb (27), Pl (13), Hb (12), Ih (10)
7.3.10a	Tu (24), Th (10), Li (9), Ms (7)
7.3.10c	Co (25), Tu (24), Ti (11), Ra (5)
7.3.12a	Th (11), Co (8), Tu (7), Li (6)
7.3.12b	Co (17), Tb (11), Bg (10), Tu (9)
7.3.12c	Th (31), Lu (15), Wm (13), Co (10)
7.3.16a	As (12), Mn (11), Ln (10), Hv (9)
7.3.16b	Ag (20), Mn (13), As (13), Bw (11)
7.3.16c	Yr (49), As (19), Hl (18), Ln (9)
7.3.17	Tu (31), Li (22), In (21)
7.3.19a	Bw (20), Hv (19), Cn (11), Th (11)
7.3.20a	Th (10), Pr (7), Vi (6), Ga (5)
7.3.20b	Th (13), Tu (8), Co (7), Ty (7)
7.3.20e	TH (23), Hv (18), Bw (13), Le (7)
7.3.21a	Hv (32), Th (19), Bw (10), HvFv (7)
7.3.23a	Li (30), Hb (20), Mk (13), In (8)
7.3.25a	Mk (13), STC (19),
7.3.28a	Li (31), STC (25), Tu (13)
7.3.32a	Tb (28), Mm (18), Tu (7), Tr (5)
7.3.34	Hl (34), Lh (15), Rp (7), Ln (5)
7.3.40	Vi (12), Th (9), Hb (9), Mk (6)
7.3.44	Ct (26), Ms (19), Bw (9), Cl (8)
7.3.45b	Mn (16), Ms (11), Cl (8), Hv (8)
7.3.45c	Tb (22), Hv (13), Th (13), Hb (9)
7.3.45f	Il (32), Cl (25), Jr (8), Bg (7)
7.3.46	Ag (17), Hb (9), Hl (9), Tb (8)
7.8.1a	Pg (81)
7.8.1b	Eu (85)
7.11.1a	Ga (53), MTN (19), Bi (6), Pg (5)
7.12.1a	Ga (34), MTN (25), Ut (21)

grasslands of *Imperata cylindrica* (RE 7.3.1), as well as hard-setting clay plains with swamp grasses and sedges (RE 7.3.32), and deep permanent lagoons (RE 7.3.29). These formed a virtually continuous plain east from Trebonne almost to Forrest Beach, and south from the Herbert River to Trebonne Creek, and included the plains surrounding Lucy Creek, Cattle Creek and the area now under Ingham township. Figure 2 shows a treeless swamp/grasslands complex in the Cattle Creek/Pomona area which still remains today.

The slightly more elevated back-plains supported extensive *Melaleuca viridiflora* woodlands and open forests (RE 7.3.8), *Eucalyptus platyphylla* woodlands (RE 7.3.16), and in some places (eg. Mountain Creek/Spring creek valley in the vicinity of Pappins Rd.), *Eucalyptus tereticornis* woodlands and open forests (RE 7.3.40). Some areas (still present in Wharps and Lannercost holdings) were laced by numerous narrow bands of the moderately well-drained soils of prior streams, which supported either dense stands of *Lophostemon suaveolens* (RE 7.3.46) or mixtures of *Lophostemon suaveolens, Eucalyptus platyphylla* and *Corymbia clarksoniana* (vegetation community 7.3.16b).

The fertile upper Herbert River (including Abergowrie) and Stone River valleys contained extensive areas of eucalypt and swamp mahogany open forest, predominantly mixtures of *Lophostemon suaveolens, Eucalyptus platyphylla* and *Corymbia clarksoniana* (vegetation community 7.3.16b), and also broad expanses of *Lophostemon suaveolens* open forest (RE 7.3.46), and areas of *Eucalyptus platyphylla* woodland (vegetation community 7.3.16a). Figure 3 illustrates a portion of this area in 1943. Open forests of *Corymbia clarksoniana* (RE 7.3.45) were common along the central and upper Stone River levee.

The upper alluvial fans such as those of the upper Herbert/ Abergowrie area supported relatively dense/tall forests of *Corymbia intermedia, Syncarpia glomulifera, Eucalyptus pellita, Allocasuarina* spp. *Eucalyptus cloeziana* and *Corymbia torelliana* (RE 7.3.20).

A mangrove ecosystem of variable floristic composition (RE 7.1.1) lined the more sheltered northern coast of the Herbert River delta, whilst areas south of Forrest Beach were a mixture of mangroves (RE 7.1.1) saltpan (vegetation community 7.1.2a), *Sporobolus virginicus* grasslands (vegetation community 7.1.2b), and *Schoenoplectus litoralis* swamps (RE 7.1.3). An extensive area of re-worked alluvium, mangrove silt and dune sands occurred in the Orient area, supporting a mixture of estuarine communities and eucalypt, *Acacia* and *Melaleuca viridiflora* open forests (REs 7.3.9 and 7.2.4). The majority of these estuarine complexes remain intact today.

Table 5. Relative proportion of pre-clearing vegetation groups in the Herbert subregion.

(Vegetation groups occur on alluvium unless specified. "Open forest" and "woodland" here means eucalypt and *Lophostemon* dominated open forest and woodland respectively.)

Vegetation Group	No. of Regional Ecosystems	Area (ha)	% of Herbert subregion
open forests	11	61 632	32
rainforest	4	8 530	4
estuarine	5	17 153	9
teatree	1	23 533	12
woodland	2	36 838	19
paperbark forests	5	11 848	6
grassland and sedgeland	3	21 606	11
dune open forests	2	2 372	1
dune paperbark forests	3	991	<1
palm swamps	1	225	<1
open forests on hills	10	1 780	<1
rainforest on hills	2	59	<1
stream beds	1	2 761	1
dune rainforests vinescrubs	3	368	<1
woodland on hills	2	1 306	<1
casuarina	1	1 305	<1
dune casuarina	1	594	<1
acacia	1	60	<1
dune shrublands and heathlands	0	0	0
fernland	0	0	0
teatree on hills	1	52	<1
shrubland on hills	1	3	0
acacia on hills	0	0	0
grassland and sedgeland on hills	0	0	0
TOTAL		**193 016**	**100**

Fig. 2. Swamps of the Cattle Creek floodplain in the Pomona area south of Ingham with sedges, swamp grasses and aquatic herbs (RE 7.3.29a). The swamp features occasional isolated trees such as *Nauclea orientalis* (right hand centre), and is bordered by natural thickets of *Melaleuca quinquenervia*. Swamps such as these were common across the Herbert floodplain.

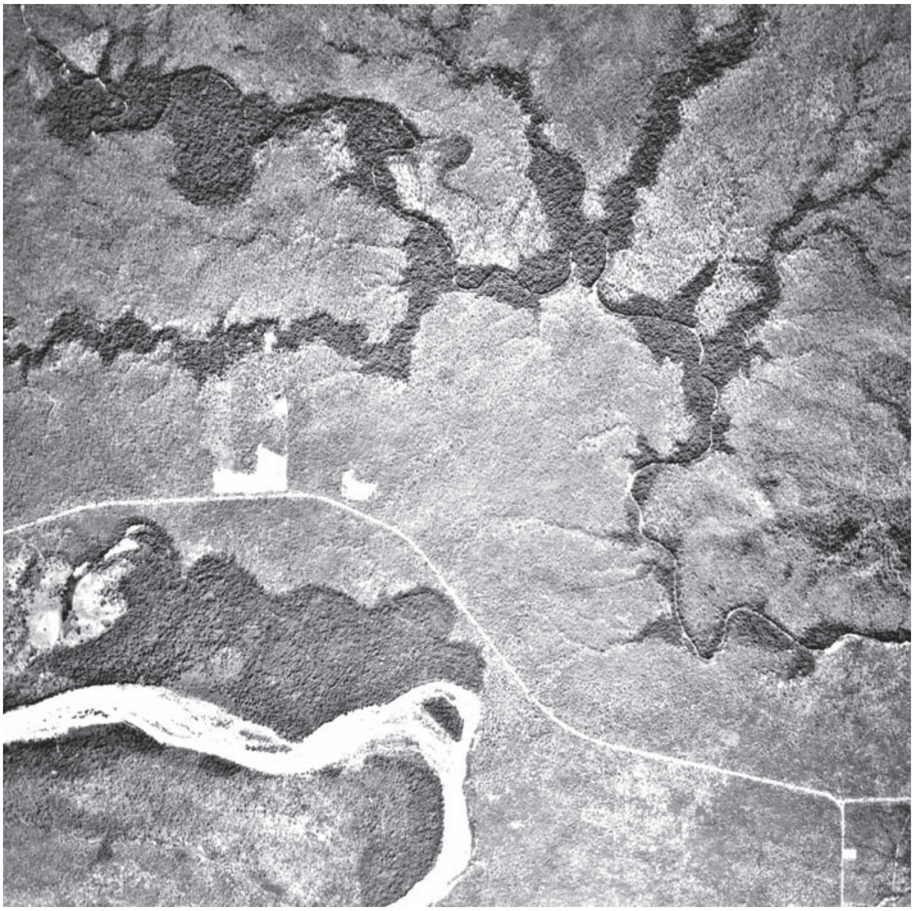

Fig. 3a. 1943 aerial photo (1:34 000 scale) of the upper Herbert floodplain showing the Herbert River, the Ingham-Abergowrie Road, and Elphinstone and Broadwater Creeks (distance across photo is approximately 2.5 km). Although there is clear evidence of disturbance and logging, these photos provide excellent evidence of the former vegetation in this now largely-cleared valley. Dark patterns were rainforest (RE 7.3.23) whilst the (lighter patterned) sclerophyll vegetation was open forest of *Eucalyptus platyphylla*, *Lophostemon suaveolens* and *Corymbia clarksoniana* (REs 7.3.16a, 7.3.16b, and 7.3.46).

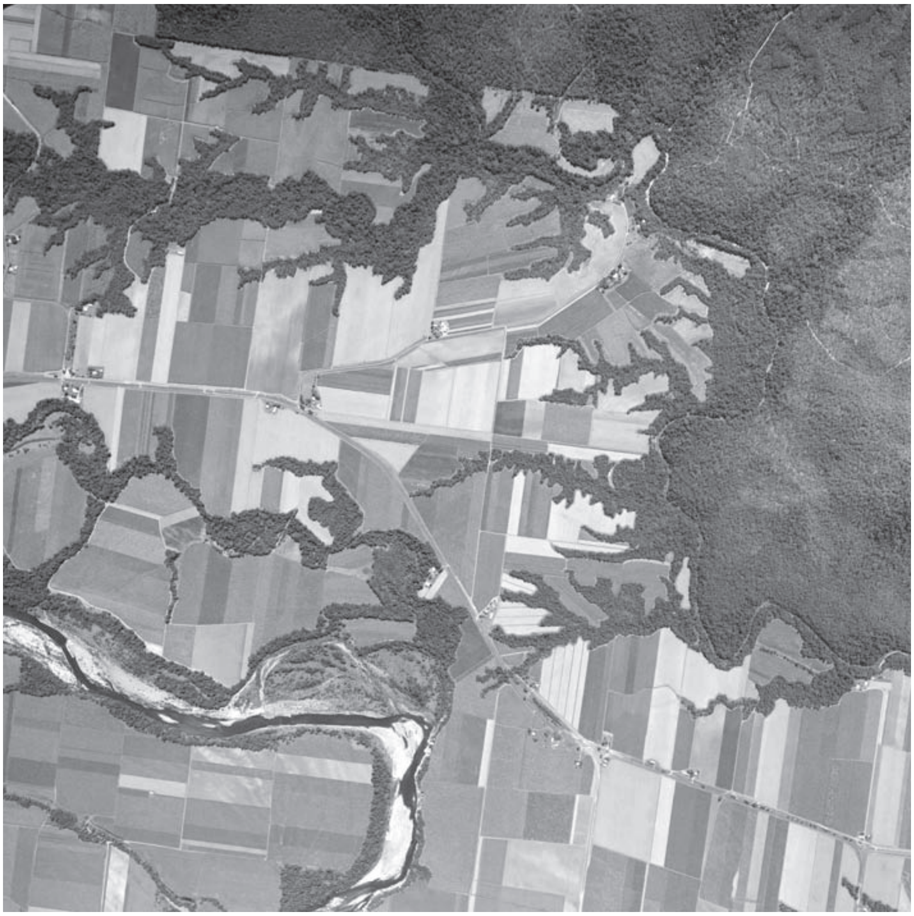

Fig. 3b. 2006 aerial photo of the same area.

The southern, drier parts of the Herbert subregion form a long narrow band of alluvium from Crystal Creek to Bluewater, and were dominated by a complex of *Corymbia clarksoniana*, *Eucalyptus drepanophylla* and *Corymbia tessellaris* open forests and woodlands (RE 7.3.45), *Melaleuca viridiflora* woodlands (RE 7.3.8), and *Eucalyptus platyphylla* woodlands and open forests (RE 7.3.16). A relatively large proportion of this remains uncleared to this date.

Lowland pre-clearing vegetation: Tully subregion

The most common vegetation groups in the Tully subregion were the eucalypt open forests (11 regional ecosystems, 28% of the subregion), rainforests (6 ecosystems, 19%), estuarine systems (4 ecosystems, 16%), paperbark forests (4 ecosystems, 11%) and tea-tree woodlands/open forests (1 ecosystem, 10%) (Table 6). Also moderately common were dune open forests (2 ecosystems, 5%), grasslands and sedgelands (4 ecosystems, 4%), dune paperbark forests (3 ecosystems, 2%), eucalypt open forests on low isolated hills (7 ecosystems, 2%), and palm swamps (2 ecosystems, 2%) (Table 6). A further 8 vegetation groups (12 regional ecosystems) made up the remaining 1% of the subregion (each vegetation group less than 1%).

The stretch of narrow alluvial fans from Lucinda to Cardwell, mainly supported (as it still does today) mangroves (RE 7.1.1), and *Melaleuca viridiflora* open forest (RE 7.3.8), with alluvial fans and creek levees often characterised by *Eucalyptus portuensis* open forest (RE 7.3.21). The deeper soils of the alluvial fans supported forests of *Corymbia intermedia, Syncarpia glomulifera, Eucalyptus pellita, Allocasuarina* spp. and *Eucalyptus cloeziana* (RE 7.3.20). The flat alluvial plains contained areas of *Corymbia clarksoniana* and *Corymbia tessellaris* open forest (RE 7.3.45), and even outlying stands of *Eucalyptus leptophleba* (RE 7.3.44) (more common on the lowlands north of Cairns). Areas of *Melaleuca quinquenervia* occur along narrow drainage lines amongst *Melaleuca viridiflora* open forests, and around the edges of mangroves.

These ecosystems extended north into the southern half and alluvial fans of the Kennedy Valley. The central Kennedy Valley also supported extensive areas of what appears to have been low woodlands with mixed *Melaleuca viridiflora* and *Melaleuca quinquenervia* with scattered *Eucalyptus tereticornis* (vegetation community 7.3.12c). Open forests and woodlands of *Eucalyptus tereticornis* on better-drained soils (RE 7.3.12) extended to the base of the mountain ranges, particularly on the northern and western fans of the valley. A band of mesophyll vine forest (RE 7.3.10) cloaked the levees of the Kennedy, Alma, Boggy Camp and Meunga creeks.

The stretch of alluvial lowlands from the Kennedy Valley to the main Murray floodplain occurs on fairly old alluvial systems with poorly drained soils, and was a mixture of *Melaleuca viridiflora* open forests, low woodlands of mixed *Melaleuca viridiflora* and *Melaleuca quinquenervia* with

Table 6. Relative proportion of pre-clearing vegetation groups in the Tully subregion.

(Vegetation groups occur on alluvium unless specified. "Open forest" and "woodand" here means eucalypt and *Lophostemon* dominated open forest and woodland respectively.)

Vegetation Group	No. of Regional Ecosystems	Area (ha)	% of Tully subregion
open forests	11	36 179	28
rainforest	6	25 323	19
estuarine	4	21 502	16
teatree	1	12 543	10
woodland	1	42	<1
paperbark forests	4	14 348	11
grassland and sedgeland	4	5 019	4
dune open forests	2	6 460	5
dune paperbark forests	3	2 845	2
palm swamps	2	2 168	2
open forests on hills	7	2 543	2
rainforest on hills	3	753	1
stream beds	1	687	<1
dune rainforests vinescrubs	3	304	<1
woodland on hills	0	0	0
casuarina	0	0	0
dune casuarina	1	223	<1
acacia	1	25	<1
dune shrublands and heathlands	1	298	<1
fernland	0	0	0
teatree on hills	1	122	<1
shrubland on hills	0	0	0
acacia on hills	0	0	0
grassland and sedgeland on hills	0	0	0
TOTAL		**131 383**	**100**

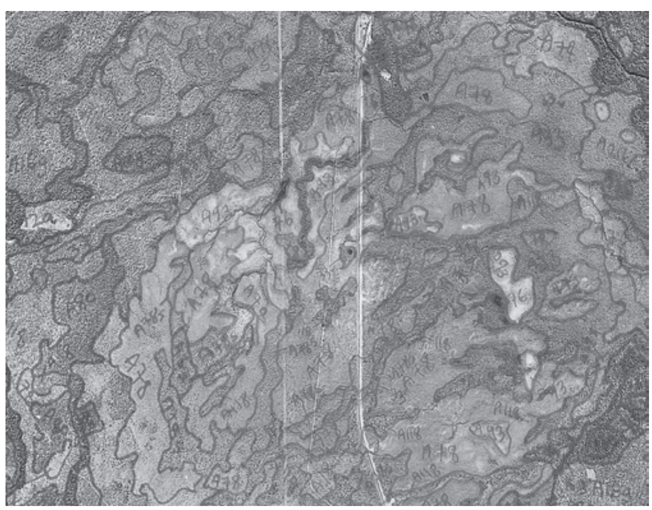

Fig. 4. Pre-clearing linework drawn on a 1961 (1:80 000) aerial photo of the almost flat Tully-Murray floodplain, showing the complex array of small vegetation units due to changes in soils and slight changes in topography.

Fig. 5a. 1937 aerial photo of a part of *Munro Plains* (junction of the Tully River and Davidson Creek), showing the natural grasslands of the plains (RE 7.3.32a) terminating abruptly at the dense rainforests of the Tully River levee (RE 7.3.17). (Distance across photo is approximately 2.5 km)

Fig. 5b. The same area in 2000.

scattered *Eucalyptus tereticornis* (vegetation community 7.3.12c), and *Melaleuca quinquenervia* swamps (RE 7.3.5).

