Swan River Trust

Control Plan for Foreshore and Wetland Weeds

Complied by Bronwyn Ryan for Darryl Miller

NOTE: Run proposal past Luke Pen first so he can input

Section 1.0 Introduction

The Swan River Trust plans to implement a foreshore and wetland weed control strategy for the Swan River Trust Management Area. This proposal outlines the current weed problem, the major weed species of concern and the alternative methods for their control. Potential environmental impacts resulting from weed control activities and the environmental safeguards required to minimise these impacts are detailed. The revegetation of foreshore and wetland areas to arrest foreshore de-stabilisation, weed invasion of disturbed areas and to provide a habitat for displaced fauna is discussed, as is the role of stakeholders. Finally, recommendations relating to the implementation of the weed control strategy are made.

Section 1.1 The Swan River Trust's role in foreshore and wetland weed control

Under Section 7 of the Swan River Trust Act (1988) the Swan River Trust has a function to protect and manage the Swan River Trust Management Area. The Trust has a role in coordinating and promoting the activities of other bodies that have responsibilities in relation to the Management Area and implementing any general management strategies applicable to the Management Area.

Foreshore reserves are generally vested in local governments which have responsibility for their management and maintenance. Control of foreshore weeds is therefore principally the responsibility of local government. However, urban weed control is generally a low priority for local government and the importance of foreshore weed control is generally not well understood by local government. The absence of a foreshore weed control strategy and limited technical advice and support available to local government on foreshore weed control also tends to inhibit local government efforts in this area.

The Trust lacks the resources to implement a consistent weed control program and undertakes weed control opportunistically when resources are available. The end result of this situation is that current efforts in shoreline and wetland weed control are unlikely to be effective.

Effective weed control will require collaboration between the Trust and local government on a foreshore and wetland weed control strategy and the provision of technical advice and support in regards to operational activities.

Section 1.2 The significance of foreshore and wetland weeds

Weeds are generally an indicator of environmental degradation and their proliferation can also be the cause of further degradation. Foreshore and wetland weeds change the structural and biological diversity of ecological communities. They compete directly with established native vegetation, inhibiting the growth of native shoreline and wetland plants and sometimes displacing species. They alter nutrient cycles and reduce habitat and food resources available to wildlife. Foreshore and wetland weeds also interfere with access to foreshores, reduce the visual amenity of foreshores and wetlands and may increase the fire hazard, as weeds, particularly grasses like bamboo and pampas grass, form a fine fuel that is easy to ignite and very flammable, produce a high fuel load each year and form a continuous fuel bed which permits fire to spread quickly (GWA, 1995).

The damp environment of foreshores and wetlands provide ideal conditions for weed establishment. In this environment, weeds which may be a minor problem elsewhere proliferate. Bamboo, Castor Oil, Pampas Grass, blackberry and other environmental weeds occur along many sections of the Swan and Canning River foreshores. In some areas these weeds are domesticated species well suited to the moist foreshore and wetland environments. The colonisation of Yule Brook by Taro at its confluence with the Canning River is an example of this.

The remaining foreshore wetlands of the Swan and Canning Rivers are particularly vulnerable to weed invasion. The spread of Pampas Grass in the vicinity of Burswood Peninsula is a disturbing example of this **need more detail.**

These, and other current and anticipated weed infestations in the Swan-Canning river system are, or have the potential to, compromising environmental values held by the community. Values associated with foreshore and wetland areas which are or may be compromised include ecological value, aesthetic value, use value, scientific research and education value and possibly heritage value, for example, sites of Aboriginal or early colonial significance.

Therefore, controlling foreshore and wetland weeds is an integral part of the Trust's role in protecting and managing the Management Area and the values associated with it.

Section 2.0 The Weed Control Strategy

Section 2.1 Introduction

The fundamental elements of successful weed control are to:

- control infestations
- control re-growth from seed or vegetative means
- control re-invasion
- remove opportunities for establishment.

Since the Swan and Canning River foreshores and wetlands occur as small areas within a broader environment in which the weed species will remain, eradication as a long term objective is not feasible. Weed re-invasion by air, water, animal and vehicle transported material and by dumping of garden refuse will continually occur.

Therefore, the focus of the Trust's weed control strategy needs to be on the other three elements of successful weed control. This means that weed control needs to be sustained as a long term activity of the Trust and local government. A significant component of the proposed operations will be the integration of controlling infestations and re-growth with foreshore and wetland restoration and revegetation to limit opportunities for weed re-establishment. The availability of NHT funding and community involvement in foreshore and wetland restoration and revegetation works provide ideal opportunities for this.

Section 2.2 The proposed weed control strategy

The National Weed Strategy (1997) recognises the importance of weed control as a component of protecting natural ecosystems. The Swan River Trust has developed a control strategy for foreshore and wetland weeds which, likewise, recognises the importance of weeds as factors in land and water degradation in natural ecosystems.

The weed control strategy was devised by the Swan River Trust after consideration of what the problem was; identification of the weed type(s) causing the problem; current knowledge of the extent and location of the problem; and consideration of the values that need to be protected during the weed control campaign. Methods of weed control were researched so that the most suitable weed control procedure can be chosen following consideration of factors on a site-specific basis. The action necessary to revegetate areas where weeds have been removed with native plants has also been appraised.

The weed control strategy will involve a combination of mechanical weed removal and the use of herbicides, dependent on the extent of the infestation, the weed species to be treated, whether weed species are to be treated together or in isolation and potential environmental impacts and site constraints. This integrated approach aims to minimise the adverse effects of weed removal on the ecology of the river system.

Another component of the strategy will be increasing awareness of the conservation consequences of weed invasions and increasing or developing an understanding of the links between weed control activities and the processes of introduction and establishment by the public and management. This awareness is essential for cooperation and political support for weed management prescriptions.

