Approved NSW & National Recovery Plan

Recovery Plan for *Zieria lasiocaulis*

J. A. Armstrong

July 2002

NSW
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Recovery Plan for *Zieria lasiocaulis* J. A. Armstrong

Prepared in accordance with the New South Wales
Threatened Species Conservation Act 1995

July 2002

Executive Summary

The conservation of threatened species, populations and ecological communities is crucial for the maintenance of this State's unique biodiversity. In NSW, the *Threatened Species Conservation Act 1995* (TSC Act) provides the framework to conserve and recover threatened species, populations and ecological communities through the preparation and implementation of recovery plans.

The object of a recovery plan is to document the research and management actions required to promote the recovery of a threatened species, population or ecological community and to ensure its ongoing viability in nature.

Introduction

Zieria lasiocaulis J. A. Armstrong ms is a tall shrub known from a limited area in Willi Willi National Park on the mid-north coast of New South Wales (NSW).

This recovery plan describes the current knowledge of the distribution and ecology of *Z. lasiocaulis*, documents the research and management actions undertaken to date, and identifies the actions required to ensure the ongoing viability of the species in the wild.

Current conservation status

Z. lasiocaulis is endemic to NSW, and is restricted to a small area of about 20 square kilometres. The total population is estimated to be between 20,000 and 25,000 individuals. All populations occur within Willi Willi National Park.

Threatening processes include inappropriate disturbance regimes, road and track construction and maintenance and potential development of recreational facilities.

Z. lasiocaulis is listed on Schedule 1 of the NSW TSC Act as Endangered. It is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Act* 1999 (EPBC Act).

Legislative context

The *Threatened Species Conservation Act* 1995 (TSC Act) is NSW's most comprehensive attempt at establishing a legislative framework to protect and encourage the recovery of threatened species, populations and communities. Under the TSC Act, the Director-General of National Parks and Wildlife has responsibilities which include the preparation of recovery plans for threatened species, populations and ecological communities. Similarly, the EPBC Act requires the Commonwealth Minister for the Environment 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. This recovery plan has been prepared to satisfy both the requirements of the TSC Act and the EPBC Act.

Preparation of plan

This recovery plan has been prepared by consultant botanist Phil Gilmour, and updated by Dianne Brown of the Threatened Species Unit, Northern Directorate of NSW National Parks and Wildlife Service (NPWS).

This plan will be reviewed and updated five years from the date of publication.

Recovery objectives

The overall objective of this recovery plan is to protect known populations of *Z. lasiocaulis* from decline induced by non-natural impacts, and to ensure that wild populations of *Z. lasiocaulis* remain viable in the long-term.

Specific objectives of this recovery plan are to:

- protect and maintain new and existing wild populations of *Z. lasiocaulis* and their habitat from threatening processes;
- improve the knowledge of the distribution, ecology, biology, population demographics and genetics of *Z. lasiocaulis* to enable appropriate management;
- protect any new populations and their habitat by suitable measures;
- ensure that land managers are familiar with *Z. lasiocaulis* both in the field and as a dried specimen;
- monitor known populations of *Z. lasiocaulis*;
- assess the need for *ex situ* conservation;
- increase community awareness of *Z. lasiocaulis* in particular, and threatened plant species in general; and
- assess whether the declaration of critical habitat for *Z. lasiocaulis* under the TSC Act would deliver demonstrable conservation benefits.

Recovery criteria

Recovery criteria are that:

- new and existing wild populations of *Z. lasiocaulis* are protected and maintained by suitable measures;
- knowledge of the distribution, ecology, biology, population demographics and genetics relevant to appropriate management of *Z. lasiocaulis* is improved;
- land managers are able to recognise *Z. lasiocaulis*;
- populations are monitored taking note of recruitment, death, flowering and seed production;
- the need for *ex situ* conservation is investigated and undertaken if appropriate;
- educational material on *Z. lasiocaulis* is available to the community; and
- assessment of the need for critical habitat for *Z. lasiocaulis* is undertaken.

Recovery actions

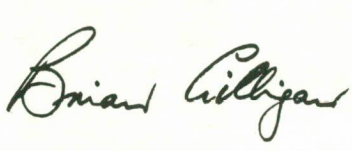
Recovery actions will be directed towards:

- implementing management strategies which ensure the survival of known wild populations of *Z. lasiocaulis*;
- research into the ecology, biology, population demographics and genetics of *Z. lasiocaulis*;
- survey in potential habitat for additional populations of *Z. lasiocaulis*;
- familiarising land managers with *Z. lasiocaulis;*
- monitoring existing populations of *Z. lasiocaulis*;
- investigating the need for establishing *ex situ* collections of *Z. lasiocaulis*;
- community education; and
- assessment of the need for the declaration of critical habitat for *Z. lasiocaulis*.

Biodiversity benefits

The occurrence of *Z. lasiocaulis* contributes to the high biodiversity of the flora of the north coast of NSW. The presence of *Z. lasiocaulis* in a number of vegetation communities makes these communities unique. The conservation of *Z. lasiocaulis* in the wild will also benefit other plant and animal species and communities of conservation significance.

By increasing the public awareness of threatened plants such as *Z. lasiocaulis*, the conservation of other threatened species, and biodiversity in general, is encouraged.



Brian Gilligan
Director-General

Bob Debus MP
Minister for the Environment

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1. Current conservation status

Zieria lasiocaulis J. A. Armstrong ms is known from nine locations restricted to an area of about 20 square kilometres. These populations are located in Willi Willi National Park, north-west of Port Macquarie on the mid-north coast of New South Wales (NSW). The species is naturally restricted with a total population estimated at 20,000 to 25,000. The largest population of about 20,000 plants occurs over about one hectare.

