



Zieria prostrata

Recovery Plan



December 1998

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Zieria prostrata

Recovery Plan

Prepared in accordance with the New South Wales

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Acknowledgments

The research into, and management of, the *Zieria prostrata* has been a joint effort of the NSW National Parks and Wildlife Service (NPWS) and Australian National University (ANU). This Recovery Plan has been the combined effort of a number of people who have contributed to the survey and research on the species. The NPWS would like to thank the following people.

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Environment Australia, formerly Australian Nature Conservation Agency, provided funding for the implementation of the original Recovery Plan, resulting in a considerable improvement in the knowledge of the ecology of *Zieria prostrata*.

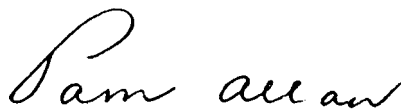
Foreword

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 preparation and implementation of recovery plans is identified by both the National Strategy for the Conservation of Australia's Biological Diversity and the draft NSW Biodiversity Strategy as a key strategy for the conservation of threatened flora, fauna and invertebrates. 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 communities and to ensure its ongoing viability in nature.

The *Zieria prostrata* Recovery Plan is the second recovery plan approved under the TSC Act. This plan describes our current understanding of *Zieria prostrata*, documents the research and management actions undertaken to date, and identifies the actions required and parties responsible to ensure the ongoing viability of the species in the wild.

The preparation of the *Zieria prostrata* Recovery Plan has been a joint effort of the NSW National Parks and Wildlife Service and the Australian National University and has been assisted by a large number of people. I thank these people for their efforts to date and I look forward to their continued contribution to the recovery of the species.



PAM ALLAN MP

Minister for the Environment

Executive Summary

Current Species Status:

Zieria prostrata is listed as Endangered under the Commonwealth *Endangered Species Protection Act 1992* and the New South Wales *Threatened Species Conservation Act 1995*. It is currently ranked 2E (occurring over a range of less than 100 km and endangered) by Briggs and Leigh (1996).

Description:

Zieria prostrata (Rutaceae) is a multi-stemmed, prostrate shrub, 0.5 to 1 metre in diameter. It is typically found on windswept headlands amongst dwarf heathland and low banksia shrubland.

Distribution and population size:

Zieria prostrata has a very restricted distribution and is currently known from only four headlands, all within the Moonee Beach Nature Reserve, 20 km north of Coffs Harbour, mid-northern New South Wales. The population size, while difficult to accurately determine, is considered to be in the order of a 1,000 plants.

Limiting factors

Despite comprehensive surveys of headlands along the New South Wales north coast, no other populations of *Zieria prostrata* have been located. In the course of these surveys, however, another *Zieria* species has been located growing in similar habitat to *Zieria prostrata*. The species is similar in form to *Zieria prostrata*, however due to morphological differences between the species, it has been called *Zieria* sp. aff. *smithii* to differentiate it from the more common and widespread *Zieria smithii* and the endangered *Zieria prostrata*.

The main threats to *Zieria prostrata* are considered to be displacement by exotic plant species, habitat degradation and inappropriate disturbance regimes. In particular, invasion of Bitou Bush onto the headlands is an ongoing problem, while exotic grasses are also invading areas where *Zieria prostrata* occurs. Plants have been destroyed from vehicular damage, and while vehicles are now excluded from the headlands, *Zieria prostrata* is vulnerable to long term pedestrian traffic. The effect of increased fire frequency on *Zieria prostrata* is unknown and may adversely affect the species long term viability.

Due to the restricted distribution and small total population size, *Zieria prostrata* is inherently vulnerable to catastrophic events that may reduce or eliminate the species from one or more locations. In particular, the small population at one site places it at risk of becoming disappearing from that location.

Previous actions undertaken

The previous recovery plan for *Zieria prostrata* (Griffith, 1992a) was written and implemented under funding from the Australian Nature Conservation Agency. A Recovery Team, comprising representatives of government departments, independent scientists and members of the public, has been in operation since 1993. All known *Zieria prostrata* habitat was included in the Moonee Beach Nature Reserve in September 1995. This passed the management of the headlands from the Coffs Harbour City Council over to the NSW National Parks and Wildlife Service.

Habitat protection has been undertaken to exclude vehicle access to the headlands and formalise walking tracks on Look-at-me-now Headland in order to reduce physical disturbance to *Zieria prostrata* habitat. A educational brochure has been prepared and an interpretative display and signs have been installed. An ongoing weed control program has been undertaken to control the weed species. A reintroduction program was implemented at two headlands in 1993. *Zieria prostrata* is commercially available and is cultivated in the Coffs Harbour and Canberra Botanical Gardens. Genetic studies have identified the significance of each *Zieria prostrata* population and the importance of protecting all four headlands. This genetic study has led to the commencement in 1996 of a three year PhD research project at the Australian National University investigating the ecology, reproductive biology and population genetics of *Zieria prostrata*.

Overall Recovery Objective:

To identify, protect and maintain all existing *Zieria prostrata* populations, ensure their long term viability, and conserve the full range of genetic diversity within *Zieria prostrata*. Specific objectives of this recovery plan are to:

- reserve and/or protect all populations of *Zieria prostrata*;
- resolve taxonomy and distribution of the closely related *Zieria* sp. aff. *smithii* and assess its conservation status;
- obtain ecological and population dynamics information to assist with effective management of *Zieria prostrata*;
- determine the extent and severity of threatening processes, and eliminate or minimise their impact as necessary; and
- inform the community about *Zieria prostrata* and its habitat.

Recovery Criteria:

The recovery criteria involve implementing and achieving the following recovery actions over the next three years, in order to meet the recovery plan objectives. Assessment of whether the recovery criteria have been met will include conducting a review of the recovery plan implementation program to assess its results and make recommendations for any further actions that may be required to ensure the long term viability of *Zieria prostrata*.

Recovery Actions:

The specific recovery actions to be undertaken are to:

- survey potential *Zieria prostrata* habitat and identify threatening processes; lodge voucher specimens with herbaria; notify all land managers of known *Zieria prostrata* locations; secure reservation for all known *Zieria prostrata* locations; consider the declaration of Critical Habitat for *Zieria prostrata*;
- search all potential locations for *Zieria* sp. aff. *smithii*, and assess conservation status; conduct genetic and morphometric analysis of *Zieria* sp. aff. *smithii*;
- conduct research into the population biology of *Zieria prostrata*, its interaction with other species and the impact of disturbance on *Zieria prostrata*;
- implement weed control plans and conduct regular monitoring; assess effectiveness of vehicle control measures; assess impact of tracks on *Zieria prostrata* and modify location of tracks where necessary; evaluate historical changes to vegetation communities and summarise information on disturbance regimes that have affected *Zieria prostrata* habitat;
- update brochure and distribute to the public; design and install interpretative signs; and
- review success of previous cultivation programs and investigate the potential for seed storage in terms of longevity, costs and source plants.

Biodiversity benefits

With the protection of *Zieria prostrata* and its habitat at the four present locations, there will be other potential conservation benefits. These include the enhanced conservation of rare headland plant communities, other rare or threatened flora species, important threatened fauna habitat and important items of cultural heritage.

The implementation of the recovery actions for *Zieria prostrata* will improve our understanding of the fragile ecology of headlands as well as ensuring that *Zieria prostrata* is not in danger of becoming extinct in the future. Continuing research into the species will also provide an important basis upon which to make management decisions that will promote the recovery of the species.



BRIAN GILLIGAN
Director-General

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Species Information

1.0 Summary of Previous Actions

The previous recovery plan for *Zieria prostrata* (Griffith, 1992a) was written under funding from the Australian Nature Conservation Agency. Since the preparation of this Recovery Plan, considerable advancement has been made in both the research and management of *Zieria prostrata*.

A Recovery Team, comprising representatives of the National Parks and Wildlife Service, Australian National University, Ulitarra Society, Environment Australia Biodiversity Group, Department of Land and Water Conservation, Coffs Harbour City Council and a horticultural consultant, has been in operation since May 1993. The Recovery Team has provided advice on the implementation of the Plan and has met seven times since its formation.

The inclusion of the four headlands where *Zieria prostrata* occurs in the Moonee Beach Nature Reserve in September 1995 was a significant conservation outcome. This passed the management of the headlands from the Coffs Harbour City Council over to the NSW National Parks and Wildlife Service (NPWS). The NPWS Dorrigo District has commenced the upgrading of facilities such as interpretive displays, walking tracks and pedestrian exclusion fencing on Look-at-me-now Headland to control pedestrian access and further reduce disturbance. A gate and formal vehicular access to Fiddamans beach has been constructed at Diggers Point. Stabilisation of a dune blowout has been undertaken at bare Bluff. Management guidelines (NPWS 1998a) have been prepared for Moonee Beach Nature Reserve, and endorse the objectives and actions of the *Zieria prostrata* Recovery Plan.

Habitat protection in the form of erection of fences and bollards has been implemented to exclude vehicle access to the headlands and to reduce physical disturbance and soil erosion to *Zieria prostrata* habitat. An ongoing weed control program, prepared by NPWS Dorrigo District (NPWS 1998b) has been initiated to control the encroachment of weeds such as bitou bush, lantana and kikuyu. Monitoring and maintenance continues to effectively assess and control this problem. A fire management plan has also been prepared for Moonee Beach Nature Reserve (NPWS 1998c)

A reintroduction program was implemented at two of the four headlands in 1993 to further increase numbers and population stability. The Look-At-Me-Now Headland and Dammerels Head populations were enhanced with 150 and 50 individuals respectively. Of these re-introduced plants 19 are still surviving at Look-At-Me-Now Headland and five at Dammerels Head. *Zieria prostrata* is widely available in the horticultural industry and is currently being cultivated in the Coffs Harbour and Canberra Botanical Gardens.

Genetic studies undertaken by the Australian National University (Peakall, 1994) identified the significance of each *Zieria prostrata* population and demonstrated the importance of protecting all four headlands in the conservation reserve system. This study also raised doubts about whether *Zieria prostrata* ever occurred at Bonville Headland, where it had been reported to have been locally extinct. This genetic study has led to the commencement in 1996 of a three year PhD research project investigating the ecology, reproductive biology and population genetics of *Zieria prostrata*. This research is being undertaken by Patricia Hogbin at the Australian National University and is jointly funded by the Australian National University, NPWS and the Commonwealth Department of Education, Employment and Training. This research will evaluate the most effective management options for protection and maintenance of the species.

2.0 Current Conservation Status

Zieria prostrata is listed as an endangered species at the National and State level and as a significant regional plant of upper North-east NSW, due to its restricted distribution, low population numbers and small population size (Table 1).

Table 1: The conservation status of *Zieria prostrata* at a National, State and Local level.