The Swan River Trust envisions that their role in the weed control strategy be one of support. This is due to both a lack of machinery and other weed control equipment or storage facilities to undertake the technical components of weed control works and that employing the services of sprayers is essential as their expertise if required as currently only one Depot staff member is trained to deal with the spraying of small weed outbreaks. Therefore, implementing the weed control strategy will involve employing contract staff who will be organised into work teams to control foreshore and wetland weed infestations and engaging the services of

community groups were possible. (David Fardig recommended Trans Australia (bigger contracting company so can provide service as and when requested - Contact is Kim Evans pH 9271 3621). Contracting work could be advertised on an annual tender based on particular area/stretch of river.

The services of a supervisor/coordinator to locate infestations, implement the management plan, supervise contractors, complete an inspection program to evaluate the success of weed control works, organise any community group involvement and plan for upcoming weed control works will also be required. The Trust will provide the resources to employ this coordinator**?????(Cost =** Annual salary for one full time supervisor/coordinator and car for work purposes = estimated $60, 000 (David Fardig)

Local government will be involved in funding weed control works within their boundaries as required, in coordinating local community groups to secure their voluntary support and in public education programs.**???anything else?**

Section 2.3 The problem defined

The problem is the need to effectively control foreshore and wetland weeds so that native vegetation inhabiting foreshore and wetland areas regenerates and in turn severely hinders any further exotic plant growth.

Section 2.4 Weed species to be controlled

The infestations of bamboo, pampas grass, castor oil plant and blackberry in the Management Area is of significant concern to the Swan River Trust. The objective of the proposed weed control program is to eradicate these and other key weed species from within the Management Area. Other key species include Japanese pepper tree, Chilean willows and Juncas species **(need to determine which ones - see Luke Pen - any more?).** These species have in common the ability to reproduce and grow quickly. Therefore, efficient weed control of these major weed species within, and adjacent to, the Management Area is crucial.

Section 2.5 Location and extent of the current weed problem

Weeds have become established in a number of areas within the Swan River Trust Management Area by natural means, including wind dispersal of seeds, transport by rivers and via animal vectors, and with human assistance.

A botanical database was completed by Nicole Siemon using FileMaker Pro 2.1. It includes a list of 303 plant species (including weed species) which can be found along the Swan-Avon Rivers. For example, areas on the Swan River containing pampas grass include:

- Heirisson Island*
- Burswood Golf Course
- Burswood Peninsula
- Banks Reserve (Mitchell Street), Mt Lawley*
- Bardon Park, Maylands*
- Berringa Park, Maylands
- Swan Bank Road to Clarkson Reserve,
- Goodwood Parade, Rivervale*
- Rivervale waterski area - north and south of grassland*
- William Street to Wright Crescent, Bayswater*
- Beverley Terrace, South Guildford*
- Pickering Park to Carnegie Road, Bassendean
- Ashfield Flats, Bassendean*
- mouth of Bennett Brook*

Note: This list of areas is not exhaustive and may have large numbers of pampas grass or just one. The isolated individual plants are the most important to remove, before they spread further. These are demarcated with an *. Some areas containing pampas have been omitted from this list where community groups and volunteers are currently implementing eradication programmes.

Areas along the foreshore of the Swan and Canning Rivers have been extensively searched by TAFE student Christopher Hart for the presence of bamboo, pampas grass and castor oil plant with the density of plants at each weed infestation (location) along the foreshore being determined and the distribution of species being mapped. He also reported on the accessibility of infested areas for treatment and suggested management options for removal or treatment of the weed. The areas searched were Canning Bridge to Point Walter; the car park at Matilda Bay Reserve to Claremont Yacht Club; and Claremont Yacht Club to Fremantle Traffic Bridge.

SRT depot staff are also aware of major problem areas that need to be controlled as a result of observation on an ad hoc basis. These areas include:

Above Narrows Bridge
Point Heathcote towards South Perth Yacht Club (bamboo)
Claremont
Point Resolution
Sandringham Hotel (all species)
Belmont Racecourse around Bunbury Bridge (both sides of river covered in pampas grass)
Heaps Bunbury Bridge to Garret Road Bridge
Behind St John of the Gods Hospital
Isolated areas along the Upper Swan, for example above Middle Swan Bridge (Bandulup Prison)
Canning River Regional Park

The Swan River Trust Report No7 titled "Fringing vegetation of the Canning, Southern and Wungong Rivers" (1993) describes the extent and location of fringing vegetation of the Canning, Southern and Wungong Rivers. The fringing vegetation of the Canning and Wungong Rivers has been highly degraded through weed invasion which has almost completely displaced the native understorey along all but the upper sections of the rivers. Section 5.2 of the report identifies the species considered to be a potential major long term problem and weed infestation maps identifying the location and extent of these infestations. The 1993 regeneration status of species within the study area is also documented and recommendations of the native plant species to be used for rehabilitation of the native vegetation given. Thus, it is seen as desirable that the weed control strategy incorporate treatment of weed infestations in the upper reaches of the Canning River.

This information will be utilised for weed control planning purposes. Other information sources should be researched to compliment or to update existing information on the location and extent of problem weed species and on the species composition of weed infested areas.

Section 2.6 Values to be protected during the weed control campaign

Weeds, along with native plant species, serve to protect the river valleys and foreshore areas against erosion and provide a corridor of habitat for many native and introduced animals. Therefore, the removal of those weed species which may be stabilising foreshore areas will necessitate replacement with indigenous species to prevent erosion of the foreshore area. Revegetation with native species will also be necessary to ensure that fauna habitat values are not compromised.

It is of utmost importance that the effects of herbicides used in the control program on non-target plants, fauna and water are minimised, or where possible, prevented. There is a need to ensure that water quality is not degraded as a result of weed control, both from

sediment and chemical residuals. Problems caused by herbicide residues in the soil and the development of herbicide resistance must be also considered. Care must be taken to not adversely affect fauna inhabiting the area and possible soil structure damage must be assessed.

