ENVIRONMENTAL
TRAINING & EMPLOYMENT INC.
EnviTE NSW

Vegetation Management Plan
East Ballina Crown Reserve

Prepared by Andy Erskine

2003

For

East Ballina Landcare Incorporated

Funded by

Wetland Care Australia

ACKNOWLEDGEMENTS

Lee Andreson, President of the East Ballina Landcare Group, has made a significant contribution to this plan.

All photos, unless otherwise credited, were taken by Andy Erskine.

EXECUTIVE SUMMARY

The East Ballina Crown Reserve Vegetation Management Plan has been prepared for East Ballina Landcare Inc. with funding from Wetland Care Australia. The plan provides site assessment and strategies for restoration of vegetation at the site.

The study site is located at East Ballina in Northern New South Wales. It comprises about 57 hectares of crown land. The south-eastern part of the site is bordered by Pine Avenue and the Coast Road which separates the site from another significant area of vegetation at Black Head. The western corner is intercepted by Links Avenue.

The site contains a number of differing but related vegetation communities including Wallum Heath, Vine Thicket, Sedgeland and Melaleuca Wetlands. Part of the site has experienced high disturbance as a result of past clearing for a nine-hole golf course. The area has subsequently become infested with exotic pine but most of the area remains substantially undisturbed.

While the site appears to be reasonably large, it is isolated from other vegetation communities. This is partly due to surrounding residential development, weed infestation, major road corridor and fire. The report details the implication of fire at the site.
In close proximity, but unfortunately not directly connected, are a number of vegetation fragments that contain vulnerable or threatened species such as *Acronychia littoralis*. Due to the lack of connectivity, birds are the only fauna species able to move between the fragmented vegetation.

The site has significant cultural value for local Aboriginal people. Historical accounts prepared by European settlers indicate that a massacre of local Bundjalung Aboriginal people occurred in this area in the years 1853/54 at the hands of a division of the native Queensland Mounted Police. (NPWS 1996).

Site inspections were conducted in late 2002 and early 2003. The site has been separated into six main work areas. Each of these area has been broken down into smaller units and the density of weed infestation in each area is detailed. A summary of recommended works for each area and general recommendations that are applicable to all areas are provided. Recognised weed species and specific weed treatment methods are described, and recommended for each weed species found at East Ballina Crown Reserve.

A systematic strategy to implement vegetation restoration work will maximise the environmental outcomes for the site. Recommendations for on-ground works include strategic control of environmental weeds, planting strategies (where required) and access issues.

The native vegetation communities at East Ballina Crown Reserve are valuable in environmental, social and recreational and economic terms. This plan provides practical guidelines for East Ballina Landcare Inc. and others to restore vegetation communities at the Reserve. The benefits of this work include conservation of individual species and vegetation communities, improved habitat for wildlife and general public amenity.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PLATES

1. AIMS AND OBJECTIVES OF THE PLAN

1.1 Vegetation Management Plan Aim

The aim of this plan is to provide practical guidelines to enable groups and individuals, engaged in rehabilitating, conserving and managing the vegetation of the East Ballina study site to carry out works that will:

- restore, to the extent possible, the structure, function and dynamics of the pre-existing vegetation and the habitat it provides,
- strengthen the resilience and regenerative capacity and otherwise contribute to the conservation of the remnant vegetation,
- provide a suitable habitat for local and migratory native fauna, and
- improve the general amenity of the area to the extent compatible with the sites future conservation status (undecided at the time of writing) for local residents and visitors (aesthetic, recreational and educational).

1.2 Vegetation Management Plan Objectives

The specific objectives of the plan and its recommended works are:

- to assess the extent and location of native plant and weed species,
- to make recommendations for regeneration and rehabilitation of the study area, taking seasonality, work priorities, skills and time required into account,
- to describe methods appropriate for gradually and systematically removing weed species from the site in order to increase biodiversity and improve habitat value,
- to increase public awareness of the importance of this area and encourage stewardship (i.e the formation of a dedicated environmental restoration group), and,
- to suggest strategies to limit re-infestation by weed species from adjoining areas.

2. BACKGROUND

The East Ballina Landcare group commissioned this plan in late 2002 with funding provided by Wetland Care Australia. The subject area for study is a 57 hectare parcel of Crown Land (see map Plate 1) that contains a number of differing but related vegetation communities. Part of the site has experienced high disturbance a result of past clearing for a nine-hole golf course. The area has subsequently become infested with exotic pine but most of the 57 hectares remains substantially undisturbed.

While the site appears to be reasonably large and its edge to area ratio is adequate it is isolated from other vegetation communities. This is partly due to surrounding residential development and major road corridor. In close proximity, but unfortunately not directly connected, are a number of vegetation fragments that contain vulnerable or threatened species such as *Acronychia littoralis*. Due to the lack of connectivity, birds are the only fauna species able to move between the fragmented vegetation.

The site has significant cultural value for local Aboriginal people. Historical accounts prepared by European settlers indicate that a massacre of local Bundjalung Aboriginal people occurred in this area in the years 1853/54 at the hands of a division of the native Queensland Mounted Police (NPWS 1996).

A number of site studies were conducted during 1996/97, as part of the process of the *East Ballina Crown Lands Assessment.* The assessment was designed to determine the development potential of the site. These specialist studies provided useful information relevant to this plan;

- Archaeological (Piper, 1997).
- Flora (Baverstock, 1996) and;
- Fauna (Senmac Environmental, 1996).

The parcel of lands present state, should be appreciated by others beyond nature lovers for its ability to;

- promote biodiversity in the area,
- provide a break to the present urban design sprawl,
- provide amenity which would be degraded if otherwise developed, and;
- provide a buffer zone between a major traffic way and the existing houses.

> "The long-term effect of preserving such areas as open space, where pressure to develop is great, has both long-term positive social effects and is a signal to the community of the Governments commitment to sustainability principles and the real value of this asset".
> (Source; correspondence from North Coast Public Health Unit).

2.1 New South Wales Coastal Policy

The NSW Coastal Policy (NSW Government, 1997) is the umbrella policy for coastal management in NSW. In conjunction with the *Environmental Planning and Assessment Act 1979* (EP&A Act) it guides local government in the planning and management of the coast and in works and activities impacting on the coast (DLWC, 2001).

The *Crown Lands Act 1989* and the *Coastal Crown Lands Policy 1990* directs that Plans of Management be prepared for all coastal Crown Land based on assessment of

the land's values. Similarly the NSW Local Government Act requires that councils prepare Plans of Management for "community land".
The study site, being within one kilometre of the open coast high water mark is subject to the NSW Coastal Policy (1997).

The NSW Coastal Council has formulated a number of goals for the management of coastal features such as this, the most relevant are:

- To protect, rehabilitate and improve the natural environment (Goal 1),
- To conserve the diversity of all native plant and animal species and to protect and assist the recovery of threatened and endangered species (Objective 1.2),
- To manage the coastline and estuarine environments in the public interest to ensure their health and vitality (Objective 1.4),
- To foster new initiatives and facilitate the continued involvement of the community in programs aimed at the restoration and rehabilitation of degraded coastal areas (Objective 1.5), and
- To develop adequate formal and informal education and awareness programs addressing coastal management issues (Objective 8.4).

The recommendations of this plan have been developed in line with the NSW Coastal Policy.

2.2 Location

The site comprises about 57 hectares of crown land, strategically located within the central part of East Ballina. The south-eastern part of the site is bordered by Pine Avenue and the Coast Road which separates the site from another significant area of vegetation at Black Head. The western corner is intercepted by Links Avenue. The housing estates of Bel-air Estate, Angels Beach Estate, Jamison Estate, East Ballina and Shelley Beach Estates are located close to the site. Bushland separates the site from Chikiba and Flatrock Housing Estates located to the north. Angels Beach and Shelley Beach are located within 200-500 metres (Pickles, 1996).

2.3 Geomorphology

The site geology is elevated Quaternary (Pleistocene) dunes of forming very low undulating rises blanketing Lismore Basalts. Relief is 15 – 30m, slopes 3 – 10 degrees and elevation is 20 – 50m. Soils are very deep, rapidly draining Podzols. Limitations of this soils type include that it is non-cohesive, highly permeable, of low fertility and low water-holding capacity and localised seasonal waterlogging. Wind erosion hazard is extreme (Morand 1994).

The site is characterised by a series of old sand dune ridges and swales bordering a lower lying wetland area (Map 2). Three drainage swales drain to the west and northwest, and site elevations extend from under 4m in the northwest of the site (wetland area) to a maximum of about 28m in the dunal ridge in the northeastern part of the site. Most of the site is flat or moderately sloping (0% - 10%) with the slopes of some of the dune ridges having side slopes slightly in excess of 20% (Pickles, 1996).

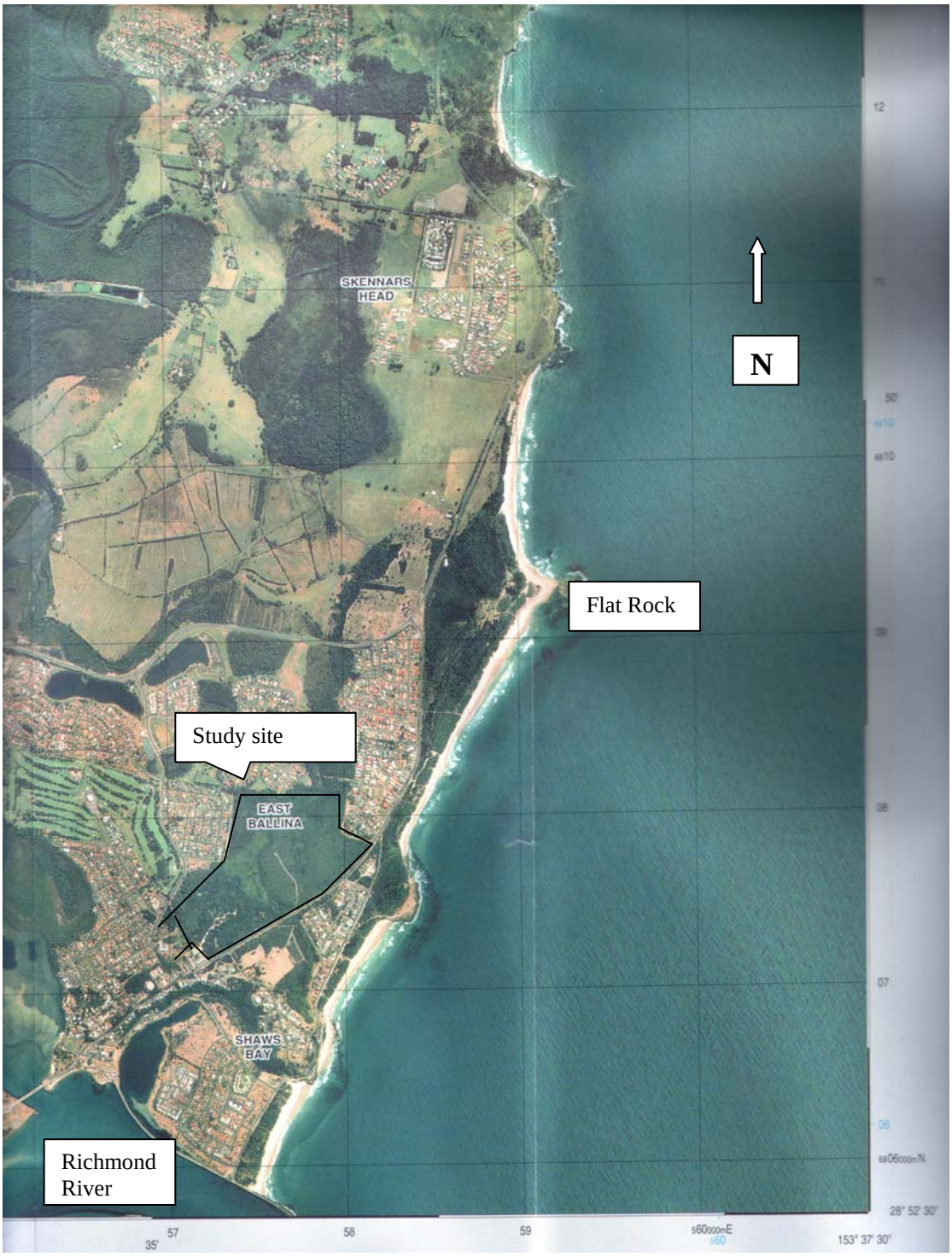

Figure 1: Aerial photo showing the study site location.
Source: Orthophoto 1:25 000 Land and Property Information NSW 2002