Z. lasiocaulis is currently listed as Endangered (Schedule 1) on the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and the listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation* Act 1999 (EPBC Act).

Z. lasiocaulis has been classified by Briggs and Leigh (1996) as 2V, which means it occurs over a geographic range of less than 100 km and is at risk of disappearing from the wild over a period of 20-50 years through continued depletion. A more appropriate classification is 2VCat. This specifies that 1000 plants or more are known to occur within a conservation reserve and the total known population is reserved.

2. Description

2.1 Taxonomic description

The manuscript name *Zieria lasiocaulis* as described by Armstrong (2002) is used in this recovery plan since a published description of the taxon was not available at the time of plan preparation. It is also described by Armstrong (1991) under the name *Zieria* species N.

The following description has been adapted from Armstrong and Harden (2002) and Armstrong (2002):

> *Z. lasiocaulis* is a tall shrub or small tree up to six metres in height. The young branches are hairy between the decurrent leaf bases, and most parts of the plant are dotted with oil glands which result in plants having a strong, though not unpleasant, aroma. Leaves are opposite and usually 3-foliolate, with the central leaflet elliptic to oblanceolate, four to six cm long and one to two cm wide, more or less glabrous, and with entire margins. Inflorescences are axillary, many-flowered and shorter than the leaves. The four white petals are 3.5-4 mm long and hairy to more or less glabrous, and the calyx lobes are and about one mm long. The fruit are hairless, dotted with oil glands, and lack an appendage. Seeds are usually black, about 2.3 mm long and 1.3 mm broad. *Z. lasiocaulis* flowers from late autumn to spring, and fruits in summer.

Z. lasiocaulis is similar in general appearance to the more widespread *Z. arborescens* ssp. *arborescens* and *Z. southwellii*, but can be distinguished by the pubescence, primarily of long simple hairs, on young growth.

2.2 Taxonomic significance

The genus *Zieria* in the family Rutaceae consists of at least 44 species, mainly occurring in eastern Australia, and one species in New Caledonia (Armstrong 1991).

Many species of *Zieria,* including *Z. lasiocaulis,* occur as highly localised endemics. Of the 43 Australian species, 13 are listed as endangered and eight as vulnerable under the Commonwealth EPBC Act. Twenty seven species of *Zieria* are considered to be rare or threatened by Briggs and Leigh (1996).

In NSW, 13 of the 35 species of *Zieria* are listed as endangered, four as vulnerable and one as an endangered population on the schedules of the TSC Act.

3. Distribution

3.1 Current and historical distribution

Z. lasiocaulis is endemic to NSW, and is known from about nine locations restricted to an area of approximately 20 square kilometres near Mount Banda Banda and Marowin Mountain on the mid-north coast of NSW (Figure 1).

There are no historical records for *Z. lasiocaulis* outside the current range, suggesting that it has evolved and persisted with a naturally very restricted distribution.