The Trust's weed control program will be directed towards minimising any environmental impact that may result in order to protect environmental values. When undertaking weed control the Trust will ensure that control measures are carried out as part of an integrated process of native plant regeneration which includes revegetation and erosion and not be considered in isolation. Monitoring of potential environmental impacts will be undertaken to ensure that the above values are not jeopardised.

Section 3.0 The Proposed Weed Control Campaign

Section 3.1 Introduction

Given the difficulties of controlling weed invasions once they become established and given the magnitude of the environmental problems already present as a result, two management principles can not be emphasised enough:

1. Prevention is the most powerful tool we have; and
2. Intervention at an early stage is crucial

Section 3.2 The weed control program

Where major infestations of weeds occur, the weed control program will generally involve a physical treatment followed by an initial and subsequent follow-up herbicide applications to control weed re-growth. Both physical and chemical treatments will vary according to the weed species being controlled.

The value (environmental and social) of each known weed infestation will firstly be determined and weed control prioritised on this basis. Weed species that grow vigorously or are difficult to remove will be the focus of the consequent weed control program with native species which are rare or restricted in distribution and/or areas of significant ecological or amenity value also receiving special attention.

Each infested area will be addressed separately and a management plan outlining weed species composition and extent and management/control to be undertaken developed. Specific weed control plans for each foreshore and wetland weed species will also be developed which will be used to eradicate individual weed species in areas where weed infestations are dominated by a particular weed species, for example, the major infestations of bamboo which has been identified in the Melville area.

Individual weed infestations will be then be assessed as to whether the weed species can be removed safely, ie. without threatening any environmental values, for example, the stabilisation of the foreshore. Areas that are "safe" will be managed first and those areas where environmental degradation may be a result of weed control will require a specific management plan, commonly involving revegetation and rehabilitation, to be devised.

Section 3.3 Stakeholder involvement

The potential exists for weeds to spread into the Swan River Trust Management Area from adjacent areas (both residential and foreshore/reserve/parkland areas), from the dumping of garden refuse and along water courses from sources upstream. As a result, the control of weeds is not possible without the cooperation of adjacent land holders, local government and other authorities and residents as re-infestation can rapidly occur from untreated areas.

The Trust will need to liaise with local government, other authorities, adjacent landholders, residents and community groups to coordinate the control and spread of weeds in the vicinity of the Management Area. For example, the opportunity may exist for collaboration with the Water and Rivers Commission's River Restoration Action Team with respect to riparian management. As a further example, existing local government management plans which address weed control issues can be incorporated.

Consideration will be given to setting up a working group comprising State government agencies, local government and community groups to develop a strategy for short-term control and long-term eradication of the targeted weed species.

Of particular significance is the necessity to determine what weed control work has already been done or will be undertaken by catchment groups and other stakeholders to ensure that eradication work is not duplicated and, more importantly, that eradication does not undermine previous work, such as revegetation, done by community groups or council.

Completed weed control work could be complimented and where groups are preparing to combat the weed problem in their local area, direction as to what species to control and assistance in the form of advice and/or resources could be made available to those community groups or local governments planning weed eradication programs.

Section 3.5.0 Methods of foreshore and wetland weed control

Section 3.5.1 Introduction

Weeds often invade in small numbers and remain at low abundance for quite a time before increasingly rapidly, often after a disturbance event. The best time to control them is as soon as possible after invasion when weeds are low in numbers and restricted in area. If they are allowed to develop into a major infestation, control will be much more difficult (Hussey & Wallace, 1993). Allowing a major weed infestation to occur could lead to major costs in the future. For example, arum lily (*Zantedeschia aethiopica*) has spread so widely on Garden Island that the Department of Defence has had to commit millions of dollars to its control (Hussey et al, 1997).

Section 3.5.2 The three phases of weed control

It is not possible or desirable to remove all of the weeds from a site in one visit because in most cases the factors causing the weed invasion are still operating. A successful weed control program has three phases:
primary weeding - initial weed removal from a site
secondary weeding - removal of weeds germinating at the site following the primary weeding and disturbance of the soil. It maybe necessary to control a different weed species that colonises the disturbed ground following primary weeding. Secondary weeding may last a few months or even a year and is vital to allow the regenerating native plants to survive.
long term maintenance - within a few months to a year the site may only need a visit every six months or annually to remove any scattered weeds that may be present.

Section 3.5.3.0 The four methods of weed control

Once weeds have been established, there are four ways in which they can be controlled:

1. Physical - hand-pulling or mechanical mowing, slashing, cultivating or scalping
2. Natural suppression - creating a situation where the required plants (native or cultivated) are encouraged to grow and weeds are discouraged
3. Biological - the introduction of a natural predator or a disease that will destroy the weed without affecting non-target plants
4. Chemical - the use of herbicides

Section 3.5.3.1 Physical Control

Manual control of weeds by pulling or digging is often an effective method of control for small infestations. There are four methods which may be used to control weeds manually, depending on the weed's root system and growing points and soil type and/or extent of soil compaction. These are: hand weeding; removal with a knife or trowel; removal by crown cut; and digging out the entire plant. The crowning (or pudding basin) cut is a useful technique for weeds which have their growing points below the surface like bamboo and pampas grass.

At all times, disturbance of the soil should be kept to a absolute minimum during hand weeding as it encourages further germination of weed seed stored in the soil and may damage the root systems of nearby plants.

Section 3.5.5 Natural Suppression

Consideration should be given to the natural suppression of weed species. One approach which appears to have several long-term advantages is to mulch the ground surface and plant native shrubs along, for example, stormwater verges. Advantages of this approach may include:

- reduced potential for weed growth
- reduced use of herbicides and of the costs associated with these;
- visual improvements
- some habitat value
- minimised risk of soil erosion (Jones, 1993).