The main Tully-Murray floodplain was an extraordinarily diverse and complex mosaic of vegetation communities and ecosystems. Vegetation community (and/or regional ecosystem) patch size was relatively small, but their occurrences numerous amongst other vegetation communities (and/or regional ecosystems). Visually the result on the pre-clearing vegetation/regional ecosystem maps is a bewildering array of small polygons (Figure 4). The main vegetation types on the older alluvial surfaces included *Melaleuca viridiflora* woodlands/open forests (RE 7.3.8), low woodlands with mixed *Melaleuca viridiflora*, and *Melaleuca quinquenervia* with scattered *Eucalyptus tereticornis* (vegetation community 7.3.12c), and open forests of *Eucalyptus pellita* and *Corymbia intermedia* (RE 7.3.7). Numerous small depressions in the landscape usually supported stands of *Melaleuca quinquenervia* (RE 7.3.5). Areas with better soils associated with younger alluvium supported mixtures of *Eucalyptus tereticornis* open forest (RE 7.3.12 and 7.3.40) and mesophyll vine forest (7.3.10) often with associated *Licuala ramsayi* swamps (RE 7.3.4). This area included what appears to have been the largest *Licuala ramsayi* swamp to have existed in the bioregion (234 Ha in area) (exceeding by 65 Ha the large "Licuala palms" tourist destination which still stands near Mission Beach.). Small, numerous low acid igneous rises in the central west of the floodplain were clothed in *Eucalyptus pellita* and *Corymbia intermedia* open forests (RE 7.12.5), and simple-complex mesophyll-notophyll vine forest (RE 7.12.1).

The fertile levees of the Tully River and Jarrah Creek supported an impressive belt of complex mesophyll vine forest (RE 7.3.17) averaging around 1km wide for it's entire length (approximately 2.4 km across at it's broadest). Associated with the edges/backplains of this levee were relatively extensive open grassy plains (eg the "Munro Plains" area) (vegetation community 7.3.32a) (Figure 5). These plains were often immediately adjacent to the main belt of the Tully River complex mesophyll vine forest. An abrupt, clear-cut boundary (with no gradation) between the rainforest and grassland was common. With very little remaining today to judge their composition it is assumed that these grasslands may have contained *Imperata cylindrica*, *Sarga* spp., *Sorghum nitidum* forma *aristatum*, and swamp grasses such as *Ischaemum australe*. Grasslands appear to have been swampier to the south of the Tully River, in the area surrounding the central Murray River (the area known as the "Bellenden Plains"), and contained numerous open swamps with standing water (RE 7.3.29).

The floodplain immediately north of the Tully township (Feluga area) was cleared very early in the history of European settlement, but apparently supported an extensive area of rainforest (probably RE 7.3.17) covering the entire western half of the valley (over 3km at it's broadest), with swampier rainforests in the central and eastern parts (RE 7.3.10) tending to swamps of *Licuala ramsayi* (RE 7.3.4), and *Melaleuca quinquenervia* (RE 7.3.5). Small pockets of eucalypt open forest were mainly dominated by *Eucalyptus pellita* and *Corymbia intermedia* (REs 7.3.7 and 7.3.20).

The broad expanse of dunes which extend from Cardwell to just north of the Tully River are an extensive Pleistocene system. An enormous range of woodland and forest types occurred on these varied sandy soils, including numerous vegetation communities of the RE 7.2.4 (*Corymbia intermedia*, *Eucalyptus pellita* and *Lophostemon suaveolens* open forest). This regional ecosystem includes an unusual vegetation community dominated by *Eucalyptus portuensis* on dune sands, which can be found on the northern outskirts of Cardwell. Other Pleistocene dune communities included *Melaleuca viridiflora* open forests (RE 7.2.11), and *Melaleuca quinquenervia* swamps (RE 7.2.9). Backed up against this massive dune system were extensive areas of alluvial *Melaleuca quinquenervia* (RE 7.3.5) associated with the regular trapping of floodwaters against the dunes.

The younger (Holocene) dunes, in closer proximity to the ocean, typically supported *Corymbia tessellaris*, *Acacia crassicarpa* and *Corymbia* spp. (RE 7.2.3), as well as swampy swales with *Melaleuca leucadendra*, and low dune ridges with stands of mesophyll to microphyll vine forests (REs 7.2.2 and 7.2.5). The majority of these Holocene dune ecosystems in the Tully subregion remain intact today.

Extensive mangrove and estuarine systems (mainly RE 7.1.1) occurred in the central and northern parts of the Tully subregion, and include substantial areas which fluctuate between freshwater and saltwater assisted by irregular flooding rains caused by cyclones (RE 7.1.3).

Lowland pre-clearing vegetation: Innisfail subregion

By far the most common and widespread vegetation group in the Innisfail subregion was rainforest, which consisted of 10 regional ecosystems and covered 52% of the subregion (Table 7). Open forests were fairly common as pockets within rainforest or as parts of near-coastal complexes or on low hills (13 ecosystems, 13%). Estuarine systems were moderately prominent (4 ecosystems, 8 %) as were paperbark forests (4 ecosystems, 7%), and dune eucalypt open forests

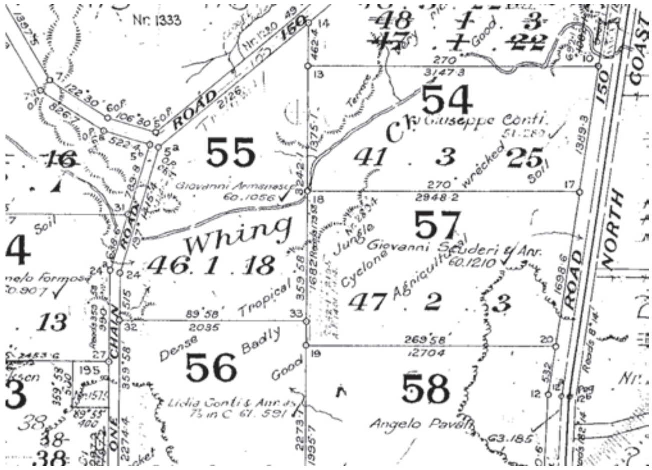

Fig. 6. 1920 survey plan of the El Arish (near Tully) area showing that most of the floodplain was covered in rainforest (eg *tropical jungle* and that much of it was *badly cyclone wrecked*) at the time.

Table 7. Relative proportion of pre-clearing vegetation groups in the Innisfail subregion.

(Vegetation groups occur on alluvium unless specified. "Open forest" and "woodland" here means eucalypt and *Lophostemon* dominated open forest and woodland respectively.)

Vegetation Group 2	**No. of Regional Ecosystems**	**Area (ha)**	**% of Innisfail subregion**
open forests	13	20 095	13
rainforest	10	79 224	52
estuarine	4	11 474	8
teatree	1	1 489	<1
woodland	0	0	0
paperbark forests	4	10 030	7
grassland and sedgeland	4	1 701	1
dune open forests	2	6 875	5
dune paperbark forests	3	3 913	3
palm swamps	2	4 326	3
open forests on hills	11	2 087	1
rainforest on hills	5	4 251	3
stream beds	1	1 290	<1
dune rainforests vinescrubs	3	2 443	2
woodland on hills	0	0	0
casuarina	1	37	<1
dune casuarina	1	336	<1
acacia	1	772	<1
dune shrublands and heathlands	1	505	<1
fernland	1	459	<1
teatree on hills	0	0	0
shrubland on hills	3	23	<1
acacia on hills	2	31	<1
grassland and sedgeland on hills	1	9	<1
TOTAL		**151 368**	**100**

(2 ecosystems, 5%). Less prominent but still relatively common were palm swamps (2 ecosystems, 3%), rainforest on low isolated hills (5 ecosystems, 3%), dune paperbark forests (3 ecosystems, 3%), dune vinescrubs (3 ecosystems, 2%), eucalypt open forest on hills (11 ecosystems, 1%) and grasslands and sedgelands (4 ecosystems, 1%). A further 10 vegetation groups comprising 13 regional ecosystems covered the remaining 2% of the subregion.

The southern end of the subregion (east of Feluga and along the Tully Mission Beach Road) consisted of a mixture of swampy sclerophyll types and rainforest. Swamps of *Melaleuca quinquenervia* (RE 7.3.5) were common especially adjacent to mangroves, changing on slightly higher ground to *Melaleuca viridiflora* open forests (RE 7.3.8) (of a rather sandier soil than more southern examples), and *Eucalyptus pellita* and *Corymbia intermedia* open forests (RE 7.3.7). Rainforests were often of the moderately to more poorly-drained variety (vegetation communities 7.3.10a and 7.3.10c), and towards Mission Beach there was a vast *Licuala ramsayi* forest (7.3.4) which is the second largest example of this regional ecosystem to have existed (and still exists today).

The Mission Beach area was a mixture of rainforests, swamps and dune scrubs including, in the northern Mission Beach area, an extensive zone of complex mesophyll vine forest on basalt (RE 7.8.1). Rainforests on alluvium (RE 7.3.10) were also common here, including swampy rainforest communities and tending to palm swamps (REs 7.3.3 and 7.3.4). A prominent Holocene dune system supported substantial areas of dune vine scrub (REs 7.2.5 and 7.2.1), as well as eucalypt open forests of *Corymbia tessellaris* and *Corymbia* spp. (RE 7.2.3). The swampy swales often supported stands of *Melaleuca leucadendra* (RE 7.2.8) or *Melaleuca quinquenervia* (RE 7.2.9).

The Kurrimine Beach area is the location of an extensive Pleistocene and Holocene beach ridge system which supported large areas of *Melaleuca quinquenervia* (RE 7.2.9) as well as *Eucalyptus pellita* and *Corymbia intermedia* open forests (RE 7.2.4). Much of this remains today. An extensive swampy sclerophyll alluvial plain once extended from this dune system, to beyond Silkwood – as far west as the Old Silkwood area, and south almost to El Arish. This was dominated by *Eucalyptus pellita* and *Corymbia intermedia* interspersed with many small swamps of *Melaleuca*

Fig. 7. *Melaleuca quinquenervia* forest (RE 7.3.5) in the Tully area.

quinquenervia and occasional areas of *Melaleuca viridiflora* woodland, and *Archontophoenix alexandrae* swamps. A large area of *Acacia mangium* and/or *Acacia celsa* open forest (RE 7.3.35) occurred towards the northern end of this sclerophyll zone.

The remaining central and western floodplain (El Arish/Silkwood/Japoonvale) was covered in either complex mesophyll vine forest (RE 7.3.17) (mainly the more fertile creek levees), or simple-complex mesophyll to notophyll vine forest (RE 7.3.10) interspersed with small pockets of relatively dense eucalypt forest (eg *Corymbia intermedia* open forest RE 7.3.19). The rainforest in this valley appears to have been heavily cyclone damaged at the time that the original land survey plans were drawn up (Figure 6).

The largest Pleistocene dune system in the bioregion was divided by the mangroves of the Moresby River and Mourilyan Creek, and occurred from Cowley Beach inland to almost as far west as Martyville near the Bruce Highway (3km south of Mourilyan), and north almost to Etty Bay. Most of this is now cleared, but it appears to have supported large areas of complex mesophyll or mesophyll vine forest (RE 7.2.1), and would have been by far the largest occurrence of dune vine forests in the Wet Tropics. The extensive Cowley Beach Holocene dune system to the east of the mangroves remains intact today, and is supported by a swampy complex of *Melaleuca quinquenervia* shrublands and open forests, and *Melaleuca viridiflora, Lophostemon suaveolens* and *Allocasuarina littoralis* open forests (REs 7.2.11 and 7.2.9), as well as areas of *Acacia crassicarpa* dominated open forest (RE 7.2.9).

Behind the dunes lay an extensive belt of alluvial rainforest from as far north as the North Johnstone River south to Liverpool Creek (Cowley), including the better developed complex mesophyll vine forest (RE 7.3.17) on the more fertile creek levees, and simple-complex mesophyll to notophyll vine forest (RE 7.3.10) on the surrounding lowlands. This includes the township of Innisfail (where there are also metamorphic rises which supported complex mesophyll rainforest (RE 7.11.1). To the west of South Johnstone, the entire Palmerston area, and the north-west of Mena Creek are part of an extensive basalt flow, and once supported the most well-developed and complex of wet tropics rainforest ecosystems - complex mesophyll vine forest on basalt (RE 7.8.1). This was indeed a vast expanse, covering over 11,000 hectares. Eastern edges of the basalt flow probably supported a poorer, swampier type of basalt rainforest (vegetation community 7.8.1b) on the more poorly drained Eubenangee soil series (Murtha 1986), though evidence of the existence of this vegetation community (ie remnant rainforest patches) are now scarce.

From the North Johnstone River through to Babinda (east of the Bruce Highway) was a mixture of undulating metamorphic and basalt rises, interspersed with low, often swampy areas, mainly forested with simple to complex mesophyll to notophyll rainforest (RE 7.3.10), *Archontophoenix alexandrae* forests (RE 7.3.3), and *Melaleuca quinquenervia* open forests (RE 7.3.5) (Figure 7). A few small open grassy plains (RE 7.3.1) were found in this area, and were best developed at Eubenangee (extending further east and north from the current grassland extent at Eubenangee Swamp today). As well as extensive *Melaleuca quinquenervia* open forests, and *Archontophoenix alexandrae* forests (RE 7.3.3), southern parts of the Babinda swamp appeared to have supported a kind of open sedge/fern swamp with scattered pioneering rainforest shrubs and trees (RE 7.3.30).

From the Russell River Valley through to Quingilli (about 8km SE of Gordonvale) was a more or less continuous valley of rainforest and palm swamps. The broad fertile levees of the mid and upper Russell River, and the Babinda Creek supported complex mesophyll vine forest (RE 7.3.17), whilst the surrounding plains a more simple to complex notophyll to mesophyll vine forest (RE 7.3.10), and numerous sizeable *Archontophoenix alexandrae* swamps (RE 7.3.3). The broad Mulgrave River levee apparently supported a drier form of levee rainforest: a simple-complex semi-deciduous notophyll to mesophyll vine forest (RE 7.3.23), perhaps due to the gradual decrease in rainfall north (from the highest rainfall area around Mirriwiini, near Babinda).

North of Quingilli through Gordonvale and Edmonton areas, sclerophyll forest became prominent again, corresponding with the drop in rainfall. Open forests of *Eucalyptus tereticornis* (REs 7.3.40 and 7.3.12) were common, along with dense stands of *Melaleuca dealbata, Lophostemon suaveolens* and *Corymbia tessellaris* (RE 7.3.9) and occasional *Melaleuca quinquenervia* swamps (RE 7.3.5). Two open grassy plains occurred to the east and south-east of Aloomba.

The Mulgrave River valley was mostly rainforested, with either rainforest on alluvium (RE 7.3.23 on the levees and 7.3.10 on the surrounding alluvium) or on basalt (RE 7.8.1 on the flats and RE 7.8.14 on the foothills)

The broad, very flat floodplain from Gordonvale to Redbank (south of Trinity Inlet) appears to have been forested in a somewhat puzzling very extensive low dense forest of *Acacia* species, *Corymbia clarksoniana*, *Melaleuca dealbata*, *Melaleuca viridiflora* and *Melaleuca quinquenervia* (the apparently extinct vegetation community 7.3.45f). Better-developed bloodwood forests (RE 7.3.45b) were common to the south and west of this area. Two isolated basalt hills (Green Hill, and a smaller hill immediately north-west of Meringa – 2km NW of Gordonvale) were clothed in complex mesophyll vine forest (RE 7.8.1) and grassland (vegetation community 7.8.7c), and on Green Hill, a eucalypt open forest consisting of *Corymbia intermedia* and *Eucalyptus tereticornis* (RE 7.8.18).

The south-eastern edge of Trinity Inlet consists of a narrow strip of alluvium having similar vegetation to the plain further south, but it is also the site of a vegetation community which was very rare even in pre-clearing times – *Melaleuca cajuputi* open forest (RE 7.3.5c). The only other occurrence of this vegetation type that has been confirmed from remnants in the field is just south of the Daintree River. Other pre-clearing occurrences have been mapped just south of Mossman and near Cowley Beach, however the confidence ratings are low given the difficulty in identifying the photo-pattern on the aerial photographs used for these areas.

The marine plain immediately opposite Cairns (east of the mouth of Trinity Inlet) was covered in mangroves and saltpans, with a few narrow parallel dunes mostly forested with *Melaleuca leucadendra* (RE 7.2.8). The 1942 mangrove shore-line was several hundred metres further inland than it is today (over 1km further inland at the area of greatest expansion). The landward edge of the estuarine area was bordered by a narrow fringe of alluvium supporting a mixture of *Eucalyptus tereticornis* open forest (RE 7.3.12), *Melaleuca quinqunervia* swamps (Re 7.3.5), rainforest (RE 7.3.10) and open forests of *Eucalyptus pellita*, and *Corymbia intermedia* (RE 7.3.20).

The area under what is now Cairns city was formerly an extensive series of long, very narrow (eg frequently only 40–50m wide), low pro-grading dunes separated by even narrower (commonly 25–30m wide) swales. The dune crests supported *Corymbia* spp. and *Corymbia tessellaris* open forests (RE 7.2.3), whilst the swales often contained mangroves (RE 7.1.1), dense swampy paperbark forests (REs 7.2.8 and 7.2.9), *Archontophoenix alexandrae* swamps (vegetation type 7.2.1g) or swampy rainforest (vegetation type 7.2.1d) (Figure 8).

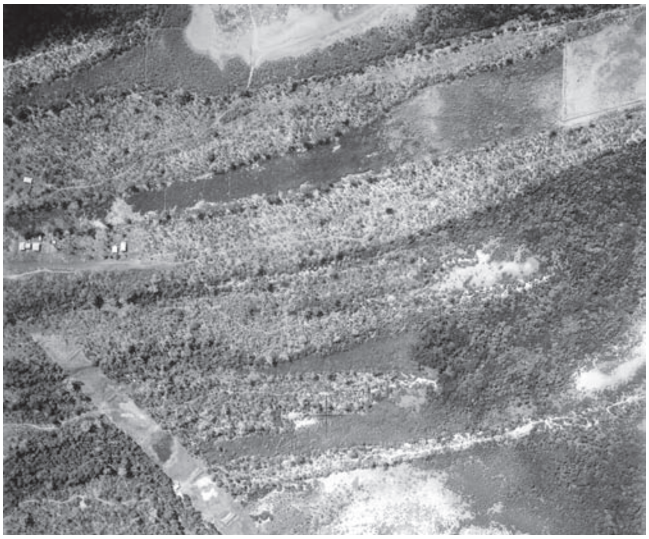

Fig. 8. Part of a 1937 aerial photo (1:7000 scale) of the Cairns city area, clearly showing the series of narrow forested/shrubby dune ridges and swampier mangrove-filled swales.

Immediately west and south-west of Cairns at the base of the Whitfield Range the vegetation was formerly a mixture of rainforest (RE 7.3.10), *Eucalyptus tereticornis* open forests (RE 7.3.12) and *Corymbia clarksoniana* open forests (RE 7.3.45) with a few patches of *Melaleuca viridiflora* open forest and woodland (RE 7.3.8). The Redlynch/Freshwater valley was mostly rainforest, with the main river levee supporting a simple-complex semi-deciduous notophyll to mesophyll vine forest (RE 7.3.23), and surrounding plains with simple-complex mesophyll to notophyll vine forest (RE 7.3.10). The western slope of the valley may have supported better-developed rainforest (complex mesophyll vine forest, RE 7.3.17) due to the presence of a deep fertile soil which includes the associated Kimberley soil unit that has a basalt or basic metamorphic origin (Murtha *et al*. 1996).