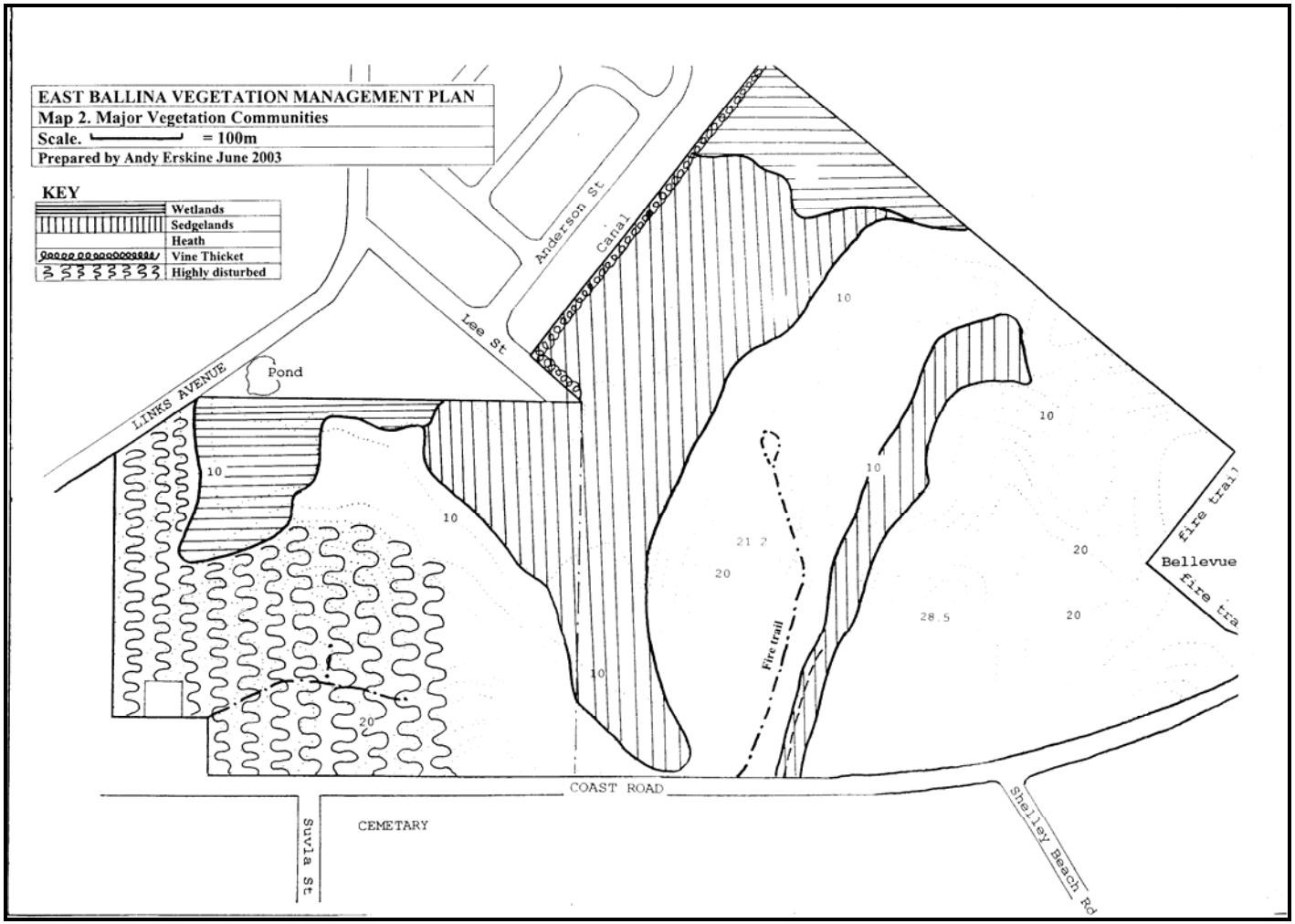

Figure 2: Map of the major vegetation communities

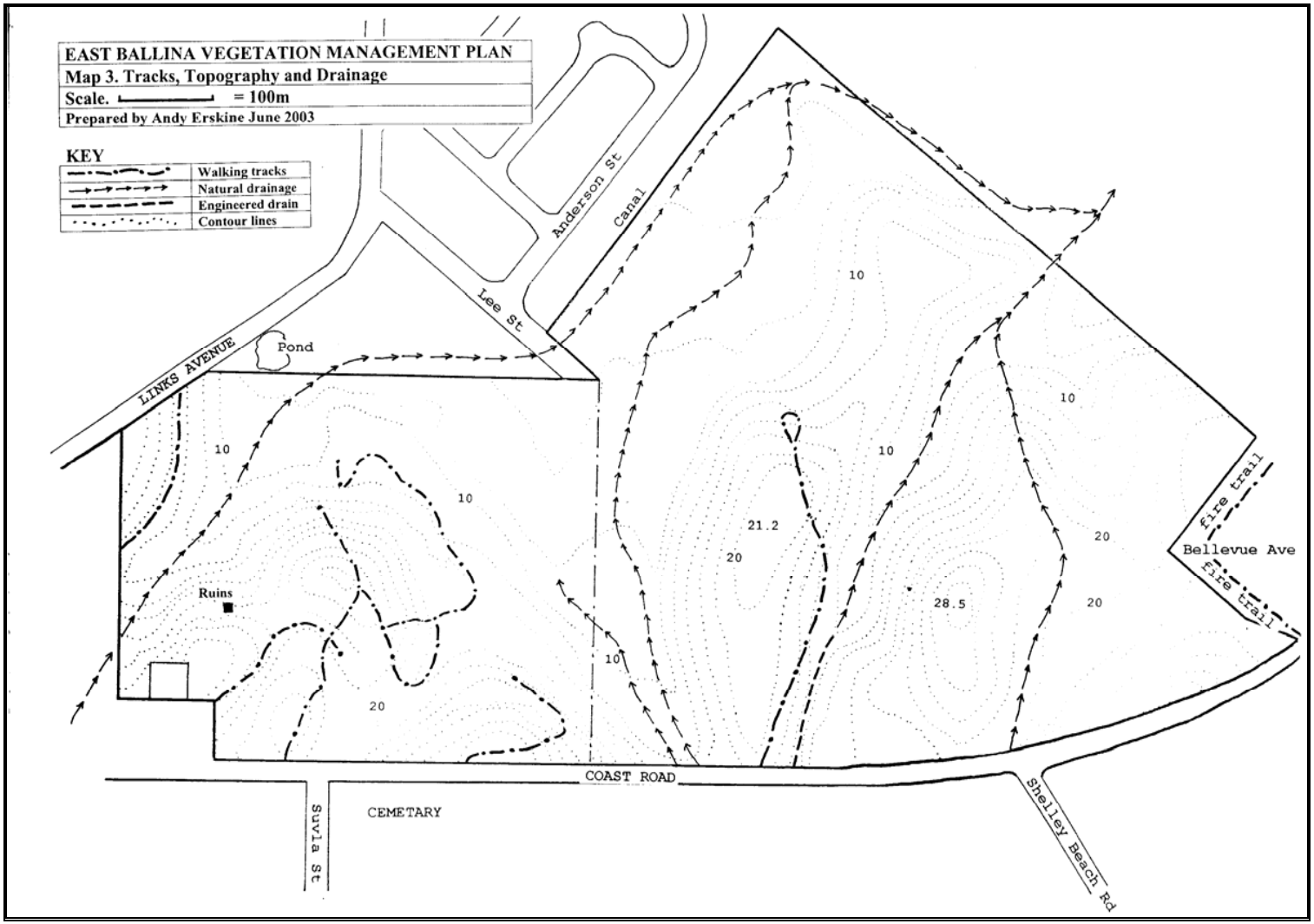

Figure 3: Tracks, topography and drainage

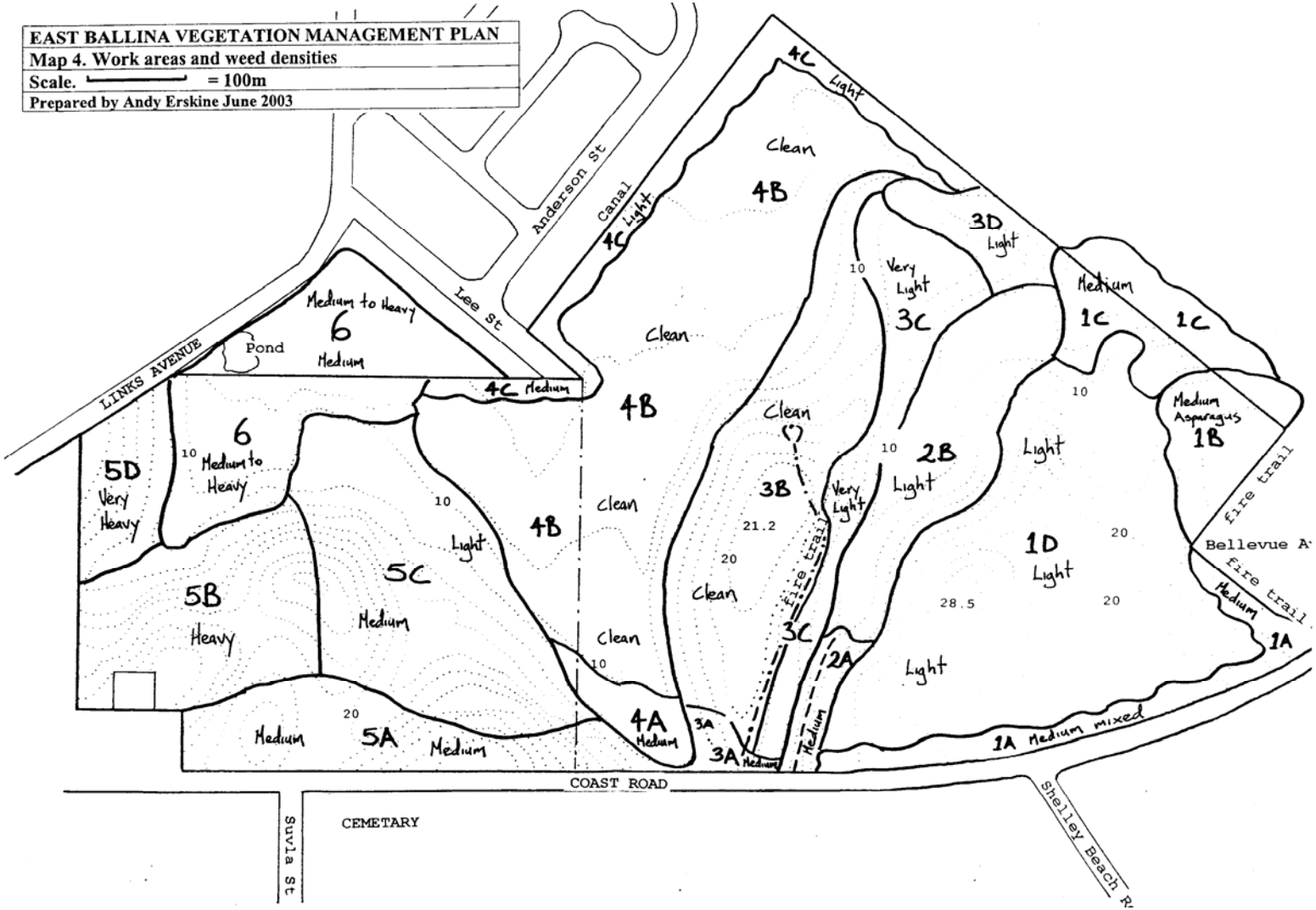

Figure 4: Work areas and weed densities

2.4 Climate

North Eastern New South wales (NSW) experiences a warm temperate to subtropical climate due to its geographic location. Average rainfall fluctuates between 1600 and 1700 millimetres per year, with the highest falls in summer (November to April) (Anderson, 1999). Frosts are generally absent in the immediate coastal strip. The prevailing wind is from the south-east, however strong winds from the north are experienced in spring and summer.

2.5 Land Tenure

Within the context of the Ballina Local Environment Plan 1987, four different zones apply to the site as described below.

Living Area 2(a) Zone – this applies to about 14 hectares of land in the southern part of the site north of the former Southern Cross School and equating with the old golf course.

Rural (Urban investigation) 1 (d) Zone This applies to nearly 50% of the site, mainly the elevated northern part of the site.

Open Space 6(a) Zone This zone applies to a strip of land in the southern part of the site along the Coast Road generally opposite the cemetery and Suvla Street.

Environmental Protection (wetlands) 7(a) Zone This zone applies to the wetland areas generally on the western and northern side of the site.

2.6 Site history and use

Prior to European settlement, members of the Bundjalung nation occupied several areas around the Richmond River. Ainsworth (1922) estimated that in 1847 there were between 400 and 500 in the native tribes belonging to East and West Ballina. Early sources suggest that the Ballina horde remained within a defined territory in small family groups which combined en masse at times of abundant food resources such as oysters, mullet and salmon (salmon have been long absent from beaches of the north coast but are now reappearing).

The study site has significant cultural value for local Aboriginal people, there are 29 registered sites in Ballina (as of 1996), 16 are middens including stone artefacts in addition to estuarine and beach shell species. Thirteen sites are open campsites containing surface scatters of stone artefacts. Two of the 15 middens mentioned above are also described as open campsites (Piper, 1996).

Within the 57 ha study area there have been four sites located, these include three low density shell middens and a quartzite flake. Kuskie (1991) concluded the sites held low archaeological value but possibly held greater significance due to their close proximity to the East Ballina massacre site.

The study site held little attraction to European settlers for agricultural purposes and it appears the area remained fairly pristine until 1953 when the Ballina Golf Club obtained a special lease from the Crown for the construction in the southern part of the site of a nine-hole golf course. This use was continued until 1986 when the lease expired. Little evidence of this past use can now be seen with the exception of a tee fortified by a retaining wall and a concrete slab that may have been a maintenance shed. There is a proliferation of large numbers of Slash Pine (*Pinus elliotii*), reputedly planted originally in small numbers, which have compounded problems on the old golf course site.

With the exception of the southern portion of the site, European settlement has not had a major impact on the immediate site. Housing development and new roads have fragmented vegetation. Some environmental weeds are present that may have originated from home gardens (via garden waste dumping and birds transporting seeds), feral animals and free roaming domestic animals are likely present. A natural drainage line slightly to the north of the main fire trail was enhanced during construction of the Coast Road but water flow is ephemeral and the drain appears to have little impact. A culvert to the south of the main fire trail appears to have either created or enhanced the Sedge / wetland zone west of the Coast Road in that area.

2.7 Fire History

The area has been burnt extensively only twice in the last thirty years. In 1969 a fire burnt out the entire area. This fire started north (Lennox Heath) of the present site before extensive development took place. A second fire burnt out part of the site in the early 1980's. This fire was less extensive and was apparently limited to the south/south-eastern area of the site. Some small fires have occurred in the ensuing years in the vicinity of Lee Street but were quickly contained.

3. STAKEHOLDERS / CURRENT USERS

3.1 Local indigenous communities

It has been established that the site (particularly the southern portion) has high cultural significance to local indigenous communities. As well as the massacre site it has been reported that there are features associated with local mythology present in this zone. Negotiations are being undertaken between the Jali Land Council and the Department of Infrastructure, Planning and Natural Resources (formerly DLWC) to protect the most culturally important area from future development.

3.2 East Ballina Landcare Group

The East Ballina Landcare Group has commissioned this plan in the interests of maintaining, to the extent possible, the natural biophysical attributes that currently exist. The group has removed dumped rubbish (including refrigerators) and have been consistently carrying out weed control with the labour assistance from programs such as Green Corps.

3.3 Neighbouring Residents

Neighbouring residents value the bushland for the green buffer it affords from nearby development but are, at times, concerned about the inherent fire danger.

3.4 Walkers

The only route through the site is in the vicinity of the old golf course from Manly Street to the Coast Road. This route appears to be well used by recreational walkers as well as trail bikes and 4WD vehicles. There is no defined route and vehicle use has led to degradation. A number of local residents have expressed a desire to have more routes available to allow them direct access to the beach but it is felt by the author that these may lead to a greater fire risk and potential damage to relatively pristine sections of bushland.

The fire trail that meanders west from the Coast Road offers the opportunity to observe seasonal displays of wildflowers and is of a suitable gradient and width to accommodate small parties of enthusiasts. Vehicle access to this track has recently been restricted by the installation of a lockable barrier.

3.5 Bird watchers

Local birdwatchers frequently visit the area and have produced substantial records of the bird life observed within the site (Appendix 6). If infrastructure such as viewing platforms or improved access were to be considered it would become possible to utilise elevated vantage points from where a variety of vegetation can be seen.

3.6 Bush fire brigade

Emergency vehicular access should be maintained on the current fire trails to facilitate control of wild fire. It is likely that the local branch would have in place a Fire Control Plan for this site. Officers from this department should consult with all land managers including the Landcare group before carrying out any hazard reduction works. Predictions on the likely effect of fire on the site are detailed within this report.

3.7 National Parks and Wildlife Service

The local office of NSW NPWS (Alstonville) should be contacted if threatened species are located or aboriginal artefacts found. Do not move these and keep location secure from the general public.

3.8 Department of Infrastructure, Planning and Natural Resources (DIPNR)

DIPNR are the Trust Managers for Crown land. They should be kept informed of activities proposed by the Landcare group, and permission sought before undertaking any major works.

4. SITE ASSESSMENT

4.1 Flora Assessment Methods

Site inspections were conducted on a number of occasions through the later part of 2002 and early 2003. These were carried out on foot and then aerial photos were used to determine the extent of dominant communities and to prepare maps.

Some areas of the site are very difficult to access due to the density of the vegetation. All plant species encountered were recorded. Additional species identified at a later date should be added to the flora list. Many of the heath plants are difficult to identify until in flower and so it is suggested that further surveys be carried out during the spring in future years, to complete the species list.

The species list contained within this report (Appendix 1) includes plants recorded in surveys carried out by Semmac Environmental Consultancy (East Ballina Crown Lands Assessment 1996) and by East Ballina Landcare Inc. Where the previous identification of a species is doubtful (i.e outside its normal range, easily mistaken) it has been corrected or omitted.

A number of guides were used for identification, a list of which appear in Section 9 of this report. The overall vegetation has been described on a plant community basis and where conspicuous, by species associations. The vegetation associations that appeared in the East Ballina Crown Lands Assessment are very thorough and appear little changed since they were recorded, consequently they have been used in this report with additional notes where appropriate

4.2 Fauna Assessment Methods

While this report concentrates primarily upon flora, it appears appropriate to utilise the comprehensive fauna records that the Landcare group has developed. Fauna species recorded within this report are primarily compiled from the observations of local bird watchers and is supplemented by species identified in the East Ballina Crown Land Assessment and species encountered during the authors field work on the site. Like the flora lists, those of fauna will hopefully grow with further observation.

5. VEGETATION DESCRIPTIONS

Descriptions within this section are based in part on those compiled by Professor Peter Baverstock of Southern Cross University.

The site contains five different vegetation communities

- Wallum Heath
- Vine Thicket
- Sedgeland
- Wetland; and
- Disturbed (revegetated area)

Plate 1: The vegetation of the site forms a complex mosaic.

5.1 Community 1: Wallum Heath

The Wallum Heath covers a large proportion of the site and characterises the undisturbed ridges and slopes to the north/north east. The structural composition, distribution and dominance of this community varies over the site, and is influenced by factors such as slope and aspect.

The height of the understorey is approximately 0.5 – 2 metres on top of the ridges, and approximately 2-3 metres in the more protected gully areas to the north. There is a wide diversity of typical heath species with Wallum Banksia (*Banksia aemula*) dominant. Emergent trees including Pink Bloodwood (*Corymbia intermedia*), Brushbox (*Lophostemon confertus*), Coast Banksia (*Banksia integrifolia*) and occasional Hard Corkwood (*Endiandra seiberii*). These emergent trees reach approximately 3-5 metres in height throughout this community.

The areas adjacent to the main fire-trail have the highest diversity and very few weeds are present with the exception of a few Umbrella trees (*Schefflera actinophylla*). Weed problems increase as you head down the gullies with Ground Asparagus (*Asparagus aethiopicus*) becoming more common as an understorey species. This pest species disappears as the sedgeland is encountered.

