January 2010

Byron Shire Bush Regeneration Guidelines

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Byron Shire Council January 2010 with Landmark Ecological Services Pty Ltd and Bower Bush Works.
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1 Introduction

1.1 Purpose of the guidelines

These guidelines have been developed to assist bush regeneration activities throughout Byron Shire. Significant contributions are made by community volunteers, landholders and Council to address weed invasion of native vegetation by undertaking bush regeneration activities. The guidelines aim to support these activities by providing best practice information to achieve successful on ground outcomes.

There can be many pitfalls in controlling weed invasion. Poor management can promote the spread of existing weeds and invasion by other species, make the weeds harder to control in the future, damage native species and communities, disrupt regeneration, waste resources and discourage workers. The use of appropriate techniques, however, will ensure that weed management is a rewarding and enjoyable activity, resulting in the recovery of native vegetation communities of high conservation significance.

1.2 Background

Byron Shire is centred in a biodiversity hot spot and is recognised as one of the richest and most diverse regions in Australia. Tropical and temperate species overlap in these intermediate latitudes. High rainfall, mild climatic conditions and variation in topography, geology and altitude interact to support a wide range of ecosystems including rainforest, wet and dry sclerophyll forest, grassland, paperbark swamp, wetlands, sedgeland, dune complex, mangroves, saltmarsh and heath. These ecosystems provide diverse habitats for a rich variety of plant and animal species.

The same factors that support the high diversity of native species in the Shire, also favour the establishment of a high diversity and density of weed species. Exotic plant species with weed potential have been deliberately and accidentally introduced in conjunction with human settlement, and new introductions continue.

Land clearing and other natural and artificial disturbances encourage weed infestation. Clearing has left remnants of original ecosystems fragmented and threatened by weed and pest animal species, altered nutrient and hydrological cycles and altered fire regimes.

Byron Shire has amongst the highest number of threatened species and endangered ecological communities of any local government area in the state. Species and communities are listed as threatened under the *Threatened Species Conservation (TSC) Act 1995* when naturally or artificially rare and subject to threatening processes such as loss of habitat through agricultural development, urban settlement and invasion and competition with introduced species.

To help reduce threats and contribute to biodiversity conservation in the Shire, Byron Shire Council has adopted the Byron Biodiversity Conservation Strategy (2004) (BBCS). High priority actions of the BBCS have been implemented by Council and funded by a biodiversity levy collected through rates for a four year period. A wide range of actions to assist biodiversity conservation on public and private land have been implemented. This includes the establishment of a bush regeneration team and provision of an extension service to assist private landholders manage biodiversity values. The development of these guidelines has been initiated and funded by the BBCS and biodiversity levy.

1.3 How to use the guidelines

These guidelines outline best practice techniques in bush regeneration including the key aspect of weed control. The guidelines describe the characteristics of weeds and explain why they are a problem. In Section 4, we describe control techniques suitable for a wide range of weeds known to occur in the Shire. The guidelines also provide the framework for preparation of a bush regeneration action plan; a critical element of achieving successful regeneration. Scientific names for all species mentioned in the document are included as an Appendix.

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2 Weeds

2.1 What is a weed?

There are many definitions of a weed which may vary according to circumstance and point of view. Generally, a weed is a plant growing where it is not wanted or out of place. Weeds share a common set of characteristics that include:

- rapid seedling growth
- production of large amounts of seed or other effective means of propagation
- vigorous vegetative production
- ability to colonise a site quickly after disturbance
- ability to survive in a range of environments
- can resprout from rootstock and
- create adverse impacts on the natural environment, economic productivity and/or human health.

Weeds can be grouped into overlapping categories according to the situations in which they grow, the problems they cause, and the obligations they impose.

Garden weeds are usually annuals or herbaceous perennials that are an annoyance to gardeners. They may compete with other desirable plants in the garden and be considered unsightly but many of them do little ecological harm when in the household garden.

However, it is important to note, that some garden plants and household pot plants have the potential to become serious environmental weeds, especially when dumped in bushland. Local examples include Variegated Arrowhead Vine, Singapore Daisy, Cocos Palm, Mother–of–Millions, Resurrection Plant, Freckle–face, Mother–in–Laws Tongue and Fishbone Fern.

Agricultural weeds compete with crops, pasture or poison stock. They can result in direct economic losses and hence agricultural weeds usually receive the greatest attention. Examples in Byron Shire include Crofton Weed, Mist Weed, Green Cestrum, Red–flowering Lantana and Giant Parramatta Grass.

Singapore Daisy, a garden plant that has become a serious bushland weed.

Noxious weeds impose a legal requirement on landholders for their control because of their impact on agriculture, the environment or human health. Examples in Byron Shire include Yellow Bells, Broad–leaved Pepper Tree, Groundsel bush, Salvinia, Alligator Weed, and Water Lettuce. Information on the identification of noxious weeds and control requirements can be obtained from statutory weed authorities and state government agricultural agencies.

Environmental weeds invade native plant communities or ecosystems. They are mostly escapees from gardens, horticultural or agricultural enterprises (Humphries et al. 1991, 1993).They may cause major modification to species richness, abundance or ecosystem function, or in extreme cases, totally and permanently destroy a vegetation community. Environmental weeds may also cause problems in gardens, agriculture and some environmental weeds are listed as noxious. On the NSW North Coast, 187 exotic plants have been identified as bushland invaders.

Australian native plants can also become environmental weeds when introduced outside their natural range. In Byron Shire, plants from north Queensland, such as Umbrella Tree, Queensland Maple, Alexandra Palm and Cadaghi are naturalised. Fishbone Fern is native in parts of the hinterland, but has become a serious weed on the coast and lowlands. A number of Acacias that are not locally native have naturalised and have weedy characteristics.

Sleeper weeds may currently occur in low abundance and density in the landscape but have the potential to become a major problem over time. The circumstances that lead a sleeper weed to wake up and begin rapid expansion are not understood, but may include unusual seasonal conditions or reaching a critical population density. Red Coral Berry, Orange Jessamine, Kahili Ginger, Black Locust and Cherry Guava are examples of species that might not have been recognised as weeds a few decades ago, but are now rapidly expanding in Byron Shire. It is difficult to predict future weed problems, but possession of general weed characteristics, especially small fruit attractive to birds and flying foxes, the ability to vegetatively spread, the ability to self seed in the garden and known weediness in other locations, are often warning signals.

There are many different types of vegetation communities in Byron Shire and none are immune to the impacts of weed invasion. In the rainforests of the Shire, all vegetation layers may be invaded e.g. by Ground Asparagus, Mistweed, Broad–leaved Paspalum, Tradescantia in the ground layer, Ochna, Winter Senna, Red Coral Berry in the shrub layer, Small–leaved Privet and Lantana in the midstorey, and by Camphor Laurel, Large–leaved Privet and Cocos Palm in the canopy. Exotic vines such as Madeira, Morning Glory, Climbing Asparagus, and Cat's Claw, commonly smother mature

Bitou Bush was planted after sand mining coastal dunes and now dominates much of the coastline.

trees and saplings in many forest communities. Heaths and wetlands may become infested with Watsonia and exotic grasses while coastal vegetation may be overrun by Bitou Bush. The presence of a shady, weed subcanopy in sclerophyll communities can prevent germination of Eucalypts and over time, alter the type of vegetation community. A change to the structure of a vegetation community in turn changes the suitability of the area as habitat for native plants and animals.

2.2 Threats posed by environmental weeds

After land clearing, exotic plant and animal invasion is the single greatest threat to the conservation of biodiversity, both in Australia and globally (Humphries et al. 1993; DEC NSW 2006). In New South Wales, the invasion and establishment of Bitou Bush, Lantana, exotic vines and scramblers, and exotic perennial grasses, are officially recognised as key threatening processes to biodiversity.

Environmental weeds may affect native flora and fauna species and their habitat through a number of mechanisms.

Competition for light, nutrients, water and space
Weeds take up space that would otherwise be available for native species and compete for available resources. Often weeds are faster growing than desirable native species. Weeds may quickly colonise gaps and edges, reducing water and nutrient availability for other plants. Shade tolerant weeds compete for nutrients and water in the lower strata, suppressing the germination and regeneration of native seedlings.

Competition for pollinators and seed dispersers
Birds, mammals and insects may be less likely to feed on fruits and disperse seeds of native species when there are more abundant, nutritious or attractive food items presented by weed species. This is particularly relevant when food resources produced by native plants are scarce. When weeds dominate a landscape, animals will be more likely to feed on weeds, thus further spreading and promoting weeds at the expense of native species. In the absence of native vegetation, weeds monocultures can provide useful habitat resources for some species (see also Section 6).

Altering nutrient cycles
Weeds can alter the nutrient cycle in native systems, by changing the form, location or availability of nutrients, or increasing the overall quantity of nutrients (e.g. when atmospheric nitrogen is fixed by weeds such as legumes). The composition of flora and fauna communities may be altered as a result. Many weeds produce prolific leaf drop, which adds organic matter to the soil and concentrates nutrients on and near the soil surface. Readily available nutrients are quickly absorbed by species typical of vegetation such as rainforest, but in some other ecosystems, many species are adversely affected (Proteaceous species such as banksias and grevilleas in sclerophyll vegetation cannot survive where phosphate levels are high). High nutrient levels may also increase the palatability of leaves of native species and increase attack by insects and other herbivores.

Allelopathy
While hard evidence is sparse, it is likely that chemicals leached from leaf litter of some weed species, or exuded from their roots, also play a part in suppressing regenerating native plants and inhibiting the growth of older plants.

Physical weighing down of trees and shrubs
Smothering of trees by vines, especially those with heavy, succulent leaves, (e.g. Madeira Vine) can add enormous weight to a tree, adding strain sufficient to break branches or trunks. In addition, overgrowth by vines can weaken native plants by blocking out sunlight from leaves. The resultant loss of canopy trees causes a break in the canopy which can further promote growth of weeds on the ground. For instance, Madeira Vine tubers commonly lie dormant in the shade of the forest floor and commence growth when light penetrates.

Impacts on fauna

Weeds can negatively affect fauna by restricting movement and altering habitat resources. For example, dense Lantana thickets can restrict the ability of Koalas to move between suitable habitats. The sticky hairs on Silver–leaved Desmodium can snare insects and small frogs, which usually die of desiccation. Dutchman's Pipe attracts the female Richmond Birdwing Butterfly to lay its eggs on its leaves. When the eggs hatch the young caterpillars feed on the toxic leaves of this weed vine and die. Flying foxes and other fauna may become entangled or injured in Cocos Palms.

Altered fire regimes

Weed invasion can alter the flammability of vegetation causing a change to natural fire regimes. Exotic grasses (such as Para Grass and Molasses Grass) may invade non–grassy ecosystems, increasing their flammability. Lantana can accumulate litter and develop a high fuel load, and the high oil content of Camphor Laurel makes crown fires possible in dry conditions. Weeds may thus increase the risk of fire in ecosystems poorly adapted for recovery (such as rainforests), so that native species growing with the weeds are eliminated or set back. On the other hand, the presence of weeds with high water content, such as Bitou Bush, may suppress fires in communities that would otherwise burn more easily. As a result, species such as Banksias that rely on fire to regenerate are disadvantaged, resulting in a less diverse native community dominated by weeds.

Vine weeds, such as Coastal Morning Glory, can smother native species to the extent that they cause the death of the tree.

3 Bush regeneration essentials

Bush regeneration, also known as ecological restoration, is the practice of restoring the natural features and ecosystem functions of bushland by reinstating natural regeneration processes. It is achieved primarily through reducing the impacts of degrading processes (such as weeds and edge effects) and capitalising on the resilience or regeneration capacity of the ecosystem. Where the regeneration capacity is lost or depleted, as in highly degraded vegetation, ecosystem reconstruction techniques including planting may be required. The aim of a bush regenerator is to work with natural processes to assist ecosystem recovery.

3.1 Bush regeneration skills base

Bush regeneration practice is taught formally at local TAFE colleges, and there are many professional bush regenerators living and working in the Northern Rivers region. Community members often learn bush regeneration skills through landcare activities, short courses and workshops, or by working alongside trained regenerators.

The following skills are required for effective bush regeneration.

- Ability to identify weeds and common and threatened native plant species; plant communities and common and threatened fauna.
- Ability to identify the target weed species at differing growth stages, from early seedling to mature plants. Many native plant species appear similar to weeds and may be misidentified and harmed or killed.
- Understanding of ecological processes as the community moves from a disturbed to a more stable state.
- The importance of vegetation for fauna habitat.
- The capacity to consider a sites ecosystem resilience and expected response to weed control (negative or positive) and of the steps that are required to sustain, improve or protect the ecological values of a site.
- Ability to determine which techniques are best used to undertake weed control or to mitigate other degrading processes that are threatening the value of a site.
- Understanding how a patch of vegetation fits a broader landscape context and whether the site is a potentially useful stepping stone or corridor for mobile fauna such as birds or bats.
- Recognise and manage fauna habitat features including the potential short to medium term role of weeds as habitat.

- Ability to identify and manage, where possible, other factors affecting restoration, e.g. garden dumping, vandalism, stormwater, proximity to source of further weed invasion, informal track–making and lack of diverse native seed source.
- Observation, navigation and First Aid skills.
- Ability to take account of seasonal variations on weed control outcomes or seasonal usage of habitat.
- Understand the role of fire in managing the vegetation types at the site.
- Chemical users certification.

This is a comprehensive list of requirements and unlikely to be able to be met by any one person. Often a group or team are able to cooperatively bring the range of skills required to a successful project. Many of these issues can also be addressed through the preparation of a bush regeneration action plan. There are many ways to access extra information, seek advice and share ideas.

3.2 Cultural artefacts and significant sites

Byron Shire is an area rich in indigenous values. It is extremely likely that artefacts of indigenous land use and habitation will be encountered when undertaking bush regeneration. There are over 35,000 known Aboriginal sites in NSW.

Some of the types of artefacts or sites that could be present in a regeneration site include: Caves and overhangs, middens, pathways, campsites, quarries, Tool making sites, spiritual sites, burial sites, scar trees, stone artefacts such as axe heads, grinding stones, sinkers, tally stones, scrapers, wedges, and other as yet undiscovered signs of habitation and culturally significant plants.

Any area that has not been extensively sand mined, cleared or capped could contain artefacts or significant sites. Many sites are known and already recorded, whilst others are yet to be discovered. All sites should be treated as potential artefact sites.

Bush regeneration may affect sites and artefacts through increasing erosion after weed control, digging for planting or fencing, track construction and removal of artefacts after exposure.