The Cairns airport was formerly mangroves (RE 7.1.1) and saltpans (RE 7.1.2), and there were substantial areas of *Melaleuca leucadendra* forests (RE 7.2.8) at the base of Mount Whitfield. Open forests and woodlands dominated by *Eucalyptus leptophleba* were common north from this area. A wide belt of rainforest (REs 7.3.23a and 7.3.10a) with pockets of *Eucalyptus tereticornis* (7.3.12) clothed the levee of the Barron River.

North of here, a broken series of Pleistocene dunes usually supported mixed open forests of *Eucalyptus tereticornis*, *Corymbia tessellaris*, *Eucalyptus pellita*, *Corymbia intermedia*, *Melaleuca dealbata*, *Lophostemon suaveolens*, and *Acacia mangium* (vegetation community 7.2.4b). The dune swales supported stands of *Melaleuca leucadendra* (RE 7.2.8). The foredunes supported *Corymbia tessellaris* and *Corymbia clarksoniana* open forests (RE 7.2.3). A very old series of dunes west of the Moon River mangroves was apparently forested with vegetation types that are fairly atypical of dunes. These included a mesophyll vine forest of *Archontophoenix alexandrae* (vegetation community 7.2.1g), open forest of *Corymbia clarksoniana* (vegetation community 7.2.3g), and open woodland of *Corymbia clarksoniana*, *Eucalyptus platyphylla, Lophostemon suaveolens, Eucalyptus drepanophylla* and *Melaleuca viridiflora*. (vegetation community 7.2.11g).

The alluvial plains from the Barron River north to Buchan Point were dominated either by open forests of *Eucalyptus tereticornis*, with *Corymbia* spp. and *Lophostemon suaveolens* (RE 7.3.12) or of *Eucalyptus leptophleba* and *Corymbia clarksoniana* (RE 7.3.44). Creek levees were often marked by well-defined corridors of simple-complex semi-deciduous notophyll to mesophyll vine forest (RE 7.3.23). The narrow dune series north of Yorkeys Point was dominated by *Corymbia tessellaris* and *Corymbia* species open forest (RE 7.2.3) or by *Melaleuca leucadendra* open forest (RE 7.2.8) with occasional areas of vine scrub (REs 7.2.1 and 7.2.2)

Lowland pre-clearing vegetation: Daintree-Bloomfield/ Macalister subregions

The most common and widespread vegetation group in the Daintree-Bloomfield/Macalister subregions was rainforest, which consisted of 5 regional ecosystems and covered 35% of the subregion (Table 8). Open forests were also very widespread (9 ecosystems, 20%), as were estuarine systems, which often dominated the relatively small lowland areas (4 ecosystems, 18 %) (Table 8). Much less extensive but still a prominent feature were dune eucalypt open forests (2 ecosystems, 5%), paperbark forests (3 ecosystems, 4%), dune vine scrubs (2 ecosystems, 3%), eucalypt woodlands (3 ecosystems, 3%), dune paperbark forests (3 ecosystems 3%) palm swamps (2 ecosystems, 2%), eucalypt open forests on low isolated hills (5 ecosystems 2%), tea-tree woodlands (1 ecosystem, 2 %), and rainforest on low isolated hills (2 ecosystems, 1%) (Table 8). A further 8 vegetation groups comprising 9 regional ecosystems covered the remaining 2% of the subregion (Table 8).

Open forests once dominated the floodplains from the small valley behind the Oak Beach/White Cliffs area, north to the Mossman River. These were mainly *Eucalyptus leptophleba* and *Corymbia clarksoniana* open forest (RE 7.3.44), or *Eucalyptus tereticornis* dominated open forests (RE 7.3.12). There were also small pockets of *Melaleuca viridiflora* woodland (RE 7.3.8), and *Melaleuca leucadendra* swamps (RE 7.3.25). Rainforest occurred on the more fertile areas such as the mesophyll vine forest (RE 7.3.10) of the Spring Creek Valley and on the better developed levees such as that of the Mowbray River which supported simple-complex semi-deciduous notophyll to mesophyll vine forest (RE 7.3.23). Dune systems in this area commonly included belts of dune vine scrub (RE 7.2.2a), especially at the Oak Beach/ White Cliffs beach where this covered almost the entire dune. Also once extensive on the dune in this area were forests of *Corymbia tessellaris*, and *Corymbia clarksoniana* (or *Corymbia intermedia*) with areas dominated by *Acacia crassicarpa* (RE 7.2.3), and *Melaleuca leucadendra* (RE 7.2.8).

The township of Port Douglas was formerly largely a dune forest dominated by *Corymbia tessellaris*, and *C. clarksoniana* (and/or *C. intermedia*), with a long strip of vine forest (RE 7.2.2) along the foredune. The metamorphic outcrop and alluvial fan at Island Point (northern end of Port Douglas) was forested with *Eucalyptus leptophleba* and *Corymbia clarksoniana* (REs 7.11.49 and 7.3.44).

Further north, the Cassowary Creek valley and Little (south) Mossman River valley were largely mesophyll vine forest (RE 7.3.10) with simple-complex semi-deciduous notophyll to mesophyll vine forest along the more fertile levees (RE 7.3.23). A few large pockets of *Eucalyptus tereticornis* dominated open forests (RE 7.3.12) occurred on the central and lower plains, whilst upper fans sometimes supported *Eucalyptus pellita* and *Corymbia intermedia* open forests (RE 7.3.20). The township of Mossman was once a *Eucalyptus tereticornis* dominated open forest (RE 7.3.12), and the main levee of the Mossman River valley was dominated by either simple-complex semi-deciduous notophyll to mesophyll vine forest (7.3.23) or complex mesophyll vine forest (7.3.17), with broad stretches of mesophyll vine forest (RE 7.3.10) across the rest of the floodplain. Some pockets of eucalypt open forest occurred on fans adjacent to the ranges (REs 7.3.19 and 7.3.20).

The stretch of lowlands from the rainforests of the Mossman River levee to those of the Saltwater Creek/Whyanbeel Creek area were largely dominated by swampy sclerophyll communities. These included *Eucalyptus pellita* and *Corymbia intermedia* open forests (RE 7.3.7), stands of *Melaleuca quinquenervia* (RE 7.3.5), and woodlands/open

Table 8. Relative proportion of pre-clearing vegetation groups in the Daintree-Bloomfield subregion.

(The Daintree-Bloomfield subregion here includes small parts of the Macalister subregion. Vegetation groups occur on alluvium unless specified. “Open forest” and “woodland” here means eucalypt and *Lophostemon* dominated open forest and woodland respectively.)

Vegetation Group	No. of Regional Ecosystems	Area (ha)	% of Daintree-Bloomfield subregion
open forests	9	6 545	20
rainforest	5	11 280	35
estuarine	4	5 677	18
teatree	1	503	2
woodland	3	962	3
paperbark forests	3	1 381	4
grassland and sedgeland	1	2	<1
dune open forests	2	1 523	5
dune paperbark forests	3	831	3
palm swamps	2	720	2
open forests on hills	5	697	2
rainforest on hills	2	375	1
stream beds	1	275	<1
dune rainforests vinescrubs	2	1 074	3
woodland on hills	1	50	<1
casuarina	0	0	0
dune casuarina	1	170	1
acacia	1	186	1
dune shrublands and heathlands	0	0	0
fernland	1	3	<1
teatree on hills	0	0	0
shrubland on hills	2	20	<1
acacia on hills	0	0	0
grassland and sedgeland on hills	1	3	<1
TOTAL		**32 278**	**100**

forests of *Melaleuca viridiflora* and *Lophostemon suaveolens* (RE 7.3.8). There were also some *Eucalyptus tereticornis* dominated communities (RE 7.3.12) and *Archontophoenix alexandrae* swamps (RE 7.3.3). The Saltwater Creek/ Whyanbeel Creek valleys were entirely rainforested with mesophyll vine forest (RE 7.3.10) and some simple-complex semi-deciduous notophyll to mesophyll vine forest (RE 7.3.23) along the levees.

The stretch of dunes from north of Port Douglas to the mouth of the Daintree River once supported a sizeable area of dune vine scrub (RE 7.2.2) including the dune north of the mouth of Saltwater Creek where vine scrub appears to have clothed almost the entire dune system. Similarly the large dune system at Wonga (south of the mouth of the Daintree River) appears also to have mainly consisted of vine scrubs (RE 7.2.2). Figure 9 shows dune vine scrub portrayed on an original surveyors' plan from Palm Beach (a few km north-east of Mossman). The sizeable dune systems either side of the Mossman River were probably mostly vegetated with *Corymbia intermedia* and *Eucalyptus pellita* open forests (RE 7.2.4). The more inland dunes upstream of the

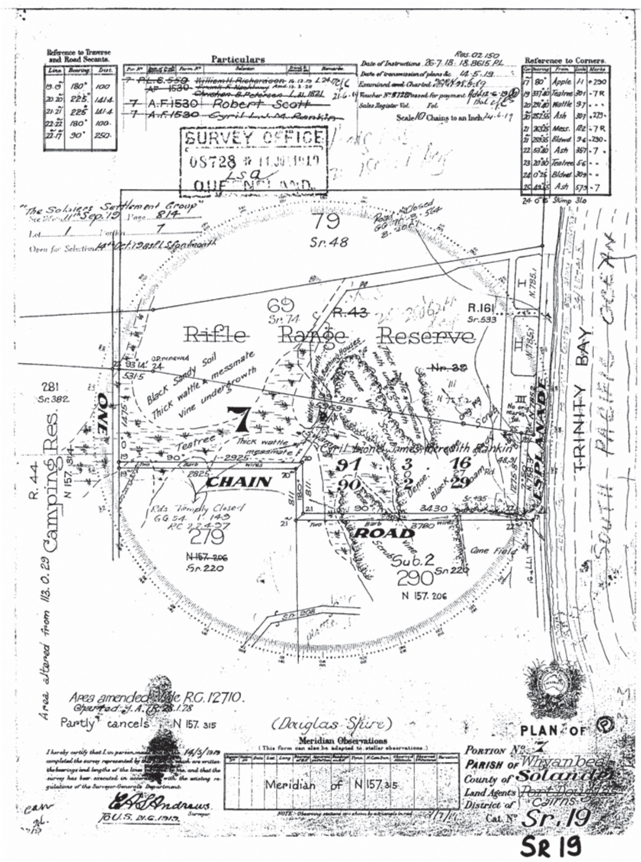

Fig. 9. Original survey plan of Palm Beach/Newell (Trinity Bay). The plans were repeatedly revised as years passed and the land was subdivided, sometimes obscuring the original annotations and text. Despite alterations this plan clearly demarks areas of *dense vine scrub*, *black sandy soil, thick wattle and messmate vine undergrowth* and a *tea tree* swamp (with swamp symbols).

mouth of the Daintree River supported a complex variety of sclerophyll associations including *Corymbia intermedia* and *Acacia crassicarpa* open forests (RE 7.2.3), *Melaleuca viridiflora*, and *Lophostemon suaveolens* open forests (RE 7.2.11), shrublands of *Melaleuca quinquenervia* (RE 7.2.9) and open forests of *Corymbia intermedia* and *Eucalyptus pellita* (RE 7.2.4).

Alluvium surrounding the mouth of the Daintree River was a complex of rainforests and swampy rainforest and sclerophyll communities. These included complex mesophyll vine forest (RE 7.3.10), extensive *Licuala ramsayi* forests (RE 7.3.4) and *Archontophoenix alexandrae* forests (RE 7.3.3), *Melaleuca quinquenervia* swamps (RE 7.3.5), and open forests of *Eucalyptus pellita* and *Corymbia intermedia* RE 7.3.7). The swampy oxbow of Bailey Creek (immediately south of the Daintree River crossing) supported stands of *Melaleuca cajaputi* (vegetation community 7.3.5c), which appears to have always been rare in the Wet Tropics.

The upper Daintree River/Douglas Creek/Stuart Creek valleys were entirely rainforest, mainly simple-complex semi-deciduous notophyll to mesophyll vine forest (RE 7.3.23) and mesophyll vine forest (RE 7.3.10).

The Hutchinson Creek valley (behind Alexandra Bay) was very complex mosaic of swampy rainforest and sclerophyll communities including swampier forms of mesophyll rainforest (RE 7.3.10), large *Licuala ramsayi* swamps (RE 7.3.4), *Melaleuca leucadendra* open forests (RE 7.3.25), *Eucalyptus pellita* and *Corymbia intermedia* pen forests (RE 7.3.7), and *Eucalyptus tereticornis* open forest (RE 7.3.40). Adjacent to the mangroves there were also pockets of *Melaleuca viridiflora* (RE 7.3.8) and swamps of *Melaleuca quinquenervia* (RE 7.3.5). The better drained alluvial fans on the western edge of the valley tended to support complex mesophyll vine forest (RE 7.3.17).

The Myall Creek/Mason Creek valley at Cape Tribulation appears to have been almost entirely complex mesophyll vine forest (RE 7.3.17) apart from the *Melaleuca leucadendra* dominated dune system (RE 7.2.8) that still remains today.

Most of the small alluvial valleys north of Cape Tribulation still remain vegetated today, and tend to become gradually more dominated by sclerophyll vegetation further north as annual rainfall decreases. Sclerophyll communities include *Corymbia intermedia*, and *Eucalyptus pellita* on alluvial fans (RE 7.3.20), *Corymbia tessellaris* and *Corymbia intermedia* open forest (RE 7.3.19), and *Corymbia clarksoniana* open forests and woodlands (RE 7.3.45). From the Wujal Wujal/ Wyalla Plain area *Corymbia nesophila* open forest to woodland (RE 7.3.13) becomes common. Rainforest vegetation tends to be restricted to levees and is either mesophyll vine forest (7.3.10) or simple-complex semi-deciduous notophyll to mesophyll vine forest (7.3.23a). Dunes are often dominated by vine scrub (REs 7.2.1 and 7.2.2), with some areas of *Corymbia tessellaris* and *Corymbia clarksoniana* open forest and *Melaleuca leucadendra* open forest (RE 7.2.8).

Fig. 10. Accuracy or confidence of pre-clearing mapping across the study area. Darker areas indicate higher confidence (and often indicate areas of remnant vegetation), whilst lighter areas represent least confidence.

Confidence in accuracy of the pre-clearing mapping

The relative confidence in accuracy across the pre-clearing area is shown in Figure 10. As a general rule, those areas that were first settled and cultivated by Europeans show the least confidence, such as the lower Herbert, Tully, Innisfail and back-plains of Cairns. Some of the areas with the lowest confidence were those where several interpretations of surveyors' plans were possible. For instance the authors believe that the majority of the grassy plains illustrated on the plans, were genuine grasslands. However it is quite feasible that some were not. The grasslands and open forests in areas that were settled and cultivated very early, were often substantially modified before the surveyors arrived. Although the surveyors' plans often described them as *plains,* it is possible that some of these *plains* may have previously (or even during the surveyors' times) been populated with eucalypts. Lumholtz (1889) describes the lower Herbert; *The banks of the river consist of rich soil, and on the higher ground are extensive plains covered with mighty gum-trees, which were continually being felled...*, He also mentions gliding possums (genus *Petaurus*) which live in trees; "*..but I found Petauroides volans and several species of Petaurus in the middle of summer on the open grass plains in the mountain regions near Herbert Vale.*

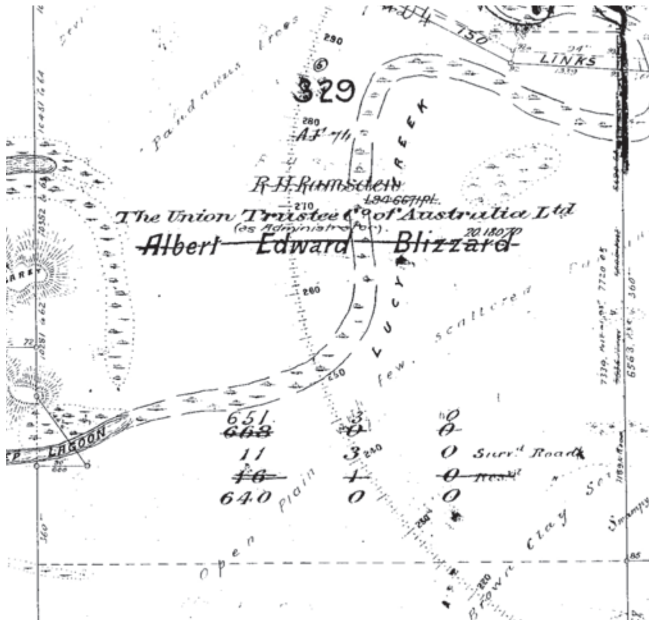

Fig. 11. Original 1885 survey plan from the Lucy Creek (central-eastern Herbert River floodplain) area showing references to plains.

Fig. 12. 2003 photograph of plains between Ingham and Forrest beach (same general area as Figure 10), believed to have been formerly treeless, and similar to today in appearance. However it would have probably been less heavily grazed, with different grass species composition. The foreground area is classed as "cleared" vegetation in the mapping coverage due to the almost complete replacement of native grasses with introduced pasture grasses.

On the lower Herbert floodplain east of Ingham the land was developed for sugarcane around the late 1860s. Aerial photos from 1942 show extensive grasslands in this area, including some areas that were obviously a result of clearing of timber. Surveyors' plans in the area date from 1872 to 1885 and use the terms *open plain*, *swampy open plain*, and *open plain with occasional clumps of pandanus* (Figure 11, Figure 12). The surveyors' plans have in other areas also used the terms *cleared land* or *land under cultivation*. Although it is possible that some of the *open plains* had been previously cleared, it seems unlikely that the surveyors would not know this, as there was probably not enough time for the stumps to have rotted away between the period of first development (late 1860s) and the surveyors' plans (1872–85). On weighing this evidence, in particular the short time period between first settlement and date of the surveyors' plans, the most likely conclusion is that the majority of the *plains* depicted were natural open grasslands and swamps.

Low confidence ratings were assigned to some vegetation types that are difficult to map even with good aerial photography, and to a few vegetation communities that are virtually extinct today (uncertainty surrounding their species composition and structure means that their boundaries are difficult to define).

Improvements in mapping

The 1:80 000 scale aerial photographs (1960–61) proved to be the most time-effective method of creating the pre-clearing coverage (older photos were only used for areas showing as cleared on these). Examination of older aerial photos (where available) for these vegetated areas would be of value, where they provide a larger scale and better detail. Complementary use of surveyors' plans for areas vegetated on these photos may be useful. Actual registration of the plans to match the pre-clearing coverage may consume equivalent time to the method used in this project, and would be of greater use (since the original information could be displayed directly under the pre-clearing layer).

