# 1. WEED SURVEYS ALONG HIGHWAYS, ROADS AND POWERLINE CLEARINGS TRAVERSING THE WET TROPICS WORLD HERITAGE AREA

**Miriam Goosem**

## 1.1 SUMMARY

The Palmerston (Kareeya-Innisfail) and Chalumbin-Woree powerline clearings and associated road networks, including K-Tree, Maple Creek, Suttie's Gap, Maalan, Bridle Creek, Shoteel Creek tracks and Lake Morris Road were examined for weed infestations and ecological condition using on-ground surveys and aerial video analysis. Major weed infestations recorded for the Palmerston network include Guinea grass, Molasses grass, Signal grass, Bluetop, Lantana and Giant Bramble as well as several other herbaceous weeds. Major weed infestations along the Chalumbin-Woree network included Blue Snakeweed, Paspalum, Lantana, Molasses grass and Signal grass with several other species being common.

Presence of a weed species appears to relate to soil fertility and moisture. There is a considerable overlap in species between the two areas but dominant species vary between the sites. Ecological condition of the Palmerston network was found to be mainly poor, particularly at lower elevations near the Palmerston Highway and Tully Gorge. However in higher elevation sections with dissected topography, where the powerline is swung above the canopy of remnant or regrowth forests, ecological condition in these smaller areas was relatively good. Similarly along the Chalumbin-Woree powerline clearing, ecological condition was relatively good in higher elevation sections with dissected topography, where tower clearings are either restricted in area or swathes are gradually being recolonised by native species. Weed control, particularly of grasses and woody weeds, could aid this recolonisation. Lower elevation sections to the west, which have been subject to past grazing management, are generally swathes of mixed weeds.

Fire and grazing exclusion, weed control and restoration plantings are recommended for the areas of both powerline clearings that are in poor ecological condition. Removal of the Palmerston powerline clearing will aid this goal by allowing taller canopy species to grow. Weed control on the Palmerston road network has been very successful in reducing weed infestations and improving ecological condition of the area and should be continued until canopy connectivity can extend over the roads. Several native species are recommended as showing potential to out-compete weeds in these linear clearings, both naturally and in conjunction with weed control and restoration plantings. It is recommended that one introduced ground orchid species, *Arundina bambusaefolia*, which has recently colonised in one location, be eradicated as soon as possible.

## 1.2 INTRODUCTION

Effective management of roads and powerline corridors is a major challenge facing the Wet Tropics Management Authority (WTMA) in their effort to achieve the primary goal of protection, conservation, rehabilitation and presentation of the natural resources of the region (WTMA 1995). Many areas of the Wet Tropics World Heritage Area (WTWHA) have been affected by settlement, agricultural practices and other anthropogenic activities in the past and are also dissected by an estimated 1,800 kilometres of roads, highways and powerline corridors (Goosem and Turton 1999).

This linear infrastructure is an integral feature of the modern landscape and one of the most obvious anthropogenic impacts on natural environments; internally fragmenting natural areas into much smaller habitat blocks. Wildlife populations may be subdivided by these linear clearings. Internal fragmentation, caused by infrastructure corridors, and its array of actual and potential impacts on ecological integrity and evolutionary processes, is considered a principal threatening process to natural World Heritage values (WTMA, 2000).

Linear clearings for infrastructure cause a suite of deleterious impacts within the rainforests of the WTWHA. These include:

- Alienation of area that would otherwise form habitat for flora and fauna. Goosem (1997) estimated that about 1,300 hectares have been alienated along 324 kilometres of powerline clearings in the WTWHA, while 608 hectares were utilised in clearings for roads and highways.
- Edge effects are a second impact and consist of a diverse array of ecological changes occurring at and in the vicinity of the abrupt artificial margins of natural habitat with the linear clearing.
- A third impact occurs when faunal movements are restricted (Goosem 2001) or even prevented (Goosem and Marsh 1997) by the 'linear barrier' formed by the clearing.
- Fourthly, fauna alien to the rainforest habitats may intrude along the altered habitat found within the clearing (Goosem and Turton 2000).
- Wildlife mortality in the form of roadkill is another impact of roads as is the penetration of noise and pollutants into the rainforest habitat (Goosem and Turton 1999, 2000).

However, one impact of roads and powerline corridors within the WTWHA that has not been examined in great depth is the extent to which such linear clearings allow the ingress of alien flora i.e. weeds. A major but very broad-scale survey of the status of weeds within the WTWHA was undertaken by Humphries and Stanton (1992), identifying major environmental weeds of concern and providing an idea of their distributions. Werren (2001) has expanded on this study to:

a) Inventory existing weeds, 'sleeper' weeds and plants not presently found in the region that are proven environmental weeds in similar environments elsewhere;
b) Prioritise potential environmental threats;
c) Categorise weeds into management categories of prevention, eradication and control; and to
d) Provide consideration of appropriate management actions.

Werren (2001) identified 504 exotic plants that have established self-maintaining populations within the Wet Tropics bioregion, and performed a preliminary ranking of a sample of fifty-seven Wet Tropics weed species; the 'environmental weed' component was the focus. 'Environmental weeds' are defined as 'introduced species capable of establishing or having a high probability of being able to establish self-sustaining populations by invading native communities or ecosystems and also capable of causing major modifications to species richness, abundance or ecosystem function' (Goosem 1993). Control agents, autecologies and extent of invasion for particular environmental weeds have also been studied (Swarbrick 1993a, 1993b, 1993c, Swarbrick and Skarratt 1994, van Haaren pers. comm., QPWS, DNR on-going).

Although disturbance is a natural feature of dynamic ecosystems, it also facilitates the invasion process by eliminating or reducing the cover and/or vigour of native competitors (Werren 2001). However, most exotic species tend to remain associated with areas of gross human disturbance (Maillet and Lopez-Garcia, 2000), whereas only a few establish in stable

natural vegetation. Road verge and powerline corridor maintenance practices including spraying, burning, mowing, grading and removal of overhanging branches provides prime habitat for colonisation by ruderal weeds. Common weeds that occur and may dominate along linear clearings in the WTWHA include Lantana (*Lantana camara*), Giant Bramble (*Rubus alceifolius*), Guinea grass (*Panicum maximum*), Molasses grass (*Melinis minutiflora*), Grader grass (*Themeda quadrivalvis*), Blue-top (*Ageratum* spp.), Blue Snakeweed *(Stachytarpheta* spp.), Guava (*Psidium guajava*), Wild Tobacco (*Solanum mauritianum)* and other *Solanum* spp.

Weeds may have unpredictable flow-on effects that may be extremely damaging to native ecosystems (Werren 2001) e.g. certain weed species, particularly grasses, increase the linear barrier effects of roads and powerline clearings on rainforest wildlife (Goosem and Marsh 1997), whilst others, such as woody weed scrubland, may allow movements of generalist species (Goosem and Turton 2000). Similarly, McFadyen (2000) argues that alien plants displace native flora on which complex native food webs depend, e.g. the exotic species of *Aristolochia* contains toxins fatal to host-specific native butterflies (Werren 2001). Reynolds (1994) found that differences in microclimate underneath the closed canopy of Lantana scrubland may prevent secondary succession of native rainforest species, resulting in self-perpetuating weed fields. Weeds also can penetrate from the rainforest edge to up to seven metres into the forest along roads and powerline corridors. These weeds include *Lantana camara*, *Rubus alceifolius* and *Solanum* spp. (Siegenthaler and Turton, 2000).

The objective of this study was to undertake an initial basic spatial inventory to provide an understanding of the distribution of weed species and relative ecological condition of selected road verges and powerline corridors within the WTWHA. Ecological condition is a relative term used to describe the degree of disturbance of forest components and their function.

## 1.3 METHODS

### 1.3.1 Study Sites

Two road and powerline clearing networks were chosen for this study. The Chalumbin-Woree powerline corridor and road network includes the powerline clearing as well as Bridle Creek and Copperlode Dam roads. The Palmerston powerline corridor and road network includes the powerline clearing and the K-Tree, Maple Creek, Sutties Gap, Maalan, Jordan Creek and H Roads.

*Chalumbin-Woree Powerline and Road Network*

The Chalumbin-Woree powerline corridor traverses the WTWHA from Bridle Creek (near Davies Creek National Park) through to Lake Morris and thence over the escarpment to Woree or White Rock, which are southern suburbs of Cairns. There are two powerlines present along this clearing as far as Lake Morris. The first, on small towers, was installed in the 1960s. This clearing follows the Copperlode Dam road before swinging above the canopy as it descends the escarpment to Woree. During the late 1990s the powerline was upgraded with much larger towers that carry the wires above the tree canopy. This powerline continues to swing above the canopy over the WTWHA following a different route to the escarpment where it descends behind White Rock, which is just south of Woree. The smaller towers remain in place, awaiting decommissioning.

The weed surveys focussed on seven sites surrounding the towers. The new towers have been subject to considerable revegetation of their cleared footprints, undertaken by the Centre for Tropical Restoration, a section of Queensland Parks and Wildlife Service based at

Lake Eacham. Additional incidental surveys were undertaken in the vicinity of Bridle Creek and Shoteel Creek Roads.