Plate 2: An example of heathland in Zone 4B

5.2 Community 2: Vine Thicket

Vines appear sporadically throughout the site, notably in gaps and edges. They play an important role in providing wind protection and unless overwhelming a desirable species should be left intact to provide protection for avifauna.

The highest concentration of vines is seen on the western edge of the site at Lee Street. Species observed were a mix of native and exotic and differ slightly from those reported in the East Ballina Crown Land Assessment. For example, *Smilax australis* is present but not *Smilax glyciphylla*. The structure of the vine thicket, though containing exotics, provides an important buffer from the adjacent urban area and still has habitat value.

Plate 3: Area 5B. Vine thickets occurs mainly on edges of the site. Madeira Vine in the canopy.

5.3 Community 3: Sedgeland

These sedgelands are indicative of low lying areas subject to occasional inundation. They are a companion community to the classically defined wetlands (dominated by *Melaleuca quinquenervia*). There is little disturbance seen within this area.

A myriad of animals tracks (scats indicate a substantial population of swamp wallabies) are apparent. The lack of weeds is due to their inability to secure a foothold in the specialist environment of waterlogged, acidic soil. Little disturbance means there are few available bare areas for weeds to become established.

The greater part of the sedgeland supports dense colonies of Pouched Coral Fern (*Gleichenia dicarpa*). This is waist deep and so dense that access can only be achieved by following wallaby trails. Emerging amongst this dense colony are rush like plants *Gahnia sieberiana* and *Restio tetraphyllus* ssp. *meiostachyus* and a variety of other ferns.

Where the ground rises slightly, Leptospermums are encountered and then copses of mixed forest containing Swamp Mahogany (*Eucalyptus robusta*), Brush Box (*Lophostemon confertus*) Swamp Box (*Lophostemon suaveolens*), Pink Euodia (*Melicope elleryana*) and Paperbark (*Melaleuca quinquenervia*).

Recent exploration of this area, accompanied by a Council intern, may result in it being included within the current SEPP14 wetland. The whole area is subject to seasonal inundation. Sedgeland is a community that depends upon seasonal inundation and is well equipped for long periods of flooding.

Plate 4: Sedgelands in Zone 4B featuring dense colonies of Pouched Coral Fern.

5.4 Community 4: Melaleuca Wetlands

The Melaleuca wetland covers an area to the south-west of the site and another, unconnected area along the north-western boundary of the site. In the north-west the wetland is bordered by a waterway which runs along the edge of the site (Semmac Environmental, 1996).

Land where *Melaleuca quinquenervia* dominates is currently protected by SEPP14 but as discussed previously in section 5.3 – Sedgelands, the line on the map containing this community may be shortly expanded to include related wetland ecosystems that are considered equal in value.

In the areas where Melaleuca dominates, they appear in good health with a canopy height estimated at 15-20m. Associated upper storey species consist of Bangalow Palms (*Archontophoenix cunninghamiana*), Tuckeroo (*Cupaniopsis anacardioides*), Blue-Berry Ash (*Elaeocarpus reticulatus*), Brushbox (*Lophostemon confertus*), Sally Wattle (*Acacia melanoxylon*), Pink Euodia (*Melicope elleryana*) and Swamp Box (*Lophostemon suaveolens*). Beneath this canopy, juveniles of the upper community are found as well as vines, ferns and rushes. Some exotic species are seen including Umbrella Tree (*Schefflera actinophylla*) and Winter Senna (*Senna pendula* var. *glabrata*).

The south-western wetland contains the endangered orchid species *Phaius australis* but in recent times this has been substantially damaged through illegal poaching.

Plate 5: The Threatened orchid species *Phaius australis.*

5.5 Community 5: Disturbed (Revegetated Areas).

The disturbed (revegetated area) covers a large area to the south/south-west of the site. This vegetation community has been cleared in the past and the area used as a golf course. The existing vegetation consists entirely of regrowth.

It is characterised by the introduced Slash Pine (*Pinus elliottii*) and endemic Sand Cypress (*Callitris columellaris*). The height of the canopy is up to 30 metres tall, the midstorey 2-10 metres and the understory (groundcovers) 0.5 metres.

Within the study site this zone has the highest incidence of weeds. The slash pine is the most conspicuous. Many groundcover species were observed, some introduced by garden waste dumping and others by birds. Of the whole 57 hectares this zone will be the most resource consuming to rehabilitate.

Plate 6: The disturbed area (formerly a golf course) a heavy understory of Ground Asparagus can be seen in this photo.

6. MANAGEMENT STRATEGY AND ACTIONS

6.1 Restoration Works

It is envisaged that the work recommended in this plan could be undertaken by a combination of East Ballina Landcare, Ballina Shire Council, Green Corps, Work for the Dole teams, local schools (including Southern Cross K12 School) and EnviTE bush regenerators.

The site has been separated into 19 work areas (Map 4). A summary of recommended works for each area and general recommendations that are applicable to all areas are outlined in Tables 6.2, 6.3 and 6.4**.** Recognised weed treatment methods are described in Appendix 4. Specific treatment methods recommended for each of the weed species encountered at the East Ballina site are outlined in Appendix 5. A list of suggested tools and equipment is included in Appendix 6.

The sequence of the proposed works is based upon the urgency to retain certain types of degradation, seasonal weather conditions, provision of follow-up maintenance, and ability for areas to naturally regenerate after initial treatment. It is strongly recommended that this sequence be adhered to. This will ensure that there is no reinfestation of weeds in treated areas that may be more aggressive than those eradicated and to reduce the detrimental effect of wind and sun exposure.

The project will take some years and considerable labour to complete. Some of the areas need extensive work, others little. While initial works will be intense, maintenance time will reduce, until follow-up is required which will be minimal. The process of restoring this unique piece of bush will be rewarding for current and future generations as well as wildlife. The longer problems are left unaddressed the more degraded the site will become.

The zone numbers allotted to the different sections of the site are not necessarily the priority in which to address the work. For ease of mapping the descriptions begin with area 1 as the northern extreme of the site and then progress as encountered to the south. Recommendations and suggested sequence of work is presented in Table 6.2.

Plate 7: A weed free woodland between areas 4B and 5C.

6.2 Site analysis and recommendations East Ballina 57Ha

To be read in conjunction with zone map

Site description and problems	Recommendations	Priority	Timeframe
1A. Edge of the Coast Road & north-eastern end of Bellevue Ave fire trail. Medium density weeds on edge consisting mainly of Lantana and Bitou Bush, these are playing a role in excluding wind, exotic grasses, weed seed and pedestrians.	• Stage removal slowly beginning with those exotics that are in direct competition with a more desirable species that will fill the gap in edge. • Survey edge for major weed inroads and prepare suitable stock for planting in these areas following weed removal.	Low Low	Within 5 years Within 5 years
1B. North-western end of Bellevue Avenue fire trail. Some dumping of garden refuse on this edge has introduced exotic species to the heath. A growing infestation of Ground Asparagus is seen beneath *Banksia aemula* for some distance back into the heath, access is difficult.	• Remove refuse, engage Council to assist if large amounts, spray established garden escapes. Talk to residents regarding this practise. • Spray full extent of Ground Asparagus using Brushoff® and marker dye. Monitor and follow up.	Medium High	Within 12 months ASAP
1C. North-western edge to path intersecting wetland. Although a portion of this zone is beyond the boundaries of the 57Ha it should be addressed or it will reinfest treated areas. Weeds heaviest on edge of path, reduces as wetland further penetrated. Some significant mature trees seen here.	• Obtain permission of land managers to work on this edge. • Inject Umbrella trees, C,S,P Lantana and woody weeds, scrape and paint or spray exotic vines. • Post permanent sign at path to inform public of project and to recruit new members.	Medium Low Low	Within 12 months Within 5 years Within 5 years

1D. Core of northern section. Well vegetated and undisturbed, isolated Umbrella trees and patches of Lantana, the greatest threat is Ground Asparagus spreading from beneath perch trees.	• Sight largest trees from distance, take compass bearing and proceed to spray Asparagus and other weeds encountered. • Inject Umbrella trees as encountered.	High Medium	ASAP Within 12months
2A. Eastern end of drain. Disturbed soils and stormwater likely to have introduced weed seed.	• Retain Lantana on roadside edge if needed as barrier, treat weeds encountered as far as ingress noted.	Medium	Within 12 months
2B. Natural drainage line. Weeds reduce as undisturbed sedge land penetrated.	• Treat weeds as encountered, should only be very minor incidence.	Low	After addressing 2A
3A. Start of fire trail. Some weeds at this point currently being addressed by EBLCG, includes Madeira vine. Weed incidence rapidly reduces as heath penetrated.	• Continue follow up treatments on Madeira vine. • Propagate and plant fast growing species such as Phebalium squameum to re-establish canopy.	High Medium	In progress Within 2 years
3B. Southern side of fire trail. Fully occupied by diverse heath there are very few disturbed areas and consequently no weeds.	• Enjoy! Use to inspire Landcarers and to promote related activities.	Complete	Complete
3C. Northern Side of fire trail. Very good heath with occasional Umbrella trees the only evident problem.	• Seek out and treat any projecting Umbrella trees. • Check under perch trees and treat asparagus if located (particularly on edge of 2B).	Medium High	In progress ASAP
3D. North-western edge of zone 3. Some exotics encountered on edge but these reduce rapidly on eastern side of small creek. Some sympathetic tree planting has been carried out by residents on edge of recreation area.	• Light treatments will quickly reduce incidence but beware of making too inviting for pedestrian access. • Post permanent sign at recreation area to inform public of project and to recruit new members. Residents may take on stewardship of this area once trained.	Low Medium	Within 5 years Within 12 months

4A. Low area off road reserve, eastern end of sedge land. Heavy Lantana and Madeira Vine. Problems reduce quickly as sedgeland entered. Sunflowers colonising edge. This area has a high public profile in relation to Landcare activities, consequently it should demonstrate a high degree of commitment from the group. A good position for explanatory signage.	• Cut up Lantana, paint stumps and monitor for natural regeneration. • Follow up weed treatments regularly. • If natural regeneration not occurring, plant with fast growing pioneer species such as Brown Kurrajong, Phebalium and Sally Wattle to establish canopy • Cut flowering heads off sunflower before seed set	High After above treatment After above treatment Medium	ASAP Twice a year, late summer and spring After 6 months Annually in May
4B. Sedgeland. A specialised environment and dense vegetation has excluded all weeds from this zone. No problems apparent, difficult to access.	• Does not require any works.	Low	Monitor for change
4C. Edge of sedgeland. Vines and Lantana restricted to urban edges offer some habitat and exclude people and domestic animals from sedgeland. Some exotics present but not considered aggressive.	• Retain this as a buffer. • Survey for aggressive exotic species that could potentially spread (such as Glory Lily or Asparagus) and treat these.	Low Medium	Replace with natives if desired. Within 2 years
5A. Eastern edge of old golf course site. Mixed Callitris, Slash Pine and heath species, Lantana, Senna, Bitou Bush, Umbrella tree, Madeira vine and increasing patches of Ground Asparagus. Camphor laurel on road edge.	• Involve a Green Corp team or similar to sweep through this area treating weeds as encountered. Cut down or stem inject pines. • Spray Asparagus with Brushoff® • Monitor area and carry out follow-up treatments. • Fell camphor rather than stem inject because of public hazard of dead tree.	Medium Medium When previous work is complete Prior to fruit set	Within 2 years Within 12 months Annually Within 12 months

5B. South-eastern edge of old golf course site. (Cronulla St entrance). Highly disturbed with rubbish dumping, Madeira Vine and uncontrolled vehicle access. Callitris stands with Asparagus beneath, Pines and Asparagus increase as heading towards Links Avenue.	• Address Zones 1,2,3,4 before beginning work here.	Low	Within 5 years
	• Treat Madeira Vine through spraying and scrape and paint, monitor following treatment for at least 10 years.	Medium	Within 2 years
	• Spray full extent of Ground Asparagus using Brushoff®, surfactant and marker dye. Monitor and follow up.	Low	Within 5 years
	• Involve a Green Corps team or similar to sweep through this area treating weeds as encountered, start from high ground working downhill. Cut down or stem inject small to medium pines. Retain Bracken.	Low	Within 5 years Within 4 years
	• Propagate Callitris for planting in large bare areas.	Low	
	• Large pines could be considered for stem injection but not in locations where falling branches may endanger public, these may have to be felled by a licensed tree lopper (resultant mulch may help cover costs). If possible removal is staged with female trees in close proximity to more desirable species removed first.	Low	Within 5 years Within 5 years
	• Plant Callitris where needed, the project should aim to extend the Callitris forest to replace Pine.	Low	Within 5 years

	• Experiment with "smudge piles" (small contained smokey fires) to stimulate regeneration.	Low	
5C. Northern edge of old Golf Course Site. Similar mixed Callitris and Pine as described in Zone 5B. Heavy Ground Asparagus encountered but decreases as approaching Zone 4B and Zone 6.	• Address Zones 1,2,3,4 before beginning work here. • Start work from east to west along boundary of 4B to increase width of weed free buffer. • Spray full extent of Ground Asparagus using Brushoff® and marker dye. Monitor and follow up. • Involve a Green Corp team or similar to sweep through this area treating weeds as encountered, start from high ground working downhill. Cut down or stem inject small to medium pines. Retain Bracken. • Propagate Callitris for planting in large bare areas • Large pines could be considered for stem injection but not in locations where falling branches may endanger public, these may have to be felled by a licensed tree lopper (resultant mulch may help cover costs). If possible removal is staged with female trees in close proximity to more desirable species removed first. • Plant Callitris where needed, the project should aim to extend the Callitris forest to replace Pine. • Experiment with "smudge piles" (small contained	Low Medium Low Low Low Low Low Low	Within 5 years Within 2 years Within 5 years Within 5 years Within 4 years Within 5 years Within 5 years Within 5 years

	smoky fires) to stimulate regeneration.		
5D. South-western corner of old Golf Course site. This zone has solid stands of Callitris but also the highest incidence of environmental weeds of the whole study site. Of particular concern are a number of groundcover species including Peperomia and Tradescantia that have completely suppressed any natural regeneration. This area will require long term treatment but will play an important role by removing the source of potential further weed invasion to less degraded areas. The track through this area is widely used by walkers and at times trail bikes. Many smaller tracks branch from it leading nowhere. If a main track can be defined it would be desirable to close off side tracks to prevent surreptitious dumping and further weed spread.	• Starting from Links Avenue, spray out groundcovers. • Manually remove and bag Climbing Cactus. • C,S,P Senna and other woody weeds. • Meet with Land Managers to discuss future of tracks. Retain walking track but prevent motorbikes and vehicles if possible. • Raise community awareness of project objectives.	Medium High Low Medium Medium	Within 3 years Within 12 months Within 5 years Within 2 years Within 2 years
Zone 6. Links Avenue Wetland. A high diversity of significant trees including threatened species. Weedy on the edges and native vines cover some trees. Part of the wetland is outside the boundary of the 57Ha but for the sake of effective management the whole area should be treated as a single unit.	• Carry out assessment of wetland health using methodology developed by Southern Cross University. • Gain permission to work on outside area from Land Managers • Begin works from edges of 5B and 5C to retain wind protection. • Treat weeds as encountered but retain barriers on edges to deter pedestrians and orchid poachers.	Medium High Low Low	Within 2 years Within 12 months Within 5 years Within 5 years

6.3 Summary of priorities and implementation timeframe

High priority

Zone	Recommendation	Timeframe
1D	Sight largest trees from distance, take compass bearing and proceed to. Spray Ground Asparagus and other weeds encountered**.**	ASAP
3C	Check under perch trees and treat Ground Asparagus if located (particularly on edge of 2B).	ASAP
1B	Spray full extent of Ground Asparagus using Brushoff® and marker dye. Monitor and follow up.	ASAP
4A	Treat weeds, install signage maintain in good order.	ASAP

