

Zieria involucrata Recovery Plan

Executive Summary

This document constitutes the draft formal Commonwealth and New South Wales State Recovery Plan for *Zieria involucrata*, and as such considers the conservation requirements of the species across its known range. It identifies the future actions to be taken to ensure the long-term viability in nature of *Z. involucrata* and the parties who will carry out these actions.

Zieria involucrata is listed as endangered on Schedule 1 of the NSW *Threatened Species Conservation Act 1995* and as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. It is a small shrub in the family Rutaceae that is endemic to a restricted area of approximately 200 km², from Yengo National Park to Katoomba to Canoelands, to the north and west of Sydney. Only 22 populations are known—many of these comprise small numbers of plants and many, especially the single Blue Mountains population, are separated by long distances from other populations. These factors leave populations vulnerable to local extinction. The species appears to have become extinct in at least two localities in the Blue Mountains.

While the majority of extant *Zieria involucrata* populations occur in conservation reserves, a large proportion (9 of the 22) occur on private property or other public land tenures which are not managed primarily for nature conservation. The key threat, which may lead to extinction of populations, is frequent fire. This endangers populations on all types of land tenure, even those within national parks or state conservation areas. Another major threat to the species is clearing or other habitat modification on private property and Crown land. The impacts of these and several additional threats are discussed in the plan.

This draft recovery plan for *Zieria involucrata* was prepared by the Threatened Species Unit of the Environment Protection and Regulation Division's Metropolitan Branch in accordance with the requirements of the *Threatened Species Conservation Act 1995* (TSC Act), and the Commonwealth *Environment Protection and Biodiversity Protection Act 1999*. The plan was prepared in consultation with a reference group consisting of stakeholders responsible for the management of public lands that support *Zieria involucrata* and specialists in the biology and ecology of the species.

The overall objective of this recovery plan is to ensure the long-term survival of *Zieria involucrata* in the wild by promoting the *in-situ* conservation of the species across its natural range. Specific recovery objectives include:

- to conserve *Zieria involucrata* using land-use and conservation planning mechanisms;
- to identify and minimise the operation of threats at sites where *Zieria involucrata* occurs;
- to develop and implement a survey and monitoring program that will provide information on the extent and viability of *Zieria involucrata*;
- to provide the community with information that assists in conserving *Zieria involucrata*;
- to raise awareness of the species and involve the community in the recovery program; and
- to conduct research that will assist future management decisions.

It is intended that this recovery plan will be implemented over a five-year period. The cost to implement the plan over that period is estimated to be approximately \$118,000 plus as yet undetermined costs for planning and implementing on-site management.

I now invite you to make written submission to the Department of Environment and Conservation regarding this draft recovery plan prior to the advertised closing date. Please refer to Appendix 4 for details on how to make such a submission. Following consideration of comments, the plan will be finalised by the Director-General and the Minister for the Environment

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1 Introduction

Zieria involucrata is a small shrub belonging to the Rutaceae family. The species is endemic to the hills and mountains north and west of Sydney where it has a disjunct distribution. It is currently known from 22 populations across a range of a range of little over 80 km. A number of threatening processes have been recorded operating or potentially occurring at *Z. involucrata* sites. The main threat to the survival of *Z. involucrata* is considered to be inappropriate fire regimes.

This document constitutes the formal NSW and national recovery plan for *Z. involucrata* and as such considers the requirements of the species across its known range. The recovery plan describes the current conservation status and summarises current biological and ecological knowledge of the species, documents past and current management actions undertaken, and details a program for the next five years to promote the recovery of the species.

2 Legislative context

2.1 Legal status

Zieria involucrata is listed as an endangered species on Schedule 1 of the NSW *Threatened Species Conservation Act 1995* (TSC Act) and as a vulnerable species under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The consequences of listing a species under the TSC Act and the EPBC Act include that:

- consideration must be given to the species when assessing the impacts of developments and activities, with the aim of minimising adverse impacts;
- other actions that are likely to result in the harming or picking of that species or damage to its habitat must be licensed; and
- a recovery plan must be prepared.

2.2 Recovery plan preparation

The TSC Act provides a legislative framework to protect and promote the recovery of threatened species, endangered populations and endangered ecological communities in NSW. Under this legislation the Director-General of the NSW Department of Environment and Conservation (DEC) has a responsibility to prepare recovery plans for all species, populations and ecological communities listed as endangered or vulnerable on

the TSC Act schedules. Similarly, the EPBC Act requires the Commonwealth Minister for the Environment to ensure the preparation of a recovery plan for nationally listed species and communities or adopt plans prepared by others including those developed by State agencies. Both Acts include specific requirements for the matters to be addressed by recovery plans and the administrative process for preparing recovery plans.

This recovery plan has been prepared to satisfy the requirements of both the TSC Act and the EPBC Act and therefore will be the only recovery plan in operation for the species. It is the intention of the Director-General of DEC to forward the final version of this recovery plan to the Commonwealth Minister of the Environment for adoption, once it has been approved by the NSW Minister for the Environment.

The TSC Act requires that, when preparing a recovery plan, consideration must be given to any species knowledge or interests that indigenous people may have in the species and the measures to be contained in the plan. The EPBC Act requires that in the preparation of a recovery plan regard must be had to the role and interests of indigenous people in the conservation of Australia's biodiversity (see section 10.5).

2.3 International obligations

In making a Commonwealth recovery plan, regard must be had to assisting in the cooperative implementation of Australia's international environmental responsibilities and meeting Australia's obligations under relevant international agreements, which include the:

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
- Convention on Biological Diversity, ratified by Australia in 1993
- Global Strategy for Plant Conservation.

The actions proposed within this plan are consistent with Australia's obligations under these international agreements.

2.4 Recovery plan implementation

The TSC Act requires that a public authority must take appropriate measures to implement the actions in a recovery plan for which they have agreed to be responsible. Public authorities identified as responsible for the implementation of recovery plan actions are required by the TSC Act to report on measures taken to implement those actions. In addition, the Act specifies that public authorities

must not make decisions that are inconsistent with the provisions of the plan.

The public authorities relevant to this plan are:

- the NSW Department of Environment and Conservation (DEC)
- the NSW Department of Infrastructure Planning and Natural Resources (DIPNR)
- the NSW Department of Lands
- the NSW Rural Fire Service (RFS)
- the Hawkesbury/Nepean Catchment Management Authority established under the *Catchment Management Authorities Act 2003*
- Baulkham Hills Shire Council
- Blue Mountains City Council
- Hawkesbury City Council, and
- Hornsby Shire Council.

Consequently, the actions outlined for each of these public authorities must be implemented as described in this plan and public authorities that manage land that supports *Z. involucrata* must, as the responsible land manager, manage the site in accordance with the plan.

The EPBC Act specifies that a Commonwealth agency must not undertake any action that contravenes a recovery plan and states that the Commonwealth must implement a recovery plan on Commonwealth lands. Presently, no occurrences of *Z. involucrata* are known to be on Commonwealth lands.

2.5 Key threatening processes

The EPBC Act and the TSC Act provide for the identification and listing of key threatening processes. A key threatening process (KTP) is a process that threatens, or has the capability to threaten, the survival or evolutionary development of species, populations or endangered ecological communities. Several key threatening processes, as well as a number of other factors or activities which are identified in section 10.1, are recognised as threatening the survival of *Z. involucrata*.

The key threatening processes listed under the TSC Act which are likely to, or potentially, threaten *Z. involucrata*, as discussed in section 10.1, are:

- ‘*High frequency fire resulting in the disruption of life cycle process in plants and animals and loss of vegetation structure and composition*’, which is likely to threaten the viability of *Z. involucrata* populations
- ‘*Clearing of native vegetation*’, as defined by NSW Scientific Committee (2001), which has drastically reduced and fragmented the habitat of *Z. involucrata*

- ‘*Bushrock removal*’
- ‘*Infection of native plants by Phytophthora cinnamomi*’.
- ‘*Anthropogenic climate change*’ and
- ‘*Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands*’

Three key threatening processes listed under the EPBC Act are likely to or potentially *Z. involucrata*. These KTPs, essentially the same as some of those listed under the TSC Act, are:

- ‘*land clearance*’
- ‘*loss of climatic habitat caused by anthropogenic emissions of greenhouse gases*’ and
- ‘*dieback caused by the root-rot fungus (Phytophthora cinnamomi)*’.

2.6 Critical habitat

The TSC Act makes provision for the identification and declaration of critical habitat. Under the TSC Act, critical habitat may be identified for any endangered species, population or ecological community occurring on NSW lands. Once declared, it becomes an offence to damage critical habitat (unless the action is exempted under the provisions of the TSC Act) and a species impact statement is mandatory for all developments and activities proposed within declared critical habitat, unless the impact is deemed trivial or negligible by the Director General of the DEC.

Under the EPBC Act, critical habitat may be registered for any nationally listed threatened species or ecological community. When adopting a recovery plan, the Commonwealth Minister for the Environment must consider whether to list habitat identified in the recovery plan as being critical to the survival of the species or ecological community. It is an offence under the EPBC Act for a person to knowingly undertake an action that will significantly damage critical habitat (unless the act specifically exempts the action). This offence only applies to Commonwealth areas. However an action which is likely to have a significant impact on a listed species elsewhere is still subject to referral and approval under the EPBC Act.

To date, critical habitat has not been declared for *Z. involucrata* under the TSC Act or the EPBC Act. However, this recovery plan identifies (in sections 5, 6 and 7 and Appendix 1) the habitat features and locations that would contain habitat that is critical to the survival of the species, as required by the EPBC Act. It is not currently considered a high priority to nominate critical habitat for *Z. involucrata*, as no demonstrable conservation outcome would accompany its identification and declaration. Action 1.5 of this Recovery Plan

provides a mechanism for reconsidering the need for critical habitat nomination by the fifth year of implementation of the plan.

2.7 Relationship to other legislation

The TSC Act and the EPBC Act interact with other NSW and Commonwealth legislation and planning instruments in a number of ways. Legislation which is also relevant to threatened species protection, management and recovery in NSW includes the

- *Environmental Planning and Assessment Act 1979*
- *National Parks and Wildlife Act 1974*
- *Native Vegetation Act 2003*
- *Rural Fires Act 1997*
- *Rural Fires and Environment Assessment Legislation Amendment Act 2002* and
- *Local Government Act 1993*.

3 Conservation status

Zieria involucreta has been listed as vulnerable at national level since the commencement of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

At state level *Z. involucreta* was initially listed as vulnerable at the commencement of the NSW *Threatened Species Conservation Act 1995*. However, a review of the conservation status of the species (Hogbin 2002) recommended that the species warranted listing as endangered. Consequently, the NSW Scientific Committee (2002c) determined that *Z. involucreta* should be listed under the TSC Act as endangered because the species was considered to be at risk of extinction in NSW as a consequence of the following circumstances:

- the knowledge of fewer than 20 extant populations;
- an estimated total population size of only 3000 individuals;
- restricted area of occurrence;
- only six populations within conservation reserves; and
- threats to its survival from inappropriate fire regimes, weed invasion and clearing for urban development.

4 Description

4.1 Description

Zieria involucreta (fig.1, fig.2) is a small, sparse, erect shrub, growing to 1-2 metres in height. The branches and leaves are densely covered with hairs,

which form a soft, velvety tomentum. The hairs are predominantly stellate, though simple and bifurcate hairs are also present. Its opposite leaves consist of either a single leaflet or three leaflets, with both 1-foliolate and 3-foliolate leaves being present on the same branch (unifoliolate leaves only are rarely present on a branch). Leaflets are dark green above, light grey-green below, more or less oblong, 30 to 55 mm long and 6 to 15 mm wide.

The specific epithet '*involucreta*' refers to the large persistent bracts that surround the dense flower heads.

The flower clusters, consisting of 3 to 21 flowers, are shorter than the leaves and enclosed in numerous small, leaf-like bracts, which are 7-12 mm long. These bracts are also covered in dense, white hairs and often persist on the plant throughout the flowering. The flowers are 3.5 to 5 mm long, white with pink tinges, and slightly hairy. (Armstrong 2002, Armstrong and Harden 2002, Maryott-Brown and Wilks 1993). A full botanical description can be found in Armstrong (2002).

Z. involucreta may be confused with the similar *Z. fraseri* ssp. B (previously known as *Z. compacta* or *Z. fraseri* ssp. *compacta*) which has an overlapping distribution. *Z. fraseri* ssp. B. is distinctive from *Z. involucreta* by its glabrous fruits, glabrous upper leaf surfaces and smaller leaves (6-35 mm long and 1-8 mm wide) (Armstrong and Harden 2002).

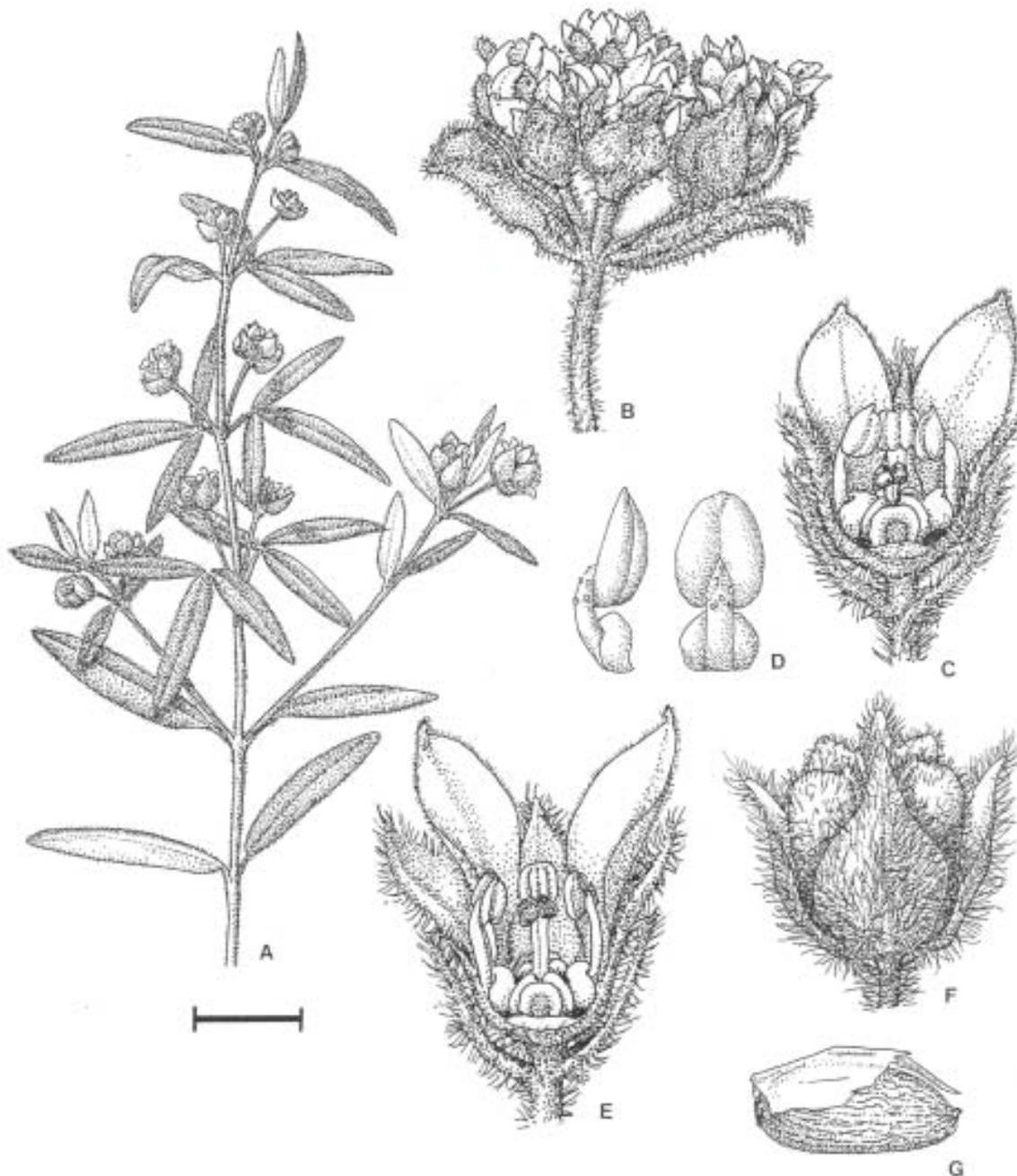
5 Distribution and abundance

5.1 Definitions: populations and subpopulations

In this recovery plan discrete groups of *Zieria involucreta* plants that are not separated from other discrete groups by more than one kilometre are considered together as a single **population**¹.