*Palmerston Powerline and Road Network*

The Palmerston (Kareeya-Innisfail) powerline was constructed in the 1950s. It traverses the WTWHA from the Tully Gorge and Kareeya sub-station north towards the Palmerston Highway and is serviced by the H Road, Sutties Gap Road and the Maalan Track. It then turns east towards Innisfail, being accessed from the Jordan Creek and K-tree Roads and from the Palmerston Highway. The weed surveys focussed on sites in the powerline corridor near the Palmerston highway. The towers are accessed from K-tree Road, Suttie's Gap Road, H-Road and the Maalan Track. Surveys were also performed in former forestry clearings and along the verges of those roads, as well as the Maple Creek Road.

### 1.3.2 Floristic Survey Methods

A well-respected botanist and plant identification expert with many years of experience within the Wet Tropics, Mr Robert Jago, was employed to identify all plant species. Herbarium specimens were prepared for as many species as possible.

*Transects*

A thirty metre long transect was laid and surveyed to a distance of five metres on either side, resulting in a 10 metre x 30 metre quadrat (Fig. 1.1). The zero metre point of the transect was generally situated under the centre of the towers, with the transect running parallel to the clearing in both directions. Data from both directions were pooled. As maintenance practices within the powerline clearings generally focus in the vicinity of towers and along the tracks, transects centred on the towers contained the greatest diversity of weed species in varying stages of weed succession. In addition, weeds and rainforest species that occurred outside the ten metre wide quadrat but within the clearing were noted, particularly in areas where the vegetation of the clearing varied from the rainforest edge to the centre of the clearing (site of tower). Weed occurrences were classified on a rank scale consisting of:

a) Dominant (dominating the area):
b) Common (not dominant but very common within the area);
c) Occasional (more than two or three occurrences within the 10 metre transect strip, but uncommon); and
d) Rare (one or two occurrences within the transect strip only).

Each thirty metre transect was divided into four sections: 0-5 metres, 5-10 metres, 10-20 metres and 20-30 metres for ease of recording. When other weed species were noticed while traversing the clearing to the transect site, these were recorded as incidental occurrences. This approach resulted in a comprehensive list of species for the 10 m x 30 m quadrats, plus records of other species occurring between the ten metre strip and the rainforest edge but not present within the quadrats, as well as incidental occurrences noted elsewhere in the vicinity. Table 1.1 lists sites surveyed.

Similar transects were surveyed along road and highway verges. However, the width of the clearing in most cases was restricted to five metres on either side of the road, so that additional species were usually not recorded unless they occurred as incidentals beyond the thirty metre distance at either end of the transect.

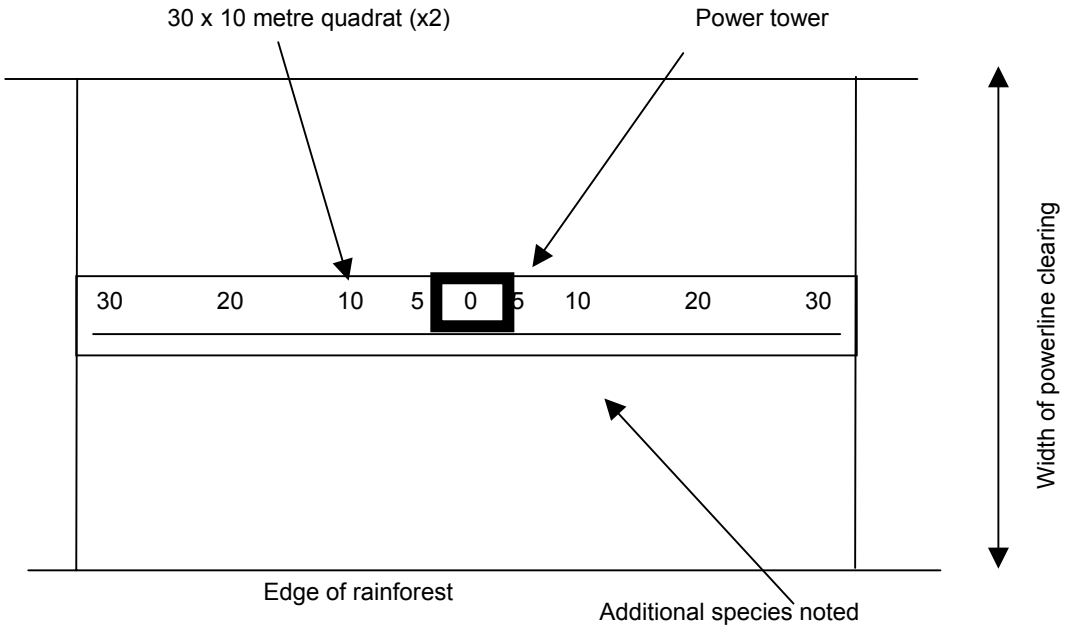


**Figure 1.1:** Design of the transect surveys.

*Percentage Cover by Species*

A stratified sampling method was used to obtain an estimate of the composition of leaf area in relatively uniform plots at several sites, with the aim of being able to assess the accuracy of species identity from remote sensing classification (see Section 3). The sites were divided into two or three relatively homogeneous areas large enough to be visible from the air. In each area, three to five quadrats, each one square metre, were examined visually for species content on the basis of leaf area. Each $1m^2$ quadrat had twenty-five cells marked within it to facilitate the estimation. Percentage leaf area in each cell was estimated and the results pooled and averaged for each quadrat. A vertical photograph was taken with the quadrat in place.

### 1.3.3 Powerline Corridor Video Analysis – Ecological Condition

Powerlink Queensland (Mr Tom Graham) supplied videos taken prior to 2000 during low flights over the powerline corridors under their control. Videos of each corridor were analysed for any large areas of weeds of the species that commonly dominate each corridor, using the field survey data to verify patterns for the dominant species. Additionally, forest linkages across the corridor were noted, together with their apparent quality. It should be noted that this method cannot substitute for field data and is only being used as an adjunct to the field interpretation. In particular, problems remain with interpretation of forest quality from the videos in areas where the plane is flying high above the canopy, especially in rugged regions with extremely deep gullies where the powerline is strung high above the canopy. In such sections, the video interpretation can only conclude that there is apparently a forest connection, assessment of whether this connection is formed by undisturbed rainforest or by weedy regrowth vegetation is impossible. In other areas, it has only been possible to state that the ground cover appears to be grassland, with no dominant species definition, or woody weed shrubland, which may be *Lantana camara, Rubus alceifolius* or a combination of both. Remote sensing data and its potential for assessing weed infestations will be discussed in Section 2.

### 1.3.4 Data Analysis

Because of variability between the sites, hypothesis testing with the field data is not possible. Rather this is observational data, providing a baseline of weed infestations along the two corridors and road networks in 2001/2002. Species composition analysis was undertaken and a qualitative comparison between the ecological condition within and between corridors is made.

**Table 1.1:** Powerline clearing and road transects surveyed.

| Powerline/ Road Network | Site No. | Power Tower | General Location | GPS Position |
|---|---|---|---|---|
| **Chalumbin-Woree** | 1 | 10091 | Bridle Creek Road. | 351336E 8121985N |
| | 2 | 10096 | Bridle Creek Road | 353531E 8121669N |
| | 3 | 10094 | Bridle Creek Road | 352551E 8121810N |
| | 4 | 10109 | Copperlode Dam Road | |
| | 5 | 10108 | Copperlode Dam Road | |
| | 6 | 10104 | Shoteel Creek Road | 356812E 8122347N |
| | 7 | 10103 | Shoteel Creek Road | 356358E 8122398N |
| **Palmerston** | 8 | | Powerline crossing 1, K-Tree Road | 368996E 8052377N |
| | 9 | | Powerline, K-tree Road, fossicking field entrance | 366786E 8051177N |
| | 10 | | K-tree Road, Jordan Creek Road turn | 366322E 8050542N |
| | 11 | | K-tree Road, log dump, Creek 1 | 365573E 8048631N |
| | 12 | | Maple Creek Road, first major road exit | 364601E 8046372N |
| | 13 | | Maple Creek Road, Creek, first clearing | 361893E 8043777N |
| | 14 | | Maple Creek Road, second major road exit | 361607E 8041945N |
| | 15 | | Maple Creek, Charappa Camp | 361607E 8042549N |
| | 16 | | Powerline, Sutties Gap Road | 357957E 8044652N |
| | 17 | | Maalan Road verge, first trap site | |
| | 18 | | Maalan Road verge | 361757E 8053271N |
| | 19 | | Maalan Road, log dump | 361044E 8053141N |
| | 20 | | Powerline crossing 1, Maalan Road | 360875E 8052605N |
| | 21 | | Powerline crossing 2, Maalan Road | 360042E 8050941N |
| | 22 | | Powerline crossing 4, Maalan Road | 359598E 8050319N |
| | 23 | | Maalan Road, wide verge, Trap 4 | 357393E 8053072N |
| | 24 | | Maalan Road, quarry | |

# 1.4 RESULTS AND DISCUSSION

## 1.4.1 Weed Species Recorded in Field Surveys of the Powerline Corridor and Road Networks

*Chalumbin-Woree Powerline Corridor and Road Network*

Table 1.2 provides a list of the weed species identified within the Chalumbin-Woree powerline corridor and road network. The Bridle Creek road follows the powerline corridor, meeting Shoteel Creek Road and continuing onto Lake Morris. The Copperlode Dam road also follows the powerline corridor. Therefore data for the powerline towers presented in Appendix 1.1 includes both road and powerline corridor data. A total of forty-four weed species were recorded in the network.