Medium priority

Zone	Recommendation	Timeframe
1B	Remove refuse, engage Council to assist if large amounts, spray established garden escapes. Talk to residents regarding this practise.	Within 12 months
2A	Retain Lantana on roadside edge if needed as barrier, treat weeds encountered as far as ingress noted.	Within 12 months
1D	Inject Umbrella trees as encountered.	Within 12 months
1C	Obtain permission of land managers to work on this edge.	Within 12 months
5D	Manually remove and bag Climbing Cactus.	Within 12 months
6	Gain permission to work on outside area from land Managers	Within12 months
5A	Spray Ground Asparagus with Brushoff®	Within12 months
3A	Propagate and plant fast growing species such as *Phebalium squameum* to re-establish canopy.	Within 2 years
6	Carry out assessment of wetland health using methodology developed by Southern Cross University.	Within 2 years
5D	Meet with Land Managers to discuss future of tracks. Retain walking track but prevent motorbikes and vehicles if possible.	Within 2 years
5D	Raise community awareness of project objectives.	Within 2 years
5C	Start work from east to west along boundary of 4B to increase width of weed free buffer.	Within 2 years
5A	Involve a Green Corp team or similar to sweep through this area treating weeds as encountered. Cut down or stem inject pines.	Within 2 years
4C	Survey for aggressive exotic species that could potentially spread (such as Glory Lily or Ground Asparagus) and treat these.	Within 2 years
5B	Treat Madeira Vine through spraying and scrape and paint, monitor following treatment for at least 10 years.	Within 2 years
5D	Starting from Links Ave spray out groundcovers.	Within 3 years

Low priority

Zone	Recommendation	Timeframe
5B	Propagate Callitris for planting in large bare areas	Within 4 years
5C	Propagate Callitris for planting in large bare areas	Within 4 years
1A	Stage removal slowly beginning with those exotics that are in direct competition with a more desirable species that will fill the gap in edge.	Within 5 years
1A	Survey edge for major weed inroads and prepare suitable stock for planting in these areas following weed removal.	Within 5 years
1C	Inject Umbrella trees, C,S,P Lantana and woody weeds, scrape and paint or spray exotic vines.	Within 5 years
1C	Post permanent sign at path to inform public of project and to recruit new members.	Within 5 years
3D	Light treatments will quickly reduce incidence but beware of making too inviting for pedestrian access.	Within 5 years
5B	Address Zones 1,2,3,4 before beginning work here.	Within 5 years
5B	Spray full extent of Ground Asparagus using Brushoff® and marker dye. Monitor and follow up.	Within 5 years
5B	Involve a Green Corp team or similar to sweep through this area treating weeds as encountered, start from high ground working downhill. Cut down or stem inject small to medium pines. Retain Bracken.	Within 5 years
5B	Large pines could be considered for stem injection but not in locations where falling branches may endanger public, these may have to be felled by a licensed tree lopper (resultant mulch may help cover costs). If possible removal is staged with female trees in close proximity to more desirable species removed first.	Within 5 years
5B	Plant Callitris where needed, the project should aim to extend the Callitris forest to replace Pine.	Within 5 years
5B	Experiment with “smudge piles” (small contained smoky fires) to stimulate regeneration.	Within 5 years
5C	Address Zones 1,2,3,4 before beginning work here.	Within 5 years
5C	Spray full extent of Ground Asparagus using Brushoff® and marker dye. Monitor and follow up.	Within 5 years

5C	Involve a Green Corp team or similar to sweep through this area treating weeds as encountered, start from high ground working downhill. Cut down or stem inject small to medium pines. Retain Bracken.	Within 5 years
5C	Large pines could be considered for stem injection but not in locations where falling branches may endanger public, these may have to be felled by a licensed tree lopper (resultant mulch may help cover costs). If possible removal is staged with female trees in close proximity to more desirable species removed first.	Within 5 years
5C	Plant Callitris where needed, the project should aim to extend the Callitris forest to replace Pine.	Within 5 years
5C	Experiment with “smudge piles” (small contained smoky fires) to stimulate regeneration.	Within 5 years
5D	C,S,P Senna and other woody weeds.	Within 5 years
6	Begin works from edges of 5B and 5C to retain wind protection.	Within 5 years
6	Treat weeds as encountered but retain barriers on edges to deter pedestrians and orchid poachers.	Within 5 years

6.4 General Vegetation Management Recommendations

- Keep local residents informed through public information campaign and encourage support. Local business may contribute to costs and can be provided with recognition and publicity of their contribution.
- Work zones systematically, treating weeds as they are encountered in accordance with the specific methods described in Appendix 4. Once an area is treated, workers can move onto the next. It is a good practice to review worked areas prior to commencing work in the current area on each workday, so that regrowth and other problems can be treated immediately and follow-up maintenance is reduced.
- Retain Bitou Bush and Lantana to the east of worked areas if they are providing shelter for regeneration areas and plantings behind.
- Maintain previously worked areas by spraying or hand weeding. Avoid creating piles as these are troublesome later, it is better to cut up material and scatter.
- When breaking new ground always consider what resources are available for follow-up treatments. If you have a team at your disposal confine their activities to an area that they can treat thoroughly or maintenance may become overwhelming. Discuss these limits, objectives and desired results openly with the team as well as the team supervisor to establish a common picture of what needs doing; this will lead to greater mutual satisfaction as well as more effective primary treatment.
- It is recognised that the volunteer time the principal Landcarers have available for this project is limited. This time is best spent in low volume but frequent application of targeted herbicide, monitoring, and coordination of the available labour market programs that offer their services. Volunteer work should not become onerous.
- The continued and increased use of volunteers in rehabilitation activities will be encouraged.
- Seed of desirable species should be collected when available (December, January for *Banksia integrifolia*, *Acacia sophorae* and *Cupaniopsis anacardioides*). Refer to EnviTE publication *Coastal Plant Propagation Manual* for equipment and methodology. If the group does not have propagation facilities available contact EnviTE to take delivery of this seed for propagation on a cost recovery basis.
- Weed management programs should take into consideration retention of native animal habitat and erosion management strategies.

6.5 Natural regeneration

Adherence to the recommendations in Table 1 should result in the following sequence of recovery. If this sequence of events is not noted, regeneration activities have not been successful and techniques used may need to be modified or improved.

1. Sprayed areas of weeds will yellow and die, which will allow more physical space for existing native vegetation to expand and for plantings to be undertaken. Woody dead material such as Lantana or Bitou Bush should be broken up by stamping or chopping otherwise it will harbour weed seedlings.
2. Green trash, that has been evenly chopped up and left on the ground, will break down and form a moisture retentive mulch (weeds must not be piled up). Aerial vines, that have been severed and left in trees, will deteriorate, so that light is slowly increased allowing plants beneath to acclimatize to increased levels of light and salt. Don't pull vines or material, such as Morning Glory or Bitou Bush, from trees, cut at head height to allow maintenance egress and allow to fall apart insitu.
3. Plantings are most successful in late summer/autumn (when local rain likely), new plants should be watered at planting and heavily mulched, provide wind protection in exposed situations. These will gather impetus and, within a three to four year period fill gaps in canopy and edge. With the resultant decrease in light, germination of weeds in these areas should diminish.

6.6 Revegetation

Plant Selection Guidelines

Most areas of the East Ballina site have a high potential to naturally regenerate with the exception of highly disturbed sands amongst the Pine forest. Areas cleared of Pine may need to be planted with endemic replacement species. Care should be taken to use appropriate species that has been grown from seed collected nearby (refer to the plant propagation publications in section 7). Nursery propagated material of uncertain origin should not be used. Many species, such as *Banksia integrifolia*, have a very broad geographic range but genetic differences are found across this range. Trees found on the site have adapted to the specific conditions that occur at East Ballina.

The introduction of species that would not naturally occur on this site is not recommended. This can be detrimental to the ecological functions of the vegetation community. If the aims of the restoration project are to facilitate the establishment of the pre-existing vegetation, then planting trees that do not belong will detract from achievement of this aim.

6.7 FIRE

6.7.1 The implications of fire at the East Ballina study site

The vegetation of the 57 Ha site is highly prone to future fire. This is an inherent feature of this type of system where many of the sclerophyll species present contain volatile oils. This "desire to burn" is a result of specialised adaptation to acidic sandy soils with low available nutrient content. Fire is a means to recycle nutrient locked up in plant material in the form of ash. While some nutrient input occurs as a result of fire, Nitrogen is lost. Epicormal growth on plants sprouting after fire is often very yellow which is a symptom of this. Nitrogen is reintroduced through fixation from the atmosphere and a recovery of vigorous micro-organisms.

The plants of the heath community are particularly well adapted to infrequent fire. There are three primary methods utilised by these specialists to recover after fire.

- Some will hold seed tightly encased in fruit only to be released after fire on the resultant nutrient rich bed that is free of competition. The parent plants in this situation are likely to be destroyed but germinating seed will ensure the species is again represented. Amongst this group are *Callitris columellaris, Callistemon pachyphyllus* and *Petrophile canescens.* Conspicuous in its absence on the site (but found nearby) is *Banksia ericifolia*, this species belongs to the above group but may have been destroyed by fires in quick succession that destroyed juvenile trees before they reached fruiting age, it would be appropriate to reintroduce the species on wet heath edges.

- The second primary method used for recovery is the utilisation of adventitious buds that are held in check by chemicals produced in foliage. When the foliage is removed (by fire or physical damage) these buds are free of their chemical inhibitors and can sprout in the form of epicormal buds (from trunk or branches) or from lignotubers (similar buds arising from roots). Species employing this method include *Corymbia intermedia, Lophostemon confertus, Xanthorrhoea* sp, *Banksia aemula* and *Lomandra longifolia.* Some species use this and the method described above.

- A third method is where plants may disperse long-lived seed that will not germinate until released from dormancy by heat and the chemicals found in smoke.

There is little dispute that fire is an essential element in a self-perpetuating heathland but difficulties arise in determining the ideal frequency of fire and the intensity required. If fire is excluded from the system some species will decline and a lack of heath diversity will result. In some cases this may lead to a succession from this vegetation type to another.

Commonly seen on the north coast is where a sclerophyll community that has not burnt for a long time will start hosting rainforest species (which are fire sensitive). Over time rainforest species may dominate the sclerophyll population forming a canopy under which few heath species can germinate. These are both important communities but the land manager may be forced to make decisions based on habitat values for threatened species including mammals and avifauna. An example of this is

seen at Wilsons Nature Reserve (Lismore), where through lack of fire, eucalypts have stopped germinating, rainforest is succeeding and koalas find it more difficult to access food.
Another possible scenario is where a particular species present such as *Banksia serrata* grows tall enough, through prolonged lack of fire, to be beyond the reach of low intensity fires. As this community expands it may lead to development of sclerophyll woodland rather than heath.

If fire is too frequent, again diversity will suffer with some species not having enough time to restore regenerative mechanisms.

6.7.2 How the season can influence fire impact on vegetation

(from Water and Rivers Commission Western Australia).
Inappropriate timing of fires can result in the loss of seed stocks or mature plants.
Autumn burns tend to be hot, intense and fast moving with a long duration. As a consequence, native fauna mortality rates may be high. Autumn burning is suggested for most regeneration burns and is particularly useful for wattle or pea "thickets".

Winter burns have a low intensity and short duration and may produce a "patchy" result, leaving some areas unburnt. Winter burning will disrupt the seeding and flowering of some plants species and the breeding cycle of certain species of native fauna. Winter burning is not recommended for regeneration burns.

Spring / Early Summer burns are of low to moderate intensity and will often leave some patches of native vegetation unburnt. Fires that occur at this time of year may lead to the erosion of topsoil including seed and nutrients. Burning too early should be avoided as this will result in the loss of the current seed crop of many native plant species. Surface seed germination is stimulated by a fire at this time of year, however it will not result in the germination of buried seed as seed dormancy will not be overcome by a fire of this intensity. A significant disadvantage of fire occurring at this time of year is that it may increase insect and fungal attack on seeds.

6.7.3 Response of the wetland and sedgeland to fire

Material seen in the wetlands of East Ballina is also highly volatile (depending on level of inundation), but like heath has mechanisms that will help it recover after fire. *Melaleuca quinquenervia* has epicormal buds that will sprout from trunk and branches following defoliation while many of the sedges and ferns present have underground rhizomes from which new growth will arise. These communities will recover from fire as long as it is not too frequent. Many species of environmental weed are favoured by fire and regeneration must be monitored closely to ensure these species do not prevail in the recovering landscape.

As an example of species sensitivity to high frequency of fire consider the wet heath *Banksia ericifolia* which is conspicuously absent at the study site. Fires of low intensity kill this species but if bearing fruit at the time will release seed from which the next generation can arise. It will take about 5 years for these plants to mature to seed production age. If another fire occurs within this time, the species is lost from the area. Mature specimens of this species are found near to the East Ballina site and it would be desirable to reintroduce them as seedlings.

6.7.4 Advantages and Disadvantages of fire in wetland systems

(from Water and River Commission Western Australia).

Advantages Fire may:

- May trigger seed release and germination in some species;
- Stimulates the development of new green shoots, roots and rhizomes of grasses and sedges producing a food source for waterbirds such as ducks and geese;
- May create pools for nesting and feeding waterbirds; and
- Can provide favourable habitat for some waterbirds by eliminating impenetrable growth of plants such as sedges, rushes and bullrushes.

Disadvantages Fire can lead to:

- loss of seed as a consequence of inappropriate timing of fires;
- degradation or loss of peat soils (organic-rich soils);
- increased predation of seed by insects;
- fungal attack on seeds;
- changes in vegetation composition and structure;
- exposure of roots and rhizomes;
- loss of vegetation, resulting in reduced biofiltering of incoming surface water flows;
- erosion of soil and increased turbidity in wetlands;
- increased weed invasion;
- destruction of fauna habitat and shelter;
- death of fauna; and
- a increase in water temperature, loss of vegetation and shade, this can initiate algal blooms occurring.

6.7.5 The effect of fire on heath fauna

Unlike plants, animals lack special adaptations to survive fire. At best they avoid burning by seeking shelter from the heat or by running from the flames. Despite this simple response, surprisingly large numbers of animals survive even the hottest burns.

After burning, a heath is devoid of foliage and there is little cover or food. Mortality may be high, both from burning and starvation (+ predation from the air), but as the heath sprouts and grows it is rapidly repopulated (Recher, H. 1981).

Fire, through its ability to change vegetation composition, will change the suitability of the community for some fauna species. Banksia nectar, which is an important food resource during the winter, may be absent until the trees sufficiently regenerate. Lack of fire may, over the long term, be to the detriment of some species, particularly those that inhabit the ground stratum. As a canopy of larger trees and shrubs develop, light is excluded and the understorey and specialist habitat for wrens and quail is reduced.

Fauna that inhabit heath must also be able to deal with fire. To these creatures advantage, is that heath tends to be quite patchy. In suitable regions unconnected heath can be found spread over large areas providing opportunities for species to migrate from an area fire effected to one that's not. Frith (1979) demonstrated that in Australia no mammal is confined to heath. The species that inhabit heath are likely to be found in greater numbers in woodland. Heath is recognised as an important seasonal resource and habitat.

Populations of small mammals present during a fire event may be decimated depending on the intensity and "patchiness" of fire as well as seasonality in regard to breeding times. The ability of these mammals to repopulate the area after fire is reliant on these factors as well as proximity to undisturbed areas. Scats of swamp wallaby (*Wallabia bicolor*) have been observed at the East Ballina study site. If they were able to flee a fire their population would likely grow in the following months due to an abundance of fresh pick and lack of major predators such as the dingo.

6.7.6 Hazard reduction

Scientists present at a Coastal Heath conference held at Kurin-gai Chase National Park in 1980 queried the concept of deliberate manipulation of heaths, particularly by fire, in order to 'maximise' diversity of species and/or structure. They agreed that many fires were unscheduled and, although it was reasonable to undertake hazard reduction burning to make wildfires less frequent and easier to control (with a view to property protection), it was unsound to argue that hazard reduction burns should be undertaken to increase diversity. There was no evidence that the combination of wildfires and necessary hazard reduction burns did not provide a sufficient mosaic of vegetation age classes. The scientists also argued that there was a real risk that additional fires would result in habitat simplification in the medium term. (Pettigrew, 1981).

Burning to reduce fuel loads in proximity to homes is not recommended at East Ballina as it is believed by the author that fire in this volatile environment will be difficult to control. Fuel loads will only be temporarily reduced before pioneer species (often more volatile) will quickly re-establish. Physical management of vegetation near houses will be more appropriate. This entails the maintenance of fire breaks at Bellevue Avenue and, if necessary, the removal of garden waste such as lawn clippings and palm fronds from these areas.