Consideration would need to be given to site suitability, for example, an area with low risk of weed re-invasion and high public profile would be preferable, economic costs/benefits and probable community response (Jones, 1993).

Section 3.5.6 Biological Control

The technique of biological control involves the introduction of a natural predator or a disease which will destroy a weed without affecting non-target plants. Biological control will usually be an initial control method, with minor herbicidal use needed two or three years later to eliminate the remaining plants. Biological control is already being used to control Paterson's curse, blackberries and heliotrope. However, it has been determined that biological control of blackberry has proved useless in metropolitan area so far (pers. comm. Bob Dixon, Kings Park 23/6/98).

Section 3.5.7 Chemical Control

The use of herbicides to control foreshore and wetland weed species will be a necessary measure as in many cases it is not possible to control weeds economically or quickly without them. However, herbicides are best used only for severe infestations; for both financial and environmental reasons and as their effects on native foreshore and wetland flora and fauna inhabiting these areas are not well known.

The optimum time to apply herbicides is during the active stages of growth. For grass weeds this is before flowering time and for bulbous species just after flowering and before seed set. Weed control should occur as early as possible as tackling weeds earlier gives native species, particularly seedlings and small herbs, a better chance to survive by reducing competition by weeds for resources.

Two of the most effective herbicides are:

Glyphosate (Biactive Lyphosilade) - a systematic non-selective herbicide. Useful for controlling most weeds especially bulbous species. This herbicide should not be sprayed in areas containing native species as it will also kill them. Glyphosate is commonly used in bush regeneration as it is reasonably safe for the operator and also is inactivated on contact with the soil thus does not move through the community or linger to prevent the germination of native plants.

Fluazifop-butyl (Fusilade^{R}) - a selective, post emergent, translocated herbicide used for the control of certain grass species. Fluazifop-butyl is fairly safe to use having a LD50>4000 mg/kg of body weight oral and >2000 mg/kg dermal acute, which compares favourably with other chemicals in common use, especially when diluted for field use. An application rate of

approximately 1.0 kg a.i/ha, with spot spraying after 3-4 weeks if necessary, is seen as desirable (Woodcock, Rose, Trayler and Chalmers, 1993).

Fluazifop-butyl should be applied at a time at which it can be expected to have maximum efficacy against the weed species. Since its effectiveness is reduced by a soil moisture deficit, it should be applied under conditions of adequate soil moisture. Fluazifop-butyl is also most effective under conditions which are warm (25-30 degrees Celsius), humid and bright (ie during spring). It is important to use a wetting agent or spreader such as Agral 60 as this can improve the effectiveness of the herbicide by up to 40% (Woodcock, Rose, Trayler and Chalmers, 1993).

Section 3.5.8 Note on the various control methods

Whatever weed control method is used it is imperative to start controlling weeds in the least affected areas first, working outwards towards the more degraded sections (this is one of the underlying principles of bush regeneration). While this will require greater surveillance effort, this allows the native plants still present to regenerate and grow in the gaps left by the weeds and will be a considerably easier task to achieve (GWA, 1995).

Section 4.0 Management Strategies for Specific Types of Weeds

Recommendations for the control of specific weed species vary, sometimes considerably. The following information has been provided as an example of the methods by which each particular weed species may be effectively treated. The control methods being detailed seem to be common to the literature reviewed so far. However, site-specific research will be essential, particularly where the prime objective is to minimise the environmental impact of weed control and especially when the control method involves the application of herbicides.

Section 4.1.0 Control of bamboo and pampas grass

Section 4.1.1 Introduction

Perennial grasses such as bamboo and pampas grass are very efficient at extracting water and nutrients and compete strongly with established indigenous plants, severely impeding native seedling regeneration. They have light seeds, easily transported by air, stock or vehicle movement. In addition, they produce an annual crop of highly flammable fuel and greatly increase the fire hazard of remnants where they occur (GWA, 1995).

The main growing period for bamboo and pampas grass is during summer, which is when control actions should be taken. Grass control should always be done prior to seed-head formation to prevent the control action actively spreading the grass.

Section 4.1.2 Control Method One: manually pull or dig up the whole plant

For plants with extensive root systems such as bamboo and pampas grass (roots of pampas grass extend to 4m radially and to 3.5m deep), manually pulling or digging up these plant species can cause extensive soil disturbance and so create an excellent seed-bed for future weed establishment. Dug out plants left on the ground may re-root, so must be removed. Therefore, for physical control soil disturbance should be minimised and weeds only removed at the rate which the native plants can recolonise an area. For major weed infestations, this method is not recommended unless revegetation work is undertaken concurrently.

Section 4.1.3 Control Method Two: chemical control

The growing points of bamboo and pampas grass (which are the most susceptible part of the plant to herbicides) are protected by a dense mass of dead stems and leaves, therefore efficient chemical control is obtained by removing the bulk of the tussock at the start of the growing season by slashing or burning off. This forces production of regrowth which is both accessible and highly susceptible to the chemical which is to be applied. Flower plumes must be removed and destroyed.

Chemical control should occur between December and March. The herbicide should be applied to the fresh new growth when it is growing vigorously. Where bamboo and pampas grass weeds fully dominate an area, Glyphosate at an application rate of 1 part to 100 parts water can be applied. If the plant is growing among desirable native plants, a grass-selective herbicide can be used, for example, fluazifop. Recommended application is Fusillade 1 part to 100 parts water and wetter). It should be applied early in the growing season when the grass is making vigorous growth, and can be sprayed over the top of most native plants - including seedlings - with no adverse effect. However, this technique affects some native grasses, cord rushes, orchids and plants of the lily family. Thus, where these species are present this is not an option.