¹ Following Keith *et al.* (1997), and consistent with Australian usage, this plan uses the terms 'total population' and 'population' instead of the terms 'population' and 'subpopulation', respectively, adopted by the International Union for the Conservation of Nature and Natural Resources (IUCN 1994). Hence, in this plan 'total population' defines the total population of a species across its extent of occurrence and 'populations' are defined as "geographically or otherwise distinct groups in the total population between which there is little [genetic] exchange, typically less than one migrant per year". A migration in the case of plant species is considered to be the movement of seed propagules or pollen between populations, though it is suggested that the dispersal of propagules is more important to the viability of plant populations, because pollen does not usually contribute to rescue or recolonisation events. Since in the case of *Z. involucreta* there is inadequate information on a species with which to assess the extent to which genetic material is exchanged, a 'population' is defined, using the rule of thumb suggested by Keith *et al.* (1997), as a "geographic discontinuity" of more than one kilometre.

Figure 1. *Zieria involucrata*. habit inflorescence, flower and fruit details.



(A) Habit (scale bar = 25.7 mm), (B) inflorescence (scale bar = 2.7 mm), (C) flower, male phase, side view (scale bar = 2.4 mm), (d) stamens (scale bar = 0.6 mm), (E) flower, female phase, side view (scale bar = 2.3 mm), (F) fruit (scale bar = 1.4 mm) and (G) seed (scale bar = 1.1 mm).

Reproduced from Armstrong, (2002), *Australian Systematic Botany* 15 (3), with permission of CSIRO Publishing. © CSIRO.

Using this definition, 25 populations of *Z. involucrata* have been recognised. Each population has been identified uniquely by using the prefix ‘Zi’ followed by a unique number (e.g ‘Zi_01’, ‘Zi_02’, etc.).

A **subpopulation** is defined as a discrete group of *Z. involucrata* plants that is separated from other groups within the same population by an arbitrary distance of 200 metres or more. A total of 34 known and historical subpopulations has thus been defined for *Z. involucrata* (see Appendix 1). Where a population consists of multiple sites, each subpopulation has been identified uniquely by an alphabetic suffix -‘a’, ‘b’, ‘c’, etc. - to the population identifier (e.g ‘Zi_01a’, ‘Zi_01b’, etc.).

5.2 Current and historical distribution

Zieria involucrata has a disjunct distribution north and west of Sydney. Recent (post 1975) records for the species come from 22 populations (31 subpopulations). These occur in the catchments of the Macdonald, Colo and Hawkesbury Rivers - from Melon Creek and Mogo Creek in the north to Little Cattai Creek in the south - and from a single population in the upper Blue Mountains north of Katoomba (Figure 2).

Historical records (prior to 1976) exist for at least two, probably three, other localities – at Springwood/Valley Heights and Kurrajong – on the eastern side of the Blue Mountains Plateau, but these lack precise locational details. Several records, probably from at least two separate populations or subpopulations, have been made at or around Springwood and Valley Heights. The most recent of these was a 1975 record of a single plant south of Valley Heights. A 1959 record exists also for north-west of Kurrajong, but other, undated information suggests that the species may have been subject to clearing in this area. It is unknown whether any of these historically known populations are still extant.

The species distribution is primarily in the Central Coast botanical subdivision of NSW, except for the Blue Mountains populations which are within the Central Tablelands subdivision (after Harden 1990).

The species current known distribution equates to a linear range of 81 km and an extent of occurrence of approximately 200 km², but most of the size of this range results from the disjunct Blue Mountains population being so distant (greater than 43 km) from the next closest known population. While it is highly likely that further populations occur within this area, given that the majority of populations are small in number and isolated, the species has a small total area of occupancy.

Z. involucrata occurs in the local government areas of Hawkesbury, Baulkham Hills, Hornsby and Blue Mountains. All populations are within the area of responsibility of the Hawkesbury/Nepean Catchment Management Authority.

Appendix 1 lists and summarises attributes of the recently recorded (post 1976) and historically known populations. References to subpopulation identifiers throughout this plan correspond to those in Appendix 1.

Given concerns that the publication of specific locational details for populations of *Z. involucrata* may compromise its conservation, detailed location descriptions and grid references will not be made publicly available. Public authorities, land managers or others with valid reasons for requiring the data may request such information from the DEC contact on the front cover of this draft plan.

5.3 Population size and structure

The population size of a species is considered to be the total number of mature individuals (IUCN 1994). However, most estimates made of population sizes of *Zieria involucrata* fail to distinguish between mature and immature individuals, so the total number of mature plants across all known extant sub-populations remains unknown.

Furthermore, even the total number of individuals - mature and immature plants together - in most populations of the species is unknown, since few populations have been systematically surveyed or comprehensively censused and many sites have not been revisited for some time – several not within the past decade. There are also a few populations whose existence is uncertain, having not been recorded for many decades. Hence, there may have been significant changes in plant numbers since the last estimates were made. It is known, for example that several populations are in areas where severe wildfires have occurred in recent years (1997-1998, 2001-2002, 2002-2003), so the numbers of individuals in and the age structures of these populations are known or are likely to have been radically altered as a result.

The number of *Zieria involucrata* individuals across all 25 recognised extant or historical populations is therefore unknown, but is estimated to be between 5000 and 8000. This figure includes an unknown, but large, number of plants that are less than three years old since regenerating from fires and have not reached reproductive maturity. Population size varies from only a single individual to thousands of plants, although more than half (13 of 22) of the known extant populations comprise 100 or fewer plants (Table 1). Only three populations consist of more than 500 plants. In addition, the majority of populations occupy only small areas.

Table 1: Population size estimates for the known extant populations of *Z. involucrata*

Size class [#]	Number of populations	Population identifier and total number estimate [#]
≤ 10	5	Zi_04 (≤10), Zi_05 (3), Zi_14 (8), Zi_18 (1), Zi_19 (3)
≥ 10 ≤ 50	7	Zi_01 (>20), Zi_06 (50), Zi_07 (50), Zi_09 (25), Zi_11 (≤20?), Zi_17 (≤20), Zi_21
≥ 50 ≤ 100	2	Zi_02 (≤73), Zi_08(100)
≥ 101 ≤ 500	4	Zi_10 (248), Zi_12 (300), Zi_16 (280), Zi_22 (200)
≥ 501 ≤ 1000	2	Zi_03 (1000), Zi_13 (1389)
≥ 1001 ≤ 5000	1	Zi_15 (3068)
Unknown	4	Zi_20, Zi_23, Zi_24, Zi_25

[#] estimates include number of mature and immature individuals

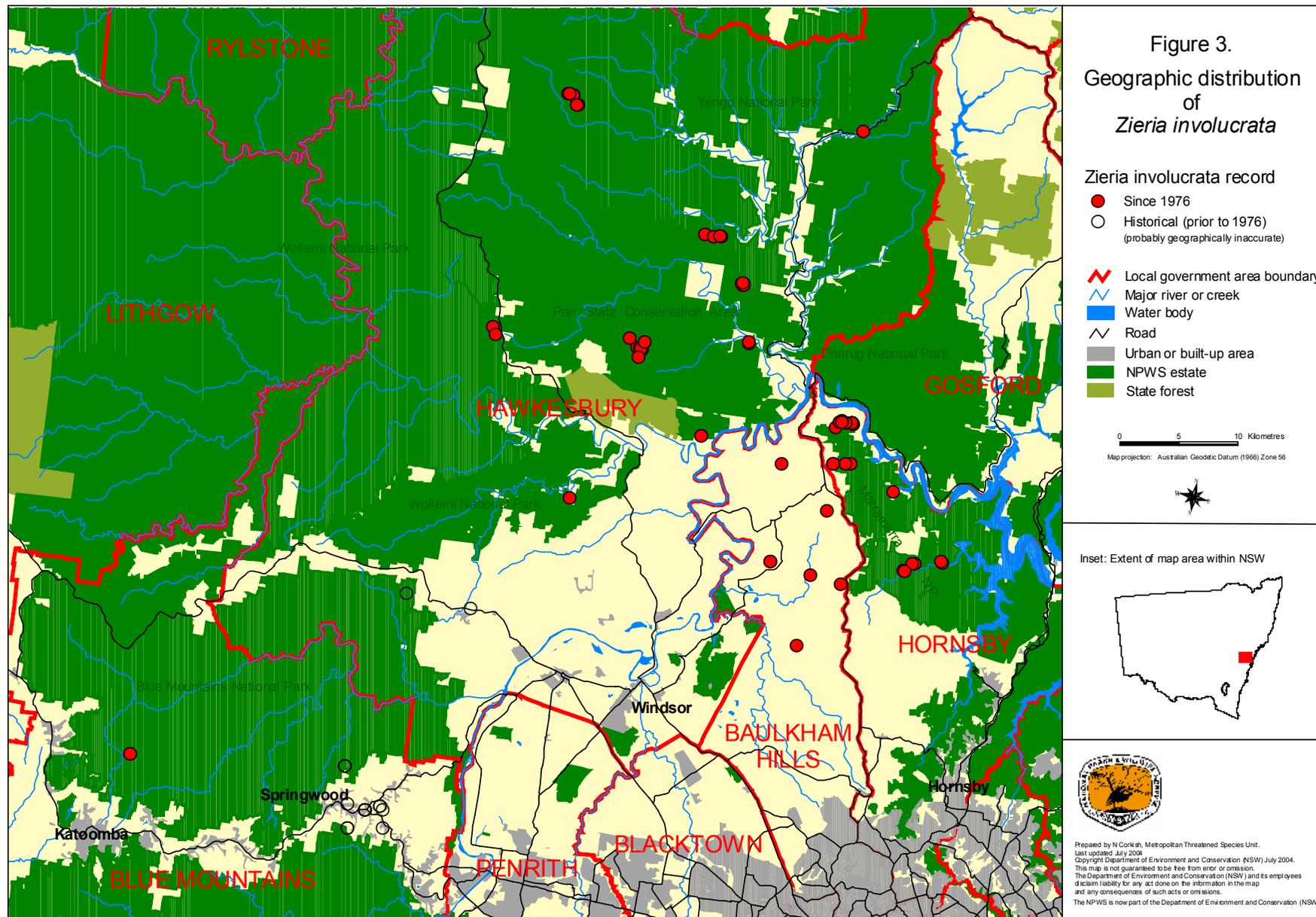


Figure 2. Geographic distribution of *Zieria involucrata*.

6 Land tenure, management and zoning

Table 2 shows the distribution of *Z. involucreta* subpopulations by tenure, land manager and local government zoning. Where a subpopulation extends across two (or more) different tenures, it has been recorded as two (or more) separate sites. While the majority of known populations occur on public lands of various types (national park, state conservation area, Crown land), seven of the 22 extant subpopulations occur on private freehold lands.

6.1 Private freehold land

Four *Z. involucreta* populations (Zi_05, Zi_19, Zi_21, Zi_22) occur on rural properties in areas zoned '1(b) Rural', primarily for agriculture, under the Baulkham Hills Local Environmental Plan 1991.

A further two populations (Zi_08, Zi_10b) occur on private property zoned for 'Environmental Protection B (River Catchment)' under the Hornsby Shire Local Environmental Plan 1994. This zoning does not preclude certain types of development or activities, including agriculture (see section 10.1.2).

Another two populations (Zi_11, Zi_18), and possibly a third (Zi_20 on Mogo Ck Rd), are on rural properties in areas zoned '7(d) Environmental Protection (Scenic)' under the Hawkesbury Local Environmental Plan 1989. This zoning does not preclude certain types of development or activities, including intensive agriculture (see section 10.1.2).

A number of these populations occur on land that was previously Crown land which is in the process of being transferred as freehold title to either the Metropolitan or Deerubbin Local Aboriginal Land Councils, under the NSW *Aboriginal Land Rights Act* 1983. These areas are also subject to native title claims under Commonwealth legislation.

Table 2: Tenure, land manager and zoning for all known *Zieria involucreta* sites.

Tenure - Land manager Zoning [§] – primary purpose	No. sites*	Subpopulation identifier
Private property – Baulkham Hills LGA 1(b) Rural – agriculture ^a	4	Zi_05, Zi_19, Zi_21, Zi_22
Private property – Hornsby LGA Environmental Protection B (River Catchment) – environmental protection ^b	2	Zi_08, Zi_10b [†]
Private property – Hawkesbury LGA 7(d) Environmental Protection (Scenic) ^c	2	Zi_11, Zi_18
Crown land – Department of Lands Unreserved Crown land [‡] – 1(b) Rural – agriculture ^a	1	Zi_09
Crown land – Baulkham Hills Shire Council Crown reserve – 1(b) Rural ^a – public recreation	1	Zi_04
Crown land – Hornsby Shire Council Public road reserve	2?	Zi_10a ^{‡?} , Zi_10b ^{‡?}
Dept of Environment and Conservation estate National park	14	Zi_01, Zi_02a, Zi_02b, Zi_03, Zi_06, Zi_07, Zi_10a [†] , Zi_14 [†] , Zi_15a, Zi_15c [†] , Zi_16a, Zi_16b, Zi_17a, Zi_17b
State conservation area	8	Zi_12, Zi_13a, Zi_13b, Zi_13c, Zi_13d, Zi_14 [†] , Zi_15b, Zi_15c [†]
Unknown [#]	4	Zi_20, Zi_23, Zi_24, Zi_25

* where a subpopulation extends across two different tenures or zoning it has been recorded as two separate sites

[†] subpopulation occurs across more than one tenure or zoning

[§] as identified in the:

^a Baulkham Hills Shire Local Environmental Plan 1991

^b Hornsby Shire Local Environmental Plan 1994

^c Hawkesbury Local Environmental Plan 1989

The meaning of the zoning primary purpose and the allowable developments or activities within the zone differs between local government areas even where the zone name is the same.

[‡] Crown land subject to Aboriginal land claim and also to native title claim

[#] Precise location unknown and/or existence not confirmed

6.2 Crown land

One population (Zi_09) is within unreserved Crown land currently under Aboriginal land claim, as yet undetermined, by Deerubbin Aboriginal Land Council. It is also within an area under native title claim. Though the Department of Lands manages this land, until the Aboriginal land claim is

determined it cannot carry out any activities to do with this land without the concurrence of the Aboriginal Land Council that lodged the claim (M. Sewell, Dept. of Lands, Parramatta). This land is zoned '1(b) Rural', primarily for the purpose of agriculture, under the Baulkham Hills Local Environmental Plan 1991.

Another population (Zi_04) occurs on Crown reserve 88000, reserved for public recreation. The control of this reserve automatically devolves onto the local council (Baulkham Hills shire) under the *Local Government Act*. There is a permissive occupancy for the purpose of a pipeline running through this reserve. This land is also under native title claim. While this land is zoned '1(b) Rural', primarily for the purpose of agriculture, under the Baulkham Hills Local Environmental Plan 1991, the Department of Lands advises that the management of the reserve must be consistent with the reserve purpose of public recreation. Baulkham Hills Shire Council controls and manages this Crown reserve.

6.3 Council-managed land

Two subpopulations (Zi_10a and Zi_10b) may extend onto the Crown road reserve for Laughtondale Gully Rd managed by Hornsby Shire Council.

Baulkham Hills Shire Council controls and manages the Crown reserve 88000 referred to in section 6.2.

6.4 Conservation reserves

Twenty of the 31 known extant subpopulations occur on land gazetted as conservation reserves. Fourteen subpopulations occur wholly or partly in national parks: one in Blue Mountains NP, six in Marramorra NP, five in Yengo NP and two in Wollemi NP. At least two of the sites in Yengo NP extend across the Womerah Track into Parr State Conservation Area. There are also a further six subpopulations wholly within Parr SCA.