6.7.7 Response of weeds to fire

(originally from Rosemary Joseph TAFE Bush Regeneration course notes)

- Crofton weed – does not burn easily. Re-shoots from the base after a low intensity fire.
- Mist Weed – As above.
- Bitou Bush – Seed germinates after fire.
- Camphor Laurel – Re-shoots from the roots and can form multiple stems.
- Fabaceae – Includes Senna and Siratro – seeds will germinate readily.
- Glory Lily – Re-sprouts from underground parts and seeds germinate profusely.
- Lantana – Burns readily but re-shoots from base.
- Asparagus Ferns – will re-shoot from crown.
- Wild Tobacco – re-shoots from the base and the seeds germinate.

Grasses (both native and exotic) will proliferate after fire depending on the amount of shade left after the burn.

6.8 OTHER ISSUES

6.8.1 Nearby significant vegetation communities

The East Ballina Crown Reserve is recognised by NSW NPWS as part of a regionally significant vegetation corridor containing key habitat (CANRI 03).

Nearby to the study site, but no longer directly connected, are a number of significant vegetation communities. Black Head vegetation includes Stinking Cryptocarya (*Cryptocarya foetida), Scented Acronyychia (Acronychia littoralis)* and White Lace Flower (*Archidendron hendersonii).* These areas have been isolated through urban development and land modification. Even though they may be very small, some of them contain rare species and are important indicators of the original vegetation mosaic. Recognition of the importance of these nearby areas and an increased awareness of their value may lead to restoration works being undertaken in the future.

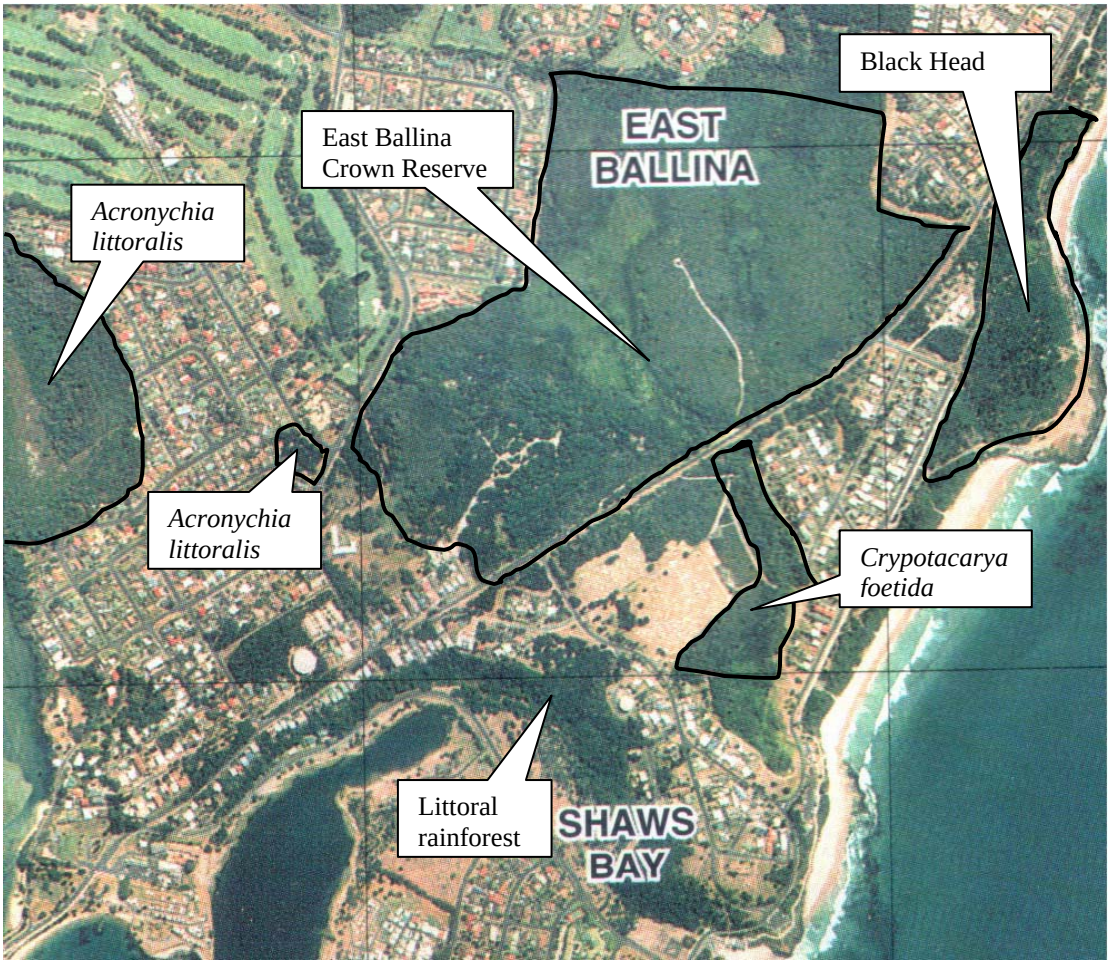

Figure 5: Nearby significant vegetation communities

6.8.2 Fauna

Snakes, ticks, ants, mosquitoes and chiggers (the larval mites that cause "scrub itch") can potentially cause discomfort, disease and serious illness. The best way to avoid complications is to minimize the risk of bites. Always wear protective clothing i.e. long sleeves and trousers tucked into sturdy boots, socks and a hat. Apply repellant (particularly one containing pyrethrins/DEET/triclosan antiseptics) to skin and clothing, and always take repellant and a comprehensive first aid kit into the field. Lignocaine gel can give localized relief from bites. Ticks should be killed before removal (by directly applying repellant), as the shock of physical removal can stimulate them to release more toxin into their host.

Birds of prey, such as the Osprey (*Pandion haliaetus*), which is listed as vulnerable, Schedule 2, on the NSW *Threatened Species Conservation Act* 1995, and Brahminy Kites (*Milvus indus*), are frequently seen hunting in the vicinity of East Ballina artificial perchs erected nearby by NPWS well used by these species.

6.8.3 Water

Taps are not readily available so plantings should be done during the wet season, the only alternative to planting in wet weather is to carry water in. Use water holding crystals if this is necessary.

6.8.4 Community Education

Walkers and neighbours will be very curious in the increasing activity at the East Ballina site. Regeneration workers can provide important community education by explaining the value of the work being conducted. The installation of interpretive signage would also be useful. Ballina Shire Council Richmond Landcare Inc and National Heritage Trust may be able to assist with funds for signage.

6.8.5 Rubbish Dumping

Dumping of rubbish and garden waste is a problem in most natural areas. It is also one of the main ways that exotic plants are introduced in vegetation remnants. Explanatory signage and personal communication with anyone observed dumping may discourage the practice, and always remove any rubbish encountered when working.

Ballina Shire Council is currently developing "Bushland perimeter" policy & guidelines for residents whose homes bound on public bushland. When this policy is completed copies should be letter box dropped to neighbours of the Reserve.

Plate 8: Rubbish dumping in Zone 3B. Rubbish has since been removed and a vehicle access barrier installed from the Coast Road to ensure this practice does not continue.

Plate 9: Rubbish dumping in Cronulla St.

6.9 Monitoring

Formal monitoring, performance indicators

It is important to monitor the project through "before and after" photography. This provides a record of progress that will prove useful to attract further funding and identify successful techniques, as well as providing reassurance to volunteers that their work has been useful. The slow success of rehabilitation works is best seen when specific photo points are established during the initial stages of the project and continually used.

Photo points should be identified with permanent markers (some sort of stake or picket). It is recommended to put two stakes within sight of each other (approximately 10 metres apart) and take a photo from one to the other and then in reverse. Referring to past photos prior to taking each subsequent photo. Photographic records should be taken at least seasonally (i.e. three to six monthly) and after major events, such as big plantings, storms or fires.

Records of working bees, including attendance, activities undertaken, weather constraints, successes and failures etc. are also invaluable monitoring tools. An example of a work record sheet is included as Appendix 7.

Another important aspect of monitoring is maintaining species lists. The flora and weed lists in this plan (Appendices 1 and 2) should be continually updated as new species are encountered. It is also useful to establish a fauna species list for the site, particularly as the site provides habitat for a threatened species. This information should be shared with land managers such as Ballina Shire Council, the Department of Infrastructure Planning and Natural Resources (DIPNR) and the NPWS. Ideally this document will appear in the local reference section of the library and be seen as a historic record.

The management strategies and actions detailed in this Plan are intended to provide a basis for the successful establishment of local native plant communities resembling those existing on the site prior to European settlement. It is important the plan implementation takes into consideration changing site conditions. Regular monitoring will provide feedback on the success or failure of management strategies and allow adaptation of the rehabilitation techniques and implementation schedule to achieve maximum effectiveness in weed control, dune stability and successful revegetation (James 2000).

7. CONCLUSION

The East Ballina Crown Reserve Vegetation Management Plan provides strategies, methods and a work plan for restoration of the vegetation communities on site.

Most of the 57 Ha site has native vegetation communities in relatively good health. The site contains a number vegetation communities including Wallum Heath, Vine Thicket, Sedgeland, Melaleuca Wetlands and areas of disturbed vegetation (former golf course). Impacts on vegetation communities at this site include isolation and fragmentation due to surrounding residential development, weed infestation and fire. Restoration work will contribute to the long term conservation and enhancement of the area.

The significant area of native vegetation at East Ballina Crown Reserve is valuable in environmental, social and economic terms. Restoration of this area will provide benefits to those who enjoy this beautiful area into the future.

8. REFERENCES

Ainsworth, J. 1922. *Reminiscences 1847 – 1922.* Beacon Printery, Ballina.

Anderson, A. 1999. *An Assessment and Inventory of the Wetland at Boulder Beach, Northern NSW.* Southern Cross University, Lismore.

Ballina Shire Council. 1987. *Ballina Local Environment Plan.*

Baverstock, P. 1996. *Crown Land – East Ballina. Project Ecologist Report.* A report for Brian J Mackney & Associates PTY LTD.

Department of Urban Affairs and Planning. *NSW Coastal Policy 1997.* NSW Government. Sydney.

Department of Urban Affairs and Planning. *Environmental Planning and Assessment Act, 1979.* NSW Government. Sydney.

James, R. 2000. *Dune Management Plan for Kings (Casuarina) Beach NSW.*

Land and Property Information NSW. *Orthophoto 1:25 000 Map. Ballina. 2002.*

Morand, D.T. 1994. *Soil Landscapes of the Lismore Ballina 1:100 000 Sheet.* Soil Conservation Service of NSW. Sydney.

NPWS. September, 1996. *Land Management Strategies for Crown Land at East Ballina* (a letter). NPWS Coffs Harbour.

Pickles, I. 1996. *East Ballina Crown Land Assessment. Planning Report for Resources Inventory.* A report for Brian J Mackney & Associates PTY LTD.

Piper, A. 1997. *An Archaeological Survey. East Ballina Crown Lands Assessment.* A report for Brian J Mackney & Associates PTY LTD.

Pettigrew, C. 1981. *Much Mulling Over Moors. Interpretation of the Heath.* Heaths in NSW. NSW NPWS.

Recher, H. 1981. *Bird Communities of Heath and their Management and Conservation Requirements.* Heaths in NSW. NSW NPWS.

Senmac Environmental PTY LTD. *Resources Inventory, Flora and Fauna. Crown Land Pine Ave East Ballina.* A report for Brian J Mackney & Associates PTY LTD.

Water and Rivers Commission of Western Australia (website). *How the season can influence fire impact on vegetation.* (n.d).

NSW Threatened Species Act. 1995. NSW Government. Sydney.

9. RECOMMENDED READING

Management

Anderson, A., 1999. *An Assessment and Inventory of the Wetland at Boulder Beach, Northern New South Wales*. Southern Cross University, Lismore.

Ballina Shire Council, 2000. *Management Plan for the Area Adjacent to the Boulder Beach Littoral Rainforest*. Ballina Shire Council, Ballina.

Greening Australia, 1995. *Local Greening Plans: A Guide for Vegetation and Biodiversity Management*. Greening Australia, Canberra.

Lennox Head Residents Association, 2000. *Environmental Impact Statement: Rehabilitation and Regeneration of Boulder Beach Littoral Rainforest*. Department of Land and Water Conservation, Alstonville.

MacFarlane, J., 1997. *Plant Communities of Boulder Beach and their Current Condition*. Southern Cross University, Lismore.

Rich, A., 2000. *Boulder Beach Littoral Rainforest Vegetation Management Plan*. Unpublished.

Bush Regeneration

Big Scrub Rainforest Landcare Group, 1998. *Subtropical Rainforest Restoration: A Practical Manual for Landowners and Land Managers on Caring for Subtropical Rainforest Remnants and Establishing Rainforest Plantings*. Big Scrub Rainforest Landcare Group, Mullumbimby.

Buchanen, R., 1989. *Bush Regeneration: Recovering Australian Landscapes*. TAFE Student Learning Publications, Sydney.

Firth, D., 1992. Camphor Laurel Control. In NSW Department of Agriculture, undated. *Trees for the New South Wales North Coast.* NSW Department of Agriculture, Alstonville.

Wright, P. (ed.), 1991. *Bush Regenerators Handbook*. National Trust of Australia, Sydney.

Stanley, R., Dodkin, M., Love, A. and Dyason, R. (eds.), 1989. *Bitou Bush Control Handbook*. NSW Agriculture and Fisheries, Soil Conservation Service of NSW, and NSW National Parks and Wildife Service, Sydney.

Plant Identification

Auld, B. and Medd, R., 1992. *Weeds: An Illustrated Guide to the Weeds of Australia*. Inkata Press, Sydney.

Big Scrub Rainforest Landcare Group, 1998. *Common Weeds of Northern NSW Rainforests: A Practical Manual on their Identification and Control*. Big Scrub Rainforest Landcare Group, Lismore.

Briggs, J.D. and Leigh, J.H., 1988. *Rare or Threatened Australian Plants*. Australian National Parks and Wildlife Service, Canberra.

Coastcare, 1998. *Attack of the Killer Weeds*. Department of Land and Water Conservation, Sydney.

Land Protection, Department of Natural Resources, 2000. *Weed Pocket Guide: South East Queensland*. Department of Natural Resources, Brisbane.

Floyd, A., 1989. *Rainforest Trees*. Inkata Press, Sydney.

Harden, G.J. (ed.), 1990-1993. *Flora of New South Wales*. Vols. 1 to 4. University Press, Sydney.

Johns, L. and Stevenson, V., 1979. *The Complete Book of Fruit*. Angus and Robertson, Sydney.

Jones, D., 1986. *Ornamental Rainforest Plants of Australia*. Reed, Sydney.

Oakman, H., 1979. *Tropical and Subtropical Gardening*. Rigby, Sydney.

Popenoe, W., 1974. *Manual of Tropical and Subtropical Fruits*. Macmillan Publishing Company, New York.

Robinson, L., 1991. *Field Guide to the Native Plants of Sydney*. Kangaroo Press, Sydney.

Williams, J.B. and Harden G.J., 1993. *Rainforest Climbing Plants; A Field Guide to the Rainforest Climbing Plants of New South Wales using Vegetative Characters*. University of New England, Armidale.

Williams, J.B., Harden G.J. and McDonald, W.J.F., 1984. *Trees and Shrubs in Rainforests of New South Wales and Southern Queensland*. University of New England, Armidale.

Plant Propagation

Environmental Training and Employment (EnviTE), 1998. *Coastal Plant Propagation Manual*. EnviTE, Lismore.

Ralph, M., 1997. *Growing Australian Native Plants from Seed for Revegetation, Tree Planting and Direct Seeding*. Murray Ralph/Bushland Horticulture, Melbourne.