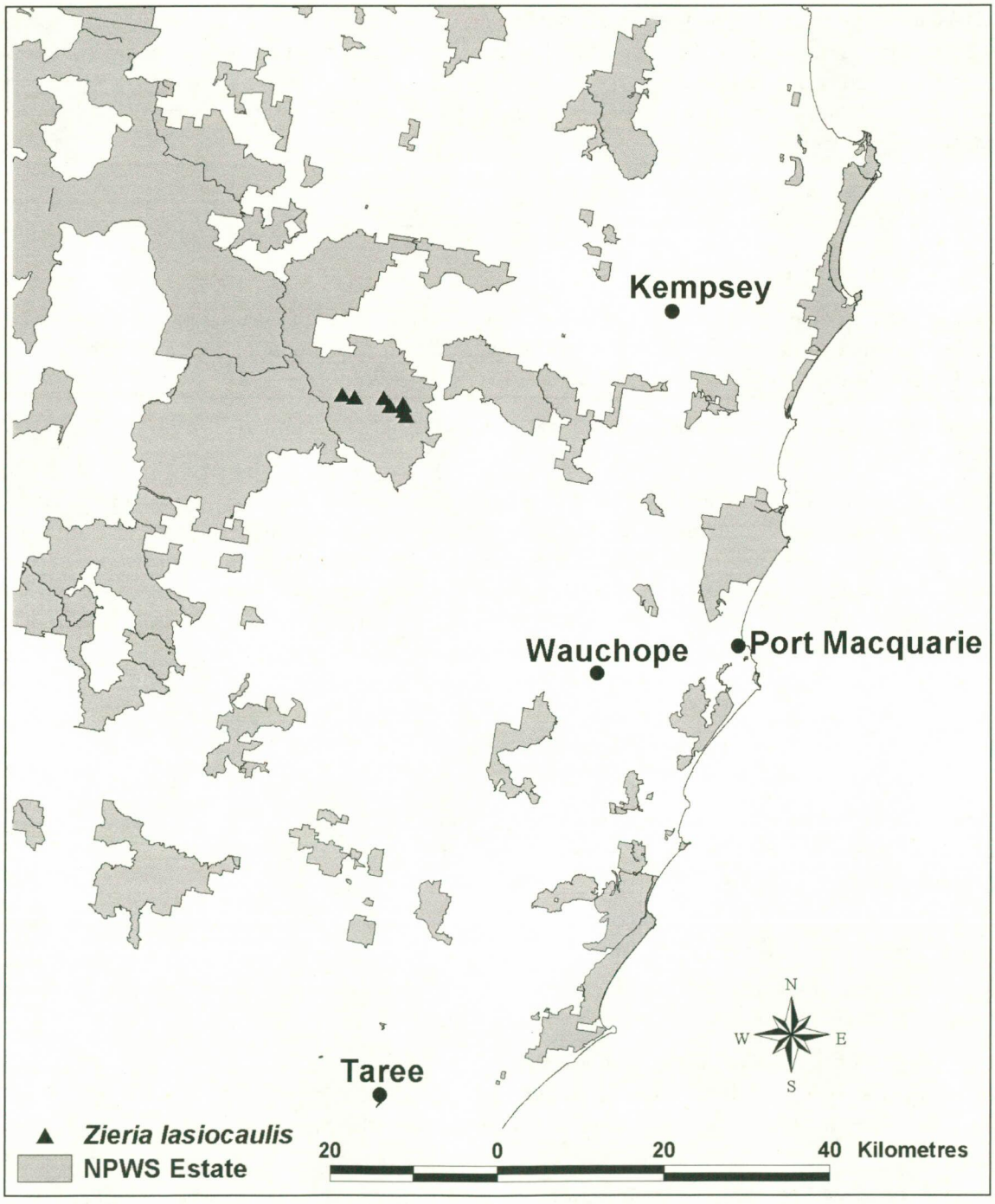

Figure 1: Locations of populations of *Zieria lasiocaulis*.

3.2 Tenure

All populations of *Z. lasiocaulis* occur within Willi Willi National Park.

Part of the area of occurrence of *Z. lasiocaulis* (previously Banda Banda Flora Reserve) is included in the 'Central-Eastern Australian Rainforest World Heritage Area' (DASET 1992).

4. Ecology

4.1 Habit

Z. lasiocaulis is a tall shrub or small tree up to six metres in height (Armstrong 2002).

4.2 Reproductive biology

Vegetative reproduction

Vegetative reproduction by either root suckering or sub-surface epicormic outgrowths occurs in some species of *Zieria*. Armstrong (2002) reports that *Z. lasiocaulis* does not vegetatively reproduce, however, a few shoots arising from the base of old plants of *Z. lasiocaulis* were seen at one location (P. Gilmour pers obs).

Breeding system

Z. lasiocaulis is probably outcrossing and self-compatible. It is generally considered to be an obligate seeder (regenerating from seed only) (Armstrong 2002). Highly variable pollen viability responses are reported, with plants at Mount Banda Banda displaying very low pollen viability (Armstrong 2002).

Flowers are produced in late winter or spring and fruit is produced in summer. Plants were recorded flowering at four years of age. This is based on the Marowin Mountain population which was burnt about January 1994 (A. Marshall pers comm). Plants that germinated following the fire were flowering profusely when surveyed in November 1998. Flowers are bisexual, and pollination is most likely by pollen- and nectar-seeking beetles (Armstrong 2002). Small native bees and several species of beetle were observed on flowers at the Marowin Mountain population (P. Gilmour pers obs).

Seed dispersal

Seeds are released explosively from the mature fruit, and possess an ant-attracting elaisome which may result in short distance dispersal by ants (Armstrong 2002; Smith 1989). Most ant dispersal of seeds is over a short disance (<10m) (Gomez and Espadaler 1998).

Germination and recruitment

A number of different germination and recruitment strategies were observed in the field, all of which appear to have resulted from some form of disturbance. Many populations occur on roadsides or in areas where logging has disturbed the soil. The largest population occurs on the summit and southern ridge of Marowin Mountain in recently burnt areas. A smaller population was observed in an area that had burnt 12 to 18 months before inspection (P. Gilmour pers comm).

An interesting aspect of the Marowin Mountain site is the fact that small seedlings and young plants are present almost five years after the fire event. This may indicate that the 1994 fire did not stimulate the entire seed-bank to germinate, and some seed was able to delay germination. Such a strategy would maximise the possibility of *Z. lasiocaulis* recruiting after fire.

South-east of the summit of Marowin Mountain a small population of about 50 seedlings occurs in a natural gap caused by a tree fall. There were no mature plants of *Z. lasiocaulis* observed in this clearing or within the surrounding forest (the nearest mature plants observed were at least 200 metres away). In this case germination may have been stimulated by exposure of soil to direct sunlight and consequent heating.

Armstrong (2002) suggests that *Zieria* species generally have short seed viability, but field observations of populations of *Z. lasiocaulis* suggest a persistent soil seed-bank. A study by Auld *et al.*

(2000) showed evidence that *Zieria involucrata* has a persistent soil seed-bank of between one to two decades. Research is required into the seed-bank dynamics of *Z. lasiocaulis* to determine the longevity and relative importance of soil-stored seed, and the importance of disturbance for stimulating germination.

Fire response

Plants of *Z. lasiocaulis* are probably killed by fire (Armstrong 2002), although if basal shoots can occur (see Vegetative reproduction section above) it is possible that individuals could survive low intensity fires. Germination of seed may be stimulated by appropriate fire regimes.

4.3 Population structure

Results of population monitoring undertaken to date has plants in a range of maturity classes ranging from seedlings through to senescent. Comparison with earlier survey data apparently shows aging of plants in the population, with some sites changing from all seedlings to all immature plants.

There are no data on the longevity of individuals, but it is estimated at 20 to 30 years, based on the approximate age of eucalypt regrowth at sites where mature *Z. lasiocaulis* occur (P. Gilmour pers comm).

5. Disturbance

5.1 Human disturbance

The major disturbance affecting the habitat of *Z. lasiocaulis* in the recent past was associated with timber harvesting. Prior to declaration of Willi Willi National Park, logging and roading occurred in the habitat of *Z. lasiocaulis*. An increased fire frequency and reduced fire intensity may have been associated with these operations.