To avoid impacting sites or artefacts

- Check with the National Parks & Wildlife Service or your local Aboriginal Land Council sites officer if there is a registered significant site nearby
- Be observant when working
- Choose weed control techniques that minimise erosion
- Minimise soil disturbance when planting, or track making
- Seek assistance or expert advice if you are uncertain

If you think that you have found something significant

- Stop works immediately. Leave the artefact or site where it is undisturbed
- If the artefact is in danger of being destroyed or taken, take steps to protect it
- Record the details of where it is. Keep this information confidential until you have reported it
- Report the find to the Local Aboriginal Land Council and to the Cultural Heritage Officer at Department of Environment, Climate Change and Water. Representatives from these organisations will inspect and assess the find. Then follow their instructions of how best to manage the area. It may require fencing, revegetation, or some other site specific action.

Tips for beginners

Ten steps to help you on your way

1. Always have a restoration plan – even a basic plan will enable you to focus on the aims of your project.
2. Start from less infested areas of native vegetation and work towards more weedy areas (unless undertaking targeted weed control).
3. Revisit patches regularly until you have a better understanding of weed recruitment and regrowth.
4. Control ground layer and understorey weeds before treating anything in the canopy.
5. Start small and stick to manageable work units.
6. Aim to do regular, small amounts of work over longer timeframes. This is better than infrequent large amounts of work, especially if it restricts the time available to do follow up.
7. You are working with a natural process; aim to use the minimum amount of effort to assist the regeneration of native plants.
8. Ecosystems are dynamic – they are in constant change so don't expect to build a rainforest in five years. You are laying the foundations for a forest to develop and persist over time.
9. Understand your weeds – they are only plants. Although some species should not be tolerated, others can provide useful functions such as erosion control, fauna habitat and preventing other weeds establishing.
10. It is meant to be enjoyable – take time to enjoy the process and watch nature at work.

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3.3 Ecosystem resilience

All ecosystems have an inherent capacity to recover from disturbance and consideration of this element of ecosystem function is an important aspect of bush regeneration. Ecosystems and their constituent species exposed to disturbance can and do recover. However the recovery rate may vary depending on the degree, frequency and extent of the disturbance (Hopkins, 1990).

Resilience is a key ecosystem property that restoration ecologists attempt to manipulate when restoring disturbed landscapes. McDonald (2000) describes two generic types of resilience mechanisms.

They are:

- in–situ resilience – the capacity of disturbed habitat to recover from regeneration material available on site; and
- migratory resilience – the capacity of disturbed habitat to regenerate from reproductive material brought into the site by other organisms or geophysical processes.

The soil seed bank is an integral element of ecosystem resilience and thus important to bush regeneration. Rainforest seedbanks, for example, contain the seed of many pioneer and secondary species (Adam, 1994). The seedbank accumulates over time, integrating seed rain from successful fruiting periods and not just the most recent fruiting season. While the fresh seed of some species readily germinates, other species may have innate dormancy due to hard seed coats. One study demonstrated that the seed of pioneer species retained their variability for at least two years after burial and rapidly germinated in greenhouse experiments (Adam, 1994). The seeds of mature phase rainforest species generally remain viable for less than a year, with many not surviving beyond six weeks and others remaining viable for much longer.

Frequent disturbance, especially by fire can have a significant impact on the soil seed banks of some species. Whilst many obligate seeders rely on fire to release seed and establish required germination conditions, each fire stimulates germination, rapidly diminishing the soil seed bank. If the disturbance also results in the loss of mature plants, the potential for seed production is also rapidly lost from the site.

Examples of in–situ resilience mechanisms in local species

Common name	Species name	Disturbance type	Resilience mechanism
Cheese Tree	*Glochidion ferdinandi*	Fire	Resprouting
Coffee bush	*Breynia oblongifolia*	Root disturbance	Resprouting
Blueberry Ash	*Eleocarpus reticulatus*	Fire	Resprouting
Native Hop Bush	*Dodonaea triquetra*	Fire	Obligate seeder
Rice flower	*Pimelea linifolia*	Fire	Obligate seeder

Examples of dispersal methods providing migratory resilience potential in local species

Common name	Species name	Dispersal method
Slender Tick-trefoil	*Desmodium gunni*	Vertebrate dispersal on animal fur
Coastal Cypress Pine	*Callitris colvmellaris*	Wind and gravity dispersal
Native Peach	*Trema tomentosa var. viridis*	Bird dispersal
Blue Quandong	*Elaeocarpus grandis*	Water and gravity dispersal

3.4. Understanding weed species

An understanding of a weed species' ecology will help determine the best method and timing to implement control measures. Of particular importance is an understanding of how and when a weed propagates, how it is spread and the nature of its root system or underground organs. Prioritising weed control actions through consideration of the role particular plants may play in the regeneration process is also possible based on an understanding of the ecology of weed species.

Understanding weed species

Plant features or function

Lifecycle

- Is it an annual, bi–annual or perennial?
- What is the time of flowering and fruiting?
- Does it die back to underground organs?
- Is it evergreen or deciduous?
- What is the period of active growth?
- Is there a vulnerable time in the plant's lifecycle?

Lifeform/ Habit

- Is the plant a grass, vine, herb, succulent, scrambler, shrub or tree?

Structure

- Is it a monocotyledon (short fibrous roots and vascular tissue held in bundles throughout the stem) or dicotyledon (a tap and lateral root systems and vascular tissue around the circumference of the stem)?
- Does it have dense or soft woody tissue?

Propagation & spread

- What is the plant's methods of propagation, does it establish from seed, underground or vegetative parts?
- Is the seed fleshy, a papery seed, or a tiny hard nut?
- What is the seed longevity (how long is the seed viable in the soil or held on the plant?)
- What is the plant's methods of dispersal (birds, flying–foxes, flood waters, wind, gravity attachment or explosive capsule?)

Underground structures

- Does the plant have underground storage organs such as bulbs, rhizome, corms, tubers or lignotubers?
- Are the storage organs comprised of a single unit or many?
  Note: Many plants have specialised root structures or storage organs that are used to sustain the plant during harsh conditions. These species can be hard to control as they die back to underground organs and may require repeated treatments. Timing is important and is best between flowering and fruiting when the storage reserves are being exhausted. Control techniques that risk dislodging basal cormes, buds, tubers, or bulbils are best conducted at this time.
- What type of root system does the plant have (tap or lateral roots, deep or shallow, adventitious, stoloniferous or a dense crown).

Response to disturbance

- Does it readily sucker or coppice from injury?
- Response to fire: is it killed or does it recover, does it require a hot or cool fire for control?
- Does it readily compartmentalise from injury or herbicide applications?
- Will aerial parts keep growing if cut at the base?
- Will the weed soil seed bank regenerate?

Climatic requirements

- Is it originally a cool temperate or subtropical species?
- Is it shade or sun tolerant?

3.5 Weed control

Controlling weeds using appropriate methods will directly reduce threats to native vegetation by reducing the availability of weed propagules and creating opportunities for the re–establishment of native vegetation. Future weed regrowth will be less likely once native vegetation competes for space and resources. Manual, mechanical or chemical methods can be used for weed control fire can also be a useful control method in some vegetation communities.

The following sections describe the general approach to undertaking weed control in a bush regeneration context. A key consideration for effective weed control is to ensure that the objectives of the project and specific site attributes are foremost in making decisions regarding weed control actions.

3.5.1 Primary weed control

The first time weed control is undertaken at a site is often termed "primary weed control" (Buchanan, 1989). The extent of primary weed control undertaken will vary from site to site and will depend on the condition of the bushland and complexity of weed infestations. Bushland in proximity to human settlement often contains a higher diversity of weeds compared with intact less disturbed bushland. Very rarely is there only one weed species to control; more commonly a diversity of weeds or associations of weeds is present. In such situations primary weed control may use a range of techniques. It entails the initial control of the bulk of weeds at a site and often aims to strategically remove reproductively mature weeds.

Weed control should generally be undertaken by working methodically and systematically through a site or management zone controlling weeds, unless the selective retention of weeds is required for environmental management reasons.

The amount of clearing undertaken during primary control should consider potential significant changes in microclimate and soil erosion. The level of primary work undertaken at a site should also be undertaken with an awareness of both the level of resources available for follow up and the site's regeneration potential. Primary weed control must be followed up at a later stage to treat any weed regrowth and weed seedling regeneration.

3.5.2 Secondary weeding and follow–up

This is a crucial part of a bush regeneration program. After primary weed control some weeds will re–sprout whilst some respond to the disturbance and modified environment and will germinate. Secondary weeding is crucial to remove the weeds that compete with native species during the recovery process. Skill, care and experience is needed to recognise native and weed seedlings when undertaking secondary weeding. This is also the time to treat any weed missed during the primary control run.

Follow up control of weed seedlings and weed regrowth is required until weed sources are removed, seed banks are exhausted and site conditions are more resistant to future weed incursion. This will be achieved when native plants dominate and have replaced weeds, or in the

Control of Camphor Laurel to assist the growth, germination and expansion of native species.

case of rainforests, when a site becomes well shaded or structurally complex and a good layer of leaf litter has developed. The frequency and extent of follow–up required will vary from site to site, depending on the nature of the weed infestation, history of site disturbance and site resilience.

The timing of follow–up will depend on the lifecycle, growth habit of the main weeds on a site and growing conditions. After undertaking primary weed control a site must be checked to assess the level of weed regrowth and native regeneration. Follow–up is generally undertaken one to two months following initial weed control and up to a few times per year, preferably before weeds set seed and re–infest the site. Follow–up weed control is often undertaken by a combination of spot spraying and hand removal of weeds. Allow weeds, such as Lantana, some regrowth prior to undertaking follow–up spraying, as good leaf cover is paramount for effective foliar application.

3.5.3 Long–term maintenance

The level and frequency of management required to maintain a site should eventually decrease over time and management of the site can then progress to a maintenance phase. Unfortunately, weed seed can still arrive at the site so a level of ongoing maintenance is required. Inspecting the site after flood and significant tree falls is recommended as the basic ongoing maintenance requirement.

3.5.4 Target weed control

Target weed control describes undertaking the control of a specific weed species in an area. Noxious weeds (such as Groundsel Bush or Broad–leaved Pepperbush) are often target controlled as their control is a legal requirement under the *Noxious Weeds Act 1993*. Control requirements vary according to the control class for a particular management area. Byron Shire is located in the Far North Coast Weed Management Area.

Isolated infestations of highly invasive weeds and weeds that are difficult to control such as Cats Claw Creeper, or infestations of newly emerging weeds, such as Leaf Cactus, could be target controlled. Target weed control can be crucial in preventing the spread of a highly invasive weed into the local environment.

The need to undertake target weed control will be established after surveying and identifying the extent of the weed infestations on a site.

Umbrella Tree is a species from northern Queensland that has become an environmental weed in areas beyond its natural range, including Byron Shire.

Interim habitat value of weeds

Many native animal species, including the Great Barred Frog *(Mixophyes fasciolatus)* rely on foliage and leaf litter for protection from predators and provision of food resources. The strategic control of weeds is required to maintain habitat values during the regeneration process. Photo Steve Wilson

Animals are important to the functioning of vegetation communities. Animals act as decomposers, pollinators, seed-dispersers and plant predators. The long term success of a restoration project will depend on restoring these ecological processes. Therefore, when undertaking a restoration project, it is important to consider the habitat requirements of native fauna in restoring the plant community (Bower and Kanowski in Big Scrub Manual 2005).

Native fauna – birds, mammals, reptiles, frogs, fishes, insects and other invertebrates all have specific habitat requirements for feeding, roosting, movement (seasonal and local), nesting and rearing young. Habitat can be provided by living components of the environment such as trees and non-living components eg rocks and overhangs.

Weeds can provide interim habitat values for native fauna. In many places where native vegetation was removed, weeds or a mix of weeds and natives have regrown and provide important habitat for native animals. Any program of weed control should consider the habitat values of the site and how these may be changed by the restoration program. The aim is to transform degraded weed infested sites into native self-sustaining plant and animal communities.

Ideally, weeds providing important habitat values such as food resources, roosting sites and shelter should be strategically controlled with an aim to minimise the impacts of loss of these resources on resident fauna. One useful strategy is to control weeds in-situ so that at least some of the structure of the habitat is maintained providing shelter and roost sites for fauna as the site regenerates.

When planning the restoration of your site:

- Assess what fauna, including threatened species, may use the area.
  - Conduct a survey of the site for fauna – eg listen and look for birds, go out at night with a torch and look for nocturnal animals
  - Look for signs eg nests, scratchings, diggings, scats
  - Think about what you have seen at other times of the year as some animals may be there seasonally
- Obtain information on what fauna is known to have used the site prior to clearing or modification of the original habitat. What species have benefited from clearing or moved since clearing?
- Think about what are the important habitat resources for these species eg flowering plants as a source of nectar, fruiting plants which are important for rainforest frugivores, koala food trees, low dense shrubby cover for ground dwelling birds, mammals, reptiles, vine – for small insectivorous birds etc.
- Assess the habitat features of the site – tree hollows, fallen logs, depth of leaf litter, rocks, overhangs, flowering plants (provide nectar and pollen), fruiting plants, prickly vegetation, vines, dense shrubs, water, mistletoe, epiphytes, canopy height and density, number of strata in vegetation.
- Which fauna species on site are seasonal or irregular visitors, rare or threatened species, or species that play a key role in the function of the target vegetation community?
- To ensure fauna can either move to a new habitat or persist on site, it may be necessary to replace habitat incrementally over time.

(Bower and Kanowski in Big Scrub Manual 2005)

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Photo Wayne Penn

3.5.5 Selective retention of weeds or staged weed control

Weed buffers

In some instances it may be necessary to retain an interim weed buffer, such as near an exposed vegetation edge or in coastal dune situations. Weed buffers can provide temporary protection to regenerating or planted vegetation from wind impacts, prevent or minimise pasture species encroachment, reduce pedestrian access or provide fauna habitat. The edge buffer can be controlled as the condition of native vegetation improves and natural recruitment takes place within the inner edge. Plan to eventually treat the buffer otherwise it will continue to be a weed sauce.

Staged control

The staged control or retention of weeds is mostly used in areas that are either highly disturbed with limited native vegetation cover, on protected lands (riparian zones and erosion prone slopes), in threatened species habitat or where ongoing resources for works is uncertain. In these instances, the first weeds to be controlled may be those in areas with higher regeneration potential, in close proximity to existing native plants. This approach will allow for the growth and expansion of the native vegetation. The area of weed removal can be increased as vegetation establishes. The selective retention of weeds may assist site recovery through providing micro–climate in the absence of native vegetation cover.

Control of weeds on river banks

On creek lines or riparian zones that are dominated by large woody weeds (such as Camphor Laurel or Large–leaved Privet) it is important to undertake the staged control of weeds. Large scale stem injection of tall woody weeds on steep creek banks can result in bank failure. A balance must be achieved between weed control and vegetation re–establishment. As a priority, understorey weeds such as Madeira Vine, Lantana, Privet and Camphor Laurel saplings should be controlled, then larger woody weeds should be selectively treated focusing control works in proximity to existing native trees or shrubs.