7 Habitat

7.1 Landform, geology and soil

Zieria involucrata is mainly found on mid- to lower slopes of rolling to very steep terrain formed from dissected Hawkesbury sandstone, in the Macdonald Ranges, Hornsby Plateau, Blue Mountains Plateau and Hawkesbury Valley physiographic regions. In all but three cases it is associated with the Hawkesbury sandstone geology and occurs on the Hawkesbury or Gynea erosional soil landscapes, as mapped by Chapman *et al.* (1989), Hazelton *et al.* (1989), King (1994), McInnes (1997a) and Murphy and Tille (1993) (Table 3).

Several of the records for these populations are in areas mapped as the Watagan soil landscape which is derived from the Narrabeen Group sandstones. However, as the Narrabeen Group often outcrops as sideslopes below Hawkesbury sandstone, it is often overlain with colluvium derived from the latter and thus soil formation and plant communities are

influenced by it. Douglas² (pers. comm.) considers that the presence of *Z. involucrata* in these situations may be related to the interface between the younger Hawkesbury and older Narrabeen sandstone geologies, so that it is often found below the final terrace of Hawkesbury sandstone on colluvium over upper Narrabeen Group sediments, sometimes extending onto the alluvial terraces of creeks or gullies.

In a few other locations *Z. involucrata* appears to occur on geological substrates not influenced by Hawkesbury sandstone. Two populations are in areas mapped as Narrabeen Group sandstone where Hawkesbury sandstone does not overly or influence it. While the precise location of population Zi_20 is unknown, it most likely is associated with the Narrabeen sandstone-derived Watagan colluvial soil landscape (as mapped by Murphy and Tille 1993) along Mogo Creek. The occurrence in the upper Blue Mountains north of Katoomba (Zi_01) also occurs on slopes formed from Narrabeen sandstone and the mapped soil landscape is the Warragamba colluvial soil landscape (King 1994). A third population (Zi_11) occurs on Quaternary alluvium of the Wisemans Ferry soil landscape (as mapped by McInnes 1997a).

While the precise locations of the historical records from the Springwood – Valley Heights area of the upper Blue Mountains are unknown, location descriptions with these records indicate that these populations would most likely have occurred on the Hawkesbury or Gynea soil landscapes derived from Hawkesbury sandstone.

Z. involucrata is usually found in neutral to slightly acid, shallow, sandy soils (Maryott-Brown and Wilks 1993) derived from the Hawkesbury and Narrabeen sandstones, often amongst sandstone outcrops and boulders.

While surveyed sites cover a range of aspects (Maryott-Brown 1994a), most populations of *Z. involucrata* occur in sheltered sites, e.g. in or on lower slopes above creeks that support sclerophyll forest. However, some populations extend further upslope. In the Marramorra – Maroota area, for example, the species can also occur below the first sandstone bench on upper slopes as long as soil moisture and/or shelter from hot, drying winds is sufficient. The presence of shale lenses or shale-influenced colluvium may be important factors in creating suitable conditions, especially on less sheltered aspects (ESP 1998). *Z. involucrata* is also known from at least two atypical ridgetop locations (subpopulations Zi_15a, Zi_18).

² S. Douglas, principal, ESP Ecological Surveys & Planning

Table 3. Distribution of the known extant subpopulations of *Zieria involucrata* by soil landscape unit

Geology	Soil landscape unit*	No. sub populations	
Qa Quaternary Alluvium	Wisemans Ferry (wf)	1	
	Rh Hawkesbury Sandstone	Hawkesbury (ha or haa)	14
		Hawkesbury (ha)/Gymea (gy)	3
		Hawkesbury (ha)/Warragamba (wb)	1
		Hawkesbury (ha)/Watagan (wn)	4
		Gymea (gy)	2
		Gymea (gy)/Warragamba (wb)	1
		Watagan (wn)/Gymea (gy)	1
		Watagan (wn)/Hawkesbury (ha)	1
		Watagan (wn)/Oxford Falls (of)? [‡]	1
Rn Narrabeen Sandstone		Warragamba (wb)	1
	Watagan (wn) ? [#]	1	

* as mapped by Chapman *et al.* 1989, Hazelton *et al.* 1989, King 1994, McInnes 1997a and Murphy and Tille 1993. A slash means that the subpopulations occur near or extend across a mapped soil landscape boundary.

[‡] Oxford Falls soils landscape possibly mapped incorrectly (Corkish, pers. obs.)

[#] Precise location unknown

7.2 Climate³ and altitude

The altitudinal range of *Z. involucrata* is 50 to 850 metres above sea level, although the vast majority of sites exist below 300 m. The occurrence in the upper Blue Mountains north of Katoomba (Zi_01) is atypical in that it occurs at much greater elevation (850 m a.s.l.).

7.2.1 Macdonald Ranges, Hornsby Plateau and Hawkesbury Valley physiographic regions

These regions have a warm temperate climate. Rainfall is highest over summer and lowest during winter. Average annual rainfall ranges from 823 mm at Wisemans Ferry on the Hawkesbury River to an estimated 665 mm at Colo Heights. It may even be less at the northernmost *Z. involucrata* sites at Melon Creek in Yengo National Park due to further distance from the coast. At Wisemans Ferry the average number of rain days per month is highest from January to March at seven, and lowest in July at four. Soil moisture availability tends to remain high throughout the year, being highest in winter when the lower rainfall is compensated for by lower evaporation rates (Edwards 1979).

Summers are warm to hot and winters are cool to cold. ESOCIM estimates that the hottest month is January, with mean maximum temperatures of 28.5°C at Maroota and 30.6°C at Colo Heights. July is estimated to be the coldest month with mean minimum temperatures of 4.2°C at Maroota and 2.7°C at Colo Heights.

7.2.2 Blue Mountains Plateau physiographic region

Due to orographic effects the Blue Mountains Plateau physiographic region receives considerably more rainfall and has a narrower average temperature range than the ranges and valleys to the east. Rainfall is highest over summer and lowest during winter to early spring. Average annual rainfall ranges from 1402 mm at Katoomba to an estimated 1317 mm at Bilpin. The average number of rain days at Katoomba is 131 per year, and per month is highest from January to February at 13, and lowest from July to September at nine. At Bilpin the average number of rain days is highest from January to March at 11 days, and lowest in May, June, July, August and September at seven days each.

Frosts occur about 45 days per year and snowfall occurs on average three times per year at Katoomba. Fogs are common with annual averages of 55 days for Katoomba.

Summers are warm and winters are cool to cold. Temperatures at Katoomba are highest in January with a mean maximum of 23.1°C. July is the coldest month at Katoomba with a mean maximum temperature of 9.2°C and a mean minimum temperature of 2.5°C. ESOCIM estimates that the hottest month at Mountain Lagoon on the eastern side of the Plateau is January, with a mean maximum temperature of 29.3°C. July is estimated to be the coldest month with a mean minimum temperature of 2.9°C at Mountain Lagoon.

Soil moisture availability tends to remain high throughout the year, but low temperatures from April to October may restrict plant growth (Edwards 1979).

7.3 Associated vegetation

While surveyed sites cover a range of aspects (Maryott-Brown 1994a), most occurrences of *Zieria involucrata* are in sheltered sites, e.g. in or adjacent to gullies which support sheltered forest, although some populations extend upslope into drier vegetation. The canopy typically includes *Syncarpia glomulifera* subsp. *glomulifera* (turpentine), *Eucalyptus agglomerata* (blue-leaved stringybark), *Allocasuarina torulosa* (forest oak) and *Angophora costata* (smooth-barked apple) (Maryott-Brown 1994a). The presence of the first

³ Climatic data for Katoomba are Bureau of Meteorology data at October 2003. Other climatic data are taken from McInnes (1997b) and King (1994b) and are derived from Bureau of Meteorology stations at Wisemans Ferry and Bilpin or generated using a climatic interpolation program ESOCIM

three species has been considered to indicate potential habitat (ESP 1998).

A dense shrub layer is often present, commonly including *Ceratopetalum gummiferum*, *Backhousia myrtifolia*, *Acacia linifolia*, *A. terminalis*, *Persoonia linearis*, *P. levis*, *Grevillea buxifolia*, *G. speciosa*, *Banksia spinulosa* var. *collina*, *Hibbertia bracteata*, *H. scandens*, *Leptospermum trinervia*, *Elaeocarpus reticulatus*, *Monotoca scoparia*, *Pultenaea flexilis* and *Bossiaea obcordata* (Maryott-Brown 1994a).

A medium to dense lower shrub and ground layer includes *Entolasia stricta*, *Patersonia sericea*, *Hybanthus monopetalus*, *Dracophyllum secundum*, *Phyllanthus hirtellus*, *Gompholobium latifolium*, *Xanthosia pilosa*, *Lepidosperma laterale*, *Xylomelum pyriforme*, *Lomatia silaifolia*, *Pandorea pandorana*, *Smilax australis*, *Astrotricha floccosa*, *Gonocarpus teucroides*, *Leucopogon muticus*, *Pteridium esculentum*, *Dianella caerulea*, *Lomandra longifolia*, *Hardenbergia violacea*, *Lomandra filiformis* subsp. *coriacea*, *Viola hederacea*, *Blechnum cartilagineum* and *Lindsaea microphylla* (Maryott-Brown 1994a).

According to the classification of vegetation communities in the mapping undertaken by Smith (1990a,b) within Hornsby Shire, the species occurs in vegetation community A (*E. piperita* – *Angophora costata* open forest) and on the edge of vegetation community O (Warm temperate rainforest) of Smith (1990a,b). Community A is equivalent to the open forest-woodland sub-unit of Sydney Sandstone Gully Forest (map unit 10ag) mapped by the Royal Botanic Gardens (Benson and Howell 1994), while community O is equivalent to the closed forest sub-unit. However, ESP (1998) considers that the species is most strongly associated with a community not identified by those mapping projects, namely a *E. agglomerata* open-forest associated with the interface between the lower Hawkesbury and upper Narrabeen Group strata. The species is also known to be associated with or found adjacent to the endangered ecological communities Sydney Coastal River-flat Forest and Western Sydney Dry Rainforest (S. Douglas pers. comm.).

8 Biology and ecology

The limited available biological and ecological information regarding *Zieria involucrata* is largely based on research by Tony Auld and Maria Matthes, including that published in Auld *et al.* (2000), Auld (2001), and unpublished work cited in Maryott-Brown (1994a).

8.1 Habit

Zieria involucrata is a sparse, erect shrub, growing to 1-2 metres in height.

8.2 Longevity

The life span of this species is not known. It is considered to be in the vicinity of 10-15 years (Maryott-Brown 1994a), however quantitative data to support this are lacking. Only a few plants in one population (Zi_14, Womerah Range) which germinated following fire in 1991 could be found in 2003 (N. Corkish, pers. obs.). The species may not be long-lived once the dominant forest structural components overtop it.

The longevity and viability of *Z. involucrata* seed in the soil was examined by Auld *et al.* (2000) who estimated a half-life of the dormant, viable seed fraction to be 4.9 years and considered that the species could persist for 1-2 decades as seed in the soil after adults have died.

8.3 Reproductive biology

8.3.1 Reproductive strategy

Auld *et al.* (2000) classed the species as fire sensitive, but capable of limited resprouting. *Z. involucrata* plants have been observed to appear to be coppicing from rootstock after fire (Auld, unpubl., Armstrong 2002). However, most observations to date are that plants are usually killed by fire (Maryott-Brown 1994a, D. Beckers, pers. obs.). The response of plants to mechanical damage is unknown. For the purposes of management and conservation, in the absence of evidence to the contrary, the species is probably best considered as a predominantly obligate seeder that relies on seed germination after disturbance to maintain populations.

8.3.2 Reproductive maturity

The age at which *Z. involucrata* is capable of flowering and producing seed is estimated to be 3-5 years after germination, but when conditions are good some plants will flower and set seed as early as 2 years (Maryott-Brown 1994a). However, the plants are quite small when first fruiting occurs, and the maximum production levels probably do not occur until 6-10 years of age (T. Auld, pers. comm.).

8.3.3 Phenology

Flower buds begin to form during April, while flowering generally occurs from August to October. Fruits take 6-8 weeks to mature, with seed set occurring from November to January. Seed is released from late November to early January

(Maryott-Brown and Wilks 1993, Maryott-Brown 1994a). It is not known whether individuals flower regularly or sporadically. Maryott-Brown and Wilks (1993) observed moderate to high flowering on all sites visited during their surveys in a single year (1993).

8.3.4 Breeding system

Zieria flowers are morphologically hermaphrodite, having both male and female organs present in each flower. The condition of dichogamy (ie the maturation of the stigma and anthers at different times) is prevalent in the genus and is frequently coupled with herkogomy (ie the spatial separation of anthers and stigma) (Armstrong 2002). These conditions act to reduce the chances of self-fertilisation and enhance cross-pollination. However, *Z. involucrata*, is genetically self-compatible and is capable of setting fruit following self-pollination (Armstrong 2002).

8.3.5 Pollination

Zieria flowers are insect-pollinated. Nectar- and pollen-seeking flies and pollen-seeking-beetles have been observed to be the most frequent vectors of *Zieria* pollen, while more rarely bees and nectar-seeking Nymphalidae butterflies have been seen visiting the flowers of *Zieria* taxa (Armstrong 2002). However, the particular pollinators of *Z. involucrata* are unknown. The open floral structure of *Zieria* indicates that pollination by a generalist pollinator is likely (Robinson 1999), although it is possible that *Z. involucrata* has specialist pollinators.

Z. involucrata is known to possess functional pollen, although pollen viability was less than 65% in the material sampled by Armstrong (2002).

8.3.6 Seed biology and ecology

Seed dispersal in *Zieria* spp. is by forcible ejection from the mature coccus (fruit) (Armstrong 2002). The presence of an elaiosome (an ant-attracting appendage to the seed) (Armstrong 2002) indicates that secondary dispersal by ants (termed myrmecochory) may also occur. At present there is little knowledge of the nature of ant interactions with *Z. involucrata* or other Rutaceae species, nor is the fate of moved seeds known. Even with such a mechanism, seed dispersal distance is likely to be small, of the order of one to a few metres (Auld 2001).

Zieria involucrata has both dormant and non-dormant seed at the time of release. Auld *et al.* (2000) observed a moderate level (40% of the viable seed) of seed dormancy at seed release. While the non-dormant seed fraction underwent rapid decay over time, dormant seeds showed no significant decay over a 2-year period, suggesting

that long-lived persistent soil seedbanks may be established in this species. Auld *et al.* (2000) estimated a half-life of the dormant, viable seed fraction to be 4.9 years and considered that the species could last 1-2 decades as seed in the soil after adults have died.

Post-fire seedlings have been observed in several populations (Auld, unpubl., Maryott-Brown 1994b, D. Beckers, pers. obs.). A positive germination response to heat has also been reported by Keith (pers. comm., cited in Armstrong 2002). Either heat or smoke or a combination of these factors may play a role in breaking seed dormancy (T. Auld, unpubl. & pers. obs., B. Kenny, unpubl.) Both the amount of smoke and the level of heating could influence germination success. A certain level of heat is optimal for breaking seed dormancy (less heat will result in seeds staying dormant, more heat will result in seeds being killed) (see section 8.4).

8.4 Response to fire and other disturbance

The response of adult plants of the species to fire is uncertain. Auld *et al.* (2000) classed the species as fire sensitive but with limited resprouting capability. *Z. involucrata* plants have been observed to appear to be coppicing from rootstock after fire (Auld, unpubl., Armstrong 2002). However, most observations to date are that plants are usually killed by fire (Maryott-Brown 1994a, D. Beckers, pers. obs.). If plants are capable of coppicing it is unknown at what age plants may be capable of this. The response of the species across its distribution may be variable depending on a number of factors, including the amount of heat experienced during a fire by the resprouting organ, the size of the organ, its genetic variation, and variation in particular site characteristics (Auld 2001).