All the known habitat of *Z. lasiocaulis* is now within Willi Willi National Park, therefore no further timber harvesting will occur. Continued disturbance may occur from hazard reduction burning, road and track maintenance and potential development of recreational facilities.

5.2 Stochastic disturbance

The area in which *Z. lasiocaulis* occurs contains large stands of rainforest, suggesting that wildfire is infrequent.

Natural disturbances affecting the habitat of *Z. lasiocaulis* include wildfire, wind throw of trees, and soil slip or erosion. These types of disturbances may stimulate seed germination (section 4.2).

5.3 Effect of disturbance

Although the germination of *Z. lasiocaulis* seed appears to be favoured by disturbance (section 4.2), the effect of increased frequency and/or intensity of disturbance on soil seed-banks and long term sustainability of populations is not known. Low intensity disturbances, particularly fire, may be insufficient to stimulate germination, and may result in a population decline if adult plants are killed. If repeated disturbances that kill adult plants occur before recruits have matured and replenished the soil seed-bank, populations will decline. Conversely, if disturbance is too infrequent (taking into account plant and soil seed-bank longevity), populations may also decline due to lack of recruitment and senescence of mature plants (Vaughton 1998). There is no information on population dynamics for *Z. lasiocaulis*.

6. Habitat

6.1 Physiography and substrate

The area where *Z. lasiocaulis* occurs is part of the rugged, steeply dissected eastern escarpment between the coast and the tablelands. Most of the populations of *Z. lasiocaulis* occur on a ridge separating the Macleay River and Hastings River catchments. This ridge is characterised by steep slopes with several cliff lines. One of the populations occurs just west of Mount Banda Banda on a small plateau with more gentle topography. Populations of *Z. lasiocaulis* occur at altitudes between 750 and 1,100 metres.

The geology of most of the area of *Z. lasiocaulis* habitat is monzodiorite (a fine grained volcanic rock). The soil that results from these parent rocks is generally a red/brown krasnozem of moderate fertility and high clay content (Truyard Pty Ltd 1993).

6.2 Climate

The climate of the area is temperate to subtropical. There is no accurate weather information available for the area in which *Z. lasiocaulis* occurs but mean annual rainfall is probably about 2,000 millimetres (Forestry Commission of NSW 1989), and mean maximum temperatures probably vary between about 22°C in summer and about 12°C in winter (Truyard Pty Ltd 1993). Frosts would be occasional and snow occurs rarely at higher elevations such as Mount Banda Banda.

6.3 Vegetation

The area in which *Z. lasiocaulis* occurs supports a mosaic of vegetation communities, including cool temperate and warm temperate rainforest, tall open and open forest, and shrublands on rock outcrops.

Examples of the vegetation communities where *Z. lasiocaulis* populations occur are listed in Table 1.

Table 1: Species commonly associated with *Z. lasiocaulis*

Vegetation type (and locality)	Common species	
Cool Temperate Rainforest (Loop Road)	*Nothofagus moorei*	*Tasmannia insipida*
	Ceratopetalum apetalum	*Blechnum wattsii*
	Orites excelsa	*Lomandra spicata*
Tall Open Forest (Mount Banda Banda)	*Eucalyptus oreades*	*Elaeocarpus reticulatus*
	Eucalyptus campanulata	*Blechnum wattsii*
	Callicoma serratifolia	*Drymophila moorei*
Tall Open Forest (Marowin Mountain, Banda Trail and North Wilson Road)	*Eucalyptus campanulata*	*Banksia integrifolia* ssp. *monticola*
	Eucalyptus laevopinea	
	Acacia elata	*Goodenia ovata*
	Callicoma serratifolia	*Hibbertia dentata*
Warm Temperate Rainforest Regrowth (Main Range Road)	*Acacia melanoxylon*	*Orites excelsa*
	Ceratopetalum apetalum	*Ozothamnus diosmifolius*
	Callicoma serratifolia	*Gonocarpus oreophilus*
Warm Temperate Rainforest (south-east of Marowin Mountain summit)	*Doryphora sassafras*	*Cyathea leichhardtiana*
	Callicoma serratifolia	*Lomandra spicata*
	Nothofagus moorei	*Parsonsia purpurascens*
	Ceratopetalum apetalum	*Blechnum cartilagineum*

7. Relevant legislation

Z. lasiocaulis occurs only on National Park estate. The *Native Vegetation Conservation Act* 1997 does not apply to land that is dedicated or reserved under the *National Parks and Wildlife Act* 1974 (NPW Act), and is therefore not applicable to *Z. lasiocaulis*.

Relevant legislation includes:

- NSW *National Parks and Wildlife Act* 1974
- NSW *Environmental Planning and Assessment Act* 1979
- NSW *Rural Fires Act* 1997
- Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999

The interaction of the above legislation with the TSC Act is varied. The most significant implications are described below.

7.1 *National Parks and Wildlife Act* 1974 and *Environmental Planning and Assessment Act* 1979

The NPW Act regulates activities within National Parks and Nature Reserves and therefore applies to areas within Willi Willi National Park that contain *Z. lasiocaulis*. This act also requires that a licence must be obtained to propagate or sell *Z. lasiocaulis*.

The NPW Act and TSC Act require that any proposal to 'pick', or damage the habitat of a threatened plant, must be approved by NPWS, unless the activity has been granted consent or approval under the *Environmental Planning and Assessment Act* 1979, or is being undertaken in accordance with the *Rural Fires Act* 1997 or the *State Emergency and Rescue Management Act* 1989. 'Pick' means to gather, pluck, cut, pull up, destroy, poison, take, dig up, remove or injure the plant or any part of the plant. If a proposal is likely to have a significant impact on *Z. lasiocaulis* or its habitat then a Species Impact Statement must be prepared.