Site inspection and follow–up treatment are important in riparian sites after flooding to prevent establishment of newly introduced weeds.

Examples of the relationship between root systems/underground organs and control problems

Common name	Species name	Roots & underground organs	Control problems
Cats Claw Creeper	*Macfadyena unguis-cati*	• One or more tubers on seedlings and large vines	Many tubers along lateral runners. Manual or herbicide based control must be undertaken in a manner that impacts the tuber.
Madeira Vine	*Anredera cordifolia*	• Lateral root systems + subterranean & aerial tubers	Must treat aerial and ground tubers. Fallen tubers will grow.
Climbing Asparagus	*Asparagus africanus*	• Rhizome	Manual or herbicide based control must be undertaken in a manner that impacts the rhizome. Broken sections of rhizome will continue to grow.
Dutchmans Pipe	*Aristolochia elegans*	• Deep tap root & lateral roots	Deep roots readily snap off from handpulling.
Ochna	*Ochna serrulata*	• Deep tap root & lateral roots	Deep tap root readily snaps off from hand pulling. Can coppice from poor technique, treatment or fire.
White Passionfruit	*Passiflora subpeltata*	• Divided lateral roots on smaller plants	Roots readily break and regrow.
Kudzu	*Pueraria lobata*	• Lateral roots & massive tubers produced at nodes	Readily re-shoots from large tuber. Control techniques must impact the tuber.
Camphor Laurel	*Cinnamomum camphora*	• Tap and lateral roots	Can coppice and sucker if poorly treated. Often re-shoots from poor stem injection e.g. cuts not deep enough, ring barked rather than overlapping alternate cuts or an inadequate amount of herbicide).
Singapore Daisy	*Sphagneticola trilobata*	• Adventitious roots, stoloniforous stems and dense layered foliage	Repeated treatment often required. Plant may die back to short stem and root section and later regrow due to incomplete spray coverage or failure to remove root sections.

Buddleja is used in gardens as a butterfly food plant but can rapidly spread into bushland areas where its scrambling habit can assist it to totally outcompete native species.

In some situations, removal of the entire plant may not be feasible but removing flowers, fruits or seeds can assist in reducing the spread of a weed species. This can be a useful strategy for species such as Cocos Palm.

3.6 Preventing weed introduction and spread

Ideally, preventing the introduction of weeds will avoid the need for weed control. Deliberate introductions can be reduced or avoided by seeking information about potentially problematic species and responsible plant use. Far North Coast Weeds is the local control authority under the *Noxious Weeds Act 1993*. The NSW North Coast Weed Advisory Committee provides advice on noxious and environmental weed control via the organisation's web site and the Bushland Friendly Nursery Scheme which accredits nurseries that do not sell environmental weeds. The scheme was developed to encourage the public to plant local native alternatives and help stop the spread of destructive weeds.

Most environmental weeds are garden plants that have jumped the fence into bushland (Groves, Boden, and Lonsdale 2005). They disperse from planted specimens or when people deliberately dump garden refuse on the edges of bushland, roads and creeks. The idea that garden refuse such as lawn clippings is good for the bush because it is organic matter is a mistake. This practice is a major source of weed infestation. Seeds (Cocos Palm), tubers and rhizomes (Madeira Vine, Gingers) runners (Singapore Daisy) and stems and leaves (Impatiens) can sprout and spread, sometimes rapidly. Dumping of garden refuse also increases nutrient levels that may favour some weeds and the debris may also be a fire hazard. Garden waste can also be moved by flood waters and have a negative impact on water quality.

Preventing the spread of weeds at their source is an important strategy for containing weeds. Preventing isolated weeds from establishing and treating outlying infestations is an effective way of reducing the total area potentially occupied by a weed population. Treated sites are likely to require continuing follow–up weed control if seed sources remain within dispersal distance. Some degree of reinfestation may be inevitable and should be planned for.

Although seed dispersal by birds, mammals, wind and water cannot always be controlled, some dispersal systems can be managed. Identifying the direction of dispersal, as in the case of floodwaters, can suggest an appropriate strategy for management, such as working downstream from the extremity of the weed population. Slashers and graders, and even standard motor vehicles, readily disperse weeds. Parramatta Grass seeds, tubers and stems of Madeira Vine and stems of Buddleja and Morning Glory are all readily carried by machinery. Avoiding seed sources during roadworks and washing down machinery regularly and before entering new areas can greatly assist in the control of weed spread.

Camphor Laurel management and rainforest recovery

Camphor Laurel (*Cinnamomum camphora*) is an exotic evergreen tree which grows approx 30 metres in height and produces prolific crops of small black fruits at maturity. These fruits are eaten and dispersed by many fruit-eating birds and other animals (Scanlon and the Camphor Laurel Taskforce, 2003). Camphor Laurel dominated vegetation makes up more than one quarter of the vegetated area in the Shire (Byron Shire Council, 1999).

Camphor Laurel is listed as a class 4 noxious weed in Byron Shire. There is a legislative requirement under the *Noxious Weeds Act 1993* to control the growth and spread of Camphor Laurel in accordance with a management plan published by the local control authority, Far North Coast Weeds.

Regardless of its noxious weed status, Byron Shire Council (BSC) recognises through the Byron Biodiversity Conservation Strategy 2004 some areas of Camphor Laurel as playing an important ecological role in the landscape. Camphor Laurel patches can provide a "bridging habitat" for many rainforest plants and animals including threatened species (Australian Association of Bush Regenerators 2008). For rainforest to recolonise the landscape, seed must be transported to sites from rainforest remnants. Fauna such as fruit-doves, play an essential role in this seed dispersal and utilise the habitat that Camphor Laurel patches provide, thereby bringing in native seeds to germinate and establish under the shade of the Camphor Laurel canopy.

Camphor may assist rainforest regeneration by attracting seed dispersers that bring in seeds of native rainforest plants, shading out competitive exotic pasture grasses and herbaceous cover and creating a micro climate suitable for rainforest plant establishment and germination (Neilan et al 2005).

However camphor can invade other types of plant communities and facilitate a transition towards a changed ecosystem dominated by fleshy fruited plants. In sclerophyll forests tolerating Camphor Laurel will not assist restoration. To assist regeneration of communities other than rainforest, aim to continually suppress camphor invasion and establishment.

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It is important to distinguish between methods to improve pasture and methods to regenerate and improve habitat. If controlling Camphor to improve habitat, large-scale machine-based methods are not appropriate as this can cause immediate habitat loss, off-target impact to native trees, saplings, seedlings and soil seed reserves, heavy soil disturbance and subsequent weed invasion and soil erosion.

To convert stands of Camphor Laurel to rainforest, it is preferable to control them in-situ, leaving the tree standing to die and decay over time. This minimises soil disturbance and maximises the natural regeneration potential of the site by taking advantage of existing natives and providing a perch for seed dispersers to distribute seed into the site. The decaying tree will return carbon and other nutrients to the soil and improve habitat complexity in the form of woody debris for fauna occupying the ground layer.

Large-scale stem injection of Camphor Laurel is also not desirable unless the subsequent incurrence of weeds can be managed. The selective control of Camphor Laurel adjacent to native trees or native plant communities, or patch control over a series of stages will achieve better habitat restoration outcomes.

Additional points to consider when undertaking a Camphor Laurel control project:

- Do primary control – It is important to control weeds in the ground layer before killing canopy trees as the influx of light and reduction in competition from roots will boost growth of these weeds.
- Follow-up and maintain the site until captured by regenerating natives. Follow-up control is essential to ensure germinating weeds are prevented from establishing and encourage native regeneration, otherwise weed problems may be exacerbated by treatment of canopy trees.
- In sites that are distant from remnant rainforest it may be necessary to supplement regeneration by planting species that are unable to be dispersed over long distances such as large seeded or wind dispersed species. Ensure that plants selected for planting are sourced from the local area.

3.7 Inappropriate weed management

The presence of weeds can have indirect flow–on effects if control methods are inappropriate. Weed treatments including herbicide or manual control methods intended for weeds may kill or damage native species. Resources needed by fauna may be removed without replacement, soils can be exposed and erosion may occur. Removal of weeds without consideration of conditions at the site or failure to undertake follow up weed control may result in more weeds invading, thus increasing cost for future management.

3.8 Planning your bush regeneration project

Planning your bush regeneration project is just as important as the actual works to be undertaken. Project planning is critical to ensure the values of a site are protected and enhanced, that weed threats are identified and that funds and labour resources are used efficiently. Planning is also important to ensure that success is recognised and good techniques and ideas can be communicated to other workers. A plan can be simple and cheap or complex and expensive depending on the particular circumstances of the project.

Commonly, bush regeneration works will involve:

- Assessment of the attributes and issues of a project site.
- Development of a restoration plan and baseline monitoring.
- Primary weed control at a rate to be determined by the severity of threats, available resources and recovery rate of native vegetation.
- Secondary, follow up weed control and maintenance.
- Assessment of results, including determining the need for planting, or other management techniques such as fencing, access control, rubbish removal, storm water amelioration.
- Adaptation of actions if necessary.

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3.9 Preparing a bush regeneration plan

The minimum information required for the preparation of a bush regeneration plan is outlined below.

Permissions

The permission of the landowner or land–manager for public land is the essential first step. Confirmation of permission in writing is recommended.

Background

Compile available information about the site and its context, conservation values and threats. Sources may include local and state government reports and databases, existing survey reports, information from local landcare groups and landowners, prior land uses and restoration works previously undertaken.

Site Assessment

Gather additional relevant information by site inspection, survey, maps and aerial photographs. Information required may include:

- Property boundaries, landform, soil, water bodies
- Vegetation and its condition
- Native and exotic plant species
- Fauna habitat and fauna observations
- Other site features relevant to ecological values and management issues (e.g. stock access, feral animals, altered fire regime)

Undertake the site inspection of the project area.

- There are a range of techniques available to do the site assessment. Information can be gathered by using quadrats, transects or a combination of both. Choosing the best technique for your site will require consideration of the time and resources available.
- Useful information to collect includes vegetation structure (e.g. dominant species in each stratum, foliage projected cover in each stratum), weed total cover abundance and/ or counts of weed species, size class of native or weeds (e.g. diameter at breast height) and fauna habitat attributes (e.g. hollow types and numbers, leaf litter depth and cover, cover and size of logs).
- Break the site up into work zones. These can be determined by existing tracks, changes in topography or vegetation or the condition of the vegetation. Work zones assist with record keeping, goal setting and communication with others involved in the project.
- Proformas to guide data collection are available from Council's Natural Resources team.
- Good data collection can be very beneficial for your project, effectively providing baseline monitoring information for the site

Assessment of values and threats

The following issues should also be considered and relevant information included in the plan:

- Species and vegetation of conservation significance
- Fauna and fauna habitat values
- Landscape context (corridors, proximity to large habitat blocks)
- Weeds (high or low priority species or impacts)

Map

A base map can be derived from topographic maps, air photos, satellite imagery or land title survey plans, or could be a hand drawn sketch map. Vegetation boundaries can be mapped by drawing boundaries on air photos. A map may represent a compilation of available background data and results of new surveys conducted for the project. An indication of the accuracy and reliability of information used should be provided with any mapping, as should a legend, north point, date and name of the map author.

Map or maps could represent:

- Vegetation units
- Infestations of serious weeds
- Locations of rare or threatened plants
- Important habitat attributes or known significant fauna
- Management zones and direction of works
- Location of quadrats, transects or other sample points

There are many advantages in entering data into a Geographic Information System (GIS) if resources permit. A Geographic Positioning System (GPS) is ideal for identifying point locations of species of conservation significance or spot weed locations. GPS can generate maps of boundaries, tracks or creek–lines from walked traverses of a project area.

Project aims and objectives

Decide what outcomes are desired from the project. Indicate predicted timeframes, and prioritise works.

An overall aim may be to return the site to the native vegetation type(s) known or expected to occur in that environmental setting. If an intact reference community, growing in similar environmental conditions (e.g. soil type, landscape position etc), is available nearby, it may be easy to decide what to aim for. Otherwise, research historical records or consult with a local ecologist or landcarer for a best approximation of important elements to restore ecological function to the site. In some instances, this aim may be overly optimistic as site conditions may be severely modified, and the nature of the original ecosystem may be unknown.

Objectives could include specific details of desired vegetation types, containment or eradication of weed infestations, protection of native vegetation from stock, stimulation of regeneration of native species and protection and enhancement of fauna habitat. Each statement of objective should relate to measurable goals, such as areas of weeds to be treated (separate primary work and follow up). Objectives should be designed to provide a specific measure of desired performance (performance criterion) e.g.

1. Undertake primary weed management in riparian zone by Year 1 with 80% controlled
2. Total eradication of Coral Tree by Year 3
3. Achieve a closed canopy of Littoral Rainforest in twenty years

A combination of short and long term goals are important for maintaining the momentum of the project and reflect the realistic nature of undertaking on–ground works.

Restoration actions

Identify and describe recommended actions to achieve the objectives of the plan.

- These include issues such as neighbour notification, weed control stages, access management, fencing rubbish removal, planting (if required) and maintenance. Identification of actions and timeframes should reflect available resources.
- Desired actions beyond available resources should be identified as such and may provide a useful basis for accessing assistance from grant programs.
- Maps are desirable to illustrate work zones and the sequence and direction of works.
- Tabulate items on a works program (action plan) with costs and timeframe for implementation.
- Estimate the time or funds required to undertake work in an area, based on a per person or team daily rate. The rate of control and achievement of goals is very site dependant, varying with weed species and abundance and site access and is best assessed by experienced operators.
- Revise and assess recommended actions once works are underway.

Monitoring and evaluation

Establish a means of record keeping that will document the progress of the project.

- Simple activities such as a series of photos from marked points are sufficient for many purposes and can be replicated easily.
- Measures and records of weed species and abundances, and changes in height and species composition of vegetation are more useful and provide detail to support photographic monitoring.
- Samples such as quadrats or transects used in the initial survey can be used as baseline data for later comparison.
- Daily work record sheets provide a detailed account of actions taken, which can be of significant benefit in later analysis of progress.
- Record any direct or indirect evidence of fauna use of the site such as scratchings, diggings, scats, birds, frogs and mammals seen or heard
- At regular intervals, e.g. annually, check to see that the project is progressing in line with the stated objectives and performance criteria.
- Consider progress of project and modify actions where required (e.g ecosystem resilience may be lower than expected thus planting may be needed; or fencing may be needed due to wallabies grazing the regeneration).