Appendix 1: Native Plant Species List East Ballina Crown Reserve

Trees and Shrubs

Family	Scientific name	Common name
Mimosaceae	*Acacia baueri*	
Mimosaceae	*Acacia elongata* var. *dilatata*	Wallum Wattle
Mimosaceae	*Acacia melanoxylon*	Blackwood / Sally Wattle
Mimosaceae	*Acacia sophorae*	Coastal Wattle
Mimosaceae	*Acacia suaveolens*	Scented Wattle
Mimosaceae	*Acacia ulicifolia*	Prickly Moses
Myrtaceae	*Acmena hemilampra*	Broad-leaved Lilly Pilly
Myrtaceae	*Acmena smithii*	Lilly Pilly
Dilleniaceae	*Adrastaea salicifolia*	
Sapindaceae	*Alectryon coriaceus*	Beach Birdseye
Casuarinaceae	*Allocasuarina littoralis*	Black She-oak
Apocynaceae	*Alyxia ruscifolia*	Prickly Alyxia
Sapotaceae	*Amorphospermum antilogum*	Brown Pearwood
Araucariaceae	*Araucaria cunninghamii*	Hoop Pine
Arecaceae	*Archontophoenix cunninghamiana*	Bangalow Palm
Myrtaceae	*Austromyrtus dulcis*	Midgen Berry
Myrtaceae	*Baeckea linearis*	
Proteaceae	*Banksia aemula*	Wallum Banksia
Proteaceae	*Banksia integrifolia*	Coast Banksia
Proteaceae	*Banksia oblongifolia*	
Proteaceae	*Banksia serrata*	Old Man Banksia
Epacridaceae	*Brachyloma daphnoides*	
Euphorbiaceae	*Breynia oblongifolia*	Breynia
Myrtaceae	*Callistemon pachyphyllus*	Wallum Bottlebrush
Cupressaceae	*Callitris columellaris*	White Cypress
Polygalaceae	*Comesperma ericinum*	
Proteaceae	*Conospermum taxifolium*	Devils Rice Flower
Proteaceae	*Conospermum taxifolium*	Devils Rice Flower
Agavaceae	*Cordyline congesta*	
Agavaceae	*Cordyline stricta*	Narrow-leaved Palm Lily
Myrtaceae	*Corymbia intermedia*	Pink Bloodwood
Sapindaceae	*Cupaniopsis anacardioides*	Tuckeroo
Cyatheaceae	*Cyathea australis*	Rough Tree Fern
Cyatheaceae	*Cyathea cooperi*	Scaly Tree Fern
Goodeniaceae	*Dampiera stricta*	Wallum Dampiera
Faboideae	*Dillwynia retorata*	Twisted Parrot Pea
Ebenaceae	*Diospyros fasciculosa*	Grey Ebony
Sapindaceae	*Dodonea triquetra*	Large-leaved Hop Bush
Solanaceae	*Duboisia myoperoides*	Corkwood
Elaeocarpaceae	*Elaeocarpus obovatus*	Hard Quandong
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blue-berry Ash
Lauraceae	*Endiandra discolor*	Rose Walnut
Lauraceae	*Endiandra sieberi*	Hard Corkwood
Epacridaceae	*Epacris microphylla*	Coral Heath

Epacridaceae	*Epacris pulchella*	Wallum Heath
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogony
Santalaceae	*Exocarpus latifolius*	Bush Ballart
Moraceae	*Ficus coronata*	Sandpaper Fig
Moraceae	*Ficus rubiginosa*	Rusty Fig
Moraceae	*Ficus watkinsiana*	Strangler Fig
Fabaceae	*Gompholobium virgatum*	Leafy Wedge Pea
Dilleniaceae	*Hibbertia fasciculata*	Clustered Guinea-Flower
Dilleniaceae	*Hibbertia vestita*	Small-leaved Guinea-Flower
Myrtaceae	*Homoranthus virgatus*	Coast Honey-Myrtle
Crassulaceae	*Kalenchoe longiflora*	
Myrtaceae	*Leptospermum johnsonii*	Tea-Tree
Myrtaceae	*Leptospermum juniperinum*	Tea-Tree
Myrtaceae	*Leptospermum liversedgei*	Tea-Tree
Myrtaceae	*Leptospermum polygalifolium*	Prickly Tea-Tree
Myrtaceae	*Leptospermum semibaccatum*	Soft Fruited Tea-Tree
Epacridaceae	*Leucopogon ericoides*	Pink Beard-Heath
Epacridaceae	*Leucopogon lanceolatus*	Brush White-Beard
Epacridaceae	*Leucopogon lanceolatus* var. *gracilis*	Wallum Beard-Heath
Lauraceae	*Litsea australis*	Brown Bolly-Gum
Myrtaceae	*Lophostemon confertus*	Brushbox
Myrtaceae	*Melaleuca quinquenervia*	Paperbark
Melastomaceae	*Melastoma affine*	Blue Tongue
Epacridaceae	*Monotoca elliptica*	Tall Broom-Heath
Epacridaceae	*Monotoca scoparia* var. *scoparia*	Prickly Broom-Heath
Myoperaceae	*Myoporum boninense* ssp. *australe*	Coast Boobialla
Oleaceae	*Notelaea ovata*	Heath Mock-Olive
Myrtaceae	*Ochrosperma lineare*	
Euphorbiaceae	*Omalanthus populifolius*	Bleeding Heart
Fabaceae	*Oxylobium robustum*	Golden Shaggy Pea
Polygonaceae	*Persicaria elatior*	A Smart Weed
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung
Proteaceae	*Persoonia virgata*	A Geebung
Rutaceae	*Phebalium woombye*	Satinwood
Fabaceae	*Phyllota phylicoides*	Heath Phyllota
Myrtaceae	*Pilidiostigma glabrum*	Plum Myrtle
Thymeleaceae	*Pimelea linifolia*	Slender Rice-Flower
Pittosporaceae	*Pittosporum revolutum*	Hairy Pittosporum
Araliaceae	*Polyscias elegans*	Celerywood
Fabaceae	*Pultenaea* sp.	Bush Pea
Faboideae	*Pultenea* sp.	Eggs and Bacon
Myrsinaceae	*Rapanea variabilis*	Variable Muttonwood
Euphorbiaceae	*Ricinocarpus pinifolius*	Wedding Bush
Epacridaceae	*Sprengelia sprengelioides*	White Swamp-Heath
Epacridaceae	*Sprengelia sprengelioides*	White Swamp Heath

Epacridaceae	*Styphelia viridus*	Green Styphelia
Myrtaceae	*Syzygium leuhmanii*	Riberry
Tremandraceae	*Tetratheca thymifolia*	Black-Eyed Susan
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Grass Tree
Xanthorrhoeaceae	*Xanthorrhoea latifolia*	Grass Tree
Xanthorrhoeaceae	*Xanthorrhoea macronema*	Grass Tree
Rutaceae	*Zieria arborescens*	Stinkwood
Rutaceae	*Zieria laxifolia*	
Rutaceae	*Zieria smithii*	Sandfly Zieria

Climbing Plants

Family	**Scientific name**	**Common name**
Dilleniaceae	*Hibbertia scandens*	Guinea Flower
Cassythaceae	*Cassytha filiformis*	Dodder
Cassythaceae	*Cassytha glabella*	Dodder
Dioscoreaceae	*Dioscorea transversa*	Native Yam
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily
Fabaceae	*Kennedia rubicunda*	Red Coral Pea
Schizaceae	*Lygodium microphyllum*	Climbing Maidenhair
Asclepiadaceae	*Marsdenia rostrata*	Common Milk Vine
Bignoniaceae	*Pandorea pandorana*	Wonga Vine
Apocynaceae	*Parsonsia straminea*	Common Silk Pod
Passifloraceae	*Passiflora aurantea* var. *aurentea*	Blunt Leaved Passionfruit
Smilaceae	*Smilax australis*	False Sarsaparilla
Convolvulaceae	*Stephania japonica*	Snake Vine

Grasses Groundcovers and Ferns

Family	**Scientific Name**	**Common Name**
Polygonaceae	*Acetosella vulgaris*	Sheep Sorrel
Araceae	*Alocasia brisbanensis*	Cungevoi
Zingiberaceae	*Alpinia caerulea*	Native Ginger
Aspleniaceae	*Asplenium australsasicum*	Birds Nest Fern
Cyperaceae	*Baumea* sp.	Sedge
Blechnaceae	*Blechnum indicum*	Bungwhal Fern
Fabaceae	*Bossiaea ensata*	Leafless Bossiaea
Cyperaceae	*Caustis recurvata*	Curly Wigs
Cyperaceae	*Cladium procerum*	
Cyatheaceae	*Cyathea australis*	Rough Tree Fern
Cyatheaceae	*Cyathea cooperi*	Scaly Tree Fern
Liliaceae	*Dianella caerulea*	Rough Flax Lily
Poaceae	*Digitaria* sp.	A Couch grass
Droseraceae	*Drosera spathulata*	Rosette Sundew
Chenopodiaceae	*Einadia* sp.	
Cyperaceae	*Gahnia sieberiana*	Red Fruited Saw-Sedge
Gleicheniaceae	*Gleichenia dicarpa*	Pouched Coral Fern
Dennstaedtiaceae	*Histiopteris incisa*	Batswing Fern
Asteraceae	*Hypochaeris radicata*	Cats Ear

Retionaceae	*Hypolaena fastigiata*	Tassel Rope-Rush
Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern
Poaceae	*Imperata cylindrica*	Blady Grass
Liliaceae	*Laxmania gracilis*	Slender Wire-Lily
Restionaceae	*Lepyrodia interrupta*	Knotted Scale-Rush
Lomandraceae	*Lomandra longifolia*	Spiny -Headed Mat-Rush
Solanaceae	*Nicotiana* sp.	
Iridaceae	*Patersonia sericea*	Wild Iris
Philydraceae	*Philydrum lanuginosum*	Frog Mouth
Rubiaceae	*Pomax umbellata*	Pomax
Dennstaedtiaceae	*Pteridium esculentum*	Bracken
Restionaceae	*Restio tetraphyllus ssp. mesotachyus*	Feather Plant
Schizaeaceae	*Schizaea dichotoma*	Branched Comb Fern
Selaginaceae	*Selaginella uliginosa*	Swamp Clubmoss
Asteraceae	*Senecio sp.*	A Fire Weed
Asteraceae	*Themeda tridandra*	Kangaroo Grass
Apiaceae	*Trachymene incisa*	Native Carrot
Campanulaceae	*Wahlenbergia* sp.	Australian Bluebell

Orchids (as surveyed by John Moye)

Family	**Scientific Name**	**Common Name**
Orchidaceae	*Acianthus fornicatus*	Pixie Caps
Orchidaceae	*Caladenia* sp.	A Spider Orchid
Orchidaceae	*Calanthe triplicata*	Christmas Orchid
Orchidaceae	*Caleana major*	Large Duck Orchid
Orchidaceae	*Calochilus* sp.	A Beard Orchid
Orchidaceae	*Corybas acontiflorus*	Spurred Helmet Orchid
Orchidaceae	*Cryptostylis erecta*	Tartan Tongue Orchid
Orchidaceae	*Phaius australis*	Lesser Swamp Orchid
Orchidaceae	*Pterostylis acuminata*	Pointed Greenhood
Orchidaceae	*Pterostylis* ssp.	A Greenhood
Orchidaceae	*Thelymitra* sp.	A Sun Orchid
Orchidaceae	*Zeuxine oblonga*	

Appendix 2: Weed Species List East Ballina Crown Reserve

Family	Botanical name	Common name	Zone 1.	Zone 2.	Zone 3.	Zone 4.	Zone 5.	Zone 6.
Mimosoideae	*Acacia saligna*	Golden Willow Wattle					**d**	
Polygonaceae	*Acetosa sagittata*	Turkey Rhubarb	**b**				**d**	
Asteraceae	*Ageratum houstonianum*	Blue Billy Goat Weed				**c**		
Basellaceae	*Anredera cordifolia*	Madeira Vine					**a,b**	
Asparagaceae	*Asparagus aethiopicus*	Ground Asparagus		**a**		**c**	**a,b,c,d**	*
Crassulaceae	*Bryophyllum delagoense*	Mother of Millions					**d**	
Crassulaceae	*Bryophyllum pinnatum*	Resurrection Plant	**b**					
Asteraceae	*Chrysanthemoides monilifera ssp. rotundata*	Bitou Bush	**a,b**		**d**		**d**	
Lauraceae	*Cinnamomum camphora*	Camphor Laurel					**a**	
Amaryllidaceae	*Clivia miniata*	Bush Lily	**b**					
Asteraceae	*Delairea odorata*	Cape Ivy					**a**	
Euphorbiaceae	*Euphorbia cyathophora*	Painted Spurge	**b**				**a**	
Euphorbiaceae	*Euphorbia milii*	Crown of Thorns	**b**					
Euphorbiaceae	*Euphorbia tirucalli*	Pencil Tree					**d**	
Cactaceae	*Hylocereus undatus*	Climbing Cactus					**d**	
Balsaminaceae	*Impatiens walleriana*	Busy Lizzie						*
Convolvulaceae	*Ipomoea batatas*	Sweet Potato				**c**		*
Convolvulaceae	*Ipomoea cairica*	Coastal Morning Glory	**b**		**d**		**a,d**	
Verbenaceae	*Lantana camara*	Lantana		**a**	**c,d**	**c**		*
Myrtaceae	*Leptospermum laevigatum*	Coastal Tea Tree	**a**					
Poaceae	*Melinis minutifolia*	Mollases Grass	**b**					*
Poaceae	*Melinis repens*	Red Natal Grass					**d**	*
Davalliaceae	*Nephrolepis cordifolia*	Fishbone Fern	**b**				**d**	
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant					**d**	
Passifloraceae	*Passiflora subpeltata*	White Passionfruit			**c,d**	**c**		*

Poaceae	*Pennisetum purpureum*	Bharna Grass					**d**	
Pinaceae	*Pinus elliotii*	Slash Pine					**a,b,c,d**	
Lamiaceae	*Plectranthus australis*	Swedish Ivy					**d**	
Rubiaceae	*Richardia brasilensis*	Brazil Weed					**d**	
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant					**a**	
Phytolacaceae	*Rivina humilis*	Coral Berry					**d**	
Dracaenaceae	*Sansevieria trifasciata*	Mother in Laws Tongue	**b**				**a**	
Araliaceae	*Schefflera actinophylla*	Umbrella Tree	**b**		**d**	**c**		*****
Caesalpiniaceae	*Senna pendula* var. *glabrata*	Winter Senna	**b**				**a,d**	*****
Solanaceae	*Solanum mauritianum*	Tree Tobacco					**a**	
Solanaceae	*Solanum seaforthianum*	Climbing Nightshade						*****
Arecaceae	*Syagrus romanzoffianum*	Cocos Palm			**c,d**			*****
Bignoniaceae	*Tecoma stans*	Yellow Bells				**c**		
Commelinaceae	*Tradescantia* sp (miniature form)	Miniature Wandering Jew					**d**	
Commelinaceae	*Tradescantia zebrina*	Striped Trad					**d**	*****
Asteraceae	*Wedelia trilobata*	Singapore Daisy	**b**		**d**			
Agavaceae	*Yucca aloifolia*	Spanish Bayonet	**b**					

Appendix 3: Weed Profiles
TREES AND SHRUBS

Agavaceae
Agave alofolia
Spanish Bayonet
A native of Mexico. A very large perennial plant with a basal rosette of fleshy leaves up to 2 metres long with long spines along the margins. The plant was originally introduced as an ornamental and now occurs as a garden escapee in many parts of Australia. (Auld & Medd, 1992)

Araliaceae
Schefflera actinophylla
Umbrella Tree
Native of North Queensland and naturalised in coastal districts of northern NSW. A tree up to ten metres high, often multi-stemmed and sometimes epiphytic high in the canopy (Harden, 1992, p.87), making removal difficult. Birds disperse its red fruit. Adventitious roots form readily from stem segments that remain in contact with the ground.

Arecaceae
Syagrus romanzoffianum
Cocos Palm
Native of Brazil. A tall palm growing to 12 metres. Its fleshy fruit is dispersed by birds, rodents and water. Fruit is also eaten and dispersed by flying foxes (Eby and Palmer, 1988, 53).

Asteraceae
Chrysanthemoides monilifera* subsp. *rotundata
Bitou Bush
Native of South Africa. An erect, shallow-rooted, densely branched perennial shrub up to three metres high (Auld and Medd, 1992). It grows on sand dunes and forest margins near beaches and poses a serious threat to native sand dune vegetation (Harden, 1992, p.315). These plants can invade and overwhelm all plant communities on the coastal system, growing in the open or in the shade of other plants. Up to 48,000 seeds per plant can be produced with a viability of up to seven years. Fruits are attractive to birds (Buchanan, 1989). There is increasing evidence that long-term domination of coastal frontal dunes by Bitou Bush leads to instability and increased erosion (Stanley et. al., 1989). It is a declared W3 noxious weed (i.e. must be prevented from spreading and its numbers reduced).