More detailed field checking would be very valuable, as small remnant stands or isolated trees (too small to map by Stanton and Stanton 2005) would provide valuable clues as to the original vegetation. Also landforms and soils observed directly in the field can be used as evidence for the existence of particular vegetation types.

Finally some of the vegetation communities mapped on the lowlands could be further improved in definition. In particular the RE 7.3.12 (*Eucalyptus tereticornis* open forests with mixtures of other species) is very broad in definition and occurs on a wide variety of landforms. Re-classification of this RE may be beneficial. Similarly the REs 7.3.16 (*Eucalyptus platyphylla* woodlands and open forests with mixtures of other species and includes densely forested types on levees as well as open woodlands on hard-setting clay plains) could be further divided. In addition the RE 7.3.8 (broad-leaf tea-tree woodlands) may benefit from division based on soil and understorey vegetation characteristics.

Table 9. Comparison of CSIRO coverage (Johnson et al. 2000) with this study.

The vegetation communities of this study grouped to match those of Johnson et al. (2000). Figures are derived only from the area that is common to both coverages. The "Area mapped by either coverage (B)" is calculated from an intersection of the two coverages. It is equivalent to: area mapped only in one coverage + area mapped only in the other coverage + area mapped by both coverages.

Vegetation category	**Area (ha) mapped in CSIRO coverage**	**Area (ha) mapped in this study**	**% area mapped in CSIRO coverage**	**% area mapped in this study**	**Area (ha) mapped where both coverages agree (A)**	**Area (ha) mapped by either coverage (B)**	**% similarity per vegetation category (A/B X100)**
mp (mangrove patterns)	14 426	13 499	9	8	12 226	15 700	**78**
edp (eucalypt dominated patterns)	65 085	88 528	39	53	50 506	103 107	**49**
bv (beach vegetation)	1 803	3 131	1	2	1 362	3 573	**38**
uss (unstable silt and sand)	848	1 338	<1	<1	576	1 610	**36**
gs (grasslands)	19 505	23 887	12	14	10 055	33 337	**30**
rp (rainforest patterns)	22 678	8 784	14	5	6 434	25 028	**26**
mdp (melaleuca dominated patterns)	42 706	27 800	25	17	11 185	59 301	**19**
ow (open water)	731	835	<1	<1	183	1 383	**0**
Total	**167 783**	**167 783**	**100**	**100**			

Table 10. Percent remaining area for each regional ecosystem (RE) which occurs in the lowlands of the Wet Tropics (figures are for the entire Wet Tropics bioregion).

REs which occur on hills (or for which the majority occurs outside the lowlands) have been excluded. Vegetation Management Status and Biodiversity Status have been obtained from the coverage of Queensland Herbarium and Wet Tropics Management Authority (2005), and an explanation of their derivation can be found in Environmental Protection Agency (2005). Ecosystems with greater than 100% remaining have increased in area due to natural environmental changes or indirect changes caused by European-man landscape modification.

Regional Ecosystem	Pre-clear area (ha)	Remnant 2003 area (ha)	Percent remaining	Vegetation Manage-ment Status	Bio-diversity Status
7.1.1	47 220	44 951	95	N	N
7.1.2	6 443	4 849	75	O	O
7.1.3	1 572	1 899	121	O	E
7.1.4	243	224	92	O	E
7.1.5	328	348	106	O	O
7.2.1	2 541	589	23	E	E
7.2.2	1 097	552	50	O	E
7.2.3	11 682	7 036	60	O	O
7.2.4	5 548	2 748	50	O	O
7.2.5	552	376	68	O	O
7.2.6	299	299	100	O	O
7.2.7	1 325	965	73	O	E
7.2.8	2 384	1 578	66	O	E
7.2.9	3 672	2 839	77	O	E
7.2.10	504	504	100	O	O
7.2.11	2 523	1 468	58	O	O
7.3.1	13 454	1 262	9	E	E
7.3.3	4 648	1 823	39	O	E
7.3.4	2 814	1 103	39	O	E
7.3.5	25 315	11 389	45	N	E
7.3.6	2 419	678	28	E	E
7.3.7	8 897	1 236	14	E	E
7.3.8	38 987	15 887	41	N	E
7.3.9	11 000	1 180	11	E	E
7.3.10	59 371	13 949	24	O	E
7.3.12	26 130	4 491	17	E	E
7.3.13	994	691	70	O	E
7.3.16	37 485	16 560	44	N	E
7.3.17	26 370	3 907	15	E	E
7.3.19	6 413	4 210	66	O	O
7.3.20	10 504	6 079	58	O	O
7.3.21	5 966	4 037	68	O	O
7.3.23	15 524	3 622	23	E	E
7.3.25	8 287	5 020	61	O	O
7.3.26	4 084	3 782	93	O	E
7.3.28	7 393	7 291	99	O	E
7.3.29	2 047	846	41	O	E
7.3.30	462	36	8	E	E
7.3.31	625	535	86	O	E
7.3.32	12 299	115	<1	E	E
7.3.34	2 222	462	21	E	E
7.3.35	1 131	279	25	E	E
7.3.36	1 186	435	37	O	E
7.3.38	200	198	99	O	O
7.3.40	15 696	4 045	26	E	E
7.3.43	3 022	2 331	77	O	E
7.3.44	2 456	597	24	E	E
7.3.45	33 852	12 180	36	N	O
7.3.46	7 593	1 729	23	E	E
7.3.47	114	114	100	O	O
7.3.49	787	793	101	O	O
7.3.50	487	452	93	O	E
7.8.1	30 675	10 776	35	N	E
7.8.2	51 907	21 451	42	N	O
7.8.7	1 304	952	73	O	E
7.8.11	553	553	100	O	O
7.8.12	319	319	100	O	E
7.8.14	899	526	59	O	E
7.8.18	925	385	42	O	O
7.8.19	8 345	1 851	22	E	E

Comparison with previous pre-clearing vegetation coverages

The broad vegetation classes in the Herbert subregion lowlands from this project were compared with the Johnson *et al*. (2000) pre-European mapping (Table 9). Mangrove patterns showed the highest degree of similarity (78%), whilst other vegetation patterns showed considerably less correspondence, with *Melaleuca*-dominated patterns very dissimilar (19%); even rainforest showed a low correlation (26%). This fairly poor correlation is despite the fact that the data sources used were similar (eg. oldest aerial photography and soils mapping). The use of old land survey plan information for the current project is most likely the reason for differences in areas mapped as grassland in the lower Palm Creek/Lucy Creek floodplain. These areas were cleared prior to the oldest aerial photography, and where Johnson *et al*. (2000) has relied on soils mapping to predict vegetation distribution, this study has used the old land survey plans for grassland and rainforest boundaries. Both methods are valid, and neither method is 100% reliable, though the authors believe that overall, the contribution of the surveyors' plans have led to a more accurate result.

Similarly, differences between the two projects in the central Herbert River levee and the Lucy Creek levee (and associated prior streams) are largely the result of the use of old land survey plan information for the current project. Both these levees were almost completely cleared on the oldest aerial photography (1942). The soil types mapped (Wilson and Baker 1990) appear to be suitable for rainforest vegetation, however old land survey plans describe various plains and pandanus clumps (Figure 11).

Surprisingly even rainforest appears to correlate poorly between the two projects. However this is most likely explained by the differences in the interpretation of "rainforest". Regional ecosystems considered to be rainforest in the current project generally do not contain emergents or an overstorey of sclerophyll species. Thus much vegetation with a well-developed rainforest component but a paperbark or eucalypt overstorey is classified into sclerophyll REs. These REs usually have very dark photo-patterns similar to rainforest and have probably been interpreted as rainforest by Johnson *et al*. (2000).

The vegetation type with the least correlation was "melaleuca dominated patterns". This is not surprising given that they were mapped over much of the area classified as grassland in the current project. In addition, the regional ecosystem 7.3.9, (which was classed into "eucalyptus dominated patterns" for this comparison), may have been interpreted as a "melaleuca dominated pattern" by Johnson *et al*. (2000) due its very dense nature, and the common presence of *Melaleuca dealbata*.

We are unable to provide a satisfactory comparison with Accad (2003) at this stage. Both projects used similar baseline data (Stanton & Stanton 2005), but Accad's work was based on a very early draft of the latter, and the Stanton and Stanton (2005) coverage had changed considerably by the time it was used for this project.

Evidence of vegetation manipulation by indigenous inhabitants

Direct evidence of indigenous people changing their environment is found in references to open ceremonial or camping areas referred to as *borboby*, *prun* or *brun* sites (local terms for *bora ground*) (Horsfall 1987). Their construction and/or maintenance are mentioned in Palmerston (1885–1886), Palmerston (1887), Mjöberg (1918), and Horsfall (1987). Some of these may have been of a size possible to map at the scale used for this project (e.g. *about 3 acres* Douglas (1882), and plate 3.2 in Mjöberg 1918), though it is possible that these largest examples were enlarged by Europeans. Research into the location of *borboby*, *prun* or *brun* sites would be a valuable addition to the map coverage. Information could come from historical compilations, old forestry maps, original explorers' manuscripts and interviews with experts, key indigenous elders and farmers who have had a long association with their local area.

Indirect evidence of the impact of indigenous people on vegetation structure is provided by the apparent occurrence, in pre-clearing times, of grasslands on very fertile, well-drained soils (including Herbert, Lucy and Palm soil types – Wilson & Baker 1990) which, in other parts of the pre-clearing map, support rainforest or eucalypt open forest. From the central Herbert River floodplain G. E. Dalrymple (Dalrymple 1865) reported *extensive rolling plains, with grasses as high as my saddle-bow, but by no means coarse, and the richest red chocolate covered loam I have seen in Queensland*. Assuming that his horse was of a reasonable stature, the possible native grass candidates (which still occur on the better soils in the general area) are *Imperata cylindrica, Heteropogon triticeus*, *Sarga* spp., *Sorghum nitidum* forma *aristatum* and *Mnesithea rottboelloides*. *Imperata cylindrica* tends to be somewhat "coarse" in nature, and favours more moderately to poorly-drained soils. The other three candidates will not tolerate swampy conditions and are indicative of relatively good soils. It is extremely rare today to find grasslands composed of these species in the wet tropics. However similar country in the Central Queensland Coast, the Goorganga plains near Proserpine, does support an occurrence of several hectares of tall dense *Sorghum nitidum* grassland. This plain is being invaded by trees of *Corymbia tessellaris* (Kemp *et al*. 2001) ; perhaps reverting to a forested state due to lack of burning.

We noted considerable reduction in grassland area in parts of the Herbert valley (comparing 1940s and 1960s aerial photos – though these changes were not incorporated into the mapping, as the 1960s photos were generally used to create the vegetation coverage for areas considered to be uncleared at that time). Possible explanations for reduction in natural grasslands include cessation of regular burning, changes to landscape drainage, or perhaps increasing CO_2 in the atmosphere.

It is clear that there were large numbers of people living in the lowlands wet tropics in pre-clearing times. The construction of bora grounds caused obvious small-scale vegetation structural change, but the extent to which country was kept open through burning requires further investigation, perhaps through analysis of soil type in relation to the pre-clearing mapping. Careful studies of sequences of aerial photos for particular areas may reveal changes over time, which could be linked to the cessation of regular burning.

Conservation value of vegetation communities and regional ecosystems

Some of the vegetation communities and regional ecosystems of the Coastal lowlands were formerly extensive but have now been dramatically reduced in area (Table 10). Those which have been cleared to the greatest extent include the three grassland ecosystems (RE 7.3.32, 1% remaining; RE 7.3.30, 8% remaining; and RE 7.3.1 9% remaining), *Corymbia tessellaris* forests with *Acacia* spp., *Melaleuca* spp. and *Lophostemon suaveolens* (RE 7.3.9, 11% remaining), *Eucalyptus pellita* and *Corymbia* spp. forests (RE 7.3.7, 14% remaining), and *Eucalyptus tereticornis* (often mixed with other species) forests (RE 7.3.12, 17% remaining). The least impacted ecosystems are those occurring on marine sediments (eg REs 7.1.1, 7.1.3, 7.1.4 and 7.1.5), some of the near-coastal REs (eg 7.2.6, 7.2.10, 7.3.31 and 7.3.47), REs occurring in narrow bands along creek banks or creek beds (eg 7.3.26, 7.3.28, 7.3.49 and 7.3.50), or REs of very restricted occurrence (eg 7.3.38, 7.8.11 and 7.8.12) (Table 10 and Maps 1–4).

The formerly most extensive grassland REs 7.3.1a and 7.3.1b appear to have been heavily impacted with only 13% and 8% remaining respectively (Table 11) though the relatively poorly-drained plains (Table 4 and Wilson & Baker 1990) which supported 7.3.1c still retains 93% of pre-clearing extent.

The RE 7.3.32 has been even more severely impacted, occurring on better-drained soils (Table 4 and Wilson & Baker 1990), with the dominant vegetation community (7.3.32a) virtually extinct at 1% remaining (Table 11). The vegetation community 7.3.32b remains intact (Table 11) but is naturally very rare. These figures are likely to be an overestimate of the status of communities as many remnant patches of vegetation have been severely invaded by weeds (particularly 7.3.1c which is heavily invaded by the exotic grass *Urochloa mutica*. It was not possible to eliminate severely-impacted remnants using the predominantly remote methods utilised by this study.

The *Corymbia tessellaris* forests with *Acacia* spp., *Melaleuca* spp. and *Lophostemon suaveolens* once covered river and creek levees, particularly the fertile levees of the Herbert River and other minor creeks on the Herbert floodplain. These were obviously targeted early for clearing due to ease of access and the moderate to relatively high-yield soils (Wilson & Baker 1990), (most commonly Toobanna (Tb), Palm (Pl) and Herbert (Hb) series (Table 4). It is probably this regional ecosystem (or possibly RE 7.3.12) being referred to by Lumholtz (1889) where he describes the lower Herbert thus; *The banks of the river consist of rich soil, and on the higher ground are extensive plains covered with mighty gum-trees, which were continually being felled...*

Though often occurring on relatively swampy soils, (eg. Bulgun (Bg) Table 4 and Canon *et al*. 1992), the *Corymbia* spp. and *Eucalyptus pellita* forests (RE 7.3.7) have also now been largely cleared (Table 10). The *Eucalyptus tereticornis* open forest and woodlands (RE 7.3.12), which mostly occurred on fairly well-drained, arable soils (Table 4, also Canon *et al*. 1992, Murtha 1986, Murtha 1989, Murtha *et al*. 1996, and Wilson and Baker, 1990) have also been severely depleted (Table 10). Of the three component vegetation communities, all are heavily impacted, and one (7.3.12c) is virtually extinct (Table 11). Although remnants of 7.3.12c occur (Maps 1–4), their structure and composition has changed considerably due to logging and rainforest invasion. All remaining fragments require field verification.

Rainforests have also been severely depleted, with the dominant REs (7.3.10, 7.3.17, 7.3.23, and 7.8.1) being cleared to low levels (Table 10). These REs sometimes also occur in upland areas, and when only the lowlands are considered, they have been reduced to a very minimal extent (RE 7.3.10 = 11%, 7.3.17 = 15%, 7.3.23 = 3% and 7.8.1 = 5%). These ecosystems often occurred on the very best soil types with REs 7.3.10, 7.3.17 and 7.3.23 frequently occurring on Tully (Tu), Coom (Co), Liverpool (Li) and Macknade (Mk) (Table 4 and Wilson and Baker 1992). Although Coom is a poorly drained soil types, the others are well-drained, deep fertile soils (Wilson and Baker 1992). The RE 7.8.1 occurs predominantly on the basalt soil series Pin Gin (Pg) (Table 4 and Murtha *et al*. 1996) which are red gradational soils, derived from basalt (Murtha *et al*. 1996).

Discussion

Coastal lowlands pre-clearing vegetation communities and regional ecosystems

Rainforests covered around 24% of the Wet Tropics coastal lowlands in pre-clearing times – fitting with the wet, green image of the Wet Tropics. Eucalypt forests dominated overall, with woodlands and open forests together covering some 32% of the lowlands. Estuarine systems, paperbark and tea-tree forests, and grasslands were also very prominent (11%). The total area of coastal lowland vegetation remaining today ranges from 37% of Herbert subregion down to 24% of Innisfail (Table 12). Overall about two-thirds of the native vegetation has been cleared.

The Herbert subregion, the driest of the lowland subregions, supported the least rainforest. Possibly the most intriguing of vegetation patterns in the Herbert are the now near-extinct grasslands which dominated the central and lower floodplain, covering a very large area (12% of the Herbert subregion lowlands). Soil type appears to be a reasonable predictor of some of the grassland vegetation communities (e.g. *Cynodon dactylon* grassland (7.3.1b) corresponds well with soil series Hl (Hamleigh) (Table 4, Wilson and Baker 1990)), however grasslands also seem to have occurred on better-drained soil types, which often also supported timbered vegetation in other areas.

The Tully subregion was perhaps once the most stunning subregions visually, with its diverse and complex patterns of tea tree and paperbark communities, eucalypt forests, palm forests and rainforest. These complex patterns are reflected in the soils mapping (Canon *et al*. 1992) and may be a result of constant re-working of materials by the changing river and creek systems across the floodplain. The vegetation type 7.3.12c with its widely spaced forest red gums and mid-stratum of tea-trees is virtually extinct now. The few patches that remain warrant field investigation to obtain further information regarding their composition, and to quantify the degree of rainforest invasion.

The Innisfail subregion supported the broadest expanses of rainforest, partly due to the high rainfall, but also due to the extensive areas of gently-sloping basalt terrain, the majority of which supported distinct rainforest types (complex mesophyll vine forest; 7.8.1a, and complex mesophyll vine forest on laterite; 7.8.1b). Almost the entire Palmerston area to Innisfail was covered in lowland rainforest, some 20 000 hectares in all. When palm swamps are included, the upper El Arish/Silkwood/Japoonvale valley, the central and upper

Table 11. Percent remaining area for selected vegetation communities in the coastal lowlands of the Wet Tropics

Vegetation Management Status and Biodiversity Status from Queensland Herbarium and Wet Tropics Management Authority (2005)- their derivation is in Environmental Protection Agency (2005).