Relevant Act/Report	Status	Criteria satisfied
National		
ROTAP (Briggs &	Endangered	The ROTAP code is 2E where: 2 = occurring Leigh, 1996) over a range of less than 100 km, and E = in serious risk of disappearing from the wild in the next few decades if present land use and other casual factors continue to operate.
Endangered Species 1992 Protection Act (ESP Act)	Endangered	For the purposes of this Act, a species is endangered if: It is likely to become extinct unless the circumstances and factors threatening its abundance, survival, or evolutionary development cease to operate.
State		
NSW Threatened Species Conservation Act (TSC Act) 1995	Endangered	It is likely to become extinct in nature in NSW unless the circumstances and factors threatening its abundance, survival, or evolutionary development cease to operate.
Local		
Significant vascular plants of upper north east New South Wales (Sheringham & Westaway, 1995)	1 (2E) 6	where: 1 = Nationally rare or threatened. Taxa included on the current working list of rare or threatened plants (ROTAP; Briggs & Leigh, 1996). 6 = Endemic. Taxa with presently known distribution entirely within Upper North Eastern NSW.



Plate 1: The prostrate form of *Zieria prostrata* (bright green patch in front of legs). *Photograph: P. Hogbin.*

3.0 Description and Taxonomy

3.1 General description

A description of *Zieria prostrata* ms based on Armstrong (1991) and Armstrong (ms.) follows with supplementary notes in italics. At present the species description has not been formally published but it is referred to hereafter as *Zieria prostrata*.

“Prostrate (Plate 1) or low scrambling (Plate 2) shrub forming mats 0.5 (to 1 or more) m diameter; branches ridged, not warted, glabrous. Leaves with central leaflet obovate, 10-16 mm long, 4-6 mm wide, apex obtuse, rounded; margins entire; discolourous, both surfaces dotted with oil glands and glabrous; secondary venation evident on lower surface; petiole 3-4 mm long. Inflorescences (Plate 3) much shorter than leaves, generally 3-7 flowered (range 3-32). Calyx lobes broad-triangular, c. 0.5 mm long, glabrous. Petals 2-2.5 mm long, *pink or white* (pink in bud) imbricate, stellate-pubescent. Cocci glabrous, not warted but dotted with oil glands. The fruit (Plate 4) comprises 1-4 basally connate cocci which dehisce explosively along the adaxial and apical margins and partially down the abaxial side. The seeds are subovoid in shape, with thin brittle testas that are irregularly sculptured and ridged.”



Plate 2: The low scrambling form of *Zieria prostrata* (center of photograph in front of Banksia shrub). *Photograph: P. Hogbin.*



Plate 3: *Zieria prostrata* inflorescence. *Photograph: P. Hogbin*



Plate 4: *Zieria prostrata* fruit. *Photograph: P. Hogbin.*

3.2 Taxonomy

The genus *Zieria* belongs to the important and cosmopolitan family, Rutaceae (Table 2). *Zieria* is distinguished from other Australasian genera by the combination of opposite leaves, conspicuous and 4-merous flowers, free petals, four stamens, free filaments, deeply 4-lobed disc and dry, dehiscent fruits (Armstrong, ms.). Within the genus, *Zieria prostrata* belongs to the *smithii* group which comprises four species: *Zieria montana*, *Zieria prostrata*, *Zieria robertsii* and *Zieria smithii* (Armstrong, MS).

Table 2: The taxonomy of *Zieria prostrata*.

Division:	Magnoliopsida (Dicotyledons)
Subclass:	Rosidae
Order:	Sapindales (Cronquist, 1981) Rutales (Kanis, 1981)
Family:	Rutaceae
Subfamily:	Rutoideae
Tribe:	Boroniaceae
Subtribe:	Boroniinae
Genus:	<i>Zieria</i> Smith
Species:	<i>Zieria</i> species Q (Armstrong, 1991) <i>Zieria</i> species 16 (Briggs & Leigh, 1988) <i>Zieria prostrata</i> ms. J.A. Armstrong (Armstrong MS; Briggs & Leigh, 1996).

The species most likely to be confused with *Zieria prostrata* are *Zieria smithii* and an undescribed taxon hereafter referred to as *Zieria* sp. aff. *smithii*. *Zieria smithii* is an erect to robust shrub to 2m in height, which occurs on rainforest margins or in wet sclerophyll forest. In contrast, *Zieria prostrata* is restricted to grassy headlands where it grows as a prostrate or low sprawling shrub less than 0.5m height. *Zieria* sp. aff. *smithii* typically shares the prostrate or low sprawling habit with *Zieria prostrata* although it may also form a low shrub to 0.5 m, and like *Zieria prostrata*, is restricted to headlands. At one location *Zieria* sp. aff. *smithii* and typical *Zieria smithii* occur within 300 m of each other, but in different habitats (Clemesha pers. comm., October 1996), suggesting the two taxa are distinct.

Zieria smithii can be distinguished from *Zieria prostrata* by its narrow elliptic central leaflet and warted branches lacking ridges, compared with the oblong central leaflet and bare ridged branches of *Zieria prostrata* (Fig. 1) (Armstrong, 1991). Due to the lack of ridges and presence of warts on the branches of *Zieria* sp. aff. *smithii*, Andrew Lyn, curator of Rutaceae at the Australian National Herbarium in Canberra, identified this form as *Zieria smithii*.

A preliminary genetic study including *Zieria prostrata*, *Zieria smithii*, the *Zieria* sp. aff. *smithii* and two outgroup taxa *Zieria arborescens* and *Zieria cystoides*, indicate the taxonomy of the *smithii* - *prostrata* group to be complex and poorly understood (Hogbin & Peakall, 1997). Four hypotheses require investigation:

1. That *Zieria* sp. aff. *smithii* and *Zieria prostrata* are distinct taxa;
2. That *Zieria* sp. aff. *smithii* is included within *Zieria smithii*;
3. That *Zieria* sp. aff. *smithii* is included within *Zieria prostrata*;
4. That both the *Zieria* sp. aff. *smithii* and *Zieria prostrata* are in fact *Zieria smithii*.

Clarification of the taxonomy of the *smithii* - *prostrata* group is a high priority with important implications for the conservation of the taxa concerned. For example, if the *Zieria* sp. aff. *smithii* is *Zieria prostrata*, this would require an expansion of the recovery plan to cover the management needs of the additional populations. On the other hand, if the *Zieria* sp. aff. *smithii* is distinct, its taxonomic and conservation status needs to be urgently assessed.

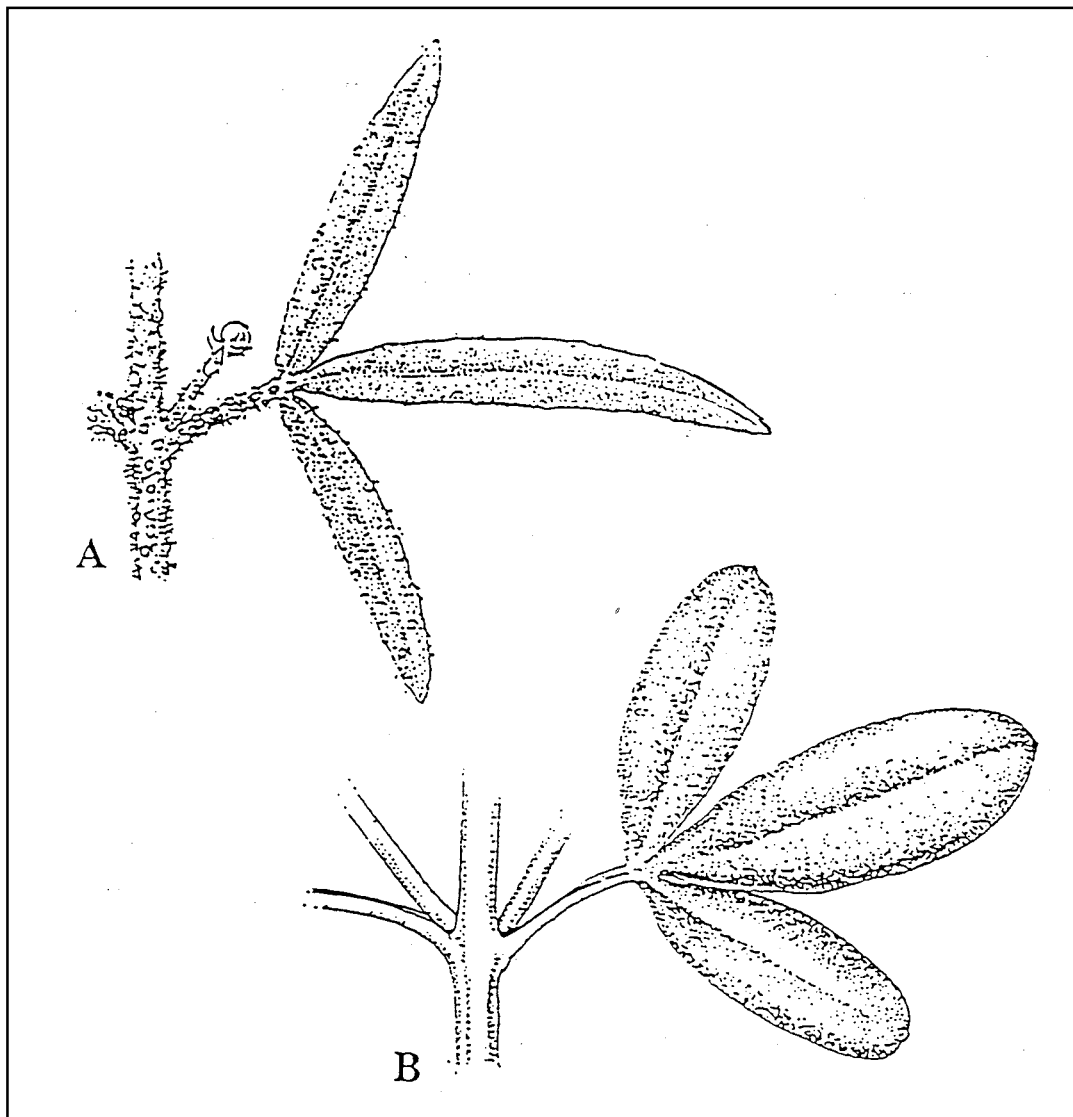


Figure 1: Differences between *Zieria smithii* and *Zieria prostrata*. *Zieria smithii* (A) can be distinguished from *Zieria prostrata* (B) by its narrow elliptic central leaflet and warty branches lacking ridges, compared with the oblong central leaflet and bare ridged branches of *Zieria prostrata*. Illustrations from Armstrong (MS).

3.3 Taxonomic Significance

Zieria prostrata is a member of the Rutaceae family, of which there are forty genera in Australia (150 in the world), consisting of 320 species (1800 species in the world). The *Zieria* genus, consisting of 44 species, is found in Queensland, New South Wales, Victoria, South Australia, Tasmania and one species in New Caledonia.

Australia-wide, seven species of *Zieria* are listed as endangered and a further eleven species are listed as vulnerable under the Commonwealth *Endangered Species Protection Act 1992*. In addition to *Zieria prostrata*, 25 of the remaining 42 *Zieria* taxa are considered to be rare or threatened in Australia (Briggs and Leigh, 1996).

In New South Wales, thirteen species of *Zieria* are listed as Endangered on Schedule 1 of the *Threatened Species Conservation Act 1995*. A further four species of *Zieria* are currently listed as Vulnerable on Schedule 2 of the *Threatened Species Conservation Act 1995*. Briggs and Leigh (1996) list 19 species of *Zieria* as rare or threatened in NSW.