Caesalpinioideae
Senna pendula* var *glabrata
Winter Senna
Native of South America. A spreading shrub up to three metres high, it does not produce root nodules and is widely naturalized in coastal areas (Harden, 1991, p.319). It produces a large number of seeds, which appear to have a long viability, possibly for up to ten years. Can regenerate from cut material in moist conditions. Can be seen flowering throughout the year, flowers are bright yellow.

Euphorbiacceae
Ricinus communis
Castor Oil Plant
Native of Asia and Africa. A large perennial shrub up to 3 metres high. It has burr-like fruits containing 3 seeds which are dispersed by the exploding fruit as it ripens. Its seeds are toxic to stock and humans. It is abundant along creek banks and creek beds (Auld and Medd 1992, 162).

Euphorbia milli
Crown of Thorns
Native to North and South America. A low spreading, shallow rooted perennial cactus forming large clumps up to 1.5 metres tall. It has succulent segments to 20 cms. Long with clumps of short tufts of hair and spines. Flowers are bright yellow and fruit is dark purple (Auld & Medd, 1992). Seeds are dispersed by birds and adventitious roots will form if segments contact the ground. It is a declared category 4f noxious weed.

Euphorbia tirucalli
Pencil Tree – Aveloz
Found in tropical South America, South Africa and Madagascar. Forms a tree up to 6m characterized by leafless 'pencil like" stems. Contains caustic white sap that can cause temporary blindness, burns to skin or dermatitis. Reproduces from vegetative pieces.

Lauraceae
Cinnamomum camphora
Camphor Laurel
Native of China and Japan. A large tree of spreading habit that can grow to approximately 25-30 metres. It has abundant seed production, effective dispersal mechanism, mainly by birds, and some seed dormancy. It is a hardy, long-living competitive tree which can also reproduce rapidly by suckering to form single species stands. Camphor Laurel prefers deep, well-drained red soil but will grow well on alluvial soil; it cannot, however, tolerate prolonged flooding (Firth, 1992, p.69). It is extensively naturalized in coastal areas on the North Coast of NSW (Harden, 1990, p.144). It is a declared W4(d) noxious weed (i.e. must not be sold, propagated or knowingly distributed and must be fully and continuously suppressed and destroyed).

Mimosoideae
Acacia saligna
Golden Wreath Wattle, Willow Wattle
Erect or spreading tree or shrub, 3 – 8 m high, bark smooth or finely fissured. Flowers July – September. Native of W. A., widely cultivated, sometimes naturalized, expecially in coastal districts (Harden 1992, p. 375).

Myrtaceae
Leptospermum laevigatum
Coastal Tea Tree
A native of Australia on sand dunes and coastal cliffs, south from Nambucca Heads. A shrub or small tree to four metres, with smooth bark that sheds in strips. Leaves are narrow-obovate, 15-30 millimetres long and five to eight millimetres wide. Introduced onto NSW North Coast dunes after sandmining operations as part of the rehabilitation process.

Ochnaceae
Ochna serrulata
Mickey Mouse Bush
Shrub two to three metres high. Leaves oblong to narrow elliptic, margins toothed. Ovoid drupes, five to eight millimetres long, black and embedded on a swollen red receptacle. Often cultivated. Native of South Africa (Harden, 1990, p. 490).

Pinaceae
Pinus elliotti
Slash Pine
From south eastern USA, this fast-growing species to 24 m, copes with most soils, even poorly drained ones. It has a pyramidal shape and narrow, deep green leaves at least 10 cm long in bundles of two or three. The cones are 15 cm long and each scale is armed with a sharp prickle. Needle like leaves create a thick sterile layer beneath the tree.

Solanaceae
Solanum mauritianum
Wild Tobacco
A shrub or small tree up to 4 metres high, widely naturalized in rainforest regrowth (Harden, 1992, 359). It's fruit are dispersed by birds. In areas of higher light levels it can form thick stands displacing native species by competing for water, space and nutrients.

Verbenaceae
Lantana camara
Lantana
Native of tropical South America. A scrambling shrub that often forms dense thickets (Harden, 1992, p.614) and can climb over 20 metres into trees. It grows best on well-drained, fertile soils including nutrient-enriched sands, roots also develop on branches which contact the ground, aiding its spread. It produces abundant seed, which is effectively dispersed by birds. According to Richard Lamb of Sydney University, when Lantana is present, particularly in sclerophyll communities, litter fall and nutrient turnover is altered, populations of native seeds are depleted, new seedlings are suppressed, soil structure is altered and micro-climate is changed, and some nutrients may be mobilized and lost to neighboring communities and others accumulated in unnatural amounts. These changed conditions seem to further favour Lantana and other weeds over native species (Buchanan, 1989, p.72) and in many forest areas can block secondary succession. It is a declared W3 noxious weed (i.e. must be prevented from spreading and its numbers reduced).

VINES AND SCRAMBLERS

Asparagaceae
Asparagus aethiopicus
Ground Asparagus
Native of South Africa. A shrub with sprawling stems up to two metres long, it is extensively naturalized in coastal districts and is a serious weed of bushland (Harden, 1993, p.46). It will form a total ground cover thereby preventing any germination of native species and inhibiting those that are present. It is a prolific seeder, making eradication difficult.

Asteraceae
Delairea odorata
Cape Ivy
Cape Ivy is a member of the daisy family, and is unrelated to English Ivy. It is a vigorous light green climber. It has succulent foliage. The leaves are broad and have lobed margins. Flowers are bright yellow and many small heads make up a single inflourescence. (Cochrane, 2001 p.52)

Basellaceae
Anredera cordifolia
Madeira Vine
Native of S. America. A climber with stems up to 20 metres long, producing tubers on roots and at nodes on aerial stems. It is widely naturalized in coastal districts, and is an invasive weed on the margins of rainforest (Harden, 1990, 177). This vine is extremely prolific, growing over 1 metre per week in warm, humid conditions. It produces countless vegetative aerial tubers which drop to the ground and remain dormant if conditions are not suitable for their growth. These tubers are spread by water, downhill movement and possibly rodents. The vine will rapidly smother plants of all sizes, destroying them through weight and inhibition of photosynthesis, and can block secondary succession (Hopkins). It is extremely difficult to control and is considered to be the most serious and destructive plant pest species affecting the North Coast rainforest remnants.

Cactaceae
Hylocereus undatus
Climbing Cactus
Native of tropical America. A succulent spinose climbing plant with stems 3-angled, climbing by adventitious roots (Harden, 1990, 205). It is semi-epiphytic and xerophytic and can survive in the canopy after the main root had been severed. The weight of this plant can cause serious damage to rainforest trees by breaking limbs. Its growth habit and spiny stems make this plant difficult to remove.

Convolvulaceae
Ipomoea cairica
Coastal Morning Glory
Native of tropical Africa and Asia. Perennial with twining and trailing stems. Violet to purplish violet flowers with a darker throat. Flowers throughout the year. Widely cultivated and frequently naturalised in coastal districts (Harden, 1992, p.380).

Euphorbiaceae
Euphorbia cyathophora
Painted Spurge
Native of tropical America. An annual, erect herb flowering most of the year. It is naturalized on coastal sands (Harden, 1990, 425). It can form dense thickets up to 1.5 metres high (Cribb and Cribb, 1985, 123) inhibiting native regeneration.

Passifloaceae
Passiflora subpeltata
White Passionflower
Native of Brazil. A climber which is a widespread weed along the coast on margins of rainforest and moist gullies (Harden, 1990, 435). Its foliage cover inhibits photosynthesis of supporting plants, which can also be damaged by its weight. Its seed is dispersed by birds and animals.

Solanaceae
Solanum seaforthianum
Climbing Nightshade
Native of S. America. Sprawling perennial shrub or climber, naturalized in moister sites (Harden, 1992, 359). Like other vines, it causes stress on the support plant by its smothering action and weight. It's red berries are dispersed by birds.

HERBS, FERNS AND GRASSES
Asteraceae
Sphagneticola trilobata
Singapore Daisy
Low-growing mat about 10" with deeply lobed leaves. Blooms profusely with 1" yellow-orange flowers resembling marigolds or zinnias, which are borne singly on the end of each stem. Plant creeps and roots at nodes, making a dense ground cover.

Ageratum houstonianum
Blue Billy Goat
Native of Mexico. Common weed of wasteland north of Sydney. Erect or decumbent branched herb, 0.3-1 metre high, coarsely hairy or nearly glabrous. Leaves ovate to triangular, two to seven centimetres long. Margins are regularly toothed and both surfaces have scattered hairs. Florets are blue-mauve (Harden, 1992, p.150).

Balsaminaceae
Impatiens wallerana
Balsam, Bush Lizzie, Impatiens
Annual or perennial succulent herb, to 1 metre high. Flowers mostly pink to red or white. Leaves alternate, margins crenate to deeply toothed. Flowers throughout the year. Often cultivated as an ornamental and garden escapees now found in many areas.

Bignoniaceae
Tecoma stans
Yellow Bells
This evergreen shrub or small tree reaches a height of 15–20 ft (4.5–6 m). The leaves are composed of 5 or 7 leaflets, each 6–8 cm long with deeply serrated edges. This species features bright yellow, trumpet-shaped flowers, 5 cm long, arranged in sprays at the branch tips. It has a long flowering season, from early summer to late autumn. The fruit is a capsule about 20 cm long, ripening to chocolate brown.

Commelinaceae
Tradescantia. zebrina
Striped Wandering Jew
Native of Mexico and Central America. A creeping, succulent herb with branching stems which root at the nodes. It is occasionally naturalized in rainforest (Harden, 1993). It can form a dense groundcover which suppresses native germination and growth.

Convolvulaceae
Ipomoea batatas
Sweet Potatoe
From Central America and the Pacific islands, this perennial climber comes in both a white-fleshed and orange-fleshed variety. It has entire, toothed or 3- lobed leaves and flowers with a lavender to pale purple tube that is darker on the inside. Plants can become invasive in warm climates.

Crassulaceae
Bryophyllum delagoense*
Mother-of-millions*
Native of South Africa and Madagascar. Erect, succulent, perennial herb, often suckering at the base and naturalized near habitation (Harden, 1990, p.528). Plantlets develop at the leaf tips forming a carpet of tiny plants, making it difficult to control.

Bryophyllum. pinnatum
Resurrection Plant
Native of S. Africa and Madagascar. Erect, succulent, perennial herb, ofteh suckering at the base and often naturalized near habitation (Harden, 1990, 528). Plantlets develop at the leaf margins forming a carpet of tiny plants, making it difficult to control.

Davalliaceae
Nephrolepis cordifolia
Fishbone Fern
A fern with rhizomes, and stolons which bear reproductive tubers (Harden, 1990, 63).
Although a native of N.S.W., it is often cultivated and has naturalized near habitation. It is considered a weed in this area (Floyd, pers. comm.).

Dracaenaceae
Sansievera trifasciata
Mother-in-law's Tongue
Plant with a very short stem, strongly stoloniferous. Leaves dark green with light or greyish green bands, margins narrow, light green, yellow or reddish. Commonly cultivated as a pot plant, occasionally naturalised. Native of Africa (Harden, 1993, p.51).

Phytolacaceae
Rivina humilis
Coral Berry
Native of S. America. A shrub or perennial herb up to 1 metre high, growing chiefly on the coast in or on the margins or rainforest, often common in lowland subtropical rainforest (Harden, 1990, 176). It is moderately shade-tolerant, forming a dense understorey and can thereby suppress secondary succession. It bears numerous red berries almost all year round, making it difficult to control.

Poaceae
Melinus minutiflora
Molasses Grass
A native of Africa. A stoloniferous perennial grass up to 1.2 metres high (Harden, 1993, 461).

Melinus repens
Red Natal Grass
A native of South America the grass is a perennial or annual with erect slender stems up to 1m high. Flowers are a panicle of silvery white to pink or purple silky, hairy spikelet. *M. ripens* is a widespread roadside and railway embankment weed, particularly in coastal NSW and Qld. (Auld & Medd, 1999).

Pennisetum purpureum
Elephant or Bharna grass
A tall grass capable of growing to 3m native to South Africa. Often used as a windbreak.

Polygonaceae
Acetosa sagittata
Turkey Rhubarb
Native of South Africa. A prostate ascending or climbing perennial herb which produces tubers. Leaves with spreading auricles. Flowers in a large, branched terminal panicle, perianth purplish with 3 broad, papery wings. (Auld & Medd 1992). Resistant to Alyphorate.

Rubiaceae
Ricardia brasiliensis
Brazil Weed/ White Eye/Mexican Clover
A pale green, softly hairy, usually prostrate, clump forming perrenial with opposite leaves. Flowers are very small, white and thickly clustered in the leaf forks. Native to South America

References:
Auld, B. and Medd, R., 1992. *Weeds: An Illustrated Botanical Guide to the Weeds of Australia*. Inkata Press, Sydney.
Big Scrub Rainforest Landcare Group, 2000. *Common Weeds of Northern NSW Rainforests, A Practical Manual on theirIdentification and Control.* Big Scrub Rainforest Landcare Group, Bangalow NSW.
Buchanen, R., 1989. *Bush Regeneration: Recovering Australian Landscapes*. TAFE Student Learning Publications, Australia.
Cremer, K.W. (ed.), 1990. *Trees for Rural Australia*. Inkata Press, Sydney.
Cribb, A. and Cribb, J., 1985. *Plant Life of the Great Barrier Reef and Adjacent Shores*. University of Queensland Press, Brisbane.
Firth, D., 1992. Camphor Laurel Control. In NSW Department of Agriculture, undated. *Trees for the New South Wales North Coast.* NSW Department of Agriculture, Alstonville.
Harden, G. (ed.), 1990–1993. *Flora of New South Wales*. Vols. 1-4. NSW University Press, Sydney.
Stanley, R., Dodkin, M, Love, A. and Dyason, R. (eds.), 1989. *Bitou Bush Control Handbook*. NSW Agriculture and Fisheries, Soil Conservation Service of NSW, and NSW National Parks and Wildlife Service, Sydney.

Source: adapted from Joseph, R. 1995. *Rainforest Remnants Restoration and Rehabilitation Project Incorporating Plant Pest Species Survey and Prior Works Documentation: Boatharbour Nature Reserve*. NSW National Parks and Wildlife Service, Alstonville.
Joseph, R., McDonald, T., Stewart, B. and Fitzgerald, M., 1998. *Tweed Coast Littoral Rainforests: Draft SEPP 26 Management Plan*. Tweed Shire Council, Tweed Heads.

Appendix 4: Weed Treatment Methods

1. "Cut-scrape-paint": this method applies to all woody shrubs, trees and some vines.

(a) Cut plant low to the ground at an angle.

(b) Apply Glyphosate immediately at the rate of 1 part Glyphosate: 1.5 parts water, with a paintbrush approximately 1.5 centimetres wide.

(c) Scrape sides lightly to reveal green tissue and apply the herbicide to the scraped area.

(d) Take care that the brush is not contaminated with soil.

Note: all seed that has high viability and longevity, e.g. *Senna* spp. and other members of the Fabaceae family, or plants with a high invasive potential, such as *Schefflera actinophylla*, must be removed from the parent and either composted on site or removed from the site.

2. "Gouge-paint": this method applies to those plant species that have a fleshy root system, such as rhizomes or large bulbs. It is particularly appropriate for the treatment of *Asparagus* spp. (Asparagus).

(a) Gouge out sections of the fleshy base with a knife (if using on Asparagus, first cut the stems at shoulder height and also at the base).

(b) Apply 1 part Glyphosate: 1.5 parts water immediately, with a paint brush approximately 1.5 centimetres wide.

3. "Stem Injection": this method applies to all woody trees and shrubs with a diameter of about six to ten centimetres or greater.

(a) With a tomahawk, make a cut the width of the blade, at a slight angle, into the trunk. **Note:** it is important not to make cuts too deep.

(b) Apply herbicide immediately into the cut using a tree-injecting device (if using Glyphosate, apply at the rate of 1 part Glyphosate: 1.5 parts water*)*.

(c) Repeat this procedure in a brickwork pattern around the circumference of the tree, as close to the ground as possible. Where the presence of a crotch angle makes this difficult, make a cut above it. **Note:** two rows of cuts will be sufficient for trees with trunks of six to ten centimetres; larger trunk diameters will need correspondingly more.

(d) Treat all visible lateral roots as per (a).