Dixon & Kieghery (1995) suggest effective weed control be achieved by removing the top of bamboo and pampas grass by burning or cutting as low to ground as possible with a heavy duty brush cutter. They recommend that the new growth be treated with Glyphosate in late spring-summer. Thus, cutting to spray regrowth must occur before this.

Section 4.2.0 Control of Castor Oil

Section 4.2.1 Introduction

Castor oil plant is remarkable in terms of its rate of growth in favourable conditions and for its tenacity. For example, castor oil plant thrives during periods of high rainfall but also withstands drought because of the amount of moisture it contains and is able to retain. Thus, a control method to achieve optimal control of castor oil must be ensured.

Section 4.2.2 Control Method One: physical control

Dig out and burn single plants. With larger colonies where cultivation is practicable, slashing followed by cultivation gives effective control. It is, however, essential to keep the cultivation shallow to prevent deep burial of seeds. Repeat cultivations as required to kill seedlings and any regrowth from old crowns (Parsons & Cuthbertson, 1992). It is recommended that cultivation be used as a treatment where practicable.

Section 4.2.3 Control Method Two: chemical control

Where cultivation is impractical chemical control will be effective. Although castor oil plant is tolerant of some herbicides, an overall spray of Glyphosate or a picloram + 2,4-D mixture gives good results. Apply the sprays when plants are growing actively, thoroughly wetting leaves and stems. With very large plants slash and immediately paint the cut stumps with picloram + 2,4-D or triclopyr, alternatively apply hexazinone by soil injection. Experimentally, an overall spray of buthidazole has also given good control, particularly in drainage ditches (Parsons & Cuthbertson, 1992).

Dixon & Kieghery (1995) recommend that small populations of castor oil are removed by hand. For larger plants use the cut stump method with Glyphosate. For large populations of seedlings spot spray with Glyphosate (application rate = 1 in 80).

Section 4.3.0 Control of Blackberry

Section 4.3.1 Introduction

Blackberry is now, unquestionably, one of the most important weeds in Australia (Parsons & Cuthbertson, 1992). This is because it is invasive and covers large areas with a dense canopy, excluding light from the soil surface. Few other plants can compete and blackberry completely dominates the vegetation of an area in a very short time. Regeneration of native plants, in particular, is seriously impeded. Furthermore, blackberry seed is easily spread for some distance by creeks and rivers and, more importantly, birds and foxes.

Blackberry rarely invades virgin bushland but establishes most readily on disturbed sites which are subsequently neglected, such as river banks. In areas of natural vegetation infestations of blackberry disturb the diversity of native species and, hence, affects wildlife habitats. At fruiting time, it is an important food for introduced birds such as starlings and blackbirds and may help to increase the population of these undesirable species. Furthermore, the impenetrable, prickly thickets of blackberry restrict access by people to streams for fishing, animals to watering points, provide an ideal harbour for rabbits, foxes and snakes and large clumps of blackberry may be a fire hazard.

Section 4.3.2 Control Method One: physical control

Effective control of established plants is achieved by physically removing the crowns and much of the root system by mattocking or through cultivation, or, on a larger scale, by bulldozing and ripping roots. (Most roots occur in the top 20cm of soil but a few are to 1m deep; there is a well defined crown at ground level). Hand weeding, removing the knotty stump and as many connected roots as possible has been successful, especially in waterlogged sites. This technique has also been used successfully in conjunction with the cut

stump method. However, these methods are seldom practical for most major infestations or where there are problems with access.

Section 4.3.3 Control Method Two: chemical control

Chemical treatment is generally recognised as the most practical method of control of blackberry. A follow up treatment will be necessary. Triclopyr, either alone or in a commercial mixture with picloram, is considered an effective herbicide. It is most reliable when applied at or about fruit maturity. Amitrole T is effective is some situations and picloram also, particularly in granular form, is very effective, more so if aerial growth and ground litter are first removed by burning. Glyphospate, fosamine and hexazinone applied by the spot gun technique, are also effective. A newer herbicide, metsulfuron methyl, is proving very effective and can be used over a wide range of application times (Parsons & Cuthbertson, 1992).

Dixon & Keighery (1995) recommend that brambles are brush cut or burnt. Regrowth should be treated with Glyphosate 360. However, Glyphospate often kills plants associated with blackberry leaving the ground bare which encourages seedling growth. Better control may be achieved using more residual herbicides, for example, Brushoff or Garlon. However, application in wetland areas requires care.

Whatever method is used to remove blackberry from natural areas, revegetation with desirable native species which grow rapidly should be attempted to prevent re-invasion. This is because the best method of control is to maintain a dense cover of useful plants to prevent blackberry seedlings from establishing (GWA, 1995).

Section 4.4 Site Constraints

Anticipated site constraints may include access for personnel, spraying equipment and machinery to the site; the need for fire control if burning and follow-up herbicide spraying of re-growth is chosen; constraints associated with the slope of foreshore areas in terms of erosion potential or surface runoff of herbicides and environmental factors influencing revegetation, such as soil type, slope and aspect.

Section 5.0 The Regeneration of Native Plants after Weeding

Section 5.1 Introduction

Riparian vegetation plays an important conservation and functional role within a riverine ecosystem. It provides habitat for wildlife and a corridor for flora and fauna, helps stabilise and reduce erosion from the river banks, acts as a sediment trap and may assist in 'filtration' of nutrients from water. Riparian vegetation also has recreational and landscape value. The diversity of plant species and complexity of vegetation types within the riparian zone are vital components in the ecosystem.

Given the importance of riparian vegetation, the need for its rehabilitation is receiving increasing recognition. In very badly degraded areas weed control may have to be supplemented with the re-establishment of native plants by planting seedlings or direct seeding. If this is not done broad leaf weeds or herbicide resistant grasses may colonise the bare areas from which the weeds have been removed. This is especially important when using highly selective herbicides such as Fusilade or when treating large dense patches of weeds, therefore is very applicable to those areas within the Management Area which have been identified as major infestations.

