Coastal Foredune Scrub and Temperate Littoral Rainforest

South Coast of NSW

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A Framework to Guide Ecological Restoration:

Coastal Foredune Scrub and

Temperate Littoral Rainforest

South Coast of NSW
2010

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Frontcover: Coastal Foredune Scrub at Narrawallee, NSW
Above: Littoral Rainforest

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Introduction

Rebuilding complex ecosystems following disturbances such as weed invasion can be extremely difficult. Experienced restorers have developed a large toolbox of techniques that increase the success of restoration activities.

These guidelines add a new technique to this toolbox that should assist restoration success by ensuring the establishment of plant communities that are more similar to the original vegetation. Fundmental to this approach is the idea that species richness in restored communities should be as similar to undisturbed vegetation as possible.

The importance of species richness in restoration has been understood by regenerators for some time. While some land managers strive to incorporate this concept into restoration programmes, a lack of consistent methodology has led to each group developing unique ways to incorporate species richness, often based on anecdotal evidence.

These guidelines are aimed at providing **a simple mechanism for deciding which species should be at a site, and how many species should occur in any particular area**. It is based on an analytical and quantitative approach that provides an objective mechanism for including missing species. This ensures that rarer species are not excluded from restoration efforts and that restoration efforts focus on those species not present at the site, rather than only widely-distributed, common species. It also provides a simple timeline for undertaking monitoring to gauge when restoration tasks might be carried out and to determine the success of community regeneration.

This restoration technique is trialled using two plant communities: **Coastal Foredune Shrub** and **Temperate Littoral Rainforest**. These communities are under threat from a range of weeds including bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*), as well as disturbances such as human damage, mining and development.

Initially, these guidelines outline some ecological principles about the importance of species richness in plant communities, followed by an outline of the role of the seed bank and dispersal in maintaining species richness. Gaps in species richness, which can occur as a result of insufficient species being dispersed into the site or an insufficient seed bank, will need to be filled by supplemental introductions to ensure species richness is restored. Finally, the guidelines provide a methodology for identifying final species richness andidentity at restored sites.

I encourage the incorporation of these guidelines into restoration programs.

Background Information

The Role of Species Richness

Restoration aims to return sites to their original community structure. If this is done effectively, then these communities should eventually require little future management. The rationale here is that natural undisturbed communities are often resilient to invasion, and replicating their structure is likely to restore these benefits. An important component of community structure is the presence of a full complement of species that naturally occur in the community. In restoration, therefore, it is important to consider species richness to facilitate the development of sustainable plant communities.

Vegetation containing only a few species has lower resilience, or capacity to recover after disturbance. Low plant species richness increases weed invasion, can cause reduced faunal richness and can change ecosystem functions such as productivity. Each of these factors increases the need for future management of sites and prevents restoration of truly sustainable vegetation communities.

At a regional level, restoring sites using a small set of easily obtained nursery species is likely to homogenize the landscape and result in increased local extinctions of even relatively common species that are excluded from planting schemes.

If restoration is going to contribute to reversing the declines of species, then activities must consider the composition of the communities that are being re-constructed and ensure the full suite of species are restored at sites and across regions.

Figure 1. Littoral Rainforest at Beecroft Peninsula.

The Role of the Seed Bank

The soil seed bank forms an important source of new recruits following disturbance such as weed removal. However, there are significant differences in many habitats between the species present in the above ground vegetation and those in the soil seed bank. For example, in undisturbed coastal hind dunes in Australia, almost 74% of species that are present in the standing vegetation are not recorded in the soil seed bank.

The duration and magnitude of disturbances such as weed invasion can seriously affect the ability of habitats to regenerate naturally from the soil seed bank. Long-term or severe disturbances are likely to result in considerable depletion of the seed bank.

In general, restoration reliant solely on the soil seed bank will not result in a typical species-rich, pre-disturbance community and further action may be needed. Despite this, it is clear that a natural seed bank occurring at the site does contribute to restoration. These early seedling recruits may also be important in protecting and reducing mortality in very small seedlings.

The Role of Dispersal

Dispersal of seeds from nearby sources also forms an important part in the natural process of restoration. This process relies on seeds being transported by a vector, usually wind or vertebrates which have the capacity to move seeds relatively long distances.

The landscapes surrounding restoration sites influence the diversity of seeds arriving at sites. Isolated sites in urban and rural landscapes may have very limited native seed dispersal, which will, in turn, limit the ability of these sites to recover following disturbance. These types of surrounding landscapes, however, are likely to be important sources of weed species.

Seeds adapted for dispersal by vectors other than vertebrates and wind do not disperse more than a few metres. Ant-dispersed seeds, identified by the presence of an elaiosome (a protein body that is consumed by the ant), generally only travel a few metres, and seeds dispersed by ballistic expulsion generally travel just beyond the parent plant. Other seeds simply fall beneath the parent plant and no further. These short-distance dispersed species are unlikely to passively disperse to isolated or large restoration sites.

The potential for site restoration from dispersal is dependent on the proportion of long vs. short distance dispersed species represented in the extant and surrounding communities. Vegetation that has a high proportion of wind and vertebrate-dispersed species will receive more recruits than vegetation characterised by species with short-distance dispersal mechanisms.

Restored sites in rainforest are likely to receive propagules from outside the restoration site, as about 36% of species in these habitats are vertebrate-dispersed (Westoby et al. 1990). However, sclerophyllous vegetation (such as coastal scrub or heath) only has a small proportion of species (around 16%, Westoby et al. 1990) that are wind or vertebrate-

dispersed and thus dispersal is unlikely to contribute a great deal to the passive enhancement of species richness.

Figure 2 *Imperata cylindrica*: long-distance wind dispersal of seeds

This is an important point, as many sclerophyllous plant communities have no significant natural succession or long distance dispersal. Over time, species composition does not change significantly and these communities maintain the same suite of species that recruited after the last major disturbance. The species present at the site following disturbance are the species that continue to be a part of the community, and only a few new species may arrive at the site later as a result of long-distance dispersal.

Thus the seed bank present at a restored site in sclerophyll vegetation provides the primary mechanism for recruiting native species. If seeds are not available within the site then spaces that develop are likely to be filled by propagules dispersing from adjacent patches in the landscape.

The majority of weed species are either wind- or vertebrate- dispersed and this means there is an increased probability of weed seeds dispersing into restored sites. In sclerophyll vegetation, where only a small percentage of native species have long distance dispersal mechanisms, the likelihood of weed species arriving and establishing is high, especially if the soil seed bank is depleted.

Small scale disturbances in these habitats provide opportunities for weed establishment. As a result, disturbed sclerophyll woodlands are highly likely to become weed invaded over time. Other habitats, such as sand dunes, are constantly being disturbed by storms, wind, and salt spray, and consequently there is also an increased probability that at least some of the available spaces will have weeds establishing even in areas without much human disturbance.

Figure 3. Fruit of *Dianella caerulea:* long distance vertebrate seed dispersal

The Relationship between Number of Species and Area

The species area curve illustrates the relationship between common and rare species in plant communities. In small areas, common species will be frequently encountered but only a few rare species will be found. As the area increases, all the common species will be present and there will be an increasing number of rarer species encountered. Eventually the area surveyed will be large enough to have encountered all species.

Graphically this relationship looks like the figure below (Figure 4) which is based on a fictitious dataset. The number of species where the curve flattens out, K, represents the total number of species present in the community. The area represented by X is the minimum sized area in which the full complement of species is present. In this fictitious example it is 40 area units.

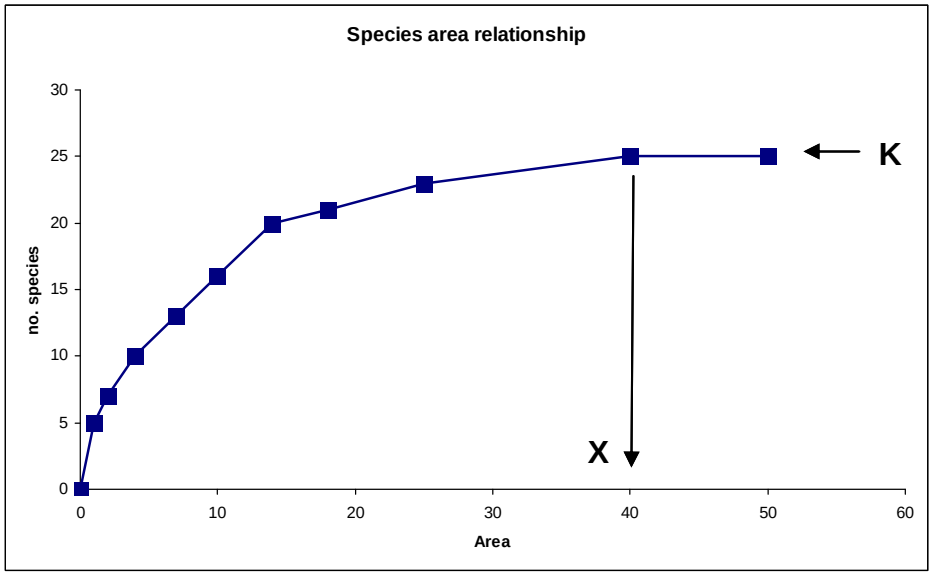


Figure 4. Generalised species accumulation curve. As the area surveyed increases, there is an increase in the number of species encountered until all species in that community are found.

What does this mean for restoration?

Small areas that are being restored should have fewer species than larger areas and restoration activities at small sites do not need to include ALL species which might be normally found in the whole vegetation community.

These guidelines aim to help site managers determine how many species they should establish at their sites as a function of site size.

Overview of a Restoration plan

This section outlines a restoration method that encompasses the natural processes detailed in the previous section. It incorporates natural processes, weed management and site assessment into a timeline that ends with a replanting plan to ensure species richness is established. These steps are visualised in Figure 6. Initially the community composition is defined which represents the endpoint for the restoration plan. Progress in restoration over time is measured against this community description and flexibility in composition is built-in to the process. This step helps direct future management and the final community. Step 2 and 3 involve weed control and allowing some time for natural regeneration processes to help in restoration. Step 4 evaluates sites and focuses replanting schemes (Step 5) to maximise species richness and reach the desired endpoint.

Figure 5. Coastal Foredune Scrub and Beach Strand Grassland vegetation

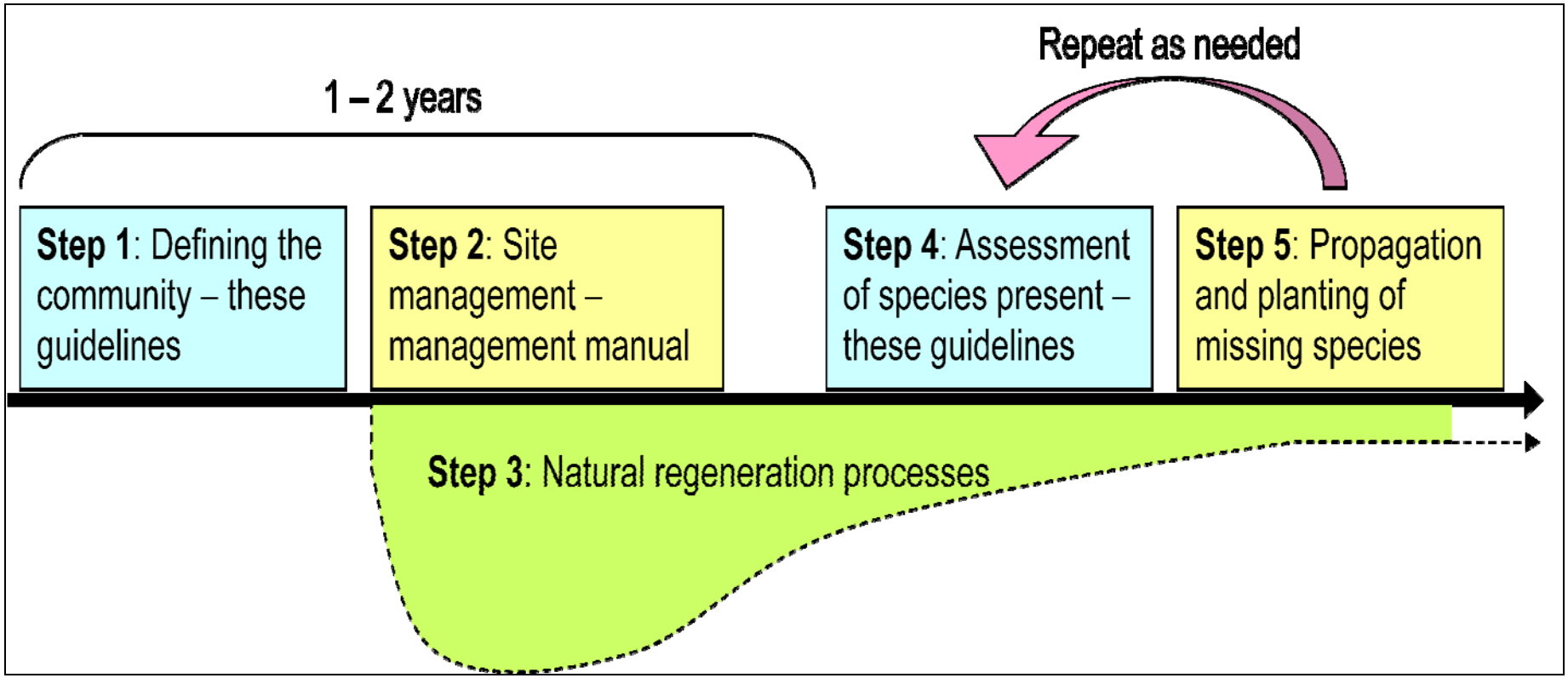


Figure 6. A timeline of site restoration with thesource of information available to inform these steps.