Vegetation community	Description	Pre-clear area (ha)	Remnant 2003 area (ha)	Percent remaining	Vegetation Management status	Bio diversity status
7.3.1a	*Hemarthria uncinata* and/or *Ischaemum australe* subsp. *arundinaceum* closed grassland.	1 693	223	13	E	E
7.3.1b	*Cynodon dactylon* grassland	11 693	976	8	E	E
7.3.1c	Ephemeral freshwater swamp dominated by sedges	68	63	93	E	E
7.3.12a	*Eucalyptus tereticornis, Corymbia tessellaris, E. pellita, C. intermedia, Melaleuca dealbata* and *Lophostemon suaveolens* woodland to open forest, often with a secondary tree layer of *Acacia mangium* and *A. crassicarpa*.	11 740	1 542	13	E	E
7.3.12b	*Eucalyptus tereticornis, Corymbia tessellaris, E. pellita, C. intermedia, Melaleuca dealbata* and *Lophostemon suaveolens* woodland to open forest, often with a secondary tree layer of *Acacia mangium* and *A. crassicarpa*, and with a very well developed vine forest understorey.	7 362	2 550	35	E	E
7.3.12c	*Eucalyptus tereticornis* open woodland to sparse woodland over a prominent secondary tree layer of *Melaleuca quinquenervia* and/or *M. viridiflora*.	7 028	399	6	E	E
7.3.32a	*Imperata cylindrica* and/or *Sorghum nitidum* and/or *Mnesithea rottboellioides* closed grassland.	12 276	92	1	E	E
7.3.32b	Grassland dominated by *Themeda triandra*.	23	23	100	E	E

Fig. 12. Scene across the Herbert lowlands in 2003, between Trebonne and Ingham (north from Wharps Holding). The Mount Leach Range and Hinchinbrook Island are in the background. In pre-clearing times the view would have been almost as open, with native grass plains and sedge swamps (REs 7.3.32 and 7.3.1) through to the Herbert River (dark trees at base of mountains).

Russell River Valley, the upper Babinda Creek valley, the entire lowland stretch from Babinda to Meerawa, the central and upper Mulgrave valley and the Freshwater Creek valley south of Redlynch were also completely covered with rainforest.

The flat plain south of Trinity Inlet (the Mulgrave Corridor) is fascinating due to its once apparently very low dense sclerophyll vegetation in pre-clearing times reflected both on the 1942 aerial photography, and the old land survey plans which have abundant reference to dense forest with a thick undergowth (eg. *thickly timbered with mahogany tea tree gum and wattle, poor grey soil, thick growth of saplings*). This is reminiscent of regrowth vegetation from a broad-scale clearing event or other similarly high-disturbance episode. Though it is possible that this area was completely cleared before the 1940s, it seems more likely that such clearing efforts would have concentrated on vegetation of the more fertile soils. It is probable that the Mulgrave River formerly flowed northwards out to sea in this area, and was later diverted southwards, possibly due to the formation of the Mulgrave fan (Willmott & Stephenson 1989). Sea levels in this area around 5500 years ago were approximately 1m higher than today (Chappell *et al.,* 1983), suggesting that this low-lying area may once have been mangroves. This vegetation type (7.3.45f) was mostly associated with the "Inlet" (Il) soil series (Table 4). Murtha *et al*. (1996) describe this soil type as being of "possible marine origin", and that it overlies marine sediments. It therefore seems possible that this area was once a broad mangrove system, and that the low dense vegetation may represent a recent colonisation by non-marine vegetation.

The Cairns city area is built on a low, complex dune system. The long narrow swales extending roughly north-south across the entire length of the city supported mangroves, or paperbark forests which received some tidal influence, or else were at least connected to the saline areas and ultimately the ocean. In short, most of Cairns city could easily be inundated by the sea, via a storm surge or sea level rise. This beach ridge system was likely formed through a series of relatively recent cyclones (as far back as about 6000 years ago) (Nott, 2003).

One of the outstanding features of the Daintree-Bloomfield/Macalister lowlands was the occurrence of large continuous vine scrubs (or "beach scrubs") on dunes, particularly notophyll vine forest (7.2.2) (the original Tracey (1975) type 7b). This ecosystem is less common in other subregions, tending to be replaced by the more mesic mesophyll vine forest in the Innisfail subregion (7.2.1). In the southern, drier subregions beach scrubs tend towards notophyll vine forest but are usually dominated by the related ecosystem mesophyll/notophyll vine forest of *Syzgium forte* subsp. *forte* (7.2.5), and are far less extensive.

Broad rainforest belts and large palm swamps were also a feature of this subregion, but with lower rainfall than that of the Innisfail subregion, there were also extensive open forests, including those of *Corymbia nesophila* which is not found in any other coastal subregion and is a species more typical of the Cape York Peninsula bioregion.

Table 12. Area of coastal lowlands alluvial and dune vegetation remaining by subregion

Note: area figures exclude estuarine systems and low isolated hills.

Subregion	Percent vegetation remaining
Daintree and Macalistair lowlands	36%
Herbert lowlands	37%
Innisfail lowlands	24%
Tully lowlands	35%

Conservation value of vegetation communities and regional ecosystems

The Queensland Government has assigned a Vegetation Management Status to each regional ecosystem in the State, which is supported by legislation (the Vegetation Management Act 1999 and Vegetation Management Regulation 2000). This status is based solely on the percent of pre-clearing area remaining at a bioregional level, as well as particular remnant area thresholds. The pre-clearing mapping for the Wet Tropics produced through the current project was used to update this legislation (Vegetation Management Regulation 2000 Reprint No. 2J, 9 December 2005). In addition to this legislated conservation status, the Queensland Environmental Protection Agency has developed a "Biodiversity Status" for each regional ecosystem (Environmental Protection Agency, 2005), which is based on an assessment of the condition of remnant vegetation in addition to the pre-clearing and remnant extent of the regional ecosystem. Thus for example an ecosystem which has greater than 70% of its area irreversibly invaded by weeds is moved to a more threatened status. This Biodiversity Status is used by a variety of government organisations (mainly the Environmental Protection Agency) and private organisations to guide development and conservation planning decisions.

A previous assessment equivalent to Biodiversity Status was made at the subregional level (and using the more detailed Vegetation Community classification level) for the Herbert and Tully subregions by Kemp *et al*. (1999) and Kemp and Morgan (1999), using estimations of pre-clearing area based on soil and land-systems mapping. However, no similar detailed examination at a subregional level has yet been undertaken using the new regional ecosystem mapping (Queensland Herbarium and Wet Tropics Management Authority 2005) which includes the pre-clearing work presented in this manuscript. This should be a priority for broad scale land managers, particularly as it may assist with identifying vegetation communities that are at the brink of local extinction, or which occur only on freehold land and are therefore at risk of degradation through farming, and gradual fragmentation (via clearing for roads and infrastructure).

The grassland and sedgeland communities have suffered great loss with *Imperata cylindrica* dominated grasslands at 1% of pre-clear extent, sedgeland/fernland complexes at 8%, and the swampier grass communities at 9% (Figure 12). From the authors' field experience it is clear that most remaining examples are severely impacted by weed invasion and species changes due to cattle grazing and the introduction of pasture species. For example, the grasslands in Wharps and Lannercost Holding, are today dominated by *Cynodon dactylon*, *Chrysopogon aciculatus*, and *Mimosa pudica*. It seems probable that grazing has favoured the resilient *Cynodon dactylon* at the expensive of more sensitive tussock grasses such as *Ischaemum* species, *Sorghum nitidum* forma *aristatum* and *Sarga* spp. The naturalised species *Cynodon dactylon* has probably become dominant as a result of grazing. Whilst some other native sedges and grasses, and other herbaceous plants still occur in these grasslands, they occur in very low abundance.

The grasslands of Eubenangee swamp are mostly *Hemarthria uncinata* and/or *Ischaemum australe* subsp. *arundinaceum* closed grassland. The current condition of these grasslands is excellent. This area is an example of a lowland swamp complex that is extremely unusual in that it remains barely affected by ponded pasture species and other pasture grasses, or even the invasive *Annona glabra*. This is entirely due to the dedicated efforts of Queensland Parks and Wildlife Service rangers and senior staff in charge of the area.

A few grasslands remain on better-drained soils (*Imperata cylindrica* and/or *Sorghum nitidum* and/or *Mnesithea rottboellioide*s closed grassland), notably that at the Ingham airport reserve. This is almost the entire extent of the 1% remaining of the regional ecosystem 7.3.32 currently on the cusp of extinction. Though invaded by numerous weed species, the dense sward of *Imperata cylindrica* has prevented weed dominance over a part of the area. Former burning regimes by indigenous locals probably kept these grasslands in a more diverse state, and possibly also prevented woody encroachment. Whilst adjacent deep-water wetlands have been recognised for their high conservation value (as illustrated by the recent development of the "Tyto wetlands" - a locally run conservation reserve), it is not clear whether the blady grass plain to the south is considered important locally. Clearly an increase in local awareness of the existence of this ecosystem is urgently required.

Other severely depleted ecosystems include several eucalypt open forest ecosystems that occurred on the better soils of the river levees and were cleared early for cultivation and for timber. Surprisingly now even very swampy tea-tree and paperbark ecosystems have been dramatically reduced in area – a testament to the effectiveness of planned and ongoing drainage programs, particularly in the Herbert and Tully floodplains.

Another vegetation community (*Eucalyptus tereticornis* open woodland to sparse woodland over a prominent secondary tree layer of *Melaleuca quinquenervia* and/or *M. viridiflora*.) has been depleted to near extinction. This community was formerly widespread across the Kennedy Valley (west of Cardwell) and the Murray River floodplain (south and south-west of Tully), and was probably highly suitable habitat for the now Endangered (Nature Conservation Act 1992) Mahogany Glider (*Petaurus gracilis*). This community contained mature, well spaced *Eucalyptus tereticornis* (suitable for roosting and gliding) and abundant *Melaleuca viridiflora* and *Melaleuca quinquenervia* both of which are food sources (Stephen Jackson NSW DPI pers. comm.). It is also highly probable that this community supported abundant *Myrmecodia beccarii* (listed as Vulnerable under the Nature Conservation Act 1992) since *Melaleuca viridiflora* is a favoured host. Although a few remnants of the vegetation community occur, their structure and composition has probably changed considerably due to logging and rainforest invasion. In addition a verification of the vegetation community type is necessary at the field level to be certain that they are indeed remnants of this community.

The rainforests, particularly those on basalts and on the river levees have been cleared extensively for their useful soils and timber. The former magnificence of these stands is evident on the historical aerial photographs where dense broad stands with diverse crown shapes and sizes clothed such rivers as the Herbert and Tully, and though often cleared before the photo record north of Tully, are clearly indicated on old land survey plans as covering entire valleys. Extremely sharp rainforest/open forest boundaries were the norm, suggesting the edges were kept stable by repetitive burning of the adjacent forests, the fires probably terminating abruptly upon reaching the wall of rainforest. Given the high species diversity typical of rainforest it is possible that plant species unknown to science have become extinct since clearing began in the Wet Tropics coastal lowlands.

It is very important to note that the small number of vegetation communities that are close to extinction once covered a large part of the Wet Tropics coastal lowlands. This means that we tend to underestimate the overall vegetation loss – especially given that a large number of the remaining types are not in the Endangered category under the Vegetation Management Act, 1999. It is easy for us to consider that these examples are "safe" when in fact they are really all that is left of our coastal lowlands, and yet with the exception of the mangrove ecosystems, they continue to be degraded and fragmented.

Generally when a vegetation community has been reduced to less than 10% of its pre-clearing extent, it is in a very fragmented and poor state, with depleted ecological functioning. For this reason any form of biodiversity assessment needs to take into account a variety of considerations, besides pre-clearing extent. The Environmental Protection Agency has developed the Biodiversity Assessment and Mapping Methodology (BAMM) (Environmental Protection Agency 2002) which ranks biodiversity significance of an area according to specified biodiversity values to account for ecological concepts such as rarity, diversity, fragmentation, habitat condition, resilience, threats, and ecosystem processes, and not just the status of the regional ecosystems. Through this methodology, "Biodiversity Planning Assessments" have been developed for 6 bioregions of Queensland, enabling land managers to access biological information and to understand the relative significance of any given area within the plan. This broad approach to assessment of the value of remnant vegetation is obviously preferable to using a single attribute such as the percent of pre-clearing remaining.

The introduction of Queensland State tree clearing laws (Vegetation Management Act 1999) followed by the cessation of broad-scale tree-clearing in December 2006, has substantially slowed the rate of clearing in most areas. However, the laws have been of only minimal advantage to the natural vegetation of the Wet Tropics lowlands, especially given that most areas suitable for agriculture on freehold land had already been cleared. The remaining areas that are now under the most threat of continued clearing and disturbance are in drier northern and western areas, and in the far south, particularly between Crystal Creek and Bluewater.

Exemptions under the Vegetation Management Act 1999 allow for legal clearing in areas, which have already been granted certain leases (eg. aquaculture), or for many areas occurring on urban or rural-residential zoning. They also allow for fence-line clearings and clearings for houses, infrastructure and dams. Forestry operations are currently also allowable on freehold land, being exempt from development approval for vegetation clearing providing the forest practice code is followed. The Vegetation Management Act 1999 provides no restrictions on grazing or deliberate alteration of the ground-stratum via mechanical means, fertilisation or sowing of pasture species. Changes to the zoning of land through the Integrated Planning Act (material change of use) can result in the clearing of remnant vegetation for uses such as urban expansion. Through this process, areas of less than two hectares are exempt from assessment under the Vegetation Management Act 1999. A new policy for the assessment of Material Change of Use applications came into force from December 2006 and it remains to be seen if this will provide any greater level of protection.

Other mechanisms for preventing degradation of Wet Tropics lowland vegetation outside of conservation reserves are becoming increasingly important. Voluntary conservation covenants (under amendments to the Land Act 1994) appear on the land title and bind successors in title. Some local governments are now using covenants to reward vegetation conservation through rate rebates. Nature Refuges (under the Nature Conservation Act 1992) enable landowners to obtain Environmental Protection Agency advice and assistance for management of native vegetation, and their management practices can also be made into binding land use agreements. The voluntary acquisition of land is another important mechanism, both by Federal and State governments, and by private conservation organisations. In some instances, conservation agreements and covenants can be placed on acquired land (to specify management practices and limit vegetation clearing), then the land resold. Tradeable rights and financial incentives (eg. rate rebates, water resources, vegetation clearing, carbon credits, and biodiversity offsets) are currently being investigated with the aim of placing a realistic economic value on environmental resources.

Conclusions

The documentation of pre-clearing vegetation in the Wet Tropics has been a revealing process. Clear, detailed photographs of lowland vegetation show numerous and extensive natural grasslands, broad bands of complex rainforest, and extensive forests and woodlands of *Melaleuca, Eucalyptus* and *Corymbia* species. These photos may have also recorded rapidly fading patterns of aboriginal landscape modification (including rainforest clearings and tracks). An array of additional air photos and land survey plans are yet to be examined, and could in future be used to refine the pre-clearing vegetation mapping. Other sources yet to be accessed include the full range of historical journal accounts, historical hand-held camera photos and indigenous knowledge. This paper and mapping coverage represents the beginning of a reconstruction of what the pre-clearing Wet Tropics vegetation was like. As a digital coverage it will be possible to improve the map as new information comes to light.

Comparison with current day mapping has shown that some of the mapped pre-clearing vegetation communities are extinct today, whilst several ecosystems have been reduced in area to less than 10% of their former extent. Prevention of further loss of significant ecosystems requires the application of various protective mechanisms, such as voluntary conservation covenants as well as the application of current vegetation management legislation.

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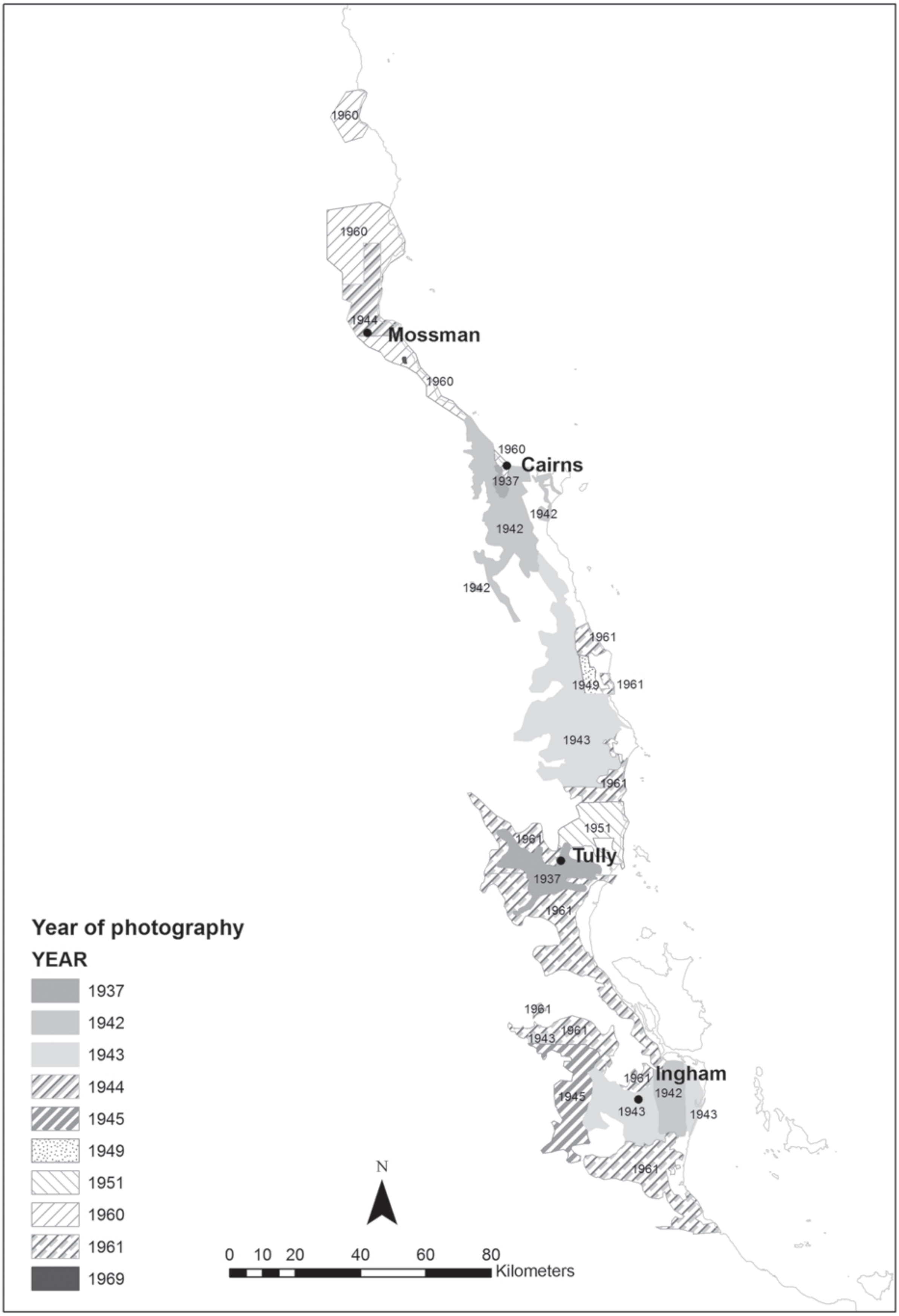
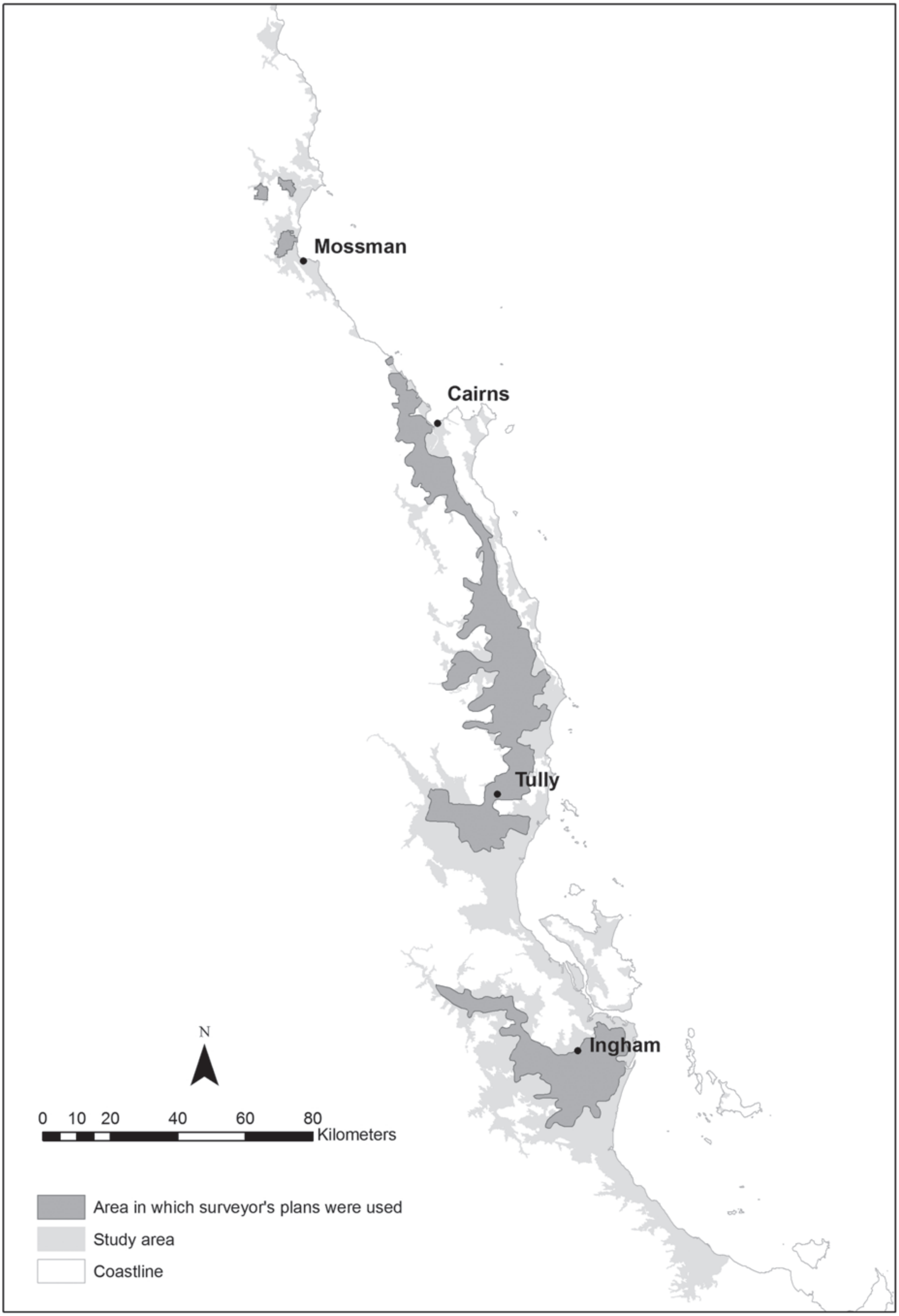
Appendix 1 Oldest aerial photographs utilised.