The weed species that were recorded most consistently along the Chalumbin-Woree powerline corridor were *Stachytarpheta jamaicensis* (blue snakeweed) and *Paspalum paniculatum* (paspalum). *Melinis minutiflora* (molasses grass), *Lantana camara* (lantana), *Mimosa pudica* (sensitive weed), *Polygala paniculata* and *Ageratum conyzoides* (bluetop) also were mostly common or dominant where they occurred and each occurred in at least ten of the twenty-eight sub-sites (four 'distance classes' along each of the seven transects). Figure 1.2 shows that the majority of these species did not completely dominate a sub-site, rather a number of species were common to dominant in different areas of sub-sites, while many were common. Another common weed species that generally dominated where it occurred was *Brachiaria decumbens* (signal grass) (Figure 1.2).

Other weeds recorded less consistently across the sub-sites, but common where they occurred, included *Stylosanthes humilis* (Townsville lucerne), *Urena lobata* (urena burr), *Axonopus compressus* (broadleaf carpet grass), *Rubus alceifolius* (giant bramble), *Scoparia dulcis, Sporobolus africanus* (rat's tail grass) and *Hyptis capitata* (knobweed).

*Palmerston Powerline Corridor and Road Network*

Table 1.3 provides a list of the weeds encountered within the Palmerston powerline corridor and road network. A total of fifty weed species were encountered. Appendix 1.2 lists all species both native and alien recorded within the network.

Figure 1.3 shows that the weed that most commonly occurs and dominates all else almost everywhere it occurs in the Palmerston powerline clearing and road network is *Panicum maximum* (Guinea grass). Guinea grass forms swathes across the clearing and often leaves only tyre tracks on roads such as Suttie's Gap and Maple Creek Roads.

In four situations, Guinea grass occurs but fails to dominate.

- The first occurs in areas where the Department of Natural Resources has undertaken weed control along the road network and at present herbaceous weeds (particularly *Ageratum conyzoides*, bluetop) and natives are dominating. However, Guinea grass is starting to return in these areas and will again dominate unless these control measures are continued.
- The second is in parts of the powerline clearing where the previously dominant Guinea grass is being gradually out-competed by *Lantana camara* (lantana), due to the reduced frequency of fires in the powerline clearing in recent years.
- The third situation is where *Melinis minutiflora* (molasses grass) out-competes Guinea grass; this appears to be related to the soils drying out in areas such as old powerline track cuttings or slopes.

- The fourth occurs under the powerline towers and along the powerline tracks, where regular track maintenance by grading favours *Brachiaria decumbens* (signal grass).

Other weeds that dominate in certain situations include *Ageratum conyzoides* (bluetop) and *Crassocephalum crepidiodes* (thickhead or fathead), particularly where weed control has been undertaken or where grading and clearing have disturbed the ground. Herbaceous weeds, and in particular bluetop, appear to form the first stage of weed succession in this area. *Brachiaria decumbens* (signal grass) is very obvious in less recently disturbed areas such as under and around the power towers and tracks, thereby seeming to form a second stage in weed succession. *Melinis minutiflora* (molasses grass) also dominates large areas, due to its ability to out-compete Guinea grass in areas that dry out quickly, such as steep banks, slopes and ridges that receive no shade during the day. These two species (Guinea and molasses grass) appear to be the third stage in succession in sunny cleared areas.

In shaded areas on the edges of the clearing adjacent to the rainforest, *Lantana camara* dominates (Figure 1.3). *Rubus alceifolius* often occurs with the Lantana along the edges. In the past, the shaded, damper rainforest edge was the main stronghold of these two woody weeds that tend to prevent regeneration of native rainforest species. However, as the powerline clearing is now no longer subject to regular fires, in some areas, principally in gullies and lower slopes, but more recently also further up the slopes, lantana has spread all the way across the clearing, gradually outcompeting the Guinea grass. Thus Lantana may be considered a final stage of weed succession where fires have been eliminated and shading for part of the day allows its establishment.

*Polygala paniculata* is very common in the majority of sub-sites but its small size and growth form does not allow it to dominate. Other common herbaceous weeds are *Mitracarpus hirtus* and *Emilia sonchifolia*. One weed species found along the South Johnstone road network, near the disused Charappa Creek forestry camp, is a South-east Asian ground orchid species, *Arundina bambusaefolia*. Specific recommendations for this particular weed infestation are found below (Section 1.4.3).

*Comparison of Powerline and Road Networks*

Figure 1.4 demonstrates that while there is considerable overlap of common weed species in the two linear clearing networks, there are also several species that occur or are common in only one network e.g. the most common weed in the Chalumbin-Woree area, *Stachytarpheta jamaicensis* was not recorded at Palmerston. Likewise the second most common weed in the Chalumbin-Woree area, *Paspalum paniculatum* is extremely unusual in the records from Palmerston. In contrast, *Panicum maximum*, the dominant species at Palmerston was relatively uncommon along the Chalumbin-Woree network. *Crassocephalum crepidioides* is another species common at Palmerston and absent along the Chalumbin-Woree network. The conspecifics *Paspalum paniculatum* and *P. scrobiculatum* appear to replace each other in the different soil and moisture conditions of the two powerline clearing and road networks. *Ageratum conyzoides, Brachiaria decumbens, Melinis minutiflora, Lantana camara, Rubus alceifolius, Polygala paniculata* and *Mimosa pudica* are common in both areas. This separation of weed species between areas may be related to soil fertility and moisture. The fertile basalt soils and higher rainfall of the Palmerston region contrast with the nutrient-depauperate granitic and metamorphic soils, and the slightly lower rainfall, of the Chalumbin-Woree area. The age of the powerline clearings may be another differential factor.

**Table 1.2:** Weed species recorded in the Chalumbin-Woree powerline clearing and road network.

| Species Name | Common Name | Family | Life Form | No. Sub-Sites. (Total 28) | Common Abund'. Category |
|---|---|---|---|---|---|
| **Ageratum conyzoides* | Bluetop | Asteraceae | Herb | 10 | C-D |
| **Arundo donax* | | | Grass | 1 | R |
| **Axonopus compressus* | Broadleaf carpet grass | Poaceae | Grass | 6 | C |
| **Axonopus fissifolius* | Narrowleaf carpet grass | Poaceae | Grass | 2 | C |
| **Bidens pilosa* | Cobbler's pegs | Asteraceae | Herb | 1 | O |
| **Brachiaria decumbens* | Signal grass | Poaceae | Grass | 9 | D |
| **Citrus limon* | Lemon tree | Rutaceae | Tree | 1 | R |
| **Conyza leucantha* | | Asteraceae | Herb | 2 | C |
| **Crotalaria goreensis* | Gamba pea | Fabaceae | Herb | 1 | O |
| **Crotalaria lanceolata* | Rattlepod | Fabaceae | Herb | 1 | O |
| **Cynodon dactylon* | Green couch | Poaceae | Grass | 1 | R |
| **Cyperus aromaticus* | Navua sedge | Cyperaceae | Herb | 3 | C-D |
| **Emilia sonchifolia* | Emilia | Asteraceae | Herb | 1 | R |
| **Eupatorium catarium* | Praxelis | Asteraceae | Shrub | 4 | O |
| **Euphorbia hirta* | | | | | |
| **Hyptis capitata* | Knobweed | Lamiaceae | Herb | 5 | C |
| **Hyptis suaveolens* | | Lamiaceae | Herb | 2 | C |
| **Indigofera suffruticosa* | | Fabaceae | | 2 | O |
| **Lantana camara camara* | Lantana | Verbenaceae | Shrub | 13 | C |
| **Macroptilium atropurpureum* | Siratro | Fabaceae | Herb | 4 | O |
| **Melinis minutiflora* | Molasses grass | Poaceae | Grass | 13 | C-D |
| **Melinis repens* | Red natal grass | Poaceae | Grass | 2 | O |
| **Mimosa pudica* | Sensitive weed | Mimosaceae | Herb | 11 | C |
| **Mitracarpus hirtus* | | Rubiaceae | Herb | 1 | O |
| **Panicum maximum* | Guinea grass | Poaceae | Grass | 3 | C |
| **Paspalum conjugatum* | Paspalum | Poaceae | Grass | 1 | C |
| **Paspalum paniculatum* | Paspalum | Poaceae | Grass | 17 | C |
| **Passiflora edulis* | Edible passionfruit | Passifloraceae | Vine | 1 | R |
| **Passiflora foetida* | Stinking passionfruit | Passifloraceae | Vine | 1 | O |
| **Polygala paniculata* | | Polygalaceae | Herb | 11 | C |
| **Centratherum punctatum* var. *punctatum* | | Asteraceae | Herb | 1 | C |
| **Richardia brasiliensis* | | Rubiaceae | | 2 | O/C |
| **Rubus alceifolius* | Giant bramble | Rosaceae | Vine | 6 | C |
| **Scoparia dulcis* | | Scrophulariaceae | | 6 | C |
| **Sida rhombifolia* | | Malvaceae | Shrub | 5 | O |
| **Solanum mauritianum* | Tobacco bush | Solanaceae | Shrub | 3 | R |
| **Solanum torvum* | Thorn apple | Solanaceae | Shrub | 1 | + |
| **Spermacoce latifolia* | | Rubiaceae | | 1 | O |
| **Sporobolus jacquemontii* | Rats-tail grass | Poaceae | Grass | 5 | C |

| Species Name | Common Name | Family | Life Form | No. Sub-Sites. (Total 28) | Common Abund'. Category |
|---|---|---|---|---|---|
| **Stachytarpheta jamaicensis* | Blue snakeweed | Verbenaceae | Herb | 22 | C-D |
| **Stylosanthes humilis* | Townsville lucerne | Fabaceae | Herb | 7 | C |
| **Tagetes minuta* | Stinking roger | Asteraceae | Herb | 1 | + |
| **Tristemma mauritianum* | | Melastomataceae | Shrub | 4 | C |
| **Urena lobata* | Urena burr | Malvaceae | Shrub | **7** | **C** |