Step 1 – Defining the Community and Endpoint for Restoration

An important part of a restoration project is the definition of the final community that should be at the site when restoration is complete. This endpoint provides the benchmark against which to assess efforts and, more particularly, to direct future management. Defining this **endpoint** can be difficult, as historical vegetation composition at a site is usually unknown. However, it is possible to use undisturbed sites of similar vegetation to define species composition. As a result, Step 1 involves the creation of a species list for the area that is being restored based on best available data from undisturbed patches of the same vegetation.

On the South Coast of NSW, Tozer *et al.* (2010) have developed a guide to the different plant communities through an extensive analysis of site data held by the Department of Environment, Climate Change and Water (DECCW). The aim of this analysis was to classify vegetation communities using knowledge of the species most typical of that vegetation. We have used the same data set, supplemented with new surveys, to classify two vegetation communities and list the species that should be present. We extend this work by defining the full suite of species in these communities to ensure that rarer species are included in the classifications. This information can be used to focus restoration efforts. Restoration success can be gauged by comparing extant and compiled species lists at a site.

The lists in these guidelines concern two vegetation communities and incorporate data for the whole of the South Coast. The species analyses are therefore based on data from a large region. While at any particular place there may have been a smaller number of species present, these guidelines advocate a **whole-of-region approach** to ensure conservation of all species along the south coast. This is a precautionary approach that is likely to have significant biodiversity benefits. It is not based on the oldest records at a site, which may, in themselves be deficient in species recorded as present.

The species recorded in a vegetation community are assigned to groups based on how commonly each species occurs in field plots. The groups vary along a gradient from species that occur in many or most plots, termed 'very common species', to those that were only recorded once or twice in the dataset, termed 'occasional' species. These species may be naturally rare, but important components of the subject community, or they may be incidental species that are more typical of neighbouring communities.

The number of species in each of these frequency of occurrence groups at any one site will depend on the size of that site and can be worked out using species accumulation curves. These will be important at the assessment stage (Step 4).

Another important element of community structure is the **density** of plants that naturally occur at sites. If too few plants are present at a site, then weed species may establish more easily in the empty spaces between native plants. In a natural community, these spaces rarely occur, as when plants are young, there are usually many seedlings that fill spaces, many of which eventually die.

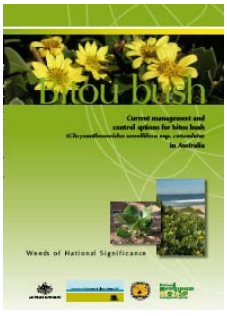
Understanding the density of plants in mature vegetation will inform restoration groups about the endpoint, and provide some direction about the density of seedlings that might be planted. Ensuring small seedlings are planted at greater densities than mature vegetation will result in mortality, but will fill spaces in the landscape and reduce weed invasion at early stages of restoration. Thus, mortality should not be considered a failure in restoration, but an important part of the process.

Supplementary planting may be needed over time to adjust the age structure of the populations within the community so that not all plants of a species are the same age.

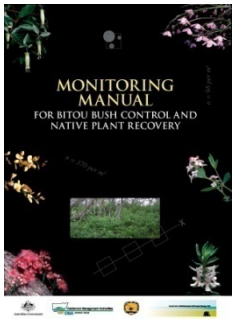
Step 2 – Site Management

Site management includes the removal of weeds and stabilisation of the site. Information on site management is not included here as it is dealt with in other resources. Site management to control weeds will be one of the early active steps in restoration. The following resources are likely to be helpful in Step 2 but there may be a range of other important resources available not listed here.

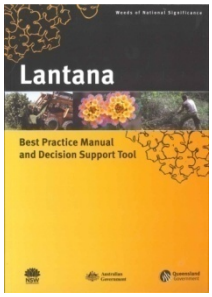
These resources provide good advice on how to manage weeds including spraying, manual removal and biological control as well as how to implement monitoring protocols. Active removal may occur initially, with follow-up activities at regular intervals. However, during this process there is space available in the landscape for native species to establish and so Step 2 (site management) and Step 3 (natural regeneration) are likely to overlap.



Winkler, MA, Cherry, H and Downey, PO (eds) (2008). *Bitou bush Management Manual: current management and control options for bitou bush (Chrysanthemoides monilifera ssp. rotundata) in Australia.* Department of Environment and Climate Change (NSW), Sydney.



Hughes, N. K., Burley, A. L., King, S. A. and Downey, P. O. (2009). *Monitoring Manual for Bitou Bush Control and Native Plant Recovery.* Department of Environment, Climate Change and Water, Sydney, NSW, http://www.environment.nsw.gov.au/bitouTAP/monitoring.htm.



Stock, D., Johnson, K., Clark, A. and van Oosterhout, E. (2009). *Lantana Best Practice Manual and Decision Support Tool.* The State of Queensland, Dept Employment Economic, Development and Innovation, Yeerongpilly.

Step 3 – Natural Regeneration

Utilising natural regeneration is a useful part of the management process, as this is the most cost effective method of restoration and provides local provenance of species. The contribution of natural regeneration depends largely on the availability of a soil stored seed bank, and, for some communities, the presence of long-distance seed dispersal.

A tradeoff exists between how long this step is allowed to continue before the next step (site assessment) is implemented. More species are likely to be naturally recruited to the community over a longer time, however this is offset against the likelihood of weed species establishing that will in turn require significant control. The time allowed for natural regeneration will depend on the degree of weed invasion (time since invasion and severity of the weed infestation) and disturbance of the community.

In coastal areas, the main contribution of the seed bank is likely be evident within 6-12 months, as there is little expectation that native seeds will arrive into the site from distant sources (see 'The Role of Dispersal'). With time, more species may germinate from the seed bank, but these are likely to be relatively rare events.

For littoral rainforest sites, the process may take more time, as not every species produces fruits and seeds each year. However, one of the difficulties in leaving sites for too long is that reinvasion of weeds (including germination of weeds from the soil seed bank) is likely to become significant. Thus the time needed for natural regeneration will vary from site to site.

Given the problems of weed invasion, follow-up weed management will be necessary at most sites. It is suggested that even littoral rainforest sites are not left more than 12-14 months before assessment and further action.

The advantage of allowing this natural regeneration step is that it eliminates a number of species from having to be replanted, as they have the ability to restore populations naturally. Some species may already be in the standing vegetation and may show increased growth rates and provide new seed. However, densities of naturally established seedlings should match expected numbers and this should be assessed to ensure that enough seedlings have established.

Economically the natural regeneration step is important because time is not invested replanting abundant species that will be restored through natural processes.

Figure 8 Restoration at Penguin Head.
Photo Kerry Thompson

Step 4 – Site Assessment and Identification of Missing Species

Following the establishment phase for naturally occurring seedlings (Step 3), a survey of species present at the site should be completed. This list of native plants present at the site should then be compared with the initial list of desired species developed in Step 1.

To do this site assessment, a defined area is searched and all observed species are recorded and crossed off on an assessment form (See below for case studies). The assessment form lists groups of species that should be in the vegetation in terms of frequency of occurrence in field plots (**frequency of occurrence groups**). The number of species in each frequency of occurrence group is counted and used to compare with the average number of species that should be in a particular frequency of occurrence group based on the size of the area surveyed. For smaller areas, the whole site can be assessed, but for larger sites, a large subset of the area can be surveyed.

For each frequency of occurrence group, the difference between the number of species at the site and the predicted number of species that should occur in the site represents the number of extra species from that frequency of occurrence group that should be planted. These collectively form the **'missing species' list.**

Any species from the frequency of occurrence group can be chosen and put in the missing species list but it would be wise to ensure that there is good representation of the smaller species. An understanding of dispersal mechanisms would be useful, although not essential. If dispersal mechanisms are understood, then those species with short-distance dispersal can be identified as a priority for replanting because this is the only mechanism to restore these species to the site. While the missing species list may encompass a range of species, site managers may choose to stagger the replanting of the full list of species over a number of years to accommodate funding limitations. This will also provide species with long-distance dispersal mechanisms an opportunity to establish naturally.

Sites should be monitored every couple of years to ensure that species that were not planted are returning naturally. A time limit needs to be set to ensure that these species are eventually replanted if they do not return from the seedbank or dispersal.

For each habitat, there is a list of species that occur only occasionally. These are not considered part of the core group of species to be included in any replanting, although they may be present. While these species occur naturally, they are not included in the replanting design unless there are special reasons to do so, e.g. a threatened species, a species that is regionally restricted. For example, *Muelenbeckia adpressa* is restricted in NSW to the coastal area near Victoria and may be useful to include in restoration at some sites in this region. The missing species list may also include species from the 'occasional' list which are deemed of local importance to the area being restored.

When plants at a restoration site have established well, an assessment of plant density is also useful. Comparing the density of different functional groups of plants (e.g. shrubs, herbs, graminoids etc) between restored and native sites can give restoration groups an indication of missing structural layers in the

vegetation and can be used to inform future replantings. For example, while shrub density may be similar to native vegetation, herbs may be sparse and future planting would therefore focus on herbaceous species. As a result, the missing species list may also include any species that are under-represented at sites relative to their densities at natural sites.

Plant communities with significant empty spaces are likely to experience increased rates of weed invasion. Weed invasion can be minimized if native seedlings are replanted in dense planting schemes. As a result, in the early stages of planting these guidelines advocate an increased density of plantings that is greater than the natural densities. This may assist in reducing weed establishment. While dense planting may also result in mortality due to crowding, it is likely to be more economical to grow and replant a species than incur the costs involved with weed management.

Site assessment forms should be maintained online for easy download by interested workers. Site assessment forms for the two habitats used as case studies in these guidelines are available from a number of sites, including via the author's webpage:

http://www.uow.edu.au/science/biol/biolschoolstaff/UOW009787.html

Figure 9. *Correa alba:* a common species in Coastal Foredune Scrub

Step 5 – Propagation and Replanting of Targeted Species

Replanting efforts should move from a focus on commonly occurring species to a targeted list of rarer or 'missing' species. This will result in a restoration program with higher biodiversity benefits. Supplying the list of plants that are 'missing' from your site will provide a nursery with the information needed to grow the right species for replanting.

Given that many of the targeted species have not been used in replanting schemes before, there will be much to learn about propagating and planting to ensure the establishment of these species at sites. Nurseries are likely to need extra time to establish sufficient stock and propagate hard-to-grow species. Future restoration efforts will be improved if information on the success of growing and planting different species is recorded and kept by groups. Sharing such information would be useful for future efforts.

Adhering to **established guidelines for the collection of seed and propagation** is critical (e.g. Florabank Guidelines and Model Code of Practice: *http://www.florabank.org.au)*. Local provenance is encouraged, although not always possible, and a wide variety of genetic stock should be sought (i.e. seeds and propagating material should not be sourced from a single plant only).

Furthermore, when organising propagation, it should be remembered that replanting at higher densities may increase the chances of establishment and reduce weed invasion and future management. Groups should also become aware of subtle microhabitat requirements of some species, which

may die if planted in the wrong conditions.

Repeat assessments and replanting is important to ensure long-term establishment at sites. Regular assessments every couple of years would ideally be undertaken, perhaps being incorporated into NRM activities or with follow-up weeding.

Weed management may be needed before Step 5, as weed species establish quickly. Given that exotic species differ in their impact on native species, targeting weed control to those high risk weed species (such as bitou bush) that compete strongly with native species, rather than low density exotic species, is likely to be economically and ecologically efficient.

Overly abundant native species may also be thinned to provide opportunities for establishment of rarer species.

Figure 10. *Elaeodendron australis*: a quite common species in Tempreate littoral Rainforest

Using the Guidelines to Improve Biodivesity across Regions

While a full complement of species may not be required at individual restoration sites, there is an opportunity to manage the full species complement of vegetation communities at the regional level. These guidelines can be used to assess regional level biodiversity, ensuring that all the less common species are incorporated into restored sites somewhere in the region, although not at all sites. Combining assessments from a number of sites into a single regional-scale assessment (the accumulated species lists from each individual site) will ensure that regional diversity is adequately assessed. This may pick up species that have not been adequately represented across the region in replanting schemes.

Case Study 1:

Restoration of Coastal Foredune Scrub

Figure 11. Coastal Foredune Scrub at Beecroft Peninsula

Step 1 – Defining the Community and Endpoint for Restoration

Community definition

Coastal Foredune Scrub is restricted to foredunes on beaches and is described by Tozer *et al*. (2010) as Unit e61. The vegetation is largely less than 2 m tall, consisting of a dense shrub layer and ground cover. The shrub layer is dominated by *Acacia longifolia* subsp. *sophorae* with *Banksia integrifolia* subsp. *integrifolia, Leucopogon parviflorus* and *Rhagodia candolleana* subsp. *candolleana.* Ground cover species include *Carpobrotus glaucescens, Ficinia nodosa*, and *Zoysia macrantha*, and also more restricted species such as *Calystegia soldanella* and *Actites megalocarpa.* Occasional trees of *Eucalyptus botryoides* occur. Closer to the strand line, a subsample of species persists as Beach Strand Grassland dominated by *Spinifex sericeus.* Behind the foredune the vegetation usually merges into Coastal Sand Forest or Temperate Littoral Rainforest.