4.0 Distribution

4.1 Geographical Distribution

4.1.1 Natural Geographical Distribution of *Zieria prostrata*

Zieria prostrata occurs on only four headlands in the Coffs Harbour area of northern NSW along a three kilometre stretch of coastline. The four headlands, Bare Bluff, Diggers Point, Dammerels Head and Look-At-Me-Now Headland (Fig. 2) were included in the Moonee Beach Nature Reserve in September 1995. The Diggers Point population was only discovered in 1993.

Despite extensive searches of headlands to the north and south of the Moonee Beach Nature Reserve, no other populations of *Zieria prostrata* have been located. Further, there have not been any historical reports of the species on any other headlands, apart from Bonville Headland (see below).

Due to the lack of previous detailed surveys it is difficult to determine whether *Zieria prostrata* has been undergoing a decline in population size or extent. Griffith (1992a) noted that an accurate count was not attempted as it would have been time-consuming and potentially destructive. As a result of this limitation, information on the decline or increase of the distribution of *Zieria prostrata* on the four headlands over time is not readily available.

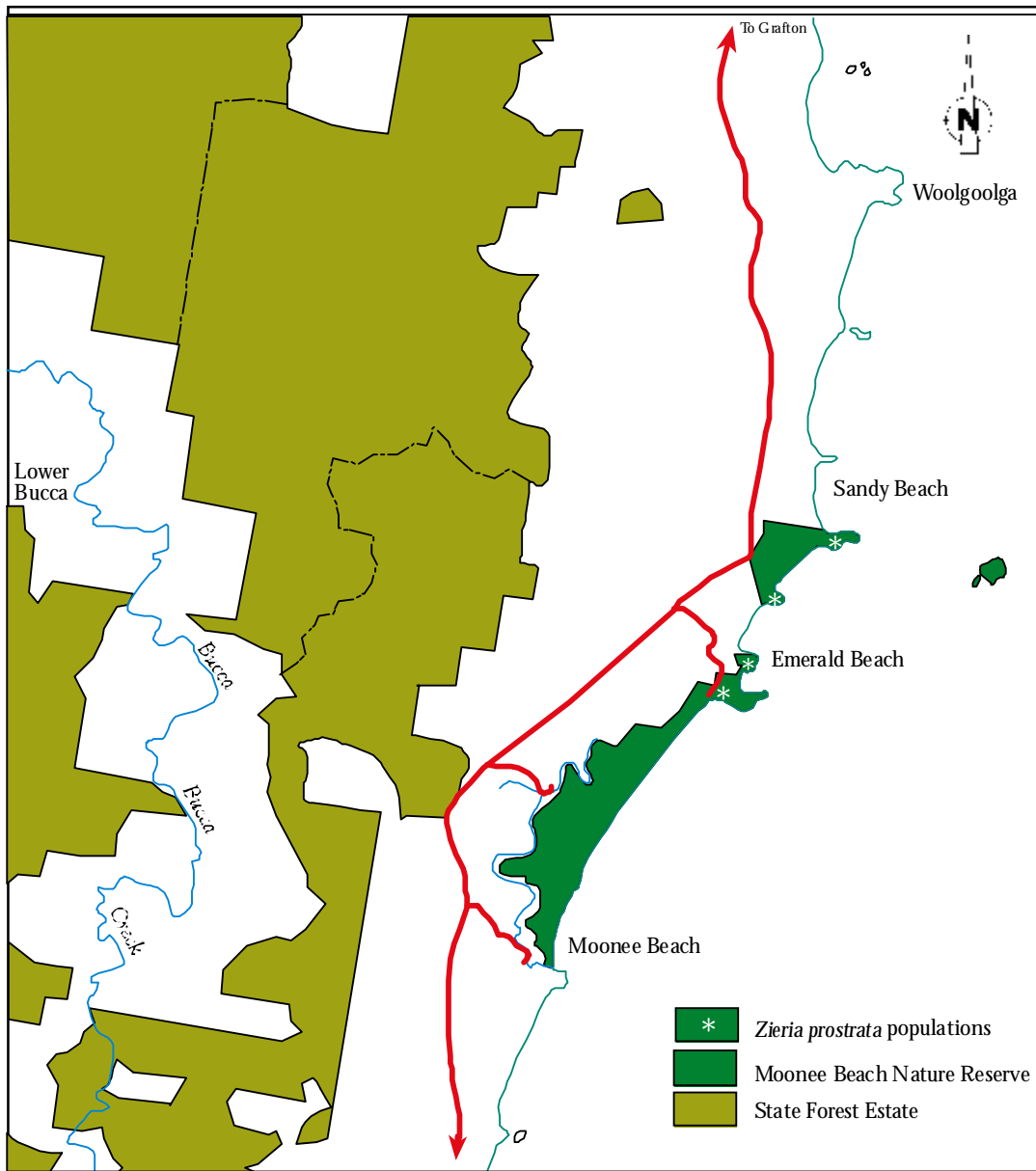


Figure 2: Location of the four known *Zieria prostrata* populations.

Zieria prostrata has also been reported to have occurred on Bonville Headland at Sawtell, 23 kilometres south of its present distribution. However, evidence supporting this claim is lacking. For example, herbarium records for this site do not exist, despite claims that cuttings were cultivated in the Australian National Botanic Gardens. In addition, genetic analysis revealed an individual reported to be from Bonville Headland shared the same DNA profile with individuals from Dammerels (Peakall, 1994). Since extensive genetic divergence occurs among populations within this species (see section 5.3) the probability of sharing DNA profiles among populations is extremely low. This has led the recovery team to conclude that reports of the species occurrence at Bonville Headland are doubtful.

4.1.2 Geographical Distribution of Similar Taxa

A search in 1996 for *Zieria prostrata* along some 300 kilometres of coastline to the north and south of Coffs Harbour located eight headlands between Byron Bay and Port Stephens which support a taxon very similar to *Zieria prostrata*, referred to as *Zieria* sp aff *smithii* for the purpose of this report (see section 3.2). The thorough survey of headlands remains incomplete, and therefore it is possible that further populations of this taxon exist.

4.2 Habitat

4.2.1 Climate

The nearest Bureau of Meteorology station to Moonee Beach Nature Reserve is located at Coffs Harbour (Station No. 059040). Information from this station is summarised below, The Coffs Harbour area experiences high rainfall, typical of the north coast of New South Wales, with an average annual rainfall of 1718 millimetres and a mean annual number of rain days of 142. The highest rainfall period is generally from January to April, when mean monthly rainfall is in excess of 190 millimetres. Extreme rainfall events occur within the region with sufficient frequency to warrant consideration in making planning decisions due to potential slope instability, high erosion levels on exposed surfaces and inundation of low lying areas. Lowest rainfall occurs from July to October with September having the lowest mean rainfall of 64 millimetres.

The Coffs Harbour area experiences mild winters and warm to hot summer conditions. The mean daily temperature range is low with the highest diurnal range of 5°C occurring in October. Maximum mean daily summer temperatures of 24.7°C are experienced in January and February, with the mean daily minimum temperatures during these months being 21.4°C and 21.5°C, respectively. Average lowest temperatures are experienced during July and August, with daily maximums of 15.8°C and daily minimum temperatures of 11.1°C and 12.3°C, respectively.

The regional wind pattern in this coastal location is strongly modified by land and sea breezes. The phenomenon expresses itself most strongly in the warmer months of the year and is characterised by a marked diurnal variation in wind direction. In the mornings, the most common wind is offshore from a generally western direction, but

as land temperatures rise, the wind switches to onshore from a generally north-easterly direction. Whilst frosts have occurred under extreme conditions throughout the Coffs Harbour area, under normal conditions most seaward facing slopes on the coastal ranges are frost free and the immediate coastal fringe can also be considered as frost free (Gutteridge Haskins & Davey, 1996).

4.2.2 Geology and soils

The headlands where *Zieria prostrata* occurs are of Carboniferous metasediment origins of the Coramba Beds, comprising greywacke, slate and siliceous argillite (Department of Mines, 1971). These rocks are hard, intensely jointed and fractured. The rock strength of individual fragments appears strong but the rock mass could be of lesser strength due to joint and bedding defects. Physical weathering of the headland predominates over chemical weathering (Camp Scott Furphy, 1993). Soils on the headlands where *Zieria prostrata* occurs comprise yellow podzolics, which are moderately deep, moderate to freely drained and weakly to moderately structured. Erosion hazard in the A horizon is low unless exposed, whereas the B horizon has a good aggregate stability (Soil Conservation Service, 1980).

4.2.3 Associated vegetation

Zieria prostrata grows mostly on exposed sites with a southerly aspect, among dwarf headland vegetation (to 20 cm in height) (Plate 5). The dwarf headland vegetation is characterised mainly by *Themeda australis* (Kangaroo Grass) grassland and dwarf heath species including: *Helichrysum bracteatum* (Golden Everlasting), *Hibbertia vestita* (Hairy Guinea Flower), *Oxylobium scandens* var. *obovatum* (Trailing Shaggy Pea), *Pultenaea* sp. aff. *villosa* (a bush pea), *Pimelia linifolia* (rice flower), *Senecio lautus* subsp. *maritimus* (variable groundsel) and *Hydrocotyle peduncularis*. On more sheltered aspects, *Zieria prostrata* also associates with wind-pruned open to sparse shrubland characterised by the species *Banksia integrifolia* var. *integrifolia* (White banksia) and *Acacia sophorae* (Beach Sally wattle). At such locations *Zieria prostrata* grows to heights up to 0.5 m, but still retains a sprawling habit rather than adopting an erect one (Plate 2).

4.3 Significant Habitats

All four headlands where *Zieria prostrata* occurs represent significant habitat for the species given the few populations and their small size. Furthermore, genetic studies show unusually large genetic divergence among populations despite their close geographic proximity (Peakall, 1994; Hogbin & Peakall, 1997). Thus, effective conservation of the species' genetic diversity cannot be achieved without the preservation of all populations. Conservation of genetic diversity is essential to ensure the species retains its evolutionary potential (ESAC, 1992).

4.4 Critical Habitat

No areas of *Zieria prostrata* have been declared as Critical Habitat within the meaning of the *Threatened Species Conservation Act 1995*. The declaration of critical habitat is the responsibility of the Director-General of National Parks and Wildlife.

The nomination of critical habitat will be considered by the Recovery Team within the first year of the Recovery, and a recommendation forwarded to the Director-General of National Parks and Wildlife as appropriate. The area covered by any critical habitat declaration will be reviewed as new information about the distribution of *Zieria prostrata* becomes available.



Plate 5: *Zieria prostrata* habitat - dwarf heath/grassland. Photograph: P. Hogbin.

5.0 Ecology and Life History

5.1 Reproductive Biology

5.1.1 Vegetative Reproduction

Griffith (1992a) suggested that the species may be capable of vegetative reproduction via the formation of adventitious roots that formed when stems contact the soil. Investigation of more than 100 plants in 1996 and 1997, has found that vegetative reproduction is a rare event with only two plants exhibiting adventitious roots. Both plants were found in what could be considered a high stress environment, on an almost sheer cliff face and along a frequented walking track (Hogbin pers. obs.).