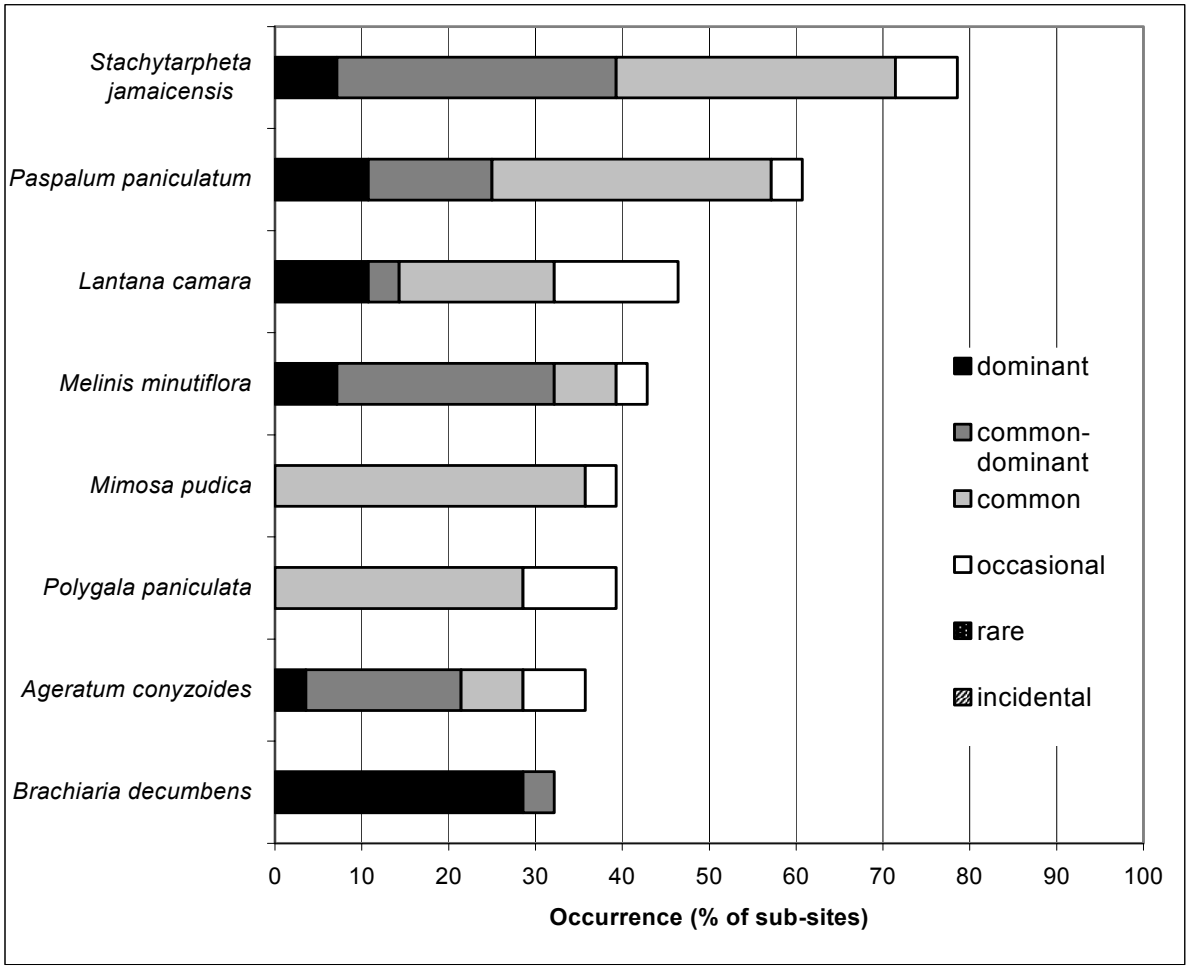


**Figure 1.2:** Abundance categories of common species found within the Chalumbin-Woree powerline corridor and road network. Species dominating sub-sites are few, although many are common or common-to-dominant within sub-sites.

**Table 1.3:** Weed species recorded in Palmerston powerline clearing and road network.

| Species Name | Common Name | Family | Life Form | No. Sub-sites (Total 68) | Common Abund' Category |
|---|---|---|---|---|---|
| **Ageratum conyzoides* | Bluetop | Asteraceae | Herb | 46 | C |
| **Arundina bambusaefolia* | | Orchidaceae | Orchid | 1 | + |
| **Axonopus compressus* | Broadleaf carpet grass | Poaceae | Grass | 1 | R |
| **Axonopus fissifolius* | Narrowleaf carpet grass | Poaceae | Grass | 3 | R |
| **Bidens pilosa* | Cobbler's pegs | Asteraceae | Herb | 2 | + |
| **Brachiaria decumbens* | Signal grass | Poaceae | Grass | 31 | D |
| **Brachiaria mutica* | Para grass | Poaceae | Grass | 1 | O |
| **Calyptocarpus vialis* | Little Synedrella weed | Asteraceae | Herb | 5 | O |
| **Centrosema pubescens* | Centro | Fabaceae | Herb | 1 | R |
| **Conyza leucantha* | | Asteraceae | Herb | 4 | C |
| **Crassocephalum crepidioides* | Thickhead | Asteraceae | Herb | 21 | C |
| **Crotalaria lanceolata* | Rattlepod | Fabaceae | Herb | 11 | O |
| **Crotalaria pallida* | Streaked rattlepod | Fabaceae | Herb | 4 | + |
| **Cyperus aromaticus* | Navua sedge | Cyperaceae | Herb | 7 | O |
| **Desmodium intortum* | Desmodium | Fabaceae | Herb | 5 | R/O |
| **Desmodium uncinatum* | Desmodium | Fabaceae | Herb | | |
| **Dichrocephala integrifolia* | | Asteraceae | Herb | 2 | O |
| **Echinochloa colona* | Awnless barnyard grass | Poaceae | Grass | 1 | R |
| **Eleusine indica* | Crowsfoot grass | Poaceae | Grass | 6 | R/O |
| **Emilia sonchifolia* | Emilia | Asteraceae | Herb | 12 | R |
| **Erechtites valerianifolia* | Brazilian fireweed | Asteraceae | Herb | 6 | O |
| **Hyptis capitata* | Knobweed | Lamiaceae | Herb | 2 | O/+ |
| **Ipomoea indica* | Morning glory | Convolvulaceae | Vine | 2 | O |
| **Lantana camara camara* | Lantana | Verbenaceae | Shrub | 21 | D |
| **Macroptilium atropurpureum* | Siratro | Fabaceae | Herb | 2 | C/+ |
| **Melinis minutiflora* | Molasses grass | Poaceae | Grass | 18 | D |
| **Mimosa pudica* | Sensitive weed | Mimosaceae | Herb | 7 | C |
| **Mitracarpus hirtus* | | Rubiaceae | Herb | 15 | O/C |
| **Oxalis corniculata* | Wood sorrel | Oxalidaceae | Herb | 7 | O |
| **Panicum maximum* | Guinea grass | Poaceae | Grass | 60 | D |
| **Paspalum conjugatum* | Paspalum | Poaceae | Grass | 1 | R |
| **Paspalum paniculatum* | Paspalum | Poaceae | Grass | 1 | R |
| **Passiflora edulis* | Edible passionfruit | Passifloraceae | Vine | 1 | R |
| **Phyllanthus amarus* | | Euphorbiaceae | | 10 | O |
| **Polygala paniculata* | | Polygalaceae | Herb | 40 | C |
| **Richardia brasiliensis* | | Asteraceae | Herb | 1 | R |
| **Rubus alceifolius* | Giant bramble | Rosaceae | Vine | 12 | C |
| **Scoparia dulcis* | | Scrophulariaceae | | 1 | R |

| Species Name | Common Name | Family | Life Form | No. Sub-sites (Total 68) | Common Abund' Category |
|---|---|---|---|---|---|
| **Setaria sphacelata* | Pigeongrass | Poaceae | Grass | 3 | R |
| **Sida rhombifolia* | | Malvaceae | Shrub | 6 | O |
| **Sigesbeckia orientalis* | | Asteraceae | Herb | 6 | O |
| **Solanum americanum* | | Solanaceae | Shrub | 5 | O |
| **Solanum mauritianum* | Tobacco bush | Solanaceae | Shrub | 3 | R |
| **Solanum torvum* | Thorn apple | Solanaceae | Shrub | 1 | + |
| **Spermacoce latifolia* | | Rubiaceae | | 4 | + |
| **Sporobolus jacquemontii* | Rats-tail grass | Poaceae | Grass | 5 | R |
| **Stylosanthes humilis* | Townsville lucerne | Fabaceae | Herb | 4 | O |
| **Synedrella nodiflora* | Cinderella weed | Asteraceae | Herb | 3 | O |
| **Triumfetta rhomboidea* | | Tiliaceae | Herb | 1 | R |
| **Urena lobata* | Urena burr | Malvaceae | Shrub | 2 | R |