Permits, licences and guidelines

Identify relevant requirements and legislation including:

- Planning considerations (eg. State Environmental Planning Policies, Local Environmental Plan and Development Control Plan)
- Licensing requirements (A Scientific Licence from the Department of Environment, Climate Change and Water is required for bush regeneration works in proximity to endangered ecological communities and threatened species)
- Pesticide records and notification requirements (Daily work record sheets are ideal for keeping a record of herbicide used, works on public lands require prior notification)
- Other relevant legislation including the *Native Vegetation Act*, *Noxious Weeds Act* and *Environmental Protection and Biodiversity Conservation Act* should also be considered.

Assess and understand Occupational Health & Safety issues.

- Conduct a risk assessment of the site and activities planned.
- Prepare an evacuation plan for the site in case of emergency.
- Carry suitable First Aid equipment and communications devices.

Protecting threatened species and significant vegetation during bush regeneration

The use of herbicide spraying has resulted in impacts on significant native species. The use of a targeted technique such as cut and paint would have been more appropriate for this situation. Photo Mark .V. Robinson

Bush regeneration and weed management is generally a positive activity. However, there are some risks to native vegetation, hence particular care is needed if rare or threatened species, communities or habitats are present. Careful planning and skill can minimise risks. The following table summarises the risks to native vegetation, associated with weed control activities.

Risks to native vegetation associated with weed control

Risks	Precautions
Accidental damage to native plants during use of heavy machinery, felling of trees.	Do not use methods where accidental damage can not be avoided.
Threatened species mistaken for weeds and removed.	Skilled workers should be employed in threatened species habitat. The general rule is to leave any plant unless its identity as a weed is certain.
Trampling, especially of small or immature individuals, may damage species or habitat.	Define tracks for access, and barricade or flag sensitive areas.
Soil disturbance associated with weed-pulling may result in increased weed germination from the soil seed bank.	Weed in stages, apply mulch for plantings only. Consider herbicide use. Conduct follow-up control
Soil disturbance can also result in soil erosion, especially in riparian and sloping sites.	Weed in stages, apply mulch for plantings only or plant to quickly stabilise. Some species of annual weed, when not inhibiting native species growth, can be beneficial to soil conditions
Weed removal exposes plants to sun, wind and, in coastal locations, salt.	Stage removal and leave dead weeds in place. replace shelter. Schedule for best seasonal conditions.
Herbicide damage of non-target species, especially small seedlings and ground species.	Flag plants needing special protection, do not spray in windy conditions. Use skilled operators.
General opening of vegetation canopy and soil disturbance favouring further weed invasion.	Plan for recognise the need for follow-up.

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4 General weed treatment techniques

To effectively control weeds and recover native bushland, an integrated approach that utilises a range of control techniques is required. Some of the techniques include:

1. Collection of weed fruits/seeds or vegetative parts
2. Hand weeding – hand pulling, digging up /prising or crowning out (non herbicide)
3. Disposal of weed material – desiccation, composting, disposal at land fill or burning
4. Herbicide applications – foliar spray, over spray, blanket spray, wick–wiping, cut scrape and paint, cut and paint and stem injection including drill and inject or frill and inject)
5. Tree felling and chipping
6. Cutting up weed biomass
7. Fire
8. Mulching
9. Machines – slasher, tritter, excavator, dozer
10. Planting
11. Aquatic weed control
12. Heat – steam and flame weeding

4.1 Collection of weed fruits/seeds or vegetative parts

The collection of weed seeds and fruits or vegetative parts can help prevent the spread of small outbreaks of weeds. This effectively prevents a season's worth of weed propagules entering the environment. For example it is advisable to collect the fruits from small infestations of Coral Berry, Moth Vine, Winter Senna or White Passionfuit. Seed collection should be followed by the actual control of the weed itself. The non reproductive vegetative material can be left on site to decompose.

Collection of material from species that spread or propagate vegetatively from stems or leafy segments can be used to control small weed infestations. For example, collect aerial tubers from Aerial Yam or Madeira Vine, or leafy segments and stems of Cape Ivy, Leaf Cactus and Madeira Vine; and bulbils from Watsonia.

Equipment: Durable stock feed bags or fertilizer bags. Buckets are not advisable as they may tip over.

4.2 Hand weeding – hand pulling, digging up /crowning out

Hand weeding is the physical control of weeds without herbicide through either hand pulling, or digging up or crowning out the basal storage organs of a plant. Hand weeding is often undertaken for the removal of limited infestations of weeds, or is used where a large labour input is available. Hand weeding is slow and is likely to not completely remove all underground growing parts of the plant. Hand weeding is often used to control grasses, herbs and small woody weeds from environmentally sensitive areas such as a threatened frog habitat or to control weeds near native seedlings, threatened plants, or from patches of herbicide sensitive ferns (e.g. Sickle Fern). Often hand weeding is used as a means of undertaking preparation prior to spraying or to control weeds that were left as a buffer during spraying. It is important to determine whether hand removal around natives or spot spraying is best employed at a site. Hand weeding can be used to control the dwindling remnants of weed propagules (such as Cats Claw Creeper tubers or Madeira Vine tuberlings) after the bulk of the infestation has been treated by herbicide application.

If properly employed, hand weeding gives surety of control as the key growing parts of the plant are removed. However it can cause soil disturbance, which can trigger further germination of seed banks.

4.2.1 Hand pulling

Hand pulling is used to remove annuals or small woody weeds with tap and lateral root system (e.g. Lantana, Ragweed). For plants with tap and lateral roots, hold plant stem near to ground and lightly rotate or shake stem to assist in freeing up root system then firmly pull plant upwards. Be sure to pull up the entire root system, otherwise they may reshoot. Use a knife to help prise up or excavate stubborn root systems.

4.2.2 Crowning/knifing out

Crowning or knifing out are techniques used to remove plants with basal or subterranean organs (corms – Watsonia, rhizomes – Ground Asparagus, tubers – Madeira Vine, bulbs – Montbretia, culms/rhizomes – grasses).

Hold plant and with knife or trowel, excavate cut or around the basal part of the plant aiming to excavate the basal organ intact. Be sure not to dislodge corms or to leave a portion of a rhizome in the soil. Cut foliage off and bag the organ/corm.

Equipment: Knife or trowel, mattock, Peter lever, weed bag

4.2.3 Digging up

Digging up is necessary for excavating deep or well developed subsurface or underground storage organs such as large tubers of Cat's Claw Creeper, large rhizome bases of Ground Asparagus, Climbing Asparagus and Taro, or smaller delicate rhizomes of Glory Lily. Rhizomes are often layered or are extensive and will require tracing to ensure complete removal. Digging up may often be the only means of removing submerged aquatic weeds. Digging up can cause a lot of soil disturbance or root damage to natives. Be sure to collect all rhizomes and tubers and propagation parts. Monitor sites where digging has occurred to follow–up regrowth of missed fragments.

Equipment: knife, trowel, garden fork, small mattock, sieve, Peter lever, weed bag.

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Each project site requires a unique range of control techniques to effectively control weeds and recover native bushland.

4.3 Disposal of weed material by burial, desiccation, composting or burning

The next step after collecting weed propagules is to appropriately manage or dispose of the material. Collected propagules (fruits, seeds or vegetative material) must be bagged and destroyed by composting, desiccation (laying in sunlight or under black plastic), burning, or burial at an approved Council landfill. Weed seed may remain viable in normal compost, therefore it is advisable to desiccate material prior to composting by exposing to heat under clear or black plastic or roof iron and roast in the sun for a few weeks, then add to compost. As a last resort, send weed material to an approved landfill, in which case it is essential to be sure the bag is tightly sealed to avoid propagules falling out or spreading in the wind.

Where weeds occur extensively on a project site, the collected weed material should be processed on site to avoid spreading it to new locations. However where serious weeds occur in a limited area on a site it is better to physically remove and process the weedy material offsite.

Example – Composting Madeira Vine
In heavily infested Madeira Vine sites, tubers and vines are often collected as part of the control program and composted on site.

The following points are advisable:
- compost material under plastic or in thick bags or garbage bins
- keep compost out of flood reach
- add leaf litter and soil to accelerate breakdown; adequate nitrogen must be added to high carbon materials
- secure compost to avoid access by scrub turkeys or bandicoots
- monitor compost piles, as larger tubers may take some time to decompose and will continue to grow, particularly if the compost pile is in the shade
- turn compost piles. If the pile isn't decomposing, open up pile, let it grow, then spray and close up pile

In the event of failure to properly decompose, Madeira Vine composts may result in the massive propagation from the compost site itself. If there is uncertainty of follow–up, compost in a plastic bin with a sealed lid, or remove collected material from the site and place in mains landfill or process at home.

Examples of species for desiccating
- Watsonia corms and bulbils
- Succulents
- Water weeds (do not reintroduce treated material to moist environments)

Examples of plants not to compost
- Leaf Cactus

4.4 Herbicide applications

The control of weeds using herbicide may include foliar spraying (spot spray or over spray), splatter gun application, trunk absorption, wickwiping, scrape and paint, cut and paint, cut – scrape and paint, frill and inject, basal bark and stem injection.

4.4.1 Introduction

Herbicide–based weed control techniques can achieve effective and environmentally sound weed control, if used appropriately. Herbicide–based weed control applications are to be undertaken in a manner that selectively and strategically controls weed species, whilst minimising off target damage to native species and their habitats.

When using herbicides the aim is to use the most effective, efficient and safe method, whilst using the smallest amount of herbicide required to achieve sound weed control. In some circumstances, repeated treatments may be required owing to the structure and reproductive characteristics of the plant. Often repeated treatments of lower toxicity scheduled herbicides such as glyphosate (Poison Schedule S5 – slightly toxic) are used, rather than using one–off or fewer applications of a higher toxicity scheduled herbicide such as triclopyr/

Garlon (Poison Schedule S6 – moderately toxic). The approach is a personal choice, based on ecological constraints, available resources, the nature and location of the weed infestation itself and product labels or permits. Refer to the herbicide product Material Safety Data Sheet, available at the place of purchase or on the internet, before use. The ultimate choice of herbicide and methods used must also be appropriate for the target weed species.

Types of herbicide

The herbicides that are commonly used in ecological restoration projects in northern New South Wales, are generally of a type that are translocated (i.e. are transferred within the plant system) and are of low toxicity. These include glyphosate, metsulfuron–methyl, and fluroxypyr. Contact herbicides are very rarely used, if at all, as contact herbicides only affect the sprayed portions of the plant. Thus they require re–application to address regrowth from non–affected underground storage organs. Pine Oil is an example of a contact herbicide, and is not widely adopted.

Stem injection is a common method of herbicide application for large woody weeds.

Product labels

Herbicide product labels provide control techniques for weeds that are generally associated with agricultural environments, public service areas or for use on widely recognised noxious or environmental weeds. Herbicides must be applied according to product labels or permits. Controlling weeds contrary to product labels without a permit is an offence under the *Pesticide Act 1999*.

Many of the weed species that are invading native habitats are not listed on general product labels, therefore a pesticide permit or off label permit is required. Pesticide permits are issued through the Australian Pesticides and Veterinary Medicines Authority (APVMA). A number of permits have been acquired for northern NSW, and allow the control of a diverse range of weeds in bushland and agricultural areas with glyphosate, and / or metsulfuron–methyl or fluroxypyr with water or diesel for basal bark spray (e.g. Permit 9907). This permit has replaced former permit No. 5206 which specified a wide range of weed species. Further trials and permits are required, however, to treat the ever increasing diversity of new weeds that are spreading into the natural environment.

Poison schedules

Herbicides are allocated a poison schedule and a signal heading, based on the level of hazard/human health risk associated with the toxicology of the ingredients (NSW Agriculture 2002). This is clearly displayed on the product label.

Herbicide poison schedule ratings

Poison Schedule	Level of hazard	Signal Heading	Active Ingredient
unscheduled	Very low toxicity	no heading required	Metsulfuron methyl
Poison – 5	Slight toxicity	Caution – keep out of reach of children, read safety directions before opening or using	Glyphosate
Poison – 6	Moderate toxicity	Poison – keep out of reach of children, read safety directions before opening or using	Triclopyr
Poison – 7	Highly Toxic	Dangerous Poison – keep out of reach of children, read safety directions before opening or using	Monosodium methylarsonate

Training
Chemical applications should only be undertaken by persons certified or trained in pesticide and chemical use. Suitable courses are run by a number of training organisations including EnviTE and TAFE.

Records
Record keeping is a requirement under the *Pesticides Act 1999*. Persons using chemicals in a commercial capacity must take records of chemical use including: name of persons using chemical, chemical used, concentration and quantity used, batch number, equipment, target species, timing, location and weather conditions. Record keeping is valuable to monitor the effectiveness of control works. Over time, chemical use should decrease within a management zone; if this is not the case then management actions should be reviewed. Records are also valuable for safety reasons, providing immediate information in the event of suspected adverse effects on humans, or unexpected off target impacts.

Herbicide use on public land also requires notification in accordance with Byron Shire Council's Pesticide Notification Plan. Landcare and Dunecare groups regular work sites are listed on Council's website as part of this requirement. Council also has a register of chemical sensitive residents and organic growers. Groups undertaking works on public land are required to notify Council prior to works so that residents on this register can be notified.

Commonly used herbicides and additives
Some of the commonly used herbicides and additives are described below.

Herbicide products

Glyphosate is a non-selective translocated herbicide, commonly used for foliar spraying lantana, grasses and many weed seedlings. It is also often used in the treatment of large woody weeds. Specialist advice is recommended when treating aquatic weeds to ensure that water quality and aquatic fauna are not negatively affected. "Roundup Biactive" and "Weedmaster Duo" are products containing glyphosate (isopropylamine salt) at 360g/kg as the active constituent.

Metsulfuron methyl is a selective, translocated herbicide that is absorbed through the roots and foliage and is effective for controlling succulent species, species that have underground organs (rhizomes, corms or bulbs), exotic ferns and leguminous species (Fabaceae family). Control can be undertaken with less impact on grasses, except annual and perennial rye grass (as per product label). Metsulfuron methyl may improve the control of plants that do not respond to glyphosate. It can be mixed with glyphosate to control a broad range of weeds. Brushkiller 600, Ally and Associate are products containing metsulfuron methyl 600g/kg as the active constituent.

Fluoroxypr is used for basal bark application with diesel; or as spray application with water; it can also be mixed with glyphosate. A face mask is advised when using this product as it readily vapourises.

Starane is a product containing fluroxypyr methlyheptyl ester as the only active constituent.

Selective control of weeds allows native species to regenerate. Ongoing maintenance is critical to the success of bush regeneration.