Section 5.2 Regeneration techniques and principles

Bush regeneration involves the rehabilitation of native species from a weed-infested or otherwise degraded plant community to a healthy community composed of local native plants (Butanone, 1989 in GWA, 1995). Three principles form the guidelines for bush regeneration, namely:

1. Work from areas in good condition towards degraded areas.
2. Disturb the soil as little as possible.
3. Let the regeneration of native plants govern the rate of weed removal.

Principle 1 - Working from areas with native plants towards weed infested areas will encourage natural regeneration of the existing native plants to replace the weeds that have been removed. Working in highly degraded (weed infested) areas will encourage more weeds to grow in the recently disturbed areas and so encourage the spread of weeds.

Principle 2 - Disturbance of the soil increases the potential for weed invasion, therefore methods of weed removal that minimise soil disturbance are essential to successful regeneration of indigenous species (for hand weeding, use the correct technique- don't rip open the ground)

Principle 3 - This principle can be interpreted to mean "let the rate of natural regeneration govern the amount of weeding". As weeds compete for resources, sites with lots of weeds will require multiple re-weeding to allow the native seedlings to survive.

Section 5.3 Re-establishing native vegetation

Foreshore and wetland areas should be given time and opportunity through the removal of disturbances to regenerate naturally. Using the Bradley method of bush generation (minimal disturbance) permits native plants to re-establish themselves where sufficient propagules, such as seeds or root stock, are present.

However, the rehabilitation of areas which are badly degraded (for example, heavily used access paths or heavily weed infested areas) may require the replanting of native vegetation. When there are insufficient propagules of the local native plants on site, techniques such as planting seedlings and direct seeding are used to obtain the diversity of the plant community. Irrespective of the method used, it is important that the seed or the vegetative material for the

plants is collected from, or close to, the site to be replanted. This will ensure that the genetic integrity of the site is maintained and enhance revegetation success. Obviously, greater effort and/or cost will be involved in collecting, storing and treating seed.

The aim of planting is to recreate an ecosystem from plants naturally occurring in the reserve. Planting should be sensitive to natural associations and specific types of locations in which plants grow. Special care should be taken to ensure the spacing of trees and other long lived species is irregular, as regular plantings look artificial. For this reason it is often preferable to use direct seeding rather than seedlings. If seedlings are to be used, make the spacings irregular by planting in clumps or in places where seedlings often establish themselves naturally, for example, besides ant's nests or logs. Natural variety in the growth habitat of eucalypts can be encouraged by planting vigorous local species within the clump. For short lived species spacing is less crucial as the plants will reproduce and die within a few years and so establish their own pattern of distribution.

Where whole plant communities, ground covers, shrubs and trees need to be established, it is best if they are all planted or sown at the same time rather than over several years. Care must be taken not to establish more plants of one layer (eg tree layer, shrub layer, herb layer) than is found in undisturbed bush as the bush gains its character form the proportion of plants in each layer. Prepare a bed for the seedlings or the seed by controlling weeds, hoeing or raking a small area and laying down a mulch of branches, stones or logs. It may be necessary to protect the newly sown or planted area by fencing it off and erecting a sign outlining what has been done and why.

Section 6.0 Environmental Impacts

Section 6.1 Introduction

The Trust's foreshore and wetland weed control strategy will ensure that special care is taken when controlling weeds in these fragile environments so that ecological and social values are not jeopardised. For example, herbicide drift and the use of chemicals that are known to move in the soil and could leach into waterways will be avoided.

Section 6.2 Potential environmental impacts

Potential environmental impacts include the effect of herbicide spray drift on humans and animals, the impact on vegetable gardens and other 'non-target' plantings and, more importantly, the likelihood of degraded water quality if herbicide application recommendations are breeched or the most favourable method of weed control is not selected.

Foreshore erosion and river and wetland sedimentation resulting from the loss of vegetative cover following weed control works are also potential environmental impacts which must be managed for, for example through appropriate revegetation techniques.

Section 7.0 Environmental Safeguards and Environmental Monitoring

Section 7.1 Environmental safeguards

One of the aims of the Trust's foreshore and wetland weed control strategy is that environmental safeguards are developed which demonstrate that all of the environmental risks associated with implementing the weed control strategy have been considered. As such, potential environmental risks will be assessed and environmental safeguards put in place to prevent or minimise potential environmental impacts and to meet legal and due diligence commitments. Where necessary, a site specific appraisal of environmental sensitivity which specifies environmental issues and safeguards will be undertaken to cover potential environmental impacts at a particular site or group of sites. For example, soil residual herbicides will not be used in any area which may contain the roots of desirable shrubs and trees.

In terms of safeguarding personnel involved in weed control works, users of herbicides will be trained in the methods of applying herbicides to avoid personal injury and danger to themselves and to the general public. It is recognised that the supervision of contractors will be difficult, exposing the Swan River Trust to liability if environmental safeguards are not observed and environmental damage occurs**???** - Therefore, it will be a contract requirement that an environmental component be incorporated into the contractor's reporting system to the Trust on work completed.

In addition, all herbicides used in controlling weed infestations will be recorded, along with methods of application and rates used. **See photocopies (given to Darryl previously).** This can assist in determining what methods of control have been most successful and any difficulties that may of arisen.

Section 7.2 Environmental monitoring

Monitoring the effectiveness of the Trust's weed control strategy is critical to the success of the weed control program. Monitoring could be achieved by, for example, a series of permanent monitoring quadrats to measure changes in the vegetation structure as weed control and revegetation works are implemented, the effectiveness of measures to control disturbance and foreshore erosion, fire risk and user impact and user requirements.

Monitoring of environmental impacts of weed control works could be carried out by local governments and possibly school and community groups, provided that the information is effectively directed to councils as the body responsible for foreshore and wetland management. The development of a complete herbarium of flora inhabiting the Management Area and its environs will help community groups interested in assisting with weed control and revegetation.