5.1.2 Flower Biology

Flowering commences annually in late August and continues until late September/October (Hogbin pers. obs.). A few flowers can be seen at other times of the year. The flowers are bisexual, regular and borne in axillary cymose inflorescences. Prakash (1995) investigated the reproductive development of *Zieria prostrata* flowers and found it to be normal and broadly comparable with that of other Rutaceous plants. Armstrong (ms.) reported that *Zieria prostrata* samples from Look-At-Me-Now Headland were devoid of pollen. However, neither Prakash (1995) or Hogbin & Peakall (1997) found any evidence of pollen sterility in natural populations.

5.1.3 Pollination

Zieria flowers are most frequently visited by nectar- and pollen-seeking beetles, whilst bees and nectar-seeking butterflies are rarer flower visitors. It is, however, presently unknown which visitors are the most important pollinators (Armstrong, ms.). Observations of flower visitors to *Zieria prostrata* are limited. However, ants have been observed to visit flowers for nectar at both wild and glasshouse plants, but appear unable to transfer pollen from anther to stigma (Hogbin pers. obs. 1996). Despite the absence of pollinator observations, pollen has been observed on the stigma and at the base of the carpel (as though it had fallen from the anthers) of all flowers examined closely (n=100).

5.1.4 Mating system

Armstrong (ms.) reported 64% of *Zieria* species examined (n=33), produced fruit when their flowers were isolated, suggesting these taxa were self-compatible. Glasshouse artificial pollination experiments revealed that not only is *Zieria prostrata* self-compatible but is also capable of self pollination in the absence of pollinator activity (autogamy) (Hogbin & Peakall, 1997). The patterns of genetic variation among populations provide further evidence for selfing in *Zieria prostrata*.

Table 3 compares the genetic patterns of *Zieria prostrata* with a number of other Australian plants. For the outcrossing species 9 to 15% of the total genetic diversity was attributed to differences among populations. In contrast the highly selfing species *Danthonia richardsoni* was characterised by 69% divergence among populations, while in *Zieria prostrata* the observed divergence of 36% is clearly more typical of a selfing than an outcrossing species.

Table 3: Genetic differentiation among populations of *Zieria prostrata* compared with that of a number of other Australian plant species.

Species Reference	Variance among populations	Breeding system	
<i>Acacia baileyana</i>	9%	Outcross	Smith (1993)
<i>Banksia integrifolia</i>	13%	Outcross	Moyle (1995)
<i>Grevillea scapigera</i>	13%	Outcross	Rossetto <i>et al.</i> (1995)
<i>Grevillea barklyana</i>	13%	Outcross	Hogbin <i>et al.</i> (1997)
<i>Cardamine lilacina</i>	15%	Outcross	Nolan (1994)
<i>Zieria prostrata</i>	36%	Selfing	Hogbin & Peakall (1997)
<i>Danthonia richardsoni</i>	69%	Selfing	Moore (1994)

5.1.5 Seed Biology

Fruit set in *Zieria prostrata* commences in September/October. The seed are released explosively (ballistic) (Armstrong, ms.) and generally retain an ant-attracting elaiosome which may facilitate ant dispersal. Long-distance dispersal capacity is poorly developed in ballistic and ant dispersed species (Wilson, 1992). It is therefore more than likely that the seeds of *Zieria prostrata* are dispersed only a short distance from the parent plant. Observations of seedling emergence support short-distance dispersal with all observed seedlings being within 30 cm of an adult plant (Hogbin, unpubl.)

Seeds were collected from all four populations of *Zieria prostrata* during the 1996 seed set period (Hogbin & Peakall, 1997). A high level of seed predation was found at both Dammerels Head and Look-At-Me-Now Headland, whereas no evidence of seed predation was found at Bare Bluff nor Diggers Point (Figure 3). Prakash (1995) found nearly 50% of *Zieria prostrata* seeds examined were consumed by an insect larvae and proposed the predator may be wasp larvae. Armstrong (ms.) claims such insect damage is common within the *Zieria* genus.

A proportion of *Zieria prostrata* seeds collected were also found to be inviable and deformed (Figure 3). The production of inviable seeds also seems to be population specific with Dammerels and Look-At-Me-Now producing significantly more inviable seeds than Bare Bluff and Diggers Point. The reduction in the output of viable seed as a result of insect predation and seed deformity at both Dammerels Head and Look-At-Me-Now headland is statistically significant. It is not known whether these site specific patterns will continue from year to year, or whether they represent seasonal variation.

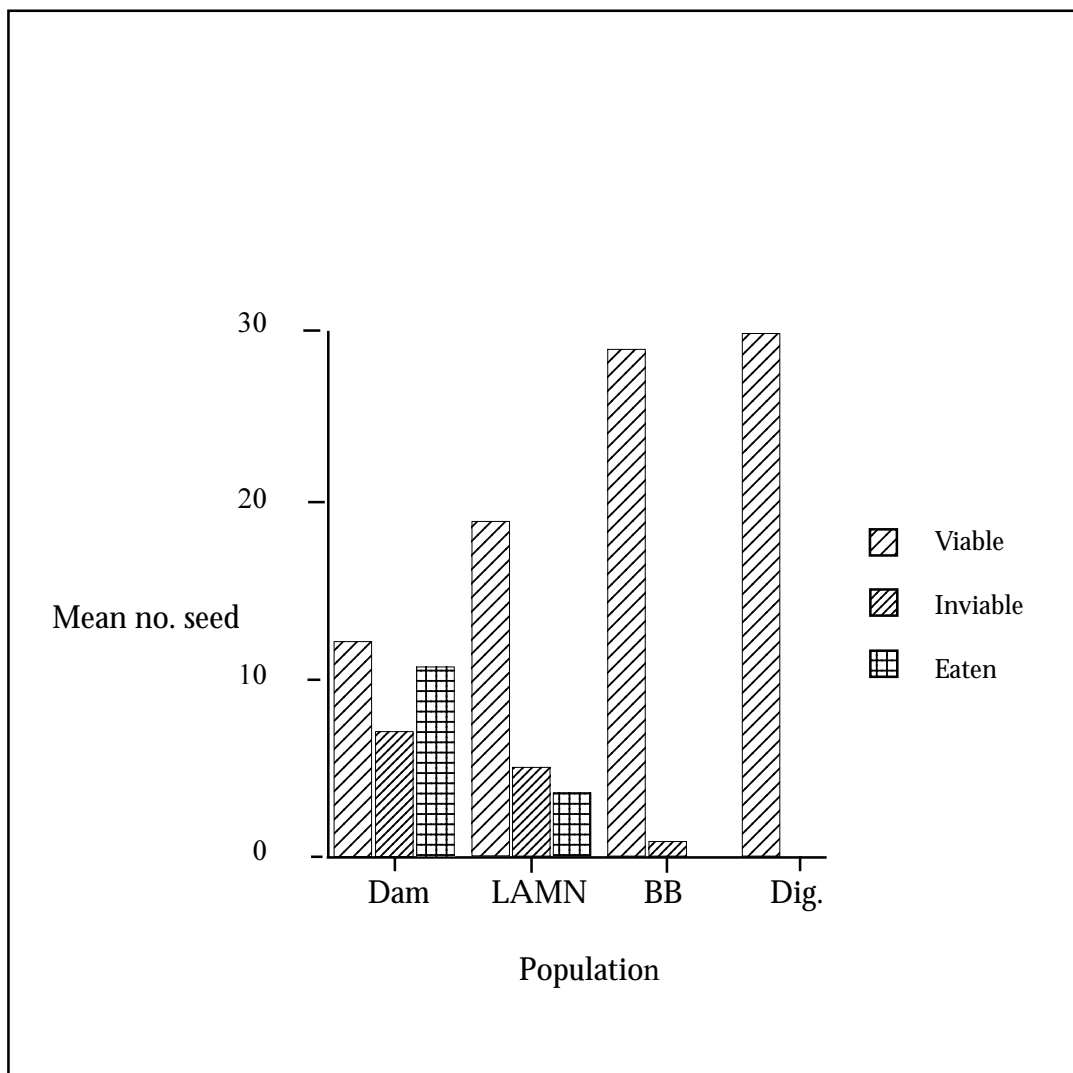


Figure 3: Mean seed predation and viability (SE) levels of seed collected from four populations of *Zieria prostrata* during 1996. (Dam + Dammerels Head; LAMN = Look-at-me-now Headland; BB = Bare Bluff; Dig = Diggers Point)

Sampling of the soil-stored seed bank of *Zieria prostrata* at Dammerels Head and Look-At-Me-Now Headland, in September 1996, 10-11 months after the previous seed fall, revealed density of seed in the soil was high, with an average of 52.5 ± 18.4 being collected from a soil sample of 200 cm^3 . This sampling also revealed an extremely low level of seed viability (<1%). At Look-At-Me-Now Headland and Dammerels Head on average 34% and 56% of seeds at the respective headlands sampled were empty with a visible hole indicating predation, while the remainder were either empty or contained a shrivelled embryo (Hogbin & Peakall, 1997). The implications of this preliminary result are that *Zieria prostrata* possesses a short-lived seed bank and requires an annual seed set for seedling recruitment and maintenance of a viable seed bank.

In order to investigate seed bank longevity in greater detail, a seed burial experiment has been conducted to investigate the germination, dormancy and viability of the seed bank over time. Nylon bags containing 25 seeds (collected from various plants, pooled and predated removed) were buried in four conditions: disturbed soil at a depth of only 2cm, disturbed soil at a depth of 5cm, under the canopy of an adult plant at a depth of only 2cm and under the canopy of an adult plant at a depth of 5cm. One bag from each treatment was collected from each of 8 plots at two month intervals for 12 months. The seeds were then scored for germination and viability. The results of this experiment showed that seeds buried at only 2cm in disturbed soil germinated at a significantly greater rate than seeds buried at 5cm under the canopy of an adult plant, implying soil disturbance, exposure and shallow burial break seed dormancy. Six months after seed burial there were hardly any dormant (viable) seed remaining in the disturbed/2cm plots, whereas there were still viable/dormant seed remaining for all other treatments over the entire 12 months. The number of inviable seeds has remained relatively constant for all treatments over time. There has been no significant reduction in seed viability over time, therefore not reinforcing the trend seen in the natural seed bank towards a reduction in viability over time (Hogbin 1998).

5.2 Disturbance Ecology

5.2.1 Fire Ecology

It is important to be aware of how various regimes of fire and disturbance affect processes that drive population and community change (Keith, 1996). The most important aspects of fire ecology in relation to *Zieria prostrata* are the impact of fire intensity, fire frequency, seasonality and spatial extent (or patchiness) on the persistence of the species. It is possible that wildfires will occur naturally upon the headlands in extreme weather conditions following a substantial build up of fuel, but small fires lit by arsonists are much more likely and have, in the past, burnt small patches of *Zieria prostrata* habitat.

A small fire on Bare Bluff (lit by arsonists) in 1993 has provided clues about the species' response to fire. All adult plants within the vicinity of the fire were killed and seedlings emerged soon after, indicating that *Zieria prostrata* is a fire sensitive species and reliant on seed stored in the soil for regeneration. For the Boronieae tribe in general, Armstrong (1989) postulates that a pH sensitive enzyme is the seed dormancy factor, and that such a factor is neutralised and denatured by highly basic post-fire leachates. However, seed germination of *Zieria prostrata* does occur in the absence of fire and may be facilitated by soil disturbance. The progress of a number of seedlings has been followed since April 1996 and as yet no mortality has been noted.