Regularly used herbicide concentrations for stem injection, cut stump or basal bark

- **Glyphosate 100%** –
  for scrape and paint of Madeira Vine.
- **Glyphosate 1:1.5 = 1 part herbicide to 1.5 parts water** for cut stump and stem injection applications (privets, Camphor Laurel and Groundsel)
- **Glyphosate 1:4 = 1 part herbicide to 4 parts water** for stem injection of Coral Tree
- **Glyphosate 1:2 or 1:3 = 1 part herbicide to 2 or 3 parts water** for use on stem injection of Camphor Laurels with chainsaw and cuts filled with a spray pack
- **Glyphosate at 1:1.5 (1 part herbicide to 1.5 parts water) + 1g Metsulfuron methyl per litre of solution** for stem injection or cut and paint of difficult to control woody weeds such as Ochna, Cherry Guava and Brazilian Cherry
- **Fluroxypyr/Starane 35ml/L = 35ml of fluroxypyr per litre (approx.) of diesel/kerosene** for basal bark application for use on Ochna, Broad–leaved Pepperbush, Chinese Elm etc.

Regularly used herbicide spray/splatter gun/wick wipe concentrations

Glyphosate

- **1:9 = 500ml herbicide plus 4.5L of water** used for splatter gun application on environmental weeds e.g. Lantana
- **1:20= 50ml herbicide plus 1 litre of water** used to wipe on leaves of environmental weeds e.g. Watsonia
- **1:50 = 20ml herbicide plus 1 litre of water** used on Madeira Vine, Trad, Camphor Laurel seedlings
- **1:75 = 13.3 ml herbicide plus 1 litre (approx.) of water** used at this rate when mixed with metsulfuron methyl for spraying Glory Lily, Ground Asparagus, Corky Passionfruit etc.
- **1:100 = 10ml herbicide plus 1 litre of water** (used on Mistflower, Morning Glory, Cats Claw Creeper, pasture grasses, or Bitou Bush during poor season etc)
- **1:200 = 5ml herbicide plus litre of water** (used on Bitou Bush during cooler season and in good growing conditions)

Metsulfuron methyl

- **1 to 2 g/10L of water** (used on a broad range of plants as spray or wipe application (e.g. Mistflower, Siratro) and can be used with or without glyphosate). This is a powdered product and must be dissolved in water prior to adding to the spray pack.
- **10g/1L of water with surfactant** (use to wipe on leaves of environmental weeds e.g. Variegated Arrowhead Vine)

Fluroxypyr

- **10ml/10L per litre of water** for foliar spray applications (Morning Glory); or 6ml/10L (Mother of Millions)

Additives
Stickers, spreaders and penetrants can be added to herbicide spray applications to increase control outcomes.

Stickers/oils
Stickers and oils are used to improve rain fastness, reduce spray drift and odour, increase herbicide cover and reduce runoff. They are either plant based or mineral based oils.

- Spraytech®, Protech Plus®
  (used with Glyphosate and Metsulfuron methyl)

Penetrants/surfactants
Penetrants and surfactants are often added to herbicides to increase uptake and effectiveness of foliar spray herbicide applications for weeds that may have a waxy leaf surface (Camphor Laurel, Watsonia, Maderia Vine, Glory Lily) or hairy leaf surface (Silver–leaved Desmodium) and other species that can be difficult to control.

- Pulse® = non ionic wetter/spreader/penetrant can be used with glyphosate, metsulfuron methyl and insecticides. This is often used as an additive in the foliar spray control of Glory Lily and Ground Asparagus.

- Li700® = surfactant & penetrant (acidifier) is used with glyphosate. Glyphosate foliar spray applications work better in water with a low/acid pH, as opposed to a high/alkaline pH. Cement rainwater tanks often have alkaline water. Li700 will lower pH. It is also used on species with waxy cuticles.

- Agral® = non ionic surfactant, spreading/wetting agent is used with glyphosate or metsulfuron methyl.

Marker dyes
Marker dyes are used to guide or mark the progress of herbicide applications. Use of dye reduces over use or 'doubling up' of spray application and also helps minimise off–target spray damage, as plants that are accidentally sprayed can have their foliage washed down or cut off. Accidental skin contact can be readily observed and treated, and practices modified where necessary. Use of dye is particularly important when working in a large team. Red dyes are easier to identify on green foliage than blue dye

- Kiwi highlight® (red dye), Herbidye®(red dye), Simplot Blue® (blue dye).

Mixing of herbicides

- Refer to product labels to ensure compatibility of additives with herbicides. Incompatible products may result in coagulation, separation, heat and residues which may cause blockage of spray equipment and reduced control outcome.

If using a number of chemicals and surfactants, refer to product labels for the correct sequence of mixing. Generally when mixing a spray pack, half fill the pack with water, then add the acidifiers, wetters, the herbicide product and oils in this order.

4.4.2 Foliar spraying
Foliar spraying of herbicide is used to achieve the strategic control of weeds on a small to large scale with a minimal level of disturbance. Spraying is used to control weed seedlings, saplings, low growing vines, weed thickets and low shrubs. Foliar spraying provides a means of controlling weeds which would otherwise be difficult, costly or unsustainable to remove by hand–based methods. Foliar spraying can be undertaken as primary and/or follow up weed control. For the effective spray treatment of most weed species, it is important that the foliage of the target weed is well covered, but not dripping with herbicide. Only spray weeds that are actively growing and not drought stressed, otherwise herbicide uptake will be limited.

Equipment – Low pressure knapsack /backpack spray pack (12–15 L capacity), power spray unit, adjustable – spray nozzle, flagging tape, hand held water sprayer, secateurs, personal protective equipment (PPE) (gumboots, face mask, plastic gloves, hat, glasses etc) and herbicide.

Reducing off target damage
Spray preparation is essential to avoid off target damage to other plants. Prior to spraying, check the site and identify important plants or habitat features that need to be protected. Where necessary, hand weed around natives so that applied herbicide is not near natives. Also prepare the area designated for spraying by tagging important plants, by walking through the area and 'pruning up' or 'propping up low branches or foliage of non target plants or by bundling foliage of weeds and laying in a strategic position for spraying (for example this is useful for Ground Asparagus, which has sprawling foliage).

To minimise off target damage whilst spraying, observe wind direction and spray accordingly. Spray application can be varied by modifying the width of the spray jet, or using the herbicide wand in a low position, reducing sprayer pressure and using protective spray boots as a barrier between the target weed and non target native species. It is possible to spray close to a non target plant without harming the plant itself. Adjustable spray nozzles are important to allow for variation in spray jet width (fine to broad). Do not spray under windy conditions, early to mid–morning can often be the best time to spray.

4.4.3 Spot spray
This is generally used to follow up an area after primary weed control by selectively spot spraying weed seedlings or patches of small weeds. It is also used for primary weed treatment where weeds occur at a low level (e.g. spot spraying scattered Mistflower plants, or small patches of Watsonia). Spot spraying can be undertaken very strategically, avoiding non–target plants and is generally applied under low pressure.

4.4.4 Over–spray.
Over spraying describes the method of spray treatment commonly used to control dense thickets of Lantana, Bitou Bush or dense clumps of grass etc, leaving the debris intact. Foliage must be well covered with herbicide, but not dripping. Overspray minimises soil disturbance, can be cost effective, and may provide interim protection or refuge habitat and microclimate for seedling germination. Dead debris can be crushed down months later where required. The negatives are that it may provide a structure for exotic vines to climb into and

has an increased risk of spray drift depending on height of weed infestations, weather conditions (wind) and experience of operator.

4.4.5 Blanket spray

This is used for controlling dense carpets of exotic grasses or ground covering weeds. The technique is useful for exposing soil seed banks of weeds so that germination is triggered for further spraying until stored seed is exhausted. Site preparation for a planting often requires blanket spraying.

4.4.6 Splatter gun application

The splatter gun is a gas powered or manually operated injector kit (e.g. Philips Powermaster portable forestry kit). The gun delivers herbicide in large droplets as a stream or splatter. It is used to apply herbicide (glyphosate or metsulfuron methyl) across large areas of weed thicket e.g. Lantana (at 1:9 with water), Bitou Bush (at 1:19 or 1:29) or Groundsel (at 1:9). The addition of sticker oil and dye is recommended. For dense Lantana thickets, only 6ml of solution is required for every square metre of foliage. Other benefits of the splatter gun are that large and difficult–to–access areas of infestation can be treated quickly by an operator. There is less potential for off–target impacts (to insects and understorey plants), when compared with blanket or overspray methods which require spraying of the entire bush.

4.4.7 Wick–wipers

Wick–wipers can include hand–held applicators such as weed wands or slasher attachments (stationary wicks or rotary chemical wick applicators). Slasher attachments are generally used to control tall annuals or tall grasses along road edges (e.g. tall grasses such as Vasey Grass and Giant Parramatta Grass) with the purpose of promoting lower growing species (refer to www.centrogen.com.au). Slasher–based wick–wiping is best undertaken prior to the seed formation of the target weed. Hand–held applicators are used mainly to deliver glyphosate 1:10 and/or metsulfuron methyl mix. They may be useful for the spot control of weeds in sensitive areas e.g. Crofton Weed growing amongst native sedges. Hand–held applicators can drip and are messy to maintain. Careful spot spraying can often achieve the same results as hand–held wick–wipers.

4.4.8 Scrape and paint (S&P)

This is mainly used for vine weeds such as Madeira Vine (and for other species – see notes below). It is important not to sever the vine stem but to keep the stem intact when using this method. Treating vine weeds by scraping and painting and leaving intact may allow for the translocation of herbicide through the plants system, including the underground storage organs or aerial tubers.

Deeply scrape the vine to about one third the thickness of the stem and paint with 100% (neat) glyphosate immediately. Scrape as much length of the vine stem as possible. Scrape, gouge and paint basal tubers (this is critical for the best chance of killing the basal tuber). Herbicide can be applied with a paint brush used with a poison pot as a quick, complete application can be achieved over exposed plant tissue, preventing compartmentalisation and sealing of the wound. Scrape and paint, working from the basal section upwards to prevent herbicide drip on the operator. In addition, scrape and paint any vine stems previously severed by flood debris or herbivores.

Aerial tubers should show signs of desiccation in a few months following treatment. This treatment is less effective when the plant is stressed by drought or frost.

Woody weeds such as Ochna can also be controlled using scrape and paint, using glyphosate with metsulphuron methyl.

Equipment: Knife, poison pot with paint brush or dripper bottle, non absorbent rubber gloves NB: for long scrapes on Madeira Vine or Ochna, ensure the wound is covered well. A partly covered wound may cause the plant to start to dry and compartmentalise, resulting in partial control rather than complete mortality.

4.4.9 Cut and paint (C&P)

The cut and paint technique is used mainly on woody weeds. Cut the stem down low as close to ground level as possible (yet keeping soil away from cut surface) and immediately apply herbicide onto cut surface with an injector kit, dripper bottle or paint brush. Generally 100% glyphosate or diluted with water at 1:1.5 is used for cut and paint applications. Failure to apply herbicide quickly will reduce the effectiveness of uptake. Cut stumps must be cut as low to the ground as possible to minimise hazards to workers. Do not cut at a sharp angle as this will create a 'spear' that can impale or create a trip hazard.

The most important point is to apply herbicide immediately. Reapply herbicide if it is readily being absorbed by plant (get as much in as possible).

Weed species treated by C&P: Cut and paint is used on plants such as Groundsel, Bitou Bush, sapling sized Camphor Laurels, small privets and Senna species. These plants do not readily coppice if treated properly.

Equipment: Loppers, secateurs, chainsaw, dripper bottle (hairdressers' perm bottle or similar, clearly labelled with current contents), injector kit hand–held sprayer or poison pot.

4.4.10 Cut, scrape and paint (CS&P)

This technique is similar to cut and paint but includes a scrape along the side of the stump and along exposed lateral roots. Cut stump down low to the ground as possible, then scrape the outer edge of the cut stump and apply herbicide immediately to exposed surfaces using a injector kit, dripper bottle or paint brush. Scrape deeply to the cambium layer to increase the surface area of herbicide uptake. Failure to scrape the stem on species that readily sucker or coppice may enable the plant to recover and re–shoot. Plants that are hard to control may require additional scrapes, spaced around the circumference of the stem.

A variation on CS&P is to drill into the top of the cut surface. This is used on vine weeds such as Cat's Claw Creeper. The aim is to create a well that can be repeatedly filled with herbicide as it is absorbed.

The scrape and paint method is commonly used for treatment of vine weeds such as Madeira Vine and Five-leaved Morning Glory.

Weed species treated by CS&P: Lantana, larger Camphor Laurels and privets, Cats Claw Creeper.

Equipment: Loppers, secateurs, knife, chainsaw dripper bottle (hairdresser's perm bottle labelled with current contents), injector kit, hand held sprayer or poison pot, drill.

4.4.11 Basal bark application

Basal bark application is a method that can be used to control woody weeds that do not respond well to 'glyphosate based' control techniques such as CS&P, S&P and stem injection, and species that readily coppice or sucker; otherwise it is a cost effective method to treat extensive infestations of woody weeds. It employs the use of diesel/kerosene as a carrier/penetrating agent mixed with oil soluble herbicides such as Starane® or Garlon 600®. The herbicide mixtures are applied by spray pack or paint brush application. Spray packs must have superior seals that can withstand the corrosive effects of diesel. Paint brush may be more accurate if there are native trunks present.

Basal barking works well on rough barked to smooth barked species, but is less effective on thick corky barked species. Species with rough bark (e.g. Groundsel) require a good soaking/spray with the herbicide mixture. The herbicide must be applied completely around the basal stem of the plant, from ground level up to 45cm high (minimum) creating a stocking of herbicide application. The wider the circumference of the trunk the taller the stocking of herbicide required. Ensure bark is dry and free of dirt or charcoal. Also, ensure plants are not in a period of bark shedding, which may reduce effectiveness. Do not apply in wet weather. Care must be taken to avoid the bark of nearby native trees.

Weed species that can be treated and controlled using basal bark application: Broad–leaved Pepper Tree, Ochna, Hackberry, Yellow Guava.

Equipment: brush and poison pot, PPE– especially a spray mask, spray pack (with specialised seals).

