EXECUTIVE SUMMARY

SECTION 1: WEED SURVEYS ALONG HIGHWAYS, ROADS AND POWERLINE CLEARINGS TRAVERSING THE WET TROPICS OF QUEENSLAND WORLD HERITAGE AREA

Research Objective

The objective of this study was to undertake an initial basic spatial inventory to provide an understanding of the distribution of weed species and the relative ecological condition of selected road verges and powerline corridors within the Wet Tropics of Queensland World Heritage Area (WTWHA).

Key Findings

- Major weed infestations recorded for powerline clearings and roads include Guinea grass, Molasses grass, Signal grass, Blue Snakeweed, Paspalum, Bluetop, Lantana and Giant Bramble as well as several herbaceous weeds. Forty-four weed species were found along the Chalumbin-Woree network, with fifty along the Palmerston network.
- The ecological condition of the Palmerston network was found mainly to be poor, particularly at lower elevations near the Palmerston Highway and Tully Gorge. However, in several sections at higher elevations with dissected topography, ecological condition was relatively good where the powerline swings above the canopy of remnant or regrowth forests, providing long sections of rainforest connectivity.
- Similarly, along the Chalumbin-Woree network, higher elevation sites with dissected topography tended to be in better ecological condition than lower elevation sections or areas where the powerline or road follows a ridge, where swathe clearing and maintenance has limited recolonisation by native species.
- Exclusion of fire from the Palmerston network and grazing from the Chalumbin-Woree network has allowed some recolonisation by native species to commence and is greatly enhanced by restoration plantings that help to divide the weedy swathes.
- Weed control on the Palmerston road network by EPA (Environmental Protection Agency) South Johnstone has been very successful in reducing weed infestations and improving ecological condition and presentation values.
- Several native species are recommended as showing potential to out-compete weeds.
- One new weed species, the Bamboo Orchid, was found on the Palmerston road network.

Recommendations

- Eradication of the new weed, *Arundina bambusaefolia*, the Bamboo Orchid, as soon as possible while it is confined to a small location and easily controlled.
- Continuation of weed control on the Palmerston road network until canopy connectivity extends completely over the roads and effectively controls weeds without herbicide.
- Restoration plantings that divide the clearings, particularly near gullies, similar to those already undertaken in the lower elevation section of the Palmerston network.
- Continued exclusion of fire and grazing.
- Removal of trees and branches above unsealed roads should be avoided, to increase canopy connectivity and thereby reduce weed infestations and the requirement for herbicide control.
- Ensuring that clearing of swathes is totally rejected. Powerlines being swung above the

canopy on high towers with clearing restricted to the tower footprints will reduce impacts of new powerlines and upgrades.

Management Implications

- Areas previously totally cleared and maintained by fire or grazing remain in worst condition, due to the ability of fire to create a self-perpetuating weedy grass swathe and the potential for livestock to spread weeds.
- Exclusion of fire from the Palmerston powerline network has allowed expansion of natural regeneration in many areas. However, in other sections previously in worse condition as grassy swathes, the expansion of woody weeds now requires control and restoration works.
- Several species of ferns, tree ferns, sedges and low shrubs show potential as alternatives to exotic grasses in the stabilisation of road embankments.
- Swathes of low native species should be encouraged to replace weedy swathes using selective weed control along the Chalumbin-Woree powerline clearing, particularly at high elevations, to retain safety aspects for power distributors whilst improving ecological condition.
- The restoration across lower sections of the Palmerston powerline clearing undertaken by the Centre for Tropical Restoration and the extension of natural regeneration in gullies is gradually improving ecological condition. Further restoration works could speed recovery.
- Weed control along the Palmerston road network is currently very successful and should be continued until canopy expansion over the roads naturally controls weed infestations whilst improving ecological condition and presentation values for visitors.

Further Research

- Examination of other road and powerline networks.

SECTION 2: POTENTIAL OF REMOTE SENSING IN THE MONITORING OF WEED INFESTATIONS ALONG POWERLINE CORRIDORS

Research Objectives

The objectives of this study were:

- To determine whether satellite or airborne imagery could discriminate individual weed species and the degree of spatial resolution provided by such imagery;
- To determine the suitability of ‘spectral mixture analysis’ for determining fractional quantities of weed species at the sub-pixel level;
- To determine which sensor system is likely to provide the best overall result for the WTWHA.

Key Findings

- Field measurements of the percent cover of weed species showed that one to three main species occurred within each $1m^2$ and therefore species ‘spectral mixture analysis’ should be viable for determining the quantity of weed fractions at 1 metre spatial resolution.

found to be separable by a statistical technique designed for this study, showing that weeds should be able to be separated using 'spectral mixture analysis'. Signatures should take account of seasonality, time of day, consistent light conditions and height above the canopy of hand-held radiometer.