The fire intensity that a site experiences will govern the proportion of seeds in the soil that have their dormancy broken and hence, the level of post-fire seedling regeneration. The effect of fire intensity on the dormancy of *Zieria prostrata* seed is unknown but for *Zieria involucreta* fire intensity is a significant threat as seed dormancy is broken by temperatures of 80-110°C, with temperatures above this range killing

the seeds and temperatures below 80°C not breaking the soil dormancy. Therefore, fires which produce soil temperatures out of the 80-110°C range have the potential to cause population decline in *Zieria involucrata* (Maryott-Brown, 1994).

Fire frequency also has the potential to influence the survival of *Zieria prostrata* as too frequent fires can lead to population declines in many Australian natives (Bradstock & Auld, 1987). A fire-free interval is required for seedlings to establish, mature and produce seed to replenish the soil seed bank. The fire-free period for *Zieria prostrata* is unknown.

The timing or seasonality of a fire should also be considered. As mentioned in section 5.1.5 the seed bank of *Zieria prostrata* appears to be short lived, with very few viable seeds remaining in the soil 10-11 months after the previous seed fall. Therefore, if a fire occurred late in the season there may not be sufficient viable seed present in the seed bank to replace the population. Little is known about the response of *Zieria prostrata* to various fire regimes and thus the safest management option is to ensure no extremes of fire are encountered.

5.2.2 Physical Disturbance

The long-term impact of physical disturbance upon *Zieria prostrata* is not well documented. It can be assumed however, that as a result of vehicular access and sheep grazing upon Look-At-Me-Now Headland in the past, that the distribution of *Zieria prostrata* upon the headland was reduced (see section 7.1.2).

There is also evidence that continuous pedestrian traffic on Dammerels Head has had an impact on several *Zieria prostrata* plants (Hogbin, pers. obs. 1997). Formalisation of the walking track, while possibly causing the loss of one or two individuals, would be preferable to the current uncontrolled trampling of numerous plants.

Aside from directly affecting mature plants, physical disturbance or alternatively, a reduction in disturbance, possess the potential to influence seed germination and recruitment. Little is known about the response of *Zieria prostrata* to various regimes of disturbance and thus the safest management option is to ensure no extremes of disturbance are encountered.

5.3 Population Structure

Estimation of population size is difficult as the stems of *Zieria prostrata* trail and branch beneath the associated vegetation often emerging at a distance from the rootstock. To obtain an accurate estimate it is necessary to trace all stems back to their source, but since this activity is potentially destructive it has not been attempted. Griffith (1992a) estimated that the total population size was of the order of 400 plants, with the majority of plants on Bare Bluff and Dammerels Head, and about 25 plants on Look-At-Me-Now Headland.

Following more detailed investigation, it is estimated that the total population size is of the order of 1,000 plants, considerably larger than that estimated by Griffith (1992a), with an approximate breakdown of the number of plants per headland as follows:

- Look-At-Me-Now Headland - ~ 130 plants (including about 20 reintroduced specimens);
- Dammerels Head - ~ 200 plants (including about 10 reintroduced specimens);
- Diggers Point - 9 plants;
- Bare Bluff - ~ 800 plants.

A long-term demographic monitoring study was established in 1996 to investigate population size, recruitment, mortality, critical-life history stages and details of any threatening processes (Hogbin and Peakall, 1997).

The genetic structure within and among populations of *Zieria prostrata* has been estimated using DNA profiling. Of the total variation, 36%, was attributed to genetic variation among populations with the remainder representing within population variation (Hogbin & Peakall, 1997). Such high genetic differentiation among populations indicates genetic isolation of the populations (Peakall, 1994) and may be a reflection of high levels of selfing within populations (see section 5.1.4).

5.2.3 Salt Input

The headlands on which *Zieria prostrata* grows are amongst some of the most exposed headlands on the north coast of New South Wales and are likely to experience high salt loads, especially during late summer when storms are relatively common. The effect of this high salt load on seedling establishment is not known. The timing of fire in relation to salt input may be important in determining subsequent regeneration levels, however fires are unlikely to occur when the salt load is the highest, as at this time of year the vegetation is usually flushing with new growth as a result of the predominate wet season. Some plants have been damaged as a result of storms (S. Clemesha pers. comm.) and salt, however this is only minimal and occurs on a very infrequent basis.

5.4 Propagation

5.4.1 Cultivation

Zieria prostrata is presently in cultivation at the Australian National Botanic Gardens in Canberra, the North Coast Regional Botanic Gardens in Coffs Harbour and the Department of Land and Water Conservation at Grassy Head (Griffith, 1992a; Australian Network for Plant Conservation, 1993). Previously, *Zieria prostrata* has been grown by the Coffs Harbour City Council as part of a reintroduction program (see section 5.4.3).

It has been reported from a variety of sources that *Zieria prostrata* is relatively easily propagated either from seed or cuttings. However, many specimens grown from cutting at the Australian National University in Canberra were killed by a nematode attack (Hogbin, pers. obs.). It has also been noted by Armstrong (1989) to be susceptible to infection by the root fungus *Phytophthora*, however this susceptibility has not been observed on the north coast of NSW where it occurs both naturally and in cultivation (S. Clemesha, pers. comm.).

5.4.2 Commercial Availability

Samples of *Zieria prostrata*, taken from Dammerels Head, are now cultivated in Victoria by R. and N. Peate of Plant Growers Australia (Griffith, 1992a) and by R. Costin of Limpinwood Nursery via Murwillumbah (Australian Network for Plant Conservation, 1993). The species is also widely grown by native plant enthusiasts and is readily available from a number of commercial nurseries on the east coast of Australia. It has been marketed through these nurseries under the trade name "Carpet Star".

5.4.3 Reintroduction

During the implementation of the previous Recovery Plan (Griffith, 1992a), *ex-situ* propagation and subsequent reintroduction was implemented in 1993. In total, 150 plants were reintroduced at Look-At-Me-Now Headland and 50 at Dammerels Head. Of these, 19 are still surviving at Look-At-Me-Now Headland and five at Dammerels Head. At Look-At-Me-Now Headland the reintroduction was sourced from plants at Look-At-Me-Now Headland. At Dammerels the plants for reintroduction were sourced from the Dammerels Head population. At each respective headland the number and location of source plants is unknown. Site specific, but not source specific labels were used so it is not possible to trace the exact origin of individuals nor assess the genetic diversity or survival of translocated individuals. Eight plants were introduced at Bonville Headland, four plants are still surviving. The source of these plants is unknown, but it is likely that they may have been derived from a clone that was originally sourced from Dammerels Head (see section 4.1.1).

6.0 Relevant Legislation

There are number of Acts that are relevant to the recovery of *Zieria prostrata*. These include the *Environmental Planning and Assessment Act 1979*, *Threatened Species Conservation Act 1995* and the *National Parks and Wildlife Act 1974*. Other relevant Acts include the *Commonwealth Endangered Species Protection Act, 1992*, which lists *Zieria prostrata* as Endangered.

6.1 Environmental Planning and Assessment Act 1979

In general, under section 90 of the *Environmental Planning and Assessment Act 1979*, a consent authority (such as a local Council) must consider a species recovery plan when a development application is being assessed for approval. Further, under sections 77C and 112A of this Act, if a species impact statement has been prepared to support a development proposal, the Director-General of National Parks and Wildlife (or the Minister administering the *Threatened Species Conservation Act 1995*) must consider any relevant recovery plan in deciding whether or not concurrence should be granted to the proposal.

The *Environmental Planning and Assessment Act 1979* requires that certain activities within a designated zone of the relevant Local Environment Plan are either prohibited, permissible only with consent from the local Council, or permissible without consent. In specific relation to *Zieria prostrata*, Look-At-Me-Now Headland is zoned 6(d) - Open Space (Coastal Headland) Zone, while Dammerels Head, Diggers Point and Bare Bluff is zoned 6(a) Open Space (Existing) Zone.

Coffs Harbour City Council is currently undertaking a review of its Local Environment Plan and are aware that all NPWS land should be zoned 8(a) - National Parks and Nature Reserves Zone. This zone only allows activities authorised under the *National Parks and Wildlife Act 1974* to be undertaken without development consent. No activities, other than those authorised under the *National Parks and Wildlife Act 1974*, are allowable with or without Development Consent from the Coffs Harbour City Council.

6.2 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* requires the preparation of a plan for all species list as threatened. It specifies, in Section 59, that a recovery plan must include the following matters:

- (a) identify the threatened species, population or ecological community to which it applies, and
- (b) identify any critical habitat declared in relation to the threatened species, population or ecological community, and
- (c) identify any threatening process or processes threatening the threatened

species, population or ecological community, and

(d) identify methods by which adverse social and economic consequences of the making of the plan can be minimised, and

(e) state what must be done to ensure the recovery of the threatened species, population or ecological community, and

(f) state what must be done to protect the critical habitat (if any) identified in the plan, and

(g) state, with reference to the objects of this Act:

(i) the way in which those objects are to be implemented or promoted for the benefit of the threatened species, population or ecological community, and

(ii) the method by which progress towards achieving those objects is to be assessed, and

(h) identify the persons or public authorities who are responsible for the implementation of the measures included in the plan, and

(i) state the date by which the recovery plan should be subject to review by the Director-General.

The *Threatened Species Conservation Act 1995* also requires that any proposal to 'pick' *Zieria prostrata* (meaning gather, pluck, cut, pull up, destroy, poison, take, dig up, remove or injure the plant or any part of the plant), must be licensed under this Act, 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 *Bush Fires Act 1949* or the *State Emergency and Rescue Management Act 1989*. If a proposal that requires a licence under the *Threatened Species Conservation Act 1995* is likely to have a significant impact on *Zieria prostrata*, then a species impact statement must be prepared.

The *Threatened Species Conservation Act 1995* has provisions for the declaration of Critical Habitat for *Zieria prostrata*. The whole or any part or parts of the area or areas of land comprising the habitat of *Zieria prostrata* that is critical to its survival is eligible to be declared critical habitat. Once Critical Habitat has been declared over an area of land, any activity that requires approval must be accompanied by a Species Impact Statement. As yet, no Critical Habitat has been declared for *Zieria prostrata*.

6.3 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* requires that a licence must be obtained to propagate and sell *Zieria prostrata*. This act also regulates activities with National Park and Nature Reserve and therefore applies to *Zieria prostrata* which occurs within the Moonee Beach Nature Reserve.

7.0 Management Issues

7.1 Threats

At the time of publication of the initial 1992 recovery plan the main threats were considered to be: habitat degradation, displacement by exotic plant species, displacement by native plant species, nutrient enrichment and fire (Griffith, 1992a). The threat of nutrient enrichment as a result of dog urination is now considered significantly reduced following the inclusion of the *Zieria prostrata* populations in the Moonee Beach Nature Reserve, as dogs are prohibited in nature reserves. While there is an occasional breach of this restriction, it is considered minimal, and usually involves the use of the Nature Reserve as a thoroughfare to Moonee Beach rather than as a dog exercise area (S. Clemesha, pers. comm.).