4.4.12 Stem injection (drill & inject or frill & inject)

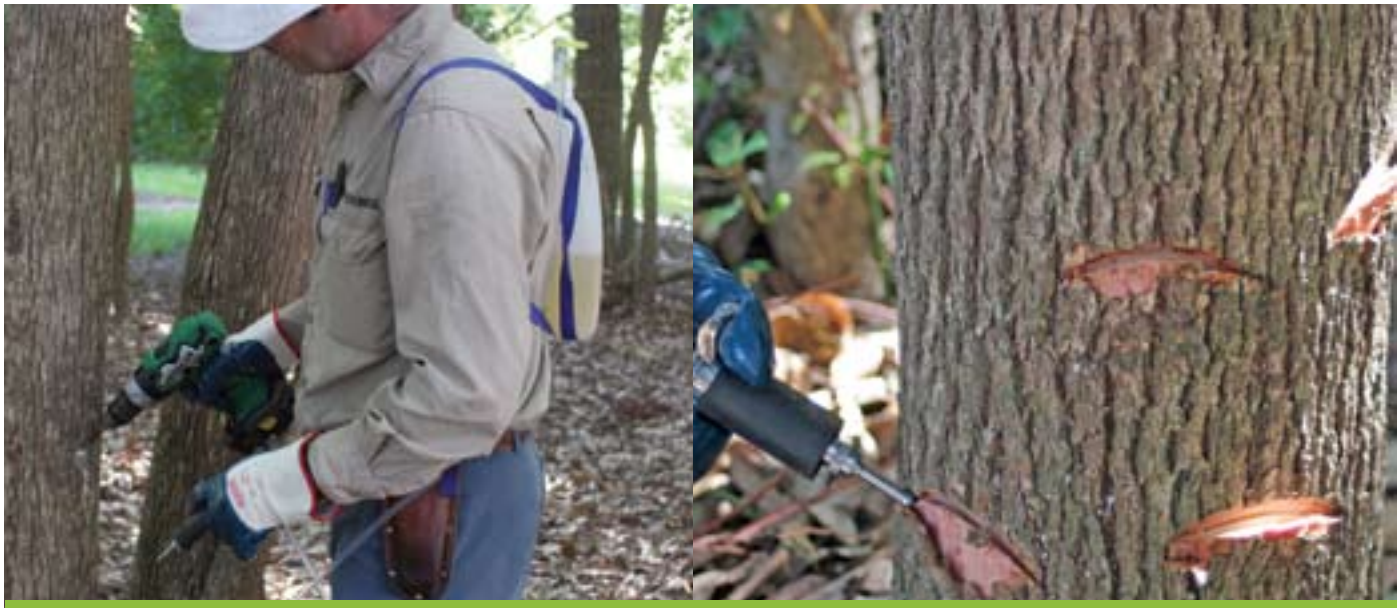
The stem injection technique is used to control shrubs and trees or very large woody vine weeds. Stem injection has the benefit of leaving tree biomass standing in situ which can provide perches for bird seed dispersers and saves dealing with the debris of felled vegetation. However, the technique should only be used where falling limbs will not compromise public safety e.g. best in forested areas and away from pedestrian activity or infrastructure that may be damaged by limb or tree fall.

Stem injection describes the application of herbicide to cuts (frilling) or drill holes (drilling) to the lower basal circumference of a tree stem or trunk. The herbicide is delivered using a stem injector kit, spray pack or sidewinder/pressurised injector. When using a chainsaw or tomahawk, cuts are generally applied at an angle and are set in staggered rows around the circumference of the tree. The cuts must overlap in a brick–work style of pattern. The rows should be at least 5cm apart and should avoid complete ring barking. Fill cuts/drill holes with herbicide immediately. Use tomahawks only on smaller diameter trees or trees with less corky bark. Tomahawk cuts must penetrate well past the bark on large Camphor Laurels, otherwise regrowth may result a year or two after initial treatment. Use a drill or chainsaw for thick barked woody weeds.

On multi–stemmed woody weeds, treat the entire circumference of each stem (this may mean injecting up high into more accessible sections of stem) and inject down lower into the buttress /root zone.

When using a drill, the holes should be angled downwards and be set in a single line or staggered application about 6cm apart. On larger trees also inject lateral roots. For Coral Trees, use glyphosphate at 1:4 or 1:5 and drill at staggered heights up the trunk due to its unusual vascular arrangement.

When using a chainsaw, plunge–cut into trunk, creating short overlapping cuts. Chainsaw cuts should be at least 3–5cm deep and angled in and down, rather than long wide shallow cuts (which really causes a lot of wounding). On larger trees also treat lateral roots.



Successful stem injection relies on correct size, placement and angle of the cuts or drill holes made in the plant to apply the herbicide.

Fill cuts immediately with herbicide. Glyphosate is generally used at 1:1.5 with water (depending on the weed species being treated). Chainsaw based treatments often use glyphosate at 1:2 or 1:3 as the cuts tend to absorb a lot of herbicide quickly and can be re–filled, hence a large quantity of herbicide can be delivered. Apply herbicide with an injector kit, or spray pack.

Pressurised stem injector (sidewinder) is another method of stem injection that delivers lower quantities of herbicide under pressure. The sidewinder is basically a spray pack type apparatus with a modified drill and hose attachment (with pressure gauge) which is used to drill and immediately fill. This method reduces the amount of herbicide needed to kill a tree. Drill holes are applied at every 10cm width of trunk circumference. Extreme care must be taken to avoid covering operator with herbicide. Dead hollow sections can burst open under pressure.

Equipment: drill, hatchet, chainsaw, injector kit/spray pack, pressurised tree injector (sidewinder), PPE including eye protection.

4.5 Tree felling & chipping

Tree felling and chipping is required in circumstances where it is not possible to leave dead stems standing for public safety reasons or where visual amenity is a concern. Tall woody weeds that occur in proximity to roads or pedestrian activity should be felled rather than stem injected to avoid the hazard of a standing dead tree. Felling and chipping of woody weeds is also useful for removing dense weed thickets (e.g. of Small–leaved Privet or Coral Tree) which would take a long time to control using alternative measures. The technique can be helpful in preparing an area for planting, when retaining dead weed material on the site would be obstructive.

Tree felling must be undertaken in a manner that minimises impact to the surrounding vegetation and the cut stump must be treated with herbicide within 10 – 15 seconds of the cut.

Fallen timber can be chopped up and chipped up for mulch or left on site to decompose as coarse timber can be valuable habitat. Logs derived from felling can also be used to assist in erosion control as long as they are not from species that can vegetatively take root from cut stems (e.g Coral Tree). Chipped material can be placed back on site as mulch to suppress weed growth, and to provide a germination medium for recently dispersed rainforest seed.Chipped woody weed material (Coral Tree) should be left to decompose for a month to avoid sprouting of any material. Avoid piling wood chips high up around the trunk of native trees, as the high temperatures associated with decomposition can result in tree decline or death.

The stumps of felled woody weeds (Camphor Laurel and Coral Tree) should be treated by stem injection and cut and paint applications to prevent resprouting. Stem inject any buttress roots. Alternatively poison the trees while standing (stem injection) and once the tree has died, fell the tree before it has time to decompose, weaken and then fall. This is particularly useful for trees whose green live stems can take root if touching the ground e.g. Coral Tree.

Equipment: Chainsaw, chipper, handsaw, herbicide applicator, PPE– protective gear, certified chainsaw operators, signage.

Native vine management

Native vines can provide important shelter and other habitat resources for many native fauna species, such as this Koala using native vines for extra shade while resting. Photo Scott Hetherington

(Adapted from Bower 2004 unpublished report)

Vines are an integral component of many native vegetation types including rainforests (Floyd, 1990). There are many species of vines, varying in size, robustness and growth rate. Their attributes may be positive or negative for the short and long term needs of vegetation management.

Dense vine thickets and native vine curtains that are often evident on rainforest edges in riparian strips or in forest gaps are a natural ecosystem response to disturbance. Vine edges and thicket can be an effective means of reducing edge effects such as wind, light and temperature fluctuations. Vine edges can assist in maintaining microclimate, which may improve conditions for seedling regeneration. Vines also provide important habitat (shelter and food resources) for a range of fauna (butterflies to birds). Many vines have fleshy fruits that provide seasonal food resources, often outside of the peak fruiting time of various rainforest trees. Several vines are prickly, which can provide protective sheltering habitat for fauna.

In small vegetation fragments the toppling or loss of canopy trees from heavy vine growth may result in the loss of valuable mature remnant trees and may further damage forest structure, promoting edge effects, weed growth or more vine incursion. Where vines are causing severe degradation and damaging of canopy trees or smothering regeneration, strategic vine management may be required. Vines that are typically advantaged by disturbance are generally the fast growing species.

Examples of native vines

Common name	Species name	Fleshy fruit	Prickly	Growth rate
Cockspur Vine	*Maclura cochinchinensis*	X	X	Fast
Water Vine	*Cissus sp.*	X		Fast
Supplejack	*Ripogonum sp.*	X	X (some)	Slow
Native Sarsparilla	*Smilax australis*	X	X	Fast
Blood Vine	*Austrosteenisia sp.*	–	–	Fast
Whip Vine	*Flagellaria indica*	X	–	Fast
Snake Vine	*Stephania japonica*	X	–	Fast

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Native vine management guidelines

There are several native vines that are threatened species (NSW NPWS, 2002) so make sure all vines are correctly properly identified.

- Only cut back common native vines that are vigorously degrading/smothering trees or shrubs and deflecting canopy development or preventing edge expansion.
- Prior to cutting native vines, assess the ecological significance of the species and the habitat value of vine thickets. Does it provide nest, roost, wintering shelter or food resources for fauna e.g. birds, reptiles, mammals or butterfly larvae?
- If vines provide important habitat resources or protection from predators, undertake vine control following the period of peak habitat use or control in a series of stages. For example, avoid cutting vines that are holding a crop of fleshy fruit or butterfly chrysalids, cut back after fruiting or emergence of adult butterfly.
- Incrementally cut back native vines that are smothering canopy trees to promote canopy expansion. Rather than cutting the vines all at once, cut vines back in a series of stages. Re-visit the site and assess the need for further vine management. In a small remnant vine cutting must be undertaken gradually.
- Within remnant bushland or in a project site, retain a mosaic of native vine-dominated areas for habitat values and structural complexity. Avoid cutting large vines, or retain a component of large vines. Avoid cutting slow growing vines such as *Ripogonum spp*.
- Cockspur often dominates disturbed vegetation along riparian zones. Cockspur is ecologically valuable as large vines provide large crops of nutritious fruit often when not much else is in fruit. Target smaller specimens where possible and always leave some larger vines. Where it is common, cut back every second or third vine.
- Vines should only be cut and not poisoned. To cut back vines, cut the vine at head height and then at ground level.
- In forest gaps or in revegetation sites, vines such as Snake Vine may establish and dominate planted trees and natural regeneration. Regularly pull up or cut back vines to reduce cover. This species will be shaded out over time as canopy cover improves.
- Consider if altered fire regime is causing a vine, such as common silkpod to poliferate on a site.

4.6 Cutting up weed biomass

Dense weed thickets such as Lantana or privets are often cut out or cut down in the course of bush regeneration. This debris is generally cut into sections to aid decomposition, to reduce trip hazards on the site and to improve access across the site for follow up weed control such as spot spraying. Some weed species (e.g. Lantana, Winter Senna, Duranta and Privet) can sprout from cut sections, so in moist environments, such as wetland or flood–prone sites, (or during the wet season), do not cut into very small pieces. In such circumstances, stem inject plants (where practical), hang cut plant parts up off the ground, or stack into piles out of flood reach. Piles can also provide fauna refuge sites. Regularly check site for reshooting stems and control as required. Be cautious about weed piles becoming trellises for some vine weeds (e.g. Cape Ivy) that may make weed control difficult. Do not cut up Coral Tree as it readily takes root wherever it touches the ground.

4.7 Heat/steam and flame weeders

Gas, diesel and kerosene powered–heat/steam and –flame weeders can be used to control a range of plants from grasses, herbs and succulents (Australian Association of Bush Regenerators 2007). The systems offer herbicide–free solutions for general weed control on tracks and road edges or adjacent bushland edges and may be used to stimulate germination of hard coated native seeds. Heat treatment is probably best for controlling succulents and annuals with poorly developed underground storage organs. A few issues are portability and accessibility (best transported on the back of a utility or on a trolley, hence some locations will not be accessible). Other issues are: fire prevention, Occupational Health & Safety, climate considerations and off target impact. Frogs and other fauna amongst the weeds are at risk from this method.

4.8 Fire

The use of fire as a means of weed management should be based on consideration of the appropriate fire regime for each ecosystem and in accordance to fire planning regulations.
Fire events can provide an opportunity to control weed species by:

- stimulating germination of soil stored seed banks e.g. Bitou Bush, non–local Acacias.
- reducing biomass and increasing site accessibility to allow treatment of basal suckers that may recover after fire (e.g. Lantana).
- It is recommended that you seek specialist advise in relation to the use of fire for weed management.

4.9 Mulching

Mulch is generally used to enhance the growth of planted trees by acting as a weed suppressant, maintaining soil moisture and conditioning soil. In highly disturbed and compacted sites (e.g. former tracks or car parks) adjacent to existing vegetation, a layer of mulch (woodchip or tea–tree) can be used to cover and rehabilitate exposed weedy topsoil and provide a medium for the germination of native species. Heavy blanket mulch close to regeneration areas is not recommended as it may suppress germination of native plants as well as weeds.

4.10 Machines (slashing – tractor or 'tritter')

Machines such as slashers and mulching machines ('tritter') can be useful to manage large areas of exotic woody weeds and grasses (e.g. Lantana, Setaria, Bitou Bush) with little or no native vegetation present. The use of such machines is dependent on accessibility, slope and whether the site contains large boulders, debris or drainage lines. Please note that threatened species use weed infested habitats and a thorough assessment is needed before large machinery is used in restoration works. Flag any native or desirable species that you do not want damaged by machinery. Machines are useful for preparing a planting site (e.g. if covered with weed thicket) or when attempting to trigger the germination of natural seed banks, such as under Lantana thickets adjacent to forest edges. Soil disturbance opens the seed bank to increased temperatures and reduces competition, thus triggering the germination of long lived seeds including rainforest pioneer species such as Sally Wattle, Macaranga, Bleeding Heart and Corkwood.

The 'tritter' is a bobcat with a front end mulcher (i.e. a spinning drum with short tines, and available with excavator tread or wheels) that can mulch weeds to form a bed of coarse to fine mulch, without causing excessive soil disturbance. The 'tritter' has more flexibility than a tractor as its mulching drum has a greater height range.

Machine–based weed control requires follow–up to treat re–shooting weed roots and stumps and any subsequent regeneration of weed seed banks. If undertaking works for planting, aim to clear the site at least 2–3 months prior to planting to allow for a few sessions of follow–up weed control to exhaust weed seed beds.

Machine operators will rarely have bush regeneration training or experience; hence communication of expectations for their work must be clear and detailed. Do not assume that the operator automatically knows what is required, and explain the preferred approach and outcome. (e.g. has flagging been used to indicate weeds to be cleared, or does it indicate native species to be protected?) It often pays to remain present on site throughout the work period.

The planning stage of the project may have identified areas with high conservation values (including habitat for fauna), requirements for staged weed control or the retention of buffers. Be sure that instructions to machinery operators take account of all the precautions indicated (methods, timing) and prepare the site with flags or fencing to prevent machinery damage to sensitive areas.

Avoid using a bulldozer or excavator to clear weed thickets for habitat restoration or revegetation works, as they tend to compact the soil and may remove valuable topsoil and rock. Dozers often create mounds of cleared weed and soil which then provide favourable conditions for weed establishment.