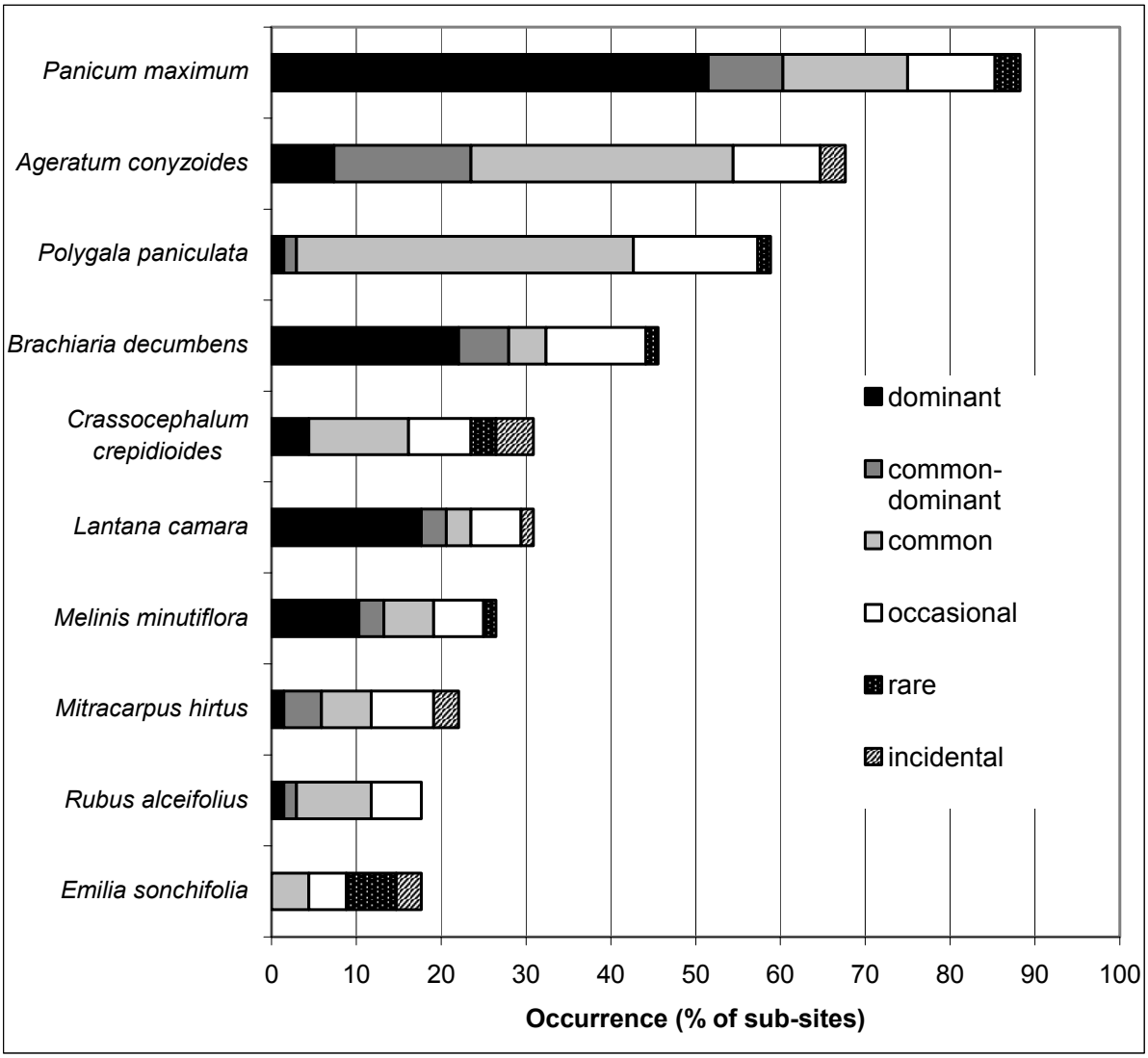


**Figure 1.3:** Abundance categories of common species found within the Palmerston powerline corridor and road network. Several species dominate sub-sites where they are found and many are common or common-to-dominant within sub-sites.

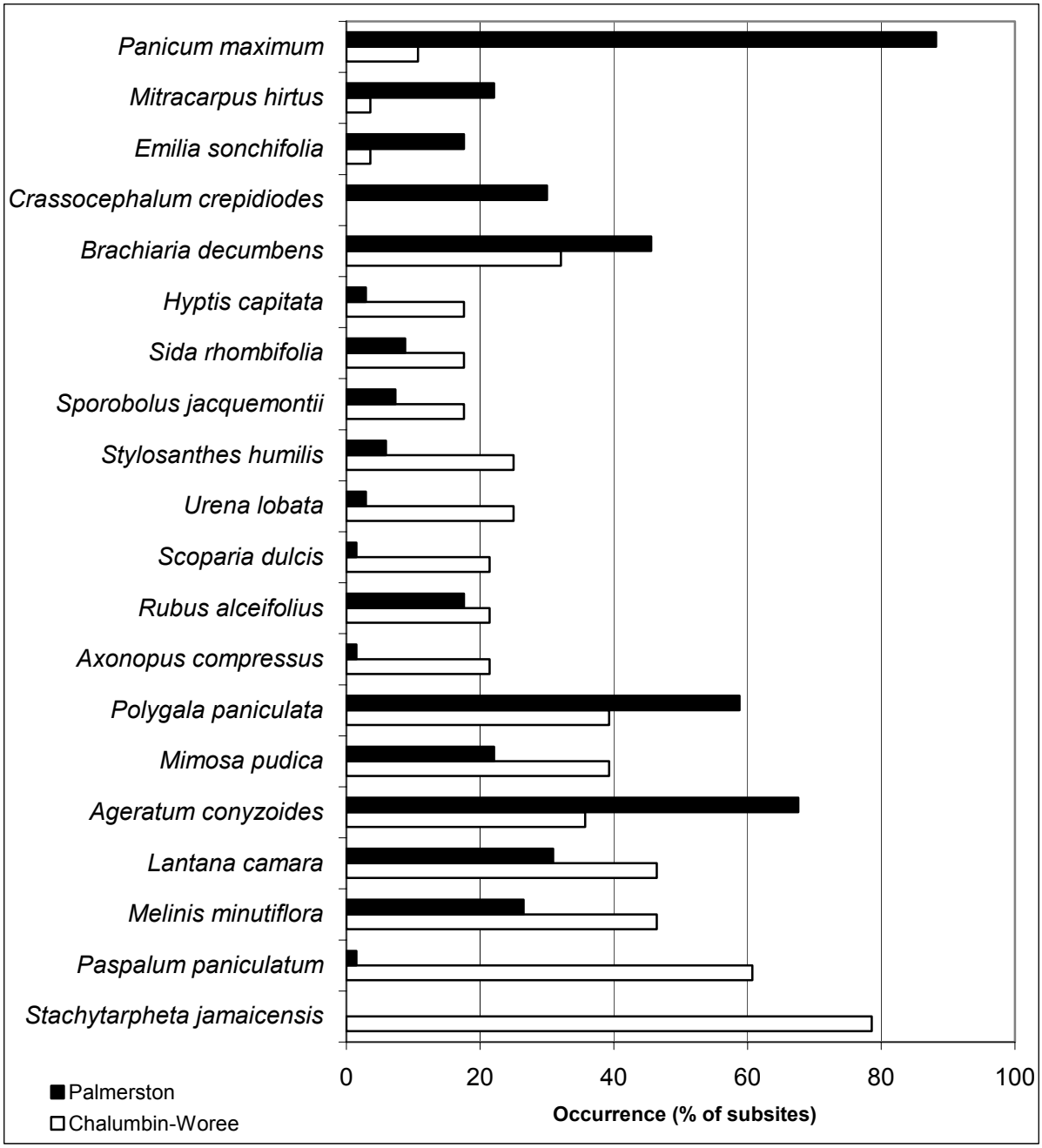


**Figure 1.4:** Occurrence of most common weed species on the Palmerston and Chalumbin-Woree powerline and road networks.

### 1.4.2 Native Species Occurrence in Weedy Areas of the Powerline and Road Networks

*Chalumbin-Woree Powerline and Road Network*

Of the native species occurring within the weedy sites chosen in the Chalumbin-Woree powerline clearing and road network, none were very common. Table 1.4 shows the most common species and their frequency of occurrence in various dominance categories. Few of these species show potential to replace and out-compete weeds. The exceptions to these are the groundcover species *Dicranopteris linearis, Lycopodiella cernua* and *Gahnia sieberiana* which occur in the wetter, eastern areas towards Lake Morris, while in the drier

areas to the west, *Themeda triandra* and *Imperata cylindrica* (blady grass) are competitive. Several canopy species have established in certain areas, whilst elsewhere they have been planted by the Centre for Tropical Restoration. These include *Acacia simsii, Alphitonia petriei, Acacia celsa* and *Omalanthus novo-guineensis*.

Where these groundcover and taller species are not already established, restoration works appear to require the approach taken by CTR e.g. clearing the area, weed control and re-planting with native species. However, the groundcover species mentioned may form an alternative planting strategy following weed control in areas where low-growing species are necessary to avoid interfering with powerlines or towers. Similarly shrubs such as *Acacia simmsii* in drier areas and *Melastome affine* in wetter sections should prove useful.