The current threats for *Zieria prostrata* are considered to be exotic weed invasion, habitat degradation and inappropriate fire &/or disturbance regimes.

7.1.1 Weeds

The main threat to *Zieria prostrata* is currently considered to be displacement by exotic plant species. A list of the main exotic plant species present at *Zieria prostrata* populations is provided in table 4. Other exotic species are present in the Nature Reserve, however these are not considered to be a current or potential threat to *Zieria prostrata*. Of the main exotic species present in the Nature Reserve, the major threats are considered to be bitou bush (*Chrysanthemoides monilifera* ssp. *monilifera*), lantana (*Lantana camara*) and kikuyu (*Pennisetum clandestinu*). The encroachment of these species onto *Zieria prostrata* populations is subject to an ongoing weed control program, and it is essential that such measures continue.

Table 4. Main exotic plant species present at *Zieria prostrata* sites (S. Clemesha pers comm. 1996).

Scientific name	Common name
<i>Pennisetum clandestinum</i>	Kikuyu
<i>Chrysanthemoides monilifera</i> ssp. <i>rotundata</i>	Bitou Bush
<i>Lantana camara</i>	Lantana
<i>Baccharis halimifolia</i>	Groundsel Bush
<i>Sporobolus indicus</i> var. <i>capensis</i>	Parramatta grass
<i>Paspalum dilatatum</i>	Paspalum

7.1.2 Habitat degradation

Habitat degradation was previously considered to be the main threat to *Zieria prostrata*'s persistence. Sheep grazed upon Look-At-Me-Now Headland for around 30 years at the turn of the century (Griffith, 1992a). The extent to which such activities affected the *Zieria prostrata* population is unknown, but it can be assumed that native shrub species were actively displaced, either directly through consumption or indirectly via trampling (see Prober & Thiele, 1995; Wahren *et al.*, 1994).

In the past, heavy vehicular traffic has caused considerable damage to the headlands. The erection of fences and bollards has effectively excluded vehicular traffic from the headlands, allowing substantial habitat regeneration. Habitat degradation caused by pedestrians is still considered to be a threat and the NSW NPWS is currently in the process of establishing walking tracks at the two most frequented headlands: Look-At-Me-Now Headland and Dammerels Head, to minimise pedestrian impact.

7.1.3 Alteration of disturbance and/or fire regimes

The optimal disturbance and/or fire regimes to facilitate the long term maintenance of the *Zieria prostrata* populations is currently unknown. Until this has been assessed, it is important to avoid occurrences of extreme disturbance and/or fire regimes which may have an adverse impact upon *Zieria prostrata* and its habitat.

It also needs to be considered that the exclusion of disturbance over a long period of time in the more sheltered sites may have an adverse impact upon *Zieria prostrata* due to the succession of vegetation communities from dwarf heathland/grassland to a banksia shrubland or woodland that could provide too much cover for *Zieria prostrata* to survive and recruit.

Currently, however, there is no evidence of succession to banksia shrubland or woodland in the more exposed sites (S. Clemesha, pers. comm.). Inspection of historical aerial photographs is currently occurring to determine areas where such succession has occurred.

7.2 Biodiversity benefits

With the preservation of *Zieria prostrata* and its habitat at the four present locations, the following non-target conservation benefits are anticipated (adapted from Griffith, 1992a):

- Enhanced conservation of headland plant communities, a key one being *Themeda australis* sod grassland which is at present inadequately reserved on the NSW north coast (Griffith, 1992b). Another community of interest is the *Baumea juncea* (Bare Twig-rush) sedgeland described at Look-At-Me-Now Headland by Floyd (1988), and which also occurs on Bare Bluff (J. Benson, pers. obs. 1991). Although a widespread community of supratidal flats in estuaries, well developed stands of *Baumea juncea* sedgeland appear to be uncommon on north coast headlands, and the stands at Look-at-me-now Headland are exceptionally well developed.

- Enhanced conservation of other rare and threatened species, namely *Thesium australe* (Austral Toadflax) and *Chamaesyce psammogeton* (formerly *Euphorbia psammogeton*, *E. sparmanii*, or *Chamaesyce sparmanii*). Both species are considered to be vulnerable (Griffith, 1992b and Clemesha, pers. comm., 1997 respectively). *Thesium australe* is currently listed as Vulnerable on both the NSW *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Endangered Species Protection Act 1992* (ESP Act). It is a short-lived herbaceous shrub parasitic on the roots of *Themeda australis*. It occurs at three of the sites supporting *Zieria prostrata* (Floyd, 1991; Griffith, 1992b). *Chamaesyce psammogeton* has been listed as Endangered under the *Threatened Species Conservation Act 1995* following a preliminary determination by the NSW Scientific Committee that its numbers have been reduced to such a critical level that it is in immediate danger of extinction.
- Enhanced conservation of other coastal headland plant species which are not considered to be rare or threatened, but nonetheless are of known or possible regional significance. An example is a prostrate maritime form of the typically erect shrub *Pultenaea villosa* (Hairy bushpea), which may prove to be a distinct species (Harden, 1991). This form of *Pultenaea villosa* is common on the headlands supporting *Zieria prostrata*.
- Besides its value for the conservation of plant communities and species, the headlands are also an important rookery and foraging site for over 100 species of birds which inhabit the Moonee region, including the Little Tern (TSC Act: endangered; ESP Act: endangered), Osprey (TSC Act: vulnerable), Comb-crested Jacana (TSC Act: vulnerable), Jabiru (TSC Act: vulnerable), and Sooty Oystercatcher (TSC Act: vulnerable). Other species of note that forage on the headlands include the White-breasted Sea Eagle and Rainbow Bee-eater.
- Furthermore, the complex is central to local Aboriginal mythology as the entry point of Yuludarra, the ancestral being who founded the Gumbaingirr Tribe, as well as being central to many other Dreamtime stories (Heron, 1994). Heron (1994) noted that the caves on Look-At-Me-Now Headland were traditional rain increase sites, while another was used for the initiation of 'clever' men. He further reported that "Look-At-Me-Now Headland is one large archaeological site with artefacts and small middens all over the Headland." Diggers Point is also the site of a shell midden which has been partly exposed and is currently actively eroding (Appleton, 1995).

8.0 Social And Economic Consequences

Socio-economic analysis is concerned with the allocation of scarce resources in the community. This assessment considers the social and economic consequences of implementation of the proposed actions in the recovery plan. Only benefits and costs that change the net benefit to society are considered. The assessment does not attempt to consider the broad social or economic consequences of recovery planning *per se*.

8.1 Consideration of economic costs

The recovery plan estimates that the total cost of recovery of *Zieria prostrata*, through the implementation of actions outlined in the recovery plan, is approximately \$35,000 over a three year implementation period (See Appendix B). This cost incorporates conducting surveys, undertaking land reservation and/or protection (where required), ecological and genetic research, threat and disturbance assessment, community involvement and, if appropriate, *ex-situ* programs.

8.2 Consideration of economic benefits

Whilst the economic cost of the proposed recovery plan can be estimated, it is necessary to also consider the economic benefits of the proposal in order to determine the net economic cost or benefit to society. The following effects, although more difficult to quantify in financial terms, are identified as likely economic benefits to society as a result of implementation of the recovery plan:

- provision of protected habitat for threatened and other significant flora and fauna species in protected *Zieria prostrata* habitat; and
- increased value of the protected land through habitat enhancement and intrinsic value of the threatened plant community.

8.3 Consideration of social costs

The recent inclusion of the *Zieria prostrata* populations in the Moonee Beach Nature Reserve has given formal protection to the species, and accordingly, management of the area will be in accordance with the requirements of the *National Parks and Wildlife Act 1974*. As such, it is anticipated that there will not be any social costs associated with the implementation of the Recovery Plan.

8.4 Consideration of social benefits

The maintenance of *Zieria prostrata*, and implementation of management actions to protect the species and its associated habitat, is considered to be a social benefit.

Whilst the Recovery Plan is unlikely to significantly increase employment statistics for the region in the long term, it will provide short term employment opportunities, and opportunities to develop and enhance skills valuable in the work force.

The proposed public education program will increase awareness of rare plants and their significance in the region, and promote community involvement in the recovery process.

8.5 Consideration of net social and economic benefits to society

Whilst social and economic costs and benefits may be difficult to quantify in financial terms, it is considered that the overall benefits to society of implementation of the recovery plan outweigh the specific costs of the proposal.

In terms of the social and economic benefits of recovery of *Zieria prostrata* and the associated benefits for conservation of other rare and threatened species and the community that forms the habitat of the species, it is considered that implementation of the recovery plan would result in a net benefit to society. Community education is expected to generate a positive attitude toward recovery planning, and a genuine concern in the community for conservation of threatened species. Successful implementation of the recovery plan would involve community participation in the recovery, so the community would have a sense of achievement by meeting the recovery objectives, and a sense of ownership of the results.

9.0 Community Involvement

The Ulitarra Society and the Emerald Beach Dunecare Group have previously expressed an interest in *Zieria prostrata* and the Moonee Beach Nature Reserve, and would be suitable community groups to have representation on a Recovery Team for the species. In particular, the Ulitarra Society was instrumental in nominating all four headlands for inclusion in the Moonee Beach Nature Reserve. If, following the completion of research into the reproductive ecology and population genetics of *Zieria prostrata*, it is determined that there is a need for an *ex-situ* program, or translocation/re-introduction program, then it would be appropriate to involve the local community in the propagation of the species.

As part of the declaration of the Moonee Beach Nature Reserve, the NPWS has concerned community meetings to inform the community about improvements proposed for the Nature Reserve, and to seek community input wherever possible. It is intended that the community will be able to ensure that deliberate damage does not occur to *Zieria prostrata* and its habitat.

An educational leaflet discussing *Zieria prostrata* and its management has been prepared for distribution to members of the local community and members of the public in general. A copy of this leaflet is attached in Appendix A.

10.0 Recovery team

A Recovery Team for *Zieria prostrata* has been established to provide advice on the implementation of the Recovery Plan and to co-ordinate the undertaking of the various management actions detailed in the Recovery Plan.

The existing membership of the Recovery Team is based on the representation of government departments, non-government organisations and individuals who have a direct interest or role in the management of *Zieria prostrata*. The Recovery Team has met seven times since 1993.

In future, the Recovery Team will continue to be co-ordinated by a representative of the National Parks and Wildlife Service and should meet at least twice annually. Meetings should be held in the Coffs Harbour area to facilitate regular field inspections of *Zieria prostrata* and its habitat.

It is suggested that the Recovery Team could include, from time to time as circumstances require their involvement, the following representatives:

- National Parks and Wildlife Service - managers of Moonee Beach Nature Reserve;
- Australian National University - currently undertaking population genetics and ecological investigations;
- An independent scientist familiar with *Zieria prostrata* and its habitat;
- Emerald Beach Dunecare Group - who have expressed interest in the Moonee Beach Nature Reserve; and
- Ulitarra Society - local conservation group who have expressed an interest in *Zieria prostrata* and have been a foundation member of the Recovery Team.