Controlling stands of Camphor Laurel using a dozer or excavator is not recommended for ecological restoration works. The use of these machines near native trees damages native plants by impacting surface and structural tree roots, causes inadvertent damage to tree limbs, removes important habitat features and disturbs the soil, which favours weed establishment.

4.11 Aquatic weed control

Exotic aquatic weeds are mostly plants that are either free floating, or are attached to the stream bed (emergent or submerged in the water column); or include terrestrial species that occur on the edges of waterways and form floating mats over the water surface. Many species are listed as noxious.

Aquatic weeds have the capacity to rapidly reproduce (mostly vegetatively) and can smother and block waterways, reduce streamflow, cause deoxygenation of water resulting in fish kills and can outcompete native aquatic plants and may be unpalatable to native aquatic fauna. Aquatic weeds are highly undesirable in an agricultural and ecological context owing to their rapid rate of growth and difficulty of control particularly once they are well established, with some species having significant seed dormancy. The seed of Water Hyacinth, for example, has the ability to germinate after 15 years dormancy (Sainty & Jacobs 1994).

Aquatic weeds often establish in natural water bodies as a result of dumping of aquarium specimens or ornamental water–garden plants, or are introduced by waterbirds or machinery. Aquatic weeds are also spread through rain or flood waters, or by boats or livestock, with stems sections readily broken and distributed downstream. Their establishment and growth can be favoured by slow moving and shallow water, increased nutrients (from urban runoff and agricultural activities), sedimentation/turbidity and increased water temperatures.

Aquatic weed management requires a holistic approach including:

- the control of off stream inputs (nutrients and sedimentation from runoff or livestock)
- improving riparian vegetation cover to reduce erosion, sunlight and temperature
- maintaining viable water flows.

Control methods vary with species life form, growth habit and habitat and include:

- physical removal
- draining and drying (ensure all plant parts are entirely desiccated) and
- careful foliar spray.

Aquatic weeds are a serious threat to remnant wetlands such as this one in Byron Shire.

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Control techniques for the main exotic aquatic plant groups/species

Aquatic weed type	Species	Control technique
Free floating	Water Lettuce *(Pistia stratiotes)* Salvinia *(Salvinia molesta)* Water Hyacinth *(Eichhornia crassipes)*	Free floating plants can be physically collected/ scooped up, then contained and desiccated; or controlled by water level management in dams (draining); or spraying (see note below).
Attached on stream bed - submerged & emergent	Parrots Feather *(Myriophyllum aquaticum)* Cabomba *(Cabomba caroliniana)*	Emergent plants can hand removed or sprayed; submerged species require hand removal or control by water level manipulation
Terrestrial and forming floating mats	Hygrophila *(Hygrophila costata)* Alligator Weed *(Alternanthera philoxeroides)* Cabomba *(Cabomba caroliniana)*	Terrestrial plants can be spot sprayed or floating mats gathered up, or embedded stems and roots physically removed

NB: Follow–up control will be required to contain regrowth from soil stored seed for some species.

Note: Physical removal must be undertaken very carefully to avoid breaking off plant parts.
This may entail using a garden fork to loosen up soil to then carefully hand remove and contain all parts of the plant.

Foliar spraying of aquatic weeds should be a last resort.
There are restrictions on herbicide use near potable water supplies and near aquatic habitat etc. Refer to herbicide product labels, and only use herbicides that are registered for use near waterways. No additional surfactants are to be added as this will increase environmental impact. Round–up Biactive® is registered for controlling emergent weeds in water bodies (flowing, non flowing or transient) and for weed control along margins of waterways. Some registered herbicides are less effective when more than a certain percentage of foliage or leafy portion is submerged. For further information on noxious aquatic weeds contact the local noxious weeds authority, Far North Coast Weeds, or the NSW Department of Primary Industries.

Timing of weed control is important – take advantage of low flow periods in rivers and creeks to treat weeds that are generally difficult to access in periods of full flow.

5 Habitat Reconstruction: Planting and other methods of re-introducing suitable plants to your site

5.1 Reasons for planting

Planting can be an important component of an ecological restoration project where natural regeneration alone is not sufficient to achieve the desired result. In severely modified sites, such as bare paddocks, planting may be the only way to achieve native vegetation cover (within a reasonable timeframe).

The aim of planting projects should be to establish viable, self-sustaining populations with evolutionary potential to adapt to environmental change over time. Planting that is poorly planned and implemented can result in poor conservation outcomes including low success rate, unviable populations, and potential risks to natural populations. Consider carefully whether to plant, as inappropriate planting projects can have unintended outcomes, be of limited ecological value and often do not compensate for losses. Natural regeneration is usually more cost effective and will often produce more ecologically valuable results.

For restoration, there are several different guidelines and planting models that can be used to assist in planning a planting project. For example, the Big Scrub Rainforest Landcare Group (2005) describes– late succession, pioneer, intermediate, frost and remnant expansion. Kooyman (1996), Woodford (1993; 2000) and Goosem and Tucker (1995) also provide valuable information to assist rainforest regeneration. Guidance for seed collection, preparation and storage, and restoring some other ecosystems is included in Buchanan (1989), Florabank (1999a; 1999b; 1999c; 1999d), and Greening Australia NSW (1999). Vallee et al (2004), although specifically designed for threatened plants, apply equally to establishing a viable population of a more common species. This includes species which may be locally rare or when creating a population from the beginning.

Bush regeneration techniques usually assist natural regeneration by removing threats such as weeds. The adequacy of the regeneration response will depend on the extent of degradation and availability and quality of seed sources nearby. Often, additional planting is unnecessary, but sometimes enrichment is desirable. Planting may also be needed to consolidate edges and provide windbreaks or frost protection, or may be combined with bush regeneration techniques in other ways.

Reasons for enrichment planting could include:

- Adding species that historically are known or highly likely to have been present in the local area (but consider that many species occur naturally in low population sizes, scattered across the landscape)
- Improving viability of populations with low numbers
- Adding plants for species that are poorly represented and/or have ineffective breeding units (only one specimen of a dioecious plant, a monoecious plant or a self-incompatible bisexual species)
- Correcting balances in species composition (e.g. where one or a few species are unusually dominant and the species composition is unusually low)
- Improving food resources for fauna (e.g. koala, rainforest pigeons)
- Improving shelter resources (e.g. dense low growing sedges and shrubs for ground dwelling birds such as the bush hen).

Consideration needs to be given to the protection of planted seedlings from damage by animals, mowers and climatic conditions (such as frost and drying winds). Photo Wendy Neilan

5.2 Direct seeding, matting, transfer of bush leaf mulch and transplanting seedlings and groundcovers

In addition to growing plants for restoration projects, other methods for re-introducing plant material including direct seeding, brush matting, transfer of bush leaf mulch and transplanting may be appropriate for a site.

Direct seeding can be done by special machinery (mechanical and hydro-seeding) or hand casting. Generally, at the scale of most local sites it is expected that hand casting is used and this involves collecting the seed, processing it if necessary to break dormancy and hand scattering the seed. NSW DLWC (2001) suggest that if necessary, only process a portion of the seed to break their dormancy so that some seeds may remain dormant for longer periods and allow for later recruitment. Direct seeding has been used in Eucalypt forests and woodlands (NSW DEC, 2005), coastal dunes (NSW DLWC, 2001) and with large fruited seeds in rainforests (Ralph Woodford pers. comm).

Brush-matting is where branchlets that have persistent woody fruits (e.g. *Eucalyptus spp*; *Melaleuca spp*., *Leptospermum spp*., *Casuarina spp*. and *Callitris spp*.) are cut from the live plant and are immediately laid on the site where they are to establish (see Buchanan, 1989). The site should be weed free prior to laying the brush matting and the surface should be raked if necessary so that the small seeds can come in contact with soil. It also helps to peg the branchlet down so that it doesn't blow away. Caution is needed when harvesting the branchlets so that all the available fruits are not over-exploited and their seed banks depleted on site. Furthermore secateurs

should be cleaned so that disease is not spread. Brush-matting has been successfully used on coastal dunes (NSW DLWC, 2001) and coastal heath (M.V. Robinson pers. obs.) but could be used in sclerophyll forests where species with woody fruits occur.

Transplanting of seedlings or vegetative portions of plants can also be an effective means of introducing plant material to a site. Transplanting of seedlings (sometime called 'wildlings') of trees, shrubs and vines can be useful means of 'saving' some species that are in vulnerable sites such as locations of developments (e.g. road or path construction) or threatened by stock grazing.

5.3 Species selection, local provenance and genetic issues

The selection of locally occurring native species for planting will depend on research conducted to determine the desired end point of your project, site conditions at the planting location, the stage of development of the vegetation and the purpose of the planting within the broad approach of the project (eg in rainforest restoration consider whether more pioneer species should be added to early successional vegetation, or whether later stage species now would be more appropriate). The aim of species selection for planting projects should be to re-establish vegetation communities likely to have been present prior to land clearing and disturbance.

Choosing locally occurring species to reconstruct or enrich native vegetation is important, but so is using suitable genetic stock. Some species are found over wide ranges, and it would be inappropriate to bring seed from north Queensland for planting in New South Wales. Local genetic types may be better adapted to local conditions, or may differ, as a result of chance and historical processes, from plants growing elsewhere. Maintaining local genetic types is therefore a necessary part of preserving all the genetic variability within a species, and thus retaining the potential for future evolutionary change and response to changing environments. Consider that of all the seed a plant produces in any one year, only a few if any will ever become mature plants. These are the plants that have the genetic make-up suited to the environmental conditions at the time. The combination and recombination of local genetic make-up with plants that may be more suited to different environmental conditions allows a species and a population to persist through environmental change.

The aim of using local provenance should be to capture the bulk of genetic variability represented in the source population or plants (Vallee et al. 2004). To reduce the negative effects of inbreeding depression, outbreeding depression and inappropriate hybridisation when selecting propagation material, consider the breeding biology of the species, the dispersal vectors of pollen and seed, and the potential sources of propagation material. Planting a 'new' species at a site can lead to the displacement of others. Guidance on the type of propagation material selected can be found in Vallee et al. (2004).

Vallee et al. (2004) provide guidance in considering the biology and ecology of species, population genetics, propagation methodology, selecting source sites for propagation material and designing a sampling strategy. However, only rarely are genetic studies available to guide the definition of "local" for the purposes of choosing or planning planting material. In their absence, a rule of thumb is to consider the natural dispersal capacity of the species – how readily do seeds and pollen of that species move around the landscape? Otherwise, "within a local catchment" is recommended. To avoid the problems of inbreeding depression, seeds should always be collected from all plants in the appropriate provenance range where possible, and from a number of parent plants (a minimum of ten, and up to fifty (50) plants if available) where sampling the entire population is not possible (Vallee et al. 2004).

Some nurseries stock native plants grown from locally sourced seeds, and can provide this information to their customers. They may also grow seeds collected by their customers. Some Landcare groups have their own nurseries to supply local stock for their project areas. Pests, diseases, pathogens, bacteria, unwanted plants (weeds), and unwanted seed (hybridised with other species or provenance in nursery) can be introduced to the planting site in the plants and soils grown in nursery conditions. Ensure that plants are collected and raised in a hygienic environment from an accredited nursery.

5.4 Planting and maintenance

A range of planting techniques and after-care considerations are provided in Vallee et al. (2004), Kooyman (1996) and Big Scrub Rainforest Landcare Group (2005). Local experience is the best guide, and specialist nurseries, experienced neighbours and landcarers will be valuable sources of advice. Consider time of year, availability of water, frost resistance, mulching options, size of planting stock, use of water crystals, fencing for stock exclusion and wallaby guards. Good site preparation is essential, and should include the control of competitive weeds.

It is important not to underestimate the time and resources needed for maintenance of a new planting. Maintenance is essential until plants are well established. Weed management (hand pulling, mechanical, herbicide, re-mulching) possibly several times a year will be necessary, and watering may also be required.

Planting effort and costs will be wasted if the plants do not survive, so aim for a small successful planting rather than a large project with patchy results.

Checklist of considerations for planting projects

- [ ] Have other management options (eg hand pollination, fire or soil disturbance, natural regeneration potential) been attempted or considered?
- [ ] Has the number and location of mature plants of the species known to occur in the locality been considered?
- [ ] Have the special needs (mycorrhizal fungi, rhizobial symbionts, hemi-parasite host) of the species been considered?
- [ ] Has a planting arrangement been designed to maximise genetic exchange, or in dioecious species, to maximise the sex ratio of plants?
- [ ] Have hygiene protocols been applied during the collection, processing, potting of plants, including tools, vehicles and clothing?
- [ ] Has the requirement for maintenance been planned to encourage survival of plants most suited to the environmental conditions at the site?
- [ ] Has a monitoring program with performance criteria been prepared?