*Palmerston Powerline and Road Network*

Similarly to the Chalumbin-Woree clearing, of the native species occurring within the weedy sites chosen in the Palmerston powerline clearing and road network, few were very common. Table 1.5 shows the most common species and their frequency of occurrence in various dominance categories. Very few of these show potential to replace and out-compete weeds.

However, in certain situations, several native species appear very useful. Where the Department of Natural Resources has undertaken weed control along road verges, native species, including the grasses *Oplismenus compositus and O. hirtellus,* have become dominant, though it is unlikely that they could out-compete weed grass species, except in areas of shade, as they are adapted to the low light regimes of small rainforest gaps. Maintenance along road verges of these low-growing species that enhance rather than restrict the presentation of World Heritage values of the rainforest, would require maintenance of a high degree of canopy closure above the road to provide the necessary shade. Another low-growing native species particularly useful along road verges for reasons of visitor appreciation is the attractive herb *Pollia macrophylla*. This herb occurs in wetter areas and once established, does appear to be able to out-compete the weed grasses, provided that a reasonable amount of shade is maintained by canopy overhangs.

On road banks in less fertile areas the groundcover species *Dicranopteris linearis, Lycopodiella cernua* and *Gahnia sieberiana* are capable of maintaining an embankment covered in native species that is attractive due to their ferny or sedge foliage. Again their survival is aided by canopy overhangs that prevent establishment of light-requiring weed species such as *Melinis minutiflora* (molasses grass). The ferns *Blechnum orientale, Pteridium esculentum* and *Christella dentata* as well as several tree fern species (*Cyathea* spp.) are also useful in this regard, in areas with greater light penetration. Low shrubs such as *Otanthera bracteata* also have potential for partly shaded areas of the powerline clearing.

Canopy species have not had much opportunity to establish due to the self-perpetuating weed succession present in the powerline clearing and along the roads with wider verges. In previously cleared gullies of the powerline clearing tree ferns form a canopy in some areas. Weed control along the road verges has not yet resulted in canopy species becoming established, other than the occasional seedling, particularly of *Omalanthus novo-guineensis,* although the native grasses and herbs have out-competed the weeds as mentioned above. Continuation of this weed control should be a high priority. It appears that to establish native canopy species more pro-active restoration works are required, such as that undertaken in three sections of the powerline clearing by the Centre for Tropical Restoration (see Section 4). The three species planted in February 2000, *Acacia celsa, Elaeocarpus grandis* and *Alphitonia petriei* are growing extremely quickly and have already established an open canopy that shades out the majority of weeds.

**Table 1.4:** More common native species occurring within the chosen weedy areas of the Chalumbin-Woree powerline and road network. Table shows the number of sub-sites where a species was found in each occurrence category.

| Species | Dominant | Common-Dominant | Common | Occasional | Rare | Incidental |
|---|---|---|---|---|---|---|
| *Acacia celsa* | | | 2 | 7 | 3 | |
| *Acacia simsii* | | | 4 | 3 | | |
| *Alphitonia petriei* | | | 1 | 2 | 10 | |
| *Alstonia muelleriana* | | | 5 | 1 | 3 | |
| *Dicranopteris linearis* | 1 | 4 | 2 | 1 | | |
| *Gahnia sieberiana* | | 3 | 4 | 1 | | |
| *Imperata cylindrica* | | 4 | 3 | 2 | | |
| *Lycopodiella cernua* | 1 | 3 | 2 | 1 | | |
| *Lygodium reticulatum* | | 1 | 4 | 1 | 1 | |
| *Melastoma affine* | | | 4 | | 1 | |
| *Omalanthus novo-guineensis* | | | 2 | 4 | | |
| *Parsonsia latifolia* | | | 5 | 2 | 1 | |
| *Rubus moluccanus* | 1 | | 1 | 3 | | |
| *Themeda triandra* | 4 | | | | | |

**Table 1.5:** More common native species occurring within the chosen weedy areas of the Palmerston powerline and road network. Table shows the number of sub-sites where a species was found in each occurrence category.

| Species | Dominant | Common-Dominant | Common | Occasional | Rare | Incidental |
|---|---|---|---|---|---|---|
| *Blechnum orientale* | | | 1 | 5 | 1 | |
| *Centella asiatica* | | 4 | 13 | 1 | | |
| *Christella dentata* | | | 2 | 5 | 1 | |
| *Dicranopteris linearis* | 2 | 2 | 1 | 2 | | |
| *Imperata cylindrica* | | | 3 | 4 | 1 | |
| *Lycopodiella cernua* | | 2 | 10 | 1 | | |
| *Otanthera bracteata* | 1 | 2 | | 2 | 1 | |
| *Omalanthus novo-guineensis* | 1 | | | 5 | 4 | 1 |
| *Oplismenus compositus* | | 2 | 1 | | | |
| *Oplismenus hirtellus* | | 1 | | | | |
| *Pollia macrophylla* | | 3 | 1 | | | |
| *Rubus moluccanus* | | | 1 | 5 | | |
| *Rubus probus* | | | 2 | 5 | | 1 |
| *Pteridium esculentum* | | | 4 | | | |

### 1.4.3 *Arundina bambusaefolia* (Bamboo Orchid) – A New Weed of the Wet Tropics World Heritage Area

The Bamboo Orchid was found on a road cutting in the South Johnstone Road network, near an old clearing for the Charappa Forestry Camp. This species has not been collected in the Wet Tropics prior to this, although Mr Rigel Jensen did note it approximately two years ago at this location. The species is a native of the South-east Asian to Himalayan region and is recognised as being able to naturalise in many tropical countries. It has been found on old lava flows in Hawaii and on lava bluffs near volcanic activity. It is also found wild in Fiji and is

considered an escapee from cultivation in Puerto Rico. However, seeds and plants are readily available on the Internet, as it appears to be a popular garden plant.

Bruce Gray, the recognised orchid expert in North Queensland (CSIRO Tropical Forest Research Centre, Atherton), has not seen this species naturalised in the Wet Tropics, but knows it from cultivation, mainly in the coastal lowlands. However, it is cultivated less frequently on the Atherton Tablelands but has been observed in a garden in Millaa Millaa (Bob Jago, pers. comm.).

The Bamboo Orchid is a large, terrestrial plant with cane-like stems 1.5 - 2.5 metres tall and up to 1.5 centimetres in diameter. The leaves are borne in two ranks and are narrowly oblong and grass-like, they are twelve to thirty centimetres long and 1.6 - 2.5 centimetres across. The simple, terminal inflorescence is fifteen to thirty centimetres long and bears many flowers that bloom in succession for two to three days.

The flowers found along the Suttie's Gap road (Figure 1.5) are rose-purple or white and a few centimetres across, the lip is darker than the sepals and petals, they are often veined purple and have a yellow patch at the base. The species blooms all year and one plant bears many flower spikes.

*Arundina bambusaefolia* prefers bright sunlight and plenty of water but tolerates a wide range of conditions, being particularly prominent as a weed of hillsides, banks and road cuttings. It is capable of vegetatively reproducing; when the tall canes fall and touch the ground they may take root. As this is the only known occurrence of this exotic species that has demonstrated weedy characteristics in other tropical areas, there is a good opportunity to control the infestation before it is transferred to other sites.

Bruce Gray (pers. comm.) recommends that it should be removed from the site and the location monitored for several years, as seed may have been set during the two years that it has been known to occur at this site (Rigel Jensen, pers. comm.).

**Figure 1.5:** *Arundina bambusaefolia* flower.

**Figure 1.6:** Growth form of *Arundina bambusaefolia.*

Bob Jago believes that the plants may have seeded.

There are many individual plants present along the road cutting for approximately fifty metres, suggesting that the species is at least vegetatively reproducing and very probably seeding also.

Removal of the plant should only require one vehicle with several people and equipment to allow safe climbing of the road cutting and the digging out of the plants. Replacement with native ferns such as *Dicranopteris linearis* or tree ferns would be preferable, to prevent colonisation by alternative weeds.

**Figure 1.7:** *Arundina bambusaefolia* on a road cutting west of Charappa Creek forestry camp clearing.

### 1.4.4 Aerial Video Analysis of Powerline Clearings

Ecological condition of the Palmerston and the Chalumbin-Woree powerline clearings was assessed using aerial videography, noting the presence of large areas of weeds and the quality of forest linkages across the clearings In several cases along the Palmerston powerline, especially when descending the escarpment to the Tully Gorge and for the majority of the Chalumbin-Woree line, the plane was flying high above the clearing or the clearing was in shadow, this made interpretation difficult. The height of the new towers along the Chalumbin-Woree line also necessitated relatively high flight paths. Interpretation was supplemented by knowledge of the sites where the weed survey was undertaken. However, this method can only supplement existing knowledge.

*Palmerston Powerline Clearing*

The lower section of the Palmerston powerline clearing (from the Palmerston Highway to the K-Tree Road and along the Jordan Goldfields Track) exists mainly as a grassy swathe dominated by Guinea grass, molasses grass and signal grass (Figure 1.8). In recent times the exclusion of fire has allowed lantana to spread across the clearing, particularly on slopes near gullies and drainage lines, where shading during part of the day reduces the competitiveness of the grasses. Lantana and giant bramble tend to form impenetrable thickets on the edge of the clearing; this is the source for the spread of the woody weeds across the clearing. In deeper gullies, rainforest regrowth occurs, often edged with tree ferns. Narrow strips of regrowth can also be found in shallower gullies, this having occurred only over the past 10 years, again a function of the reduction in fires. However, for several spans in this lower section, rainforested connections remain along deep creek lines, probably

having never been completely cleared. These occur twice near the K-Tree Road and more commonly near the Jordan Goldfields Track. Additionally, along the Jordan Goldfields track section, several regrowth gullies that were present as thin strips ten years ago have been strengthened by further growth of the forest to form excellent connections for faunal movements.

