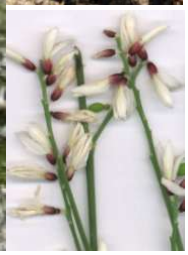
White weeping broom
Retama raetam

Draft strategic plan for the Swan NRM Region

December 2009







swan catchment council

Natural Heritage Trust
Helping Communities Helping Australia

Australian Government

Department of Environment and Conservation

ACRONYMS

DEC – Department of Environment and Conservation
DAFWA – Department of Agriculture and Food Western Australia
SCC – Swan Catchment Council
LGA – Local Government Authority
NRM – Natural Resource Management
IBRA – Interim Biogeographic Regionalisation of Australia
NHT – Natural Heritage Trust

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FOREWORD

White weeping broom, *Retama raetam*, is one of a growing list of highly invasive species that threaten biodiversity in Western Australia and sections of the rest of the country. It is one of 28 highly invasive plants appearing on the *National Alert List of Environmental Weeds* (Australian Government 2001), and although it occurs in low numbers and has a restricted distribution, it can have serious impacts on the environment.

Occurring mainly on the western side of the Swan Coastal Plain in the Swan Natural Resource Management (NRM) Region, it endangers the ecology of regionally significant bushland, Threatened Ecological Communities (TEC) and remnant vegetation. Although most infestations are still small and localised, it has the potential to significantly extend its range and increase in abundance in its current range. Consequently, removal and eradication of weeping broom is a high priority in the Swan Natural Resource Management (NRM) Region.

Management and eventual eradication presents major challenges. Awareness of the weed potential of weeping broom is low, especially in regions where it is already established (Emms *et al.* 2006). Historically, the species has been valued as an ornamental garden plant (CRC for Weed Management 2003) and is currently available for sale in the horticulture industry. As with many other weeds, it occurs across a range of tenures, making communication, coordination and cooperation integral to implementing an effective management program. While listed as a high priority on the *National Alert List of Environmental Weeds* (2001), in Western Australia it is not declared or listed as a pest plant, thus there is no legal requirement for eradication.

This strategy has been developed as part of broader Swan NRM environmental weed management planning. The priority of the strategy is to facilitate awareness and provide a plan of action to eradicate weeping broom. With appropriate resources and investment, it is possible to eradicate weeping broom from the Swan NRM Region and statewide. This will help provide long-term protection of the region's unique biodiversity.

Eradicating weeping broom from the region will require careful monitoring, planning and investment. Due to the long-lived seed bank, management will be required for up to ten years. The strategy outlines actions for 2007 to 2014 but will need to be regularly reviewed and evaluated against its objectives.

This strategy provides information on weeping broom:

1. biology and ecology
2. current and potential distribution in the Swan NRM Region and WA
3. impacts and threats
4. legislation
5. best practice control options
6. management.

The purpose of this strategy is to:

1. encourage, facilitate and support efforts to strategically control and eradicate weeping broom in the Swan NRM Region
2. raise awareness amongst land managers and the public.

CONTENTS

1. CONTEXT AND PREPARATION OF STRATEGY

This strategy has been developed as an outcome of a Natural Heritage Trust-funded *Invasive Environmental Weed Project* for the Swan NRM Region. The project forms part of the *2006-2008 Swan Catchment Council* (SCC) *Investment Plan* and is being completed by the Department of Environment and Conservation (DEC). Among the project's outcomes are the development of strategic plans for six of the region's high priority environmental weeds, including sharp rush. Each of the species presents a major threat to the region's rich biodiversity values. The six species were selected to represent a range of life forms and different management objectives and approaches, so the plans may be used as models to develop strategies for other environmental weeds.

2. AREA COVERED

This strategy centres on the Swan NRM Region in the south-west of Western Australia. It is made up of the swan and jarrah forest Interim Biogeographic Regionalisation of Australia (IBRA) regions and numerous, overlapping management boundaries. These include NRM sub-regions, DEC regions and districts and Local Government Authority (LGA) boundaries, as shown in Figure 1.

3. DESCRIPTION

Taxonomic relationships

Sometimes placed in the genus *Genista*, weeping broom is one of a much larger group of brooms that are evergreen, semi-evergreen and deciduous shrubs in the legume family Fababceae. All brooms are from the sub-family Faboideae in the tribe Genistaea. The three larger genera are *Chamaecytisus*, *Cytisus* and *Genista*, with *Retama* being one of five other smaller groups (four species of *Retama* are currently recognised). These genera are all closely related and share similar characteristics of slender green stems and are adapted to dry growing conditions.

As with several other species such as Spanish broom (*Spartum junceum*), weeping broom is popular in horticulture, with many popular brooms in gardens being hybrids. Several other species of brooms have been introduced as ornamentals to parts of North America, southern Australia and New Zealand but with aggressive seed dispersal they have become naturalised and invasive weeds. For example, Cape broom (*G. monspessulana*) is a native Mediterranean perennial but has become the most widespread broom to invade southern Australia (CSIRO 2007).

Features

A full description of weeping broom is given in Appendix 1. Weeping broom is an erect shrub that grows up to 3m tall and may reach up to 6m across. Plants are grey-green with slender drooping divaricate branches. Young plants are single stemmed, covered with fine, soft hairs and have a long tap root. As they age, plants become glabrous (hairless) and become multi-stemmed. Leaves are very small (5mm long) and narrow (1mm wide). These leaves are dropped in summer and the plant is leafless for the majority of the year (State Herbarium of South Australia 2007).

Flowers are typically pea-like, 8 to 10mm long, white, and develop on pedicels close to the stems in clusters of three to 15. Each flower tube contains ten stamens. Abundant flowers are produced from July to October and occasionally in November.

Figure 1: Close-up of flowers (far left), specimen (left), mass flowering (right), fruit and seed (top right) and typically sized plant growing on coastal dunes (lower right).

Glabrous (hairless) seedpods 10 to 15mm in diameter contain one or two kidney-shaped seeds, up to 6.5mm long. These seeds are brown or black when mature and/or viable. Pods are indehiscent or mildly dehiscent, often falling to the ground with the seed intact. Fleshy at first, eand later leathery, smooth or wrinkled, these pods have a short mucro or an erect or curved beak (State Herbarium of South Australia 2007).

Similar species – native and exotic

Weeping broom's habit and growth are similar to that of scotch broom (*Cytisus scoparius*) but its branches are longer and more flexible, forming an erect dense bush one to 4m tall (Moldenke 2007). A very similar looking and closely related species is *R. monosperma,* a popular garden plant that has been sold throughout Australia since the early 1900s, occasionally under the name of *R. raetam*. *R. monosperma* is also a potential weed in Australia. In California, weeping broom has already become a problematic plant, as it displaces native vegetation and threatens several animal species that rely on vegetation for survival (Weed CRC 2003). Neither species are recommended for gardens or ornamental situations and safer native alternatives are available. These include the Australian native broom (*Viminaria juncea*) and *Jacksonia sternbergiana*.