The response of plants to other physical disturbance, such as grazing and slashing, has not been recorded.

Seed dormancy in *Z. involucrata* appears to be broken by heat shock (see section 8.3.6), with temperatures above 110°C killing the seeds and temperatures below 80°C not breaking the seed dormancy. This may occur during the passage of a fire, but not all fire will produce optimal soil heating. Such temperatures are only reached in the top 4 cm of soil under fires that consume a large amount of fine ground fuel (Bradstock and Auld 1995). This usually occurs in fires of moderate to high fire intensity or fires of low intensity that move slowly and fully combust fuels. Fires with different characteristics may cause population decline.

Considerable levels of seedling recruitment have been observed at a number of sites following fire

disturbance (Maryott-Brown 1994b), but there is currently little data on survivorship following such disturbances. Furthermore, there have been no systematic observations of the effects of fire frequency, intensity or seasonality on *Z. involucreta* or its soil seed bank. Continued research into the fire response of the species is considered to be a critical aspect of the species biology requiring further investigation.

The non-dormant seed fraction provides a source of germinants over time between fire events. It is likely that “natural” disturbances (resulting from storm damage, animal scratchings and possibly cooler fires) provide recruitment opportunities for the species in a healthy ecosystem.

It can be reasonably assumed that frequent disturbances (as a consequence of grazing, slashing, fire or other activities that destroy the aboveground parts of the plant and prevent seed production) may lead to local extinctions of the species in the long term. This will occur if the disturbances are of a frequency that prevents the plants that germinate in response to an initial disturbance from reaching sexual maturity and/or coppicing in response to a subsequent disturbance.

Conversely, long-term absence of disturbance may also be detrimental to population persistence. If the interval between fires is long, adult plants may die due to competitive exclusion and seed in the soil deteriorate and become inviable before conditions suitable for successful germination and survival occur. Auld *et al.* (2000) estimated that the species could last 1-2 decades as seed in the soil after adults have died. So given that plants may not be long-lived, fire-free intervals more than 1-2 decades longer than the mean life span of plants may result in local extinction.

9 Previous recovery actions

9.1 Preparation and implementation of a recovery plan

A conservation research statement (Maryott-Brown 1994a, 1994b) and a recovery plan (Maryott-Brown 1994b) were prepared for the Australian Nature Conservation Agency⁴ Endangered Species Program by the NSW National Parks and Wildlife Service in 1994 prior to the commencement of the TSC Act. Actions proposed in that recovery plan were to:

- 1) inform other management organisations of the presence of this species and its management requirements;

⁴ ANCA, now part of the Commonwealth Department of Environment and Heritage

- 2) survey for more locations in suitable habitats;
- 3) negotiate a conservation agreement for off-park land at Laughtondale Gully Road (subpopulation Zi_10b);
- 4) carry out continual monitoring of populations, taking note of recruitment, death, flowering and seed production, followed by modelling of population demography;
- 5) monitor fire response of populations burnt in January 1994 and develop a fire plan of management for sites; and
- 6) collect and use material from the larger populations for seed storage and some cultivation.

With respect to proposed action 4, monitoring of two of the populations was being carried out at the time of preparation of the recovery plan, but was not continued (T. Auld, pers. comm.). Auld *et al.* (2000) and Auld (2001) incorporated some of the results from this work in published papers.

With respect to proposed action 5, a reserve fire management plan has been developed for Yengo National Park and Parr State Conservation Area reserves. However, these plans do not address fire management requirements specifically for *Z. involucreta*.

It appears that lack of ongoing funding precluded the implementation of any of the other actions proposed in the 1994 recovery plan.

9.2 Survey, research and monitoring

Little targeted survey for survey for *Zieria involucreta* is known to have occurred since that carried out during the preparation of the conservation research statement and previous recovery plan (Maryott-Brown 1994a). S. Douglas carried out targeted surveys for threatened plant species, including *Z. involucreta* in the Hornsby local government area in the late 1990s.

Monitoring of seedling recruitment, survival and growth in burnt and unburnt replicates has been initiated by DEC's Parks and Wildlife Division Central Coast Hunter Range Region for subpopulations Zi_15c, Zi_21 and Zi_13c (D. Beckers, pers. comm.).

9.3 Threatened species data collation and audit

The Department of Environment and Conservation Metropolitan Threatened Species Unit has conducted a literature review, and an audit of RBG NSW Herbarium, NSW NPWS Atlas of Wildlife, State Forests and other records prior to the preparation of this recovery plan.

9.4 Profile and environmental impact assessment guidelines

A species profile and environmental impact assessment guidelines have been prepared for *Z. involucrata* (Appendix 2). The aim of these documents is to assist the assessment of potential impacts on the species during the preparation and review of assessments under Parts 4 and 5 of the EP&A Act and Part 6 of the TSC Act.

9.5 Establishment of a recovery team

A recovery team has not been established for *Zieria involucrata*. However, consultation has occurred with members of a recovery plan reference group, comprising representatives of relevant public authorities that will be responsible for the planning and/or management of this species and scientists who have special knowledge of the species.

9.6 Community awareness initiatives

There has been limited public relations work, comprising an article about the monitoring program (section 9.2) in each of the Rural Fire Service magazine and *Napawi*, the staff newsletter of the DEC Parks and Wildlife Division (NPWS).

9.7 In situ protection

Currently, there are no formalised *in situ* conservation measures in place for *Zieria involucrata*. However, the location of several populations of the species in a state conservation area and several national parks affords some constraints on threatening processes affecting this species, e.g. no grazing of domestic stock, some control of feral animal grazing (although feral goats have been known to exist in the Laughtondale Gully Road area), control of plant collection and limitation on disturbance by humans.

9.8 Ex situ protection

Numerous cuttings of *Z. involucrata* were collected in February 1991 from a single wild population (Zi_10, Laughtondale Gully Road), propagated and planted at Mt. Annan Botanic Gardens. At June 1993 five of the seven accessions were reported to be growing well, with two having been planted in the Gardens (G. Fensom, pers. comm., cited in Maryott-Brown 1994b). Cuttings were also taken in July 1975 from south of Valley Heights in the Blue Mountains (RBG Herbarium record NSW366425), but the success of any propagation, if any, is not recorded. Currently, there are no surviving propagated plants in the Gardens (T. Armstrong, pers. comm.).

Seed was collected in November 2002 by Mt Annan Botanic Gardens staff from the

subpopulation Zi_10b (Laughtondale Gully Road) as part of the Seedquest NSW project. Seed has also been collected in the past from one or more populations in the Blue Mountains, but it is unrecorded whether propagation or storage, if any, was successful.

The species belongs to a family, Rutaceae, about which little is known regarding seed biology and ecology; generally it is thought that germination is difficult (Auld *et al.* 2000). The genus is a target group for research on seed viability and the requirements for successful conservation storage, and in this context *Z. involucrata* is a candidate, subject to funding, for the Seedquest NSW program being carried by RBG in partnership with the "Millennium Seedbank" program of the United Kingdom's Royal Botanic Gardens at Kew (P. Cuneo⁵, pers. comm.).

At this stage the Botanic Gardens Trust does not have, nor does it intend to collect, cutting or seed material to cover the range of geographical, morphological or genetic variability across the total population of the species (P. Cuneo, pers. comm.).

9.9 Lower North East Regional Forest Agreement

The Lower North East Regional Forest Agreement resulted in the issue of a Threatened Species Licence (TSL) to State Forests of NSW (SFNSW) as part of the Integrated Forestry Operations Approvals. Under that licence, SFNSW must meet a number of conditions that relate to surveying for or protecting *Zieria involucrata* before or during harvesting or other specified forestry activities on State forest or other Crown timber lands.

10 Management issues

The management and conservation of *Zieria involucrata* requires the development of a recovery program which considers

- (i) the factors that threaten the survival of the species;
- (ii) limits to current knowledge;
- (iii) the social, political and organisational parameters that may affect the success or otherwise of the program;
- (iv) any special knowledge or interests that indigenous people may have in the species or the measures in the plan; and
- (v) the economic factors which may influence the plan's implementation.

⁵ P. Cuneo, Manager - Natural Heritage, Botanic Gardens Trust, Sydney

This section discusses these issues as well as community awareness of the species; consideration of a translocation and *ex-situ* conservation program; and the ability of the species to 'recover'.

10.1 Threatening processes

The main threat to the survival of *Zieria involucrata* is inappropriate fire regimes. Other threats or potential threats include habitat loss and fragmentation due to clearing and other disturbances resulting from roadside maintenance activities, bush rock removal, weed invasion; grazing, climate change and alteration of stream hydrology.

10.1.1 Inappropriate fire regimes

"High frequency fire" is recognised as a key threatening process for many threatened plant species, populations and ecological communities under the NSW *Threatened Species Conservation Act 1995* (TSC Act). For further information about this key threatening process see the NSW Scientific Committee Determination Advice 00/06 (NSW Scientific Committee 2000b).

Several populations have probably been burnt by wildfire at least twice since the beginning of 1994. Furthermore, these wildfires have promoted community and political pressure for more frequent hazard reduction; as well, arson in such bush-urban interface areas and increased numbers of visitors to nearby conservation reserves (NSW NPWS 2001) increases the likelihood of more frequent fire impacting on populations of *Z. involucrata*.

Current knowledge about the response of *Z. involucrata* to fire is outlined in section 8.4. While there is considerable uncertainty about the effects of fire frequency (as well as fire intensity and seasonality) on *Z. involucrata* and its soil seed bank, the available evidence suggests that frequent fires will adversely impact the species. It can be reasonably assumed that frequent fire (or other) disturbances that destroy the aboveground parts of the plant and prevent seed production may lead to local extinctions of the species in the long term. This will occur if the disturbances are of a frequency that prevents the plants that germinate in response to an initial disturbance from developing to a stage where they are capable of producing seed and/or coppicing in response to a subsequent disturbance.

While the critical fire frequencies for the long-term survival of *Z. involucrata* have not yet been determined, the life-span (10-15 years), time to maximum seed production (6-10 years) and soil-seed longevity (1-2 decades) estimates (Maryott-Brown 1994a, Auld, pers. comm. and Auld *et al.* 2000, respectively) suggest that fire frequency

should probably be in the range of 10-30 years. While the lower threshold of this range is consistent with the fire interval guidelines developed by the NSW National Parks and Wildlife Service (NSW NPWS 2002) for the broad vegetation types in which *Z. involucrata* occurs or is likely to occur, the upper threshold is considerably lower. NSW NPWS (2002) also recommends that a period of three reproductive years should be added to the minimum fire interval for all vegetation types to allow for seed production and building of seedbank reserves. Therefore, the recommended minimum fire-free interval for *Z. involucrata* populations is 10 years plus an additional 3 years in each of which seed production occurs. Recurrent burning at or below the minimum threshold (i.e. several successive short intervals) is likely to lead to a critical decline if the species is sensitive to frequent disturbance; conversely repetition of long intervals may have the same effect if it is sensitive to infrequent fire (NSW NPWS 2002).

Z. involucrata is listed on the Threatened Species Hazard Reduction List (TSHRL) of the NSW Rural Fire Service's *Bush Fire Environmental Assessment Code for Asset Protection and Strategic Fire Advantage Zones*. Consequently, if a particular site is identified as the location of the species, or if an issuing or certifying authority (under the *Rural Fires Act*) determines that the species is likely to be present at a site, the mitigative actions identified in the list for the species must be incorporated as a condition of any approved bush fire hazard reduction works carried out according to the code. To ensure that these conditions are applied to *Z. involucrata* it is essential that the Atlas of NSW Wildlife (the source of TSHRL records) contains precise locations (better than or equal to 100 metres) for all populations of the species.

Currently, the TSHRL requires that no fire more than once every 12 years occurs in *Z. involucrata* locations. This legal requirement is inconsistent with the previous recommendation (of 10 plus 3 productive years), so it is considered that the adequacy of the mitigative conditions required to be applied to bush fire hazard reduction works under the *Bush Fire Environmental Assessment Code* should be reassessed in light of the current data and any that becomes available in the future.

Other elements of a fire regime (i.e. intensity and season) have not been considered in deriving the recommended fire interval threshold range, as sufficient data is lacking. However, some management considerations are prompted by the available knowledge.

The influence of fire intensity is two-fold, affecting mortality of the standing vegetation and post-fire germination of the seedbank. Many species, including—as discussed in sections 8.3 and 8.4—

Z. involucreta and other Rutaceae species, require a heat-cue for germination and show minimal recruitment after low-intensity fires (Auld *et al.* 2000). Repetition of low-intensity fires leaves these species at risk of decline and local extinction (e.g. Auld & O'Connell 1991). Fires of moderate to high fire intensity or fires of low intensity that move slowly and fully combust a high proportion of ground fuels are probably required to generate a level of heat to break seed dormancy (Maryott-Brown 1994b) and should be planned for *Z. involucreta* at appropriate intervals.

Seasonal impacts are related to pre- and post-fire climatic conditions (importantly rainfall and temperature) as well as coincidence of fire with breeding cycles. As with fire frequency, it is important that variation exists in the intensity and seasonal occurrence of fires.

The objective of promoting the persistence of *Z. involucreta*, or any other single species, must also be weighed against that of maintaining species diversity. NPWS (2002) cautions that to maintain species diversity the actual inter-fire intervals experienced at a site should be variable. Intervals constantly in the mid-range of the domain can lead to dominance of particular species at the expense of others (Keith *et al.* 2002). Greatest species diversity is maintained by ensuring variation in the length of inter-fire intervals (Morrison *et al.* 1995).

Public authorities which approve bush fire hazard reduction activities should use the biological and ecological information summarised in this recovery plan, as well as any new data that becomes available in the future, to consider the immediate and cumulative impact of such activities on *Z. involucreta*.

10.1.2 Clearing for residential or rural purposes

“Clearing of native vegetation” is listed as a key threatening process for many threatened species, populations and ecological communities under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). For further information about this key threatening process see the NSW Scientific Committee Determination Advice 01/17 and the relevant Commonwealth Threatened Species Scientific Committee listing advice⁶. Clearing means not only removal or destruction of vegetation, but also encompasses the alteration of habitat causing changes to its structure and floristic composition, which may occur through

road/track construction, mechanical fuel hazard reduction activities, or slashing and herbicide spraying along road verges.

Clearing of native vegetation is considered to be a threat to the survival of *Z. involucreta*. It is thought that at least one population (near Kurrajong) may have become extinct following clearing. In its area of occurrence clearing has occurred over many years and continues to occur, particularly for agricultural and rural-residential development. Population growth on the northern outskirts of the Sydney metropolitan area is likely to place *Z. involucreta* in these areas under increasing pressure from such development.

Clearing may also be resulting in the fragmentation of *Z. involucreta* habitat, with populations and subpopulations of the species separated by severely modified or totally cleared areas. Fragmentation impacts may include the creation of small isolated populations with limited gene flow between them, leading to inbreeding depression and reduced potential to adapt to environmental change. In addition, small isolated populations may be subject to local extinction from stochastic (random) events. Fragmentation may also lead to the loss or severe modification of the interactions between *Z. involucreta* and other species, including those interactions – such as with pollinators – that are important for the survival of the species. The hostility of the surrounding cleared or modified environment is a major factor in limiting movement of organisms between patches. Furthermore, the physical environment within remnant patches may be altered as a result of creation of edges and associated anthropogenic influences.

All or parts of eight populations are known to occur on private freehold property (see Table 2). Four of these populations are on properties within Baulkham Hills local government area zoned for rural uses, primarily agriculture. Populations of *Z. involucreta* on these properties are potentially threatened by clearing for agriculture or other reasons, or from other activities such as grazing.

The other four populations occur in Hornsby or Hawkesbury LGAs on private property in zones identified for some level of “environmental protection”. However, even within these zones protection against destruction or disturbance of these populations is not guaranteed, as a number of different types developments may be carried out, either with or without the consent of council. Activities or development permissible without consent include agriculture (excluding intensive agriculture, in both LGAs), utility installations (in Hawkesbury) and dwellings (in Hornsby LGA), while those which require consent include intensive agriculture, forestry, communications facilities, roads, dams and other constructions.