7.2 *Rural Fires Act* 1997

A Bush Fire Management Committee must prepare a draft bush fire management plan for each rural fire district. The plan may restrict or prohibit the use of fire or other particular fire hazard reduction activities in all or specified circumstances or places to which the plan applies.

7.3 *Environment Protection and Biodiversity Conservation Act* 1999

The EPBC Act regulates actions that may result in a significant impact on nationally listed threatened species and ecological communities. It is an offence to undertake any such actions in areas under State or Territory jurisdiction, as well as on Commonwealth-owned areas, without obtaining prior approval from the Commonwealth Environment Minister. As *Z. lasiocaulis* is listed nationally under the EPBC Act, any person proposing to undertake actions likely to have a significant impact on this species should refer the action to the Commonwealth Minister for the Environment for consideration. The Minister will then decide whether the action requires EPBC Act approval.

7.4 Critical habitat

The TSC Act makes provision for the identification and declaration of critical habitat for species, populations and ecological communities listed as endangered. To date, critical habitat has not been declared for *Z. lasiocaulis* under the TSC Act. If declared, it becomes an offence to damage critical habitat (unless the action is specifically exempted by the TSC Act) and a species impact statement is mandatory for all developments and activities proposed within critical habitat.

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. On Commonwealth land, it is an offence under the EPBC Act for a person to knowingly take an action that will significantly damage critical habitat (unless the action is specifically exempted by the EPBC Act). However an action which is likely to

have a significant impact on a listed species is still subject to referral and approval under the EPBC Act.

7.5 Recovery plan preparation and implementation

Recovery plan preparation

The TSC Act requires that the Director-General of National Parks and Wildlife (NPW) prepare recovery plans for all species, populations and ecological communities listed as endangered or vulnerable on the TSC Act schedules. This recovery plan satisfies these provisions.

Similarly, the EPBC Act requires the Commonwealth Minister for the Environment 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 process for preparing recovery plans.

This recovery plan has been prepared to satisfy both the requirements of the TSC Act and the EPBC Act. It is the intention of the Director-General of NPW to forward this recovery plan to the Commonwealth Minister of the Environment for adoption, once it has been approved by the NSW Minister for the Environment.

Recovery plan implementation

The TSC Act requires that a government agency must not undertake actions inconsistent with a recovery plan. The government agency responsible for the implementation of this recovery plan is the NSW NPWS.

The EPBC Act specifies that a Commonwealth agency must not take any action that contravenes a recovery plan.

8. Management issues

8.1 Threats and reasons for decline

There is no evidence to show that populations of *Z. lasiocaulis* have declined in recent times. As there are no historic records outside the area of occurrence, and all populations occur on very restricted geological types, it is also likely that the distribution of *Z. lasiocaulis* has not been significantly reduced in recent times. A limited geographic distribution is consistent with the characteristics of the genus *Zieria* (Armstrong 2002).

The threats to the populations of *Z. lasiocaulis* have changed since the recent inclusion of its habitat in Willi Willi National Park. Prior to dedication as National Park, much of the area was State Forest available for timber harvesting. Disturbance associated with timber harvesting no longer needs to be considered.

Threats that need to be considered include inappropriate fire regime, road or track construction and maintenance, and potential development of recreational facilities. These activities could have a direct impact on populations of *Z. lasiocaulis* unless adequate planning and site assessment is carried out.

The main threat to this species is likely to be an inappropriate disturbance regime. Although it appears to require some form of disturbance for germination and recruitment, the natural disturbance regime through events such as wildfire and storm damage (tree fall gaps and soil slips) must be adequate for the perpetuation of this species. As it is not known how current management practices affect the germination and persistence of *Z. lasiocaulis*, it is critical that research into the biology, and monitoring of the population demography, of *Z. lasiocaulis* be carried out. It is likely that too-frequent fires (<5-10 years) will adversely affect the long-term viability of the species.

Z. lasiocaulis contains cyanogenic glycosides (naturally occurring organic compounds that contain cyanide) and is potentially toxic (Armstrong 2002), making it unlikely that plants would be browsed by either native or feral herbivores. At the time of preparation of this recovery plan invasive plant species and feral animals were not considered to be a threat to any of the known populations of *Z. lasiocaulis*.

8.2 Social and economic consequences

Associated costs of this recovery plan can be located in Table 2.

Intrinsic ecological value

The ecological function of *Z. lasiocaulis* is not known. However, given optimum conditions, it forms dense stands and may be an important coloniser of disturbed sites in this area. All species have intrinsic ecological values, and have the right to exist independently.

Scientific and taxonomic value

The genus *Zieria* contains many species with restricted natural distributions, and the study of the biogeography, biology and genetics of such groups of species may help with understanding the processes of speciation and extinction.

Biodiversity value

The presence of *Z. lasiocaulis* in a number of vegetation communities within its restricted area of occurrence makes these communities unique. Rare and threatened plant species such as *Z. lasiocaulis* represent those species most likely to become extinct due to human-induced causes. Consequently, *Z. lasiocaulis* is a priority species to consider in conservation efforts aimed at arresting further loss of biodiversity from our natural ecosystems.

Commercial and pharmaceutical value

Z. lasiocaulis currently has no known commercial or pharmaceutical value. The family Rutaceae contains many species that are used commercially. For example, the cut flower industry (e.g. *Boronias*), food plants (citrus fruits), and timber (e.g. Australian Teak *Flindersia australis*) (Harden 2002).