Species richness and frequency of occurrence

We used quadrat data derived from standard 20 x 20m surveys from the Illawarra to the Eurobodalla region to investigate species composition in undisturbed coastal foredune scrub. Using 60 sites derived from the DECCW database, Mason and French (2007) and more recent surveys, an understanding of the commonness or rarity of species included in Coastal Foredune Scrub community was developed.

Initially, we tested whether coastal dune scrub varied along the south coast. The region was divided into 3 subregions based on council boundaries (Illawarra and Kiama, Shoalhaven, Eurobodalla), but as there were no differences in species composition among these subregions, all subregions were grouped together. As a result we consider, like Tozer et al (2010), that **Coastal Foredune Scrub is the same across the South Coast region**.

A large number of species (90) occurred at only one or two sites across the region and are termed *occasional* species. Groups may wish to use some of these species in replanting, particularly if a species is regionally significant (see Appendix 2).

The remaining species were divided into 4 frequency of occurrence groups depending on the number of plots where the species occurred: *very common, common, quite common and uncommon*. This process was done subjectively but tried to use any natural grouping of species that occurred in similar frequencies to delineate the boundaries between each of the groups. All species were considered to occur frequently enough to be useful in planting schemes.

Overall, we found **75 species** belonging to the top 4 groups. When the species were divided into different frequency of occurrence categories, we identified 11 very common, 13 common, 17 quite common and 34 uncommon species.

We used the data to develop species accumulation curves for combinations of the frequency of occurrence groups (Fig. 12 and Table 1). This defined, for any particular sized area, how many of each group are present. For example for an area that is 0.4ha, there should be 11 very common species, 11 common, 13 quite common and 19 uncommon species.

Very common species are all present at sites that are larger than 0.4 ha (10 quadrats), whereas all uncommon species were only present when 40 quadrats were included (1.6 ha or 800 x 20m). These numbers can be used as a guide for the number of species that should be present in restored sites.

The list of species and their dispersal modes (long- and short- distance dispersal) are provided in Table 2. It can be assumed that most of the species with short distance dispersal will not arrive at sites if they do not establish from the seed bank. They are unlikely to gain representation if ignored in a planting scheme.

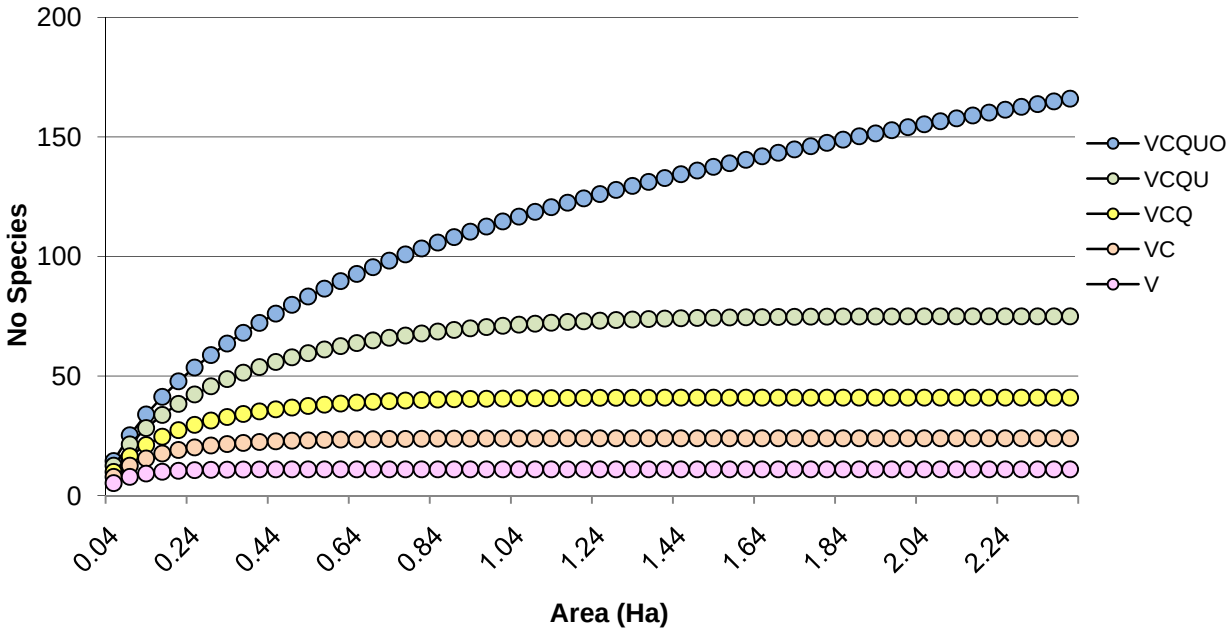


Figure 12. Species accumulation curve for different subsets of plants in Coastal Foredune Scrub. V – only data for very common species used to develop the curve. VC – used data for very common and common species, VCQ – used data from very common, common and quite common species, VCQU – used data from very common, common, quite common and uncommon species. VCQUO – used data from very common, common, quite common, uncommon and occasional species

Table 1. The number of species within each abundance class that are present at sites of different size for Foredune Coastal Scrub. This can be used as a guide to determining how many and what types of species might be missing from sites. # does not include Occasional species

Area ha	Quadrat Size m x m	No. Occasional	No. Uncommon	No. Quite Common	No. Common	No. Very Common.	TOTAL#
0.04	20x20m	2	3	2	3	5	13
0.2	100x20	9	11	8	9	10	38
0.4	200x20	18	19	13	11	11	54
0.6	300x20	27	24	15	12	11	62
0.8	400x20	36	28	16	13	11	68
1	500x20	44	30	17	13	11	71
1.2	600x20	51	32	17	13	11	73
1.4	700x20	59	33	17	13	11	74
1.6	800x20	66	34	17	13	11	75
1.8	900x20	73	34	17	13	11	75
2	1000x20	79	34	17	13	11	75
2.2	1200x20	85	34	17	13	11	75
2.4	1300x20	91	34	17	13	11	75

REPRESENTATIVE SPECIES IN COASTAL FOREDUNE SCRUB

VERY COMMON SPECIES	Life Form	DISPERSAL Long/short
Acacia longifolia subsp. sophorae	S	Long – verte/ant
Actites megalocarpa	H	Long - wind
Banksia integrifolia subsp. integrifolia	TS	Long - wind
Carpobrotus glaucescens	H	Long - vertebrate
Dichondra repens	H	Short - none
Isolepis nodosa	G	Short - none
Leucopogon parviflorus	S	Long - vertebrate
Lomandra longifolia	G	Short - ant
Monotoca elliptica	S	Long - vertebrate
Rhagodia candolleana subsp. *candolleana*	S	Long - vertebrate
Spinifex sericeus	G	Long - wind

COMMON SPECIES		
Poa billardierei	G	Long - wind
Breynia oblongifolia	TS	Long - vertebrate
Calystegia soldanella	H	Short - none
Commelina cyanea	H	Long - water
Correa alba var. alba	S	Short - ballistic
Correa reflexa	S	Short - ballistic
Cynodon dactylon	G	Short - none
Imperata cylindrica var. major	G	Long - wind
Leptospermum laevigatum	S	Short - none
Oxalis perennans	H	Short - ballistic
Pelargonium australe	H	Short - ballistic
Senecio lautus subsp. maritimus	S	Long - wind
Zoysia macrantha	G	Long - wind

QUITE COMMON SPECIES		
Acaena novae-zelandiae	H	
Banksia serrata	TS	Long - wind
Carex pumila	G	Short - none
Dianella caerulea	H	Long - vertebrate
Dichelachne crinita	H	Long - vertebrate
Entolasia stricta	G	Short - none
Eucalyptus botryoides	TS	Short - none
[1]*Glycine clandestina*	V	Short - none
Kennedia rubicunda	V	Short - ant
Melaleuca armillaris subsp. armillaris	TS	Short - none
[2]*Pittosporum undulatum*	TS	Long - vertebrate
Pratia purpurascens	H	Short - none
Solanum stelligerum	S	Long - vertebrate
[1]*Stephania japonica var. discolor*	V	Long - vertebrate
Themeda australis	G	Long - vertebrate
Viola hederacea	H	Short - ant
Westringia fruticosa	S	Short - none

UNCOMMON SPECIES	Life Form	DISPERSAL Long/short
Alyxia buxifolia	S	Short - ballistic
Atriplex cinerea	S	
Austrostipa flavescens	G	
Baumea juncea	G	Short - none
Casuarina glauca	TS	Long - wind
Centella asiatica	H	
Cynoglossum australe	H	Long - vertebrate
Desmodium varians	H	Long - vertebrate
Elaeocarpus reticulatus	TS	Long - vertebrate
[1]*Glycine tabacina*	V	Short - none
Gonocarpus teucrioides	S	Short - none
Hibbertia acicularis	S	Short - none
Hibbertia scandens	V	Long - vertebrate
Lepidosperma laterale	G	Short - ant
Macrozamia communis	S	Long - vertebrate
Microlaena stipoides	G	Short - none
[3]*Muehlenbeckia adpressa*	V	
Olearia axillaris	S	Long - wind
Opercularia aspera	S	Short - ant
Oplismenus imbecillis	G	Short - none
Oxalis radicosa	H	Short - ballistic
Oxalis rubens	H	Short - ballistic
Pittosporum revolutum	S	Long - vertebrate
Poa meionectes	G	
Poa poiformis var. poiformis	G	Long - wind
Pteridium esculentum	H	Long - wind
Rhodamnia rubescens	TS	Long - vertebrate
Rubus parvifolius	V	Long - vertebrate
Scaevola calendulacea	V	Long - vertebrate
Senecio linearifolius	H	Long - wind
Solanum opacum	H	Long - vertebrate
Solanum prinophyllum	H	Long - vertebrate
Solanum pungetium	H	Long - vertebrate
Sporobolus virginicus	G	Short - none

[1] Vines which often establish easily from bird dispersal and can be weedy
[2] Species often considered weedy and may be avoided if abundant in nearby areas.
[3] Species has limited distribution in far south coast

Table 2. Plant species in each commonness category and their dispersal modes, where known, for Coastal Foredune Scrub TS – tall shrub or tree, S – shrub, H – herb, V – vine, G – grass or grass-like species.

Plant density

Thirty sample quadrats at Seven Mile Beach, Comerong Island and Currarong Beach were used to measure the number of plants in a 20 x 20 m quadrat in relatively undisturbed foredune vegetation. Plant densities at these sites are used as representative of densities in a target post-restoration community. The density values can thus be used as a guide to planting densities when planning or assessing sites (Table 3).

Counting plants with stems that root at nodes (some grasses and herbs) is difficult without destructive sampling. As a result, it is difficult to provide clear advice on the number of plants that should be planted for these species. Planting too many **stoloniferous grasses** (grasses that spread from 'runners') may cause them to dominate. It is suggested that a small number of plants of these species are planted and then their progress followed, with an aim to achieve approximately 20% cover across the site at maturity.

For **herbs** with underground stems (e.g. *Oxalis, Viola*), the species are unlikely to dominate, so planting a larger number of these is not a problem. It is suggested that, in total, about 40 herbaceous plants are planted in each 20 x 20m area. This equates to plants having on average 10 above-ground ramets per plant. A ramet is a tuft seen above ground that is connected by underground (or above ground) stems to other tufts.

Tall shrubs include species such as *Pittosporum undulatum, Banksia integrifolia, Breynia oblongifolia, E. botryoides* and *Casuarina glauca.* Eucalypts should only be planted on relatively flat foredunes where the hind dune vegetation mixes quite closely with foredune vegetation.

Although it is not suggested that **vines** be planted in the early stages of restoration, we provide the information about how many vines occur in quadrats for assessment at a later stage. Early planting of vines is likely to smother newly establishing species. Management of these species may be needed if they naturally establish in high densities.

Similarly, planting of native species which are considered weedy is also undesirable; these are identified in Table 2.

Many species naturally occur in clumped distributions, perhaps associated with subtle microhabitat differences. For instance, some of the tall shrub species may not survive at the very front of the foredune and are more typical of areas a little further back.

Life form	No. plants
Shrubs	394
Tall shrubs	91
Herbs	190
Tussocking grasses	240
Vines	112
Stoloniferous grasses	20% cover
Stoloniferous herbs	373 ramets

Table 3 Average density of plants found in 20 x 20m plots assessed at 3 beaches on the south coast.

Step 4 - Site Assessment and Identification of Missing Species

Following weed management (Step 2 – not dealt with in these guidelines) and after leaving plots for a year or so to enable natural regeneration to occur, groups should assess their area to determine if the species richness is similar to undisturbed native areas. In Step 1, we established a list of species that should occur in the restored site, as well as an approximation of the densities of those species (page 18). Step 3 uses that baseline data to assess each site and to determine the direction of further restoration. This process is best illustrated by three case studies of sites where work has been ongoing.