Adapted from Vallee et al. (2004)

This Project is a Byron Shire Council Environmental Levy Initiative.
Your Environmental Levy at Work

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Other Resources:

A comprehensive list of useful resources and contacts is available at

www.byron.nsw.gov.au/biodiversity

7 Glossary

adventitious	organ arising in an abnormal position, eg roots arising from shoot system
allelopathy	the inhibition of the growth of a plant due to chemicals released by another
annual	a plant completing its life cycle within one year from germination to fruiting and then dying1
basal cormels	cormels arising from the base of a larger corm
bi-annual	twice in a year
bi-ennial	every two years
biodiversity	the variety of lifeforms, the genes they contain and the ecosystems they form[3]
biomass	weight of living material
biota	life form
bi-sexual	both male and female organs contained within the same flower
buds	knob-like shoot from which a stem, leaf or flower develops[2]
bulbils	small bulb formed in axil of leaf or bract and functioning to propagate the plant vegetatively[1]
bulbs	storage organ, usually underground, composed of stem and leaf bases[1]
clonality	individual stems produced asexually from a parent plant (rhizomes, stolons)
compartmentalise compartmentalisation	ability to keep injured sections separate from other portions of plant
coppice	shoot developed from a dormant bud in the trunk or larger branches of a tree, often develop after damage to the trunk by fire, cutting etc[1]
cormel	small, underdeveloped corm, usually attached to a larger corm
corms	short, broad, fleshy subterranean stem which produced aerial stems, leaves and flowers and in which food reserves are stored
deciduous	plant that is adapted to shed its leaves in response to change in environmental conditions (e.g. winter, dry season)
decumbent	spreading horizontally with the ends growing upward (Harden)
desiccation	remove moisture from, dry up[2]
dioecious	male and female flowers on different plants[1]
dormant	lying inactive, sleeping[2]
ecosystem	living things in a particular location, plus their non-living environment and all interactions
evergreen	having leaves all year round
exotic	introduced, non-local native species, subspecies, or variant
ex-situ	out of the original place, the maintenance of living plant material away from the wild[3]
genetic diversity	the sum total of all genetic variation for a population, taxon, or other taxonomic rank[3]
genetic make-up	the genetic constitution of an individual[3]
genetic variability	Variation in the genetic composition between individuals, populations or taxa[3]
herbaceous	non-woody
herbivore	an animal that feeds on plants
hybrid	the progeny of a cross between different taxa[3]
hydrological cycle	repeated movement of water, in gas, liquid and sometimes solid form, between the atmosphere, waterbodies and the earth
inbreeding	the mating of individuals related by descent[3]
inbreeding depression	a reduction of fitness and vigour due to inbreeding[3]
landcarer	member of a landcare group
lateral	from the side, attached to side of an organ, e.g leaves on a stem
mesic	requiring abundant water
microclimate	small-scale conditions of temperature, light and water availability
monoculture	vegetation made up of only one species
monoecious	separate male and female flowers on the same plant
mulch	natural or artificial material used in layers on top of the soil to prevent erosion, inhibit weeds and conserve water
mycorrhiza	a non-pathogenic association of a fungus with a plant or bryophyte[3]

naturalise	originating elsewhere but established and reproducing itself as though native to the area[1]
node	level of a stem at which one or more leaves arise[1]
nomenclature	system of naming
noxious	harmful, generally referring to noxious weeds under the Noxious Weed Act
outbreeding depression	reduction in fitness due to the mating of individuals adapted to different environmental conditions[3]
perennial	plant with life span extending further than one growing season[1]
pioneer	first plants to colonise an area, often after disturbance
pollinator	agent by which pollen is transferred from the anther to the stigma of flowers
pro forma	a document providing structure and headings to guide data recording
propagate	to grow from parent stock (from seed or cutting)
propagule	structure with capacity to give rise to a new plant, eg seed or part of vegetative body capable of independent growth if detached from the plant1
proteaceous	from family Proteaceae (includes Banksias, Grevilleas, Persoonias)
provenance (genetic)	area identifying genetic distinction and usually thought to represent genetic adaptation to local environmental conditions[3]
quadrat	a four-sided sample plot
regime	a pattern of timing, frequency and intensity over an area
remnant	a patch of original vegetation. Some definitions require that the vegetation has never been cleared, although it is usually modified to some extent
rhizome	underground stem, usually growing horizontally[1]
riparian	creek or riverside
ROTAP	Rare or Threatened Australian Plant from Briggs & Leigh (1996)
sclerophyll	plant with hard stiff leaves[1]
seed bank	stored seeds, often present in the soil and leaf litter (mostly in a dormant state), sometimes stored on the plant (Banksias, Eucalypts, Hakeas)
seed dispersal	movement of seeds within and across the landscape
self-compatible	pollen from a male flower will produce viable seeds on the same plant
self-incompatible	pollen from a male flower will not produce viable seeds on the same plant
shrub	woody plant less than 5m in height at maturity, the main stem usually branched
strata	layers (of vegetation). Singular stratum
stoloniferous	(stolon) more or less horizontal stem growing above the ground and rooting at the nodes (stoloniferous - adjective)[1]
subcanopy	a layer of vegetation just below the tallest layer
succession	step-wise development of vegetation through stages of maturity, following disturbance or on a newly colonised site
succulent	juicy, fleshy (plant with fleshy habit)[1]
sucker	vegetative shoot of underground origin[1]
symbionts	two organisms living together to their mutual benefit
threatened species	listed on schedules of the NSW Threatened Species Conservation Act 1995 or the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999
topography	Terrain
transect	A sample line along which plants and other ecological features are counted and measured
translocate/translocation	the deliberate movement of plants or plant regenerative material from an ex-situ collection or natural population to another location in the environment[3]
traverse	to cross
tree	woody plant greater than 5m in height (or 8m by some definitions)
tuberling	small new plant developing from a tuber
tubers	underground storage stem formed by the swelling of a stem, eg a potato[1]
understorey	vegetation layers under a canopy
vascular tissue	tissue transporting water, minerals and carbohydrates within the plant
vegetation processes	changes in composition, growth and development of plant communities
viable	capable of living or existing
viable population	a group of plants of the same species that possesses the ecological, demographic, and genetic attributes required to persist in both the short and long term[3]
water crystals	usually made of a polymer gel, material that absorbs and stores water and releases into the root zone of a plant during dry periods

(Sources: 1: Harden (2002); 2: Pocket Oxford Dictionary; 3: Vallee et al. (2004)

8 Appendix – Weeds of the Byron Shire

Common name	Scientific name
Aerial Yam	*Dioscorea bulbiferum*
African Boxthorn	*Lycium ferocissimum*
African Olive	*Olea europaea* subsp. cuspidata
Alexandra Palm	*Archontophoenix alexandrae*
Alligator Weed	*Alternanthera philoxeroides*
Angels Trumpet	*Brugmansia suaveolens*
Arsenic Bush	*Senna septemtrionalis (syn X floribunda)*
Asparagus Fern	*Asparagus aethiopicus*
Asparagus Fern	*Asparagus virgatus*
Atro	*Macroptilium atropurpureum*
Balloon Vine	*Cardiospermum grandiflorum*
Balsam	*Impatiens walleriana*
Barbados Gooseberry	*Pereskia aculeata*
Barner Grass	*Pennisetum purpureum*
Basket Plant	*Callisia fragans*
Billy Goat Crofton	*Ageratum houstonianum*
Bitou Bush	*Chrysanthemoides monilifera* subsp. rotundata
Black Bamboo	*Phyllostachys nigra*
Black Locust	*Robinia pseudoacacia*
Black–eyed Susan	*Thunbergia alata*
Blade Apple	*Pereskia aculeata*
Blood Flower	*Asclepias curassavica*
Blue Trumpet Vine	*Thunbergia grandiflora*
Blue–leafed Wattle	*Acacia saligna*
Boston Fern	*Nephrolepis exaltata*
Brazilian Pepper Tree	*Schinus terebinthifolius*
Brazillian Cherry	*Eugenia uniflora*
Bridal Creeper, Smilax	*Asparagus asparagoides (syn Myrsiphyllum)*
Broad–leaf Paspalum	*Paspalum wettsteinii*
Broad–leaved Pepper Tree	*Schinus terebinthifolius*
Buddleja	*Buddleja madagascariensis*
Bunya Pine	*Araucaria bidwillii*
Bush Lemon	*Citrus X taitensis*
Busy Lizzie	*Impatiens walleriana*
Cabomba	*Cabomba caroliniana*
Cadaghi	*Corymbia torelliana (syn Eucalyptus)*
Camphor Laurel	*Cinnamomum camphora*
Canary–throat Vine	*Pithecoctenium cynanchoides*
Canna Lily	*Canna indica*
Cape Honeysuckle	*Tecomaria capensis*
Cape Ivy	*Delairea odorata*
Castor Oil Plant	*Ricinus communis*
Cats Claw Creeper	*Macfadyena unguis–cati*
Century Plant	*Agave americana*
Cherry Guava	*Psidium cattleianum*
Chinese Rain Tree	*Koelreuteria paniculata*
Chinese Tallow	*Triadica sebifera*
Christmas Berry Tree	*Schinus terebinthifolius*
Christmas Lily	*Lilium formosanum*
Climbing Asparagus	*Asparagus africanus*
Climbing Asparagus Fern	*Asparagus plumosus*
Climbing Nightshade	*Solanum seaforthianum*
Coast Teatree	*Leptospermum laevigatum*
Cockspur Coral Tree	*Erythrina crista–galli*
Cocos Palm	*Syagrus romanzoffiana*
Coffee	*Coffea arabica*
Common Guava	*Psidium guajava*
Common Morning Glory	*Ipomoea purpurea*
Common Olive	*Olea europaea*
Common Passionfruit	*Passiflora edulis*
Coolatai Grass	*Hyparrhenia hirta*
Coral Berry	*Ardisia crenata*
Coral Berry	*Rivina humilis*
Coral Tree	*Erythrina x sykesii*
Corky Passionflower	*Passiflora suberosa*
Crabs–eye Creeper	*Abrus precatorius*
Creeping Charlie	*Plectranthus verticillatus*
Creeping Inchplant	*Callisia repens*
Crofton Weed	*Ageratina adenophora*
Dagger Plant	*Yucca aloifolia*
Date Palm	*Phoenix canariensis*
Devil's Fig	*Solanum torvum*
Dragon Fruit	*Hylocereus undatus*
Duranta	*Duranta repens*
Dutchmans Pipe	*Aristolochia elegans*
Dwarf Umbrella Tree	*Schefflera arboricola*
Edible Passionfruit	*Passiflora edulis*
Elephant Grass	*Pennisetum purpureum*
Elephants Ears	*Colocasia esculenta*
Fame Flower	*Talinum paniculatum*
Fishbone Fern	*Nephrolepis cordifolia*
Five–leaved Morning Glory	*Ipomoea cairica*
Formosan Lily	*Lilium formosanum*
Fountain Grass	*Pennisetum setaceum*
Freckle Face	*Hypoestes phyllostachya*
Giant Devil's Fig	*Solanum chrysotrichum*
Giant Reed	*Arundo donex*
Glory Lily	*Gloriosa superba*
Glycine	*Neonotonia wightii*
Golden Rain Tree	*Koelreuteria paniculata*
Golden Trumpet Tree	*Tabebuia chrysantha*
Golden Wreath Wattle	*Acacia saligna*
Goosefoot Plant	*Syngonium podophyllum*
Green Cestrum	*Cestrum parqui*
Green–leaved Desmodium	*Desmodium intortum*

Ground Asparagus	*Asparagus aethiopicus*
Groundsel Bush	*Baccharis halimifolia*
Guinea Grass	*Panicum maximum* var maximum
Hackberry	*Celtis sinensis*
Hairy Commelina	*Commelina benghalensis*
Hill's Weeping Fig	*Ficus microcarpa* var. hillii
Honey Locust	*Gleditsia triacanthos*
Icecream Bean	*Inga edulis*
Impatiens	*Impatiens walleriana*
Indian Hawthorn	*Rhaphiolepis indica*
Japanese Climbing Fern	*Lygodium japonicum*
Japanese Honeysuckle	*Lonicera japonica*
Johnson Grass	*Sorghum halepense*
Johnston River Grass	*Paspalum conjugatum*
Kahili Ginger	*Hedychium gardnerianum*
Kudzu	*Pueraria lobata*
Lady–of–the–Night	*Cestrum nocturnum*
Lamb's Tails	*Anredera cordifolia*
Lantana	*Lantana camara*
Large Leaved Privet	*Ligustrum lucidum*
Leaf Cactus	*Pereskia aculeata*
Live Plant	*Bryophyllum pinnatum*
Loquat	*Eriobotrya japonica*
Madeira Vine	*Anredera cordifolia*
Mickey Mouse Plant	*Ochna serrulata*
Mist Weed	*Ageratina riparia*
Molasses Grass	*Melinis minutiflora*
Monkey's Comb	*Pithecoctenium cynanchoides*
Montbretia	*Crocosmia x crocosmiiflora*
Moon Flower	*Ipomoea alba*
Morning Glory	*Ipomoea indica*
Moth Vine	*Araujia sericiflora*
Mother–in–Law's Tongue	*Sansevieria trifasciata*
Mother–of–milliions	*Bryophyllum delagoense*
Murraya	*Murraya paniculata*
Natal Ivy	*Senecio macroglossus*
Night Blooming Cactus	*Hylocereus undatus*
Ochna	*Ochna serrulata*
Olive	*Olea europaea* subsp. europaea
Orange Jessamine	*Murraya paniculata*
Orange Wattle	*Acacia saligna*
Painted Spurge	*Euphorbia cyathophora*
Palm Grass	*Setaria palmifolia*
Pampas Grass	*Cortaderia selloana*
Para Grass	*Urochloa mutica*
Parrot Lily	*Alstroemeria pulchella*
Perennial Soybean	*Neonotonia wightii*
Potato Vine	*Anredera cordifolia*
Queen Palm	*Syagrus romanzoffiana*
Queensland Maple	*Flindersia brayleyana*
Queensland Umbrella Tree	*Schefflera actinophylla*
Ragweed	*Ambrosia artemisiifolia*
Rambling Dock	*Acetosa sagittata*
Redhead Cottonbush	*Asclepias curassavica*
Resurrection Plant	*Bryophyllum pinnatum*
Rhus tree	*Toxicodendron succedaneum*
Ricepaper Plant	*Tetrapanax papyrifer*
Rosary Pea	*Abrus precatorius*
Running Bamboo	*Bambusa spp*
Salvia	*Salvia coccinea*
Salvinia	*Salvinia molesta*
Satinleaf	*Chrysophyllum oliviforme*
Schott Arrowhead Plant	*Syngonium podophyllum*
Senegal Tea	*Gymnocoronis spilanthoides*
Setaria	*Setaria sphacelata*
Silver–leaved Desmodium	*Desmodium uncinatum*
Silvery Inch Plant	*Tradescantia zebrina*
Singapore Daisy	*Sphagneticola trilobata (syn Wedelia)*
Siratro	*Macroptilium atropurpureum*
Slash Pine	*Pinus elliottii*
Small Leaved Privet	*Ligustrum sinense*
Sour Grass	*Paspalum conjugatum*
South African Pigeon Grass	*Setaria sphacelata*
Spanish Bayonet	*Yucca aloifolia*
Stinking Passionfruit	*Passiflora foetida*
Strawberry Guava	*Psidium cattleianum*
Striped Trad	*Tradescantia zebrina*
Swedish Ivy	*Plectranthus verticillatis*
Taro	*Colocasia esculenta*
Tecoma	*Tecoma stans*
Thorny Poinciana	*Caesalpinia decapetala*
Thunbergia	*Thunbergia grandiflora*
Trad	*Tradescantia fluminensis*
Tree of Heaven	*Ailanthus altissima*
Turkey Rhubarb	*Acetosa sagittata*
Turkeyberry	*Solanum torvum*
Turtle Vine	*Callisia repens*
Twin–leaf (local name)	*Pithecoctenium cynanchoides*
Umbrella Sedge	*Cyperus eragrostis*
Variegated Arrowhead Vine	*Syngonium podophyllum*
Vasey Grass	*Paspalum urvillei*
Wandering Dew	*Tradescantia fluminensis*
Wandering Jew	*Tradescantia fluminensis*
Warrel Grass	*Paspalum wettsteinii*
Water Hyacinth	*Eichhornia crassipes*
Water Lettuce	*Pistia stratiotes*
Watsonia	*Watsonia meriana*
Wax Vine	*Senecio macroglossus*
Whiskey Grass	*Andropogon virginicus*
White Ginger	*Hedychium coronarium*
White Passionfruit	*Passiflora subpeltata*
Wild Star Apple	*Chrysophyllum oliviforme*
Wild Tobacco Bush	*Solanum mauritianum*
Wild Watsonia	*Watsonia meriana*
Winter Senna	*Senna pendula* var. glabrata
Yellow Bignonia	*Tecoma stans*
Yellow Guava	*Psidium guajava*