Social benefits

The preparation of a recovery plan for *Z. lasiocaulis* will provide an information base for future management and research of this species. Given that the commercial and pharmaceutical value of *Z. lasiocaulis* is unexplored at this stage, future direct benefits cannot be quantified.

Increased community awareness of threatened species such as *Z. lasiocaulis* should increase support for the conservation of such species and, as a result, for the protection of biodiversity.

8.3 Biodiversity benefits

The occurrence of *Z. lasiocaulis* contributes to the high biodiversity of the flora of the north coast of NSW. The presence of *Z. lasiocaulis* in a number of vegetation communities within its known habitat makes these communities unique.

The conservation of *Z. lasiocaulis* in the wild could also benefit other plant and animal species and communities of conservation significance that occur in or near the habitat of *Z. lasiocaulis*. A plateau just west of Mount Banda Banda displays the best developed stand of cool temperate rainforest of the *Nothofagus-Ceratopetalum* sub-alliance in NSW (Floyd 1990). The habitat of *Z. lasiocaulis* is also habitat for several species of threatened fauna including Rufous Scrub-bird (*Atrichornis rufescens*), Tiger Quoll (*Dasyurus maculatus*) and Sphagnum Frog (*Philoria sphagnicolus*).

Significant plant species that will benefit from the conservation of *Z. lasiocaulis* and its habitat include *Grevillea guthrieana* (TSC Act Endangered). A small population occurs just north-west of Mount Banda Banda. A disjunct occurrence of the tussock grass *Dryopoa dives* (otherwise known from south of Robertson on the NSW southern highlands), and an undescribed species of *Astrotricha*

that is considered rare (B. Makinson, pers comm) also occur in the locality. A newly described species of *Solanum (Solanum curvicuspe)* has been recorded in the general vicinity in similar habitats to *Z. lasiocaulis* (Bean 2001). Bean (2001) proposes a category of "vulnerable" for the conservation status of this species.

By increasing the public awareness of threatened plants such as *Z. lasiocaulis*, the conservation of other threatened species and biodiversity in general is encouraged.

9. Previous actions undertaken

9.1 Taxonomic research

A draft systematic and evolutionary study of the genus *Zieria* was prepared by J. A. Armstrong about ten years ago. This manuscript is yet to be published.

9.2 Targeted survey

Targeted surveys for *Z. lasiocaulis* were carried out during late 1997 as part of the Comprehensive Regional Assessment of North-east NSW forests (NSW NPWS 1999). Known localities from herbarium records were visited and other suitable habitat for *Z. lasiocaulis* in the general area of occurrence was searched. Details of population size, physical attributes and vegetation community were recorded at each site where *Z. lasiocaulis* was located.

9.3 Monitoring

Marked monitoring plots were established in 2001 to sample each of the main populations of *Zieria lasiocaulis*. Seven monitoring plots in total have been established and have recorded population numbers, age structure, reproductive status of plants and dominant species associated with each site. A proforma (Appendix 1) was developed to consistently record monitoring information.

10. Species' ability to recover

There is no evidence to indicate that *Z. lasiocaulis* has undergone a significant reduction in either population size or distribution, and it appears to have a number of germination and recruitment strategies. Provided a suitable disturbance regime is established and maintained, it is expected that the species will maintain populations in the wild.

As population sizes and structure of *Z. lasiocaulis* vary with time since disturbance it can be expected that populations will exhibit variations from 1000's of seedlings soon after a disturbance event to few remaining mature adults following a long period without disturbance. The population may also exist only as a soil seedbank(Section 4.2) until a disturbance event such as fire triggers germination of plants. The absence of a large number of plants is not necessarily a reflection of a decline in the species, but often the time since disturbance.

11. Recovery objectives and performance criteria

11.1 Objectives of the recovery plan

The overall objective of this recovery plan is to protect populations of *Z. lasiocaulis* from decline induced by non-natural impacts, and to ensure that wild populations of *Z. lasiocaulis* remain viable in the long-term.

Specific objectives of this recovery plan are to:

- protect and maintain new and existing wild populations of *Z. lasiocaulis* and their habitat from threatening processes;
- improve the knowledge of the distribution, ecology, biology, population demographics and genetics of *Z. lasiocaulis* to enable appropriate management;

- protect any new populations and their habitat by suitable measures;
- ensure that land managers are familiar with *Z. lasiocaulis*;
- monitor known populations of *Z. lasiocaulis*;
- assess the need for *ex situ* conservation;
- increase community awareness of *Z. lasiocaulis* in particular, and threatened plant species in general; and
- assess whether the declaration of critical habitat for *Z. lasiocaulis* under the TSC Act would deliver demonstrable conservation benefits.

11.2 Recovery performance criteria

Recovery criteria are that:

- new and existing wild populations of *Z. lasiocaulis* are protected and maintained by suitable measures;
- knowledge of the distribution, ecology, biology, population demographics and genetics relevant to appropriate management of *Z. lasiocaulis* is improved;
- land managers are able to recognise *Z. lasiocaulis*;
- populations are monitored;
- the need for *ex situ* conservation is investigated and undertaken if appropriate;
- educational material on *Z. lasiocaulis* is available to the community; and
- assessment of the need for critical habitat for *Z. lasiocaulis* is undertaken.

12. Recovery actions

Recovery actions will be directed towards:

- implementing management strategies which ensure the survival of new and existing wild populations of *Z. lasiocaulis*;
- research into the ecology, biology, population demographics and genetics of *Z. lasiocaulis*;
- survey in potential habitat for additional populations of *Z. lasiocaulis*;
- familiarising land managers with *Z. lasiocaulis*.
- monitoring existing populations of *Z. lasiocaulis*;
- investigating the need for establishing *ex situ* collections of *Z. lasiocaulis*;
- community education; and
- assessment of the need for the declaration of critical habitat for *Z. lasiocaulis*.