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Narrawallee

Figure 13. Narrawallee Beach Restoration Area

A survey of the Narrawallee area that has been restored by the Narrawallee Foreshore & Reserves Bushcare Group was undertaken in 2010. While surveying the whole area would be preferable, in this exercise we surveyed only a 100 x 20m strip of the foredune vegetation. Using the assessment form (Appendix 5), the boxes were crossed for all species found in the plot. If a species was not listed but was native, then it was added in the 'occasional species' count. Using Table 1, we identified how many species were predicted in native areas for each of the groups and wrote this in brackets next to the number of species found (Table 4). For example, we found 8 very common species, but should have found 10 and we found 8 common species but should have found 9, etc. Overall there were 14 species recorded, suggesting that 2 very common, 1 common, 5 quite common and 11 uncommon species are missing, totalling 26 missing species.

Recommendation for planting

Table 5 shows a set of possible species from each grouping that might be propagated for replanting at Narrawallee. While any species not already present at the site from each group could have been chosen, it is suggested that the species picked come from a range of life forms (shrubs, grasses, herbs). Vines were not chosen in this example but could be, as there is relatively mature vegetation already present. There is flexibility for groups to vary planting from site to site.

VERY COMMON SPECIES	
Acacia longifolia subsp. sophorae	x
Actites megalocarpa	x
Banksia integrifolia subsp. integrifolia	x
Carpobrotus glaucescens	x
Dichondra repens	
Isolepis nodosa	x
Leucopogon parviflorus	x
Lomandra longifolia	x
Monotoca elliptica	
Rhagodia candolleana subsp. candolleana	
Spinifex sericeus	x
TOTAL number	A 8 (10)

COMMON SPECIES	
Poa billardierei	
Breynia oblongifolia	x
Calystegia soldanella	
Commelina cyanea	
Correa alba var. alba	x
Correa reflexa	
Cynodon dactylon	x
Imperata cylindrica var. major	x
Leptospermum laevigatum	
Oxalis perennans	x
Pelargonium australe	x
Senecio lautus subsp. maritimus	x
Zoysia macrantha	x
TOTAL number	B 8 (9)

QUITE COMMON SPECIES	
Acaena novae-zelandiae	
Banksia serrata	
Carex pumila	
Dianella caerulea	
Dichelachne crinita	
Entolasia stricta	
Eucalyptus botryoides	x
Glycine clandestina	
Kennedia rubicunda	
Melaleuca armillaris subsp. armillaris	x
Pittosporum undulatum	
Pratia purpurascens	
Solanum stelligerum	x
Stephania japonica var. discolor	
Themeda australis	
Viola hederacea	
Westringia fruticosa	x
TOTAL number	C 3 (8)

UNCOMMON SPECIES	
Alyxia buxifolia	
Atriplex cinerea	
Austrostipa flavescens	
Baumea juncea	
Casuarina glauca	
Centella asiatica	
Cynoglossum australe	
Desmodium varians	
Elaeocarpus reticulatus	
Glycine tabacina	
Gonocarpus teucrioides	
Hibbertia acicularis	
Hibbertia scandens	
Lepidosperma laterale	
Macrozamia communis	
Microlaena stipoides	
Muehlenbeckia adpressa	
Olearia axillaris	
Opercularia aspera	
Oplismenus imbecillis	
Oxalis radicosa	
Oxalis rubens	
Pittosporum revolutum	
Poa meionectes	
Poa poiformis var. poiformis	
Pteridium esculentum	
Rhodamnia rubescens	
Rubus parvifolius	
Scaevola calendulacea	
Senecio linearifolius	
Solanum opacum	
Solanum prinophyllum	
Solanum pungetium	
Sporobolus virginicus	
TOTAL number	D 0 (11)

No. OCCASIONAL Species	E 3

TOTAL SPECIES A+B+C+D+E	14

Numbers in brackets refer to how many species are predicted to be in plot based on Table 1.

Table 4. Assessment survey of Narrawallee

A possible list of species that might be used in replanting projects at

Narrawallee

based on comparison with intact vegetation

Very Common species (2 missing)

Dichondra repens
Rhagodia candolleana subsp. candolleana

Common Species (1missing)

Poa billardierei (Austrofestuca littoralis)

Quite Common Species (6 missing)

Acaena novae-zelandiae
Banksia serrata
Carex pumila
Dianella caerulea
Entolasia stricta
Pratia purpurascens

Uncommon Species (11 missing)

Atriplex cinerea
Austrostipa flavescens
Baumea juncea
Gonocarpus teucrioides
Hibbertia acicularis
Microlaena stipoides
Olearia axillaris
Oxalis rubens
Senecio linearifolius
Solanum opacum
Sporobolus virginicus

Table 5. An example of a species list that could be used in a future replanting scheme at Narrawallee.

Culburra

Figure 14 Culburra Beach vegetation

Culburra beach has been managed by Culburra Landcare Dunecare Group. A survey was carried out along 100 x 20m strip of the foredune vegetation (Table 6) in a similar manner to the Narrawallee survey. Existing species at the site were compared to the desired species list. Nine very common species were found where there should have been 10, 4 common species where there should have been 9, 3 quite common species where there should have been 8 and 1 uncommon species. As at Narrawallee, 19 species were found that were heavily weighted towards the most common species, while species losses (i.e. 'missing' species) were associated with the less common species.

Recommendation for planting

A potential set of species from each group that might be replanted at the site to increase species representation was compiled (Table 7). Any species not already present at the site from each group could have been chosen although it is suggested that the species picked come from a range of life forms (shrubs, grasses, herbs). If species that are present are in low densities then these can be added to the propagation list.

VERY COMMON SPECIES	
Acacia longifolia subsp. sophorae	x
Actites megalocarpa	x
Banksia integrifolia subsp. integrifolia	x
Carpobrotus glaucescens	x
Dichondra repens	x
Isolepis nodosa	x
Leucopogon parviflorus	x
Lomandra longifolia	x
Monotoca elliptica	
Rhagodia candolleana subsp. candolleana	x
Spinifex sericeus	
TOTAL number	A 9 (10)

COMMON SPECIES	
Poa billardierei	
Breynia oblongifolia	
Calystegia soldanella	
Commelina cyanea	
Correa alba var. alba	x
Correa reflexa	
Cynodon dactylon	
Imperata cylindrica var. major	
Leptospermum laevigatum	x
Oxalis perennans	
Pelargonium australe	x
Senecio lautus subsp. maritimus	
Zoysia macrantha	x
TOTAL number	B 4 (9)

QUITE COMMON SPECIES	
Acaena novae-zelandiae	
Banksia serrata	
Carex pumila	
Dianella caerulea	x
Dichelachne crinita	
Entolasia stricta	
Eucalyptus botryoides	
Glycine clandestina	
Kennedia rubicunda	
Melaleuca armillaris subsp. armillaris	
Pittosporum undulatum	
Pratia purpurascens	
Solanum stelligerum	
Stephania japonica var. discolor	x
Themeda australis	x
Viola hederacea	
Westringia fruticosa	
TOTAL number	C 3 (8)

UNCOMMON SPECIES	
Alyxia buxifolia	
Atriplex cinerea	
Austrostipa flavescens	
Baumea juncea	
Casuarina glauca	
Centella asiatica	
Cynoglossum australe	
Desmodium varians	
Elaeocarpus reticulatus	
Glycine tabacina	
Gonocarpus teucrioides	
Hibbertia acicularis	
Hibbertia scandens	x
Lepidosperma laterale	
Macrozamia communis	
Microlaena stipoides	
Muehlenbeckia adpressa	
Olearia axillaris	
Opercularia aspera	
Oplismenus imbecillis	
Oxalis radicosa	
Oxalis rubens	
Pittosporum revolutum	
Poa meionectes	
Poa poiformis var. poiformis	
Pteridium esculentum	
Rhodamnia rubescens	
Rubus parvifolius	
Scaevola calendulacea	
Senecio linearifolius	
Solanum opacum	
Solanum prinophyllum	
Solanum pungetium	
Sporobolus virginicus	
TOTAL number	D 1 (11)

No. OCCASIONAL Species	2
	E 2

TOTAL SPECIES A+B+C+D+E	
	19

Table 6. Assessment survey of Culburra

A possible list of species that might be used in replanting projects at

Culburra

based on comparison with intact vegetation

Very Common species (1 missing)

Monotoca elliptica

Common Species (5 missing)

Calystegia soldanella
Commelina cyanea
Correa reflexa
Oxalis perennans
Senecio lautus subsp. maritimus

Quite Common Species (5 missing)

Dichelachne crinita
Entolasia stricta
Melaleuca armillaris subsp. Armillaris
Solanum stelligerum
Viola hederacea

Uncommon Species (10 missing)

Alyxia buxifolia
Centella asiatica
Cynoglossum australe
Desmodium varians
Lepidosperma laterale
Macrozamia communis
Opercularia aspera
Oplismenus imbecillis
Oxalis radicosa
Sporobolus virginicus

Table 7. An example of a species list that could be used in a future replanting scheme at Culburra

Cronulla

At Cronulla, the area surveyed has been managed for many years following artificial rebuilding of the sand dune. In this area we sampled an 80 x 20 m plot. This size is not listed in Table 1 but is closest in size to the 100 x 20m estimate and so this is used to approximate the number of species that should be present in each group. In the survey, 5 of the 10 very common species predicted were found, 2 of the 9 common species, 1 of the 8 quite common species and no uncommon species (Table 8). As in other sites surveyed, many uncommon species were missing from the site.

Recommendations for plantings

A possible set of species is provided that might be replanted at the site to increase species representation (Table 9). Vines have not been chosen at this stage as they may require mature plants on which to grow and may limit successful establishment of some of the species. Species such as *Glycine clandestina* and *Stephania japonica var. discolor* are also vertebrate dispersed and can establish regularly by themselves.

CRONULLA	80 x 20m
VERY COMMON SPECIES	
Acacia longifolia subsp. sophorae	x
Actites megalocarpa	x
Banksia integrifolia subsp. integrifolia	
Carpobrotus glaucescens	x
Dichondra repens	
Isolepis nodosa	
Leucopogon parviflorus	
Lomandra longifolia	
Monotoca elliptica	
Rhagodia candolleana subsp. candolleana	x
Spinifex sericeus	x
TOTAL number	A 5 (~10)

COMMON SPECIES	
Poa billardierei	x
Breynia oblongifolia	
Calystegia soldanella	
Commelina cyanea	
Correa alba var. alba	
Correa reflexa	
Cynodon dactylon	
Imperata cylindrica var. major	
Leptospermum laevigatum	
Oxalis perennans	
Pelargonium australe	
Senecio lautus subsp. maritimus	x
Zoysia macrantha	
TOTAL number	B 2 (~9)

QUITE COMMON SPECIES	
Acaena novae-zelandiae	
Banksia serrata	
Carex pumila	
Dianella caerulea	
Dichelachne crinita	
Entolasia stricta	
Eucalyptus botryoides	
Glycine clandestina	
Kennedia rubicunda	
Melaleuca armillaris subsp. armillaris	
Pittosporum undulatum	
Pratia purpurascens	
Solanum stelligerum	
Stephania japonica var. discolor	x
Themeda australis	
Viola hederacea	
Westringia fruticosa	
TOTAL number	C 1 (~8)

UNCOMMON SPECIES	
Alyxia buxifolia	
Atriplex cinerea	
Austrostipa flavescens	
Baumea juncea	
Casuarina glauca	
Centella asiatica	
Cynoglossum australe	
Desmodium varians	
Elaeocarpus reticulatus	
Glycine tabacina	
Gonocarpus teucrioides	
Hibbertia acicularis	
Hibbertia scandens	
Lepidosperma laterale	
Macrozamia communis	
Microlaena stipoides	
Muehlenbeckia adpressa	
Olearia axillaris	
Opercularia aspera	
Oplismenus imbecillis	
Oxalis radicosa	
Oxalis rubens	
Pittosporum revolutum	
Poa meionectes	
Poa poiformis var. poiformis	
Pteridium esculentum	
Rhodamnia rubescens	
Rubus parvifolius	
Scaevola calendulacea	
Senecio linearifolius	
Solanum opacum	
Solanum prinophyllum	
Solanum pungetium	
Sporobolus virginicus	
TOTAL number	D 0 (~11)

No. OCCASIONAL Species	
	E 4

TOTAL SPECIES A+B+C+D+E	
	12

Numbers in brackets refer to how many species are predicted to be in plot based on Table 1. As the plot size is a little smaller than the 100 x 20m plot highlighted, the plot would only be expected to have something near these numbers

Table 8. Assessment survey of Cronulla

A possible list of species that might be used in replanting projects at

Cronulla

based on comparison with intact vegetation

Very Common species (5 missing)

Banksia integrifolia subsp. integrifolia
Dichondra repens
Leucopogon parviflorus
Lomandra longifolia
Monotoca elliptica

Common Species (7 missing)

Breynia oblongifolia
Calystegia soldanella
Commelina cyanea
Correa alba var. alba
Oxalis perennans
Pelargonium australe
Senecio lautus subsp. maritimus

Quite Common Species (7 missing)

Acaena novae-zelandiae
Carex pumila
Dianella caerulea
Kennedia rubicunda
Melaleuca armillaris subsp. armillaris
Solanum stelligerum
Viola hederacea

Uncommon Species (11 missing)

Alyxia buxifolia
Atriplex cinerea
Centella asiatica
Desmodium varians
Gonocarpus teucrioides
Hibbertia scandens
Lepidosperma laterale
Oplismenus imbecillis
Oxalis radicosa
Solanum prinophyllum
Solanum pungetium

Table 9. An example of a species list that could be used in a future replanting scheme at Cronulla

Case Study 2:

Temperate Littoral Rainforest

Figure 15. Temperate Littoral Rainforest.