Section 8.0 Recommendations

Section 8.1 General recommendations

1. It is recommended that the Swan River Trust prepare and initiate a five-year weed control strategy which gives priority to the control of bamboo, pampas grass, castor oil plant, blackberry and other key weed species within the Swan River Trust Management Area. After consideration of environmental, practical and financial constraints on a site-specific basis, the most favourable weed control method for each species and/or alternatively for each infested area should be determined.

2. It is recommended that weed control works be conducted in those areas within the Swan River Trust Management Area which are of greatest conservation and amenity value, where there is greatest perceived environmental threat from weed infestation and where small and new infestations occur (as a preventative measure).

3. To compliment and to update existing information on the location and extent of problem weed species and information regarding the species composition of weed infested areas in the Swan River Trust Management Area, it is recommended that the inventory work initiated by the Trust and carried out by TAFE student Christopher Hart be continued in order to locate and map areas for weed control works the following year. Ideally, the distribution of each weed species should be determined by walking through the shrub along the foreshore and in wetland areas. However, it is recognised that this will be a difficult and time-consuming exercise as a result of inaccessibility in some areas. As such, other methods of identification should be researched, for example, using aerial photographs or remote sensing techniques to determine the location and extent of weed infestations. In addition, existing local government and government agency management plans which identify the extent and location of infestations in the vicinity of the Management Area, along with local knowledge of infestations by other stakeholders, should be utilised.

4. It is recommended that 'natural succession' and 'biological' weed control methods be more thoroughly researched as an alternative to physical and chemical treatments. In particular, the natural suppression of weeds by mulching the ground surface and planting native shrubs along foreshore and within wetland areas should be pursued and the economic costs of this and other options be evaluated.

5. With respect to foreshore and wetland bush regeneration, it is recommended that where practicable areas denuded by weed control measures are revegetated with appropriate local native species. In addition, an inventory of plants that will be suitable for planting in specific areas and the optimum time and method of planting should be developed. The need for the watering of species utilised for revegetation purposes should also be determined. Furthermore, it is recommended that the Swan River Trust start pilot trials of native plantings and appraise costs and performances.

6. It is probable that other problem foreshore and wetland weed species that require control will be identified when the weed control strategy is presented and when weed control works begin. For example, David Fardig (Works Superintendent at the Swan River Trust Depot) has suggested that elephant leaf may become a problem in the future. Moreover, future foreshore assessment surveys and/or investigations may bring other weed species requiring treatment to the attention of the Trust. Therefore it is recommended that the control of other undesirable weed species which have the potential to develop into major infestations, thus threatening environmental and social values, be incorporated in the Trust's weed control strategy where possible.

Section 8.2 Recommended Work Schedule

The weed eradication works must be continued for a minimum of five years. Funding must be committed to weed removal and to weed control follow-up work. A full time staff member to implement the weed control works and contract staff will have be employed for this duration. Other costs will include the costs of depot facilities in terms of support. It is suggested that the costs of removing *hydrocotyle* infestation be used for comparative purposes, keeping in mind that the area controlled for *hydrocotyle* only covered a stretch of river 3km long and that access is a problem.

The following provides an example of a weed control works programme that may be adopted by the Swan River Trust to meet the aims and objectives of its weed control strategy:

Year 1

1. Develop an inventory and map of known weed occurrences and the extent of those occurrences.
2. Initiate weed control program. Remove key weed species, starting up river and concentrating on small infestations in order to prevent further spread of weeds.
3. Determine areas and weed species to be sprayed in the following year.
4. Develop a reference herbarium of introduced weeds so that community volunteers can become familiar with the relevant species.

Year 2

1. Follow up first year weeding program.
2. Commence spraying program of major infestations down river.
3. Identify further infestations for next years control works.

Years 3-5

Follow up weeding and spraying programs.
Identify further infestations for following year's weed control program.

Section 8.3 Environmental safeguards and monitoring recommendations

1. Not withstanding the environmental safeguards outlined above, there are still potential environmental impacts resultant from the chemical treatment of weeds, namely impacts on water quality and aquatic fauna, from the residual activity of herbicides in soils and potential soil destabilisation with loss of vegetative cover. Thus, the continued use of herbicide in the longer term is not considered to be an environmentally sustainable practice. It is recommended that alternative options for weed removal be subject to pilot testing and evaluation with a view to reducing herbicide use in the longer term. Moreover, spot sampling of water quality downstream of sprayed areas before and after spraying and the effects of spraying form year to year on native plants should be undertaken.

2. Woodcock, Rose, Trayler and Chalmers (1993) recommend that when using fluazifop-butyl:

- the herbicide should be applied at a rate of no greater than 1.5 kg a.i./ha;
- a follow-up vegetation survey should be conducted 3-4 weeks after application to determine whether the herbicide has been effective in the control of the perennial grasses, the need for follow-up spot spraying, any adverse effects on native vegetation and undue and severe mortalities of invertebrates and other animal life;
- a spraying regime should be established that includes areas within the foreshore area which do not have the herbicide applied to them so that mobile invertebrate fauna can recolonise areas in which the fauna had become depleted as a result of spraying.

- With the exception of the application rate, these recommendations may be seen as applicable to the use of all herbicides, along with the following prescriptions:

- Apply herbicides in accordance with manufacturers specifications.
- Carefully direct application at the emergent foliage, avoiding runoff from the leaf surface and over spraying.
- Do not apply broadcast over water.
- The herbicide should be applied when there is little or no wind or when the wind is blowing in a direction away from the waterbody.
- Application should take place at low tide and when rain is not imminent (during the next week) so that runoff is minimised.
- An officer should be on-site to supervise spraying activity and to restrict public access to the site.
- Contract staff are to comply with safety standards as specified on the manufacturer's safety data sheet.
- Any adverse effects on aquatic fauna from the proposed use must be immediately reported to the National Registration Authority.