***Zieria Prostrata* Recovery Actions**

11.0 Objectives

11.1 Overall Objectives

The overall objective, in relation to *Zieria prostrata*, is to:

- Identify, protect and maintain all existing populations and ensure their long term viability.
- To conserve the distribution of the full range of genetic diversity of the species.

11.2 Specific Objectives

In order to achieve the overall objective, a number of specific objectives have been developed that would be a target for specific actions to be undertaken for the recovery of *Zieria prostrata*. The aim of these secondary objectives is to:

- Reserve and/or protect all populations of *Zieria prostrata*.
- Resolve taxonomy and distribution of *Zieria* sp. aff. *smithii* and assess its conservation status.
- Obtain ecological and population dynamics information to assist with effective management of *Zieria prostrata*.
- Determine the extent and severity of threatening processes, and eliminate or minimise the impact as necessary.
- Inform the community about *Zieria prostrata* and its habitat.
- Assess the need for an *ex-situ* conservation program.

11.3 Recovery performance criteria

Recovery criteria are:

- No significant decrease in the area covered by all known populations.
- Threatening processes are eliminated or reduced at all known locations.
- All known populations are included in the conservation reserve system.

12.0 Actions

12.1 Identify, reserve and protect all *Zieria prostrata* populations.

Action 1.1

Identify the full distribution of *Zieria prostrata*, assess current and potential threats and adequately reserve or protect all populations of *Zieria prostrata*.

Priority 1.1

One.

Performance Criteria 1.1

All potential habitat areas are surveyed, and all threats to every population are assessed, within 12 months of commencement of Recovery Plan. All relevant land managers have been informed of locations of *Zieria prostrata* immediately following surveys and negotiations commenced to reserve or protect these populations within three months following the surveys.

Tasks 1.1

1. Systematically survey potential *Zieria prostrata* habitat, document survey locations and effort, and identify threatening processes and their severity.
2. Lodge voucher specimens from all locations with herbaria in Sydney and Canberra.
3. Notify all appropriate land managers of known locations.
4. Secure reservation for the whole of all known *Zieria prostrata* locations in a conservation reserve or protection through a Voluntary Conservation Agreement or Environmental Protection Zone.
5. Consider the declaration of Critical Habitat for *Zieria prostrata* under the Threatened Species Conservation Act 1995.

Outcome 1.1

1. All populations are either reserved in conservation reserves, protected by Voluntary Conservation Agreements or Environmental Protection Zoning.
2. Critical Habitat is identified and declared for *Zieria prostrata* as appropriate.

Responsibility for Implementation 1.1

- 1 and 2. Consultant.
- 3 and 4. NPWS Northern Zone
5. Recovery Team

Implementation Schedule for specific tasks 1.1

1. First year of Recovery Plan.
2. First two years of Recovery Plan.
3. First two years of Recovery Plan.
4. During second year of Recovery Plan.
5. During third year of Recovery Plan.

Justification

In order to ensure that all populations of *Zieria prostrata* have been located, further field surveys are necessary. An assessment of the threats to any new populations should be undertaken at the time of discovery to ensure that appropriate management actions can be undertaken as soon as possible and to eliminate the need to revisit the location to subsequently assess threats. As a matter of course, specimens from all populations should be lodged with appropriate herbaria, such as the NSW Herbarium, to ensure that material is available at a future date for any research or verification needs.

In order to ensure that new populations are protected from adverse disturbance or impacts in the short term, it is necessary to liaise with the relevant landowner or manager and commence discussions about the long term protection of new populations through inclusion in the conservation reserve system or environmental protection zone or under a Voluntary Conservation Agreement with the NPWS. It is recognised that it may not be possible, or appropriate, to reserve all areas where *Zieria prostrata* occurs as part of the conservation reserve system. However, other procedures are available to protect these areas from adverse disturbances. These procedures, such as Environmental Protection Zones under a local council's Local Environment Plan, or a Voluntary Conservation Agreement between the land owner or manager and the NPWS, may be able to afford the appropriate level of protection

The consideration of the declaration of Critical Habitat for *Zieria prostrata* will take into account the need to provide a further level of protection for the species and the requirement to ensure that a rigorous assessment is made of all activities that may affect *Zieria prostrata* and its habitat.

It is estimated that approximately 10 days field work would be required to undertake comprehensive surveys of potential *Zieria prostrata* and *Zieria* sp. aff. *smithii* habitat, and to assess the threats present at each site where either *Zieria prostrata* and *Zieria* sp. aff. *smithii* are located. NPWS Northern Zone should be able to provide logistical support and data processing of the results. The collection and preparation of herbarium specimens would be undertaken following the field surveys and would involve approximately two days work.

12.2 Resolve taxonomy and distribution of, and assess threats to, *Zieria* sp. aff. *smithii*.

Action 2.1

Clarify the distribution of, and assess threats to, *Zieria* sp. aff. *smithii*.

Priority 2.1

One.

Performance Criteria 2.1

All potential locations of *Zieria* sp. aff. *smithii* have been searched and threats assessed.

Tasks 2.1

Identify and search all potential locations for *Zieria* sp. aff. *smithii*, and assess threats to *Zieria* sp. aff. *smithii* at each of the locations where it is located.

Outcome 2.1

The distribution, and threats to, *Zieria* sp. aff. *smithii* have been determined.

Responsibility for Implementation 2.1

Consultant.

Implementation Schedule for specific tasks 2.1

First year of Recovery Plan.

Justification

The taxonomy of the *Zieria* genus has been under review for a considerable period of time without resolution. During the time of this review, a possible new taxon, *Zieria* sp. aff. *smithii*, has been located on headlands to the south and north of the current distribution of *Zieria prostrata*. This new taxon may be either a new species, or a form of either *Zieria prostrata* or *Zieria smithii*. The distribution of *Zieria* sp. aff. *smithii* needs to be determined so that the full range of the species can be considered in a taxonomic review (see Action 2.2 below). The assessment of threats should be made at the same time as a distribution survey to avoid the need to revisit these sites should *Zieria* sp. aff. *smithii* be determined to be *Zieria prostrata*, or a new species that is considered to be threatened. It is estimated that approximately 10 days field work would be required to undertake surveys, and should be incorporated with action 1.1.

Action 2.2

Clarify the genetic, taxonomic and conservation status and of *Zieria* sp. aff. *smithii*.

Priority 2.2

One.

Performance Criteria 2.2

Taxonomic revision, genetic analysis and conservation status assessment of *Zieria* sp. aff. *smithii* occurs within 12 months of determination of distribution of the species.

Tasks 2.2

1. Conduct genetic analysis of *Zieria* sp. aff. *smithii* both within and between all populations and with respect to *Zieria prostrata* and *Zieria smithii*.
2. Conduct morphometric analysis of *Zieria* sp. aff. *smithii* both within and between all populations.
3. Assess conservation status of *Zieria* sp. aff. *smithii* and list as a threatened species on the *Threatened Species Conservation Act 1995* if appropriate.

Outcome 2.2

Resolution the taxonomic and conservation status of *Zieria* sp. aff. *smithii*.

Responsibility for Implementation 2.2

- 1 and 2. Consultant.
3. NPWS Northern Zone and Recovery Team.

Implementation Schedule for specific tasks 2.2

1 , 2 and 3. First year of Recovery Plan.

Justification

The resolution of the taxonomy of the *Zieria prostrata* - *Zieria smithii* group will determine whether this apparent new taxon is either:

- a) part of *Zieria smithii* and is a variant form of a relatively common species;
- b) part of *Zieria prostrata*, and therefore needs to be considered within this Recovery Plan, or
- c) a new species, in which case it will require formal description and consideration of its conservation status.

This action could be undertaken following the collection of suitable material during the field surveys described in Action 1.1 and 2.1. This would eliminate the repetition of site visits to collect material for genetic and morphological studies. The estimates of the cost of the research are based on previous genetic and morphological studies, but is dependent largely upon the number of sites from which material is available. Following the resolution of the taxonomy of *Zieria* sp. aff. *smithii*, then its conservation status should be assessed to determine whether it warrants listing on the *Threatened Species Conservation Act 1995* as a threatened species.

12.3 Obtain ecological and population dynamics information to assist with effective management of *Zieria prostrata*.

Action 3.1

Undertake research in order to make informed decisions about the management of *Zieria prostrata* and its habitat.

Performance Criteria 3.1

Research is to continue throughout the duration of the Recovery Plan.

Priority 3.1

Two.

Tasks 3.1

Conduct ecological research on *Zieria prostrata*, its interaction with other species and the impact of disturbance on *Zieria prostrata*. This is to include investigation of population dynamics, mating system and the seedbank dynamics of *Zieria prostrata*. It will also establish long term monitoring of both control and experimental populations that have been subject to a range of disturbance regimes.

Outcome 3.1

Detailed knowledge of the ecology, population dynamics and response to disturbance of *Zieria prostrata*.

Responsibility for Implementation 3.1

Australian National University.

Implementation Schedule for specific tasks 3.1

Duration of the Recovery Plan.

Justification

There is a need to understand the ecological requirements of *Zieria prostrata* so that effective management strategies can be implemented. In particular, research into the mating system of *Zieria prostrata* will provide important information on the strategies used by the species to ensure its ongoing survival, and to potentially expand into unoccupied areas of potential habitat. Knowledge of population dynamics will allow an assessment of whether the population is effectively recruiting new individuals into the population. This assessment will assist in the development of management strategies to ensure that *Zieria prostrata* populations are self maintaining. Part of the population at Bare Bluff will be used as a control as this population is visited the least and is unlikely to be accidentally disturbed. The response of *Zieria prostrata* to disturbances such as trampling, soil disturbance and fire will be investigated as opportunities are available. It will also allow an assessment of whether the population is undergoing long term decline. The cost of this program will support the current research program undertaken by the Australian National University and will involve a part 'in kind' contribution by the NPWS, such as logistical support wherever possible.

12.4 Determine the extent and severity of threatening processes, and eliminate or minimise the impact as necessary.

Action 4.1

Minimise the impact of weed competition on *Zieria prostrata* and its habitat.

Performance Criteria 4.1

Weed control programs are commenced at all relevant sites within the first year of the Recovery Plan with a view to short term minimisation and long term elimination of weeds that may compete with *Zieria prostrata*.

Priority 4.1

One.

Tasks 4.1

Implement weed control plans for each *Zieria prostrata* population and conduct regular weed monitoring of all sites and updating of plans annually.

Outcome 4.1

Ongoing weed control program in operation and competition minimised or eliminated.

Responsibility for Implementation 4.1

NPWS Dorriggo District.

Implementation Schedule for specific tasks 4.1

Ongoing during life of Recovery Plan.

Justification

The extent and severity of threatening processes needs to be determined so that effective management strategies can be implemented to eliminate or minimise the impact as necessary. In particular, weed control needs to commence immediately to ensure that *Zieria prostrata* is not displaced by aggressive exotic species such as bitou bush, lantana and kikuyu. Weed control has been undertaken for the last four years, however it has not been undertaken according to a weeding plan. The implementation of a weed control program needs to be undertaken so that the weeding can be done in a systematic manner and to ensure that threats are regularly reviewed and re-assessed, thus allowing appropriate actions to be undertaken..