Step 1 – Defining the Community and Endpoint for Restoration

Community definition

Littoral rainforests are closed forests that are influenced by, and receive significant nutrients from salt spray. On the South Coast, they occur on deep sands behind the foredunes of beaches and in protected gully areas. They have a dense tree canopy but a sparse understorey and ground layer. Vines may occur frequently. Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions is listed on Schedule 1 of the NSW *Threatened Species Conservation Act* (1995). Temperate Littoral Rainforest is described by Tozer et al (2010) as Unit p210.

Species Richness

We used quadrat data derived from standard 20 x 20m surveys from the Illawarra to the Eurobodalla region to investigate species composition in undisturbed sites Using 52 sites derived from the DECCW database and more recent surveys, a description of the species included in Temperate Littoral Rainforest was developed. Initially we sought to test whether littoral rainforest varied along the South Coast. The region was divided into two subregions based on council boundaries (Illawarra and Kiama, Shoalhaven and Eurobodalla). The main distinguishing feature was an increase in the frequency

of *Pittosporum undulatum* in the northern areas and differences associated with the southern limits of some species (Table 11). As a result Littoral Rainforest was treated as a single community along the coast but southern distributions were noted on the list. Southern limits were taken as the most southern record of presence by one of three sources; this study, PlantNet webpage by the Sydney Botanic Gardens or Mills (1996). As Mimosa Rocks was the most southern source of data for the latter two sources, these southen limits are likely to cover all areas of littoral rainforest on the South Coast of NSW to this area.

As with Coastal Foredune Scrub, there were a large number of species that occurred only at one or two sites (96 species). These are classified as *occasional* species and listed in Appendix 4.

The remaining species were divided into 4 frequency of occurrence groups depending on the number of plots where they were found: v*ery common, common, quite common, uncommon.* The cutoff between frequency of occurrence groups process was done subjectively. All species were considered to occur frequently enough to be useful in planting schemes. Overall, we found 112 species. When the species were divided into different commonness categories, we identified 12 very common, 14 common, 22 quite common and 64 uncommon species. Common names are listed in Appendix 3.

We used the data to develop species accumulation curves for combinations of groups (Fig. 16 and Table 10). This defined, for any particular sized area, how many species are present within each group. All very common species were all present when 5 quadrats were surveyed (0.2ha or 100 x 20m), whereas all uncommon species were all present when 35 quadrats were surveyed (1.4 ha or 700 x 20m). These species accumulation curves and the associated table can be used as a guide for the number of species that should be present in restored sites (Fig. 16 and Table 10). Table 12 is the list of littoral rainforest species and their dispersal modes (long- and short- distance dispersal). It can be assumed that most of the species with short distance dispersal will not arrive at sites if they fail to establish from the seed bank. These are particularly vulnerable if ignored in a planting scheme.

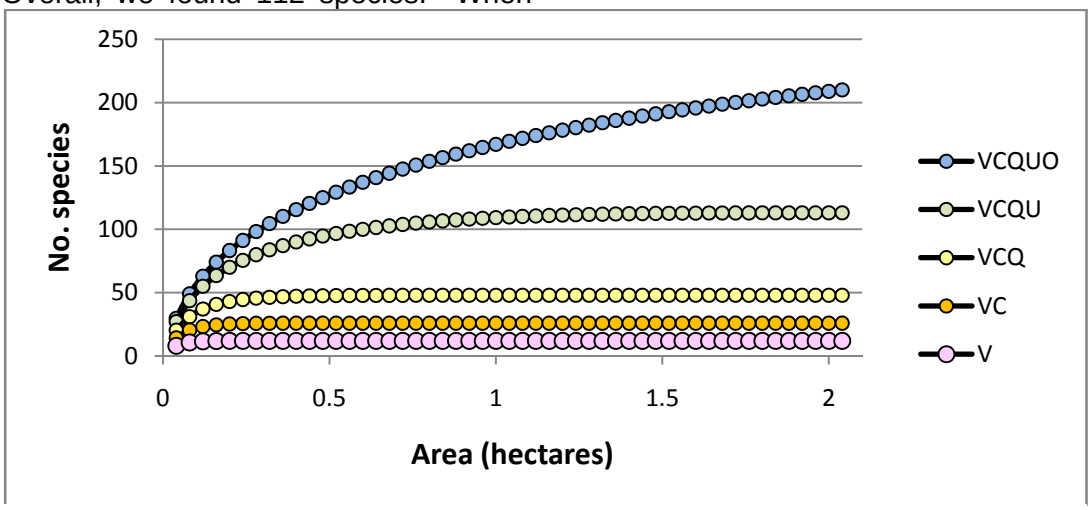

Figure 16. Species accumulation curve for different subsets of plants in Temperature Littoral Rainforest. V – only data for very common species used to develop the curve. VC – used data for very common and common species, VCQ – used data from very common, common and quite common species, VCQU – used data from very common, common, quite common and uncommon species.

Table 10. The number of species within each abundance class that are present at sites of different size for Temperate Littoral Rainforest. This can be used as a guide to determining how many and what types of species might be missing from sites. # does not include Occasional species

Area ha	Quadrat size m x m	No. Occasional	No. Uncommon	No. Quite common	No. Common	No. Very Common	TOTAL#
0.04	20x20m	3	7	6	6	8	27
0.2	100x20	13	27	18	13	12	70
0.4	200x20	26	43	21	14	12	90
0.6	300x20	37	52	22	14	12	100
0.8	400x20	48	58	22	14	12	106
1	500x20	58	61	22	14	12	109
1.2	600x20	67	63	22	14	12	111
1.4	700x20	75	64	22	14	12	112
1.6	800x20	83	64	22	14	12	112
1.8	900x20	90	64	22	14	12	112
2	1000x20	96	64	22	14	12	112

Table 11.Southern limit of species in littoral rainforest in the south coast. The most southern location is listed together with its source. PlantNet – RBG webpage, Mills,- K. Mills 1996.

	Known southern limit	Source
Shoalhaven area		
Cayratia clematidea	Comerong Is	PlantNet
Gymnostachys anceps	Comerong Is	This study
Planchonella australis	Gerroa	Mills
Jervis Bay area		
Cyclophyllum longipetalum	Jervis Bay	PlantNet
Diospyros pentamera	Beecroft Pen.	This study
Euroschinus falcatus var. falcatus	Jervis Bay	PlantNet
Melicope micrococca	Beecroft Pen.	This study
Myrsine variabilis	Beecroft Pen.	This study
Podocarpus elatus	Beecroft Pen.	PlantNet
Polyscias elegans	Jervis Bay	PlantNet
Scolopia braunii	Jervis Bay	PlantNet
Batemans Bay area		
Celtis paniculata	Marramarang	This study
Clerodendrum tomentosum	Batemans Bay	PlantNet
Duboisia myoporoides	Batemans Bay	PlantNet
Guioa semiglauca	Batemans Bay	PlantNet
Maclura cochinchinensis	Milton	PlantNet
Wilkiea huegeliana	Batemans Bay	PlantNet
Gulaga		
Alphitonia excelsa	Gulaga	PlantNet
Cryptocarya glaucescens	Gulaga	PlantNet
Ficus obliqua	Gulaga	PlantNet
Tuross Head		
Diospyros australis	Tuross Head	This study
Endiandra sieberi	Tuross Head	This study
Glochidion ferdinandi	Tuross Head	PlantNet
Smilax glyciphylla	Tuross Head	This study
Trophis scandens	Tuross Head	Mills
At least Mimosa Rocks		
Commelina cyanea	Mimosa Rocks	This study
Elaeodendron australis	Mimosa Rocks	This study
Platycerium bifurcatum	Mimosa Rocks	PlantNet
Pseuderanthemum variabile	Mimosa Rocks	This study
Synoum glandulosum subsp. glandulosum	Mimosa Rocks	This study

REPRESENTATIVE SPECIES FOR TEMPERATE LITTORAL RAINFOREST

VERY COMMON SPECIES	Life Form	DISPERSAL Long/short
Acmena smithii	T	Long-vertebrate
Breynia oblongifolia	ST	Long-vertebrate
Commelina cyanea	H	Long- water*
Eucalyptus botryoides	T	Short - none
Eustrephus latifolius	V	Long-vertebrate
Geitonoplesium cymosum	V	Long-vertebrate
Livistona australis	T	Long-vertebrate
Marsdenia rostrata	V	Long-wind
Oplismenus imbecillis	G	Short-none
Pittosporum undulatum	ST	Long-vertebrate
Pseuderanthemum variabile	H	Short-none
Viola hederacea	H	Short-ant

COMMON SPECIES		
Cissus hypoglauca	V	Long-vertebrate
Diospyros australis	T	Long-vertebrate
Eupomatia laurina	S	Long-vertebrate
Guioa semiglauca	ST	Long-vertebrate
Lomandra longifolia	G	Short-ant
Morinda jasminoides	V	Long-vertebrate
Notelaea venosa	ST	Long-vertebrate
Parsonsia straminea	V	Long-wind
Pellaea falcata	F	Long-wind
Pittosporum revolutum	ST	Long-vertebrate
Sarcopetalum harveyanum	V	Long-vertebrate
Smilax australis	V	Long-vertebrate
Smilax glyciphylla	V	Long-vertebrate
Synoum glandulosum	ST	Long-vertebrate

QUITE COMMON SPECIES		
Acacia maidenii	ST	Short-ant
Adiantum aethiopicum	F	Long-wind
Cissus antarctica	V	Long-vertebrate
Claoxylon australe	ST	Long-vertebrate
Dianella caerulea	H	Long-vertebrate
Doodia aspera	F	Long-wind
Elaeocarpus reticulatus	ST	Long-vertebrate
Elaeodendron australe	ST	Long-vertebrate
Endiandra sieberi	T	Long-vertebrate
Ficus coronata	ST	Long-vertebrate
Gahnia aspera	G	Short-none
Glochidion ferdinandi	T	Long-vertebrate
Kennedia prostrata	V	Short - ant
Myrsine howittiana	ST	Long-vertebrate
Myrsine variabilis	ST	Long-vertebrate
Notelaea longifolia	ST	Long-vertebrate
Pittosporum multiflorum	ST	Long-vertebrate
Podocarpus elatus	T	Long-vertebrate
Pteridium esculentum	F	Long-wind
Stephania japonica	V	Long-vertebrate
Tylophora barbata	V	Long-wind

UNCOMMON SPECIES	Life Form	DISPERSAL Long/short
Duboisia myoporoides	T	Long-vertebrate
Entolasia marginata	G	Short - none
Euroschinus falcata var. falcata	T	Long-vertebrate
Ficus obliqua	T	Long-vertebrate
Gahnia erythrocarpa	G	Short-none
Gahnia sieberiana	G	Short-none
Geranium homeanum	H	Short-none
Glycine sp.	V	Short - none
Gymnostachys anceps	G	Long-vertebrate
Hibbertia scandens	V	Long-vertebrate
Hymenanthera dentata	ST	Long-vertebrate
Hypolepis muelleri	F	Long-wind
Imperata cylindrica	G	Long-wind
Lepidosperma laterale	G	Short-ant
Litsea reticulata	T	Long-vertebrate
Maclura cochinchinensis	V	Long-vertebrate
Macrozamia communis	S	Long-vertebrate
Marsdenia flavescens	V	Long-wind
Melicope micrococca	T	Long-vertebrate
Microlaena stipoides var. stipoides	G	Short - none
Oplismenus aemulus	G	Short - none
Oxalis rubens	H	Short-ballistic
Pandorea pandorana	V	Long-wind
Planchonella australis	T	Long-vertebrate
Platycerium bifurcatum	F	Long-wind
Plectranthus parviflorus	S	Short-none
Polyscias elegans	T	Long-vertebrate
Psychotria loniceroides	ST	Long-vertebrate
Pteris tremula	F	Long-wind
Pyrrosia rupestris	F	Long-wind
Rhagodia condolleana	S	Long-vertebrate
Ripogonum album	V	Long-vertebrate
Rubus moluccanus var. trilobus	V	Long-vertebrate
Rubus rosifolius	V	Long-vertebrate
Sarcomelicope simplicifolia	ST	Long-vertebrate
Scolopia braunii	T	Long-vertebrate
Stellaria flaccida	H	Short - none
Stephania japonica var. discolor	V	Long-vertebrate
Trema tomentosa var. aspera	ST	Long-vertebrate
Trophis scandens	V	Long-vertebrate
Urtica incisa	H	Short-none

* method unknown but can be transported long distance by water.

Table 12. Plant species in each category and their dispersal modes, where known, for Temperate Littoral Rainforest
T – tree, TS – tall shrub or small tree, S – shrub, H – herb, V – vine, G – grass or grasslike species, F – fern.

Step 4 – Site Assessment and Identification of Missing Species

Chatham Park, Tuross Head

Tuross Head Landcare group has been working to restore Chatham Park since 1995. While surveying the whole area would be preferable, in this exercise we surveyed only a 100 x 20m strip of the rainforest vegetation. Using the assessment form, boxes were crossed for all species found in the plot. If a species was not listed and was native, then it was included in the 'occasional species' count. Using Table 10, we identified how many species were predicted in native areas for each of the groups and wrote this in brackets next to the actual number found (Table 13). Overall there were 34 (plus 13 occasional species) species of an expected 70 species (84 including occasional species). This suggests that there are 4 very common, 8 common, 8 quite common and 16 uncommon species missing. Very few understorey species were present, suggesting that future management should focus on these species.