Section 8.4 Recommendations for involving stakeholders

It is recognised that stakeholder participation will be crucial to the success of the Trust's foreshore and wetland weed control strategy, particularly in term of controlling the third fundamental element of a successful weed control strategy, re-invasion. Therefore, it is recommended that ways by which stakeholders can contribute to the control of foreshore and wetland weeds should be evaluated and implemented. For example, local governments can attempt to minimise reticulation and fertilising near bushland to discourage weed invasion; ensure that access paths be made with discouraging grass and weed spread in mind and ensuring that weeds are not deposited in nearby bushland areas.

It is recommended that landholders of property adjacent to areas where re-invasion of undesirable weed species may result are informed in a public education program of what the problem is; what the problem weeds look like; methods of safe removal and who to inform and/or contact for information.

Examples of the ways in which individuals and groups can become involved include:

- growing plants that are native to their local area instead of introduced plants
- replacing introduced plants that are known or potential weeds with native plants
- containing the plants in their garden and ensuring that any known or potential environmental weeds do not spread into nearby native vegetation
- depositing garden waste in a compost heap to return nutrients to their gardens (rather than dumping it in the bush or leaving it piled up on their boundary)
- making sure material from compost heaps will not wash down the drain during storms as seeds carried by stormwater can start weed invasions downstream
- joining their local park care or bush regeneration group
- restraining from taking native plants or rocks from the bush. Apart from being illegal, such action disturbs wildlife habitat and allows weeds to invade
- when in the bush, whether on foot, horseback or trail bike or in a vehicle, keeping to the tracks made for that purpose as weeds invade where native vegetation has been disturbed.

References (need to be verified - misplaced reference list)

??? Noxious weeds of Australia. Melbourne: Inkata Press

Hussey et al. (1997). Western Weeds; a guide to the weeds of WA. Victoria Park: Plant Protection Society of WA.

Hussey, BMJ and Wallace, KJ. (1993). Managing Your Bushland; a guide for WA landowners. Perth: CALM.

Jones, D. (1993). In Tang and Dunkerly's Review of environmental factors: chemical control of vegetation growth along open stormwater channels in central region. Water Board.

Scheltema & Reid. (1995). Principles of bush regeneration and re-establishing native vegetation In Greening Western Australia's Managing Perth's Bushlands.

Woodcock, S., Rose, T., Trayler, K., and Chalmers, C. (1993). A trial to determine the effect of the herbicide fluazifop-butyl on flora and fauna of the Swan River system. Perth: Swan River Trust.

Contacts and information sources to assist in further development of the Swan River Trust's Proposed Weed Control Strategy.

1. Nicole Siemon - EMS Consultants ph 9375 3731.

Nicole has done a lot of relevant work (whilst employed by the SRT) including:

- survey work on the location and extent of flora species on Swan -Avon foreshores (set up a database). Brett Harrison has the base maps which were created.
- survey of the vegetation of the Canning River foreshores and other areas of remnant vegetation falling within the Canning River's immediate vicinity. Detailed descriptions of weeds present in Reserves along the Upper Canning River have been documented.
- areas of specific weed species and strategies for their control eg pampas and poplars
- rehabilitation techniques- techniques for establishing and planting seedlings and seed banks
- work on remnant vegetation
- species that may be used for revegetation purposes and areas where the revegetation of each species would be suitable

Sources of information accessed by Nicole included:

1. Vegetation surveys undertaken of major wetlands upstream of the Causeway - Mosquito control strategy for upstream of Causeway
2. Vegetation surveys undertaken by Environmental Management students from Curtain and Murdoch universities
3. Lower Canning River Management Plan
4. River Trust Report No7 titled "Fringing vegetation of the Canning, Southern and Wungong Rivers" (1993).

Nicole's files are located in SRT (File name is Nicole-s). It is highly recommended that this information is accessed to compliment this proposed strategy. If any of this information cannot be found Nicole has offered that we contact her to photocopy the hard copies.
Barbara Porter from EMS may also be a good source of information.

2. John Pearce - Agriculture WA, Bunbury Office ph 08 9780 6221

Referred by Rob Randall - AgWA Como

John Pearce is currently working on the updated version of the "Nuisance Weeds Handbook" (published by AgWA) (should have a copy on email).

I have not been able to contact him as yet. He will be away until Thursday 02 July 1998.

3. Chris Sharp - Agriculture WA, Como ph 9368 3815

Verity Klem suggested that I contact Chris for information regarding why and when Roundup was banned and details of the herbicide Biactive Lyophilside, namely its uses with regard to the above mentioned weed species, the use of surfactants, rate and frequency of application, methods of application, costs (economic), potential environmental impact and any specific safeguards associated with its use.

4. John Robertson - Robertson Bush Regeneration

Bob Dixon from Kings Park recommended that I contact John Robertson re weed control and revegetation information requirements. John has undertaken extensive work on the control of blackberry, pampas grass and castor oil plant. Apparently he is developing a machine to cut pampas grass (as it is hard work).

5. John Tapley - Agriculture Protection Board

Referred by David Fardig (SRT Depot Works Superintendent).

John was involved in previous spraying works on weeds in the Management Area.

6. Water and Rivers Commission

Luke Pen
Jeff Kite

Helpful Publications

Durham, S. Glyphosate herbicide: its environmental impact - a review.

Extra

Section 4.4 Control of Japanese Pepper Tree
Remove small seedlings by hand
Suggest cut stump method with Glyph. Failing this try Velpar or Garlon.
Follow up treatment is essential as initial treatment may only kill part of the plant.
In wetland areas treat when water recedes and plants are not waterlogged (late summer/autumn). Cuttings will regrow if left in wetland. Check area yearly for seedlings.