The higher sections of the powerline clearing near the Jordan Goldfields Track and the Maalan Track are more varied. Guinea and molasses grass swathes with lantana/bramble edges remain dominant, particularly along shorter spans and ridgelines. In several places, shade characteristics due to differing aspects has allowed lantana to again out-compete the grasses and stretch across the clearing (Figure 1.9). Additionally, several major creeks and their tributaries cross the clearing and these are associated with long rainforest connections. Regrowth is a feature in shallower gullies, but shadows in the video image caused difficulty in determination of the quality of these connections.

The section along the West Palmerston Track between the last crossing of the Maalan Track and Sutties Gap Road has a number of rainforest connections or regrowth gullies associated with the South Johnstone River and its tributaries. Each forested connection appears to be fringed with lantana, while grassy swathes predominate on slopes to the towers. However flight height restricted interpretation. Grassy areas occur on the riverbank itself.

**Figure 1.8:** Lower section of Palmerston powerline clearing illustrating swathes of molasses grass (purple flowers), signal grass (bright green in foreground) and Guinea grass (taller pale green in foreground). Note small amounts of regrowth in gullies in middle distance.

**Figure 1.9:** Upper section of Palmerston powerline clearing illustrating a Guinea grass swathe and areas where Lantana is expanding through the grass in the centre of the clearing.

The pattern of forested connections fringed with woody weeds and grassy swathes near the towers continues down the H Road section of the powerline, although grassy swathes predominate where the line follows a ridge and has shorter spans. Further south on the H Road, tower footprints become smaller grassy clearings and the forested connections are the dominant feature. Along the escarpment of the Tully Gorge, the majority of tower footprints are small with long forested connections separating them. Although the height of the plane over the area where the powerline leaves the major escarpment makes interpretation difficult, it is likely that the clearing has regrowth and weeds with narrower forested gullies. At Cochable Creek, grasses infest the creek banks and islands, these grassy swathes become dominant except in steep sections and along the riverbanks where lantana and regrowth predominate as the line crosses the Tully River. The Tully Gorge, the Tully Gorge Road and the powerline clearing are dominated by grassy swathes, except in small gullies leading to the Tully River and along the riverbanks.

In summary, the general ecological condition of the Palmerston powerline clearing is extremely poor, being dominated by grassy swathes and lantana. In sections, particularly along the H Road and the Tully Gorge escarpment, and to a lesser extent along parts of the Maalan Track and West Palmerston Track, long forested connections where the powerline swings above the canopy, together with the small tower footprints leads to a relatively good ecological condition rating. However, even in these sections, weeds infest the tower sites. The lower elevation sections near the Palmerston highway, K-Tree Track, Jordan Goldfields Track and the Tully River are mostly in extremely poor condition. However, there has been a change in ecological condition since fires were excluded over the past few years. In some cases that has resulted in one weed type (woody) overtaking another (grass), but in others it has allowed regrowth forests along gullies to grow taller and the extent of these regrowth patches has increased, thus improving ecological condition.

*Chalumbin-Woree Powerline Clearing*

The lower elevation swathes of the Chalumbin-Woree powerline clearing, where Bridle Creek runs parallel to the clearing, are mostly heavily weed-infested. The adjacent forest is relatively dry and the dryness is reflected in the clearing vegetation that consists mainly of

grasses, including the native species *Themeda triandra* and *Imperata cylindrica,* as well as weeds such as molasses grass and paspalum. Dense thickets of lantana commonly occur while herbaceous weeds such as blue snakeweed, bluetop, knobweed and sensitive weed are common everywhere. Riparian vegetation along Bridle Creek forms the main forest connections.

**Figure 1.10:** Chalumbin-Woree lower elevation swathes of grass and blue snakeweed.

As the powerline climbs, wet-adapted grasses such as Signal and Carpet grass take over, while the herbaceous weeds, particularly Blue Snakeweed and Bluetop, remain common, with lantana still forming dense thickets. Forested connections become more common with clearings around the towers reducing in size and weeds therefore becoming less dominant.

The powerline climbs quickly in the vicinity of the Clohessy River and its tributaries, with the line mainly swinging above the canopy and tower footprints small. Weeds comprise mainly signal and molasses grasses.

Once the Shoteel Creek Road rejoins the clearing, it again becomes a swathe of grass and herbaceous weeds near the powerline towers, with woody weeds and regrowth down the slopes, often with native ferns, sedges and rainforest pioneers interspersed. Long forested connections still occur in the gullies that form the headwaters of Shoteel Creek and Freshwater Creek.

**Figure 1.11:** As the powerline climbs, forested connections become more common; clearings around towers are still dominated by grasses adapted to wetter habitats and woody weeds.

Near Copperlode Dam, weeds are prevalent around the water's edge as well as in the clearing, carpark and tracks associated with the kiosk. The clearing generally has lower regrowth including native ferns, sedges and pioneers but woody weeds including giant bramble and lantana are still prevalent on road embankments with weedy grasses occurring in the vicinity of towers and hillcrests. Forested gullies that form rainforested connections commonly occur at the headwaters of Freshwater Creek's tributaries. Low regrowth, with woody weed thickets, native ferns and pioneers, occurs where the clearing follows the main ridge. Weeds are particularly prevalent where the clearing reaches the escarpment to descend. The majority of towers on the descent of the escarpment are situated in old fire scarred grassland on the foothills behind Cairns suburbs.

In summary, the Chalumbin-Woree powerline corridor has sections in relatively poor condition, particularly at the drier end towards Bridle Creek where lantana and herbaceous weeds as well as weedy grasses are dominant or common. At higher elevations, the powerline swings above the canopy in many areas, resulting in smaller weed fields with some native regrowth that are mainly associated with towers, and to a lesser extent the slopes adjacent to towers. The Lake Morris Road, Copperlode Dam and the kiosk provide opportunities for woody weeds and grasses on the eastern end of the powerline clearing, with power towers surrounded by a mixture of herbaceous, grassy and woody weeds as well as native ferns, sedges and pioneer rainforest trees. Swathes in the eastern section where the line does not swing above the canopy tend to be more native regrowth and herbaceous weeds rather than grasses. As the powerlines descend toward the coast, the towers are mainly situated in existing clearings that are often fire scars from cane fire escapes.

### 1.4.5 Characteristics of Major Weeds Found Along Road and Powerline Networks

Many of the species mentioned above can be associated with the six major impacts of exotic plant species in the tropical environment of Hawaii that were listed by Smith (1989). Examples are:

1. Physical displacement of native species (all weeds);
2. Formation of monotypic stands resulting in biodiversity loss and devastating effects on survival of endemic species with limited ranges and small population sizes (e.g. *Lantana camara, Rubus alceifolius, Melinus minutiflora, Panicum maximum*);
3. Changing fire characteristics, particularly promotion of fire by exotic pasture grasses (e.g. *Panicum maximum*);
4. Alteration of soil-water regimes;
5. Alteration of soil nutrient status by nitrogen-fixing legumes (e.g. *Macroptilium atropurpureum*, not a problem at Palmerston); and
6. Promotion of mutually beneficial interactions between feral animals and weeds (e.g. *Rubus alceifolius*)(Werren 2001).

Werren (2001) evaluated a group of exotic terrestrial plant species within the Wet Tropics bioregion according to a number of risk criteria that included existing species posing major management problems as well as the plants' habitat and life form. Informal functional groups and examples found in the powerline corridors comprised:

a) Herbaceous, shrubby plants that invade relatively slowly but that may dominate or replace the natural herb/shrub layer of more open communities (e.g. *Stachytarpheta*, *Hyptis* spp.);
b) Graminoids and herbaceous species that spread rapidly or more extensively, thereby replacing the herb layer with a monospecific stand and seriously inhibiting recruitment of

tree and shrub layers (e.g. *Panicum maximum, Melinis minutiflora* and other introduced pasture grasses), also promoting highly modified fire regimes;

c) Scramblers and climbers that have spread widely and become integrated into natural communities (e.g. *Passiflora* spp.,*)* that exert at least intermittent competition and can form dense mats to adversely affect the growth of native species;

d) Shrubs and small trees that form dense stands preventing other herbaceous and woody growth (e.g. *Lantana camara, Rubus alceifolius)*;

e) Trees invading slowly forming 'sleeper weeds' in the early stages of invasion or being inconspicuous (e.g. *Mangifera indica)*;

*f)* Trees that spread rapidly by wind-borne or small animal (especially bird) dispersal that can form dense stands (e.g. *Solanum mauritianum);*

g) Miscellaneous species that have adverse interactions with native species

Of the fifty terrestrial weed species assessed by Werren (2001) in a trial weed risk assessment system, nine were found within the two powerline clearings examined in this study. Two of these, Guinea grass, *Panicum maximum*, and Para grass, *Brachiaria mutica*, were judged as forming part of the eleven-strong top risk cohort, that display extremely aggressive weedy tendencies within the Wet Tropics bioregion. They greatly impair ecosystem function and are considered 'transformer species' that change the character, condition, form or nature of a natural ecosystem over a substantial area (Richardson *et al*. 2000). Therefore the Palmerston powerline clearing, particularly at lower elevations, would be considered to have greatly impaired ecosystem function due to the presence of swathes of Guinea grass. It should be noted that molasses grass, *Melinis minutiflora*, was not one of the weeds assessed, but would be expected to fall within the same group.