4. HISTORY OF INTRODUCTION AND SPREAD

Weeping broom was first recorded in South Australia in 1841 when it was brought into the country as an ornamental shrub (CRC Weed Management 2003). It is not known when it was introduced into Western Australia. Although the first herbarium collection was made in 1990, the current size and extent of populations suggest it was present long before. After its introduction, weeping broom gained popularity for its showy white flowers and became more widely available in nurseries and was also propagated for use in parklands and roadside plantings (CRC Weed Management 2003). Flourishing in semi-disturbed and disturbed sites and producing prolific amounts of seed, it is not surprising many planted populations expanded rapidly along road corridors and became naturalised in coastal areas and urban bushland. Around 65 per cent of weeds established in Australia, including weeping broom, have escaped from plantings in gardens and parks (CRC Weed Management 2006).

Seed may have also been spread inadvertently in the dumping of garden waste and the movement of soil (particularly limestone) involved in road construction and quarrying. This is evident in several sites such as the Munster Pumping Station and southern end of Kensington

bushland, where weeping broom populations occur on an old dumping site and limestone quarry.

5. HABITAT AND DISTRIBUTION

Native range

Weeping broom originates in northern Africa, the Western Sahara, Sicily and Middle Eastern areas of the Mediterranean, where it naturally grows in dry, sandy, often saline conditions on coastal dunes, deserts and grasslands (USDA 2007). The climate of many of these areas is typified by high daytime temperatures and limited irregular rainfall (Fragman-Sapir 2007).

Current distribution – Australia and beyond

Weeping broom has become naturalised in Australia, the United States and Great Britain (CRC Weed Management 2003). The types of ecosystems most readily invaded tend to be semi-disturbed areas, from naturally dynamic coastlines to highly disturbed sites such as road verges (DPI 2007). In Australia, weeping broom can survive in a range of soil types and habitats but mostly infests grazing land, deserts, grasslands, sheoak woodlands and stabilised and semi-mobile dunes (Izhaki and Ne'eman 1997). It is particularly suited to lower rainfall regions with alkaline soils (Emms *et al* 2006). Weeping broom is naturalised in coastal and several inland areas of South Australia, where it is recognised as a serious woody weed (DeLaine and Stokes 2006). It is also known from over 20 mainly coastal sites in Western Australia (Western Australian Herbarium 2007). Predictive modeling based on climate parameters shows it is suited to much of southern Australia and has the potential to significantly extend its range (Figure 2).

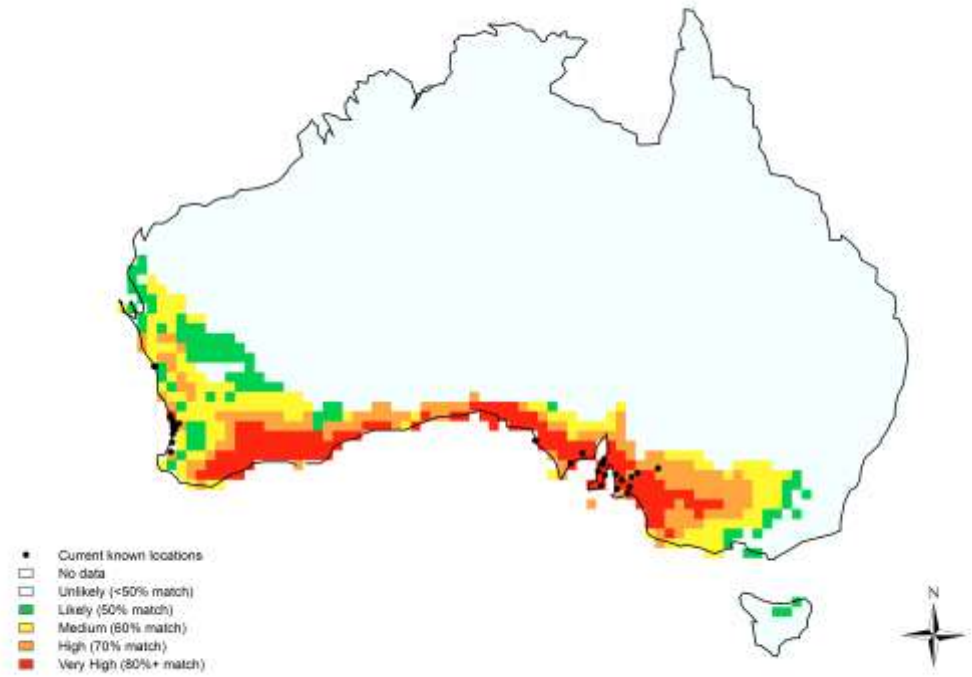

Figure 3: Current and potential distribution of weeping broom in Australia, based on herbarium records and application of Climate® software. Areas shown in red indicate very high likelihood of invasion.

Western Australia

Based on herbarium collections and survey results, weeping broom is currently known in Western Australia from 24 sites (Western Australian Herbarium 2007), the majority of which are in coastal areas of the Swan NRM Region, in southwest corner of the state (Figure 3). One exception is an unconfirmed outlying population at Greenough, south of Geraldton. Prior to this discovery the most northerly and outlying population occurred at Two Rocks, south of Yanchep. A collection at the base of the Darling Scarp on the east side of the Swan Coastal Plain was made in 1991, however, this plant has since not been relocated. There are several other scattered populations south of the Swan NRM boundary, including one at Lake Clifton south of Mandurah and another on a road verge in Bunbury (Western Australian Herbarium 2007).

Figure 3: Current known locations of weeping broom in Western Australia, based on survey results and herbarium collections (Western Australian Herbarium 2007). Red represents confirmed sites and blue represents unconfirmed sites.

The 24 known populations represent both naturalised and planted populations. The types of ecosystems most readily invaded tend to be semi-disturbed, from naturally dynamic coastlines to highly disturbed sites such as road verges (DPI 2007). Almost half of the known populations are naturalised, the remainder of populations are a result of plantings that as yet do not appear to be naturalising.

Swan NRM Region

Twenty of the 24 known populations occur in the Swan NRM Region (Figure 5). The region also contains the majority of garden plantings. Naturalised populations and those planted on public land are largely confined to the western side of the Swan Coastal Plain. Weeping broom may be particularly suited to the alkaline soils of the Quindalup and Spearwood soil assocations. While Climate® predictive modeling suggests the region has suitable climate parameters for invasion, weeping broom's intolerance of heavier soils and waterlogging associated with clay based soils

of the eastern Coastal Plain, Darling Scarp and Plateau, are more likely to be factors limiting its spread further eastward.

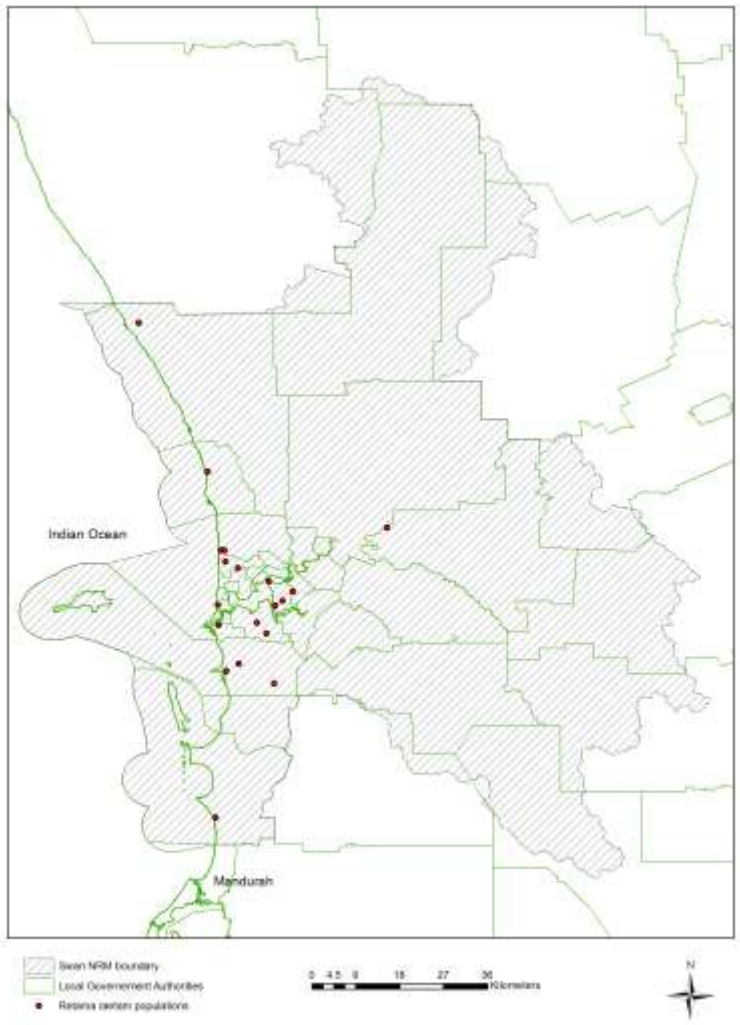

Figure 4: Current distribution of weeping broom in the Swan NRM Region, based on survey results and herbarium collections (Western Australian Herbarium 2007).

A summary of all known populations, planted and naturalised, is given in Table 1. Significant populations of more than 1ha and/or less than 100 plants occur in the western suburbs of Perth, at Fred Burton Reserve, Templetonia Crescent and Munster Pumping Station. Smaller populations of more than 10 plants and/or more than 1ha occur at Kensington bushland, Bold Park and Wireless Hill. Smaller, often-planted, populations occur on road verges.

Table 1: Summary of all weeping broom populations in Western Australia (NB: * represents populations outside of the Swan NRM Region).

Popn	Location description	Naturalised (N) Planted (P) Uncertain (U)	Suburb	Current No. plants (previous in brackets)	Land type	Managing Agency/Owner
1	Fred Burton Reserve	N	Floreat	~200	Reserve	Town of Cambridge
2	Two Rocks old tipsite	N	Two Rocks	0 (12)	Road Reserve	City of Wanneroo
3	Bold Park	N	Floreat	0 (6)	Conservation Reserve	BGPA
4	Templetonia Crescent	N	Floreat	~200	Reserve	LGA
5	Quenda Lake, Cnr Murdoch Dve	N	Murdoch	1	Reserve	Murdoch TAFE
6	Mill Point Reserve	P	South Perth	1	Reserve	City of South Perth
7	Kensington Bushland-south end	N	Kensington	14	Shire Reserve	Town of Victoria Park
8	West Coast Hwy verges	N	Floreat	~20	Road verge	MRWA and LG
9	Munster pumping station four	N	Munster	204	MRWA, Water Corporation	MRWA, Water Corporation
10	Wireless Hill	N	Applecross	0 (3)	Reserve	City of Melville
11	John Forest NP	U	Kalamunda	0 (1)	Reserve	DEC
12	Kwinana Freeway-Berrigan Dve to Thomas Rd	P	South Lake	~50	MRWA road reserve	MRWA
13	Kwinana Freeway-Canning Hwy	P	Como	1	MRWA Road reserve	MRWA
14	Cnr Goss and Henley St	P	Manning	0 (1)	Road verge	City of South Perth
15	Opposite Secret Harbour Golf Course	U	Secret Harbour	1	Freehold private	Private
16	Rockingham Rd, 700m north of Yangebup Rd	P	Spearwood	3	MRWA Road reserve	MRWA
17	West of Marine Parade, 80m north of Curtin Rd	P	Cottesloe	2	Other Crown Reserve	Town of Cottesloe
18	Stirling Highway, near Boundary Rd, east verge	P	Mosman Park	1	MRWA Road Reseve	MRWA
19	Bushland, circa Ocean Village Shopping Centre	P & N	Wembley Downs	2	Conservation Area	Town of Cambridge
20	300m north of Ocean Reef Rd and Oceanside Prom.	P	Ocean Reef	1	Road Reserve	City of Joondalup
21*	Lot 1175, centre of horse paddocks	P	Lake Clifton	6	Freehold Private	Private
22*	300m south of 25km Geraldton marker, Greenough	P?	Greenough	3	Private	Private
23*	Mandurah Bypass, 200m east of Estuary Bridge	U	Dudley Park	1	MRWA Road reserve	MRWA
24*	Moore Rd, dunal road verge	U	Bunbury	3	Road Reserve	Shire of Bunbury

6. BIOLOGY AND ECOLOGY

Weeping broom flowers, sets seed and grows at slightly different times to that of populations in the Eastern States and South Australia. In Western Australia it flowers from late winter to the end of spring/start of summer and produces seeds in early summer, shedding them in late summer to autumn (Table 2). Active growth occurs whenever there is moisture but mainly from autumn to spring. Seeds mainly germinate in late autumn and winter but can germinate outside these times under suitable conditions (CRC Weed Management 2003).

Table 2: Calendar of biology and management, based on Weeds CRC timeline (2003).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Active growth												
Flowering												
Seed formation												
Seed drop												
Germination												
Herbicide application												
Physical removal												

Weeping broom flowers are closed, pea-like in appearance and attract insects, suggesting cross-pollination is required (Whitinger 2006). Each plant can produce large numbers of seed (hundreds to thousands) and may fruit over a period of at least three years (Johnson 2005). Seeds have a hard coat and can remain viable in the soil for at least several years, until they have aged or the seed coating is worn. Mass germination can occur after fire, or when adult plants are removed and is most visible in late summer and autumn. Seedlings are not significantly affected by dry soil conditions (Emms *et al.* 2006). Seed may survive any mulching or composting process and scarification can increase the rate of germination significantly (Izhaki and Ne'eman 1997).

Research into the soil surface seed bank has shown there may be more than 3,000 seeds in $1m^2$. Large seed production and physical dormancy helps to disperse populations in time and guards parent plants against events such drought or fires (Emms *et al.* 2006).

In cultivation, brooms are known to thrive best in well-drained, infertile soils and poor growing conditions, needing little care. Normal growth rate has been observed at 30cm or less per year which rates fairly slowly for a shrub (Johnson 2005). It can establish under no, to moderate, canopy. It is highly tolerant to drought, moderate fire, high levels of salt, frost to at least -9 degrees Celsius but is intolerant of water logging. Similar species of brooms invade nutrient-poor to fertile well-drained soils where they can fix nitrogen and form a layer that can out compete and shade native plants (DPI 2007).

Although commencing with a long tap root (Figure 5), as it matures weeping broom develops both a shallow and deep root system (CRC Weed Management 2003). Like the roots of scotch broom, its roots are extremely nauseous and even poisonous if eaten (Moldenke 2007). There have been cases where herbal remedies caused respiratory failure (Schmid *et al.* 2006) and its toxic and bitter taste repels animals (El Bahri *et al.* 1999).

Figure 4: Juvenile plant showing length of the tap root (far left), seedlings emerging during winter (left), prolific immature fruits (right) and soil seed bank with new germinants (far right).

The main vectors of seed dispersal include dehiscing, water and soil movement, deliberate exchange by gardeners or in the horticultural industry, garden or park waste. In addition, hares in the sandy ecosystem of the Mediterranean coastal plain in Israel are known to consume and disperse the pods of weeping broom from 200 to 1,000m from parent plants (Izhaki and Ne'eman 1997).

Weeping broom has particular adaptations to be capable of tolerating desert conditions. It has been suggested that it is the most drought tolerant of the exotic brooms in Australia, making it a particular threat in dry regions and during drought (CRC Weed Management 2003).

In its native range, rainfall is extremely limited and irregular, thus it must be able to survive very prolonged dry periods, as well as tolerate high salt levels. Like many other desert species, limited surface area in reduced leaves results in a minimum of water loss. It also rapidly loses its leaves after flowering in winter, resulting in it being leafless most of the year. The green stems of weeping broom are capable of carrying out photosynthesis in lieu of the leaves. The stomata are sunken into canals or grooves covered by trichomes, which prevent excess water loss when the stomata are open (Fragman-Sapir 2007).

Research using fire to control other species of broom has shown while it results in some plants being killed, lightly scorched plants may re-sprout (Delaine and Stokes 2006). Although it may kill a proportion of seeds, fire also has a role in breaking the physical dormancy of seeds. Follow-up treatment of seedlings and juvenile plants is needed for many years until the seedbank is depleted (CRC Weed Management 2003).

7. IMPACTS AND THREATS

The biological and ecological characteristics of weeping broom make it a significant threat to biodiversity in the Swan NRM Region. Prolific seed production, the ability of seed to germinate all year round in suitable conditions (CRC Weed Management 2003), rapid regeneration and the ability to spread quickly after disturbance make it a particular threat to disturbed or semi-disturbed sites and open plant communities, including coastal vegetation and woodlands.

Weeping broom readily colonises bare ground and is most conspicuous along roadsides, where it is at a advantage because of access to poor soils, disturbance and little competition. While the majority of populations occur on disturbed edges of bushland or as roadside plantings, it

threatens nearby or adjacent bushland where it may gradually spread. With land clearing and urbanisation, these fragmented and small areas of remnant vegetation are particularly susceptible to incursions.

In the western portion of the region it endangers the ecology of several areas of regionally significant bushland, or Bush Forever sites, TEC's and other areas of coastal or woodland remnant vegetation. Some of these remnants areas have a high conservation value due to the presence of locally endemic and rare plants. For example, Fred Burton Reserve in the Town of Cambridge has weeping broom that is rapidly encroaching on and degrading dune systems (WAPC 2006).

Weeping broom has several major ecological impacts. It is able to form a layer that can out compete, shade and displace many native plant species in the understory and mid-story, though it is less likely to impact on the tree layer (CRC Weed Management 2003).

In addition, it can have major impacts on the frequency and intensity of fire-regimes. Larger, senescing or dead stands with high fuel load can increase the severity of bushfires and the recovery of native systems is hampered by mass re-sprouting and seedling germination.

It has a root system that may help to reduce erosion, however, if these plants are destroyed by fire large areas may be exposed, increasing the risk of erosion (CRC Weed Management 2003). Being unpalatable and out-competing native plant species, its presence may also reduce food and appropriate habitat available to fauna (DPI 2007). This may be of particular concern in Quindalup or coastal dunes, where naturally open areas important for a variety of reptile species are highly susceptible to invasion.

As well as serious environmental impacts, weeping broom has the potential to become a significant threat to Australia's pastoral industry. Southern dry agricultural landscapes and remnant vegetation may be at particular risk (Emms *et al*. 2006). It may infest grazing land and be the least palatable to stock of the introduced brooms (CRC Weed Management 2003). While this is less of an issue in the Swan NRM Region, it may be a concern for other areas in WA, particularly agricultural land on the mid-west and south coasts.

8. LEGISLATION

Weeping broom is part of the National Alert List for Environmental Weeds developed in 2001 (Australian Government 2001). Although species on this list are earmarked for eradication there are no legislative requirements to control populations, as it is not declared or rated as a priority species by the Department of Food and Water. At a local government level, it may be identified and treated opportunistically, or can be listed as a pest plant, however, this is at the discretion of individual authorities and to date this has not occurred. Importation of material into Australia is banned because of the risk of further spread and the potential introduction of new genetic diversity that could make future control more difficult (CRC Weed Management 2003). In February 2007, weeping broom was nominated for inclusion to a list of plants to be used in a code of practice for the nursery industry as part of the *Biosecurity and Agriculture Management Act* (2007).

9. CONTROL METHODS

The timing of control methods coinciding with weeping broom biology is given in Table 2. The most cost-effective control is carried out when plants and populations are small. There has been limited research into the most effective control methods for weeping broom although it can be treated effectively with herbicides applied by foliar spraying post-fire, directly on the stem after cutting or applied by basal barking.

Methods of controlling other broom species may also be extrapolated to weeping broom. In general they can be controlled using an integrated approach of chemicals, physical removal and/or fire. Best practice in broom management requires a specific strategy for each situation (Sheppard 2000). Experience in controlling scotch broom can be applied, although weeping broom has a longer growing period than most other brooms, enabling it to be controlled over a greater period. The use of natural enemies (ie. biological control) has been investigated for other species, such as french broom, but has not yet been undertaken for weeping broom (Sheppard 2000).

To be effective, any management program may have to extend up to ten years or until the seed bank is depleted, making control expensive. Programs should also include monitoring and spot removal of regenerating plants before they set seed (Sheppard 2000). Control efforts not carried out appropriately, or without this follow-up, can help spread weeping broom and exacerbate impacts, thereby worsening the problem.

Physical and mechanical control

Physical or hand removal may be an option for isolated plants or for those in environmentally sensitive areas, however, larger seedlings may be difficult to hand pull due to the taproot. Larger plants are very difficult to remove and cutting stems near the ground will result in vigorously re-sprouting (Figure 5). Any physical removal is best carried out during flowering, prior to seed set.

Figure 5: Cutting of stems by hand or chainsaw (left) will result in vigorous resprouting (centre), as opposed to chemical application via basal barking (right).

Hand pulled plants and seeds ideally should be removed and placed in bags disposed of in landfill, taking care not to spread seeds. Cut material may be accommodated on the site via mulching or drying, however, if it is to be used elsewhere, no seed should be included in the production of mulch or compost (CRC Weed Management 2003). Any site where plants have been removed should be monitored in late spring and/or summer for any germinants, as once an area has been treated, burnt or plants removed, masses of new seedlings can be produced.

Mechanical control carried out with heavy equipment, such as bulldozers, has been a common method used in large stands of other brooms. Plants are piled and later burnt, or mulched when infestations are thick enough to produce deep mulch. While it can prevent reproduction it causes massive soil disturbance and can spread plants, cause subsequent germination and bury seeds (Sheppard 2000). In one example this practice has exacerbated problems with scotch broom (CRC Weed Management 2003). Safeguards need to be taken, including cleaning-off equipment and permits may be required to mechanically clear vegetation if native species are likely to be affected.

Chemical control

Weeping broom has a more continuous growth pattern than other broom species, enabling it to be treated with herbicides throughout the year whenever it is actively growing, ideally before it sets seed (CRC Weed Management 2003). Application may be effective in killing mature plants and/or used in conjunction with other techniques to deplete the seed pool.

Cutting and immediately painting stumps with 50 per cent Glyphosate has proven highly effective with no re-sprouting (unpublished data). This option may be beneficial in sensitive areas where soil disturbance needs to be minimised. After physical removal of plants, herbicide could be used to treat the replacement germinants. On certain sites where it suppresses native plants, revegetation or direct seeding may be appropriate.

Chemical control may be effective in the short term but is expensive, may present a risk to non-target species and needs to be followed up for many years until the seed bank is depleted (CRC Weed Management 2003). Glyphosate or triclopyr herbicides are useful in controlling weeping broom through either foliar application or basal barking with a penetrant, however, they are currently not registered for this use (DeLaine and Stokes 2006). Consult the Department of Agriculture and Food Western Australia (DAFWA) for further information, as these herbicides must be used in compliance with off-label permit conditions.

Fire

Fire as a control method for weeping broom may be useful in reducing biomass, killing seed or depleting the seedbank and easily controlling germinants. However, it is not recommended for the populations in the Swan NRM Region, prescribed burning is not permitted or practiced in these areas as it can cause uncontrolled fires and create an environment that encourages further weed invasion.

10. MANAGEMENT

Vision

The main vision for management is *to reduce impacts, contain spread and eradicate weeping broom at key sites, to protect the region's high biodiversity assets*.

Management objectives

The focus of management will be on eliminating populations at high biodiversity value sites and ensuring new populations are controlled before they establish.

Management objectives include:

- understanding the true extent of weeping broom populations
- assessing biodiversity value assets directly and indirectly at risk
- containing further expansion outside existing range
- controlling outlying populations
- eradicating populations at high biodiversity value sites
- excluding weeping broom from other high biodiversity value sites (Bush Forever sites, TEC's, regionally significant remnant vegetation and areas containing significant flora and/or fauna)
- reducing impacts at other areas
- preventing further invasion and new populations appearing in bushland - removing other sources such as weeping broom plants in gardens/parks before they invade natural ecosystems
- undertaking detailed mapping to reveal the extent of individual populations

- managing human activities, including road maintenance, to limit the spread of weeping broom
- fostering and continuing to develop partnerships with land managers such as local government, the public and community groups
- encouraging partnership commitment by undertaking discussion with partner organisations to develop and implement a long term monitoring program
- maintaining a detection and surveillance program.

Actions to date

The following actions have been or are currently being implemented:

1. Raised industry and community awareness
Images, descriptions and general information on weeping broom have been disseminated in a number of ways, including electronic and print media and public forums.

2. Survey to understand the extent and distribution
After gathering all herbarium collection information, field surveys were undertaken in 2006/7 to better understand the distribution and extent of populations. Reports were sought from the community and land managers on any new or previously unknown populations.

3. Mapping of key populations
Detailed mapping using a differential GPS was undertaken at several key sites.

4. Assessment of threat to biodiversity assets and development of management priorities
Locations of weeping broom populations were plotted in GIS against various data layers for biodiversity assets, as shown in Figure 6. *Bush Forever Volume 2* (Government of Western Australia 2000) was used to list the values of each infested site as well as sites in close proximity (within 2km) at risk from invasion (Table 3). Sites were also inspected and assessed in the field. Each area was rated according to the following basic criteria (described further in Table 4):

- conservation value of site
- feasibility of controlling the infestation
- whether it is outlying
- level of threat to nearby biodiversity assets.

From these ratings, sites were given a management priority (Table 3).

Four populations occur in high biodiversity conservation areas and were rated high priority for management. These areas include Bush Forever sites, are adjacent to TEC's and/or contain significant flora or fauna. A number of other high/moderate priority populations occur in or near areas with significant conservation such as national parks, TEC's and/or significant areas of remnant vegetation. Outlying populations were given special consideration for management due to the risk of expanding or filling in the range. Several populations on road verges present little threat of invasion to bushland or inadvertent spread. These have generally rated as low management priorities.

5. Development of an implementation plan, aimed at eradicating small to medium-sized populations in or in close proximity to high conservation areas and outlying populations
Specific short-term (2007-2008) and long term management recommendations have been developed for sites rated high ('H'), high/moderate ('H/M') and moderate ('M'), as well as lower management priority sites (Table 5). Most of these actions involve removing mature plants, herbicide spraying, monitoring and surveillance.

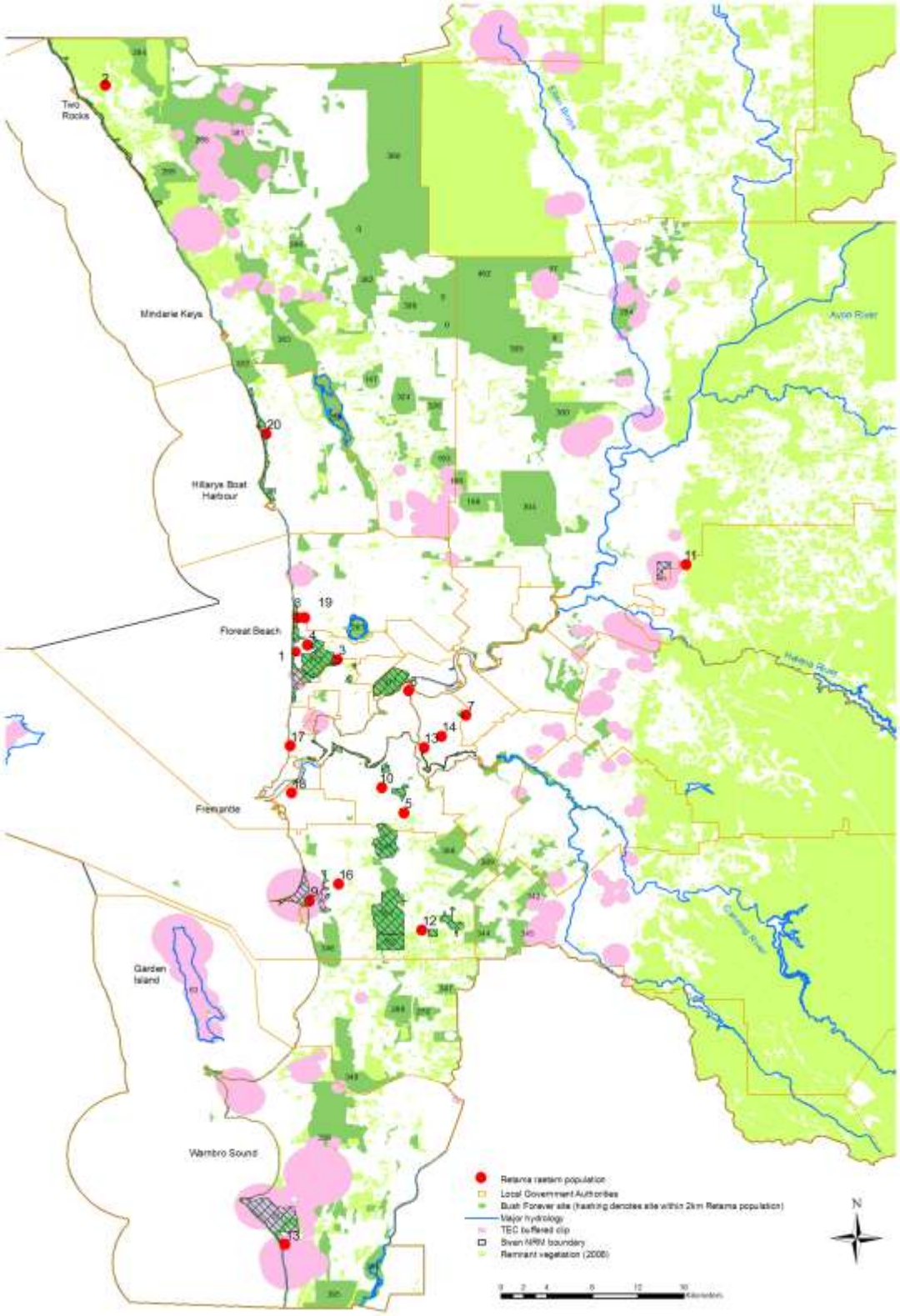

Figure 6: Detail of distribution of weeping broom against high biodiversity value assets in the Swan NRM Region, based on survey results and herbarium collections (Western Australian Herbarium 2007).

6. Commenced partnership with stakeholders
After liaison with relevant stakeholders including local government and the Water Corporation, plants at populations two, three, five, 10 and 14 have been cut, painted and removed. These sites will need to be re-checked in one to two years time in September, with any germinants treated (hand removed or by herbicide application). Liaison is underway with other agencies to carry out control at other sites.

7. Commenced research into control methods and climate change modelling
Control trials were established in December 2006 on a large weeping broom population on a degraded private property. The aim was to test a variety of treatments to determine the most effective and appropriate control method.

8. Removal from sale in the horticultural trade
Around 65 per cent of weeds established in Australia, including weeping broom, have escaped from plantings in gardens and parks (Weeds CRC). In February 2007, weeping broom was nominated for exclusion for production and sale, in a code of practice for the horticultural industry as part of the *Biosecurity and Agriculture Management Act (*2007).

Recommended actions

The following actions are recommended:

1. Undertake control and liaising with key stakeholders
- Cut, paint and remove plants at populations one, seven, eight and nine.

2. Continue mapping and monitoring program
- Monitor known population sites at least every two years in spring/summer following control. Remove new seedlings either by hand or treat with herbicide.
- Undertake and continue detailed mapping of individual populations to ascertain spread/decline.
- Establish photo-monitoring at populations one, eight and nine.

3. Detection and surveillance
- Establish a process of detecting, reporting and eradicating new infestations.

5. Liaise with stakeholders outside the Swan NRM Region
- Liaise with the DEC Midwest Region, South West NRM Region and South Coast NRM Region.
- Liaise with the DEC Geraldton District regarding population 12. Inspect ion during flowering, voucher, remove plants and possibly survey further.
- Conduct further surveys outside known range and outside the Swan NRM Region.
- Distribute extension material.

6. Maintain quarantine
- Prevent from spreading by prohibiting propagation, cultivation, sale and importation into Western Australia.

7. Increase understanding and awareness
- Raise awareness among the community and land managers, particularly those involved in road maintenance, with particular emphasis on Main Roads WA and local governments.
- Develop an information brochure, possibly including broader information on broom species, in 2008.

8. Obtain ecological and biological information

- Obtain current information on the biology, ecology, impacts of climate change and control technique trials for weeping broom.

9. Maintain contact and cooperation with other land managers and research scientists

10. Keep fire and other disturbance out of high biodiversity sites

11. Remove other sources – garden plantings

- Remove other sources of plants before they invade natural ecosystems. There are numerous isolated plantings of weeping broom in private gardens in the Perth metropolitan area. Whilst they represent a low threat to bushland, these populations should also be targeted for removal in any eradication program. Incentives in the form of offering to remove the plants, native replacements and nursery vouchers may be options.

Targets

To fulfill the aims of the strategy, the following targets should be met in the Swan NRM Region by 2010, unless otherwise stated:

- *no nett increase in number of populations*
- *no nett increase in extent*
- *brochure produced by June 2008*
- *publication of best practice control methods by June 2008*
- *eradication of all mature plants by 2010, excluding those in private gardens*
- *prohibited from sale by 2009.*

Resourcing

This strategy will help determine funding priorities for the SCC's investment planning process. Some funding has already been obtained for controlling weeping broom. The community group Cambridge Coastcare was successful in obtaining a $7,000 Coastwest grant to fund treatment of plants at population one (Western Australian Planning Commission 2006). Approximately $4,000 has been available for control of populations three and nine in 2006 and 2007 as part of DEC's Saving our Species Biodiversity Conservation Initiative (BCI). However BCI funding will not be available past 2008. To continue implementing the strategy, a funding commitment would be required for a period of five years, with surveillance required for up to 10 years because of the long-lived seedbank. With relevant expertise, and as one of the leading conservation agencies, DEC should provide resources in the form of a coordinating project officer and funds to continue implementing recommendations. As yet, other funding sources or contributions potentially available from LGA's are unknown.

Stakeholders

The weeping broom populations currently known occur on both private and public lands vested in a range of agencies. Developing partnerships with these organisations is integral to achieving the desired outcomes of the strategy. The key agencies include:

- Swan Catchment Council
- Department of Environment and Conservation
- Local Government Authorities - Town of Cambridge, Town of Victoria Park, Town of Cottesloe, City of Wanneroo, City of Joondalup, City of South Perth, City of Melville, City of Nedlands, City of Cockburn and City of Rockingham
- Main Roads Western Australia
- Department for Planning and Infrastructure
- Botanic Gardens and Parks Authority
- Water Corporation
- Department of Agriculture and Food and Western Australia

- Cambridge Coastcare
- community members
- Friends groups
- Private landholders.

To eradicate weeping broom in Western Australia and protect the Swan NRM Region, communication between other NRM regions and agencies, such as DEC, needs to take place. Additional stakeholders include:

- Shire of Bunbury
- South West and South Coast NRM Region
- DEC Midwest Region.

11. MONITORING AND EVALUATION

Monitoring and evaluation are key parts of measuring the successful implementation of this strategy. New information can also provide the basis to adapt the management program. At the completion of three years (July 2010), the strategy should be reviewed and evaluated against the management targets. With baseline information already gathered, data needs to be recollected in 2010 to assess the spread/decline of weeping broom and evaluate the success or progress toward management targets. Indicators to show this include:

- Mapping. Spatial data can allow identifying changes in distribution and numbers of plants
- Records of numbers of plants (separating adults, juveniles/seedlings)
- Survey for expansions in existing populations and new populations.

It is important to note, that because of the long-lived soil seed bank, monitoring and management actions will need to be carried out for up to ten years.

12. CONTACTS

As further information is gathered, the strategy may be altered accordingly. Submissions and comments are encouraged. Please contact DEC on (08) 9423 2900 or the SCC on (08) 9374 3333.

13. ACKNOWLEDGMENTS

Kate Brown, Danielle Witham, Paul Yeoh, David Mitchell and Greg Keighery are gratefully acknowledged for their contribution.

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15. FIGURES AND TABLES

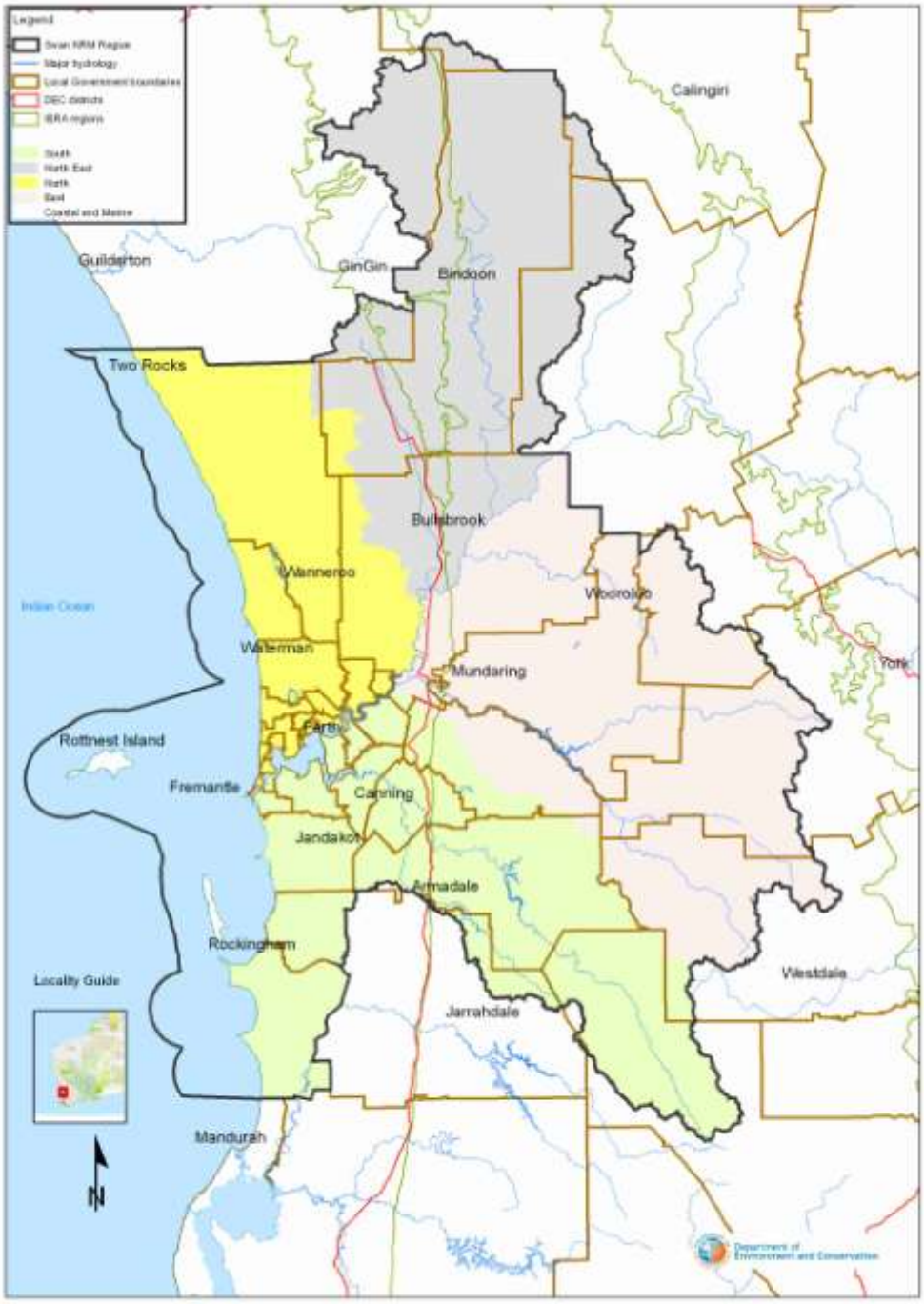

Figure 1: Management boundaries of the Swan NRM Region, including NRM Sub-regions, DEC regions, districts and LGA's.

Table 3: Biodiversity assets at risk from each infestation of weeping broom.

Popn	Location description	(N) (P) (U)	Suburb	Biodiversity assets in site[1]	Conservation Rating[2]	Biodiversity assets most at threat, adjacent or in close proximity[3]	Threats (adjacent lands)[4]	Feasibility of control[2]	Outlying population	Management priority
1	Fred Burton Reserve	N	Floreat	Remant vegetation, locally significant flora (two spp)	1	BFS310, 315, 312	M	3	N	H
2	Two Rocks old tipsite	N	Two Rocks	Disturbed road verge	3	Remnant vegetation BFS307, 284, 406, 288	M	1	N	H
3	Bold Park	N	Floreat	BFS312, significant flora, significant fauna habitat	1	BFS315, 310, 220, 218, 281	M	2	Y	H
4	Templetonia Crescent	N	Floreat	Degraded private property	3	BFS312, 315, 310, 281	L	1	Y	L
5	Quenda Lake, Cnr Murdoch Dve	N	Murdoch	Remnant vegetation-wetland	2	BFS339, 224, 338	M	1	Y	H
6	Mill Point Reserve	P	South Perth	Degraded remnant vegetation	2	Remnant vegetation BFS317, 402	L	2	N	M
7	Kensington Bushland – south end	N	Kensington	BFS48, significant flora (two spp), fauna (one sp)	1		H	3	N	H
8	West Coast Hwy verges	N	Floreat	Disturbed road verge	2	BFS310, 312, 315, 281, 308 TEC	H	1	Y	M
9	Munster Pumping Station 4	N	Munster	Degraded remnant vegetation	2	BFS341, 261, 247, 346 TEC	H	1	N	M
10	Wireless Hill	N	Applecross	BFS336, significant flora (three spp), fauna (one sp)	1	BFS226, 339, 337, 226	M	1	Y	H
11	John Forest National Park	U	Kalamunda	Disturbed remnant vegetation	2	Remnant vegetation (John Forrest NP), BFS306	M	1	N	M
12	Kwinana Freeway - Berrigan Dve to Thomas Rd	P	South Lake, Success, Anketell	Disturbed road verge	3	BFS492	L	1	Y	L
13	Kwinana Freeway - Canning Hwy	P	Como, South Lake, Success	Disturbed road verge	3	BFS227	L	1	N	L
14	Cnr Goss and Henley St	P	Manning	Disturbed road verge	3		L	1	Y	L
15	Opposite Secret Harbour Golf Course	U	Secret Harbour	Degraded private property	3	Remnant vegetation BFS377, 379, 356, 395	M	2	Y	H
16	Rockingham Rd, North Yangebup Rd	P	Spearwood	Disturbed road verge	3	BFS435, 429	L	U	Y	L
17	West of Marine Parade	P	Cottesloe	Disturbed remnant vegetation	3		L	1	Y	L
18	Stirling Highway, east verge	P	Mosman Park	Disturbed remnant vegetation	3		L	U	Y	L
19	Bushland surrounding Ocean Village	P/N	Wembley Downs	Disturbed remnant vegetation	2	BFS310, 312	L	3	N	M
20	300m north of Ocean Reef Rd and Oceanside Prom	P	Ocean Reef	Disturbed road verge	2	BFS325	M	2	N	M
21*	Lot 1175, centre of horse paddocks	P	Lake Clifton	None - paddock	1	Remnant vegetation	H	2	N	M
22*	South of 25km Geraldton marker	P?	Greenough	Disturbed private property	1	Remnant vegetation	H	1	N	H
23*	Mandurah Bypass, east of Estuary Bridge	U	Dudley Park	Disturbed road verge	3	Remnant vegetation	M	1	N	M
24*	Moore Rd, dunal road verge	U	Bunbury	Disturbed road verge	U	Remnant vegetation	U	1	N	

Table 4.1 below: Criteria for ranking threat to biodiversity values of site (from highest to lowest).

Ranking	Criteria (serves as a guide only)
1	TEC **and/or** (Declared Rare Flora) present. Priority/significant flora species present. Regionally significant/Bush Forever site. Vegetation in good, very good to excellent condition in majority of site. International/nationally significant. Contains other special attributes (e.g. scientific importance).
2	No TEC **or** DRF present. Priority/significant flora species may be present. May be regionally significant. May contain other special attributes. Vegetation in good to degraded condition. Occurs on road verge/buffer adjoining and threatening sites ranked one or is an outlier population at known extent of range.
3	No TEC, DRF or priority/significant flora species present. Not recognised as regionally significant. No other special attributes. Vegetation degraded to poor, completely disturbed or very poor condition, (vegetation structure disappeared, few if any native species, high percentage cover and abundance of weeds). Does not threaten high biodiversity value sites.

Table 4.2 below: Criteria for ranking feasibility of control of weed species (from high to low feasibility).

Ranking	Criteria (serves as a guide only)
1	Weed in low numbers and/or low density. Occasional/localised to a specific area of site and in low density. Possibility population/s eradicated in two to three years. Site easily accessible.
2	Weed in low numbers and/or low density. Occasional and widespread/present in most or all of site or weed in medium densities. Common and localised/confined to specific areas of site. Possibility population/s severely reduced or eradicated in two to three years. Site accessible/moderately accessible.
3	Weed in high density. Widespread or localised and abundant. Infestation difficult to control, eradication unlikely. Likelihood infestation would require intensive treatment for over three years. Site may be difficult to access. Site has complication for management, for example, sensitive site, permanent water.

Table 5: Management priorities and recommended actions for each population of weeping broom.

Popn	(N) (P) (U)	Suburb	Conservation rating[1]	Feasibility of control[2]	Outlying population	Threats (adjacent lands)[3]	Management Priority	Management actions – short term (2007-2008)	Management recommendations – medium term (2008-2010)	Management recommendations – long term (2010+)
1	N	Floreat	1	3	N	M	H	Detailed mapping completed. Liaise with Cambridge Coastcare	Follow-up monitoring and control of seedlings annually	Follow-up monitoring and control of seedlings annually
3	N	Floreat	1	1	N	M	H	Surveillance	Surveillance	Surveillance
7	N	Kensington	1	2	Y	H	H	Liaise with Town of Victoria Park. Basal bark plants. Control seedlings	Monitor every two years	Surveillance
10	N	Applecross	1	1	Y	M	H	Monitor site every two years, control seedlings	Monitor every two years	Surveillance
2	N	Two Rocks	3	1	Y	M	M/H	Monitor site every two years, control seedlings	Monitor every two years	Surveillance
8	N	Floreat	2	2	N	H	M/H	Basal bark treat remainder of plants	Monitor every two years	Surveillance
9	N	Munster	2	3	N	H	M/H	Cut, paint road verge plants, basal bark remainder	Monitor every two years	Surveillance
15	U	Secret Harbour	3	1	Y	M	M/H	Contact land-owner, cut, paint	Monitor every two years	Surveillance
20	P	Ocean Reef	2	1	Y	M	M/H	Contact City of Wanneroo, cut and remove plant	Monitor every two years	Surveillance
22*	P?	Greenough	1	U	Y	H	M/H	Contact owner. Remove plants. Offer native replacements	Monitor every two years	Surveillance
5	N	Murdoch	2	1	Y	M	M	Monitor site every two years, control seedlings	Monitor every two years	Surveillance
6	P	South Perth	2	1	N	L	M	Monitor site every two years, control seedlings	Monitor every two years	Surveillance
11	U	Kalamunda	1	1	Y	H	M	Surveillance/inform local DEC Districts and the City of Swan	Surveillance	Surveillance
19	P/N	Wembley Downs	2?	1	N	L	M	Liaise with Town of Cambridge to control plants	Monitor every two years	Surveillance
21*	P	Lake Clifton	1	2	Y	H	M	Contact owner. Remove plants. Offer native replacements	Monitor every two years	Surveillance
23*	U	Dudley Park	3	1	Y	M	M	Liaise MRWA. Remove fruit. Basal bark treatment	Monitor every two years	Surveillance
4	N	Floreat	3	3	N	L	L	Liaise with Town of Cambridge. Bulldoze plants when site developed	Liaise with Town of Cambridge. Bulldoze plants when site developed	Surveillance
12	P	South Lake, Success	3	2	N	L	L	Basal bark treatment	Monitor every two years	Surveillance
13	P	Como, South Lake, Success, Anketell	3	2	N	L	L	Basal bark treatment	Monitor every two years	Surveillance
14	P	Manning	3	1	Y	L	L	Monitor site every two years, control seedlings	Monitor every two years	Surveillance
16	P	Spearwood	3	1	N	L	L	Basal bark treatment	Monitor every two years	Surveillance
17	P	Cottesloe	3	1	N	L	L	Liaise with Town of Cottesloe to control plants	Monitor every two years	Surveillance
18	P	Mosman Park	3	1	N	L	L	Basal bark treatment	Monitor every two years	Surveillance
24*	U	Bunbury	U	U	Y	U		Liaise with South West Region to control popn.	Liaise with South West Region to control popn.	Monitor every two years

16. APPENDICES

Appendix 1: Detailed description of weeping broom.

Weeping broom

(*Retama raetam*)

Stem grows up to 3m high, erect, divaricately branched, branches pendent, sericeous when young, leaves linear-lanceolate or linear-subspathulate, sericeous-pubescent, deciduous, three to15 flowered, bracts triangular, c. 1.5mm long, glabrous, bracteoles distal on the pedicel, wart-like.

Flowers eight to10mm long on pedicels c. 1mm long; clayx urceolate or campanulate, three to four xc. 2.5mm, glabrous, two-lipped, upper lip with triangular teeth deeply divided by a large sinus; lower lip with three linear-subulate short teeth, often ciliate, circumscissilely caduceus after anthese; petals white, pubescent outside, standard rhombic-ovate; wings oblong, obtuse, as long as the cuspidate-acuminate keel; ovary oblong, glabrous, attenuate into a long style.

Pod obovoid, c. 15 x 10 mm indehiscent to tardily dehiscent, with a short mucro or an erect or curved beak, at first fleshy, later leathery, smooth or wrinkled, two seeded; seed globular-reniform, yellow or brown to black, c. 6.5 x 5mm.

Extract from Jessop and Toelken (1986) or
www.flora.sa.gov.au/cgi-bin/texhtml.cgi?form=speciesfacts&genus=Retama&species=raetam
(accessed 11/5/2007)