12.1 Management strategy

The application of specific management strategies suitable for the maintenance of *Z. lasiocaulis* is not possible given the lack of information about the biology and ecology of the species. Consequently, the 'precautionary principle' will apply, and human-induced disturbance of populations of *Z. lasiocaulis* are to be avoided until such time as research data are available.

Any proposed action in potential habitat of *Z. lasiocaulis* to be preceded by adequate survey to ensure that known and/or previously unrecorded populations of *Z. lasiocaulis* are not adversely affected.

Data from monitoring and research programmes will need to be used to adopt appropriate management for the maintenance of the species in the wild. This information should also provide data to assess any weed invasion, feral animal or fire impacts on *Z. lasiocaulis* populations.

Environmental Impact Assessment guidelines will be prepared to assist land use planners to assess the likely impacts of any proposed development on *Z. lasiocaulis* and its habitat. These guidelines will

include survey guidelines, information on the life cycle of the species, any threatening processes and distributional and habitat information.

12.2 Familiarisation with *Z. lasiocaulis*

NPWS staff directly responsible for the management of *Z. lasiocaulis* populations and habitat will be made familiar with the species, both in the wild and as a dried specimen to assist with identification of the species. A list of features to distinguish *Z. lasiocaulis* from other similar species will be developed. Dried specimens are to be prepared and stored in an accessible place for land managers including State Forests of NSW (SFNSW) and the Department of Land and Water Conservation (DLWC).

A GIS layer will be developed which digitises the habitat areas of *Z. lasiocaulis*.

12.3 Monitoring

There is no evidence to suggest that the populations of *Z. lasiocaulis* have changed significantly in recent times (section 8.1). To determine whether populations of *Z. lasiocaulis* are declining, stable or increasing, a monitoring program will need to be maintained. Monitoring should measure recruitment, death, flowering and seed production.

Permanent plots were established in 2001 within populations and suitable habitat of *Z. lasiocaulis*. Measurements within plots should continue to include the number, age estimate, growth stage of individuals and dominant species present in the plots. Disturbance regimes that populations are subjected to should also be recorded.

In addition to monitoring permanent plots, individual plants should be tagged to monitor their growth and survival.

Permanent plots for monitoring to be maintained. Monitoring should be undertaken on an annual basis.

A plot monitoring proforma is provided in Appendix 1.

12.4 Ecological research

Survey

Survey of suitable habitat for *Z. lasiocaulis* should be carried out. Surveys should be both targeted and opportunistic: targeted for population assessment reasons and in areas that may be impacted by management actions, and opportunistically when conducting inventories in suitable habitat.

Prior to targeted surveys for *Z. lasiocaulis* in 1997 (NSW NPWS 1999) and 1999 (Gilmour pers obs), and the establishment of monitoring plots in 2001 (Gilmour 2001), the only information available on population sizes and localities were from herbarium labels and in Armstrong (2002). Other land management agencies such as SFNSW and DLWC will be encouraged to survey for the plant in suitable habitat.

Population ecology

The long-term survival of *Z. lasiocaulis* in the wild is determined by how the life history attributes of the species are affected by the management of natural ecosystems. Limited study of life history attributes of the genus *Zieria* has been undertaken (Armstrong 2002). Research is needed in the following areas:

- seedling survival, plant longevity and juvenile period;
- flowering, pollination and seed set;
- seed-bank dynamics, particularly the time required to establish an adequate seed-bank and the effect of different disturbance regimes on the seed-bank;
- mortality rates, particularly of seedlings after a germination event; and

- response to fire and physical disturbances.

To enable additional flexibility, it may be useful to separate out design and implmementaion of the research program.

Genetic research

In order to conserve the genetic diversity of the species, all sites will need to be protected. An assessment of the genetic variation between and within populations of *Z. lasiocaulis* would only be a priority if there was a risk of extinction of any of the sites.

There is some potential to source funding for genetic research via a SPIRT grant in partnership with NPWS.

12.5 *Ex situ* conservation

Investigations should be made into the need to establish *ex situ* plants and a seed-bank of *Z. lasiocaulis* in appropriate locations (e.g. regional and national botanic gardens or universities). This measure would act as insurance against loss in the wild due to a catastrophic disturbance or series of disturbances.

Z. lasiocaulis plants have been propagated in the past at the Australian National Botanic Gardens in Canberra, however, a check of the living collection database for these gardens indicated that *Z. lasiocaulis* is no longer in cultivation there.

12.6 Community education

Maintenance of biodiversity is an important conservation issue, and the continued survival of rare plant and animal species is a critical component of the maintenance of biodiversity. It is important that the general public be made aware of the significance of threatened plants and their habitats.

A leaflet on *Z. lasiocaulis* suitable for distribution to the general public is to be produced, and the recovery plan publicised through the media.

12.7 Critical habitat

An assessment of the need to declare critical habitat for *Z. lasiocaulis* under the TSC Act will be carried out.

13. Implementation

Table 2 allocates responsibility for the implementation of recovery actions specified in this plan to NPWS for the period until this recovery plan is reviewed, and details the costs of implementing the recovery plan.

Priority is categorised as 1 (high), 2 (medium) or 3 (low).