Recommendation for planting

Table 14 shows a set of possible species from each grouping that might be propagated for replanting at Chatham Park. Any species not already present at the site from each group could have been chosen. It is suggested that the species chosen to plant come from a range of life forms (shrubs, grasses, herbs). Vines were not chosen in this example but could be, as there is relatively mature vegetation already present. There is flexibility for groups to vary planting from site to site.

SURVEY FOR LITTORAL RAINFOREST Chatham Park

Size of Area 100 x 20m

VERY COMMON SPECIES	
Acmena smithii	x
Breynia oblongifolia	
Commelina cyanea	
Eucalyptus botryoides	x
Eustrephus latifolius	x
Geitonoplesium cymosum	x
Livistona australis	
Marsdenia rostrata	x
Oplismenus imbecillis	x
Pittosporum undulatum	x
Pseuderanthemum variabile	x
Viola hederacea	
TOTAL number	A 8 (12)

COMMON SPECIES	
Cissus hypoglauca	x
Diospyros australis	
Eupomatia laurina	
Guioa semiglauca	
Lomandra longifolia	
Morinda jasminoides	x
Notelaea venosa	
Parsonsia straminea	x
Pellaea falcata	x
Pittosporum revolutum	
Sarcopetalum harveyanum	
Smilax australis	x
Smilax glyciphylla	
Synoum glandulosum subsp. glandulosum	
TOTAL number	B 5 (13)

QUITE COMMON SPECIES	
Acacia maidenii	x
Adiantum aethiopicum	x
Cissus antarctica	x
Claoxylon australe	x
Dianella caerulea	
Doodia aspera	x
Elaeocarpus reticulatus	
Elaeodendron australe	x
Endiandra sieberi	
Ficus coronata	x
Gahnia aspera	
Glochidion ferdinandi	
Kennedia prostrata	
Myrsine howittiana	
Myrsine variabilis	x
Notelaea longifolia	x

continued overleaf

UNCOMMON SPECIES	
Banksia integrifolia subsp. integrifolia	
Acronychia oblongifolia	X
Alectryon subcinereus	X
Alphitonia excelsa	
Aphanopetalum resinosum	X
Arthropodium sp.	
Asplenium flabellifolium	X
Banksia serrata	
Calochlaena dubia	
Canthium coprosmoides	
Cassine australis	
Casuarina glauca	
Cayratia clematidea	
Celtis paniculata	
Clematis aristata	
Clerodendrum tomentosum	
Corymbia maculata	
Cryptocarya glaucescens	
Cryptocarya microneura	
Cyperus gracilis	
Davallia solida var. pyxidata	
Desmodium gunnii	
Diospyros pentamera	
Duboisia myoporoides	
Entolasia marginata	
Euroschinus falcata var. falcata	
Ficus obliqua	
Gahnia erythrocarpa	
Gahnia sieberiana	
Geranium homeanum	
Glycine sp.	
Gymnostachys anceps	
Hibbertia scandens	
Hymenanthera dentata	X
Hypolepis muelleri	
Imperata cylindrica	
Lepidosperma laterale	X
Litsea reticulata	
Maclura cochinchinensis	
Macrozamia communis	
Marsdenia flavescens	X
Melicope micrococca	
Microlaena stipoides var. stipoides	
Oplismenus aemulus	
Oxalis rubens	
Pandorea pandorana subsp. pandorana	X
Platycerium bifurcatum	X
Plectranthus parviflorus	X

continued overleaf

quite common species cont.	
Pittosporum multiflorum	
Podocarpus elatus	
Pteridium esculentum	
Stephania japonica	x
Tylophora barbata	
Wilkiea huegeliana	
TOTAL number	C10(18)

uncommon species cont.	
Polyscias elegans	
Planchonella australis	
Psychotria loniceroides	
Pteris tremula	
Pyrrosia rupestris	
Rhagodia condolleana	
Ripogonum album	
Rubus moluccanus var. trilobus	
Rubus rosifolius	
Sarcomelicope simplicifolia subsp. simplicifolia	
Scolopia braunii	
Stellaria flaccida	x
Stephania japonica var. discolor	
Trema tomentosa var. aspera	
Trophis scandens	
Urtica incisa	
	D11(27)

No. OCCASIONAL Species	E 13

TOTAL SPECIES A+B+C+D+E	47

Table 13 Assessment Survey of Chatham Park

A possible set of species that might be used at

Chatham Park

based on comparison with intact vegetation

Very Common species (4 missing)

- *Breynia oblongifolia*
- *Commelina cyanea *(may become superabundant)*
- *Livistona australis*
- *Viola hederacea*

Common Species (8 missing – other species outside range)

- *Diospyros australis*
- *Lomandra longifolia*
- *Eupomatia laurina*
- *Notolaea venosa*
- *Pittosporum revolutum*
- *Sarcopetalum harveyanum*
- *Smilax glyciphylla*

Quite Common Species (8 missing)

- *Dianella caerulea*
- *Elaeocarpus reticularis*
- *Endiandra sieberi*
- *Gahnia aspera*
- *Kennedia prostrata*
- *Myrsine howittiana*
- *Pittosporum multiflorum*
- *Tylophora barbata*

Uncommon Species (16 missing) – a focus here on the smaller understorey species.

- *Calochlaena dubia*
- *Cassine australis*
- *Cryptocarya glaucescens*
- *Cyperus gracilis*
- *Davallia solida var. pyxidata*
- *Desmodium gunnii*
- *Entolasia marginata*
- *Gahnia erythrocarpa*
- *Hypolepis muelleri*
- *Microlaena stipoides var. stipoides*
- *Oxalis rubens*
- *Psychotria loniceroides*
- *Pyrrosia rupestris*
- *Ripogonum album*
- *Stellaria flaccida*
- *Trema tomentosa*
- *Trophis scandens*

Table 14. An example of a species list that could be used in a future replanting scheme at Chatham Park

References

Hughes, N. K., Burley, A. L., King, S. A. and Downey, P. O. (2009). *Monitoring Manual for Bitou Bush Control and Native Plant Recovery.* Department of Environment, Climate Change and Water, Sydney, NSW, http://www.environment.nsw.gov.au/bitouTAP/monitoring.htm.

Mason, T. J. and French, K. (2007) Management regimes for a plant invader differentially impact resident communities. *Biological Conservation*. 136: 246-259

Mills, K. (1996) Plant species lists for Littoral Rainforest sites in southern New South Wales. *Illawarra Vegetation Studies paper (5).* Coachwood Publishing, Jamberoo, NSW.

Stock, D., Johnson, K., Clark, A. and van Oosterhout, E. (2009). *Lantana Best Practice Manual and Decision Support Tool.* The State of Queensland, Dept Employment Economic, Development and Innovation, Yeerongpilly.

Tozer, M. G., Turner, K., Keith, D. A., Tindall, D., Pennay, C., Simpson, C., MacKenzie, B. and Cox, S. (2010) Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. *Cunninghamia* 11(3).

Westoby, M., Rice, B. and Howell, J. (1990) Seed size and plant growth form as factors in dispersal spectra. *Ecology* 71, 1307-1315.

Winkler, M. A., Cherry, H. and Downey, P. O. (eds) (2008). *Bitou bush Management Manual: current management and control options for bitou bush (Chrysanthemoides monilifera ssp. rotundata) in Australia.* Department of Environment and Climate Change (NSW), Sydney

Appendices

Appendix 1.
Common names of Species from Coastal Foredune Scrub Vegetation

Appendix 2.
Common names of Occasional Species from Coastal Foredune Scrub Vegetation

Appendix 3.
Common names of Species from Temperate Littoral Rainforest Vegetation

Appendix 4.
Common names of Occasional Species from Temperate Littoral Rainforest Vegetation

Appendix 5.
Assessment form for Coastal Foredune Scrub

Appendix 6.
Assessment form for Temperate Littoral Rainforest.

Appendix 1.
Common names of Species from Coastal Foredune Scrub Vegetation

Acacia longifolia subsp. sophorae	Coastal Wattle, Wadanguli (Cadigal)
Acaena novae-zelandiae	Bidgee-widgee, Biddy Biddy
Actites megalocarpa	Dune thistle
Alyxia buxifolia	Sea Box
Atriplex cinerea	Grey Saltbush, Coast Saltbush or Barilla
Austrofestuca littoralis	Beach Fescue
Austrostipa flavescens	Coast spear grass
Banksia integrifolia subsp. integrifolia	Coast Banksia
Banksia serrata	Old-man Banksia, Wiriyagan (Cadigal)
Baumea juncea	Bare Twig Rush
Breynia oblongifolia	Coffee Bush
Calystegia soldanella	Seashore False Bindweed, Beach Morning Glory
Carex pumila	Strand Carex
Carpobrotus glaucescens	Pigface
Casuarina glauca	Swamp Oak, Guman
Centella asiatica	Gotu Kola, Indian Pennywort, Asiatic Pennywort, Antanan, Pegaga, Brahmi
Commelina cyanea	Native Wandering Jew
Correa alba var. alba	White Correa
Correa reflexa	Common Correa, Native Fuchsia
Cynodon dactylon	Couch, Bermudagrass
Cynoglossum australe	Australian hound's tongue
Desmodium varians	Slender Tick-trefoil
Dianella caerulea	Blue Flax-lily
Dichelachne crinita	Longhair Plumegrass
Dichondra repens	Kidney Weed, Yilibili (D'harawal)
Elaeocarpus reticulatus	Blueberry ash, Ash Quandong, Blue Olive berry, Fairy Petticoats, Fringe Tree, Koda, Lily of the valley Tree, Scrub Ash
Entolasia stricta	Wiry Panic
Eucalyptus botryoides	Bangalay, Southern Mahogany
Glycine clandestina	Twining Glycine
Glycine tabacina	Variable Glycine, no real common name
Gonocarpus teucrioides	Raspwort
*Hibbertia aciculari*s	Prickly Guinea-flower
Hibbertia scandens	Climbing Guinea Flower, Golden Guinea Vine, Snake Vine
Imperata cylindrica var. major	Blady Grass
Isolepis nodosa	Knobby Club-rush
Kennedia rubicunda	Dusky Coral Pea
Lepidosperma laterale	Variable Sword-sedge
Leptospermum laevigatum	Coast Teatree
Leucopogon parviflorus	Coastal Beard-heath, Native Currant
Lomandra longifolia	Spiny-headed Mat-rush, Honey Reed
Macrozamia communis	Burrawang
Melaleuca armillaris subsp. armillaris	Bracelet Honey-myrtle
Microlaena stipoides	Weeping Grass, Weeping Rice Grass and Weeping Meadow Grass
Monotoca elliptica	Tree Broom-heath
Muehlenbeckia adpressa	Climbing Lignum
Olearia axillaris	Coast Daisy-bush
Opercularia aspera	Coarse Stinkweed
Oplismenus imbecillis	Basket Grass
Oxalis perennans	Grass Wood-sorrel
Oxalis radicosa	Dwarf Woodsorrel
Oxalis rubens	Dune Wood sorrel, Wood Sorrel

Pelargonium australe	Native Storksbill, Wild Geranium
Pittosporum revolutum	Wild Yellow Jasmine, Rough fruit Pittosporum, Yellow Pittosporum, Hairy Pittosporum
Pittosporum undulatum	Native Daphne, Sweet Pittosporum, Snowdrop Tree, Mock Orange
Poa meionectes	Provincial Pigmy Poa, Fine Leaf Tussock Grass
Poa poiformis var. poiformis	Coast Tussock-grass, Blue Tussock-grass
Pratia purpurascens	Whiteroot
Pteridium esculentum	Common Bracken, Gurgi (Cadigal), Austral Bracken, Bracken, Bracken Fern
Rhagodia candolleana subsp. candolleana	Seaberry Saltbush
Rhodamnia rubescens	Scrub Turpentine, Brown Malletwood, Brush Turpentine
Rubus parvifolius	Native Raspberry, Small-leaved Bramble
Scaevola calendulacea	Dune Fan Flower
Senecio lautus subsp. maritimus	
Senecio linearifolius	Fireweed Groundsel, Fireweed
Solanum opacum	Greenberry Nightshade
Solanum prinophyllum	Southern Forest Nightshade, Forest Nightshade
Solanum pungetium	Eastern Nightshade
Solanum stelligerum	Devil's Needles
Spinifex sericeus	Hairy Spinifex
Sporobolus virginicus	Sand Couch, Saltwater Couch, Nioaka
Stephania japonica var. discolor	Snake Vine
Themeda australis	Kangaroo Grass, Durawi (D'harawal)
Viola hederacea	Ivy-leaved Violet
Westringia fruticosa	Coastal Rosemary
Zoysia macrantha	Prickly Couch

Appendix 2.
Common names of Occasional Species from Coastal Foredune Scrub Vegetation