Appendix 2. Area for which historic surveyors plans were utilised.



Appendix 3. Regional ecosystems, vegetation communities and broad vegetation groups of the Wet Tropics Bioregion lowlands

Regional ecosystems and vegetation communities are as per Environmental Protection Agency (2005). Descriptions (in bold are summarised across vegetation communities to represent the regional ecosystem (RE) across its full range in the Wet Tropics bioregion (not just the lowlands). Vegetation communities (in regular text) that do not occur in the lowlands are not listed. The broad vegetation groups in this table were developed specifically for discussion in this manuscript and therefore differ to those in Environmental Protection Agency (2005). Where not indicated otherwise (eg estuarine, dune), broad vegetation groups occur on alluvium.

RE	Vegetation Community	Broad Vegetation Group (applied at RE level)	Description
7.1.1	7.1.1	**estuarine**	**Mangrove low closed forest to open shrubland.**
7.1.2		**estuarine**	***Sporobolus virginicus* grassland, samphire open forbland to sparse forbland, and bare saltpans, on plains adjacent to mangroves.**
	7.1.2a		Samphire flats with open forbland to sparse forbland of *Halosarcia* spp., and *Suaeda australis*. Includes bare saltpans.
	7.1.2b		*Sporobolus virginicus* (saltwater couch) grassland.
7.1.3		**estuarine**	***Schoenoplectus litoralis* and/or *Eleocharis dulcis* sparse sedgeland, or *Melaleuca quinquenervia* shrubland to open forest, in swamps which fluctuate periodically between freshwater and estuarine.**
	7.1.3a		*Schoenoplectus litoralis* (bulrush) and/or *Eleocharis dulcis* (bulkuru) sedgeland. May include scattered *Melaleuca quinquenervia* and/or mangrove species.
	7.1.3b		*Melaleuca quinquenervia* woodland, shrubland and open forest.
	7.1.3c		Water, in dune swamps.
7.1.4		**estuarine**	**Mangrove and vine forest communities of the brackish zone.**
	7.1.4a		Mesophyll vine forest/mangrove complex, of the brackish zone. Canopy species include *Heritiera littoralis, Bruguiera gymnorhiza, Sonneratia alba, Barringtonia racemosa, Archontophoenix alexandrae, Elaeocarpus grandis, Melicope elleryana, Acacia mangium* and *Syzygium tierneyanum*.
	7.1.4b		Simple mesophyll vine forest with canopy dominated by *Barringtonia racemosa* and/or *Hibiscus tiliaceus*. *Heritiera littoralis* is common on mangrove fringes.
	7.1.4c		Mangrove communities with *Livistona drudei* emergents.
	7.1.4d		Riverine communities dominated by *Nypa fruticans*.
7.1.5	7.1.5	**estuarine**	***Melaleuca viridiflora* or *Melaleuca* spp. ± *Acacia* spp. ± mangrove spp. open woodland, shrubland and open forest.**
7.2.1		**dune rainforests vinescrubs**	**Mesophyll vine forest on beach ridges and sand plains of beach origin.**
	7.2.1a		Complex mesophyll or mesophyll vine forest.
	7.2.1b		Mesophyll vine forest with *Intsia bijuga, Beilschmiedia obtusifolia*, and *Palaquium galactoxylon*.
	7.2.1c		Low to medium closed forest with *Calophyllum inophyllum, Terminalia arenicola, Dillenia alata, Myristica insipida, Pouteria obovoidea, Pongamia pinnata*, and *Hibiscus tiliaceus*.
	7.2.1d		Swampy mesophyll vine forest with *Archontophoenix alexandrae* (feather palm) in the sub-canopy.
	7.2.1e		Simple Notophyll vine forest with *Syzygium angophoroides*.
	7.2.1f		Simple notophyll vine forest with *Blepharocarya involucrigera, Acacia celsa, Flindersia bourjotiana, Syzygium angophoroides, Dillenia alata, Grevillea baileyana, Syzygium kuranda, Calophyllum sil, Backhousia hughesii, Achronychia acronychioides*.
	7.2.1g		Mesophyll vine forest with *Archontophoenix alexandrae* (feather palm).

	7.2.1h		Mesophyll vine forest with *Licuala ramsayi* (fan palm).
	7.2.1i		Mesophyll vine forest.
7.2.2		**dune rainforests vinescrubs**	**Notophyll to microphyll vine forest on beach ridges and sand plains of beach origin.**
	7.2.2a		Notophyll vine forests, often with *Acacia* emergents. Species commonly include *Cupaniopsis anacardioides, Diospyros geminata, Canarium australianum, Alphitonia excelsa, Acacia crassicarpa, Pleiogynium timorense, Chionanthus ramiflora, Mimusops elengi, Polyalthia nitidissima, Pongamia pinnata, Geijera latifolia, Ficus opposita, Pouteria sericea, Terminalia muelleri, T. arenicola, Drypetes deplanchei*, and *Exocarpos latifolius*.
	7.2.2b		Closed shrubland and low closed forest with *Blepharocarya involucrigera, Randia sessilis, Choriceras tricorne, Endiandra glauca, Cyclophyllum multiflorum, Syzygium banksii, Polyscias australiana, Terminalia muellerii, Dillenia alata* and *Acacia polystachya*.
	7.2.2c		Simple notophyll vine forest dominated by *Blepharocarya involucrigera*. Sites subject to episodic disturbance or a seral stage of recovery from a single event or period of disturbance.
	7.2.2d		*Acacia mangium* closed forest, with *A. crassicarpa, Hibiscus tiliaceus, Cupaniopsis anacardioides, Pouteria obovata, Breynia stipata, Morinda citrifolia* and *Terminalia muelleri*.
	7.2.2e		Low notophyll vine thicket.
	7.2.2f		Microphyll vine thicket occurring in clumps/groves. Inter-grove areas are occupied by sparse grasses and herbs. Common tree species include *Mimusops elengi, Terminalia muelleri, Diospyros ferrea* var. *reticulata, Pouteria sericea, Ficus obliqua* var. *obliqua, Pleiogynium timorense, Canarium australianum, Exocarpos latifolius, Celtis paniculata, Maytenus fasciculiflora, Brucea javanica, Ximenia americana, Acacia oraria, Acacia leptocarpa* and *Persoonia falcata*.
	7.2.2g		Vine forest with *Hibiscus tiliaceus* and *Calophyllum australianum*.
	7.2.2h		Medium to tall semi-deciduous notophyll vine forest with species including *Melia azedarach, Pleiogynium timorense, Ganophyllum falcatum, Paraserianthes toona, Ficus racemosa, Argyrodendron polyandrum*, and *Alstonia scholaris*.
7.2.3		**dune open forests**	***Corymbia tessellaris* and/or *Acacia crassicarpa* and/or *C. intermedia* and/or *C. clarksoniana* closed forest to woodland, of beach ridges, predominantly of Holocene age.**
	7.2.3a		*Corymbia tessellaris, C. clarksoniana* (and/or *C. intermedia*), *Melaleuca dealbata* ± *Lophostemon suaveolens*, open forest and woodland with *Acacia mangium, A. crassicarpa, Canarium australianum* and *Deplanchea tetraphylla*.
	7.2.3b		*Corymbia tessellaris* and *Corymbia clarksoniana* (or *C. intermedia*), woodland or open forest.
	7.2.3c		*Corymbia tessellaris* and *Corymbia clarksoniana* (or *C. intermedia*), woodland or open forest, with a very well developed vine forest understorey (due to infrequent burning).
	7.2.3d		*Corymbia intermedia* open forest.
	7.2.3e		*Corymbia intermedia* open forest, with a very well developed vine forest understorey (due to infrequent burning).
	7.2.3f		*Acacia crassicarpa* open to closed forest.
	7.2.3g		*Corymbia clarksoniana* woodland to open forest.
	7.2.3h		*Corymbia tessellaris, Acacia crassicarpa, Melaleuca leucadendra* and *M. viridiflora* woodland.
	7.2.3i		*Acacia crassicarpa* low closed forest (wind sheared).
	7.2.3j		*Corymbia clarksoniana, C. tessellaris* and *Acacia crassicarpa* woodland.
7.2.4		**dune open forests**	***Eucalyptus* spp. (often *E. pellita* or *Corymbia intermedia*) open forest and/or *Lophostemon suaveolens* open forest on swampy sand plains of beach origin, and Pleistocene beach ridges.**
	7.2.4a		*Corymbia intermedia, Eucalyptus pellita, Lophostemon suaveolens* and *Melaleuca dealbata* open forest to woodland.
	7.2.4b		*Eucalyptus tereticornis, Corymbia tessellaris, E. pellita, E. intermedia, Melaleuca dealbata, Lophostemon suaveolens, Acacia mangium* and *A. crassicarpa* woodland to open forest.

	7.2.4c		*Eucalyptus tereticornis, Corymbia tessellaris, E. pellita, E. intermedia, Melaleuca dealbata, Lophostemon suaveolens, Acacia mangium* and *A. crassicarpa*, woodland to open forest with a very well developed vine forest understorey.
	7.2.4d		*Eucalyptus pellita* and *Corymbia intermedia*, ± *C. tessellaris, E. tereticornis, Lophostemon suaveolens, Acacia celsa, A. cincinnata, A. mangium* and *A. flavescens* open forest.
	7.2.4e		*Eucalyptus pellita* and *Corymbia intermedia*, ± *C. tessellaris, E. tereticornis* and *Lophostemon suaveolens*, open forest to woodland with a very well developed vine forest understorey.
	7.2.4f		*Lophostemon suaveolens* ± *Corymbia tessellaris, Melaleuca* sp.aff. *viridiflora*, and *M. dealbata* woodland and open forest.
	7.2.4g		*Melaleuca dealbata* ± *M. leucadendra* open forest to woodland.
	7.2.4h		*Melaleuca dealbata, Lophostemon suaveolens, Corymbia tessellaris, Acacia mangium* and *Livistona drudei* open forest.
	7.2.4i		*Eucalyptus portuensis* open forest.
	7.2.4j		*Allocasuarina littoralis, Corymbia intermedia* and *Lophostemon suaveolens* open forest, woodland and shrubland.
	7.2.4k		*Acacia mangium* and *A. celsa* open to closed forest.
	7.2.4l		*Melaleuca leucadendra, M. viridiflora, M. dealbata, Acacia leptocarpa, A. crassicarpa, Excoecaria agallocha, Hibiscus tiliaceus* and *Thespesia populnea* woodland to low open forest.
	7.2.4m		*Acacia celsa* open to closed forest.
	7.2.4n		*Eucalyptus tereticornis* open forest and woodland.
7.2.5		**dune rainforests vinescrubs**	**Mesophyll/notophyll vine forest of *Syzgium forte* subsp. *forte* on beach ridges and sand plains of beach origin.**
	7.2.5a		Simple mesophyll to notophyll vine forest with *Syzygium forte* subsp. *forte, Buchanania arborescens, Pleiogynium timorense, Dillenia alata, Litsea fawcettiana*, and *Chionanthus ramiflora*.
	7.2.5b		*Acacia polystachya* dominant communities, mostly closed forest but includes some woodlands, with a lower layer of vine forest species.
7.2.6		**dune shrublands and heathlands**	**Mosaic of clumps of notophyll vine forest, sclerophyll spp. shrublands and open woodlands, and bare sand blows, on aeolian dunes.**
	7.2.6a		Open shrubland to low open forest.
	7.2.6b		Evergreen notophyll vine thicket with *Acacia crassicarpa, Elaeodendron melanocarpum, Aglaia elaeagnoidea* and *Drypetes deplanchei*.
	7.2.6c		Complex of open to closed shrublands, grasslands and low to medium woodlands and forests. Includes pure stands of *Casuarina equisetifolia*, and open to closed woodlands dominated by *Acacia crassicarpa, Syzygium forte* subsp. *forte*, and *Calophyllum inophyllum* and *Pandanus* sp.
7.2.7		**dune casuarina**	***Casuarina equisetifolia* ± *Corymbia tessellaris* open forest ± groved vine forest shrublands of the beach strand and foredune.**
	7.2.7a		Complex of open to closed shrublands, grasslands and low to medium woodlands and forests. Includes pure stands of *Casuarina equisetifolia*, and open to closed woodlands dominated by *Acacia crassicarpa, Syzygium forte* subsp. *forte*, *Calophyllum inophyllum* and *Pandanus* sp.
	7.2.7b		Groved shrubland with *Corymbia tessellaris, Casuarina equisetifolia* and vine forest species including *Canarium australianum, Terminalia arenicola, Pouteria sericea*.
	7.2.7c		Areas of open sand.
7.2.8	7.2.8	**dune paperbark forests**	***Melaleuca leucadendra* open forest to woodland.**
7.2.9		**dune paperbark forests**	***Melaleuca quinquenervia* shrubland to closed forest, or *Lepironia articulata* open to closed sedgeland on dune swales and swampy sand plains of beach origin.**
	7.2.9a		*Melaleuca quinquenervia* open forest to woodland and shrubland.
	7.2.9b		Mixed sedgeland-shrubland complex with *Melaleuca quinquenervia*.
	7.2.9c		*Lepironia articulata* sedgeland.
	7.2.9d		*Melaleuca quinquenervia* and *Acacia crassicarpa* open forest and woodland.