Table 2: Implementation schedule

Section	Description	Responsibility for implementation	Timeframe	Priority	Costs of implementing the recovery plan				
					Year 1	Year 2	Year 3	Year 4	Year 5
12.1	**Management strategy**	NPWS	Life of plan	1	*	*	*	*	*
12.2	**Familiarisation with species**	NPWS	Year 1	1	*				
12.3	**Monitoring**	NPWS	Life of plan	1	*	*	*	*	*
12.4	**Ecological research**								
	Survey	NPWS	Year 1	2	$4000#	-	-	-	-
	Population ecology: design	NPWS	Year 1	1	$3000#	-	-	-	-
	Population ecology: implementation	NPWS	Years 1 & 2	1	$5000#	$5000#	$5000#		
	Genetic research	NPWS	Year 1	3	▲	▲	▲	▲	▲
12.5	***Ex situ* conservation**	NPWS	Year 1	2	$1000#	-	-	-	-
12.6	**Community education**	NPWS	Year 1	1	$1000#	-	-	-	-
12.7	**Critical habitat**	NPWS	Year 1	3	*				
Annual cost of implementing recovery plan					$14000#	$5000#	$5000#		

Total cost of implementing recovery plan $24 000

* = Cost covered by agency's core responsibility

= Subject to the availability of funding. Funding will be sought from external sources.

▲ = Not costed: action only undertaken if there is a risk of extinction of a site or if external funding becomes available.

14. Preparation details

This recovery plan was prepared by consultant botanist Phil Gilmour and updated by Dianne Brown of the NSW NPWS Threatened Species Unit, Northern Directorate.

14.1 Date of last amendment

No amendments have been made to this recovery plan to date.

14.2 Review date

This recovery plan will be reviewed within five years of the date of publication.

15. Acknowledgments

This recovery plan was prepared for the NSW National Parks and Wildlife Service by consultant botanist Phil Gilmour and updated by Dianne Brown of the Threatened Species Unit, NPWS Northern Directorate. The project was co-ordinated by Dianne Brown.

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16 References

Armstrong, J. A. (2002) *Zieria* (Rutaceae): a systematic and evolutionary study. *Australian Systematic Botany* **15**(3): 277-463.

Armstrong, J. A. and Harden, G. J. (2002) *Zieria*. In: *Flora of New South Wales Volume 2*. (ed G. J. Harden) pp. 277-288. NSW University Press, Kensington, NSW.

Auld, T. D., 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.

Bean, A. R. (2001) A revision of *Solanum brownii* Dunal(Solanaceae) and its allies. *Telopea* **9***(3):* 639-661.

Briggs, J. D. and Leigh, J. H. (1996) *Rare or Threatened Australian Plants*. CSIRO Publishing, Victoria, Australia.

DASET (Department of the Arts, Sport, Environment and Territories) (1992) *Nomination of the Central Eastern Rainforests of Australia by the Government of Australia for Inscription in the World Heritage List*. Commonwealth of Australia, Canberra.

Floyd, A. G. (1990) *Australian Rainforests in New South Wales*. Surrey Beatty and Sons, Chipping Norton, NSW.

Forestry Commission of New South Wales (1989) *Forest Preservation in State Forests of New South Wales*. Forestry Commission of New South Wales, Sydney, NSW.

Gilmour, P. (2001) Population monitoring of the threatened plant species *Zieria lasiocaulis*. Internal report to the National Parks and Wildlife Service Threatened Species Unit, Northern Directorate.

Gomez, C. and Espadaler, X. (1998) Myrmecochorous dispersal distances: a world survey. *Journal of Biogeography* **25**:573-580.

Harden G. J. (Ed.) (1990-93) *Flora of New South Wales* Volumes 1 to 4. NSW University Press, Kensington, NSW.

Harden G. J. (Ed.) (2002) *Flora of New South Wales* Volume 2 – revised edition. NSW University Press, Kensington, NSW.

NSW NPWS (1999) Upper and lower north-east NSW Comprehensive Regional Assessment targeted flora surveys. NSW NPWS Northern Zone, Coffs Harbour, NSW.

Olde, P. M. and Marriott, N. (1994) *The* Grevillea *Book* Volume 1. Kangaroo Press, Kenthurst, NSW.

Smith, J. (1989) Ant-assisted plant invasion. *Australian Journal of Ecology* **14** (2): 247-250.

Truyard Pty Ltd (1993) *Proposed Forest Management Kempsey and Wauchope Management Areas. Environmental Impact Statement*. Forestry Commission of New South Wales.

Vaughton, G. (1998) Soil seed-bank dynamics in the rare obligate seeding shrub, *Grevillea barklyana* (Proteaceae). *Australian Journal of Ecology* **23**: 375-384.

Appendix 1

Zieria lasiocaulis monitoring proforma

Date
Recorder
Easting
Northing

Plot ID No
Tenure
1:25,000 map sheet

Location.....

Comments (eg general health, presence of weeds, browsing by feral animals, etc) .....

.....

Fire Year of last fire ☐ Intensity (L- low; M – medium, H – high) ☐

Total no. plants (count)	No. plants in each height class (cm)			Reproductive status (% of plants in plot)					Age structure (% of plants in plot)			
	0-50	51-100	>100	V	B	F	S	OS	S	IM	M	SE

Reproductive Status: V = vegetative; B = buds; F = flowers; S = fresh seed; OS = old seed
Age Structure: S = seedling; IM = immature; M = mature; SE = Senescent

Associated vegetation at site (record 4 most dominant species in each stratum):

Strata	Form	Ht Rg (m)	%Cover	Species 1	Species 2	Species 3	Species 4

Strata: E = emergent; T = tallest stratum; M = mid stratum. If more than one mid stratum, number M1, M2, M3; L = lowest stratum. If more than one low stratum, number L1, L2, L3.

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