Acacia suaveolens	Sweet Wattle
Acacia terminalis	Sunshine Wattle
Acmena smithii	Lilly Pilly, Midjuburi (Cadigal)
Allocasuarina littoralis	Black She-oak
Amyema congener subsp. congener	Erect Mistletoe
Arrhenechthites mixta	Purple Fireweed
Austrodanthonia setacea	Smallflower Wallaby Grass, Mulga Wallaby-grass
Billardiera scandens	Hairy Apple Berry, Apple Dumpling
Bossiaea prostrata	Creeping/Berry Saltbush, Creeping Bossiaea
Brachyloma daphnoides	Daphne Heath
Carex appressa	Tall Sedge
Carex breviculmis	Short Stem Sedge
Carex longebrachiata	Drooping sedge
Cassytha pubescens	Dodder Laurel, Devil's Twine
Cayratia clematidea	Slender Grape, Native Grape
Centaurium spicatum	Australian Centaury, Spiked Centaury
Cheilanthes austrotenuifolia	Rock Fern
Cissus antarctica	Kangaroo Vine, Water Vine
Clematis aristata	Old Man's Beard, Traveller's Joy, Goatsbeard
Clerodendrum tomentosum	Hairy Clerodendrum, Downy Chance Tree, Hairy Lolly Bush
Corymbia maculata	Spotted Gum
Cyperus polystachyos	Leafy Twigrush, Bunchy Sedge, Manyspike Flatsedge
Dianella caerulea var. producta	Blue Flax-lily, variety N/A
Dianella congesta	Beach Flax Lily
Dianella crinoides	Flax Lily
Dianella longifolia var. longifolia	Pale flax lily
Dianella revoluta	Blueberry Lily, Blue Flax-Lily, Anther Flax Lily
Dillwynia glaberrima	Heath Parrot Pea, Smooth Parrot Pea
Echinopogon ovatus	Forest Hedgehog Grass
Elaeodendron australe	Red Olive Plum
Eragrostis leptostachya	Paddock Lovegrass, Australian lovegrass
Eucalyptus sieberi	Silvertop Ash, Black Ash
Eucalyptus tereticornis	Forest Red Gum, Burringoa
Euchiton gymnocephalus	Holub Cudweed
Euchiton sphaericus	Clustered Cudweed, Holub Cudweed
Gahnia melanocarpa	Black Seeded Saw-sedge, Black Fruit Saw-sedge
Gahnia radula	Thatch Saw-sedge
Gahnia sieberiana	Red-fruited Saw Sedge
Galium propinquum	Maori Bedstraw
Geitonoplesium cymosum	Scrambling Lily
Glochidion ferdinandi var. ferdinandi	Cheese Tree,Buttonwood
Goodenia ovata	Hop Goodenia
Hardenbergia violacea	False Sarsaparilla, Purple Coral Pea, Happy Wanderer, Waraburra
Hibbertia aspera	Rough Guinea Flower
Hibbertia obtusifolia	Showy/Grey Guinea
Homalanthus populifolius	Bleeding-heart Tree, Queensland Poplar, Umbrella Tree
Hydrocotyle laxiflora	Stinking Pennywort, Stinking Pennywort
Hydrocotyle peduncularis	Native Pennywort
Isolepis cernua	Nodding Club-rush
Juncus continuus	N/A
Lepidosperma concavum	Sandhill Sword-sedge
Leptinella longipes	Long Cotula

Leucopogon juniperinus	Prickly Beard-heath
Lobelia anceps	N/A
Marsdenia rostrata	Milk Vine
Melaleuca hypericifolia	Hillock Bush
Myoporum boninense subsp. australe	Boobialla, var. N/A
Myoporum insulare	Boobialla, Juniper, Common Boobialla
Myrsine howittiana	Brush muttonwood
Notelaea venosa	Veined Mock-olive, Smooth Mock-olive, Large-leaved Mock-olive
Oplismenus aemulus	Reeping Shade Grass, Australian Basket Grass
Panicum simile	Two-colour Panic
Parsonsia straminea	Common Silkpod, Monkey Rope
Persoonia mollis subsp. leptophylla	N/A
Phebalium squamulosum subsp. argenteum	N/A
Phyllanthus hirtellus	Thyme Spurge
Plantago debilis	Shade Plantain, Weak Plantain
Plectranthus parviflorus	Cockspur Flower
Podocarpus spinulosus	Spiny-leaf Podocarp
Polymeria calycina	Swamp Bindweed
Pomax umbellata	Pomax
Poranthera microphylla	Small Poranthera
Ricinocarpos pinifolius	Wedding Bush
Rumex brownii	Swamp Dock
Samolus repens	Creeping Brookweed
Schelhammera undulata	N/A
Selliera radicans	Swamp Weed
Senecio minimus	Shrubby Fireweed, Saw Groundsel
Solanum aviculare	Kangaroo Apple, Poroporo
Stackhousia spathulata	Candles
Stephania japonica	Snake Vine
Syncarpia glomulifera subsp. glomulifera	Turpentine
Tetragonia tetragonioides	New Zealand Spinach, Native Spinach
Thinopyrum elongatum	tall wheatgrass
Tylophora barbata	Bearded Tylophora
Typha orientalis	Broadleaf Cumbungi
Veronica plebeia	Trailing Speedwell, Creeping Speedwell
Viola betonicifolia	Native Violet
Wahlenbergia gracilis	Sprawling Bluebell, Australian Bluebell
Xanthosia pilosa	Woolly Xanthosia

Appendix 3.
Common names of Species from Temperate Littoral Rainforest

Acacia maidenii	Maiden's Wattle
Acmena smithii	Lilly Pilly, Midjuburi (Cadigal)
Acronychia oblongifolia	White Aspen, Yellow Wood
Adiantum aethiopicum	Common Maidenhair
Alectryon subcinereus	Native Quince, Wild Quince, Bird's Eye
Alphitonia excelsa	Red Ash
Aphanopetalum resinosum	Gum Vine
Asplenium flabellifolium	Necklace Fern
Banksia integrifolia subsp. integrifolia	Coast Banksia
Banksia serrata	Old-man Banksia, Wiriyagan (Cadigal)
Breynia oblongifolia	Coffee Bush
Calochlaena dubia	Rainbow Fern
Canthium coprosmoides	Coastal Canthium
Cassine australis	Red Olive Berry, Red Fruited Olive Plum, Cassine
Casuarina glauca	Swamp Oak, Guman
Cayratia clematidea	Native Grape
Celtis paniculata	Native Celtis
Cissus antarctica	Kangaroo Vine, Water Vine
Cissus hypoglauca	Water Vine
Claoxylon australe	Brittlewood
Clematis aristata	Old Man's Beard
Clerodendrum tomentosum	Hairy Clerodendrum, Downy Chance Tree
Commelina cyanea	Native Wandering Jew
Corymbia maculata	Spotted Gum
Cryptocarya glaucescens	Jackwood
Cryptocarya microneura	Murrogun
Cyperus gracilis	Slender Flat-sedge
Davallia solida var. pyxidata	Hare's Foot Fern
Desmodium gunnii	Slender Tick Trefoil
Dianella caerulea	Blue Flax-lily
Diospyros australis	Black Plum, Yellow Persimmon, Grey Plum
Diospyros pentamera	Myrtle Ebony, Grey Persimmon, Black Myrtle, Grey Plum
Doodia aspera	Prickly Rasp Fern
Duboisia myoporoides	Corkwood, Eye opening Tree, Poisonous Corkwood, Poison Corkwood, Yellow Basswood
Elaeocarpus reticulatus	Blueberry Ash, Ash Quandong, Blue Olive berry, Fairy Petticoats, Fringe Tree, Koda, Lily of the valley Tree
Elaeodendron australe	Red Olive Plum
Endiandra sieberi	Hard Corkwood
Entolasia marginata	Bordered Panic
Eucalyptus botryoides	Bangalay, Southern Mahogany
Eupomatia laurina	Bolwarra, Copper Laurel
Euroschinus falcata var. falcata	Ribbonwood
Eustrephus latifolius	Wombat Berry
Ficus coronata	Sandpaper Fig, Creek Sandpaper Fig
Ficus obliqua	Small-leaved Fig
Gahnia aspera	Rough Saw-sedge
Gahnia erythrocarpa	N/A
Gahnia sieberiana	Red-fruit Saw-sedge
Geitonoplesium cymosum	Scrambling Lily
Geranium homeanum	Australasian geranium
Glochidion ferdinandi	Cheese Tree
Guioa semiglauca	Guioa
Gymnostachys anceps	Settlers' Twine, Boorgay
Hibbertia scandens	Climbing Guinea Flower

Hymenanthera dentata	Tree Violet
Hypolepis muelleri	Harsh Ground Fern
Imperata cylindrica	cogongrass, kunai grass
Kennedia prostrata	Running Postman, Scarlet Coral Pea
Lepidosperma laterale	Variable Sword Se
Litsea reticulata	Bolly Gum
Livistona australis	Cabbage Fan-palm, Cabbage-tree Palm, Daranggara (Cadigal), Caggage Palm, Fan Palm
Lomandra longifolia	Spiny-headed Mat-rush, Honey Reed
Maclura cochinchinensis	Cockspur Thorn
Macrozamia communis	Burrawang
Marsdenia flavescens	Yellow Milk-vine
Marsdenia rostrata	Milk Vine
Melicope micrococca	Hairy-leaved Doughwood, White Euodia
Microlaena stipoides var. stipoides	Weeping Grass
Morinda jasminoides	Sweet Morinda
Myrsine howittiana	Brush Muttonwood
Myrsine variabilis	Muttonwood
Notelaea longifolia	Large Mock-olive, Large-leaved Olive
Notelaea venosa	Veined Mock-olive, Smooth Mock-olive, Large-leaved Mock-olive
Oplismenus aemulus	Creeping Shade Grass, Australian Basket Grass
Oplismenus imbecillis	Basket Grass
Oxalis rubens	Wood Sorrel
Pandorea pandorana subsp. pandorana	Wonga Vine
Parsonsia straminea	Common Silkpod, Monkey Rope
Pellaea falcata	Sickle Fern
Pittosporum multiflorum	Orange Thorn
Pittosporum revolutum	Wild Yellow Jasmine, Rough Fruit Pittosporum
Pittosporum undulatum	Native Daphne, Sweet Pittosporum, Snowdrop Tree, Mock Orange
Planchonella australis	Black Apple
Platycerium bifurcatum	Elkhorn Fern, Staghorn, Stag's Horn Fern
Plectranthus parviflorus	Cockspur Flower
Podocarpus elatus	Plum Pine, Brown Pine
Polyscias elegans	Celery Wood, Silver Basswood, Black Pencil Cedar
Pseuderanthemum variabile	Pastel Flower
Psychotria loniceroides	Hairy Psychotria
Pteridium esculentum	Common Bracken, Gurgi (Cadigal), Austral Bracken, Bracken
Pteris tremula	Tender Brake, Tender Brakefern
Pyrrosia rupestris	Rock Felt Fern
Rhagodia condolleana	Sea Berry Saltbush
Ripogonum album	White Supplejack
Rubus moluccanus var. trilobus	Molucca Bramble
Rubus rosifolius	Rose-leaf Bramble, Native Raspberry
Sarcomelicope simplicifolia subsp. simplicifolia	N/A
Sarcopetalum harveyanum	Pearl Vine
Scolopia braunii	Flintwood, Mountain Cherry, Brown Birch, Scolopia
Smilax australis	Lawyer Vine, Wait-a-while, Barbwire Vine
Smilax glyciphylla	Sweet Sarsaparilla
Stellaria flaccida	Forest Starwort
Stephania japonica	Snake Vine
Stephania japonica var. discolor	Snake Vine, var. N/A
Synoum glandulosum subsp. glandulosum	Scentless Rosewood
Trema tomentosa var. aspera	Native Peach, Poison Peach
Trophis scandens	Burny Vine
Tylophora barbata	Bearded Tylophora
Urtica incisa	Stinging Nettle
Viola hederacea	Ivy-leaved Violet
Wilkiea huegeliana	Veiny Wilkiea

Appendix 4.
Common names of Occasional Species from Temperate Littoral Rainforest Vegetation

Acacia binervata	Two-veined Hickory
Acacia longifolia	Acacia Trinervis, Aroma Doble, Golden Wattle, Sallow Wattle, Sydney Golden Wattle
Acacia melanoxylon	Blackwood
Allocasuarina littoralis	Black She-oak
Amyema congener subsp. rotundifolium	N/A
Arthropteris tenella	Climbing Fern
Asplenium australasicum	Bird's Nest Fern
Austrodanthonia racemosa var. racemosa	Slender Wallaby-grass
Austrostipa ramosissima	Stout Bamboo Grass
Backhousia myrtifolia	Grey Myrtle, Ironwood
Baloghia inophylla	Brush Bloodwood, Ivory Birch, Scrub Bloodwood
Blechnum cartilagineum	Gristle fern, Soft Water Fern
Blechnum nudum	Fishbone Water Fern
Calystegia marginata	Forest Bindweed
Carex appressa	Tall Sedge
Carex brunnea	Greater Brown Sedge
Carex inversa	Knob Sedge
Carex longebrachiata	Drooping Sedge
Celastrus australis	Staff Climber
Centella asiatica	Gotu Kol
Cissus sterculiifolia	Yaroong
Clematis glyciphylla	N/A
Coprosma quadrifida	Prickly Currant Bush, Native Currant
Crinum pedunculatum	Swamp Lily, River Lily
Cyathea australis	Black Tree-fern, Rough Tree-fern
Cyathea cooperi	Straw Treefern
Cyperus imbecillis	N/A
Cyperus laevigatus	Smooth Flatsedge
Cyperus tetraphyllus	N/A
Daucus glochidiatus	Native Carrot
Desmodium brachypodum	Large Tick-trefoil
Dichondra repens	Kidney Weed, Yilibili (D'harawal)
Diplazium australe	Austral Lady Fern
Doryphora sassafras	Sassafras
Echinopogon ovatus	Forest Hedgehog Grass
Ehretia acuminata var. acuminata	Koda
Entolasia stricta	Wiry Panic
Eucalyptus gummifera	Red Bloodwood
Eucalyptus pilularis	Blackbutt
Eucalyptus robusta	Swamp Mahogany
Ficus rubiginosa	Little-leaf Fig, Rusty Fig
Gahnia melanocarpa	Black Fruit Saw-sedge
Geranium solanderi	Native Geranium
Glycine clandestine	Love Creeper
Glycine microphylla	Small-leaf glycine
Glycine tabacina	Love Creeper
Gonocarpus teucrioides	Raspwort
Hibbertia bracteata	Yellow Guinea Flower
Hibbertia dentata	Twining Guinea Flower
Histiopteris incisa	Bat's Wing Fern, Oak Fern
Homalanthus populifolius	Bleeding-heart tree, Queensland poplar, Umbrella tree
Kennedia rubicunda	Dusky Coral Pea