⁶ see DEH website www.deh.gov.au/biodiversity/threatened/ktp/clearing.html

Clearing could also be carried on the Crown reserve (for public recreation) on which population Zi_04 occurs and the unreserved Crown land on which population Zi_09 occurs.

Councils should consider options for rezoning such sites to afford more secure environmental protection for these populations. In addition, to mitigate both direct and indirect impacts on the species, councils should consider features which could be incorporated into the design and implementation of developments that are to be constructed upslope of, or proximate to, *Z. involucrata* sites. Vegetated buffers should be retained around *Z. involucrata* sites to maintain the integrity and health of its habitat.

Liaison with the owners of these properties is required to prevent inadvertent clearing or detrimental modification of habitat for the species. In potential habitat where *Z. involucrata* is currently unrecorded, it is important that consent and determining authorities are aware of the need for targeted survey for the species when assessing the impacts of a development. As *Z. involucrata* may only be present in very small numbers or even only in the form of soil-stored seed, the species could easily be missed during flora surveys conducted as part of the development assessment process.

In addition to directly impacting upon *Z. involucrata* through habitat loss and fragmentation, such development and associated increases in human activity can directly and indirectly affect the species by otherwise contributing to habitat degradation and modifying the environmental conditions experienced at those sites. Such impacts can result from factors including:

- increased pedestrian and vehicular access to sites, resulting in greater likelihood of trampling, rubbish and garden waste dumping, weed infestations, bush rock removal and transmission of the root-rot fungus (*Phytophthora cinnamomi*);
- more frequent fire because of bushfire hazard reduction works and arson;
- altered overland flows (and associated problems with sedimentation and erosion); and
- changed soil pH and nutrient levels.

These management issues are discussed in more detail in the following sections. On-going active management (including bush regeneration, fencing and liaison with residents to prevent dumping and other inappropriate activities) may be required to mitigate the indirect impacts of these threats on the species.

10.1.3 Road and utility construction and maintenance and mechanical methods of bushfire fuel hazard reduction

Some sites may be affected by mechanical methods for vegetation management or bushfire fuel hazard reduction where populations are proximate to roads, utilities and other assets.

At least two *Z. involucrata* subpopulations (Zi_10a, Zi_10b) probably occur, at least partially, on road verges managed by Hornsby Shire Council. A number of other populations (Zi_12, Zi_14, Zi_15a, Zi_15b, Zi_15c) occur on or proximate to the edges of roads or trails within several conservation areas managed by the Department of Environment and Conservation. Repeated disturbance through road maintenance activities, including grading and slashing, potentially threatens these populations (D. Beckers and S. Douglas, pers. comm.).

One population (Zi_18), possibly comprising only a single plant, occurs very close to a Telstra communications tower on a leased area of private property which may be subject to underscrubbing, slashing or other such activities that may directly or indirectly impact on the species. Another population (Zi_07) on Coopers Creek, Murrumbidgee National Park is partially under high voltage electricity transmission lines managed by Transgrid, but it is understood that any maintenance associated with this facility does not affect the population (T. Burton⁷, pers. comm.). However, this remains to be confirmed.

It is possible that *Z. involucrata* may tolerate infrequent disturbances of this nature, but the species is unlikely to be able to survive repeated mechanical damage from mowing, slashing or grading, as discussed in section 8.4. Until further information regarding the response of the species to multiple disturbances is gained, it is important that mowing, slashing and grading are excluded from *Z. involucrata* sites and that council and utility staff and contractors responsible for planning or implementing such activities are made aware of the occurrence of the species.

The mitigative actions for *Z. involucrata* identified in the Threatened Species Hazard Reduction List (TSHRL) must be incorporated as a condition of any approved bush fire hazard reduction works carried out according to the Rural Fire Service's *Bush Fire Environmental Assessment Code for Asset Protection and Strategic Fire Advantage Zones*. Currently, the TSHRL requires that no slashing, trittering or tree removal for bush fire hazard reduction work occurs in *Z. involucrata* locations. To ensure that this condition is applied to

⁷ T. Burton, Ranger, Murrumbidgee NP

Z. involucrata it is essential that the Atlas of NSW Wildlife (the source of TSHRL records) contains precise locations (better than or equal to 100 metres) for all populations of the species.

10.1.4 Grazing and other farming activities

All eight known *Z. involucrata* populations that occur on private freehold property are in areas where the zoning allows agriculture to be carried out without the consent of council. Grazing of livestock and other non-intensive agricultural activities may also be permissible under Crown licence, or be occurring illegally, on unreserved or reserved Crown land in the vicinity of some *Z. involucrata* populations.

Grazing may impact directly on the species through grazing, or lead to degradation of vegetation structure and floristics through trampling, erosion and the spread of weeds. Land-holders may be unaware of the presence of *Z. involucrata* on their properties and any potential impacts that their activities may be having on it. Liaison with these land-holders is required to raise their awareness of the species and the potential impact of intense grazing, and to facilitate the implementation of protection measures, such as fencing to exclude livestock and machinery.

Additionally, feral goats, which were known to exist in the Laughtondale Gully Road area and northern part of Marramarra National Park (Maryott-Brown 1994b, ESP 1998), may present a threat to some populations both within and outside conservation reserves. Their management may require cooperation between the managers of Marramarra National Park, adjoining private property owners and Hornsby Council.

10.1.5 Bush rock removal

“Bush rock removal” is recognised as a key threatening process for several threatened plant species under the NSW *Threatened Species Conservation Act 1995* (TSC Act). For further information about this key threatening process see the NSW Scientific Committee Determination Advice 99/25 (NSW Scientific Committee 1999) and the NPWS fact sheet ‘Bushrock removal: a key threatening process’ (NSW NPWS 1999). As *Z. involucrata* often occurs in areas where Hawkesbury sandstone outcrops or occurs as colluvium, removal of bush rock is considered to be one of the threats to the survival of *Z. involucrata*. Legal or illegal bush rock removal in such areas may destroy plants and degrade the habitat of the species.

Bush rock removal is prohibited from National Parks and Wildlife Service estate and requires ‘lawful authority’ on public land (under the *Crown*

Lands Act 1989). The Hawkesbury Local Environmental Plan prohibits bush rock removal and the Blue Mountains LEP has provisions which specifically regulate the activity.

The impact of this threat could be minimised through land-holder, neighbour and community education. Baulkham Hills and Hornsby councils could also consider including provisions regulating bush rock collection in local environmental plans.

10.1.6 Weed invasion

Weed invasion is a symptom of habitat degradation. Weeds can take the place of native species in the habitat (particularly in the understorey) and eventually change the composition and ecological function of that habitat to the detriment of native species that occur there. Weed invasion is considered to be a threatening process at several *Z. involucrata* sites (Zi_10a and Zi_10b along Laughtondale Gully Road; Zi_11) and in some areas of potential habitat for the species (e.g. along Marramarra Creek) (Maryott-Brown 1994b, ESP 1998, S. Douglas, pers. comm. 2004). Current levels of weed infestation are unknown, nor is it known whether they warrant remedial action. However, weeds may become an increasingly important threat to populations in catchments where rural-residential and agricultural development along ridgetops is a vector for weed species and promotes their spread through increased nutrient levels in run-off.

The management of weeds at *Z. involucrata* sites will require targeted bush regeneration efforts. These efforts should aim to restore, maintain and expand suitable habitat for the species. It is important that land managers are aware that weed control measures have the potential to impact negatively on *Z. involucrata*. Caution should be applied when using herbicides to control environmental weeds within or near the habitat *Z. involucrata*, as its tolerance to herbicides is unknown. Manual weed management methods may be more appropriate.

10.1.7 Infection by *Phytophthora cinnamomi*

“Infection of native plants by *Phytophthora cinnamomi*” is listed as a key threatening process for many threatened species, populations and ecological communities under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). For further information about this key threatening process see the NSW Scientific Committee Determination Advice 02/27 (NSW Scientific Committee 2002b) and the Commonwealth *Threat abatement plan for dieback caused by the root-rot fungus*. However, there is no

published evidence regarding the susceptibility of *Z. involucrata* to *P. cinnamomi* dieback. Nor is the distribution of *P. cinnamomi* in the area of occurrence of *Z. involucrata* known. However, it can be considered a potential threat to *Z. involucrata* due to the growing potential for spread of the pathogen because of increasing human activities on the northern outskirts of the Sydney metropolitan area.

10.1.8 Climate change

“Human-induced climate change” is listed as a key threatening process for many threatened species and ecological communities under both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). For further information about this key threatening process see the NSW Scientific Committee Determination Advice 00/24 (NSW Scientific Committee 2000a) and the relevant Commonwealth Threatened Species Scientific Committee listing advice⁸. There is evidence that modification of the environment by humans may result in future climate change, which includes changes to the frequency of occurrence of extreme events such as droughts and fires. The apparent requirement of *Z. involucrata* for sheltered and/or high soil moisture conditions may make this species susceptible to population decline as a result of more frequent or long-term drought, which may reduce the extent and connectivity of suitable habitat.

10.1.9 Hydrological change

Alteration to the natural flow regimes of rivers and streams is recognised as a key threatening process for several threatened plant species, populations and ecological communities under the NSW *Threatened Species Conservation Act 1995* (TSC Act). For further information about this key threatening process see the NSW Scientific Committee Determination Advice 02/12 (NSW Scientific Committee 2002a). The alteration of the water regime patterns and water quality due to agricultural and rural-residential development may facilitate establishment and spread of semi-terrestrial weed species that may impact at several sites as discussed in section 10.1.5.

10.2 Limits to current knowledge

Our ability to manage a threatened species is dependent on our knowledge of the biological and ecological requirements of that species and the circumstances that threaten population persistence. As outlined in section 8, we currently have little

understanding of the reproductive biology and population ecology of *Zieria involucrata*. Greater understanding of a number of aspects will assist in the effective management of this threatened species, particularly if we are to conserve the species in the long-term. In addition, increased understanding will assist consent and determining authorities in making informed judgements as to its conservation requirements.

Systematic survey targeted in areas of likely habitat – sheltered aspects and lower slopes, for example – within the potential habitat of the species is required to obtain further information on its distribution and conservation status and better understanding of its habitat characteristics. While many of the ridgelines in the Marramorra – Maroota area have been surveyed for rare or threatened plants, survey effort has been largely absent from lower slopes and gullies of the rugged sandstone terrain (S. Douglas, pers. comm.). Such survey should occur on both national park estate and other tenures.

Future investigations should target aspects, as outlined as follows, which are relevant to the practical and long-term management of the species and its habitat. Further research for the species could include investigation of:

Demography and reproductive ecology

- the survivorship and growth patterns of seedlings and adults;
- the age at which *Z. involucrata* is capable of flowering and producing seed, the factors (e.g. plant size, plant age, time since fire) which influence flowering and fruiting, and the magnitude and variation in seed production in relation to those factors;

Seed biology and ecology

- determination of the period that the soil seed bank remains viable;
- seed dormancy and germination mechanisms, including the interactive effects of heat and smoke on breaking seed dormancy;
- dispersal mechanisms;

Disturbance ecology

- a systematic and quantitative assessment of the response of the soil seed bank to different fire regimes (frequency, intensity, seasonality);
- investigation of resprouting ability and how this might affect reproductive capability;

Genetic investigation

- genetic investigations across the natural range of *Z. involucrata* would improve our understanding of the species’ population structure and consequently, could inform

⁸ see DEH website www.deh.gov.au/biodiversity/threatened/kt/greenhouse.html

impact assessment and recovery planning decisions.

10.3 Community awareness

An increased awareness of *Z. involucrata* is required to ensure that the species is appropriately considered in statutory environmental planning and impact assessment processes, and to facilitate the implementation of threat abatement works. The target groups for awareness raising initiatives are:

- public authorities;
- affected private landowners; and
- the general community.

Public authorities with consent, determining or environmental planning responsibilities under the EP&A Act require an understanding of the species, particularly its known locations, habitat requirements and sensitivity to impacts. Initiatives to assist these authorities in meeting their statutory obligations regarding the conservation of *Z. involucrata* habitat include:

- preparation and distribution of a species profile and environmental impact assessment guidelines; and
- inclusion of all known site locations on the DEC Atlas of NSW Wildlife.

The informed support of the private landowners whose land contains *Z. involucrata* is essential to the success of the recovery program. Liaison with affected landowners will be implemented through this recovery plan to facilitate such support.

The third target audience for awareness raising initiatives is the general community. These initiatives aim to enhance the social benefits of the recovery program and include:

- preparation of press releases to highlight the implementation of key recovery actions; and
- involvement of community members in the implementation of recovery actions.

10.4 Translocation and ex-situ conservation

10.4.1 Translocation

Translocation is defined as the deliberate transfer of plants or regenerative plant material, from an *ex-situ* collection or natural population, to a location in the wild, including existing or new sites or those where the taxon is now locally extinct. It is often raised as a possible method of conserving threatened flora. The process, benefits and costs of translocation have recently been reviewed by Vallee *et al.* (2004).

Translocation requires long-term commitment, is expensive and often prone to failure. Many previous attempts at translocating threatened flora have failed for reasons which include the unsuitability of recipient sites, poor information in relation to the species biology, ecology, and genetic variation, and a lack of ongoing commitment to site maintenance and monitoring. Given the high cost and risk associated with the technique, translocation should only be considered as a last resort when all other management options are deemed inappropriate or have failed. Vallee *et al.* (2004) argue that resources will be more effective when directed towards conserving existing populations *in-situ* through habitat protection and/or habitat rehabilitation measures and through the control of threatening processes.

Translocation is not currently considered necessary for the survival of *Zieria involucrata* as the *in-situ* conservation measures proposed in this recovery plan are expected to meet the conservation needs of the species. Furthermore, primarily due to the uncertainty of success and the risks associated with translocation, the technique should not be considered by consent/determining authorities to be an appropriate means of ameliorating the impact of a development proposal on the species (Vallee *et al.* 2004). In addition, the use of translocation should not be considered as a mitigative measure when determining the potential impact of a development (i.e. translocation does not decrease the significance of an impact) (Vallee *et al.* 2004).

10.4.2 Ex-situ collection

As indicated in section 9.8, the Botanic Gardens Trust does not have, nor does it intend to collect, cutting or seed material to cover the range of geographical, morphological or genetic variability across the total population of the species.

10.5 Roles and interests of indigenous people

Zieria involucrata occurs in the areas of the Deerubbin and Metropolitan Local Aboriginal Land Councils, and in the area of interest to the Darug Tribal Aboriginal Corporation, Darug Custodian Aboriginal Corporation, Gundungurra Tribal Council Aboriginal Corporation and Blue Mountains Aboriginal Cultural Resource Centre. These groups and other Aboriginal people in the areas affected by this recovery plan have yet to be consulted to determine if they have an interest in the species or the actions proposed. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

10.6 Ability to recover

10.6.1 Rarity

It is not known whether *Z. involucrata* is naturally uncommon or whether it has suffered minor or substantial declines in population size. At the time the species was listed as endangered under the TSC Act, not more than 15 extant populations of the species were known. However, a further seven populations have subsequently been discovered. The rugged and isolated nature of much of its range makes survey difficult and costly, but it is highly likely that further populations are present within its known area of occurrence.

10.6.2 Viability

The viability of a species can be broadly defined as the ability of that species to be self-replacing in nature. There is currently little information as to the viability of the *Z. involucrata* populations identified in this recovery plan. In the absence of a detailed assessment demonstrating otherwise (and including consideration of the potential *Z. involucrata* soil seedbank), all *Z. involucrata* populations and sites should be assumed to be viable.

10.6.3 Likelihood of recovery

“Recovery” of *Z. involucrata* is defined in the TSC Act as “to promote the species to a position of viability in nature”, by ensuring its continued and long-term survival in the wild. The explicit performance goal of this plan is to at least maintain, and if possible improve, the current conservation status of *Z. involucrata* (as endangered) and prevent its decline to a less desirable one (i.e. presumed extinct). The actions in this recovery plan are focused on protecting and maintaining known populations *in situ* across the species’ natural range. The likelihood of achieving this recovery objective is high provided these actions are implemented, reviewed and amended as required.