7.2.10		**dune shrublands and heathlands**	**Shrubland, sedgeland and heath complex with *Thryptomene oligandra* and/or *Asteromyrtus* spp., ± *Melaleuca quinquenervia* on sand plains of beach origin.**
	7.2.10a		*Thryptomene oligandra* low open forest, closed shrubland and heath complex.
	7.2.10b		*Asteromyrtus lysicephala, Asteromyrtus angustifolia, Thryptomene oligandra, Acacia crassicarpa, Jacksonia thesioides, Leucopogon yorkensis, Hibbertia banksii, Canthium coprosmoides* and *Aidia racemosa* open to closed scrub and heath.
	7.2.10c		Low open forest, shrubland and sedgeland complex with *Melaleuca quinquenervia, Asteromyrtus lysicephala, Deplanchea tetraphylla, Dillenia alata, Gahnia sieberiana, Pandanus sp., Lepironia articulata, Nepenthes mirabilis, Blechnum indicum* and *Myrmecodia beccarii*.
	7.2.10d		*Allocasuarina littoralis* woodland and open forest.
	7.2.10e		*Acacia flavescens, Allocasuarina littoralis* and *Allocasuarina torulosa* low shrubby open forest to woodland.
7.2.11		**dune paperbark forests**	***Melaleuca viridiflora* ± *Lophostemon suaveolens* ± emergent *Eucalyptus* spp. woodland to open forest, or *Melaleuca* sp. aff. *viridiflora* open forest to woodland, on swampy sand plains of beach origin.**
	7.2.11a		*Melaleuca viridiflora* woodland to open forest.
	7.2.11b		*Melaleuca viridiflora*, and *Lophostemon suaveolens* woodland.
	7.2.11c		*Melaleuca viridiflora, Lophostemon suaveolens* and *Allocasuarina littoralis* open shrubland.
	7.2.11d		Complex of *Melaleuca quinquenervia* shrublands and open forests, and *Melaleuca viridiflora, Lophostemon suaveolens* and *Allocasuarina littoralis* low woodland and open forest.
	7.2.11e		*Melaleuca* sp. aff. *viridiflora* open forest and woodland.
	7.2.11f		*Melaleuca quinquenervia* and *Melaleuca viridiflora* open grassy woodland.
	7.2.11g		*Corymbia clarksoniana, Eucalyptus platyphylla, Lophostemon suaveolens, E. drepanophylla* and *Melaleuca viridiflora* open woodland.
	7.2.11h		Grassland, probably dominated by *Imperata cylindrica* (all extinct).
7.3.1		**grassland and sedgeland**	***Hemarthria uncinata* and/or *Ischaemum australe* and/or *Cynodon dactylon* grassland, and/or ephemeral sedgelands, on seasonally inundated alluvial plains.**
	7.3.1a		*Hemarthria uncinata* and/or *Ischaemum australe* subsp. *arundinaceum* closed grassland.
	7.3.1b		*Cynodon dactylon* grassland.
	7.3.1c		Ephemeral freshwater swamp dominated by sedges.
7.3.3		**palm swamps**	**Mesophyll vine forest with *Archontophoenix alexandrae* on poorly drained alluvial plains.**
	7.3.3a		Mesophyll vine forest with *Archontophoenix alexandrae* (feather palm).
	7.3.3c		Mesophyll vine forest with dominant *Syzygium tierneyanum* and/or *Barringtonia racemosa* and sub-canopy dominated by *Archontophoenix alexandrae* (feather palm).
7.3.4	7.3.4	**palm swamps**	**Mesophyll vine forest with *Licuala ramsayi* (fan palm).**
7.3.5		**paperbark forests**	***Melaleuca quinquenervia* and/or *Melaleuca cajuputi* closed forest to shrubland on poorly drained alluvial plains.**
	7.3.5a		*Melaleuca quinquenervia* open forest, woodland and shrubland.
	7.3.5b		Mixed shrubland-sedgeland complex with *Melaleuca quinquenervia*.
	7.3.5c		*Melaleuca cajuputi* open forest to woodland.
	7.3.5d		*Melaleuca quinquenervia* and *M. viridiflora* open grassy woodland with a dense grassy ground layer, usually dominated by *Ischaemum australe* and *Isachne globosa*.
	7.3.5e		*Melaleuca quinquenervia* and *Lophostemon suaveolens* open shrubland with a ground layer of by *Ischaemum australe* var. *arundinaceum*.
7.3.6		**paperbark forests**	***Melaleuca dealbata* ± *Melaleuca leucadendra* open forest on poorly drained alluvial plains.**
	7.3.6a		*Melaleuca dealbata* ± *M. leucadendra* open forest to woodland. Includes two areas on the northeastern edge of Wharps Holding that are young dense recruiting stands of *Melaleuca dealbata* which have taken over naturally open areas. The reason for this recruitment is unclear.

	7.3.6b		*Melaleuca dealbata* open forest.
7.3.7		**open forests**	***Eucalyptus pellita* and *Corymbia intermedia* open forest to woodland (or vine forest with emergent *E. pellita* and *C. intermedia*), on poorly drained alluvial plains.**
	7.3.7a		*Eucalyptus pellita* and *Corymbia intermedia* open forest and woodland.
	7.3.7b		*Eucalyptus pellita* and *Corymbia intermedia* open forest and woodland, with a very well developed vine forest understorey.
	7.3.7c		*Corymbia intermedia, Eucalyptus pellita, Lophostemon suaveolens* and *Melaleuca dealbata* open forest and woodland.
7.3.8		**teatree**	***Melaleuca viridiflora* ± *Eucalyptus* spp. ± *Lophostemon suaveolens* open forest to open woodland on alluvial plains.**
	7.3.8a		*Melaleuca viridiflora* open forest to open woodland. Includes areas of natural invasion onto former grasslands.
	7.3.8b		*Melaleuca viridiflora* open forest to open woodland with eucalypt emergents (or sparse eucalypt overstorey) of species such as *Corymbia clarksoniana, Eucalyptus platyphylla, Lophostemon suaveolens* and *E. drepanophylla*.
	7.3.8c		*Melaleuca viridiflora*, and *Lophostemon suaveolens* open forest to woodland.
	7.3.8d		*Melaleuca viridiflora, Lophostemon suaveolens* and *Allocasuarina littoralis* open shrubland.
7.3.9		**open forests**	***Corymbia tessellaris, Acacia* spp., *Melaleuca* spp., open forest on poorly drained alluvial plains.**
	7.3.9a		*Melaleuca dealbata, Lophostemon suaveolens, Corymbia tessellaris, Acacia mangium* ± *Livistona drudei* open forest.
	7.3.9b		*Corymbia tessellaris, Acacia crassicarpa, Melaleuca leucadendra, M. viridiflora* woodland to open forest.
7.3.10		**rainforest**	**Simple to complex mesophyll to notophyll vine forest on moderate to poorly drained alluvial plains of moderate fertility.**
	7.3.10a		Mesophyll vine forest.
	7.3.10c		Mesophyll vine forest with scattered *Archontophoenix alexandrae* (feather palm) in the sub-canopy.
	7.3.10d		Open areas in vine forests dominated by sprawling vines, with emergent vine-draped trees or clumps of trees. Vines commonly include *Merremia peltata*.
	7.3.10e		Simple notophyll vine forest with *Blepharocarya involucrigera, Acacia celsa, Flindersia bourjotiana, Syzygium angophoroides, Dillenia alata, Grevillea baileyana, Syzygium kuranda, Calophyllum sil, Backhousia hughesii* and *Achronychia acronychioides*.
	7.3.10f		Simple Notophyll vine forest with *Syzygium angophoroides*.
	7.3.10g		Simple notophyll vine forest dominated by *Blepharocarya involucrigera*.
7.3.12		**open forests**	**Mixed eucalypt open forest to woodland, dominated by *Eucalyptus tereticornis* and *Corymbia tessellaris* ± *Melaleuca dealbata*, (or vine forest with these species as emergents), on alluvial plains of lowlands.**
	7.3.12a		*Eucalyptus tereticornis, Corymbia tessellaris, E. pellita, C. intermedia, Melaleuca dealbata* and *Lophostemon suaveolens* woodland to open forest, often with a secondary tree layer of *Acacia mangium* and *A. crassicarpa*.
	7.3.12b		*Eucalyptus tereticornis, Corymbia tessellaris, E. pellita, C. intermedia, Melaleuca dealbata* and *Lophostemon suaveolens* woodland to open forest, often with a secondary tree layer of *Acacia mangium* and *A. crassicarpa*, and with a very well developed vine forest understorey.
	7.3.12c		*Eucalyptus tereticornis* open woodland to sparse woodland over a prominent secondary tree layer of *Melaleuca quinquenervia* and/or *M. viridiflora*.
7.3.13	7.3.13	**woodland**	***Corymbia nesophila* open forest to woodland.**
7.3.16		**woodland**	***Eucalyptus platyphylla* woodland to open forest on alluvial plains.**
	7.3.16a		*Eucalyptus platyphylla, Corymbia clarksoniana, Lophostemon suaveolens* woodland, or *E. platyphylla, Lophostemon suaveolens, C. tessellaris* open forest.
	7.3.16b	woodland	*Eucalyptus platyphylla, Lophostemon suaveolens, Corymbia clarksoniana, C. tessellaris* open forest with a prominent shrub layer of *Acacia* spp., *Planchonia careya*, ± vine forest elements.
	7.3.16c		*Eucalyptus platyphylla* grassy woodland to open woodland.

7.3.17	7.3.17	**rainforest**	**Complex mesophyll vine forest.**
7.3.19		**open forests**	***Corymbia intermedia* or *C. tessellaris* ± *Eucalyptus tereticornis* open forest (or vine forest with these species as emergents), on well drained alluvium.**
	7.3.19a		*Corymbia intermedia, Eucalyptus tereticornis, E. drepanophylla, Allocasuarina torulosa, Allocasuarina littoralis, Lophostemon suaveolens*, woodland with *Acacia cincinnata, A. flavescens, Banksia aquilonia* and *Xanthorrhoea johnsonii*.
	7.3.19b		*Corymbia tessellaris* and *C. intermedia* woodland and open forest.
	7.3.19c		*Corymbia tessellaris* and *C. intermedia* woodland and open forest with a very well developed vine forest understorey.
	7.3.19d		*Corymbia intermedia* open forest.
	7.3.19e		*Corymbia intermedia* open forest with a very well developed vine forest understorey.
	7.3.19h		*Corymbia tessellaris* ± *Eucalyptus tereticornis, C. intermedia, E. drepanophylla, E. platyphylla* and *Lophostemon suaveolens* layered grassy woodland with *Acacia celsa* and *Cycas media*.
	7.3.19j		*Themeda triandra* and *Imperata cylindrica* grassland.
7.3.20		**open forests**	***Corymbia intermedia* and *Syncarpia glomulifera*, or *C. intermedia* and *Eucalyptus pellita*, or *Syncarpia glomulifera* and *Allocasuarina* spp., or *E. cloeziana*, or *C. torelliana* open forests (or vine forests with these species as emergents), on alluvial fans at the bases of ranges.**
	7.3.20a		*Eucalyptus pellita, Corymbia intermedia, C. tessellaris*, open forest often with *Acacia celsa, A. cincinnata, A. mangium* and *A. flavescens*. Includes small areas dominated by *A. crassicarpa*.
	7.3.20b		*Eucalyptus pellita, Corymbia intermedia, C. tessellaris*, open forest often with *Acacia celsa, A. cincinnata, A. mangium* and *A. flavescens*, with a very well developed vine forest understorey.
	7.3.20c		*Syncarpia glomulifera, Corymbia intermedia, Eucalyptus pellita, E. tereticornis*, open forest often with *Acacia celsa* and *A. mangium*.
	7.3.20d		*Corymbia intermedia, Syncarpia glomulifera, Lophostemon confertus* open forest with *Allocasuarina torulosa* and *Banksia aquilonia*.
	7.3.20e		*Corymbia intermedia, Eucalyptus pellita, E. tereticornis, C. tessellaris, C. torelliana*, open forest, often with *Acacia celsa, A. mangium, Lophostemon suaveolens*, and *Syncarpia glomulifera*.
	7.3.20f		*Corymbia intermedia, Eucalyptus pellita, E. tereticornis, C. tessellaris, C. torelliana*, open forest with a very well developed vine forest understorey, and often with *Acacia celsa, A. mangium, Lophostemon suaveolens*, and *Syncarpia glomulifera*.
	7.3.20g		Simple notophyll vine forest with *Corymbia torelliana, Eucalyptus tereticornis, C. intermedia, E. pellita, Acacia celsa, A. cincinnata* and *A. polystachya* emergents and co-dominants.
	7.3.20h		*Acacia mangium* and *Lophostemon suaveolens* open forest with scattered emergent sclerophyll species including *Eucalyptus pellita, Corymbia tessellaris* and *C. intermedia*.
	7.3.20i		*Syncarpia glomulifera, Allocasuarina torulosa* and/or *A. littoralis* open forest and woodland.
	7.3.20j		*Syncarpia glomulifera, Allocasuarina torulosa* and/or *A. littoralis* open forest and woodland with a very well developed vine forest understorey.
	7.3.20k		*Eucalyptus cloeziana* open forest.
	7.3.20l		*Syncarpia glomulifera, Corymbia intermedia, Allocasuarina littoralis* woodland, low woodland and open forest with *Banksia aquilonia, Acacia flavescens* and *X anthorrhoea johnsonii*.
	7.3.20m		*Acacia flavescens, Allocasuarina littoralis* and *A. torulosa* low shrubby open forest to woodland.
7.3.21		**open forests**	***Eucalyptus portuensis* ± *Corymbia intermedia* open forest to woodland on alluvium.**
	7.3.21a		*Eucalyptus portuensis, Corymbia intermedia, E. drepanophylla, E. platyphylla, E. tereticornis, C. tessellaris, Lophostemon suaveolens, Syncarpia glomulifera* open forest to woodland. May include small areas of *Acacia leptostachya* dominated communities.
	7.3.21b		*Eucalyptus portuensis, E. drepanophylla, Corymbia intermedia, Lophostemon suaveolens* low to medium woodland with *Melaleuca viridiflora, Acacia flavescens* and *Allocasuarina littoralis*.

	7.3.21c		*Corymbia intermedia, Eucalyptus portuensis, E. drepanophylla, E. platyphylla, C. tessellaris, E. tereticornis, Syncarpia glomulifera, Lophostemon suaveolens, L. confertus* woodland to low woodland with *Xanthorrhoea johnsonii* and *Cycas media*.
7.3.23		**rainforest**	**Simple to complex semi-deciduous notophyll to mesophyll vine forest on lowland alluvium.**
	7.3.23a		Simple-complex semi-deciduous notophyll to mesophyll vine forest.
	7.3.23b		Semi-deciduous vine forest with *Nauclea orientalis, Cryptocarya hypospodia* and *Castanospermum australe*.
7.3.25		**paperbark forests**	***Melaleuca leucadendra* ± vine forest species, open to closed forest, on alluvium fringing streams.**
	7.3.25a		*Melaleuca leucadendra* open forest and woodland.
	7.3.25b		*Melaleuca leucadendra* and *Eucalyptus tereticornis*, layered open forest, and closed forest with a vine forest understorey.
	7.3.25c		Closed forest of *Tristaniopsis exiliflora* and *Xanthostemon chrysanthus*.
7.3.26		**casuarina**	***Casuarina cunninghamiana* woodland to open forest on alluvium fringing streams.**
	7.3.26a		*Casuarina cunninghamiana, Eucalyptus tereticornis, Lophostemon suaveolens, Melaleuca leucadendra, M. fluviatilis, Buckinghamia celsissima, Mallotus philippensis* woodland and forest with an understorey of *Callistemon viminalis* and *Bursaria tenuifolia*.
	7.3.26b		*Casuarina cunninghamiana* woodland and forest.
7.3.28		**stream beds**	**Rivers and streams including riparian herbfield and shrubland on river and stream bed alluvium, and rock within stream beds.**
	7.3.28a		Water from natural non-tidal rivers.
	7.3.28b		Bare sand or silt, herblands, grasslands, shrublands and woodlands (exotic species, particularly of grasses and herbs may dominate).
	7.3.28c		*Callistemon viminalis* shrubland.
	7.3.28d		Unvegetated rock.
7.3.29		**grassland and sedgeland**	**Sedgelands and grasslands of permanently and semi-permanently inundated swamps, including areas of open water.**
	7.3.29a		Complex of sedgelands, grasslands, fernlands and forblands. Prominent species include *Cyperus lucidus, Actinoscirpus grossus, Lepironia articulata, Scleria poiformis, Gahnia sieberiana, Panicum paludosum, Isachne globosa, Blechnum indicum* and *Persicaria* sp.
	7.3.29b		Open water.
7.3.30	7.3.30	**fernland**	**Complex of fernlands and sedgelands with emergent rainforest pioneering spp.**
7.3.31	7.3.31	**grassland and sedgeland**	***Lepironia articulata* sedgeland to open sedgeland.**
7.3.32		**grassland and sedgeland**	***Imperata cylindrica* and/or *Sorghum nitidum* and/or *Mnesithea rottboellioides* and/or *Themeda triandra* closed tussock grassland on alluvial plains.**
	7.3.32a		*Imperata cylindrica* and/or *Sorghum nitidum* and/or *Mnesithea rottboellioides* closed grassland.
	7.3.32b		Grassland dominated by *Themeda triandra*.
7.3.34	7.3.34	**paperbark forests**	***Melaleuca* sp. aff. *viridiflora* (undescribed taxon) open to closed forest.**
7.3.35		**acacia**	***Acacia mangium* and/or *A. celsa* and/or *A. polystachya* closed forest on alluvial plains.**
	7.3.35a		*Acacia mangium* and *A. celsa* open to closed forest.
	7.3.35b		*Acacia celsa* open to closed forest.
	7.3.35c		*Acacia polystachya* closed forest, or *A. polystachya* woodland with a secondary layer of vine forest species.
7.3.36		**rainforest**	**Complex mesophyll vine forest of high rainfall, cloudy uplands on alluvium.**
	7.3.36b		Simple notophyll vine forest.
7.3.38	7.3.38	**rainforest**	**Complex notophyll vine forest with emergent *Agathis robusta*.**
7.3.40	7.3.40	**open forests**	***Eucalyptus tereticornis* open forest.**

7.3.43		**open forests**	***Eucalyptus tereticornis* open forest to woodland, on uplands on well drained alluvium.**
	7.3.43a		*Eucalyptus tereticornis* open forest, tall open forest and woodland including communities ranging from those dominated by *E. tereticornis* to mixtures of that species with *Corymbia intermedia, E. drepanophylla, Lophostemon suaveolens* and *Allocasuarina torulosa*.
7.3.44	7.3.44	**open forests**	***Eucalyptus leptophleba* ± *Corymbia clarksoniana* open forest to woodland.**
7.3.45		**open forests**	***Corymbia clarksoniana* ± *C. tessellaris* ± *Eucalyptus drepanophylla* open forest to open woodland on alluvial plains.**
	7.3.45a		*Eucalyptus drepanophylla, Corymbia clarksoniana*, ± *E. platyphylla*, ± *C. tessellaris*, ± *C. dallachiana* woodland to open forest.
	7.3.45b		*Corymbia clarksoniana* woodland to open forest. May include small areas of *Acacia leptostachya* shrubland.
	7.3.45c		*Corymbia clarksoniana* and *C. tessellaris* ± *E. tereticornis* ± *E. platyphylla* ± *Lophostemon suaveolens* ± *Melaleuca dealbata* ± *C. dallachiana* woodland.
	7.3.45d		*Corymbia tessellaris, C. intermedia, C. clarksoniana* grassy woodland, open woodland and sparse woodland occurring only on the Palm Islands.
	7.3.45e		Woodland with *Corymbia clarksoniana* in the Cowie Point and Duncans Flat area.
	7.3.45f		*Corymbia clarksoniana* dense open forest, with *Melaleuca dealbata, Eucalyptus platyphylla, C. tessellaris, Lophostemon suaveolens*, and occasionally *E. pellita*. Dense secondary tree layer of *Alphitonia excelsa, Acacia oraria, A. mangium, A. crassicarpa, A. flavescens, Pandanus* sp., and *Planchonia careya*. (This is an extinct vegetation community).
7.3.46	7.3.46	**open forests**	***Lophostemon suaveolens* open forest to woodland.**
7.3.47	7.3.47	**open forests**	***Allocasuarina littoralis, Corymbia intermedia* and *Lophostemon suaveolens* open forest.**
7.3.49		**rainforest**	**Notophyll vine forest on rubble terraces of streams.**
	7.3.49a		*Tristaniopsis exiliflora* and *Xanthostemon chrysanthus* medium to tall layered open forest, and medium closed forest. Common associated species include *Grevillea baileyana, G. hilliana*, and *Blepharocarya involucrigera*.
	7.3.49c		Mixed open forest, low open forest, low closed forest, vine woodland, and open scrub with *Lophostemon suaveolens, Chionanthus ramiflora, Acacia flavescens*, and in areas of open scrub *Pittosporum spinescens* and *Wikstroemia indica*.
7.3.50		**paperbark forests**	***Melaleuca fluviatilis* ± vine forest species, open to closed forest, on alluvium fringing streams.**
	7.3.50a		*Melaleuca fluviatilis* open forest and woodland, often with *Casuarina cunninghamiana, Eucalyptus tereticornis, Lophostemon suaveolens, Corymbia intermedia* and *Nauclea orientalis*.
	7.3.50b		Low notophyll vine thicket with emergent *Melaleuca fluviatilis*.
7.8.1		**rainforest**	**Complex mesophyll vine forest on well drained basalt lowlands and foothills.**
	7.8.1a		Complex mesophyll vine forest.
	7.8.1b		Complex mesophyll vine forest on lateritic soils.
7.8.2		**rainforest**	**Complex notophyll to mesophyll vine forest of high rainfall, cloudy uplands on basalt.**
	7.8.2a		Complex mesophyll vine forest.
7.8.7		**open forests**	***Eucalyptus tereticornis* open forest, and associated grasslands, predominantly on basalt uplands.**
	7.8.7a		*Eucalyptus tereticornis* open forest, tall open forest and woodland. May also include *Corymbia intermedia, E. drepanophylla, Lophostemon suaveolens* and *Allocasuarina torulosa*.
	7.8.7b		Grassland dominated by *Themeda triandra*.
	7.8.7c		Grassland of unknown composition, possibly *Imperata cylindrica*.
7.8.11		**rainforest**	**Closed vineland of wind disturbed vine forest on basalt.**
	7.8.11a		Open areas in vine forests with sprawling vines and emergent vine-draped trees or clumps of trees. *Merremia peltata* is often present.