Lastreopsis decomposita	Trim Shield-fern, Trim Shield Fern
Lastreopsis microsora subsp. microsora	Creeping Shield Fern
Lepidosperma concavum	Sandhill Sword-sedge
Leptospermum laevigatum	Coast Teatree
Monotoca elliptica	Tree Broom-heath
Myoporum acuminatum	Boobialla
Olearia argophylla	Native Musk, Silver Shrub, Musk Daisy-bush
Palmeria scandens	Anchor Vine, Pomegranate Vine
Pararchidendron pruinosum var. pruinosum	Snow Wood
Passiflora herbertiana	Native Passionfruit
Pellaea paradoxa	Large-leaf Sickle Fern
Phyllanthus gunnii	Scrubby Spurge
Pisonia umbellifera	Birdlime Tree
Planchonella australis	Black Apple
Plantago debilis	Shade Plantain, Weak Plantain
Poa labillardierei	Tussock Grass
Poa queenslandica	N/A
Podocarpus spinulosus	Spiny-leaf Podocarp
Polyscias murrayi	Pencil Cedar, Pencil Cedar, Umbrella Tree, White Basswood, Pencilwood
Polyscias sambucifolia	Elderberry Panax, Ornamental Ash, Elderberry Ash
Polystichum proliferum	Mother Shield Fern
Pomaderris aspera	Hazel Pomaderris
Pratia purpurascens	Whiteroot
Rubus parvifolius	Native Raspberry, Small-leaved Bramble
Rumex brownii	Swamp Dock
Sarcochilus olivaceus	Green Tree Orchid, Lawyer Orchid
Schelhammera undulata	Lilac lily
Schizomeria ovata	Crabapple, White Birch, White Cherry, Snowberry
Senecio linearifolius	Fireweed Groundsel, Fireweed
Solanum nigrum	Black Nightshade
Solanum prinophyllum	Forest Nightshade
Solanum pungetium	Eastern Nightshade
Sticherus flabellatus var. flabellatus	Shiny Fan Fern, Umbrella Fern
Streblus brunonianus	Whalebone Tree
Syzygium australe	Brush Cherry
Syzygium oleosum	Blue Lilly Pilly
Todea barbara	King Fern
Toona ciliata	Red Cedar
Tradescantia fluminensis	Small-leaf Spiderwort
Trema tomentosa var. viridis	Native Peach, Peach-leaved Poison Bush
Veronica plebeia	Trailing Speedwell, Creeping Speedwell
Zieria smithii	Sandfly Zieria, Smithian Zieria, Dr Smith's Zieria

APPENDIX 5 – Assessment form for Coastal Foredune Scrub

COASTAL FOREDUNE SCRUB	
Location	
Date	
Area surveyed	

VERY COMMON SPECIES	
Acacia longifolia subsp. sophorae	
Actites megalocarpa	
Banksia integrifolia subsp. integrifolia	
Carpobrotus glaucescens	
Dichondra repens	
Isolepis nodosa	
Leucopogon parviflorus	
Lomandra longifolia	
Monotoca elliptica	
Rhagodia candolleana subsp. candolleana	
Spinifex sericeus	
TOTAL number	A

COMMON SPECIES	
Austrofestuca littoralis	
Breynia oblongifolia	
Calystegia soldanella	
Commelina cyanea	
Correa alba var. alba	
Correa reflexa	
Cynodon dactylon	
Imperata cylindrica var. major	
Leptospermum laevigatum	
Oxalis perennans	
Pelargonium australe	
Senecio lautus subsp. maritimus	
Zoysia macrantha	
TOTAL number	B

QUITE COMMON SPECIES	
Acaena novae-zelandiae	
Banksia serrata	
Carex pumila	
Dianella caerulea	
Dichelachne crinita	
Entolasia stricta	
Eucalyptus botryoides	
Glycine clandestina	
Kennedia rubicunda	
Melaleuca armillaris subsp. armillaris	
Pittosporum undulatum	
Pratia purpurascens	
Solanum stelligerum	
Stephania japonica var. discolor	
Themeda australis	
Viola hederacea	
Westringia fruticosa	
TOTAL number	C

UNCOMMON SPECIES	
Alyxia buxifolia	
Atriplex cinerea	
Austrostipa flavescens	
Baumea juncea	
Casuarina glauca	
Centella asiatica	
Cynoglossum australe	
Desmodium varians	
Elaeocarpus reticulatus	
Glycine tabacina	
Gonocarpus teucrioides	
Hibbertia acicularis	
Hibbertia scandens	
Lepidosperma laterale	
Macrozamia communis	
Microlaena stipoides	
Muehlenbeckia adpressa	
Olearia axillaris	
Opercularia aspera	
Oplismenus imbecillis	
Oxalis radicosa	
Oxalis rubens	
Pittosporum revolutum	
Poa meionectes	
Poa poiformis var. poiformis	
Pteridium esculentum	
Rhodamnia rubescens	
Rubus parvifolius	
Scaevola calendulacea	
Senecio linearifolius	
Solanum opacum	
Solanum prinophyllum	
Solanum pungetium	
Sporobolus virginicus	
TOTAL number	D

No. OCCASIONAL Species	E

TOTAL SPECIES A+B+C+D+E	

No species of each abundance class that should occur in sites.

Area ha	Quadrat Size m x m	No. Occasional	No. Uncommon	No. Quite Common	No. Common	No. Very Common.	Total
0.04	20x20m	2	3	2	3	5	13
0.2	100x20	9	11	8	9	10	38
0.4	200x20	18	19	13	11	11	54
0.6	300x20	27	24	15	12	11	63
0.8	400x20	36	28	16	13	11	68
1	500x20	44	30	17	13	11	71
1.2	600x20	51	32	17	13	11	73
1.4	700x20	59	33	17	13	11	74
1.6	800x20	66	34	17	13	11	75
1.8	900x20	73	34	17	13	11	75
2	1000x20	79	34	17	13	11	75
2.2	1200x20	85	34	17	13	11	75
2.4	1300x20	91	34	17	13	11	75

Appendix 6. Assessment form for Temperate Littoral Rainforest

TEMP. LITTORAL RAINFOREST
Location
Date
Size of Area

VERY COMMON SPECIES	
Acmena smithii	
Breynia oblongifolia	
Commelina cyanea	
Eucalyptus botryoides	
Eustrephus latifolius	
Geitonoplesium cymosum	
Livistona australis	
Marsdenia rostrata	
Oplismenus imbecillis	
Pittosporum undulatum	
Pseuderanthemum variabile	
Viola hederacea	
TOTAL number	A

COMMON SPECIES	
Cissus hypoglauca	
Diospyros australis	
Eupomatia laurina	
Guioa semiglauca	
Lomandra longifolia	
Morinda jasminoides	
Notelaea venosa	
Parsonsia straminea	
Pellaea falcata	
Pittosporum revolutum	
Sarcopetalum harveyanum	
Smilax australis	
Smilax glyciphylla	
Synoum glandulosum subsp. glandulosum	
TOTAL number	B

QUITE COMMON SPECIES	
Acacia maidenii	
Adiantum aethiopicum	
Cissus antarctica	
Claoxylon australe	
Dianella caerulea	
Doodia aspera	
Elaeocarpus reticulatus	
Elaeodendron australe	

continued overleaf

UNCOMMON SPECIES	
Banksia integrifolia subsp. integrifolia	
Acronychia oblongifolia	
Alectryon subcinereus	
Alphitonia excelsa	
Aphanopetalum resinosum	
Arthropodium sp.	
Asplenium flabellifolium	
Banksia serrata	
Calochlaena dubia	
Canthium coprosmoides	
Cassine australis	
Casuarina glauca	
Cayratia clematidea	
Celtis paniculata	
Clematis aristata	
Clerodendrum tomentosum	
Corymbia maculata	
Cryptocarya glaucescens	
Cryptocarya microneura	
Cyperus gracilis	
Davallia solida var. pyxidata	
Desmodium gunnii	
Diospyros pentamera	
Duboisia myoporoides	
Entolasia marginata	
Euroschinus falcata var. falcata	
Ficus obliqua	
Gahnia erythrocarpa	
Gahnia sieberiana	
Geranium homeanum	
Glycine sp.	
Gymnostachys anceps	
Hibbertia scandens	
Hymenanthera dentata	
Hypolepis muelleri	
Imperata cylindrica	
Lepidosperma laterale	
Litsea reticulata	
Maclura cochinchinensis	
Macrozamia communis	

continued overleaf

quite common species cont.

Endiandra sieberi	
Ficus coronata	
Gahnia aspera	
Glochidion ferdinandi	
Kennedia prostrata	
Myrsine howittiana	
Myrsine variabilis	
Notelaea longifolia	
Pittosporum multiflorum	
Podocarpus elatus	
Pteridium esculentum	
Stephania japonica	
Tylophora barbata	
Wilkiea huegeliana	
TOTAL number	C

uncommon species cont.

Marsdenia flavescens	
Melicope micrococca	
Microlaena stipoides var. stipoides	
Oplismenus aemulus	
Oxalis rubens	
Pandorea pandorana subsp. pandorana	
Platycerium bifurcatum	
Plectranthus parviflorus	
Polyscias elegans	
Pouteria australis	
Psychotria loniceroides	
Pteris tremula	
Pyrrosia rupestris	
Rhagodia condolleana	
Ripogonum album	
Rubus moluccanus var. trilobus	
Rubus rosifolius	
Sarcomelicope simplicifolia subsp. simplicifolia	
Scolopia braunii	
Stellaria flaccida	
Stephania japonica var. discolor	
Trema tomentosa var. aspera	
Trophis scandens	
Urtica incisa	
	D

No. OCCASIONAL Species	E

TOTAL SPECIES A+B+C+D+E	

No species of each abundance class that should occur in sites.

Area	quadrat size						
ha	m x m	No. Occasional	No. Uncommon	No. Quite common	No. Common	No. Very Common.	TOTAL UQCV
0.04	20x20m	3	7	6	6	8	27
0.2	100x20	13	27	18	13	12	70
0.4	200x20	26	43	21	14	12	90
0.6	300x20	37	52	22	14	12	100
0.8	400x20	48	58	22	14	12	106
1	500x20	58	61	22	14	12	109
1.2	600x20	67	63	22	14	12	111
1.4	700x20	75	64	22	14	12	112
1.6	800x20	83	64	22	14	12	112
1.8	900x20	90	64	22	14	12	112
2	1000x20	96	64	22	14	12	112

not planted

Southern limit of species

	known southern limit	source
Shoalhaven area		
Planchonella australis	Gerroa	Mills
Gymnostachys anceps	Comerong Is	This study
Cayratia clematidea	Comerong Is	Plantnet
Jervis Bay area		
Melicope micrococca	Beecroft Pen.	This study
Myrsine variabilis	Beecroft Pen.	This study
Diospyros pentamera	Beecroft Pen.	This study
Podocarpus elatus	Beecroft Pen.	Plantnet
Cyclophyllum longipetalum	Jervis Bay	Plantnet
Euroschinus falcatus var. falcatus	Jervis Bay	Plantnet
Polyscias elegans	Jervis Bay	Plantnet
Scolopia braunii	Jervis Bay	Plantnet
Batemans Bay area		
Maclura cochinchinensis	Milton	Plantnet
Celtis paniculata	Marramarang	This study
Clerodendrum tomentosum	Batemans Bay	Plantnet
Duboisia myoporoides	Batemans Bay	Plantnet
Guioa semiglauca	Batemans Bay	Plantnet
Wilkiea huegeliana	Batemans Bay	Plantnet
Gulaga		
Alphitonia excelsa	Gulaga	Plantnet
Cryptocarya glaucescens	Gulaga	Plantnet
Ficus obliqua	Gulaga	Plantnet
Tuross Head		
Trophis scandens	Tuross Head	Mills
Endiandra sieberi	Tuross Head	This study
Diospyros australis	Tuross Head	This study
Smilax glyciphylla	Tuross Head	This study
Glochidion ferdinandi	Tuross Head	Plantnet
At least Mimosa Rocks		
Elaeodendron australis	Mimosa Rocks	This study
Commelina cyanea	Mimosa Rocks	This study
Synoum glandulosum subsp. glandulosum	Mimosa Rocks	This study
Pseuderanthemum variabile	Mimosa Rocks	This study
Platycerium bifurcatum	Mimosa Rocks	Plantnet