- When data from an Airborne Data Acquisition and Registration (ADAR) system with an excellent 1 metre spatial resolution was examined, calibration was difficult due to poor camera performance.
- Ikonos satellite imagery had high quality data with good spectral coverage but the 4 metre spatial resolution was inadequate for mapping weeds along the Chalumbin-Woree powerline clearing, although possibly adequate in less heterogeneous clearings such as that for the Palmerston powerline.

Recommendations

- Improved characterisation of field spectral responses of weeds requires use of standardised conditions, coloured targets during data capture and consideration of phenology of weeds.
- Estimation of proportions of weed cover from imagery requires:
  a) calibrated imagery;
  b) suitable band widths (20–30nm) in the appropriate areas of the spectrum;
  c) a high spatial resolution (0.5–2m) that contains few spectral components;
  d) correction for illumination effects; and
  e) processing with classifiers that allow for the variation seen in the spectral response patterns of vegetation ('Fuzzy C-means', or 'Artificial Neural Networks').
- Test alternative image interpretation software with the ability to handle 12-bit data and real numbers to take advantage of the high dynamic range of the latest satellite data to discriminate subtle differences in vegetation signatures.
- Regular use of airborne imagery will require quick set-up times to take advantage of unpredictable cloudless periods in the Wet Tropics that rarely last more than a few days. Ultra–light, computer or radio-controlled aircraft, or powerline maintenance helicopters may provide a more timely means for monitoring of environmental weeds.
- Test hyperspectral imagery (8-20 narrow bands) at 1m spatial resolution and easily-acquired satellite imagery at 2m spatial resolution (available in 2–3 years) for their effectiveness in 'spectral mixture analysis' of weeds.

Management Implications

- There is a definite potential to discriminate individual weed species using spectral signatures, using the new statistical technique designed in this study.
- ADAR imagery is not recommended due to poor camera performance and unpredictable cost.
- Ikonos satellite imagery may be useful in some powerline and road networks, but spatial resolution was too coarse for the Chalumbin-Woree network.
- Hyperspectral (CASI) imagery may be ideal, both for camera performance and spatial resolution. Alternatively, a four-camera airborne system (MAVS) or a 4-band satellite sensor with 2 metre resolution should provide possibilities for weed monitoring.

Further Research

- Future work on the spectral response of weeds should be directed at measuring the seasonal variations for each species by establishing permanent plots for regular monitoring. A clustering routine in a GIS that looks for true shoulders or peaks in spectral data should then be used to find spectral groups on a species by species basis.
- Hyperspectral imagery should be tested, as should 2m spatial resolution satellite imagery to become available in 2-3 years.

SECTION 3: WEED PENETRATION, EDGE EFFECTS AND REHABILITATION STRATEGY SUCCESS IN WEEDY SWATHES OF THE PALMERSTON POWERLINE CLEARING

Research Objectives

The objectives of this study were:

- To examine the success of rehabilitation plantings across a powerline clearing in prevention of weed germination;
- To compare the penetration of weeds and weed seeds into the forest from powerline clearings with and without restoration plantings; and
- To examine the effect of edges on vegetation floristic composition at these treatments.

Key Findings

- Rainforest restoration across the clearing undertaken in 2000 by the Queensland Parks and Wildlife Service (QPWS) Centre for Tropical Restoration, using three framework species has almost eliminated grassy weeds that prevent germination of native rainforest species. However, in these early stages of growth, little recruitment of rainforest species has occurred.
- Edge-induced changes in floristic composition penetrate the rainforest to a distance of 3-7m, with early successional stage rainforest species more prevalent.
- Floristic composition was altered further into the rainforest to distances varying between 25 and 45 metres, suggesting a more insidious, longer-term and more widespread effect of wide linear clearings.

Management Implications and Recommendations

- Rehabilitation plantings are already demonstrating success after only two and a half years in terms of reduction in fire-promoting grassy weeds.
- If Palmerston powerline is to remain *in situ* for several more years, rather than be removed in 2003, removal of trees in rehabilitation plantings should only be contemplated where their growth is a source of imminent danger to the powerline. Lopping should be considered as an alternative to removal as these restoration areas are already serving a useful ecological function.
- The dominance of weeds within the powerline clearing almost eliminates the possibility of native species recolonising the cleared swathe in this lower elevation section of the powerline clearing without assistance in terms of restoration works, *i.e*. plantings of native trees after weed control. Where fires have been less frequent over recent years, woody weeds have out-competed the grasses in some areas, spreading across the clearing and preventing recolonisation by native species. Recovery of native habitat requires further

restoration works.

- Changes in floristic composition that penetrate to distances of 20-45 metres were found in this study, suggesting an insidious, long-term and widespread effect of wide linear clearings. As this clearing was created in the 1950s, recovery from these changes after removal of linear clearings may be a long-term process.

Recommendations for Further Research

- Examine several more transects with differing edge aspects on control and rehabilitation treatments at Palmerston for weed penetration and floristic edge effects.
- Examine similar number of transects along Palmerston highway as a direct comparison of weed penetration and edge effects.
- Analysis of soil seedbank results from selected transects on powerline clearing treatments and highway.