10.7 Social and economic consequences

10.7.1 Social consequences

Negative social impacts are not envisaged as the implementation of the recovery plan is not expected to affect public land usage to any great extent, and modification of private land management patterns will occur at the land manager’s discretion. Continued liaison with the local community, affected land-holders and public authorities will address and minimise any unforeseen negative social impacts arising from the implementation of this plan.

Indeed, it is expected that the implementation of this recovery plan will have positive social impacts

on the local communities involved and, in particular, on the owners and managers of *Z. involucrata* habitat. The implementation of recovery actions (including site monitoring and surveys) will provide benefits to the environment and/or enhance the general well being of the community and individuals involved.

Increased awareness regarding the conservation of threatened species in a rural setting will encourage recognition amongst land-holders of the value of remnant vegetation and their responsibility for habitat management. Personal and regular contact with land-holders and local community groups is a key strategy to achieving this.

10.7.2 Economic consequences

The economic consequences of this recovery plan comprise costs that are associated with its implementation. This includes the costs associated with on-ground habitat management, conducting biological research and monitoring, community education and participation, and on-going coordination of the reference group. These costs can be off-set and minimised by:

- implementing a long-term strategic framework for managing the species and its habitat;
- maintaining accurate information on the distribution and status of sites;
- adopting a cooperative approach to management by involving the relevant land managers and the local community; and
- seeking funds from external sources.

The improved environmental impact assessment resulting from mechanisms established in this recovery plan will assist consent and determining authorities to meet their statutory responsibilities. The production of this recovery plan will decrease the costs associated with collating available information on *Z. involucrata* when undertaking impact assessment.

Substantial economic consequences may result where the species’ conservation requirements prevent or restrict the use of land that is currently identified for mineral extraction, agriculture or urban development. These consequences will be identified and addressed by statutory environmental impact assessment processes.

10.8 Biodiversity benefits

The conservation and study of *Zieria involucrata* will benefit other threatened species that share the same habitat, particularly *Asterolasia elegans*, a species listed as endangered at state and national levels, and other rare or threatened plant species such as *Boronia fraseri* and *Platysace clelandii*, and the threatened fauna *Pseudophryne australis* (red-

crowned toadlet) and *Heleioporus australiacus* (giant burrowing frog) which have been found at some *Z. involucrata* sites (ESP 1998).

Increased awareness of *Z. involucrata* resulting from the implementation of this recovery plan will raise the profile in the community of all threatened species. This in turn will lead to greater opportunities for the conservation of threatened species and increased protection of biodiversity.

11 Proposed recovery objectives, actions and performance criteria

This plan includes six recovery objectives that will each contribute to achieving the overall goal of maintaining or improving the current conservation status of *Z. involucrata*. These objectives are to:

- conserve *Z. involucrata* using land-use and conservation planning mechanisms;
- implement a survey and monitoring program that will provide information on the extent, viability and habitat of *Z. involucrata*;
- identify and minimise the operation of threats at sites where *Z. involucrata* occurs;
- provide public authorities and the community with information that assists in conserving the species;
- raise awareness of the species and involve the community in the recovery program; and
- promote research that will assist future management decisions.

Specific recovery actions and performance criteria follow.

11.1 Recovery objective 1: Conserve *Z. involucrata* using land-use and conservation planning mechanisms

A high proportion of *Z. involucrata* sites occur on freehold land or public land that is not managed primarily for conservation purposes. This objective aims to increase the legislative protection afforded to these sites through the following mechanisms:

- conservation agreements and covenants under the NPW Act and *Conveyancing Act 1919*;
- joint management agreements and property management plans under the *Threatened Species Conservation Act*,
- property vegetation plans under the *Native Vegetation Act* and catchment action plans under the *Catchment Management Authorities Act 2003*;
- environmental planning instruments under Part 3 of the EP&A Act and development standards;

- classification of land as community land under the *Local Government Act* and subsequent consideration of the species in plans of management for such land;
- environmental impact assessment under the EP&A Act; and
- consideration of a critical habitat declaration under the TSC Act.

Action 1.1a: The DEC Environment Protection and Regulation Division (DEC EPRD) or Parks and Wildlife Division (PWD) will advise private land-holders of the presence of Z. involucrata on their land and of the opportunities and advantages of entering into conservation agreements or other covenants.

Action 1.1b: The DEC Environment Protection and Regulation Division (DEC EPRD) or DEC Parks and Wildlife Division (PWD) will advise relevant public authorities and public utilities (e.g. Telstra) of the presence of Z. involucrata on lands under their control or management.

Performance Criterion 1.1: Within six months of the implementation of this recovery plan, all land owners and managers of land supporting Z. involucrata will be notified by DEC EPRD or PWD, of the presence of the species, and private land-holders will be advised of the advantages of entering into a conservation agreement or covenant.

Action 1.2: The Department of Infrastructure Planning and Natural Resources (DIPNR) will prepare or review all relevant environmental planning instruments with reference to this recovery plan and its objectives and any future advice from DEC regarding the distribution, habitat, biology and ecology of and threats to the species.

Performance Criterion 1.2: Each relevant environmental planning instrument by DIPNR is prepared or reviewed in accordance with this action.

Action 1.3: Councils will prepare or review local environment plans and development control plans with reference to this recovery plan and its objectives and any future advice from DEC regarding the distribution, habitat, biology and ecology of the species.

Councils should consider the options for rezoning such sites to afford more secure environmental protection for these populations. In particular, Baulkham Hills Shire Council should consider revising the zoning of Crown reserve 88000, also known (by Council) as Reserve No.561.

In addition, to mitigate both direct and indirect impacts on the species, councils should consider features which could be incorporated as

development controls into the design and implementation of developments that are to be constructed upslope of, proximate to, or between *Z. involucrata* sites. Sufficient vegetated buffers should be retained around and between *Z. involucrata* sites to maintain the integrity and connectivity of its habitat.

This action should also include consideration by councils of the inclusion in local environmental plans of provisions regulating bush rock collection.

Performance Criterion 1.3: Each relevant local environment plan and development control plan is prepared or reviewed in accordance with this action.

Action 1.4: DEC Environment Protection and Regulation Division (EPRD) will liaise with the Department of Lands regarding reviews of the status of Crown lands on which populations of Z. involucrata occur, with a view to reserving them primarily for environmental protection.

Relevant Crown land on which *Z. involucrata* is currently known to occur is:

- Unreserved Crown land (no proper title description) in the former Maroota State Forest (population Zi_09). This area is under the control of the Department of Lands, but is currently subject to an Aboriginal land claim by the Deerubbin LALC.
- Crown reserve 88000 for public recreation, on Wisemans Ferry Road, South Maroota (population Zi_04). This area of Crown land is under the control of Baulkham Hills Shire Council.

Such reviews should include a land assessment in accordance with Part 3 of the *Crown Lands Act 1989* and consideration of the preparation of a plan of management for the reserve. This action could be carried out in conjunction with Action 3.5.

Performance Criterion 1.4: The Department of Lands reviews the current reservations of Crown lands supporting Z. involucrata populations, with a view to reserving it primarily for environmental protection, within 3 years of adoption of this recovery plan.

Action 1.5: DEC will consider the need for declaration of critical habitat by the fifth year of implementation of this recovery plan.

Performance Criterion 1.5: DEC will consider the need for and prepare a submission to the Minister regarding declaration of critical habitat by the fifth year of implementation of this recovery plan.

11.2 Recovery objective 2: Implement a survey and monitoring program

Action 2.1: DEC Environment Protection and Regulation Division (EPRD) will coordinate surveys to assess the size, characteristics and conservation status of and threats to known Z. involucrata populations and habitats.

Performance Criterion 2.1: Surveys of all known Z. involucrata populations carried out and documented within three years, subject to landholder approval.

Action 2.2: DEC Environment Protection and Regulation Division (EPRD) and DEC Parks and Wildlife Division (PWD) to conduct surveys of potential habitat on public or private lands.

Performance Criterion 2.2: At least one survey within potential habitat to be conducted annually for Z. involucrata.

Action 2.3: DEC Environment Protection and Regulation Division (EPRD) will design and facilitate a monitoring program that will enable long-term monitoring of the population dynamics and viability of selected Z. involucrata populations.

Performance Criterion 2.3: A long-term monitoring program to be designed by year three and implemented by year five, following adoption of this recovery plan.

11.3 Recovery objective 3: Identify and minimise the threats operating at sites where the species occurs

Actions under this objective aim to identify and manage these threats through the implementation of appropriate *in situ* threat abatement measures in accordance with management plans and site management statements.

Action 3.1: DEC Parks and Wildlife Division (PWD) and Environment Protection and Regulation Division (EPRD) will prepare site management statements for each known Z. involucrata population located on DEC estate or on land that becomes subject to a conservation agreement.

The DEC Parks and Wildlife Division (PWD) and Environment Protection and Regulation Division (EPRD) will assess the condition and document the fire and management history of all sites that are located on DEC estate or on land that becomes subject to a conservation agreement. For each site DEC will subsequently prepare a site management statement (based on the guide in Appendix 3) that details the specific threat abatement measures

required and a timetable to implement these measures.

Performance Criterion 3.1: DEC PWD and EPRD will prepare site management statements for all sites located on DEC estate or on land that becomes subject to a conservation agreement within three years of the adoption of this recovery plan.

Action 3.2: DEC PWD will consider and incorporate *Z. involucrata* recovery objectives into reserve fire management strategies and district bush fire management plans. DEC PWD will also consider and incorporate *Z. involucrata* recovery objectives into the asset management system for sites where *Z. involucrata* occurs along trails on DEC estate.

Performance Criterion 3.2: DEC PWD considers and incorporates *Z.* recovery objectives into each relevant reserve fire management strategy, district bush fire management plan and the asset management system.

Action 3.3: DEC Environment Protection and Regulation Division (EPRD), in consultation with land-holders, will prepare site management statements for *Z. involucrata* sites located on freehold land.

DEC Environment Protection and Regulation Division (EPRD), in consultation with land-holders, will assess the condition of sites located on freehold land and prepare site management statements that detail the specific threat abatement measures required at those sites.

Performance Criterion 3.3: Site management statement prepared, subject to land-holder approval, for each site on freehold land, within three years of the adoption of this recovery plan.

Action 3.4: DEC Environment Protection and Regulation Division (EPRD) will encourage and assist land-holders to seek funding for and carry out threat abatement measures for *Z. involucrata* on private property in accordance with the site management statements prepared under Action 3.3.

Performance Criterion 3.4: Funding secured and threat abatement measures for relevant sites implemented in accordance with site management statements within five years, subject to land-holder approval.

Action 3.5: DEC Environment Protection and Regulation Division (EPRD) will liaise with the Department of Lands, the Deerubbin Local Aboriginal Land Council and relevant councils regarding the preparation and implementation of site-specific protection measures for each *Z. involucrata* population on Crown land.

Relevant Crown land on which *Z. involucrata* is currently known to occur is:

- Unreserved Crown land (no proper title description) in the former Maroota State Forest (population Zi_09). This area is under the control of the Department of Lands, but is currently subject to an Aboriginal land claim by the Deerubbin LALC.
- Crown reserve 88000 for public recreation, on Wisemans Ferry Road, South Maroota (population Zi_04). This area of Crown land is under the control of Baulkham Hills Shire Council.
- possibly two locations on Crown road reserve along Laughtondale Gully Road in Hornsby LGA (subpopulations Zi_10a and Zi_10b). This Crown road reserve is under the control of Hornsby Shire Council.

However, the species may be found at other sites in the future.

Planning and implementation of such measures should occur with reference to this recovery plan and any future advice provided by DEC regarding the biology and ecology of and threats to the species. Site-specific information to be incorporated into these plans should be guided by that outlined in Appendix 3 and should include:

- population numbers, condition and location details;
- an assessment of existing and potential threats to *Z. involucrata* at the site;
- measures to be implemented to address these threats;
- description of procedures that ensures that construction, maintenance and other staff and contractors are made aware of the location of *Z. involucrata* plants and the measures to be taken to manage them;
- measures to manage habitat for the species;
- a program to monitor and evaluate the effectiveness of the proposed identification, protection and regeneration measures.

Performance Criterion 3.5: Preparation of site-specific protection measures for each currently known *Z. involucrata* population on Crown land within three years of the adoption of this recovery plan. Site-specific protection measures for populations subsequently found on Crown land to be prepared and implemented within three years from notification of the presence of the population.

Action 3.6: Councils, the Department of Infrastructure Planning and Natural Resources (DIPNR) and other consent or determining authorities will assess developments and activities with reference to this recovery plan,

environmental impact assessment guidelines and any future advice from DEC regarding the distribution, habitat, biology and ecology of and threats to the species.

Environmental impact assessment guidelines, provided in Appendix 2, will be updated periodically. There may be a need for targeted survey for the species when assessing the impact of a development, including survey within potential habitat of *Z. involucrata* where the species is currently unrecorded. Features to mitigate both direct and indirect impacts on the species could be incorporated into the design and control of developments that are to be constructed upslope of, or proximate to, *Z. involucrata* sites. Sufficient vegetated buffers should be retained around sites containing *Z. involucrata* sites to maintain the integrity of its habitat. The extent and design of the buffers required to achieve this will be site-specific, depending on factors such as aspect and slope, drainage patterns and adjacent land uses.

Performance Criterion 3.6: Each relevant development or activity is assessed with reference to this recovery plan, the environmental impact assessment guidelines and any future advice from DEC regarding the distribution, habitat, biology and ecology of and threats to the species.

11.4 Recovery objective 4: Provide public authorities and the community with information that assists in conserving the species

The prompt and effective distribution of information on *Z. involucrata* and its habitat is an important component of ensuring that the conservation requirements of the species are appropriately considered in land-use planning decisions. Actions under this objective use the following mechanisms to aid the dissemination of information about the species:

- verification and distribution of accurate location records to relevant parties
- preparation of potential habitat model, species profiles and environmental impact assessment guidelines.

Action 4.1: DEC Environment Protection and Regulation Division (EPRD) will update the Atlas of NSW Wildlife dataset and ensure that verified Z. involucrata records are entered with precise georeferences (better than or equal to 100 metres).

Performance Criterion 4.1: Precise location records from the Atlas of NSW Wildlife are made available to relevant authorities within four months of verification or discovery.

Action 4.2: Approval and certifying authorities (including authorities that issue or certify bush fire hazard reduction certificates) will incorporate

updated Atlas of NSW Wildlife data into relevant datasets (including the Threatened Species Hazard Reduction List of the Bush Fire Environmental Assessment Code) and distribute it to appropriate officers.

Performance Criterion 4.2: Updated Atlas of NSW Wildlife data is incorporated and used by approval and certifying authorities in decision making.

Action 4.3: DEC Environment Protection and Regulation Division (EPRD) will model potential habitat using the most recent dataset of Z. involucrata records.

Modelled habitat will improve targeting of new surveys for the species to appropriate habitats.

Performance Criterion 4.3: Z. involucrata potential habitat is re-modelled and mapped.

Action 4.4: DEC EPRD Threatened Species Unit will update the species profile and environmental impact assessment guidelines for the species to incorporate information acquired during the implementation of this recovery plan

Performance Criterion 4.4: Species profile and environmental impact assessment guidelines for the species updated as required and made publicly available.

Action 4.5: DEC Environment Protection and Regulation Division (EPRD) and the NSW Rural Fire Service will review the mitigative conditions for Z. involucrata in the Threatened Species Hazard Reduction List of the Bush Fire Environmental Assessment Code.

DEC and RFS will use available biological and ecological information to reassess the immediate and cumulative impact of bush fire hazard reduction works on *Z. involucrata* and the adequacy of the mitigative conditions in the Threatened Species Hazard Reduction List.

Performance Criterion 4.5: The mitigative conditions for Z. involucrata on the Threatened Species Hazard Reduction List TSHRL reviewed in year 4 or 5 of the implementation of this recovery plan.

Action 4.6: Public authorities will inform the DEC EPRD of decisions that may affect Z. involucrata or its habitat.