Mango, *Mangifera indica*, was a species ranked in the second worst group (Werren 2001). Although not found in any of our transects, Mango trees were observed near Bridle Creek and may be expected to spread through the mediation of feral pigs and fruit bats that eat the fruit and drop the seeds later further afield. In the next group, two herbaceous species common in the Chalumbin-Woree network were found, Snakeweed, *Stachytarpheta* spp. and Praxelis, *Eupatorium catarium*. These are widespread species found in disturbed areas. A fourth group of species considered either of less serious environmental risk or less pervasive, include Knobweed, *Hyptis* spp., Navua sedge, *Cyperus aromaticus*, and Stinking Passionfruit, *Passiflora foetida.*

Lantana, *Lantana camara*, is considered a weed of national significance. It was not assessed in the trial weed risk assessment system undertaken by Werren (2001), but would be expected to rate very highly due to its potential to alter substantial areas and impair ecosystem function. Again the Palmerston clearing harbours major infestations of this weed, whilst the Chalumbin-Woree clearing is less affected but still has relatively large areas where lantana dominates.

'Sleeper weeds' are those invasive plants that have naturalised in a region but have not yet increased their population size exponentially (Groves 1999). While not currently considered a problem, they may be in the early phases of an explosive invasion (Werren 2001). Species listed by Space (2001) as invasive in Pacific Island ecosystems may also constitute 'sleeper weeds'. Those found in the two powerline and road networks include Cobbler's pegs, *Bidens pilosa*, Knobweed, *Hyptis capitata*, *Hyptis suaveolens*, Siratro, *Macroptilium atropurpureum*, Red Natal grass, *Melinis repens*, Sensitive weed, *Mimosa pudica*, Paspalum, *Paspalum conjugatum, Paspalum paniculatum,* Edible Passionfruit, *Passiflora edulis*, Stinking Passionfruit, *Passiflora foetida*, Giant Bramble, *Rubus alceifolius*, Tobacco Bush, *Solanum mauritianum*, Thorn Apple, *Solanum torvum* and Urena Burr, *Urena lobata.*

The weeds of the powerline and road networks assessed have a variety of characteristics that predispose them either to the formation of large infestations that alter the ecosystem and are self-perpetuating, or to form mixtures with other weeds and/or natives. Many may be 'sleeper weeds' that may have the potential to increase population size exponentially in the future. Several have the potential to colonise within the rainforest and the rainforest edge as well as the cleared areas.

## 1.5 CONCLUSION – ECOLOGICAL CONDITION OF POWERLINE AND ROAD NETWORKS

The differences in weed composition and ecological condition observed along both the Palmerston powerline clearing and road network and the Chalumbin-Woree powerline clearing and road network are linked to the substrate and topography of each powerline clearing and to past and present construction and maintenance procedures. Where topography is deeply incised with deep creeks and high crests, clearing for powerline construction was limited or avoided. In these areas the powerlines swing above the majority of the canopy, retaining connectivity of forests (either remnant or regrowth) below the line, and leaving only relatively small clearings around the towers to be infested by weeds. Such deeply-incised topography is found along the escarpments crossed by both of the powerline clearings, in particular where granites and metamorphic substrates occur. This has resulted in excellent connectivity where clearing did not occur and relatively good connectivity where regrowth has occurred. Where the topography is relatively flat, swathe clearing was used for construction and these areas are generally in poor condition.

Burning of the lower sections of the Palmerston powerline clearing encouraged self-perpetuating grassy swathes that currently, in the absence of fire, are partially being overtaken by woody weeds. Where restoration works have been undertaken, rainforest species establish quickly to form a weed-excluding tree canopy. Further restoration works centred on gullies in large weedy swathes should continue to subdivide the weed areas and encourage adjacent natural regeneration. The advantage of these restoration works is that they aim to allow faunal movements, reduce linear barrier effects and reduce the movements of alien species along the weedy swathes of the clearing. In certain areas where fires have been excluded in recent times, rainforest species, including *Cardwellia sublimis* as well as other rainforest pioneers have been able to colonise the clearing. This is particularly true of gully areas. However, this recolonisation in gullies is limited by the degree of infestation of lantana and bramble already present. Encouragement of such natural regeneration may be improved by woody weed control.

The dominance of grass and woody weeds along the lower Palmerston clearing has caused the ecological condition of that section of the World Heritage Area to be identified as the worst of all areas assessed in this study. Areas of the Palmerston road network that have not been subject to weed control are similarly infested with swathes of grass and herbaceous weeds. In contrast, where weed control has been undertaken, the emphasis has shifted from swathes of grass to herbaceous weeds and natives. This situation causes a great improvement in ecological condition, reducing linear barrier effects for fauna and greatly improving presentation values for tourists. Encouraging canopy connections above the road would maintain this improvement without the need for herbicide controls. Until this canopy closure can be achieved, continuation of the weed control measures in areas where weeds are presently reduced and extension of those measures into those areas where control has not yet been undertaken, is considered a high priority.

Grazing along the western sections of the Chalumbin-Woree powerline corridor has encouraged a self-perpetuating weedy swathe. Although cattle are not currently in evidence, weeds remain diverse. Some regrowth species are beginning to colonise, and areas of

native grasses including *Themeda triandra* and *Imperata cylindrica* occur, however swathes of blue snakeweed, lantana, molasses grass, signal grass, paspalum, bluetop and mixed herbaceous weeds are dominant. Areas of restoration revegetation may help to subdivide these areas and increase recolonisation by native species. Weed control similar to that undertaken in the Palmerston road network may also encourage the recolonisation of native species but would require maintenance to prevent weed swathe re-establishment.

Areas of the Chalumbin-Woree powerline clearing in the vicinity of the Lake Morris Road vary from good condition, where the powerline swings above the canopy between crests of hills, through to large areas dominanted by weeds. However, native ferns, sedges and pioneers have established in many areas and weed control of areas of grass, lantana and bramble may encourage expansion of these low swathes of native species. These low native swathes appear ideal in reducing many of the impacts of linear infrastructure, whilst not impinging on safety aspects for the power distributors.

## 1.6 RECOMMENDATIONS

Similar examination of other powerline clearings and road networks within the WTWHA, including the Creb Track and powerline clearing, Mt Lewis Road, Rex Range and powerline clearing, Kuranda Range Road, Black Mountain Road and the Gillies Highway is recommended. The ecological condition of southern linear infrastructure such as the Paluma Road, Bluewater Road, Kirrama Road and Tully Falls Road and the associated powerline clearings is relatively unknown.

## 1.7 MANAGEMENT IMPLICATIONS

- Areas of powerline clearing that were totally cleared and then subjected to fire or grazing for maintenance purposes remain the areas in worst ecological condition.
- Exclusion of fire from the Palmerston powerline network has allowed some expansion of natural regeneration, but in many areas the absence of fire has allowed the expansion of woody weeds which now require control and possibly restoration work to prevent their establishment at the top of a weed succession within the clearing.
- Weed control along the Palmerston road network undertaken by EPA South Johnstone has been extremely successful in improving the ecological condition of the area and reducing the impacts of weeds but does require continued maintenance over several years whilst canopy connectivity is established.
- The removal of trees and branches from above unsealed roads should be avoided as this decreases canopy connectivity. Increased connectivity is necessary for reducing weed infestations and thus the requirement for herbicide control.
- Removal of the new weed species, *Arundina bambusaefolia*, which was found along the South Johnstone road network, should be undertaken as soon as possible, as elimination of this weed is currently achievable.
- Encouragement of the extension of swathes of low native species to replace weedy swathes using selective weed control along the Chalumbin-Woree powerline corridor, particularly at higher elevations, and along the Lake Morris Road, should result in excellent gains in ecological condition whilst retaining safety aspects crucial to the power distributors.
- Grazing should be excluded from powerline clearings due to the potential of livestock to spread weeds and contribute to maintenance of weed fields.
- Species of ferns, tree ferns, sedges and low shrubs have been suggested as alternatives to exotic grasses for stabilisation of road banks.

- Ensure that future clearing of swathes is totally rejected. When powerline are swung above the canopy on high towers with natural vegetation clearing restricted to tower footprints only, the impacts of new powerlines or powerline upgrades on weed establishment will be reduced
- Although parts of the Palmerston powerline clearing are currently in poor ecological condition, restoration work across the clearing, such as that undertaken by the Centre for Tropical Restoration, and extension of the natural regeneration in gullies is improving this situation gradually. Further restoration works could speed this recovery. As this is an area of high biological diversity, vegetation complexity and the habitat of many species of rare and threatened fauna and flora, it is considered a high priority for restoration. Removal of the powerline infrastructure will aid in the recovery by allowing further restoration works as well as the natural regeneration to proceed without concerns for safety.
- Weed control and restoration work, together with the exclusion of livestock, is required in the western sections of the Chalumbin-Woree powerline and road network, to improve the ecological condition of the area.