	7.8.11b		Complex mesophyll on very wet and wet lowlands, suffering from extreme wind damage where at least half the canopy has been destroyed.
7.8.12	7.8.12	**rainforest**	**Complex notophyll vine forest dominated by *Backhousia bancroftii*.**
7.8.14	7.8.14	**rainforest**	**Complex notophyll vine forest with emergent *Agathis robusta*.**
7.8.18		**open forests**	***Corymbia intermedia* and/or *Lophostemon suaveolens* ± *Allocasuarina torulosa* open forest to woodland on basalt.**
	7.8.18a		*Corymbia intermedia, Eucalyptus tereticornis, E. granitica* open forest to woodland with *Allocasuarina torulosa, A. littoralis, Lophostemon suaveolens, Acacia cincinnata, A. flavescens, Banksia aquilonia* and *Xanthorrhoea johnsonii*.
	7.8.18b		Corymbia intermedia open forest, with a very well developed vine forest understorey.
7.8.19	7.8.19	**open forests**	***Corymbia clarksoniana* open forest to woodland.**
7.11.1		**rainforest on hills**	**Simple to complex mesophyll to notophyll vine forest on moderately to poorly drained metamorphics (excluding amphibolites) of moderate fertility of the moist and wet lowlands, foothills and uplands.**
	7.11.1a		Mesophyll vine forest.
	7.11.1g		Mesophyll vine forest with scattered *Archontophoenix alexandrae* (feather palm) in the sub-canopy.
7.11.5		**open forests on hills**	***Eucalyptus pellita* ± *Corymbia intermedia* open forest (or vine forest with *E. pellita* and *C. intermedia* emergents), on metamorphics.**
	7.11.5a		*Eucalyptus pellita, Corymbia intermedia, C. tessellaris* open forest with *Acacia celsa, A. cincinnata, A. mangium* and *A. flavescens*.
	7.11.5b		*Eucalyptus pellita, Corymbia intermedia, C. tessellaris* open forest with *Acacia celsa, A. cincinnata, A. mangium* and *A. flavescens* and with a very well developed vine forest understorey.
	7.11.5c		*Corymbia intermedia, Eucalyptus pellita, E. tereticornis, C. tessellaris, C. torelliana*, open forest to woodland with *Acacia celsa, A. mangium, Lophostemon suaveolens* and *Syncarpia glomulifera*.
	7.11.5d		*Corymbia intermedia, Eucalyptus pellita, E. tereticornis, C. tessellaris, C. torelliana*, open forest to woodland with *Acacia celsa, A. mangium, Lophostemon suaveolens* and *Syncarpia glomulifera*, and with a very well developed vine forest understorey.
	7.11.5e		*Eucalyptus pellita* and *Corymbia intermedia* open forest and woodland.
7.11.7		**rainforest on hills**	**Complex notophyll vine forest with *Agathis robusta* emergents, on metamorphics of moist foothills and uplands.**
	7.11.7a		Complex notophyll vine forests (with emergent *Agathis robusta*).
7.11.8		**acacia on hills**	***Acacia polystachya* woodland to closed forest, or *Acacia mangium* and *Acacia celsa* open to closed forest, on metamorphics.**
	7.11.8b		*Acacia mangium* and *A. celsa* open to closed forest.
7.11.16		**open forests on hills**	***Eucalyptus portuensis* and *Corymbia intermedia* open forest to woodland, on wet and moist metamorphics of foothills and uplands.**
	7.11.16a		*Eucalyptus portuensis, Corymbia intermedia, E. drepanophylla, E. platyphylla, E. tereticornis, C. tessellaris, Lophostemon suaveolens, Syncarpia glomulifera* open forest to woodland.
7.11.18		**open forests on hills**	***Corymbia intermedia* and/or *C. tessellaris* ± *Eucalyptus tereticornis* medium to tall open forest to woodland (or vine forest with these species as emergents), on coastal metamorphic headlands and near-coastal foothills.**
	7.11.18a		*Corymbia intermedia* open forest to tall open forest.
	7.11.18b		*Corymbia intermedia* open forest to tall open forest with a very well developed vine forest understorey.
	7.11.18d		*Corymbia intermedia* open forest to tall open forest with a very well developed vine forest understorey.
	7.11.18e		*Corymbia tessellaris* and *C. intermedia* woodland to tall woodland and open forest.
	7.11.18g		*Eucalyptus tereticornis, Corymbia tessellaris, C. intermedia, E. drepanophylla, E. platyphylla, Lophostemon suaveolens* woodland and low layered grassy woodland with *Acacia aulacocarpa* and *Cycas media*.
	7.11.18h		*Eucalyptus tereticornis, Corymbia tessellaris, E. pellita, E. intermedia, Melaleuca dealbata, Lophostemon suaveolens* woodland, low woodland and open forest with *Acacia mangium* and *A. crassicarpa*.
7.11.19		**open forests on hills**	***Corymbia intermedia* and/or *Lophostemon suaveolens* open forest to woodland of uplands, on metamorphics.**

	7.11.19a		*Corymbia intermedia, Eucalyptus tereticornis, Allocasuarina torulosa, A. littoralis* and *Lophostemon suaveolens* open forest, low open forest and woodland with *Acacia cincinnata, A. flavescens, Banksia aquilonia* and *Xanthorrhoea johnsonii*.
	7.11.19c		*Lophostemon suaveolens* woodland and open forest.
7.11.25		**rainforest on hills**	**Simple-complex mesophyll to notophyll vine forest on amphibolites of the very wet lowlands and foothills.**
	7.11.25a		Mesophyll to notophyll vine forest.
7.11.26		**shrubland on hills**	**Rock pavements with *Allocasuarina littoralis* and *Syncarpia glomulifera* open to closed shrublands or *Bombax ceiba* and *Cochlospermum gillivraei* open woodland, or *Acacia* spp. shrubland, on metamorphics.**
	7.11.26a		*Acacia flavescens, Allocasuarina littoralis* and *Allocasuarina torulosa* low shrubby open forest to woodland.
	7.11.26f		Bare rock.
7.11.34		**shrubland on hills**	**Complex of shrublands, low heathy or shrubby woodlands and low forests, with *Corymbia tessellaris* and *C. intermedia* or *Melaleuca viridiflora*, *Allocasuarina* spp. and *Acacia* spp. on metamorphic coastal headlands and islands.**
	7.11.34a		Woodland, low woodland, low forest and shrubland with *Corymbia tessellaris, C. intermedia, Lophostemon suaveolens, Eucalyptus platyphylla, Melaleuca viridiflora, Acacia crassicarpa, A. flavescens, A. celsa, A. polystachya, Dillenia alata, Randia sessilis*, and *Canthium coprosmoides*.
	7.11.34c		Heath shrubland and grassland complex of coastal headlands with *Melaleuca viridiflora, Allocasuarina littoralis, Casuarina equisetifolia, Lophostemon suaveolens, Acacia holosericea, A. polystachya, Lophostemon grandiflorus, A. calyculata, Thryptomene oligandra, Pittosporum ferrugineum, Xanthorrhoea johnsonii* and *Alyxia spicata*.
	7.11.34d		Bare rock on coastal headlands.
7.11.39		**grassland and sedgeland on hills**	***Themeda triandra*, or *Imperata cylindrica, Sorghum nitidum* and *Mnesithea rottboellioides* closed tussock grassland, on metamorphic headlands and near-coastal hills.**
	7.11.39c		*Imperata cylindrica, Sorghum nitidum* and *Mnesithea rottboellioides* grassland.
7.11.43	7.11.43	**open forests on hills**	***Corymbia clarksoniana* ± *C. tessellaris* open forest to woodland.**
7.11.44	7.11.44	**open forests on hills**	***Eucalyptus tereticornis* open forest to woodland.**
7.11.47	7.11.47	**woodland on hills**	***Corymbia nesophila* open forest.**
7.11.49	7.11.49	**open forests on hills**	***Eucalyptus leptophleba, Corymbia clarksoniana* and *E. platyphylla* open forest to woodland.**
7.11.50		**woodland on hills**	***Eucalyptus platyphylla* ± *E. drepanophylla* ± *Corymbia* spp. open woodland to open forest on metamorphics.**
	7.11.50a		*Eucalyptus platyphylla, E. drepanophylla, Corymbia intermedia, Lophostemon suaveolens* open woodland to open forest.
7.11.51		**open forests on hills**	***Corymbia clarksoniana* and/or *Eucalyptus drepanophylla* open forest to woodland on metamorphics.**
	7.11.51a		*Corymbia clarksoniana, Eucalyptus tereticornis, E. drepanophylla* woodland, low woodland to open forest with *Allocasuarina torulosa, Allocasuarina littoralis, Lophostemon suaveolens, Acacia cincinnata, A. flavescens, Banksia aquilonia* and *Xanthorrhoea johnsonii*.
7.12.1		**rainforest on hills**	**Simple to complex mesophyll to notophyll vine forest on moderately to poorly drained granites and rhyolites of moderate fertility of the moist and wet lowlands, foothills and uplands.**
	7.12.1a		Mesophyll to notophyll vine forest.
7.12.2		**rainforest on hills**	**Notophyll or mesophyll vine forest with *Archontophoenix alexandrae* or *Licuala ramsayi*, on granites and rhyolites.**
	7.12.2e		Notophyll to mesophyll vine forest with *Archontophoenix alexandrae*.
7.12.4	7.12.4	**open forests on hills**	***Syncarpia glomulifera* ± *Eucalyptus pellita* open forest.**
7.12.5		**open forests on hill**	***Eucalyptus pellita* ± *Corymbia intermedia* open forest, or *Acacia mangium* and *Lophostemon suaveolens* open forest (or vine forest with these species as emergents), on granites and rhyolites.**

	7.12.5a		*Eucalyptus pellita, Corymbia intermedia* and *C. tessellaris* open forest with *Acacia celsa, A. cincinnata, A. mangium* and *A. flavescens*.
	7.12.5b		*Eucalyptus pellita, Corymbia intermedia* and *C. tessellaris* open forest with *Acacia celsa, A. cincinnata, A. mangium* and *A. flavescens*, with a very well developed vine forest understorey.
	7.12.5c		*Corymbia intermedia, Eucalyptus pellita, E. tereticornis, C. tessellaris* and *C. torelliana*, open forest to woodland with *Acacia celsa, A. mangium, Lophostemon suaveolens* and *Syncarpia glomulifera*.
	7.12.5e		*Acacia mangium* and *Lophostemon suaveolens* open forest with emergent *Eucalyptus pellita, Corymbia tessellaris*, and *C. intermedia*.
	7.12.5h		*Melaleuca viridiflora*, and *Lophostemon suaveolens* woodland.
	7.12.5i		*Imperata cylindrica, Sorghum nitidum* and *Mnesithea rottboellioides* grassland.
7.12.9	7.12.9	**acacia on hills**	***Acacia celsa* open to closed forest.**
7.12.11		**rainforest on hills**	**Simple notophyll vine forest and notophyll semi-evergreen vine forest of rocky areas and talus, of moist granite and rhyolite foothills and uplands.**
	7.12.11b		Simple notophyll vine forest.
7.12.17	7.12.17	**open forests on hills**	***Corymbia torelliana* open forest usually with a well developed simple notophyll vine forest element.**
7.12.23		**open forests on hills**	***Corymbia intermedia* and/or *C. tessellaris* ± *Eucalyptus tereticornis* medium to tall open forest to woodland (or vine forest with these species as emergents), on coastal granite and rhyolite headlands and near-coastal foothills.**
	7.12.23a		*Corymbia intermedia* open forest to tall open forest.
	7.12.23b		*Corymbia intermedia* open forest to tall open forest with a very well developed vine forest understorey.
	7.12.23c		*Corymbia tessellaris* and *C. intermedia* open forest to tall woodland and open forest.
	7.12.23d		*Corymbia tessellaris* and *C. intermedia* open forest to tall woodland and open forest with a very well developed vine forest understorey.
	7.12.23e		*Eucalyptus tereticornis, Corymbia tessellaris, E. pellita, E. intermedia, Melaleuca dealbata, Lophostemon suaveolens, Acacia mangium* and *A. crassicarpa* woodland to low woodland.
	7.12.23f		*Eucalyptus tereticornis, Corymbia tessellaris, C. intermedia, E. drepanophylla, E. platyphylla, Lophostemon suaveolens* and *Acacia aulacocarpa* woodland to low woodland and low layered grassy woodland, with *Cycas media*.
7.12.24		**open forests on hills**	***Eucalyptus portuensis* and *Corymbia intermedia* open forest to woodland (or vine forest with *E. portuensis* and *C. intermedia* emergents), on wet and moist foothills and uplands on granite and rhyolite.**
	7.12.24a		*Eucalyptus portuensis, Corymbia intermedia, E. drepanophylla, E. platyphylla, E. tereticornis, C. tessellaris, Lophostemon suaveolens, Syncarpia glomulifera* open forest to woodland.
7.12.26		**open forests on hills**	***Syncarpia glomulifera* ± *Corymbia intermedia* ± *Allocasuarina* spp. closed forest to woodland, or *Lophostemon suaveolens, Allocasuarina littoralis, C. intermedia* shrubland, (or vine forest with these species as emergents), on exposed ridgelines or steep rocky slopes.**
	7.12.26d		*Syncarpia glomulifera, Corymbia intermedia, Allocasuarina littoralis, Banksia aquilonia, Acacia flavescens* woodland to low woodland with *Xanthorrhoea johnsonii*.
7.12.28		**woodland on hills**	***Eucalyptus platyphylla* ± *E. drepanophylla* ± *Corymbia* spp. open woodland to open forest on granite and rhyolite.**
	7.12.28a		*Eucalyptus platyphylla, E. drepanophylla, Corymbia intermedia, Lophostemon suaveolens* woodland to low woodland to open forest.
	7.12.28b		*Eucalyptus platyphylla* woodland to open woodland.
7.12.29		**open forests on hills**	***Corymbia intermedia* and/or *Lophostemon suaveolens* open forest to woodland ± areas of *Allocasuarina littoralis* and *A. torulosa*, of uplands, on granite and rhyolite.**
	7.12.29a		*Corymbia intermedia, Eucalyptus tereticornis, E. drepanophylla* open forest to low open forest and woodland with *Allocasuarina torulosa, A. littoralis, Lophostemon suaveolens, Acacia cincinnata, A. flavescens, Banksia aquilonia* and *Xanthorrhoea johnsonii*.

7.12.40		**rainforest on hills**	**Closed vineland of wind disturbed vine forest, on granites and rhyolites.**
	7.12.40a		Open areas in vine forests, dominated by sprawling vines, commonly *Merremia peltata* and a number of other vine species, presumed to mostly originate from cyclone damaged Type 2a forests (where the entire canopy has been destroyed.).
	7.12.40b		Mesophyll to notophyll vine forest suffering from extreme wind damage where at least half the canopy has been destroyed.
7.12.53		**open forests on hills**	***Corymbia clarksoniana* ± *C. tessellaris*, ± *Eucalyptus drepanophylla* ± *C. intermedia* open forest to woodland, or *E. drepanophylla* woodland, of moist to dry lowlands, foothills and uplands on granite and rhyolite.**
	7.12.53a		*Corymbia clarksoniana* woodland to open forest.
	7.12.53b		*Corymbia clarksoniana, C. tessellaris*, ± *Eucalyptus drepanophylla, E. tereticornis, E. platyphylla, Lophostemon suaveolens* and *C. dallachiana* woodland and open forest.
	7.12.53e		*Eucalyptus drepanophylla* open woodland.
7.12.54		**shrubland on hills**	**Complex of shrublands and low open forests on wind-exposed granite and rhyolite coastal headlands and islands, on skeletal soils.**
	7.12.54g		Bare rock.
7.12.59	7.12.59	**open forests on hills**	***Eucalyptus leptophleba* and *Corymbia clarksoniana* open forest to woodland.**
7.12.60		**teatree on hills**	***Melaleuca viridiflora* ± *Corymbia clarksoniana* ± *Eucalyptus platyphylla* woodland to open forest, on granite and rhyolite.**
	7.12.60a		*Melaleuca viridiflora* woodland.
	7.12.60b		*Corymbia clarksoniana*, and/or *C. intermedia*, ± *Lophostemon suaveolens* open woodland to low open woodland with a prominent secondary tree layer of *Melaleuca viridiflora*, and often with *Xanthorrhoea johnsonii* in the ground stratum.
	7.12.60c		*Melaleuca quinquenervia* woodland, open forest or shrubland.
7.12.61		**open forests on hills**	***Eucalyptus tereticornis* ± *E. granitica* woodland to open forest of moist and dry foothills and uplands on granite and rhyolite.**
	7.12.61a		*Eucalyptus tereticornis* open forest to tall open forest and woodland. Includes communities ranging from those dominated by *E. tereticornis* to mixtures of that species with *Corymbia intermedia, E. drepanophylla, Lophostemon suaveolens* and *Allocasuarina torulosa*.
7.12.66		**shrubland on hills**	**Exposed rocky slopes on granite and rhyolite, with *Lophostemon confertus* low shrubland or low to medium closed forest.**
	7.12.66e		Bare rock.
11.3.30	11.3.30b	**woodland**	***Eucalyptus crebra, Corymbia dallachiana* woodland on alluvial plains.**
3.3.2	3.3.2a	**woodland**	**Semi-deciduous mesophyll/notophyll vine forest. Occurs on alluvia.**