Public authorities will inform DEC EPRD if planning or development decisions are made that may affect *Z. involucrata* or its habitat. This includes information on decisions that protect habitat, as well as those that lead to a reduction in habitat and/or individuals. For the purposes of this action public authorities are taken to include the following:

- the NSW Department of Infrastructure, Planning and Natural Resources
- Blue Mountains City Council
- Baulkham Hills Shire Council
- Hawkesbury City Council
- Hornsby Shire Council
- the NSW Department of Lands
- the NSW Rural Fire Service.

The Rural Fire Service will implement this action, with respect to bush fire hazard reduction, by ensuring that there is adequate access by DEC EPRD to temporal and spatial data from the Bushfire Risk Information Management System (BRIMS).

Performance Criterion 4.6: DEC EPRD informed of all decisions that affect the species or its habitat.

11.5 Recovery objective 5: Raise awareness of the species and involve the community in the recovery program

In order to enhance the social benefits of the recovery program for *Z. involucrata* and assist in its implementation, actions under this objective aim to raise awareness of the recovery plan and involve the community in its implementation.

Action 5.1: DEC Environment Protection and Regulation Division (EPRD) or DEC Parks and Wildlife Division (PWD) will consult with the Deerubbin and Metropolitan Local Aboriginal Land Councils, the Darug Tribal Aboriginal Corporation, Darug Custodian Aboriginal Corporation, Gundungurra Tribal Council Aboriginal Corporation and Blue Mountains Aboriginal Cultural Resource Centre, and, if identified, other interested Aboriginal groups or individuals to seek special knowledge about Z. involucrata and to consider of the roles and interests of indigenous communities in the region.

Performance Criterion 5.1 DEC EPRD or PWD will consult with these parties within the first year of implementation of this recovery plan.

Action 5.2: DEC Environment Protection and Regulation Division (EPRD), DEC Parks and Wildlife Division (PWD) and councils that manage land that supports Z. involucrata will raise awareness of, and encourage community involvement in, the recovery program.

Under this action, the DEC EPRD, DEC PWD, Baulkham Hills Shire and Hornsby Shire councils will raise awareness of the recovery program among the community, and will encourage involvement in the implementation of recovery

actions, including survey, monitoring and bush regeneration. One way this action may be facilitated by councils is through the formation of “friends” groups for relevant council-managed reserves. DEC will also distribute information about the *Z. involucrata* recovery program to affected landholders, public authorities, community groups and interested individuals.

Performance Criterion 5.2: Active community involvement in the implementation of recovery actions occurs at least once a year.

Action 5.3: The DEC Environment Protection and Regulation Division (EPRD) and DEC Parks and Wildlife Division (PWD) will assist community groups and local government in preparing funding applications to undertake recovery for Z. involucrata.

Community groups, if provided adequate funding and appropriate support, would be able to assist in the implementation of threat abatement works (Recovery objective 3).

Performance Criterion 5.3: At least one funding application prepared annually by community group and/or local government to undertake threat abatement works within the habitat of Z. involucrata.

11.6 Recovery objective 6: Promote investigations into the ecology and biology of the species in order to provide information to assist future management decisions

As outlined in section 10.2, there are a number of potential research questions that could assist in the management of *Z. involucrata*. However, given the absence of funds to conduct this research, this plan advocates the promotion of potential research questions rather than funding the research in itself.

Action 6.1: DEC Environment Protection and Regulation Division (EPRD) to promote potential research projects as identified in this recovery plan.

The EPRD will liaise with tertiary and other research institutions to encourage and facilitate research into the species consistent with the priorities outlined in section 10.2.

Performance Criterion 6.1: All universities and other research institutions within the Newcastle, Central Coast and Sydney areas contacted regarding potential research areas by the end of the second year following implementation of this recovery plan.

Action 6.2: DEC Botanic Gardens Trust will consider Z. involucrata as a candidate, as part of the SeedQuest NSW program, for research on

seed viability and the requirements for successful conservation storage.

Performance Criterion 6.2: Z. involucrata formally considered by Mt Annan Botanic Gardens for research in the SeedQuest NSW program.

12 Implementation

The cost to implement the plan is approximately \$118,000 over five years, plus as yet undetermined costs for planning and implementing on-site management on private and Crown lands as these costs are yet to be determined. Of this total, approximately \$82,000 is expected to be provided as in-kind contributions by the Department of Environment and Conservation with an additional \$36,000 required to implement actions that are currently unfunded. Additional funds will be sought from sources including the Natural Heritage Trust, Environment Trust, industry sponsors, the NSW State Biodiversity Program, Threatened Species Network, Threatened Species Appeal and DEC annual provisions for implementation of threatened species programs.

Table 4 details the costs and identifies the parties responsible for the implementation of specific recovery actions.

13 Preparation details

This recovery plan was prepared by Nick Corkish of the Department of Environment and Conservation (NSW), Metropolitan Region, Threatened Species Unit, with the advice and assistance of those acknowledged at the front of this plan. This plan supersedes a recovery plan prepared by Kylie Maryott-Brown (1994b) under the Commonwealth *Endangered Species Protection Act 1992*.

14 Review date

This Recovery Plan is to be formally reviewed and updated by the Department of Environment and Conservation (NSW) five years from the date of its publication.

Draft Recovery Plan for *Zieria involucrata*

Table 4: Estimated costs, funding source and responsible parties for implementing the actions identified in the *Zieria involucrata* recovery plan

Action	Action description	Priority	Responsible party	DEC fund source	Cost estimate (\$/year)					Total Cost (\$)
					Yr 1 2004-05	Yr 2 2005-06	Yr 3 2006-07	Yr 4 2007-08	Yr 5 2008-09	
1.1	Notification of land-holders	1	DEC (EPRD), DEC (PWD)	DEC in-kind	1400	-	-	-	-	1400
1.2	Preparation/review of EPIs	1	DIPNR	-	#	#	#	#	#	-
1.3	Preparation/review of LEPs and DCPs	1	BHSC, BMCC, HCC, HSC	-	#	#	#	#	#	-
1.4	Liaison re review of Crown land reservations	2	DEC (EPRD) with Lands	DEC in-kind	√ (Action 3.5)	√ (Action 3.5)	√ (Action 3.5)	-	-	*
1.5	Critical habitat consideration	2	DEC (EPRD)	DEC in-kind	-	-	-	-	1100	1100
2.1	Surveys of known populations	1	DEC (EPRD)	Unsecured	6000	6000	6000	-	-	18000
2.2	Targeted survey within potential habitat	1	DEC (EPRD), DEC (PWD)	Unsecured	2100	2100	2100	2100	2100	10500
2.3	Design and implement monitoring program	1	DEC (PWD) & DEC (EPRD)	DEC in-kind	5000	5000	4000	4000	4000	22000
3.1	Site management statements for DEC estate	1	DEC (PWD) & DEC (EPRD)	DEC in-kind	5000	5000	5000			15000
3.2	Consideration in reserve fire management strategies & district bush fire management plans		DEC (PWD)	DEC in-kind	#	#	#	#	#	-
3.3	Site management statements for private property	1	DEC (EPRD)	Unsecured	1800	1800	1800	-	-	5400
3.4	Threat abatement funding assistance for private property sites	1	DEC (EPRD)	Unsecured	*	*	*	*	*	*
3.5	Liaison re site-specific protection measures for populations on Crown land	1	DEC (EPRD) with Lands, BHSC, BMCC, HCC, HSC & Deerubbin LALC	DEC in-kind	1400 *	1400 *	1400 *	- *	- *	4200 *
3.6	Environmental impact assessment	1	BHSC, BMCC, HCC, HSC, DIPNR, Lands	-	#	#	#	#	#	-
4.1	Verify, update & distribute location records	1	DEC (EPRD)	DEC in-kind	1800	700	700	700	700	4600
4.2	Obtain & distribute updated location records	1	BHSC, BMCC, HCC, HSC, Lands & RFS	-	#	#	#	#	#	-
4.3	Model potential habitat	1	DEC (EPRD)	Unsecured	2100	-	-	-	-	2100
4.4	Update species profiles and EIA guidelines	1	DEC (EPRD)	DEC in-kind	-	-	-	1100	-	1100
4.5	Review Threatened Species Hazard Reduction List conditions	2	DEC (EPRD)	DEC in-kind	-	-	-	-	1100	1100
4.6	DEC informed of planning decisions	2	BHSC, BMCC, HCC, HSC, DIPNR, Lands & RFS	-	#	#	#	#	#	-
5.1	Consultation with Aboriginal interests	1	DEC (EPRD), DEC (PWD)	Unsecured	2100	2100	2100	2100	2100	10500
5.2, 5.3	Community awareness & involvement	2	DEC (EPRD), DEC (PWD), BHSC, BMCC, HCC, HSC	DEC in-kind	3500 *	3500 *	3500 *	3500 *	3500 *	17500 *
6.1	Promote research	2	DEC (EPRD)	DEC in-kind	700	700	700	700	700	3500
6.2	Consider as subject for SeedQuest program	2	DEC (BGT)	DEC in-kind	#	#	#	#	#	-
Total costs				Unsecured	12000	9900	9900	2100	2100	36000
				DEC in-kind	20900	18400	18500	12100	13200	82000
				TOTAL	32900	28300	28400	14200	15300	118000

Key to abbreviations, terms and symbols in costing table:

BGT – DEC Botanic Gardens Trust, **BHSC** – Baulkham Hills Shire Council; **BMCC** – Blue Mountains City Council, **DEC** – Department of Environment and Conservation (NSW), **DIPNR** – Department of Infrastructure Planning and Natural Resources, **EPRD** – DEC Environment Protection & Regulation Division, **HCC** – Hawkesbury City Council, **HSC** – Hornsby Shire Council, **Lands** – Department of Lands (NSW), **PWD** – DEC Parks & Wildlife Division, **RFS** – Rural Fire Service NSW, **SFNSW** – State Forests of NSW.

Priority rankings: **1** - Action critical to meeting plan objectives, **2** - Action contributing to meeting plan objectives, **3** – Desirable but not essential action.

DEC in-kind funds represent the salary component of permanent DEC staff and recurrent resources. Salary for in-kind contributions is calculated at \$350 per day, which includes officer salary and on-costs, provision of office space, vehicles, administration support and staff management. **Unsecured** funds will be sought from sources including DEC annual operational provisions for the implementation of threatened species programs, the Natural Heritage Trust, Environmental Trust, industry sponsors, the NSW State Biodiversity Program, Threatened Species Network, Threatened Species Appeal and DEC annual provisions for implementation of threatened species programs.

- Cost of action is negligible or action is a statutory responsibility of the responsible party; √ - No additional costs (included in the cost of other actions); * - Amount to be determined by the responsible party.

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Appendix 1: *Zieria involucrata* location details and population-specific information

SUBSTITUTE 2 PAGES WITH TABLE ON A3-SIZE PAGE

Appendix 2: *Zieria involucrata* species profile and environmental impact assessment guidelines

The information provided in the species profile and the environmental impact assessment guidelines is the best available at the time of publication of this recovery plan. They will be updated periodically as new information becomes available. Consent and determining authorities, developers and EIA consultants should ensure that they obtain the most recent information by contacting the Threatened Species Unit of the relevant region of the Department of Environment and Conservation.

THREATENED SPECIES INFORMATION

Zieria involucrata

R.Br ex Benth.

Common name: **none**Family: **Rutaceae****Conservation status**

Zieria involucrata is listed as an **endangered species** on Schedule 1 of the NSW *Threatened Species Conservation Act 1995* (TSC Act) and as a **vulnerable species** under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).



Photo: D. Beckers

Description

Zieria involucrata (family Rutaceae) is a small, erect, sparse shrub, growing to 1-2 metres in height. The branches and leaves are densely covered with hairs, which form a soft, velvety

covering (tomentum). The hairs are predominantly star-shaped, though simple and two-forked hairs are also present. Its opposite leaves consist of either a single leaflet (1-foliolate leaves) or three leaflets (3-foliolate leaves), with both forms usually being present on the same branch (rarely unifoliolate leaves only are present on a branch). Leaflets are dark green above, light grey-green below, more or less oblong, 3 to 6 cm long and 6 to 15 mm wide. The flower clusters, consisting of 3 to 21 flowers, are shorter than the leaves and enclosed in numerous small, leaf-like bracts, which are 7-12 mm long. These bracts are also covered in dense, white hairs and often persist on the plant throughout the flowering. The flowers are 3.5 to 5 mm long, white with pink tinges, and slightly hairy. (Armstrong 2002, Armstrong and Harden 2002, Maryott-Brown and Wilks 1993).

Distribution

Zieria involucrata has a disjunct distribution north and west of Sydney. Recent records for the species come from 22 populations in the catchments of the Macdonald, Colo and Hawkesbury Rivers—between Melon Creek and Mogo Creek in the north to Little Cattai Creek (Hillside) and Marramarra Creek (Canoelands) in the south—and from a single population in the upper Blue Mountains north of Katoomba (DEC 2004). In addition, historical records exist for at least two other localities in the eastern Blue Mountains, south of Springwood—Valley Heights, and north-west of Kurrajong. The recent records span a range of more than 80 km and it is highly likely that further populations occur within this range.

Z. involucrata occurs in the local government areas of Baulkham Hills, Blue Mountains, Hawkesbury and Hornsby.

Recorded occurrences in conservation reserves

Zieria involucrata has been recorded from Blue Mountains, Marramarra, Wollemi and Yengo National Parks and Parr State Conservation Area (NPWS 2004). Nearly half of the extant populations occur on private property or on other types of Crown land.

Habitat

Zieria involucrata is found in sheltered forests on steep to gentle, mid- to lower slopes and valleys formed primarily on Hawkesbury sandstone. It is usually found in neutral to slightly acid, shallow, sandy soils derived from this substrate (Maryott-Brown and Wilks 1993). In a few locations *Z. involucrata* appears to occur on geological substrates not influenced by Hawkesbury sandstone. Two populations are in areas mapped as Narrabeen Group sandstone where Hawkesbury sandstone does not overly it and a third one occurs on Quaternary alluvium. It has been recorded at altitudes ranging from 50-850 metres above sea level.

While surveyed sites cover a range of aspects, most occur in sheltered sites, e.g. in or adjacent to gullies which support sheltered forest, although some populations extend upslope into drier vegetation. *Z. involucrata* is also known from at least two atypical ridgetop locations. The canopy typically includes *Syncarpia glomulifera* subsp. *glomulifera* (turpentine), *Angophora costata* (smooth-barked apple), *Eucalyptus agglomerata* (blue-leaved stringybark), and *Allocasuarina torulosa* (forest oak).

A dense shrub layer is often present, commonly including *Ceratopetalum gummiferum*, *Backhousia myrtifolia*, *Acacia linifolia*, *A. teminalis*, *Personia linearis*, *P. levis*, *Grevillia buxifolia*, *G. speciosa*, *Banksia spinulosa* var. *collina*, *Hibbertia bracteata*, *H. scandens*, *Leptospermum trinervia*, *Elaeocapus reticulatus*, *Monotoca scoparia*, *Pultenaea flexilis* and *Bossiaea obcordata*. A medium to dense lower shrub and ground layer can include *Entolasia stricta*, *Patersonia sericea*, *Hybanthus monopetalus*, *Dracophyllum secundum*, *Phyllanthus hirtellus*, *Gompholobium latifolium*, *Xanthosia pilosa*, *Lepidosperma laterale*, *Xylomelum pyriforme*, *Lomatia silaifolia*,

Pandorea pandorana, *Smilax australis*, *Astrotricha floccosa*, *Gonocarpus teucroides*, *Leucopogon muticus*, *Pteridium esculentum*, *Dianella caerulea*, *Lomandra longifolia*, *Hardenbergia violacea*, *Lomandra filiformis* subsp. *coriacea*, *Viola hederacea*, *Blechnum cartilagineum* and *Lindsaea microphylla*. (Maryott-Brown 1994).