4. "Scrape-ditch-paint": this method is applicable to many species of vines where it is desirable to treat the vines intact, particularly those with aerial tubers such as *Anredera corifolia* (Madeira Vine) or those which will propagate from segments, e.g. *Delairia odorata* (Cape Ivy).

(a) Scrape the stem tissue on one side of the stem only for at least 20-30 centimetres if possible. **Note:** on Madeira Vine, it is necessary to scrape heavily. Scrape as many sections of the stem as possible.

(b) Apply undiluted Glyphosate with a paintbrush.

(c) On stems that are thicker or horizontal, make a ditch into the stem with a knife and apply herbicide. Tubers and side roots should be treated the same way. **Note:** care must be taken not to sever the stem.

5. "Spraying": this is carried out using a 15 litre backpack spray unit with a modified spray nozzle that gives a solid spray pattern. Glyphosate is the main herbicide used with the addition of a marker dye. For plants that show some resistance (e.g. Madeira Vine) or where growing conditions are not optimal, an acidifying agent, such as Protec® is added (in the past LI700® has been used. Protec® is an oil based alternative which is effective and more versatile in its applications), is added. Metsulfuron can also be used for resistant species and grasses. It should be used with a surfactant, such as Protec® (Previously LI700® has been used for this purpose).

Note: where both Glyphosate and Metsulfuron are recommended for a species, it may be possible to use a commercially available compound of these two herbicides. This approach is currently under trial and is not suitable for operators unskilled in precision spraying.

Note: dilution rates for Glyphosate and Metsulfuron are in accordance with the manufacturer's recommendations and any variation requires a permit from the National Registration Authority.

Dilution Rates (Glyphosate: water):

- Plants with more or less succulent leaves, *e.g. Tradescantia fluminensis, Anredera cordifolia* (autumn to winter is the suggested time for spraying these plants), *Chlorophytum* spp. etc.
  1 part Glyphosate: 50 parts water + Protec®
- *Lantana camara*
  1 part Glyphosate: 100 parts water
- Other soft-leaved plants, annuals and grasses
  1 part Glyphosate: 100 parts water
- *Chrysanthemoides monilifera* subsp. *rotundata*
  1 part Glyphosate: 150 – 400 parts water

Dilution Rates (Metsulfuron: water):

- 1.0g Metsulfuron: 10 litres water + Protec®:

6. "Overspray": this method is applicable to large, dense infestations of such plants as *Chrysanthemoides monilifera* subsp. *rotundata* (Bitou Bush) and *Lantana camara* (Lantana), where it is desirable to leave the dead plants intact to prevent erosion and over-exposure of large areas, protect native seedlings from predators such as wallabies, and avoid trampling by humans.

(a) Spray over the top of the infestation, using a weak solution of Glyphosate.
Note: any native plants that may be under the weed will be protected by the foliage cover of the weed.

(b) Leave the sprayed plants intact so that native seedlings can establish under the shelter provided.

Note: Lantana – 1 part Glyphosate: 100 parts water
Bitou Bush – 1 part Glyphosate: 150 parts to 400 parts water

Alternatively: *weeds can be cut and flattened with bush-hooks or loppers and the subsequent regrowth sprayed with Glyphosate.*

Note: *in many cases it is preferable to overspray wherever practicable as this will cause less erosion and trampling of suppressed native plants, such as ferns and seedlings. However, handwork will be necessary to "cut-scrape-paint" any unsprayed Bitou Bush or Lantana that surrounds native plants.*

7. "Crowning": *this method is applicable to weeds which have their growing points below the surface of the ground (corms, bulbs, rhizomes, clumped or fibrous root systems, etc. e.g.* Asparagus *spp.,* Chlorophytum comosum *and grasses).*

(a) Grasp the leaves or stems and hold them tightly so that the base of the plant is visible. Plants with sharp leaves or stems should be cut back first.

(b) Insert the knife close to the base of the plant at a slight angle, with the tip well under the root system.

(c) Cut through the roots close to the base. Depending on the size of the plant, two or more cuts may be needed to sever all the roots.

(d) Remove the plant. Make sure that the base of the plant where the roots begin is completely removed.

Source: adapted from Joseph, R., 2001. *Course Notes from Certificate II in Bushland Regeneration*. TAFE, Wollongbar.

Appendix 5: Treatment Methods for Weeds at East Ballina Crown Reserve

Note: Ratios for Application of Herbicide

Dilution ratios for application of a mix of herbicide (Glyphosate based such as Round Up®) and water are provided. For example, 1:50 means that one part by volume of herbicide is mixed with fifty parts by volume of water . All cut, scrap and paint at 1:1.5 refers to Glyphosate. For some weeds a combination of Glyphosate and Metsulfuron is recommended, however a permit will be required for this off label usage.

Protec ® are added in some treatments to assist the transfer of the herbicide through the surface tissue – particularly plants with waxy leaves, such as Camphor Laurel, Madeira Vine and Wandering Jew.

For more detail on control method techniques refer to Appendix 5: Weed Removal and Control Techniques

Trees and Shrubs

Scientific Name	Common Name	Control Method
Acacia saligna	Willow Wattle	Cut, scrape and paint *glyphotsate* **1:1**
Chrysanthemoides monilifera spp. Rotundata	Bitou Bush	Hand pull young seedlings and hang up, cut & paint **1:1.5** small plants. Over spray mature plants if no risk to native seedlings, *glyphosate* **1:200**
Cinnamomum camphora	Camphor Laurel	Stem inject **1:15** larger trees, cut scrape and paint **1:1.5** small plants. Spray seedlings *glyphosate* **1:50 + Protec** ®
Euphorbia milii	Crown of Thorns	Small infestations – cut and paint *glyphosate* **1:1** and bag cut plant. Trial spray Metsulfuron **1.5g/10L** and **Protec**® **20ml/10L** on larger areas.
Lantana camara	Lantana	Lopper and cut, scrape and paint base **1:1.5.**. Spray regrowth *glyphosate* **1:100 + Protec**®
Leptospermum laevigatum	Coast Tea Tree	Cut close to ground cut, scrape and paint base **1:1.5** and bag seed.
Ochna serrulata	Mickey Mouse Bush	Cut, scrape and paint **1:1.5**. Spray seedlings *glyphosate* **1:50 + Protec**® Difficult to pull will regrow from broken root. Paint stem on larger specimens with neat *glyphosate* to a height of 50 cm
Pinus elliotii	Slash Pine	Seedlings: hand-pull, saplings and trees: cut close to ground.
Schefflera actinophylla	Umbrella Tree	Hand pull seedlings and bag. Cut, scrape and paint or stem inject **1:1.5**. Cut sections, can regrow if left on the ground
Senna pendula var. glabrata	Winter Senna	Hand pull young plants or spray seedlings *glyphosate* **1:50 + Protec**. ® Cut, scrape and paint **1:1.5**. Stem inject large specimens **1:1.5**, bag seeds
Syagrus romanzoffianum	Cocos Palm	Hand pull or crown seedlings, cut larger plants below growing point, spray resistant
Solanum mauritianum	Tobacco Bush	Stem inject **1:1.5** larger trees. Cut, scrape and paint **1:1.5**. Spray seedlings *glyphosate* **1:100 + Protec**®
Tecoma stans	Yellow Bells	Stems; Cut, scrape and paint **1:1.5**, regrowth: trial spray seedlings *glyphosate* **1:50 + Protec**, bag seed heads.
Yucca aloifolia	Spanish Bayonet	Hand pull young plants where possible; cut larger plants near ground and paint stumps 1:1.5. Ensure all cut stem material is removed from site

Vines and Scramblers

Scientific Name	Common Name	Control Method
Anredera cordifolia	Madeira Vine	Scrape as much stem as possible (on one side) and paint with 100% glyphosate, tubers: scrape/gouge and paint (100%); spray ground infestations 1:50 + Protec®). Bag tubers. Do not cut the stem.
Asparagus aethiopicus	Ground Asparagus	Hand remove (crowning of rhizome). Spray Metsulfuron **1.0g/10L** and **Protec**® **20ml/10L**.
Hylocerius undatus	Night Flowering Cactus	Very difficult to control. All parts must be physically removed and taken to a landfill.
Ipomoea batatas	Sweet Potatoe	Trial *glyphosate* **1:50** while actively growing, monitor for regrowth. Follow up may be required.
Ipomoea cairica	Coastal Morning Glory	Hand pull, cut scrape and paint **1:1.5**. Roll up vines, spray *glyphosate* **1:100 + Protec**®
Passiflora subpeltata	White Passionfruit	Hand pull smaller vines, cut, scrape and paint **1:1.5**. Spray regrowth *glyphosate* **1:50 + Protec**®
Solanum seaforthianum	Climbing Nightshade	Hand pull or scrape and paint **1:1.5.** Best to locate the flower. If in seed, bag the fruit

Herbs, Ferns and Grasses

Scientific Name	Common Name	Control Method
Bryophyllum delagoense	Mother of Millions	Hand removal of all plants where possible; spray plantlets. Metsulfuron **1.5g/10L** with **Protec**®
Bryophyllum delagoense	Resurrection Plant	Hand removal of all plants where possible; spray plantlets *glyphosate* **1:50** with Brush Off **1.5g/10L** and **Protec**®
Euphorbia cyathorphora	Painted Spurge	Spray *glyphosate* **1:100 + Protec**®. Hand pull
Nephrolepis cordifolia	Fishbone Fern	Spray *glyphosate* **1:50** with Metsulfuron **1.5g/10L** and **Protec**®
Pennisetum purpureum	Elephant or Bharna grass	Spray *glyphosate* **1:100** or cut stems and paint with glyphosate **1:1**
Rivina humulis	Coral Berry	Bag fruit or whole plants including fruit. Spray **1:50 + Protec**®. Hand pull where possible
Sansevieria trifasciata	Mother In Laws Tongue	Spray Metsulfuron **1.5g/10L** with **Protec**® **20ml/10L**
Tradescantia zebrina	Zebrina	Spray *glyphosate* **1:50 + Protec**®
Wedelia trilobata	Singapore Daisy	Trial Metsulfuron **1.5g/10L** with **Protec**® **20ml/10L**

Note: Unless otherwise stated the herbicide recommended for the techniques described above is Glyphosate e.g. Roundup®. Protec® should be used as per manufacturer's instructions. An off label permit is required from the National Registration Authority for any combination of herbicides or for rates not described on the product labels.

Appendix 6: Fauna species list, East Ballina Crown Reserve

Bird Species	Ibis, Australian White
Bee-eater, Rainbow	Kestrel, Nankeen
Bowerbird, Regent	Kingfisher, Azure
Bronzewing, Common	Kingfisher, Forest
Bush Turkey	Kingfisher, Sacred
Butcherbird, Grey	Kite, Brahminy
Butcherbird, Pied	Kite, Whistling
Cicadabird	Kookaburra, Laughing
Cormorant, Little Black	Lorikeet, Rainbow
Cormorant, Little Pied	Lorikeet, Scaly-breasted
Cormorant, Pied	Magpie Lark, Australian
Coucal, Pheasant	Magpie, Australian
Crow, Torresian	Magpie-lark
Cuckoo, Fan-tailed	Miner, Noisy
Cuckoo-shrike, Black faced	Mistletoebird
Currawong, Pied	Moorhen, Dusky
Dollarbird	Mynah, Common
Dove, Rock	Osprey
Dove, Bar-shouldered	Owl, Barking
Dove, Peaceful	Pardalote, Spotted
Drongo, Spangled	Pardalote, Striated
Duck, Maned Wood	Pigeon, Crested
Duck, Pacific Black	Pigeon, White-headed
Emerald Ground-dove	Plover, Masked Lapwing
Fairy Wren, Red-backed	Robin, Eastern Yellow
Fairy-wren Variegated	Rosella, Eastern
Fantail, Grey	Scrubwren, White-browed
Figbird	Shrike-thrush, Grey
Finch, Double-barred	Shrike-thrush, Little
Firetail, Red-browed	Silvereye
Flycatcher Leaden	Sparrow, House
Flycatcher, Restless	Sparrowhawk, Collared
Friarbird, Little	Spoonbill, Royal
Friarbird, Noisy	Swallow, Welcome
Frogmouth, Tawny	Swamp Hen, Purple
Galah	Thornbill, Brown
Goshawk, Brown	Turtle-Dove, Spotted
Heron, Nankeen Night	Wattlebird, Brush
Heron, White-faced	Wattlebird, Little
Heron, White-necked	Whipbird, Eastern
Honeyeater, Blue-faced	Whistler, Golden
Honeyeater, Brown	Whistler, Rufous
Honeyeater, Lewin’s	Wilie Wag-tail
Honeyeater, New Holland	Woodswallow, White-breasted
Honeyeater, Scarlet	Shrike-thrush, Little
Honeyeater, White-cheeked	Silvereye

Sparrow, House	Wattlebird, Brush
Sparrowhawk, Collared	Wattlebird, Little
Spoonbill, Royal	Whipbird, Eastern
Swallow, Welcome	Whistler, Golden
Swamp Hen, Purple	Whistler, Rufous
Thornbill, Brown	Wilie Wag-tail
Turtle-Dove, Spotted	Woodswallow, White-breasted

Mammals	
Swamp Wallaby	**Fawn-footed Melomy**
Grey-headed Flying Fox	**Swamp Rat**
Common Blossom Bat	**Black Rat**
Northern Brown Bandicoot	**Cat**
Common Brushtail Possum	**Dog**
Short-beaked Echidna	

Amphibians	
Common Eastern Froglet	Tusk Frog
Wallum Froglet	Green Tree Frog

Reptiles	
Common Tree Snake	Eastern Brown Snake
Carpet Python	Eastern Blue-tongued Lizard

The information detailed in the fauna species lists was obtained from:
East Ballina Crown Land Bird Survey January 29 – 31, 2002, carried out by Joanne Green (Wetland Care Australia), Dr Lee Andresen (East Ballina Landcare Group), Wendy McFadden (Australian Bird Society and East Ballina Landcare Group), Allan Richardson (bird expert), Time Davies (SCU Postgraduate) and Katie Pratt (SCU student).
Ballina Crown Lands – Resource Inventory – Flora and Fauna prepared by Semmac Environmental Pty Ltd, Lennox Head.

Appendix 7: Tools and Equipment Required

Non-consumables

- Plastic or steel boxes for equipment storage
- Leather pouches with belts to secure secateurs and knives
- Felco® secateurs (no.5)
- Victorinox® boning knives with non-slip handles
- Sandvik® loppers (no.16)
- Large bow saw
- Small pruning saws
- Poison pots, stands, and paintbrushes
- Goggles for mixing and applying herbicide
- Tomahawk
- Tree injection unit
- Sharpening stone
- Post hole shovels for tree planting
- Hoses
- Wheel barrow
- Chemical measuring container
- Rubber gloves for measuring and applying herbicide
- Gardening gloves
- 15 litre backpack spray unit with Rega® nozzle
- Fertilizer (or other large) sacks for weed and tuber removal
- Black builders' plastic for composting
- Native plant and weed identification manuals
- Hand lens
- Camera
- First aid kit
- Tarp for laying tools out on when the ground is wet (various other uses i.e. erecting sunshade, rain protection etc.)

Consumables

- Aerosol oil for tool maintenance (WD40® or Inox®)
- Tree fertilizer tablets (Agriform®)
- Diary/ journal
- Work record sheets (see Appendix 7)
- Flagging tape
- Photographic film
- Glyphosate (Roundup®)
- Metsulfuron (Brushoff® or Brush Killer®)
- Protec® – surfactant
- Spray marker dye
- Fencing material – timber posts, pig wire, shade cloth
- Trees for planting
- Nitram® – fertiliser
- Water crystals or wetting agent
- Tree guards and/or wallaby repellant spray
- Stakes or star pickets for photo points

Appendix 8: Regeneration Record Sheet

REGENERATION RECORD SHEET

Remnant Name:	Date:
Personnel/Volunteers:	Hours Worked:

Weather Conditions (temperature, prevailing wind, cloud cover etc.):

Work Completed (work zone – use map on reverse, methods trialed, comments on previous works, monitoring, followup or reminders etc.):

Weeds Treated	Methods Used	Chemical & Application Rate

Chemical	Vol. Used (ml)	Chemical	Vol. Used (ml)

Payment/Funding	Cheque No.	Invoice No.

Observations (flora, fauna, fruiting, flowering etc.):

Accidents/Incidents/Near Misses: