Geraldton Carnation Weed (*Euphorbia terracina*)

Workshop and Field Day

Department of Environment and Conservation

Proceedings from a Skills for Nature Conservation workshop held at Naragebup
Rockingham Regional Environment Centre (Inc.), Peron, Western Australia
Thursday 21 June 2007

Government of Western Australia
Department of Environment and Conservation

urban nature

swan catchment council

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Acknowledgements: Leonie Stubbs (Friends of Paganoni).

Front cover photograph: Paganoni Swamp (Kate Brown).
Euphorbia terracina close-up (Karen Bettink).

This workshop is part of the Skills for Nature Conservation (SFNC) training program delivered as a partnership between the Urban Nature Program of the Department of Environment and Conservation and Greening Australia WA. SFNC is funded by the Natural Heritage Trust through the Swan Catchment Council and by the Swan River Trust through the Swan-Canning Cleanup Program.

Australian Government

Greening Australia Western Australia

HELP KEEP OUR RIVERS HEALTHY

PREFACE

Geraldton Carnation Weed, or *Euphorbia terracina*, is a highly invasive and an increasingly problematic environmental weed of southwestern Australia. This document is the proceedings of a forum on *E. terracina* conducted by the Urban Nature, Department of Environment and Conservation, in conjunction with the Skills for Nature Conservation training program.

The aim is for participants to gain an understanding of the biology, ecology, distribution and management of this weed and gain insight into why it poses such a serious threat to biodiversity. The program includes case studies, current research into biocontrol and community and government experiences in managing invasions.

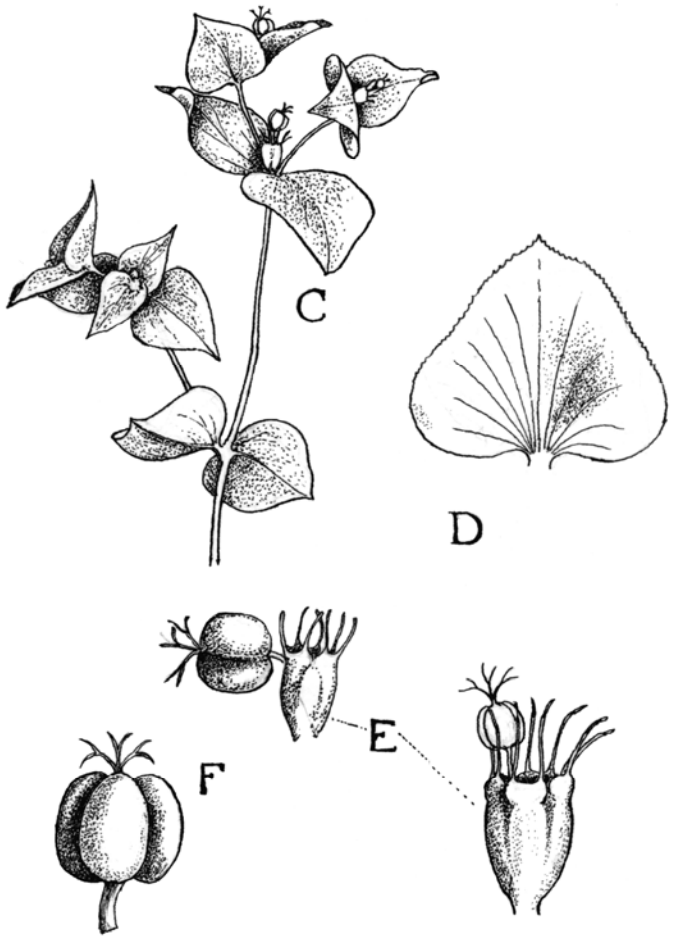
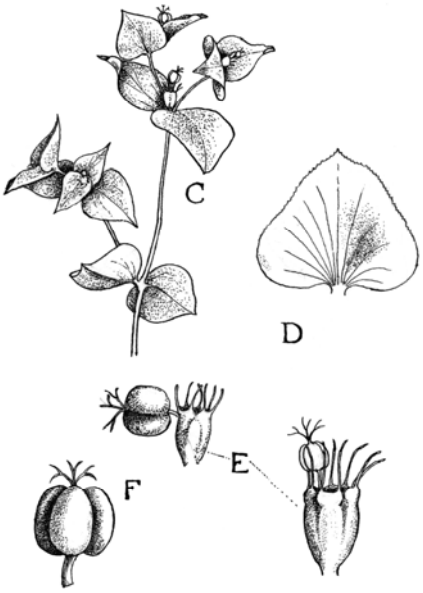


Illustration: C.A. Gardner, from Meadly, G.R.W. (1965) Weeds of Western Australia, Department of Agriculture, Western Australia.

Skills for Nature Conservation

Geraldton Carnation Weed (*Euphorbia terracina*) Field Day and Workshop

Thursday 21 June 2007
9:00 am – 4:00 pm
Naragebup Environmental Centre
Safety Bay Road, Peron



Geraldton Carnation Weed, or *Euphorbia terracina*, is a highly invasive and an increasingly problematic environmental weed of southwestern Australia.

This field day and workshop presented by the Department of Environment and Conservation (DEC) will allow participants to gain an understanding of the biology, ecology, distribution and management of this weed and gain insight into why it poses such a serious threat to biodiversity.

The program will include case studies, current research into biocontrol and community and government experiences in managing invasions. It will feature a series of field visits to sites in the Rockingham region, including Port Kennedy and Paganoni Swamp.

Speakers and topics include:

- Greg Keighery (DEC) – Biology and weed risk
- Kate Brown (Urban Nature, DEC) – Herbicide control and case studies in management
- Friends of Point Peron – A new approach to tackling invasions
- Friends of Rockingham Lakes (Paganoni) – Cooperative management
- Renee Miles (Regional Parks, DEC) – Case studies
- John Scott (CSIRO) – Biocontrol of Euphorbias
- Karen Bettink (Swan Region, DEC) - Strategic planning

For information or to regiser contact the Department of Environment and Conservation's Swan Region on 9423 2924 or email joanne.gomersall@dec.wa.gov.au.

Registrations essential by 11 June, 2007.

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Department of Environment and Conservation

HELP KEEP OUR RIVERS HEALTHY

Skills for Nature Conservation
Geraldton Carnation Weed (*Euphorbia terracina*)
Field Day and Workshop

Thursday 21 June **Naragebup Regional Environmental Centre**		
9.00 – 9.15	**WELCOME – Introduction and background**	Greg Keighery, Science Division, DEC.
9.15 – 9.45	Biology and weed risk	Greg and Bronwen Keighery, Science Division and Strategic Policy, DEC.
9.45 – 10.15	Herbicide control and case studies in management	Kate Brown, Urban Nature, DEC.
10.15 – 10.25	MORNING TEA	
10.25 – 10.55	Community and Regional Parks experience	Renee Miles, Regional Parks, DEC.
10.55 – 11.00	Board Coach	
11.15--1.00	Field Trip Lake Coolongup Paganoni Swamp	*Greg Keighery* Science Division, DEC*, Kate Brown and Karen Bettink* Urban Nature, DEC. *Renee Miles* Regional Parks DEC*, Leonie Stubbs* Friends of Paganoni
1.00 – 1.30	LUNCH – Paganoni Swamp	
1.30 – 2.15	Point Becher, Port Kennedy Scientific Park	All
2.45 – 3.00	Afternoon Tea	
3.00 – 3.40	Bio-control and Euphorbia terracina	John Scott (CSIRO).
3.40 – 4.00	Strategic Planning	Karen Bettink, Urban Nature,DEC.
4.00	Close – Please return name badges and completed evaluation sheets.	

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BIOLOGY AND WEED RISK OF *EUPHORBIA TERRACINA* IN WESTERN AUSTRALIA

Greg Keighery[1] and Bronwen Keighery[2]

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Background

The Euphorbiaceae are a large cosmopolitan family of flowering plants. Western Australia has 166 species of native Euphorbiaceae and 21 weeds. The family is mainly tropical and desertic (70 species occur in the Kimberley). Of these species, 29 natives and 16 weeds are from the genus *Euphorbia.* The weedy members of *Euphorbia* are: *E. australis* (in part), *E. cyathophora* (painted Spurge), *E. dendroides* (Tree Spurge), *E. drummondii* subsp. *drummondii* (in part), *E. helioscopia* (Sun Spurge), *E. heterophylla* (Mole Plant), *E. hirta* (Asthma Plant), *E. hyssopifolia*, *E. lathyrus* (Caper Spurge), *E. maculata* (Eyebane), *E. marginata* (Snow on the Mountain), *E. paralias* (Sea Spurge), *E. peplus* (Petty Spurge), *E. segetalis* (Short Stem Carnation Weed), *E. terracina* (Geraldton Carnation Weed) and *E. tirucalli* (Finger Tree).

Euphorbia hirta, *E. paralias*, *Euphorbia peplus* and *E. terracina* are major widespread environmental weeds. While *Euphorbia helioscopia* and *E. segetalis* are localised serious weeds. *Euphorbia paralias*, which is spreading rapidly and regarded as potentially a serious weed in Eastern Australia is also spreading up the coast of Western Australia (Keighery and Dodd, 1997. This spread has occurred largely by boats and has reached the Moore River and is likely to continue to Geraldton.

This paper updates the one presented on *Euphorbia terracina* in 2000 (Keighery and Keighery, 2000).

Biology

The species is a short-lived perennial herb with succulent erect branches growing to a metre in height from a basal woody stem. In summer most leaves are lost and many of the stems die back to the base, with new stems produced after autumn rains. Plants are killed by fire and reproduce by soil-stored seed. Like many species in the genus plants contain a toxic white milky sap which is present in the leaves and stems of the plant. This sap provides a defense against grazing and helps reduce water loss by lowering the potential loss of water through evaporation since it is bound in the sap. The toxic sap also deters native herbivores like kangaroos and tammars that are not used to these chemicals and this defense mechanism aids in the invasion of *E. terracina* into bushland.

Flowering occurs in spring from August to November in Western Australia, Flowers are inconspicuous and lack petals, but are displayed in a large compound head composed of small inflorescences (called cyathia). These cyathia are composed of several male and

one female flower enclosed by five fused bracts forming a cup shape. Nectary glands are found at the junctions of the bracts. The whole inflorescence also has large green – yellow leafy bracts at the base adding to the visual attraction. The flowers are visited by a wide range of small to medium sized insects (native and European honey bees, flies and wasps) that collect nectar or pollen and hence transfer pollen.

The flowers are male or female but considerable pollen is spread from the male flowers and since the female flower hangs over the male flowers, pollen easily falls on the stigmas of female flowers in the same cyathia. Seed set occurs on isolated plants. The plant is therefore, a generalist insect pollinated species that out-breeds but is also capable of self-pollination.

The ripe fruit contains 3 sections each with a single hard seed, 3-5 mm long with an oily white aril. Local dispersal is by seeds being scattered by the fruit opening explosively, and then the seed being gathered by ants (who eat the aril). This results in dense clumps being observed germinating from ant seed caches. Laughing Turtle Doves have also been observed feeding on the seeds in Cottesloe (Friends of Allen Park, 2007). Long distance dispersal is along roads in road making materials. Isolated populations of *Euphorbia terracina* are found along most major roads throughout southern Western Australia.

Natural distribution

Euphorbia terracina occurs naturally on rocky and stony coastal areas, dunes, along pathways and amongst ruins from the Canary Islands in the Atlantic, around the Mediterranean Sea coast and islands, on the north of the Red Sea coast and the Black Sea to Georgia. The species is naturally weedy and occurs in a range of climates some not unlike southern Western Australia.

Distribution in Australia

In Australia *Euphorbia terracina* is found in southern Western Australia, South Australia, Victoria and New South Wales. It is a declared plant in Western Australia and South Australia. Serious levels of infestation are recorded in SE South Australia (Government of South Australia, 2007).

Euphorbia terracina is not recorded as a weed, apart from Australia.

Western Australia

In Western Australia *Euphorbia terracina* is found from north of Geraldton to Esperance (Table 1). It was noted as common around Geraldton by the Danish Botanist, C.H. Ostenfeld in 1914, although the first herbarium record is from Geraldton in 1919. The reason for introduction is uncertain but many species of *Euphorbia* are used as ornamentals.

The majority of populations are found from Geraldton to Perth, with an isolated area around Esperance. The species prefers sandy calcareous soils, but Parsons and Cuthbertson (1992) note that in eastern Australia the species has spread onto fertile and inland soils and may well do the same here.

Populations of *Euphorbia terracina* are normally found on pastures, wasteland, road-verges, paths and firebreaks. Entry into bushland seems to be via disturbance by grazing or fire, however, once established within a bushland area *Euphorbia terracina* can aggressively expand into natural bushland.

Keighery and Keighery (2001) recorded the weed as present in 19 nature reserves and national parks in Western Australia (Table 2), no doubt more could be added. It has also been recorded in at least 17 other bushland areas on the Swan Coastal Plain (Table 3). It is one of the major weeds of Tuart woodlands in the region, being found in every Tuart reserve on the plain. Invasion appears greatly enhanced by past (and present) grazing, fire and soil disturbance. This species, once established, is able to invade relatively undisturbed coastal heath, and is one of the few weeds able to do this.

Current and future actions

Euphorbia terracina has been spreading slowly south and east over the past 60 years, being introduced to Esperance before 1944. Currently it appears to be increasing on roadsides and highways as the use of earth moving equipment and soil relocation has increased. There seems no doubt that it will spread further over the next 50 years. This species should be **preferentially eradicated on road verges** to help limit its spread and a public awareness and lobbying campaign may help raise awareness of the weed in transport circles.

The species has, for example recently turned up on Garden Island, introduced in soil from the adjacent mainland. This highly toxic species could easily spread throughout the island, like Arum Lily has, and needs eradication.

There are few records of this weed between Busselton and Esperance. Efforts are being directed to reducing the spread of this species between Bunbury and Cape Naturaliste (A. Webb, pers. comm. 2007). The area between Bunbury and Augusta and Albany to Bremer Bay should be a focus to contain spread.

Habitats at risk from this weed were identified in Keighery and Keighery 2001, and include offshore islands and calcareous communities throughout southern Western Australia. Several of these communities such as the *Callitris preissii* forest on Garden Island and the Muchea limestone communities that are already listed as threatened ecological communities (TEC's) plus any occurrences of this weed near them should be eradicated.

Major actions required are to limit spread between Bunbury and Augusta, Albany to Bremer Bay, eradicate outliers on Garden Island and to manage infestations in areas of high significance, such as TEC's.

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Government of South Australia (2007). http://www.dwlbc.sa.gov.au/assets/files/ibsap-false-caper.pdf (accessed June 2007).

Keighery, G.J. and Dodd, J. (1997). Occurrence and spread of Sea Spurge (*Euphorbia paralias*) along the West Coast of Western Australia. *Nuytsia* **11**: 285-286.

Keighery, B. and Keighery, G. (2000). Biology and weed risk of *Euphorbia terracina* in Western Australia. **In**: *Euphorbia terracina (Geraldton Carnation Weed or Spurge). A guide to its biology and control and associated safety issues*. Proceedings of a workshop conducted by the Environmental Weeds Action Network, October 2000. Environmental Weeds Action Network, Greenwood, WA.

Parsons, W.T. and Cuthbertson, E.G. (1992). *Noxious Weeds of Australia*. Inkata Press, Melbourne.

Table 1: Plant communities invaded by *Euphorbia terracina.*

Coastal Dune Heath
Limestone Heath
Acacia Shrubland
Tuart Woodland
Banksia Woodland
Ephemeral Wetlands

From Keighery and Keighery (2000).

Table 2: Nature Reserves and National Parks with *Euphorbia terracina* present.

Utcha Swamp Nature Reserve (80 kms n geraldton)
Beekeepers Nature Reserve
Nambung National Park
Nilgen Nature Reserve
Yanchep National Park
Neerabup National Park
Melaleuca Park
Woodvale Nature Reserve
Alfred Cove Nature Reserve
Forrestdale Lake Nature Reserve
Leda Nature Reserve
Woodmans Point Nature Reserve
Yalgorup National Park
Crampton Nature Reserve
Leschenault Conservation Park
Tuart forest National Park
Leeuwin Naturaliste National Park
Lake Warden Nature Reserve (Esperance)
Mullet Lake Nature Reserve (Esperance)

From Keighery and Keighery (2000).

Table 3: Regional Parks and Bushlands invaded *by Euphorbia terracina***.**

Seabird Bushland
Gnangarra Regional Park
Yellagonga Regional Park
Hepburn Heights
Star Swamp
Trigg Dunes
Warwick Open Space
Bold Park
Shenton Bushland
Blackwell Reach
Cantonment Hill
Sir Frederick Sampson Park
Yagan Reserve
Beeliar Regional Park (Manning Lake, Spectacles, Market Garden Swamp, Lake Coogee, Mt Brown area).
Rockingham Lakes Regional Park (Point Peron, Lake Richmond, Lakes Coolongoolup/Walyungup, Anstey and Paganoni Swamps)
Garden Island
Becher Scientific Reserve (Port Kennedy)

From Keighery and Keighery (2000).

Table 4: Areas at risk from *Euphorbia terracina* spread

Offshore Islands between Shark Bay and Augusta
Reserves along the Swan River
Coastal reserves between Shark Bay and Israelite Bay
Muchea Limestone communities
Wheatbelt woodlands/communities on calcareous clay

From Keighery and Keighery (2000).

GERALDTON CARNATION WEED; MANAGING INVASION INTO A THREATENED ECOLOGICAL COMMUNITY, THE HOLOCENE DUNE SWALES AT POINT BECHER

Kate Brown[1] and Julia Cullity[2]

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There is little published information on effective herbicide control of Geraldton Carnation Weed (*Euphorbia terracina*) where it is invading native plant communities. The present herbicide recommendations for southwest Australia include hand removal of adult plants and spraying of smaller plants and seedlings with Brushoff® (metsulfuron methyl) (2.5-5g/hectare). The recommendations come from Brown and Brooks 2002, and are based on work carried out over a number of years in the bushland at Kings Park (Dixon 2000). Brushoff® (metsulfuron methyl) has been reported to be ineffective on adult plants. With large infestations on the scale that can be found in some of our coastal bushlands including the Rockingham Lakes Regional Park and Burns Beach Bushland**,** hand removal of adults is often an impractical and expensive option. Hand removal is also hazardous due to a caustic sap that is released when plants are physically damaged.

In recent years Geraldton Carnation Weed has been recognized as a serious environmental weed in parts of North America including Pennsylvania and Southern California (Brigham 2006). Workers there have found RoundUp® (glyphosate) to be fairly effective on monotypic stands of Geraldton Carnation Weed. RoundUp® is non selective however, and its use not appropriate where Geraldton Carnation Weed is invading native plant communities. These workers have also found that without follow up treatment infestations returned to pre-treatment levels within 3 years (Brigham 2006).

In 2004 a study into alternative control techniques for Geraldton Carnation Weed was initiated as part of a project involving the restoration of the threatened ecological community occurring at Point Becher in the Rockingham Lakes Regional Park. The area, immediately south of Rockingham, consists of a series of Holocene (less than 10,000 year old) sand dunes running parallel to the coast. This landform has been largely cleared for development and the wetland plant community that occurs in the dune swales is now considered threatened (Figure 1). One of the most significant threats is invasion by Geraldton Carnation Weed.

Preliminary trials were established at the site to screen a series of herbicides at various rates for effectiveness on Geraldton Carnation Weed and impacts on co-occurring native species. Herbicides screened included Glean® (chlorsulfuron), Brushoff® (metsulfuron methyl), Broadstrike® (flumetsulam), Eclipse® (metosulam), and Logran® (triasulfuron). The most effective against Geraldton Carnation Weed, Logran® at a rate of 12.5 g/100L, appeared to have little impact on native species occurring at the site.

In 2005 a full scale trial of Logran® at 12.5g/100L was established in the threatened ecological community. Five 50m transects were run across a population of Geraldton Carnation Weed invading one of the dune swales and cover of individual plant species (natives and weeds) were measured along each transect in June 2005 and the site treated (Figure 2). Plant species cover was re-measured along transects in June 2006. The site was treated again in 2006 and will be re-measured in 2007.

A significant difference in species composition and cover was found between 2005 and 2006 (Table 1). Geraldton Carnation Weed decreased from an average of 19.2 % in 2005 to 1.1% in 2006. In contrast two natives, the sedges *Ficinia nodosa* and the rush *Baumea juncea*, increased in cover as did bare ground across the site. *Ficinia nodosa* increased from 35.8% in 2005 to 48% in 2006 and *Baumea juncea* from 48.5% to 60.6% while bare ground increased from 2.0% to 8.2% (Table 1).

The results are encouraging. Logran® has clearly been effective on Geraldton Carnation Weed and there has been an increase in native plant cover at the site since the weed has been controlled. However there are only 2 years of data and some of these changes may be related to seasonal conditions. In addition the dune swales at Point Becher have a relatively simple flora (Table 2) and these results have limited relevance to plant communities with a more complex flora such as coastal heathlands on limestone and some of our Banksia woodlands.

Finding an appropriate herbicide to control Geraldton Carnation Weed is only one part of the answer. Understanding the invasion process is also a crucial factor in the successful management of Geraldton Carnation Weed.

Observations in southwest Western Australia suggest that fire plays a major role in facilitating the spread of Geraldton Carnation Weed into bushland. Many adults re-sprout from woody stem bases and massive seedling recruitment occurs in the post fire environment. Californian workers also observed that fire has played a major role in the invasion process with stands of mixed coastal sage scrub, native grass with scattered Geraldton Carnation Weed going to a dominant stand of Geraldton Carnation Weed following a single fire event (Brigham 2006). These observations indicate that control of populations in the growing season following fire is integral to successful management of Geraldton Carnation Weed.

References and further reading

Brigham, E.D. (2006). www.cal-ipc.org/symposia/archive/pdf/2006/EDBrigham.pdf (accessed June 2007).

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Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M.N. (1994). *A floristic survey of the southern Swan Coastal Plain.* Report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc).

Acknowledgements

Thanks to John Moore for providing advice and herbicides for the preliminary trials.

Table 1: Average changes in cover of weed and native flora at Point Becher before and after treatment with Logran® * = weed

Species	**Average Abundance 2005** (Before treatment)	**Average Abundance 2006** (After treatment)
***Geraldton Carnation Weed** (*Euphorbia terracina*)	**19.2%**	**1.1%**
Twig Rush (*Baumea juncea*)	**48.5%**	**60.6%**
Knotted Club Rush *Ficinia nodosa*	**35.8%**	**48.0%**
***Rye Grass** *Lolium sp. Port Kennedy*	**20.68%**	**11.3%**
***Hare's tail Grass** *Lagurus ovatus*	**20.0%**	**18.3%**
***Guildford Grass** *Romulea rosea*	**10.0%**	**4.0%**
Bare ground	**0.2%**	**8.2%**
***Annual Veldt Grass** *Ehrharta longiflora*	**0.0**	**3.3%**

Table 2: Typical native flora of the sedgelands in Holocene dune swales at Point Becher

Family	Genus	Species
Apiaceae	*Daucus*	*glochidiatus*
Cyperaceae	*Baumea*	*juncea*
Cyperaceae	*Isolepis*	*cernua*
Cyperaceae	*Ficinia*	*nodosa*
Cyperaceae	*Lepidosperma*	*"coastal terete" scps (BJK&NG 231)*
Dasypogonaceae	*Lomandra*	*maritima*
Epacridaceae	*Leucopogon*	*australis*
Epacridaceae	*Leucopogon*	*parviflorus*
Geraniaceae	*Geranium*	*retrorsum*
Geraniaceae	*Pelargonium*	*littorale*
Juncaceae	*Juncus*	*kraussii*
Lobeliaceae	*Lobelia*	*alata*
Loganiaceae	*Logania*	*vaginalis*
Mimosaceae	*Acacia*	*lasiocalyx*
Mimosaceae	*Acacia*	*rostellifera*
Mimosaceae	*Acacia*	*saligna*
Onagraceae	*Epilobium*	*billardierianum*
Papilionaceae	*Kennedia*	*prostrata*
Poaceae	*Poa*	*porphyroclados*
Poaceae	*Sporobolus*	*virginicus*
Poaceae	*Stipa*	*flavescens*
Polygonaceae	*Muehlenbeckia*	*adpressa*
Proteaceae	*Banksia*	*littoralis*
Proteaceae	*Hakea*	*prostrata*
Restionaceae	*Loxocarya*	*pubescens*
Rubiaceae	*Opercularia*	*vaginata*
Stackhousiaceae	*Stackhousia*	*monogyna*
Xanthorrhoeaceae	*Xanthorrhoea*	*preissii*

From Gibson *et al*. (1994).

Figure 1: An example of the Threatened Ecological Community - Sedgelands in Holocene dune swales at Point Becher. Photograph-Kate Brown

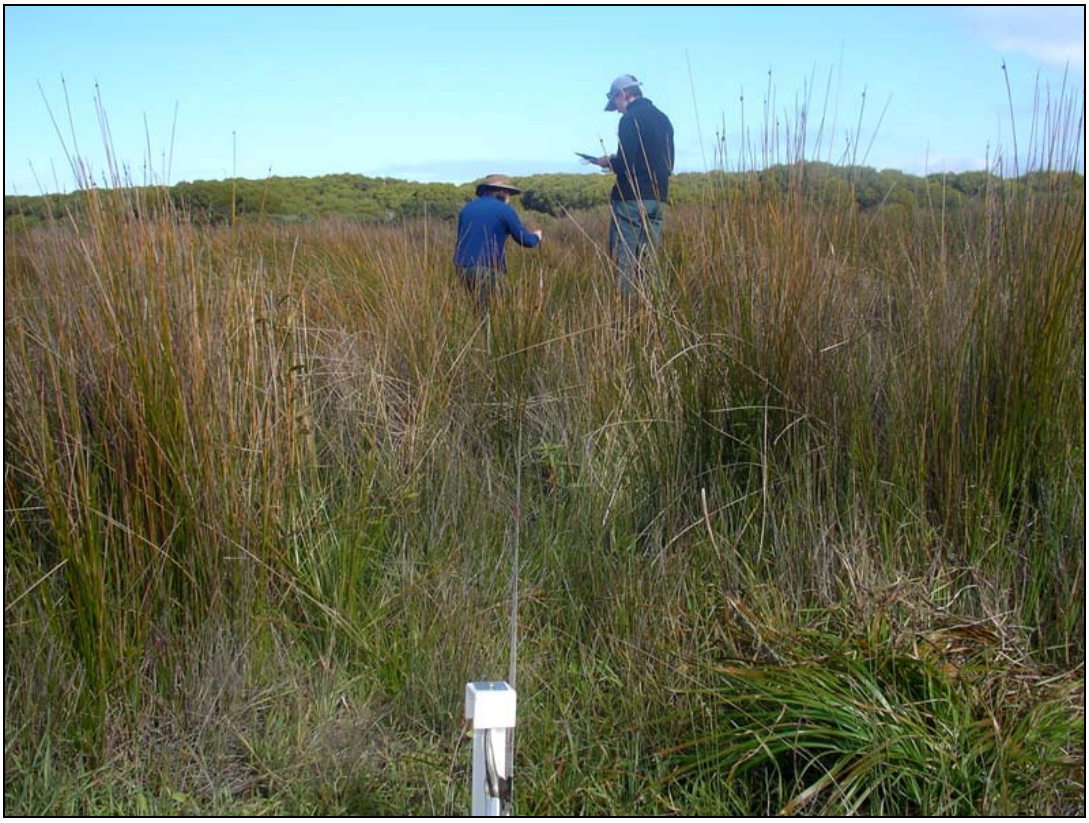

Figure 2: Five 50m transects were run across the dune swale before treatment and cover of all species (native and weeds) recorded. Photograph-Julia Cullity

From; Bushland News, issue 61, Autumn 2007, Department of Environment and Conservation.

BUSHLAND **WEED**WATCH:

Geraldton carnation weed

(*Euphorbia terracina*)

By Kate Brown (Bushland Management Advisor, Urban Nature)

GERALDTON carnation weed or false spurge (*Euphorbia terracina*) is recorded to have been naturalised around Geraldton as early as 1914. Today it invades coastal heaths, wetlands and woodlands on calcareous soils from Geraldton to Cape Arid. With the ability to invade undisturbed vegetation, form dense monocultures and displace native flora, the weed poses a serious threat to remnant bushland on the Swan Coastal Plain and beyond.

Interesting biology

- Geraldton carnation weed is a short-lived perennial herb, growing to one metre.
- It dies back to a woody base over summer, producing new stems with autumn rains.
- Its peak flowering time is during August and September.
- Seedlings can mature within a few months, small plants flower and set seed any time following rain.
- A flush of germination follows autumn rain and any other heavy rain throughout the year.
- The hard-coated seed (three per fruit) are three to five millimetres long with a white, oily aril.
- Seed is scattered by the explosive action of dehiscing fruit and are dispersed by birds, ants and water flow.
- Long-distance dispersal occurs with soil movement, particularly crushed limestone into bushland for track construction.
- Seed may remain viable in the soil for up to five years.
- Following fire many plants will re-sprout from woody bases.
- Fire provides optimal conditions for germination and the establishment of new populations.

Implications for management

- Herbicide control is most effective on mature plants just before flowering, usually in July but depending on seasonal conditions.
- The current year's seedlings can be controlled at the same time.
- If heavy rains initiate a flush of germination, a second or third control later in the season is necessary.
- Intensive management following fire activity is effective at controlling and preventing the spread of populations. Re-sprouting plants are accessible and receptive to herbicide, and massive numbers of seedlings are easily targeted in the reduced native vegetation cover.

Suggested control methods

Physical control

Care must be taken to minimise soil disturbance when physically removing plants. Plants re-sprout from base or root material left in the soil, so the entire plant must be removed. Plants left lying on the soil surface can go on to produce seed, so all material should be carefully removed from the site.

WARNING
Contact with the sap of *E. terracina* can cause painful inflammation of skin and temporary or permanent blindness. When undertaking physical control, safety glasses, gloves and protective clothing are essential.

Current herbicide control suggestions

Metsulfuron methyl (Brushoff®) at 0.1g in 15 litres of water + Pulse® (2mls/litre) is reasonably effective but may not always kill adult plants. Removing large adult plants from a population by hand followed by herbicide control of smaller plants and seedlings is often recommended.

References and further information

Brown, K and Brooks, K. (2002) *Bushland Weeds; A Practical Guide to Their Management*. Environmental Weeds Action Network, Greenwood WA.

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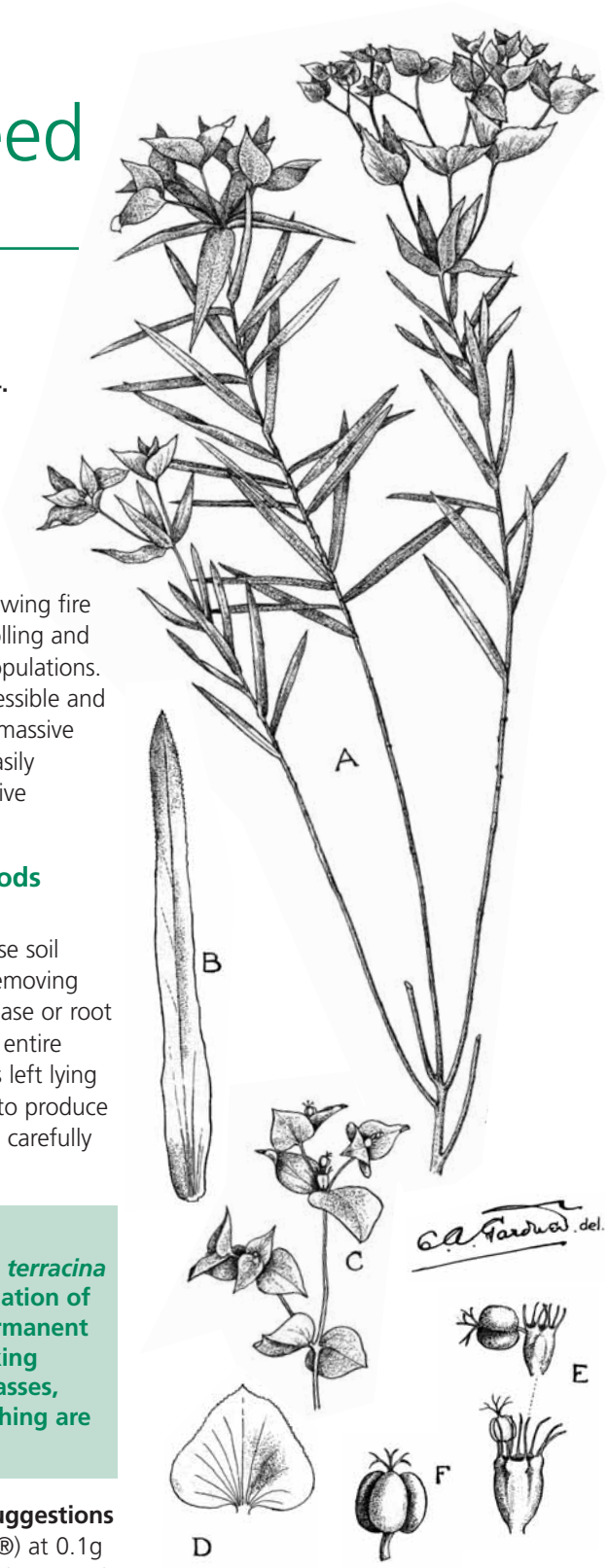

COMMUNITY EXPERIENCE

Renee Miles

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Community involvement in the Regional Parks
One of the objectives of regional park management plans is to encourage as much community involvement in managing the parks as possible. Volunteers and community groups play an important role in helping DEC to implement management plans and to implement on-ground works with the available resources.

Within Rockingham Lakes Regional Park in particular, the Friends groups and volunteers are involved in:

- planning projects and works within the parks;
- obtaining funding for projects and on-ground works;
- conducting a number of on-ground programs including weed control;
- taking part in research based projects and monitoring; and
- meeting with DEC, having input and obtaining feedback regarding management of the parks.

Adopt-a-Patch Point Peron
Adopt-a-Patch Point Peron is an initiative of the Friends of Point Peron to encourage the community to adopt sections of Point Peron, and assist DEC by hand removing the serious environmental weed *Euphorbia terracina* (Geraldton Carnation Weed). This weed is invading coastal plant communities at an alarming rate, and this program focuses on encouraging the local community to get into Rockingham Lakes Regional Park, stay fit and help with this conservation initiative.

Structure of the Program
Site selection is based on:

- the distribution of *Euphorbia terracina* across the Point Peron site;
- areas where Friends members are walking or recreating; and
- areas where weed control or rehabilitation is taking place currently.

- Training was provided through two community briefings that were held with members to educate them on
    - biology of the weed;
    - distribution around Point Peron;
    - impacts on native vegetation;
    - correct hand weeding procedures;
    - collection of weeds; and

- monitoring and follow-up.

Larger groups are now making contact with DEC and the Friends group regarding this program and are keen to adopt large sections of the park. The program assists DEC by:

- reducing the spread of *Euphorbia terracina* across the site;
- encouraging education about weed control and conservation; and
- enabling DEC to target spray programs more effectively, and to coordinate hand-weeding activities with works currently taking place.

Paganoni Swamp

The Friends of Paganoni have been working for the last 3-4 years on controlling and monitoring the population of *Euphorbia terracina* at Paganoni Swamp. The Urban Nature Program has mapped the weed's distribution and established monitoring sites within the weed-invaded areas of the swamp to asses effectiveness of control. Regional Parks has provided assistance with equipment and information and has linked with the Friends group and DEC's Urban Nature program by:

- conducting meetings at the commencement of every year with the Friends and Urban Nature to plan monitoring days and control programs;
- organising and implementing control programs; and
- assisting with applications for additional funding.

School involvement

A number of schools are now approaching DEC and offering community work of 20 hours per student within the parks network as part of the students' studies. At present, Safety Bay High School is working on projects within the parks. These projects focus on pruning, hand weeding and erosion control and will focus on planting and restoration works in the future. Hand-weeding of *Euphorbia terracina* is a task scheduled for these groups in the coming months, with the outcomes being a more strategic and holistic approach to managing this weed issue across the parks network.

Regional Park Strategy

Weed control across the park is done in a strategic way to ensure that:

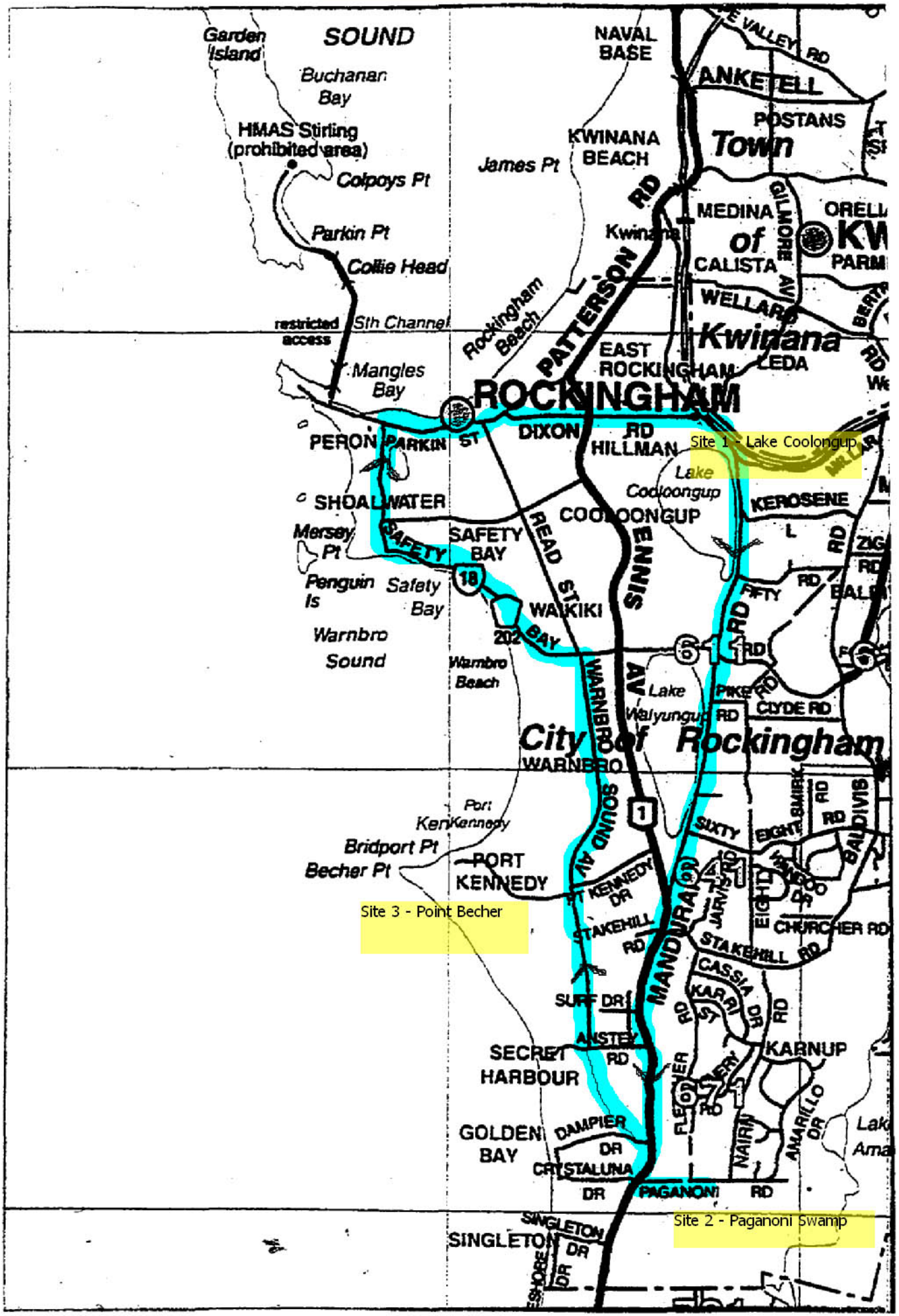
- good areas of bushland are protected;
- serious environmental weeds are targeted;
- small infestations of weeds are dealt with to prevent them from becoming larger issues; and
- maximum result is obtained for every investment.

Investment into weed control is prioritised at the whole scale Regional Park scale as well as a site by site level.

For example, *Euphorbia terracina* control was given priority at Paganoni Swamp because:

- Paganoni Swamp is the best condition bushland within the Rockingham Lakes Regional Parks;
- spread of this weed is limited to the edges; and
- only short-medium term effort is required to get this weed under control.

Field trip route and site locations



LAKE COOLOONGUP, LAKE WALYUNGUP AND ADJACENT BUSHLAND, HILLMAN TO PORT KENNEDY

Boundary Definition: protected area/bushland (part taken to cadastre) boundary (Areas of bushland within the boundaries of the Site are not accurately mapped.)

SECTION 1: LOCATION INFORMATION

Bush Forever Site no. 356 **Area (ha):** bushland 1617.5 (Site also includes open water.)

Map no. 69, 70, 74, 75 **Map sheet series ref. no.** 2033–II NW, 2033–II SW

Other Names: White Lake, Salt Lake, Lark Hill, Tamworth Hill, part of Rockingham Lakes Regional Park

Local Authorities (Suburb): Shire of Rockingham (Hillman, Cooloongup, Waikiki, Warnbro, Port Kennedy, Baldivis)

System 6 (1983): M103 area of bushland goes beyond System area boundaries, all bushland described

SECTION 2: REGIONAL INFORMATION

LANDFORMS AND SOILS

Bassendean Dunes

Bassendean Sands (Qpb: S8)

Spearwood Dunes

Sands derived from Tamala Limestone (Qts: S7)

Tamala Limestone (Qtl: LS1)

Quindalup Dunes (Holocene dunes)

Safety Bay Sands (Qhs: S13, LS4)

Wetlands (within the Quindalup/Spearwood Dunes)

Holocene Swamp Deposits (Qhw: Cps, Cs1)

Lagoonal and Estuarine Deposits (at or near interface of Quindalup/Spearwood Dunes)

Lagoonal and Estuarine Deposits (Vasse) (Qhg: M5)

VEGETATION AND FLORA

Vegetation Complexes

Spearwood Dunes

Karrakatta Complex — Central and South

Cottesloe Complex — Central and South

Quindalup Dunes

Quindalup Complex

Floristic Community Types: *not sampled, types inferred

Supergroup 2: Seasonal Wetlands

17 *Melaleuca rhaphiophylla — Gahnia trifida* seasonal wetlands

*19a Sedgelands in Holocene dune swales (DEP 1996, equivalent to 19 in Gibson *et al.* 1994, English and Blyth 1997)

19b Woodlands over sedgelands in Holocene dune swales (DEP 1996, equivalent to 19 in Gibson *et al.* 1994, English and Blyth 1997)

Supergroup 3: Uplands centred on Bassendean Dunes and Dandaragan Plateau

21a Central *Banksia attenuata — Eucalyptus marginata* woodlands

Supergroup 4: Uplands centred on Spearwood and Quindalup Dunes

24 Northern Spearwood shrublands and woodlands (most southern occurrence)

*29b *Acacia* shrublands on taller dunes

WETLANDS

Wetland Types: lake, sumpland, dampland, artificial lake

Natural Wetland Groups

Spearwood Dunes

Stakehill (S.4)

Quindalup

Cooloongup (Qu.1)

Becher (Qu.2)

Wetland Management Objectives: Conservation (1462.3ha)

Swan Coastal Plain Lakes EPP: 312.8ha + 24.2ha + 438.6ha + 48.8ha = 824.4ha (total)

THREATENED ECOLOGICAL COMMUNITIES
Not assessed, Critically Endangered (floristic community type 19 as defined by Gibson *et al.* 1994)

SECTION 3: SPECIFIC SITE DETAIL

Landscape Features: open water, vegetated wetlands, vegetated uplands
Vegetation and Flora: detailed survey (part Site — Keighery, BJ, *et al.* 1997c, Tingay and Tingay 1977); limited survey (DEP 1999, EPA and WAWA 1990, Gibson *et al.* 1994 (Tam 01, Cool 01–04, 08–09, 11, Kero 01–02), Keighery, GJ, 1996 D (Cool 14–15))

Structural Units: mapping (part Site — EPA and WAWA 1990, Keighery, BJ, *et al.* 1997c, Tingay and Tingay 1977)

Spearwood Dunes

Uplands — Sands derived from Tamala Limestone: *Banksia attenuata* and *B. menziesii* Low Woodland; *Eucalyptus gomphocephala*, *E. marginata* and *Banksia attenuata* Open Forest; *Grevillea vestita* Closed Heath; *Hibbertia hypericoides* Open Low Heath

Quindalup Dunes

Uplands — Beach ridge plain: *Eucalyptus gomphocephala* Woodland to Forest; *Acacia rostellifera* Tall Open Scrub; *Jacksonia furcellata* and *Acacia rostellifera* Shrubland; *Acacia saligna* Low Open Woodland to Low Woodland; *Xanthorrhoea preissii* Open Heath

Wetlands (at or near the interface of the Quindalup and Spearwood Dunes): Open to Closed Sedgelands dominated by *Baumea juncea*, *Gahnia trifida*, *Lepidosperma longitudinale*, *Juncus kraussii* or *Baumea vaginalis* or combinations of these; *Banksia littoralis* Low Woodland; *Melaleuca rhaphiophylla* Low Woodland to Forest; *Eucalyptus gomphocephala* Woodland to Forest

Wetlands — Beach ridge plain: *Isolepis nodosa* and *Baumea juncea* Closed to Open Sedgeland, generally with an overstorey of *Xanthorrhoea preissii*

Scattered Native Plants: *Eucalyptus gomphocephala* Woodland; *Acacia saligna* Low Woodland; *Xanthorrhoea preissii* Open Heath

Vegetation Condition: >60% Very Good to Pristine, <40% Good to Degraded, with areas of severe localised disturbance

Total Flora: 174 native taxa, 82 weed taxa (part Site — Keighery, BJ, *et al.* 1997c) (>85% of expected flora)

Significant Flora: Keighery, BJ, *et al.* 1997c — *Trachymene coerulea*, *T. pilosa* (distinct form found also at Rottnest Island), *Sonchus hydrophilus* (at risk), *Atriplex suberecta* (not previously recorded on the Swan Coastal Plain), *Linum marginale* (rarely recorded on Quindalup dunes), *Acacia pulchella* var. *goadbyi* (only known occurrence on the Swan Coastal Plain), *Eremophila glabra* subsp. *albicans*, *Jacksonia furcellata* (floriferous shrub form), *Kennedia coccinea* (becoming increasingly uncommon on the western margins of the Plain)

Fauna: multiple surveys for birds (73 species) (Tingay and Tingay 1977; RAOU 1996 D, 3 visits), limited survey for native mammals (2 species), reptiles (1 species), amphibians (3 species) and fish (1 species) (Tingay and Tingay 1977). Significant bird species: category 2 (6), category 3 (10), category 4 (5). Significant population of Black Swan. Significant mammal species: Western Brush Wallaby and Quenda (Friend 1996 D)

Linkage: adjacent bushland to the north (Site 349, across road), south, east and west (Site 377, across road); part of Greenways 83, 85, 86, 89, 122 (Tingay, Alan & Associates 1998a); part of a regionally significant contiguous bushland/wetland linkage (Part A, Map 7)

Other Special Attributes
Meets five of the six specific criteria for coastal reserves—

(i) Quindalup Dune types: beach ridge plain and older dunes
(ii) Continuing natural processes: 1079.4ha (837.4 bushland) of Quindalup Dunes extending to 8.8km inland (through Site 377 to coast)
(iv) Linkage: Quindalup/Spearwood Dunes (Tamala Limestone) interface
(v) Vegetation: five regional floristic groups, one of which is a threatened community
(vi) Habitats: see Fauna section above;

Part Site (Lake Cooloongup and Lake Walyungup) — wetland of 'national significance'; part Site (Tamworth Lakes) — wetland of 'regional significance' (Semeniuk, V&C Research Group 1991b); contains examples of microbialites, organo-sedimentary structures formed by microorganisms, the oldest life-form on earth (Tingay, Alan & Associates 1997); majority of Site included in Port Kennedy and Rockingham Parks proposal (Tingay, Alan & Associates 1997)

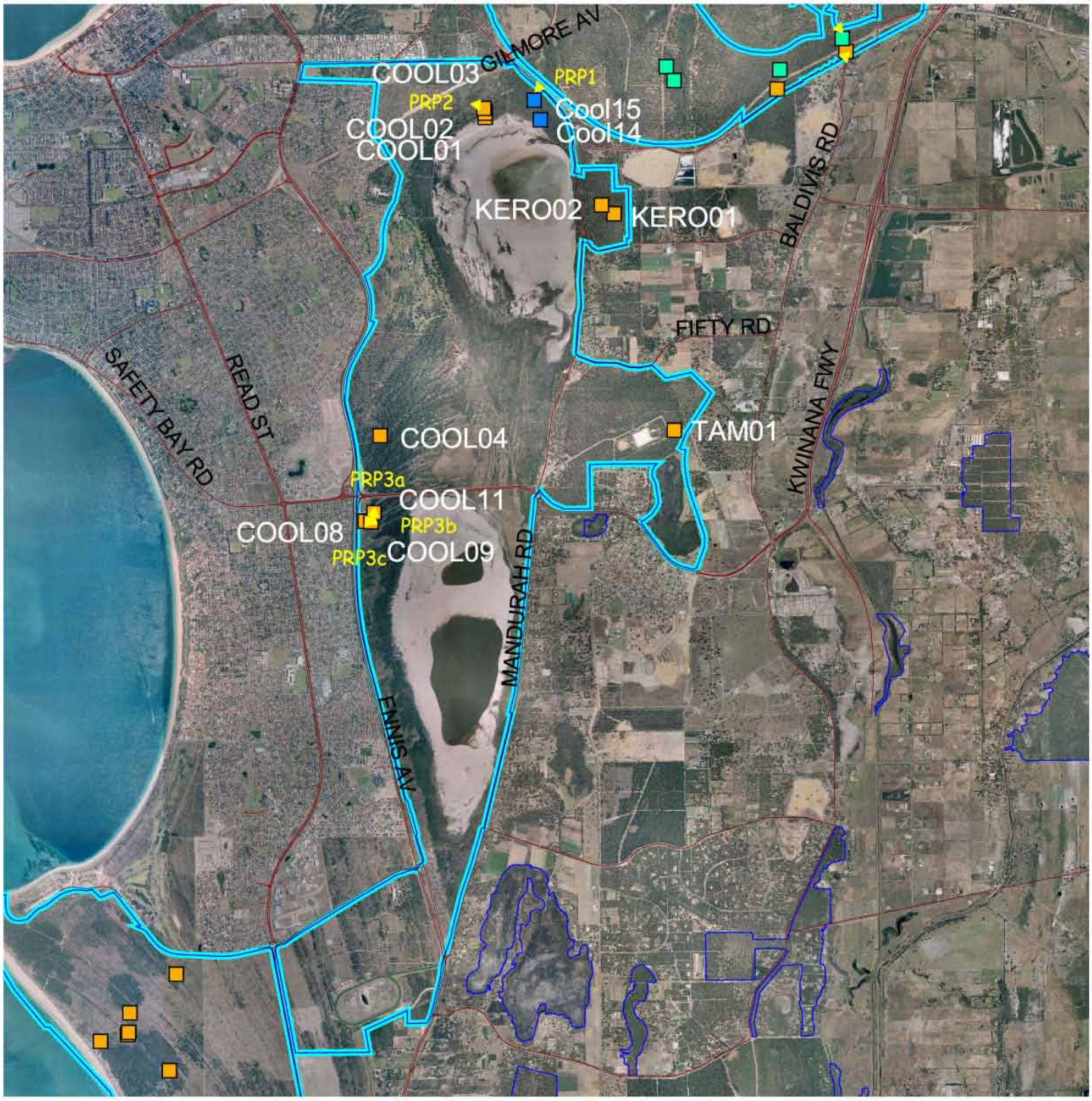
SECTION 4: INTERNATIONAL AND NATIONAL SIGNIFICANCE

Entered in the Register of the National Estate; location for JAMBA/CAMBA species; subject to protection under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

SECTION 5: SELECTION CRITERIA AND RECOMMENDATIONS

Criteria: Representation of ecological communities, Diversity, Rarity, Maintaining ecological processes or natural systems, Scientific or evolutionary importance, General criteria for the protection of wetland, streamline and estuarine fringing vegetation and coastal vegetation
Recommendation: Part A: Site with Some Existing Protection; the care, control and management of this Site for conservation purposes within Rockingham Lakes Regional Park is endorsed. Part B: Other Government Land Mechanism. Part C: Proposed Parks and Recreation Reservation (see Table 3, Volume 1).

Perth Region Plant Biodiversity Project
BFS 356: Lake Coolongup, Lake Walyungup and Adjacent Bushland, Hillman to Port Kennedy



Legend

- Photo Reference Point

Floristic Survey Sites of the Perth Metropolitan Region

- Keighery 1996
- Griffin 1993 & Weston et al. 1992
- Gibson et al. 1994
- DEP 1996
- Roads
- Bush Forever Sites
- Bush Forever Reference Sites

0 2 4 Kilometres

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Information derived from this map should be confirmed with the data custodian acknowledged by the agency acronym in the legend.
Prepared by: E Harris, May 2006

Name	Custodian	Date	Scale	+/-
Photo Reference Points	DoE/CALM/WALGA	2005	1:2,000	5m
Floristic Survey Sites	DoE/CALM	2005	1:5,000	100m
Bush Forever Sites	DPI	2002	1:25,000	NA
Bush Forever Reference Sites	DoE/CALM/WALGA	2005	1:25,000	NA

Department of Environment
Department of Conservation and Land Management
Perth Biodiversity Project
Western Australian Local Government Association

PAGANONI SWAMP AND ADJACENT BUSHLAND, KARNUP

Boundary Definition: protected area/bushland (part taken to cadastre) boundary (Boundary adjusted after vegetation survey and negotiations with land owner(s) in response to a submission to draft *Perth's Bushplan*.)

SECTION 1: LOCATION INFORMATION

Bush Forever Site no. 395 **Area (ha):** bushland 705.5 (Site also includes open water.)
Map no. 79, 80 **Map sheet series ref. no.** 2033–II SW
Other Names: part of Rockingham Lakes Regional Park, Submission Area 266 and Submission Area 151, Lot 1 cnr Paganoni and Mandurah Rds
Local Authorities (Suburb): City of Rockingham (Karnup)

SECTION 2: REGIONAL INFORMATION

LANDFORMS AND SOILS
Pinjarra Plain
Guildford Formation (Qha: Cp) (associated with Serpentine River)
Bassendean Dunes
Bassendean Sands (Qpb: S8)
Spearwood Dunes
Sands derived from Tamala Limestone (Qts: S7)
Tamala Limestone (Qtl: LS1)
Wetlands (within the Spearwood Dunes)
Holocene Swamp Deposits (Qhw: Scp, Cps)

VEGETATION AND FLORA
Vegetation Complexes
Spearwood Dunes
Karrakatta Complex — Central and South
Cottesloe Complex — Central and South
Wetlands
Herdsman Complex
Floristic Community Types: *not sampled, types inferred
Supergroup 2: Seasonal Wetlands
17 *Melaleuca rhaphiophylla — Gahnia trifida* seasonal wetlands
Supergroup 3: Uplands centred on Bassendean Dunes and Dandaragan Plateau
21a Central *Banksia attenuata — Eucalyptus marginata* woodlands
Supergroup 4: Uplands centred on Spearwood and Quindalup Dunes
*24 Northern Spearwood shrublands and woodlands
25 Southern *Eucalyptus gomphocephala — Agonis flexuosa* woodlands

WETLANDS
Wetland Types: sumpland, dampland
Natural Wetland Groups
Bassendean Dunes
Gnangara (B.2)
Spearwood Dunes
Stakehill (S.4)
Coastal Plain Rivers
Goegrup (R.4)
Wetland Management Objectives: Conservation (107.8ha)
Swan Coastal Plain Lakes EPP: 4.5ha + 9.6ha + 4.1ha + 0.3ha = 18.5ha (total)

THREATENED ECOLOGICAL COMMUNITIES
Not assessed

SECTION 3: SPECIFIC SITE DETAIL

Landscape Features: open water, vegetated uplands, dune crest, limestone ridge

Vegetation and Flora: limited survey (DEP roadside survey 1998, DEP 1999, Gibson *et al.* 1994 (Paga 01–08)); detailed survey (Keighery, GJ, 1996, Semeniuk, V&C Research Group 1991d, part Site — Tingay 1999c)

Structural Units: mapping (Semeniuk, V&C Research Group 1991d)

Uplands — Sands derived from Tamala Limestone: *Eucalyptus gomphocephala* Forest to Woodland; Woodlands dominated by *Banksia attenuata* with scattered emergent *Eucalyptus marginata* and *E. gomphocephala* mixed with varying proportions of *Banksia ilicifolia, B. grandis, B. menziesii, Allocasuarina fraseriana* and *Xylomelum occidentale*; *Eucalyptus decipiens* Shrub Mallee; Mixed Low Heaths with a variety of dominants such as *Melaleuca huegelii, Grevillea preissii* and *Hakea trifurcata*

Uplands — Tamala Limestone: Low heath dominated by *Olearia axillaris, Melaleuca systena, Acacia truncata, A. cyclops* and *A. saligna*

Wetlands: Woodlands to Forests dominated by *Eucalyptus rudis, E. calophylla* or *E. gomphocephala*; *Melaleuca preissiana, Banksia littoralis* and *Acacia saligna* Low Woodland; *Melaleuca rhaphiophylla* Low Forest; Closed Scrub to Open Scrub dominated by *Melaleuca teretifolia* or *M. viminea*; Closed to Open Heath dominated by *Pericalymma ellipticum* alone or in combination with *Hakea varia, Calothamnus lateralis* and *Aotus* species; *Astartea* aff. *fascicularis* Heath; Sedgelands dominated by *Lepidosperma longitudinale, Baumea articulata, B. juncea* or *Gahnia trifida*

Vegetation Condition: >75% Excellent to Very Good, <25% Good to Degraded

Total Flora: 305 native taxa, 45 weed taxa (Keighery, GJ, 1996, Semeniuk, V&C Research Group 1991d) (estimated >80% expected flora)

Significant Flora: *Lasiopetalum membranaceum* (2) (Tingay 1999), *Hibbertia spicata* subsp. *leptotheca* (3), *Acacia benthamii* (3) (Keighery, GJ, 1999), *Dillwynia dillwynioides* (3); *Jacksonia calcicola* (most southern
population), *Trachymene coerulea*, *Mesomelaena tetragona* (most western record, generally associated with eastern side of the Swan Coastal Plain), *Senecio ramosissimus* (one of two populations known in the PMR, Keighery, GJ, 1996), *Pterostylis* sp. cauline leaves (NG & ML 1490), *Pterostylis* sp. crinkled leaf (GJK 13426); typical Tamala Limestone taxa (DEP 1999 and Tingay 1999) — *Melaleuca huegelii Grevillea preissii, Trymalium ledifolium* subsp. *ledifolium, Diplopeltis huegelii* subsp. *huegelii, Eucalyptus foecunda, Jacksonia calcicola*

Fauna: Significant mammal species: Quenda (Friend 1996 D)

Linkage: adjacent bushland to the north (Site 379, across road), east (to Serpentine River) and west; part of Greenways 89, 123 (Tingay, Alan & Associates 1998a); part of a regionally significant contiguous bushland/wetland linkage (Part A, Map 7)

Other Special Attributes: Paganoni wetland is the largest in the Stakehill Suite; wetland of 'regional to international significance' (Semeniuk, V&C Research Group 1991e); majority of Site included in Port Kennedy and Rockingham Parks proposal (Tingay, Alan & Associates 1997b)

SECTION 4: INTERNATIONAL AND NATIONAL SIGNIFICANCE

Entered in the Interim List of the Register of the National Estate

SECTION 5: SELECTION CRITERIA AND RECOMMENDATIONS

Criteria: Representation of ecological communities, Diversity, Rarity, Maintaining ecological processes or natural systems, Scientific or evolutionary importance, General criteria for the protection of wetland, streamline and estuarine fringing and coastal vegetation

Recommendation: Part A: Site with Some Existing Protection; the care, control and management of this Site for conservation purposes within Rockingham Lakes Regional Park is endorsed. Part B: Urban Negotiated Planning Solution (see Table 3, Volume 1).

Perth Region Plant Biodiversity Project
BFS 395: Paganoni Swamp and Adjacent Bushland, Karnup

Legend

- Photo Reference Point

Floristic Survey Sites of the Perth Metropolitan Region

- Keighery 1996
- Griffin 1993 & Weston et al. 1992
- Gibson et al. 1994
- DEP 1996
- Roads
- Bush Forever Sites
- Bush Forever Reference Sites

0 500 1000 Metres

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Information derived from this map should be confirmed with the data custodian acknowledged by the agency acronym in the legend.
Prepared by: E Harris, April 2006

Name	Custodian	Date	Scale	+/-
Photo Reference Points	DoE/CALM/WALGA	2005	1:2,000	5m
Floristic Survey Sites	DoE/CALM	2005	1:5,000	100m
Bush Forever Sites	DPI	2002	1:25,000	NA
Bush Forever Reference Sites	DoE/CALM/WALGA	2005	1:25,000	NA

Department of Environment
Department of Conservation and Land Management
Perth Biodiversity Project
Western Australian Local Government Association

PORT KENNEDY

Boundary Definition: protected area/bushland (part taken to cadastre) boundary (Areas of bushland within the boundaries of the Site are not accurately mapped. The boundary has been drawn to include any unmapped bushland.)

SECTION 1: LOCATION INFORMATION

Bush Forever Site no. 377 **Area (ha):** bushland 674.9
Map no. 74, 79
Map sheet series ref. no. 2033–II SW, 2033–III NE, 2033–III SE
Other Names: Becher Point Wetlands, part of Port Kennedy and Rockingham Lakes Regional Parks
Local Authorities (Suburb): City of Rockingham (Port Kennedy, Secret Harbour)
Includes CALM Managed Land: Nature Reserve 44077 (Conservation of Flora and Fauna), 45041 (Conservation of Flora and Fauna)
System 6 (1983): Part M106 area of bushland goes beyond System area boundaries, only bushland described

SECTION 2: REGIONAL INFORMATION

LANDFORMS AND SOILS
Quindalup Dunes (Holocene dunes)
Safety Bay Sands (Qhs: S2, S13)
Wetlands (within the Quindalup Dunes)
Holocene Swamp Deposits (Qhw: Cps)

VEGETATION AND FLORA
Vegetation Complexes
Quindalup Dunes
Quindalup Complex
Floristic Community Types: *not sampled, types inferred
Supergroup 2: Seasonal Wetlands
19a Sedgelands in Holocene dune swales (DEP 1996, equivalent to 19 in Gibson *et al.* 1994, English and Blyth 1997)
Supergroup 4: Uplands centred on Spearwood and Quindalup Dunes
29b *Acacia* shrublands on taller dunes
*S13 Northern *Olearia axillaris* — *Scaevola crassifolia* shrublands
*S14 *Spinifex longifolius* grassland and low shrubland

WETLANDS
Wetland Types: dampland, sumpland
Natural Wetland Groups
Quindalup
Cooloongup (Qu.1)
Becher (Qu.2)
Peelhurst (Qu.3)
Wetland Management Objectives: Conservation (19.5ha)
Swan Coastal Plain Lakes EPP: none identified

THREATENED ECOLOGICAL COMMUNITIES
Not assessed, Critically Endangered (floristic community type 19 as defined by Gibson *et al.* 1994), Not determined

SECTION 3: SPECIFIC SITE DETAIL

Landscape Features: coastal dunes

Vegetation and Flora: detailed survey (Keighery, GJ, and Keighery 1993c; part Site — Trudgen 1989); limited survey (Gibson *et al.* 1994 (PB 01–06))

Structural Units: mapping (part Site — Trudgen 1989)
Quindalup Dunes
Uplands — Beach ridge plain: *Olearia axillaris* Open Shrubland to Closed Heath to Closed Tall Scrub; *Scaevola crassifolia* and *Olearia axillaris* Low Open heath to Closed Heath to Open Scrub; Open Heath to Open Low Heaths dominated by *Acacia rostellifera*, *A. lasiocarpa* var. *lasiocarpa*, *Melaleuca systena*, *Olearia axillaris*, *Jacksonia furcellata* and combinations of these over *Austrostipa flavescens* Grassland
Wetlands — Beach ridge plain: *Juncus kraussii* Closed Sedgeland, at times over *Sarcocornia quinqueflora* Closed Herbland; *Isolepis nodosa* and *Baumea juncea* Closed to Open Sedgeland, generally with an overstorey of *Xanthorrhoea preissii*
Strand: *Spinifex longifolius* Grassland
Scattered Native Plants: not assessed
Vegetation Condition: >60% Very Good to Pristine, <40% Good to Degraded, with areas of severe localised disturbance
Total Flora: 172 native taxa, 68 weed taxa (Keighery, GJ, and Keighery 1993) (estimated >90% expected flora)
Significant Flora: Keighery, GJ, and Keighery 1993 — *Cryptandra mutila* and *Zygophyllum fruticulosum* (southern range end), *Hibbertia cuneiformis* (most northern known population); *Jacksonia furcellata* (floriferous shrub form)

Fauna: limited surveys for birds (22 species), native mammals (5 species), reptiles (7 species) and amphibians (3 species) (Binnie & Partners 1988, Tingay, Alan & Associates 1997). Significant mammal species: Western Brush Wallaby and Quenda

Linkage: adjacent bushland to the north and east (Site 356, across road); part of Greenways 1, 83 (Tingay, Alan & Associates 1998a); part of a regionally significant fragmented bushland/wetland linkage (Part A, Map 7)

Other Special Attributes

Meets all six of the specific criteria for coastal reserves —

(i) Quindalup Dune types: beach ridge plain
(ii) Continuing natural processes: 764.2ha (657.9ha bushland) of Quindalup Dunes extending to 4km inland
(iii) Shoreline: soft (sandy)
(iv) Linkage: through adjacent Site 356 to Spearwood Dunes
(v) Vegetation: two regional floristic groups, one of which is a threatened community, areas of vegetation in apparently Pristine condition
(vi) Habitats: see Fauna section above;

Part Site recommended to be declared an A-class Nature Reserve for the protection of flora and fauna in Gibson *et al.* (1994); wetlands of 'national and international significance' (Semeniuk, V&C Research Group 1991b); majority of Site included in Port Kennedy and Rockingham Parks proposal (Tingay, Alan & Associates 1997)

SECTION 4: INTERNATIONAL AND NATIONAL SIGNIFICANCE

Directory of Important Wetlands in Australia; Entered in the Register of the National Estate; subject to protection under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

SECTION 5: SELECTION CRITERIA AND RECOMMENDATIONS

Criteria: Representation of ecological communities, Diversity, Rarity, Maintaining ecological processes or natural systems, Scientific or evolutionary importance, General criteria for the protection of wetland, streamline and estuarine fringing vegetation and coastal vegetation

Recommendation: Site with Some Existing Protection; the care, control and management of this Site (Reserves 44077, 45041) for conservation purposes within Port Kennedy and Rockingham Lakes Regional Park is endorsed (see Table 3, Volume 1).

Perth Region Plant Biodiversity Project
BFS 377: Port Kennedy

Legend

- Photo Reference Point

Floristic Survey Sites of the Perth Metropolitan Region

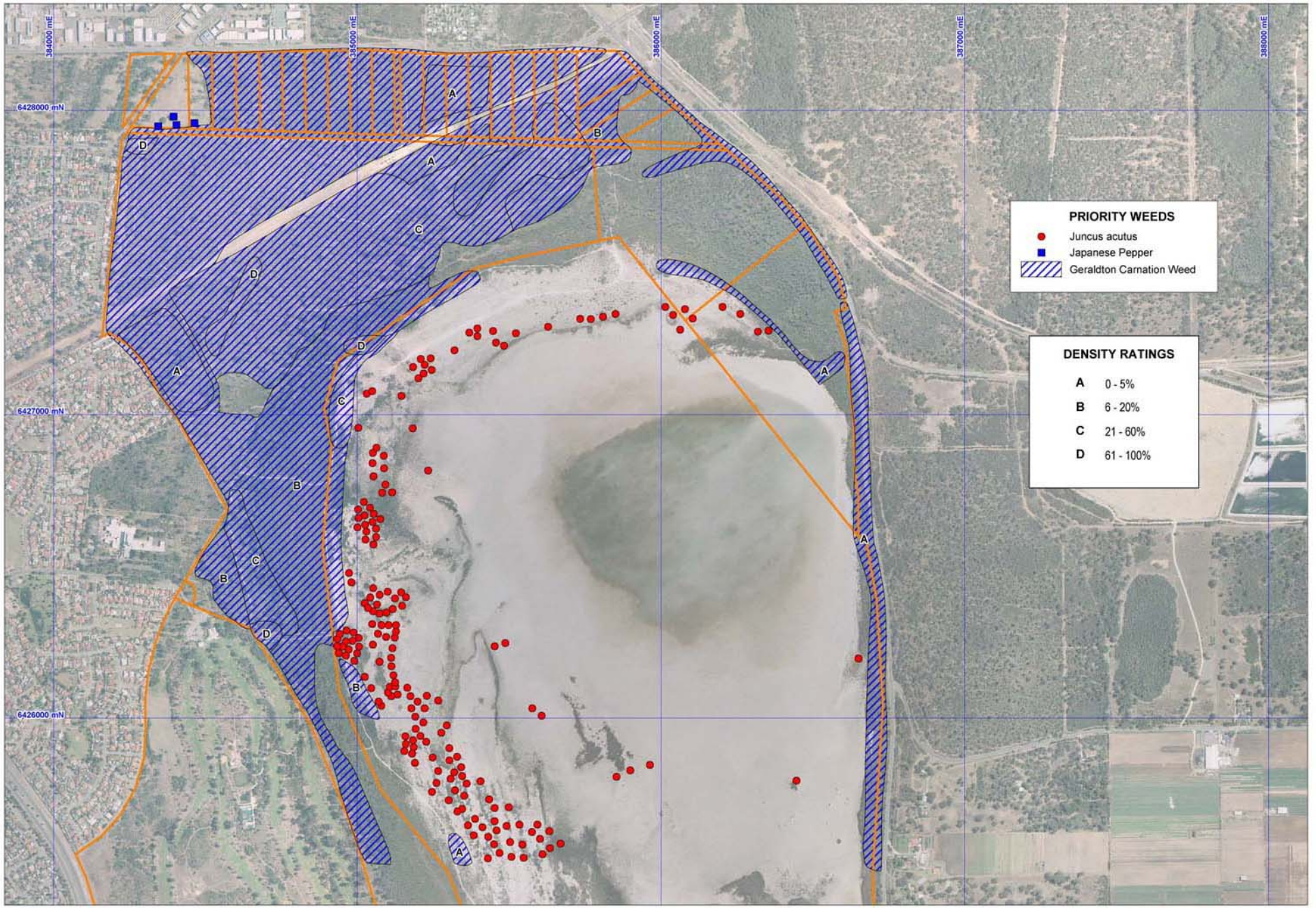
- Keighery 1996
- Griffin 1993 & Weston et al. 1992
- Gibson et al. 1994
- DEP 1996
- Roads
- Bush Forever Sites
- Bush Forever Reference Sites

0 1 2 Kilometres

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Information derived from this map should be confirmed with the data custodian acknowledged by the agency acronym in the legend.
Prepared by: E Harris, May 2006

Name	Custodian	Date	Scale	+/-
Photo Reference Points	DoE/CALM/WALGA	2005	1:2,000	5m
Floristic Survey Sites	DoE/CALM	2005	1:5,000	100m
Bush Forever Sites	DPI	2002	1:25,000	NA
Bush Forever Reference Sites	DoE/CALM/WALGA	2005	1:25,000	NA

Department of Environment
Department of Conservation and Land Management
Perth Biodiversity Project
Western Australian Local Government Association



DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

ROCKINGHAM LAKES REGIONAL PARK
LAKE COOLOONGUP (NORTH)
PRIORITY WEED SPECIES (1)

CLIENT: DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
PROJECT: Vegetation and Weed Mapping of Rockingham Regional Park

LCN-4.2C1

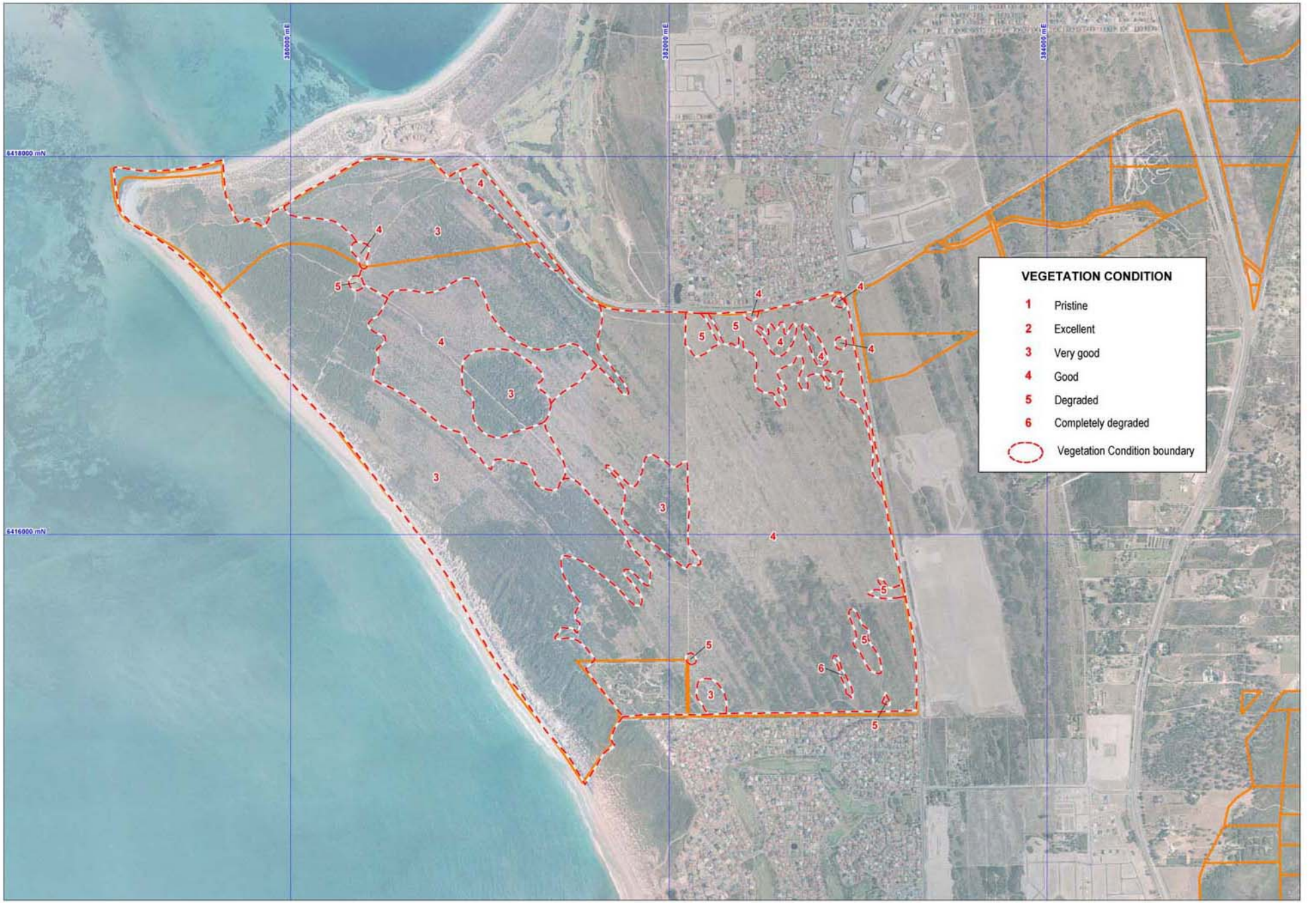
Revision	Description	Drawn	Approved	Date
0				

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

ROCKINGHAM LAKES REGIONAL PARK
PAGANONI SWAMP
PRIORITY WEED SPECIES

CLIENT: DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
PROJECT: Vegetation and Weed Mapping of Rockingham Regional Park

SHEET PS-4.11C



Revision	Description	Drawn	Approved	Date
0	DESCRIPTION	INITIAL	INITIAL	DATE

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

ROCKINGHAM LAKES REGIONAL PARK
PORT KENNEDY
VEGETATION TYPE AND CONDITION

Syrinx environmental pl

Perth
a 12 Ringer Street, Perth, WA, AUSTRALIA, 6000
p +61 (0) 8227 8000
f +61 (0) 8227 8033

Melbourne
a 113 Fergie St, North Fitzroy, VIC, AUSTRALIA, 3068
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w www.syrinx.net.au

DATE	08.05.06	DESIGN	DM Insert
SCALE	1:20,000	DRAWN	John Burke GIS
SYX. REF	<Consultants' Dwg No.>	APPROVED	DM Insert
SHEET	A3	APPROVED	DM Insert

CLIENT: DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

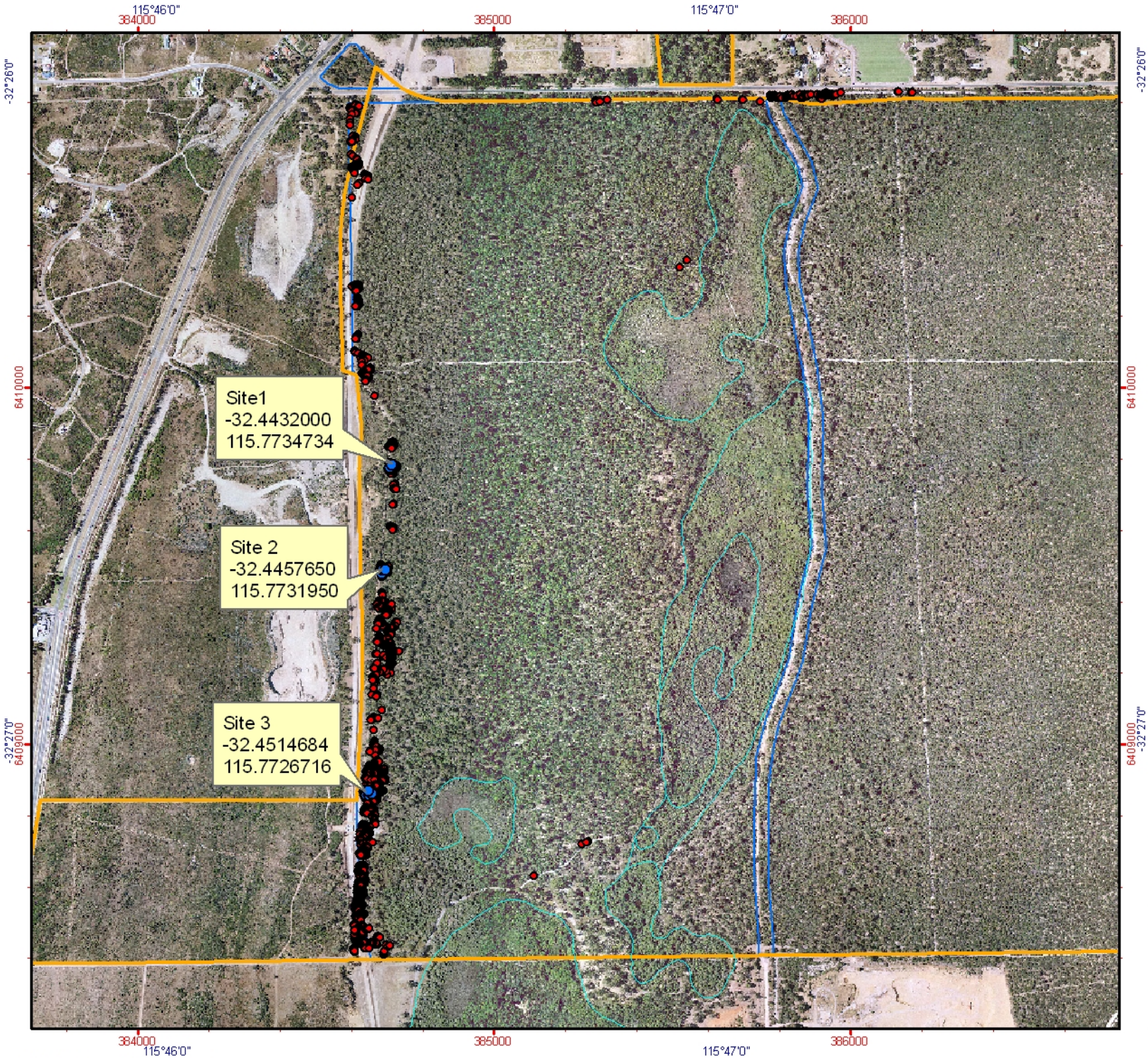
PROJECT: Vegetation and Weed Mapping of Rockingham Regional Park

TITLE

SHEET DRAWING NO. REV.

PK- 4.8A

APPROVED



Paganoni Swamp
Monitoring Plots for Euphorbia

Legend

- site1q1to5_point
- site2plot1to5p_point
- site3plot1to5p_point
- peuphorbiadec04feb05all
- SWAN Minor Hydrography
- Bush Forever Sites
- Regional Parks

N

1:15,000 (A4)

0 120 240 480 720 960

Meters

Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94

Department of Environment and Conservation

Produced under the Direction of
Keiran McNamara
Director General, Department of
Environment and Conservation

Graticule shown at 1 minute intervals
Grid shown at 1000 metre intervals

Euphorbia terracina distribution Port Kennedy Scientific Park

<20% cover	
<20% cover	
50-100% cover	
20-50% cover	
50-100% cover	
Regional Parks	

0 750 1500 2250 3000

Scale in Meters

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Director General, Department of
Environment and Conservation

Ehuphorbia trials - Point Becher, Port Kennedy

Legend

DEC Regional Parks

N

0 200 400 800 1,200 1,600
Meters

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Keiran McNamara
Director General, Department of
Environment and Conservation

BIOLOGICAL CONTROL AND *EUPHORBIA TERRACINA*

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Abstract

The prospects of biological control being used against *Euphorbia terracina* are reviewed. Species of *Euphorbia* closely related to *E. terracina* have been successfully controlled in North America using insect biological control agents. However, *E. terracina* has not been examined in its native region, the circum-Mediterranean region and the potential biological control agents are unknown. *Euphorbia terracina* would be a suitable target for biological control in Australia because it is not related to crops nor is it closely related to Australian native species in the *Euphorbia* genus. Biological control offers a permanent solution to the problem of *E. terracina* provided that sufficient resources can be made available for the risk assessment, release and assessment of potential biological control agents.

Introduction

Biological control is the utilisation of organisms for the regulation of host plant densities. This involves the introduction of natural enemies of a target weed that will reduce the density of the weed to a level that is acceptable and that will maintain the weed density at that level. This is commonly called "classical biological control" and in Australia, about 80 weed species have been targeted using some 200 host specific agents (insects, mites and fungi). This technique has been used for about 100 years in Australia and includes recent successes such as the use of a rust fungus and insects against bridal creeper in Western Australia.

Classical biological control has been successfully applied to *Euphorbia* species (Family Euphorbiaceae, spurges) in North America. *Euphorbia esula* (leafy spurge) was a problem costing over $US100 million per year in northwestern States. Insect biological control agents from Europe (leaf beetles - *Aphthona* species) were introduced and controlled the weed successfully (Bangsund *et al*. 1999, Butler *et al.* 2006). A second species, *Euphorbia cyparissias* (cypress spurge) has also been controlled by insect biological control agents in North America (Faubert and Casagrande 2002).

Biological control has not been tried against *Euphorbia* species in Australia. This report outlines the prospects for biological control of *Euphorbia terracina*, Geraldton carnation weed.

Nomination as a target for biological control

A prerequisite for biological control is nomination as a target (http://www.weeds.org.au/management.htm). This requires strong evidence that the weed causes economic or environmental loss. Likewise, there needs to be evidence that other control options are not feasible or cost-effective. The nomination process, which is managed by the Australian Weeds Committee, requires that all State and Federal

agencies agree that the weed is a suitable target and that there are no conflicts of interest. There do not appear to be any conflicts of interest for *E. terracina*, however an application would require strong evidence of the ecological impact of the weed. Obtaining this information should be a priority of research because it also would provide information that assists other control options.

An important issue that needs to be considered is what will happen when the weed is removed. Experimental work is required that will show the longer-term impacts of successful control. This type of research also will help in the establishment of overall objects for control, such as what percentage of weed can be tolerated.

Search for biological control agents.
Euphorbia terracina is native to the circum-Mediterranean region (Smith and Tutin 1968), on stabilised dunes just behind the mobile dunes of the coastline. The plant has given its name to a vegetation community, the "*Euphorbia terracina* dunes" found in this region. However, much of coastal Europe has been used for construction of cities and tourist facilities, and *E. terracina* is a relatively rare species in some areas.

Euphorbia terracina has not been surveyed for potential biological control agents and previous surveys on other *Euphorbia* species have been situated in more northern European regions. But it would be expected that the plant would be host to insect species and fungi similar to those found on *E. esula* and related species. These have been a rich source of biological control agents for North America (Gassmann and Schroeder 1995). CSIRO has a research station in Montpellier, in the region where *E. terracina* is found, and this would be a logical base from which to start a search of the Mediterranean region. An initial search and setting of priorities amongst potential agents should be a priority for future research.

Risk assessment of biological control agents
Once a potential biological control agent is identified it is taken through a risk assessment process to determine whether or not it is safe to release in Australia (http://www.csiro.au/org/ps2id.html). Issues to be considered in the risk assessment for biological control of *E. terracina* are:

- native *Euphorbia* species (69 genera, 450 spp.), including any that are rare and endangered (there are three);
- crop species (e.g. rubber, castor oil); and
- horticultural species (e.g. poinsettia).

Likelihood of success
Approximately two-thirds of the agents released for biological control establish and approximately one-third have significant impact. A level of control eventuates in at least half of weeds targeted (Julien and Griffiths 1998, McFadyen 1998) and about 10% have spectacular control. Overall the benefit to cost ratio of biological control is in the order of 23.1 to 1 (Page and Lacey 2006). As an example, the bridal creeper program has cost around $7.3 million over 15 years (Page and Lacey 2006), but the work can be broken up into smaller fundable units. In addition, the science required for biological control

programs often leads to improvements in other forms of control (e.g. the use of herbicides on blackberry).

Potential synergies

A weed closely related to *E. terracina* is *E. paralias*, the sea spurge. In Australia, this species is found on the fore dune, between where *E. terracina* is found on the stable dunes and the sea. In its native region it occupies the same habitat in the Mediterranean region and Atlantic coasts of Europe. Like *E. terracina* it has not been examined for biological control. *Euphorbia paralias* is now found along most coasts of southern Australia where it is a major invasive species. Combining projects on both *Euphorbia* species would lead to efficiencies and the support of a greater range of potential funding agencies.

Conclusion

Implementing biological control is the only option that will provide a permanent and ecologically suitable form of control for *E. terracina*. The following initial research is required as steps towards this goal:

- understanding the ecology and impact of *E. terracina* on the environment, including the effect of its removal;
- preliminary searches for biological control agents in the region of origin; and
- nomination of *E. terracina* as a target for biological control.

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STRATEGIC PLANNING IN THE SWAN NRM REGION - GERALDTON CARNATION WEED (*EUPHORBIA TERRACINA*)

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Introduction

The goal of a two-year Natural Heritage Trust funded project is to provide a strategic approach to managing environmental weeds in the Swan NRM Region. Due to be completed in June 2008, the project is administered by the Swan Catchment Council and is being carried out by the Department of Environment and Conservation (DEC) in consultation with stakeholders in the region. It directly contributes to targets in the *Swan Region Strategy for Natural Resource Management* and will provide a mechanism for implementing the *State Weed Plan* and *Environmental Weeds Strategy for WA* (EWSWA) within the Region.

One of the main project objectives is to assess and prioritise all environmental weeds in the Region, which will form the basis of the Environmental Weed Strategy. The focus will be on identifying high priority species impacting on biodiversity. One of the high priority species already identified is *E. terracina*, which was listed by Keighery (2005) as one of the 40 most significant weeds in Western Australia. The species is already widespread in the Swan Coastal Plain IBRA Region and has the potential to spread into the Jarrah Forest. The species is particularly high risk because it has the ability to flourish in disturbed areas as well as invade relatively intact or undisturbed bushland.

As such, it is one of six key species for which an individual strategic plan will be developed as part of the broader Regional Environmental Weed Strategy. The species specific plan will allow the systematic prioritising of threats, outline management targets and enable a coordinated approach to managing the impact of *E. terracina* across the Region, particularly on high biodiversity assets such as regionally significant bushland.

The basic process in developing the strategy is as follows, with the first step already well underway:

1.Gather all information

Seek information on biology, habitat, distribution and management, best practice control methods, from a range of sources and stakeholders, including Florabase, Local Government, DEC, natural area assessments, community groups, management plans, surveys, maps, identification and assessment of threats. Understand the factors operating behind *E. terracina*'s presence and spread.

2. Develop a strategy

Identify the priorities, set measurable objectives and determine resources, develop an implementation plan, keeping a long-term view.

1. Gather all information and review literature

Information on legislation, biology, ecology, habitat, distribution, assets at risk and management of *E. terracina* is being collected from a range of sources.

Legislation

E. terracina is currently not a legislated (Declared) species, thus it is not necessary by law for land owners or land managers to control or eradicate infestations. However, most Local Government Authorities acknowledge it affects biodiversity, and thus manage it as a "Pest Plant".

Habitat and Distribution

Herbarium collections show *E. terracina* in Western Australia is mainly found in coastal areas from Geraldton to Esperance (Figure 1). A larger scale map of southwest WA shows 35 of the total 88 collections have been made within the Swan NRM Region, with a distribution from Yanchep in the north, to Secret Harbour in the south and out to Mundaring in the east (Figure 2).

The species is found on sandy calcareous soils in disturbed and semi-disturbed sites such as pastures, wasteland, road verges or firebreaks. It can enter bushland via disturbance, soil disturbance, grazing and/or fire, where once established, it can then aggressively expand into intact bushland. Plant communities invaded include limestone heath, acacia shrubland, Banksia and Tuart woodland, and ephemeral wetlands. It is a major weed of Tuart woodlands and recorded in at least 17 bushland areas on the Swan Coastal Plain (Keighery and Keighery 2001). While it prefers sandy calcareous soils it has the potential to spread into fertile and inland soils of the eastern Swan Coastal Plain, Darling Scarp, Plateau and Avon/western Wheatbelt.

Biodiversity assets at risk

An asset-based risk management approach to weed management is currently being applied in other parts of Australia, including the Ottway Ranges in Victoria (Environmental Weeds Working Group 2006). A similar process of identifying and rating risks to environmental assets will be a key part of the strategic planning for managing *E. terracina* in the Region, particularly as Euphorbia is such a widespread and highly invasive species.

Habitats currently at risk include calcareous communities along the western portion of the Region. Identifying and prioritising the assets will be based on such features as regionally significant bushland (eg. Bush Forever Sites), size and shape, condition, distance from other reserves, Threatened Ecological Communities (TECs), presence of rare, priority and/or significant flora/fauna, extent of weed infestation, ecological linkage values, remnant vegetation and any other special attributes.

These features may be listed and shown spatially across the Region with other layers in GIS (Figure 3). Showing the distribution of infestations in relation to biodiversity assets can help develop priorities for protection and management. This can be done at a variety

of scales or management boundaries, including Swan NRM sub-regions, DEC districts and local governments. For example, examining the distribution of *E. terracina* in the Rockingham Region shows a number of TECs including the Holocene dune swales at Port Kennedy, *Callitris preissii* on Garden Island and areas of regionally-significant bushland (Bush Forever sites) are at significant risk (Figure 4).

The problem for determining management priorities in this way is that the true extent of *E. terracina* is not represented in databases or collections, thus mapping in this form can only offer a broad layout of populations. Where there are gaps or limited information, survey and mapping data will be need to gathered and/or undertaken at a local level. This information will also help assess the feasibility of control.

2. Develop a strategy

As information is being gathered, priorities and objectives for management are also being developed. The completed strategy will contain short (1-2 years) and longer term (5 to 10 years and beyond) objectives, but because it is in its early stages, at present only broad goals have been developed. These broad goals are listed below:

Protectable areas - exclusion

There are numerous high value biodiversity sites which *E. terracina* occurs in close proximity to or is at the very early stages of invasion. These areas have been termed "protectable", where the main management aim is *eradication* and *exclusion*.
Examples include:

- Mt Henry Peninsula bushland
- Kings Park
- Paganoni Swamp
- Neerabup National Park
- Shenton Park Bushland
- Garden Island
- Lowlands

It may be possible to eradicate *E. terracina* from some of these sites where it occupies a small area, will not re-invade from adjoining areas, all of the infested area is known and plants can be killed before reaching maturity, provided resources are available for initial treatment, regular surveys and control for the lifespan of the seedbank (Weeds CRC 2004). It is also necessary to address the sources of infestation, such as adjoining road verges.

Examples of areas currently not invaded but at high risk, where the main management aim is *surveillance* as well as to maintain ecosystem function (eg. excluding disturbance) are:

- Muchea limestone communities; and
- western wheatbelt woodlands/communities on calcareous clay

Containment and control
While desirable, because it is widespread and established, eradication of *E. terracina* in many other sites is not a realistic approach. Containment and control of select populations is likely to be a more realistic management goal. Biological control is also most likely to be appropriate for these situations.

Containment is worthwhile as it protects all areas of remaining native vegetation, reduces new infestations and the need for further control by limiting the extent and intensity of infestations. In high priority sites with well-established populations, resources should be used to contain the infestation and remove it from the best condition native vegetation. This may be best achieved using a site plan with detailed mapping of Euphorbia distribution and vegetation condition. Containment may also involve restoration of treated areas. Further prioritsation can be made by assessing the feasibility of control (extent of population density, area and other site limitations such as accessibility).

Examples of high value biodiversity assets where *E. terracina* is established, where the main management aim is *containment* and *control* are:

- Lake Cooloongup (Rockingham Lakes Regional Park)
- Bold Park
- Yanchep National Park
- Woodvale Nature Reserve
- Forestdale Lake Nature Reserve
- Port Kennedy Scientific Park – Becher Point

Region-wide, containment of *E. terracina* to prevent and control new infestations is likely to be the most realistic and appropriate management approach. While controlling roadside populations is important, the focus is on treating isolated outlying or "satellite" infestations rather than large core infestations. For *E. terracina* it is important to stop its current spread slowly northward and eastward, by controlling some of the outlying infestations such as those at Mundaring and Ellenbrook (Figure 3). The goal of reducing spread can be applied at a local, regional or state scale, as is currently being done to reduce its spread between Bunbury and Augusta.

Things to note
It is important to allow resources for long term and ongoing follow-up work on *E. terracina*. Management will also involve focusing on assets for protection rather than on weed management alone. It is therefore important to think in terms of managing threatening processes at high value biodiversity sites where *E. terracina* does not yet occur or is limited in extent. To limit introduction and spread, it is vital to prevent disturbance events such as fire, soil movement or disturbance.

Further actions and recommendations

- The program to control *E. terracina* should aim to control the causes and source of infestations
- Prevention is better than the cure – early detection and intervention is essential

- The next step in the strategy is to determine the true extent – especially outlier populations within the Swan NRM Region.
- Awareness-raising in the community and land managers of *E. terracina* is required, particularly those managers involved in road works.
- Lobbying is required to obtain funding for implementation of the strategy.
- The use of quarantined soil on islands is recommended.
- Liaison with The Department of Planning and Infrastructure (DPI) to develop a policy for control is required.

References

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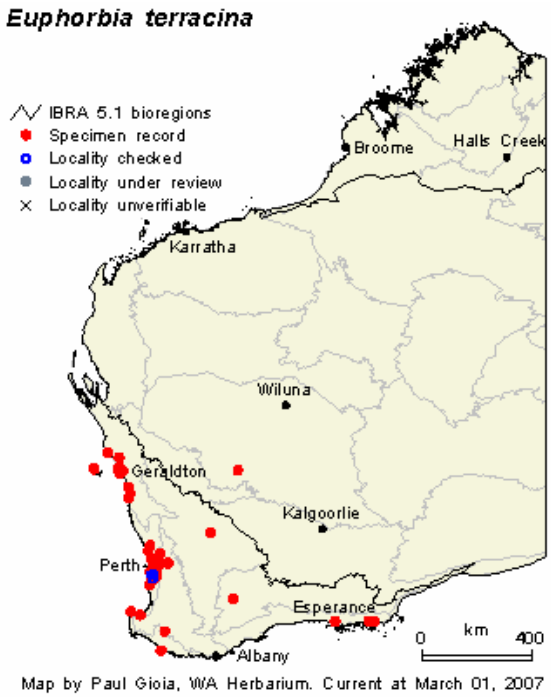

Figure 1: Distribution of *E. terracina* within Western Australia, based on WA Herbarium collections, August 2006 (*Florabase* 2006).

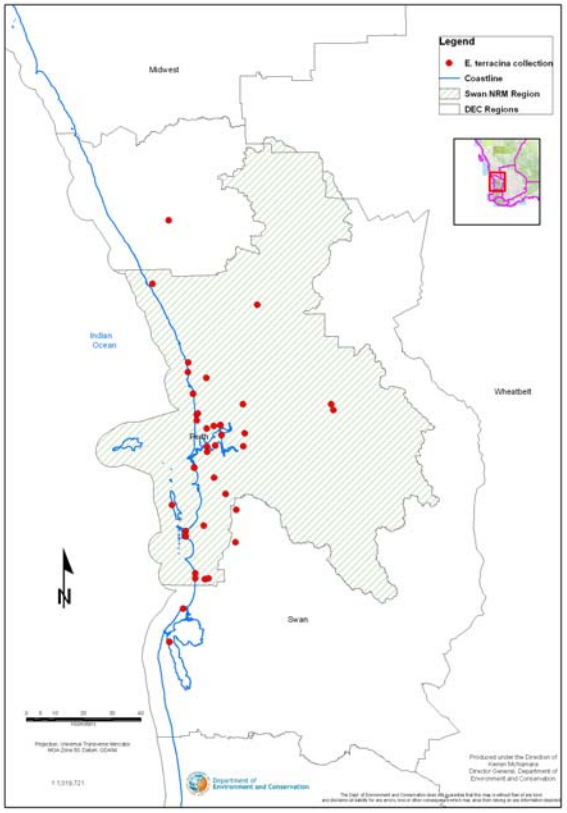

Figure 2 : Distribution of *E. terracina* in the Swan NRM Region, based on WA Herbarium collections, August 2006.

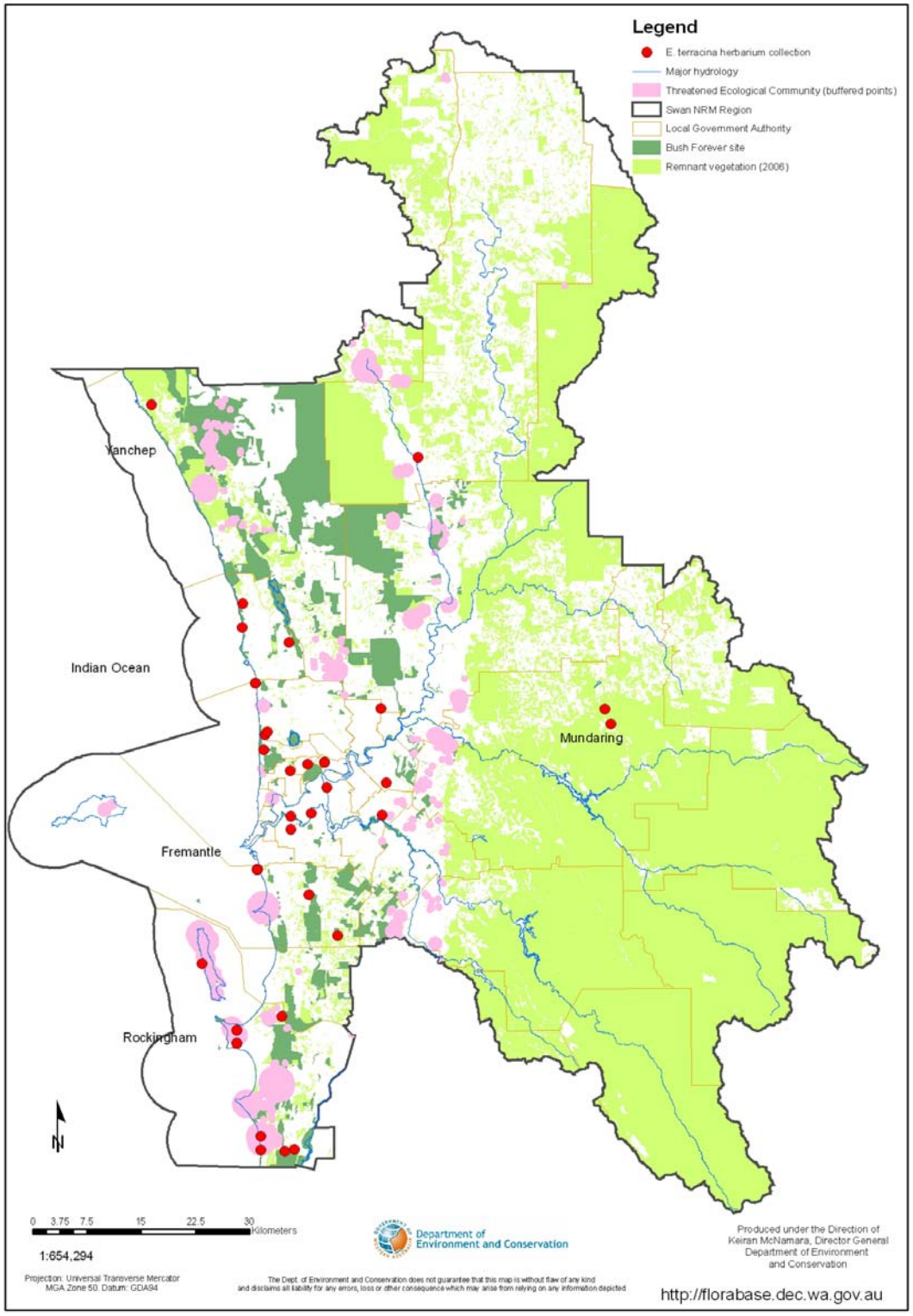

Figure 3: Distribution of *E. terracina* in the Swan NRM Region based on WA Herbarium collections, August 2006, against major biodiversity assets.

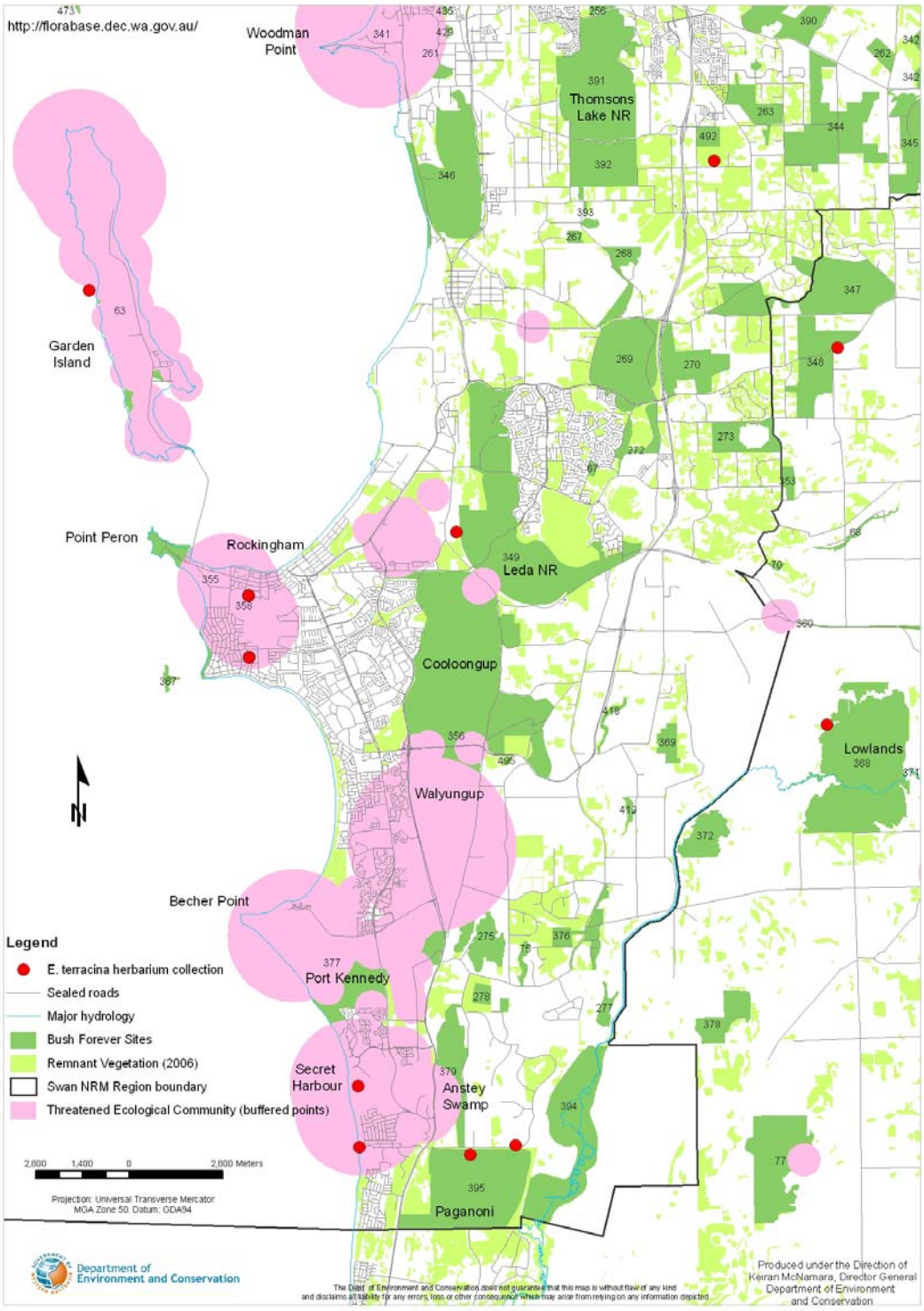

Figure 4: Detail of *E. terracina* distribution in the Rockingham Region based on WA Herbarium collections, August 2006, against major biodiversity assets.