Ecology

The limited ecological information known about *Zieria involucrata* is largely based on unpublished research by T. Auld and M. Matthes. The life span of *Z. involucrata* is not known, but is expected to be in the vicinity of 10-15 years. Plants usually first flower and set seed 3-5 years after germination, but when conditions are good some will do so within 2 years. Flower buds begin to form in early April, with flowering taking place in spring. Fruits take 6-8 weeks to mature, with seed set occurring from November to January. The species is genetically self-compatible and is capable of self-pollination and of setting fruit following self-pollination (Armstrong 2002). Pollen vectors are currently unknown.



Photo: D. Beckers

Seed dispersal in *Zieria* spp. is by forcible ejection from the mature coccus (fruit). The presence of an elaiosome (an ant-attracting appendage to the seed) indicates that secondary dispersal by ants (termed myrmecochory) may also occur (Armstrong 2002).

Auld *et al.* (2000) observed a moderate level (40% of the viable seed) of seed dormancy at seed release for *Zieria involucrata*. While the non-dormant seed fraction underwent rapid decay over time, dormant seeds showed no significant decay over a 2-year period, suggesting that long-lived persistent soil seedbanks may be established in this species. Auld *et al.* (2000) estimated a half-life of the dormant, viable seed fraction to be 4.9 years and considered that the species could last 1-2 decades as seed in the soil after adults have died.

The response of adult plants of the species to fire is uncertain. Auld *et al.* (2000) classed the species as fire sensitive but with limited resprouting capability. *Z. involucrata* plants have been observed to appear to be coppicing from rootstock after fire (Auld, unpubl., Armstrong 2002), but observations to date indicate that plants are usually killed by fire (Maryott-Brown 1994a, N. Corkish, pers. obs.). Hence, the species is probably best considered as a predominantly obligate seeder that relies on seed germination after disturbance to maintain populations. If plants are capable of coppicing it is unknown at what age plants may be capable of this or what factors influence it.

Post-fire seedlings have been observed in several populations (Auld, unpubl., Maryott-Brown 1994, D. Beckers, pers. obs.). Either fire or smoke or a combination of them may play a role in breaking seed dormancy (T. Auld, pers. comm.) A positive germination response to heat has been reported (D. Keith, pers. comm. cited in Armstrong 2002) but there is currently little data on survivorship following such disturbances. Maryott-Brown (1994) estimated a 'half-life' (the time over which half the individuals in a population would die) of 2.3 years for the species, but this was based on data from only four monitored populations.

The response of the species to other physical disturbance, such as grazing and slashing, has not been recorded.

Threats

Key Threatening Processes currently listed under the Commonwealth EPBC Act or in Schedule 3 of the NSW TSC Act (NSW) that are relevant to *Zieria involucrata* are:

- “High frequency fire resulting in the disruption of lifecycle processes in plants and animals and loss of vegetation structure and composition” (TSC Act)

Most known populations of the species are located within conservation reserves, so given that the persistence of a population is likely to be dependent on regeneration from seed, the main threat to the species is likely to be the impact of an unsuitable fire regime. If the fire interval is shorter than the period between germination and seed production, recruitment to the soil-stored seedbank will be limited or not occur at all and post-fire regeneration will deplete the existing seedbank. Three or more fires in close succession may therefore result in population decline or extinction.

Sustained high frequency can also lead to a reduction in vegetation structure and subsequent changes in microclimate, affecting the suitability of the habitat for species like *Z. involucrata* which appear to require moister, sheltered aspects. For further information about this key threatening process see the NSW Scientific Committee Determination Advice 00/06.

Conversely, if the interval between fires is long, adult plants may die out due to competitive exclusion and seed in the soil is likely to deteriorate and become inviable before the occurrence of conditions suitable for successful germination and survival, resulting in population decline or extinction. Fire-free intervals more than 1-2 decades longer than the mean life span of established plants may result in their local extinction (Auld *et al.* 2000).

- “Clearing of native vegetation” (TSC Act) or “Land clearance” (EPBC Act)

Fragmentation and probably direct loss of *Zieria involucrata* habitat has occurred as a result of vegetation clearing or modification for semi-rural and urban expansion and agricultural development within in the range of the species. Vegetation loss, fragmentation and modification may directly or indirectly impact on populations of *Z. involucrata* in a number of ways (see the NSW Scientific Committee Determination 01/17 and the Commonwealth Threatened Species Scientific Committee Listing Advice for further

information about this key threatening process). In particular, vegetation clearing and slashing for track maintenance and fire trail construction may threaten some *Z. involucrata* populations in both national parks and other areas.

- “Bushrock removal” (TSC Act)

As *Zieria involucrata* often occurs in areas where Hawkesbury sandstone outcrops, legal or illegal bush rock removal in such areas may destroy plants and degrade the habitat of the species. For further information about this key threatening process see the NSW Scientific Committee Determination Advice 99/25.

- “Anthropogenic climate change” (TSC Act) or “Loss of climatic habitat caused by anthropogenic emissions of greenhouse gasses” (EPBC Act).

Zieria involucrata may be adversely affected by changes to habitat or fire regimes caused by climate changes resulting from or accelerated by human activities (see the NSW Scientific Committee Determination 00/24 for further information about this key threatening process). Species such as *Z. involucrata*, with restricted distributions and fragmented populations, may

For further information contact

Threatened Species Unit, Metropolitan Branch, Environment Protection and Regulation Division, Department of Environment and Conservation, PO Box 1967, Hurstville NSW 2220.
Telephone: 02 9585 6678. Internet: www.nationalparks.nsw.gov.au

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- Armstrong J.A. (2002) The genus *Zieria* (Rutaceae): a systematic and evolutionary study. *Australian Systematic Botany* Vol. 15 (3): 277–463.
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be especially susceptible to reductions in the bioclimatic range caused by climate change.

Management

Management of *Zieria involucrata* should attempt to:

- prevent frequent fires from impacting on the populations.
- at appropriate intervals, plan and implement fires of suitable intensity to generate a level of heat to break seed dormancy.
- minimise habitat loss, fragmentation or disturbance by retaining native vegetation containing the species and maintaining connectivity between populations.
- ensure that road and track maintenance and construction and weed control activities are planned and implemented to take account of the presence of the species and avoid damaging individual plants as well as habitat for the species.

Recovery plans

A draft recovery plan is currently being prepared for *Zieria involucrata*.

IMPORTANT DISCLAIMER

The Department of Environment and Conservation (NSW) and the editor expressly disclaim all liability and responsibility to any person, whether a purchaser or reader of this document or not, in respect of anything done or omitted to be done by any person in reliance upon the contents of this document although every effort has been made to ensure that the information presented in this document is accurate and up to date.

ENVIRONMENTAL IMPACT ASSESSMENT GUIDELINES

Zieria involucrata

R.Br ex Benth.

Common name: **none**

Family: **Rutaceae**

The following information is provided to assist authors of Species Impact Statements, development and activity proponents, and determining and consent authorities, who are required to prepare or review assessments of likely impacts on threatened species pursuant to the provisions of the *Environmental Planning and Assessment Act 1979*. These guidelines should be read in conjunction with the NPWS *Information Circular No. 2: Threatened Species Assessment under the EP&A Act: The '8 Part Test' of Significance* (November 1996).

Survey

Survey for *Zieria involucrata* may be undertaken at any time of the year. A combination of leaf and stem characteristics as well as habit should enable the species to be identified in the absence of flowers. However, the species is most readily observed during its flowering season between September to October when plants are covered in a dense mass of white flowers.

Survey should not necessarily be confined to areas of intact remnant vegetation because *Z. involucrata* plants have also been recorded growing in disturbed environments.

Z. involucrata is found on steep to gentle, mid- to lower slopes and valleys, usually on Hawkesbury sandstone. Surveyed sites cover a range of aspects, but most occur in or adjacent to gullies which support sheltered forest, although some populations extend upslope into drier vegetation. The canopy typically includes *Syncarpia glomulifera* subsp. *glomulifera* (turpentine), *Angophora costata* (smooth-barked apple), *Eucalyptus agglomerata* (blue-leaved stringybark), and *Allocasuarina torulosa* (forest oak). A dense shrub layer is often present. In Hornsby Shire, the species is most strongly associated with *E. agglomerata* open-forest at the interface between the lower Hawkesbury and upper Narrabeen Group strata (Ecological Surveys & Planning 1998).

Where new sites are located, site details including plant numbers, habitat and location should be recorded and forwarded to the DEC.

Life cycle of the species

The ecology of *Z. involucrata* is described in the draft recovery plan (DEC 2004) and summarised in the species profile.

Proposals that are likely to impact upon the life cycle of the species include those that contribute to the following:

- Loss of individuals

The significance of a particular activity that physically destroys individual plants will require an examination of the number of plants to be destroyed in relation to the size of the population and a discussion of how recruitment, gene flow and the overall health of the population will be affected. Translocation should not be considered as an appropriate means of compensating for the loss of individuals due to the uncertainty associated with the long-term survival of translocated plants.

- Loss and fragmentation of habitat

As the breeding system of *Z. involucrata* is not well understood, the effects of loss and fragmentation of its habitat are not known. Destruction of habitat may place a local population at risk of extinction.

- Altered fire regimes

The response of adult plants of the species to fire is uncertain. Auld *et al.* (2000) have classed the species as fire sensitive, but with limited resprouting capability. Most observations to date are that plants are usually killed by fire (Maryott-Brown 1994). Proposals that result in the frequent burning (ie successive fires <10 years apart) of sites are considered likely to impact upon recruitment of the species. Recommended fire frequencies for the species are provided in the draft recovery plan (DEC 2004).

- Modification of habitat

Development in close proximity to *Z. involucrata* sites is likely to cause modification of habitat through altered hydrological conditions, soil pH and nutrient levels, weed invasion, potential introduction of plant pathogens and altered fire frequency. Subsequent increases in pedestrian and/or vehicular traffic through sites may result in trampling, soil compaction, soil erosion and rubbish dumping. Other proposals that result in grazing, slashing, spraying or burning of *Z. involucrata* habitat are also likely to result in the modification of that habitat.

- Damage to the soil seedbank

Disturbances that will destroy or prevent germination of *Z. involucrata* seed include rubbish dumping, the removal of leaf litter and topsoil, weed invasion and spraying with residual herbicides that are capable of killing seeds in the soil. Frequent disturbances (from slashing, grazing, herbicide spraying or burning for example) may prevent the soil seed bank from being replenished.

Threatening processes

There are six key threatening processes listed in Schedule 3 of the NSW *Threatened Species*

Conservation Act 1995 (TSC Act) that are potentially relevant to *Z. involucrata*. These are:

- *High frequency fire resulting in the disruption of life cycle processes in plants and animals and the loss of vegetation structure and composition;*
- *Clearing of native vegetation;*
- *Bushrock removal;*
- *Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands;*
- *Infection of native plants by *Phytophthora cinnamomi*; and*
- *Anthropogenic climate change.*

Other threatening processes relevant to this species include slashing and herbicide spraying to maintain road verges, grazing and trampling by livestock, weed invasion, rubbish dumping (including green waste, household rubbish and construction materials) and the other disturbances associated with adjacent urban development.

Viable local population of the species

The viable population size for *Z. involucrata* is unknown. In the absence of a detailed assessment demonstrating otherwise, all populations should be assumed to be viable.

A significant area of habitat

Assessment of habitat significance for *Z. involucrata* requires consideration of the following:

- number of *Z. involucrata* plants present (including consideration of the soil seed bank);
- proportion of the local population present;
- location in relation to the current distributional limits of the species;
- size, condition and connective importance of the habitat;
- uniqueness of habitat; and
- management potential including the likelihood of ameliorating any existing threatening processes.

The DEC considers that all viable populations of *Z. involucrata* occupy significant area of habitat

until such time as adequate and representative examples are conserved across its range.

Isolation/fragmentation

The distance between populations that will create genetic isolation is unknown because the pollen vectors for *Z. involucrata* are unknown. Seed dispersal is likely to be localised, despite the possibility of secondary dispersal by ants, so interaction via this mechanism is unlikely.

The clearing of interconnected or proximate areas of habitat for the species (or its pollen/seed vectors) is clearly undesirable as this may expose populations to an increased risk of genetic isolation and subsequent decline.

Regional distribution of the habitat

The known distribution of *Z. involucrata* is confined to the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation of Australia (Thackway & Cresswell 1995).

For further information contact

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Telephone: 02 9585 6678. Internet: www.nationalparks.nsw.gov.au

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- Auld, T.K., Keith, D.A. and Bradstock, R.A. (2000) Patterns in longevity of soil seedbanks in fire-prone communities of south-eastern Australia. *Australian Journal of Botany* 48: 539-548.
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Limit of known distribution

Z. involucrata has a disjunct distribution north and west of Sydney from Melon and Mogo Creeks in Yengo National Park in the north to Hillside in the south. The western limit of its known distribution occurs on the Blue Mountains Plateau north of Katoomba (DEC 2004).

Adequacy of representation in conservation reserves or other similar protected areas

Z. involucrata is not considered to be adequately represented in conservation reserves across its range.

Critical habitat

Critical habitat has not been declared for *Z. involucrata*.

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Appendix 3: Threatened plant population description and site management statement forms

Site Management Statement

Prepared by:

Date:

Site details:

Site Name:

Site Code:

Location:

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AMG Zone: Easting: Northing:

Land owner/Land manager contact details

Name:

Phone number(s):

Postal address:

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Parcel details:

Portion/Parish or Lot/DP no.:

Tenure:

Street address:

LGA:

Zoning:

Current land use:

Population details:

No. adults: Count: [] Estimate: []

Lowest estimate = Best estimate = Upper estimate =

No. seedlings: Count: [] Estimate: []

Lowest estimate = Best estimate = Upper estimate =

Area of Occupancy: Accurate: [] Estimate: []

Reproduction: Buds: [] Flowers: [] Fruit: []

Detailed **site map** attached: Yes / No

Photographs taken:

Previous management actions (describe apparent success):

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Threat abatement actions required:

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Recommended monitoring and evaluation program:

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Timetable for implementation of actions and monitoring:

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Appendix 4: Making a submission regarding this draft recovery plan

This draft recovery plan will be placed on public exhibition for a period of six weeks and written submissions are invited from the public during this time. To make your submission as effective as possible:

- refer to the section or action of the plan you wish to address;
- briefly explain the reasons for your comments, providing source information or examples where possible; and
- provide your name and address, on the following form, to enable receipt of your submission to be acknowledged. Your personal details and submission will be a matter of public record and will be stored in the NPWS record system for two years from the closing date of submissions.

Alternatively, submissions may be made via the DEC (NPWS) website.

The DEC will consider all written submissions received during the period of public exhibition and must provide a summary report of those submissions to the Minister for the Environment prior to final approval of this recovery plan.

Please note, that for the purposes of the NSW *Privacy and Personal Information Protection Act* 1998, any comments on this draft recovery plan, including your personal details, will be a matter of public record and will be stored in the DEC records system. Following approval of the plan by the Minister, copies of all submissions, unless marked 'confidential' will be available by arrangement for inspection at the DEC office responsible for the preparation of the recovery plan.

Should you not wish to have your personal details disclosed to members of the public once the recovery plan has been adopted, please indicate on the form that you wish to have your personal details remain confidential to DEC and not available for public access. Further information on the *Privacy and Personal Information Protection Act* 1998 may be obtained from any office of the DEC or from the website: www.nationalparks.nsw.gov.au

Submissions should be received no later than the advertised date and should be addressed to:

Director-General of Department of Environment and Conservation
c/- *Zieria involucrata* Recovery Plan Coordinator,
Threatened Species Unit
Conservation Programs and Planning Branch
Metropolitan Region
Environment Protection and Regulation Division
Department of Environment and Conservation (NSW)
PO Box 1967
Hurstville, NSW 2220

SUBMISSION ON DRAFT RECOVERY PLAN

Please ensure that you provide the following information, even if you do not use this form to make your submission.

Name Individual/Organisation:

Postal Address:

Postcode: Contact Number(s):

Date:

Draft Recovery Plan: *Zieria involucrata* recovery plan

Yes, please keep my personal details confidential to DEC
(Explain why)