Action 4.2

Eliminate vehicular disturbance having direct impact on *Zieria prostrata* habitat.

Performance Criteria 4.2

Vehicle disturbance to all populations is eliminated within the first year of the Recovery Plan.

Priority 4.2

Three.

Tasks 4.2

Assess effectiveness of current vehicle control measures and take appropriate action as required to control vehicle access.

Outcome 4.2

Vehicular access to all populations is eliminated.

Responsibility for Implementation 4.2

NPWS Dorriggo District.

Implementation Schedule for specific tasks 4.2

First year of Recovery Plan

Justification

It is important that vehicles are not allowed to damage *Zieria prostrata* and its habitat. Vehicular disturbance has been previously identified as a major threat to the survival of *Zieria prostrata*. Currently, vehicular access has been eliminated from Look-At-Me-Now Headland, Dammerels Head and Bare Bluff, but vehicle barriers need to be erected at Diggers Point to allow legal access for Fishermen to Fiddaman's Beach. Current erosion control measures being undertaken by NPWS Dorrigo District will prevent the recent incident where a vehicle drove onto Bare Bluff. Any habitat degradation that has resulted from vehicular traffic will need restoration and the assessment of the need for this action should occur during the habitat survey undertaken in objective 1.

Action 4.3

Minimise and rationalise the impact of the existing walking tracks on *Zieria prostrata*.

Performance Criteria 4.3

Walking tracks are relocated to minimise the impacts on *Zieria prostrata*.

Priority 4.3

Two.

Tasks 4.3

Assess impact of existing tracks on *Zieria prostrata* and modify location of tracks where necessary.

Outcome 4.3

Pedestrian impacts on *Zieria prostrata* are minimised at all *Zieria prostrata* sites.

Responsibility for Implementation 4.3

NPWS Dorrigo District.

Implementation Schedule for specific tasks 4.3

First year of Recovery Plan.

Justification

There is currently evidence that pedestrian traffic has damaged *Zieria prostrata* plants, especially on Look-At-Me-Now Headland, and there is potential for this threat to become more serious with increased visitation to the Moonee Beach Nature Reserve. The rationalisation of the walking track system will assist in the reduction or prevention of continued trampling of plants.

NPWS Dorrigo District has recently upgraded the current walking track system on Look-At-Me-Now Headland to reduce the number of tracks and the level of erosion. The informal walking track across to Diggers Point is also close to the *Zieria prostrata* plants and it is intended to relocate the track. The current tracks at Dammerels Head are having a limited impact on a number of *Zieria prostrata* plants. There is concern, however, that track reconstruction may have a greater impact than the current level of trampling, given that visitation to Dammerels Head is much less than for Look-at-me-now Headland. Therefore, the impact of trampling on Dammerels Head should be monitored and addressed as necessary.

Action 4.4

Assess the role of disturbance regimes on the maintenance of *Zieria prostrata* habitat.

Performance Criteria 4.4

The effect different disturbance types and frequency has upon *Zieria prostrata* and its habitat is assessed.

Priority 4.4

Three.

Tasks 4.4

1. Evaluate historical changes to vegetation communities using aerial photographs.
2. Summarise existing information on disturbance regimes that have affected *Zieria prostrata* habitat over time.

Outcome 4.4

Improved understanding of the processes influencing the maintenance of *Zieria prostrata* habitat.

Responsibility for Implementation 4.4

Recovery Team

Implementation Schedule for specific tasks 4.4

First year of Recovery Plan.

Justification

There is a need to determine the type of disturbance regimes that may benefit or adversely affect *Zieria prostrata* to ensure that management actions do not further threaten the species. There is also a need to ensure that the exclusion of disturbance in *Zieria prostrata* habitat does not adversely affect the ability of the species to maintain recruitment into the populations. It is anticipated that this action would involve about 4 days work, and could be undertaken by NPWS Northern Zone and ANU Northern Zone as part of other duties, and thus would be an 'in kind' contribution. The NPWS is able to obtain the aerial photographs required for the action.

12.5 Inform the community about *Zieria prostrata* and its habitat.

Action 5.1

Increase community awareness and education of *Zieria prostrata* and its habitat.

Performance Criteria 5.1

Ongoing program of promotion of *Zieria prostrata* protection is developed within second year of Recovery Plan.

Priority 5.1

Four.

Tasks 5.1

Update and distribute brochure on *Zieria prostrata*.

Outcome 5.1

Increased community knowledge of *Zieria prostrata*.

Responsibility for Implementation 5.1

NPWS Northern Zone and Recovery Team.

Implementation Schedule for specific tasks 5.1

First year of Recovery Plan.

Justification

The four headlands within the Moonee Beach Nature Reserve upon which *Zieria prostrata* occurs are all extensively visited by members of the public. The education of the community about the *Zieria prostrata* populations and threats to the species will help to ensure that any new threats are identified quickly, and will provide an important resource for the implementation of the Recovery Plan actions, such as weed control where appropriate. It will give also the local community a sense of ownership of the Moonee Beach Nature Reserve and its unique conservation values, and therefore reduce the likelihood of any deliberate or accidental damage occurring to the *Zieria prostrata* populations. The costs associated with the production of the brochure could be covered by an 'in kind' contribution by the NPWS.

12.6 Assess the need for an ex-situ cultivation, seed storage and population enhancement program.

Action 6.1

Evaluate all available knowledge from other Recovery Plan actions and determine appropriate actions (if any).

Priority 6.1

Five.

Performance Criteria 6.1

Assessment of need for an *ex-situ* cultivation and seed storage program, as well as a population enhancement program, is completed by end of third year of Recovery Plan.

Tasks 6.1

1. Assess each population for the need, options and feasibility of an *ex-situ* cultivation program and review the success of previous cultivation programs.
2. Investigate the potential for seed storage in terms of longevity, costs and source plants and the need, options and feasibility of an enhancement program for each population.

Outcome 6.1

Determination of the need (if any) and options for an *ex-situ* cultivation and seed storage program, as well as a population enhancement program.

Responsibility for Implementation 6.1

NPWS Northern Zone and Recovery Team.

Implementation Schedule for specific task 6.1

Third year of Recovery Plan implementation.

Justification

Due to the limited distribution of *Zieria prostrata*, and the lack of potential habitat, there is potential for a catastrophic loss of an entire population on one of the headlands, especially Diggers Point where there are a very low number of plants. Consideration should be given to establishing an *ex-situ* collection of both living plants and viable seeds to be used for re-introduction should the need arise. In view of the low numbers present at Diggers point, consideration should be given to the development and implementation of a population enhancement program. This assessment will be undertaken with due consideration of all factors relevant to such a program.

Previous enhancement programs have occurred at Bonville Headland, Look-at-me-now Headland and Dammerels Head. These programs were not successful due to a failure to fully consider the implications of the programs prior to their commencement and a failure to fully document the location and fate of all those plants reintroduced to these sites. Accordingly, it is not possible to remove these plants, with the exception of those plants at Bonville Headland, as it cannot be determined with surety that they are not naturally occurring plants. The plants at Bonville Headland occur in a highly altered environment and their presence is not considered to be detrimental to the area and therefore does not warrant their removal.

The costs of this action will be determined according to whether the action is warranted and/or feasible and would be undertaken in consultation with NPWS staff and members of the Recovery Team.

13.0 Implementation table for Recovery Plan actions

Table 5: Implementation schedule for all Recovery Plan actions

Tasks	Priority	Responsibility	Year to be implemented
1.1.1 Systematically survey potential <i>Zieria prostrata</i> habitat and assess threats.	1	Consultant	1
1.1.2 Lodge voucher specimens from all locations with herbaria.	1	Consultant	1 - 2
1.1.3 Notify all appropriate land managers of known locations.	1	NPWS Northern Zone	1 - 2
1.1.4 Secure reservation for the whole of all <i>Zieria prostrata</i> locations.	1	NPWS Northern Zone	2
1.1.5 Consider Critical Habitat for <i>Zieria prostrata</i> under TSC Act.	1	NPWS Northern Zone	3
2.1.1 Search potential locations for <i>Zieria</i> sp. aff. <i>smithii</i> and assess threats.	1	Consultant	1
2.2.1 Conduct genetic analysis of <i>Zieria</i> sp. aff. <i>smithii</i> .	1	Consultant	1
2.2.2 Conduct morphometric of <i>Zieria</i> sp. aff. <i>smithii</i> .	1	Consultant.	1
2.2.3 Assess conservation status of <i>Zieria</i> sp. aff. <i>smithii</i> .	1	Recovery Team.	1
3.1.1 Conduct research on <i>Zieria prostrata</i> population biology.	2	Australian National University	1 - 3
4.1.1 Develop priority plan for weed control and regular weed monitoring.	1	Recovery Team	1
4.2.1 Assess effectiveness of current vehicle control and take appropriate action to control vehicle access.	3	NPWS Dorriggo District	1
4.3.1 Assess impact of existing tracks on <i>Zieria prostrata</i> and modify location of tracks where necessary.	2	NPWS Dorriggo District	1
4.4.1 Evaluate historical changes to vegetation communities.	3	Recovery Team	1
4.4.2 Summarise existing information on disturbance regimes.	3	Recovery Team	1
5.1.1 Update and distribute educational brochure.	4	NPWS Northern Zone and Recovery Team	1
6.1.1 Assess need for an <i>ex-situ</i> cultivation program and review success of previous cultivation programs.	5	NPWS Northern Zone and Recovery Team	3
6.1.2 Investigate potential for seed storage and the need for population enhancement program.	5	NPWS Northern Zone and Recovery Team	3

14.0 Preparation Details

14.1 Persons Responsible For The Recovery Plan Preparation

This Recovery Plan was prepared by Ms Patricia Hogbin (Australian National University) and Mr Andrew Steed (National Parks and Wildlife Service) with assistance from Dr Rod Peakall (Australian National University), Dr Tony Auld (National Parks and Wildlife Service) and Mr Steve Clemesha (Ulitarra Society). The Recovery Plan was based on the original Recovery Plan prepared by Mr Steve Griffith in 1992.

14.2 Date Of Last Amendment

The Recovery Plan was last amended in December 1998.

15.0 Review Date

The Recovery Plan should be reviewed following the completion of the ecological and genetic research programs at the end of year two. It is anticipated that at this stage, surveys may have located new populations and the research program will have produced results that may require a change in the implementation strategy of the Recovery Plan. It will also be an appropriate time to determine whether a population enhancement or *ex-situ* program is feasible and appropriate.

16.0 Contacts

The Recovery Plan for *Zieria prostrata* is co-ordinated by the Manager, Threatened Species Unit, Northern Zone office, National Parks and Wildlife Service, 24 Moonee Street Coffs Harbour, NSW 2450. Ph 02 6651 5946 Fax 02 6651 6187. All inquiries about *Zieria prostrata* should be directed to this office.

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Appendix A: Educational leaflet on *Zieria prostrata*.



ENDANGERED SPECIES PROGRAM

Zieria prostrata



How you can help

You can help this species in a number of different ways. If you are a resident of the local communities near the Moonee Beach Nature Reserve, join your local Landcare group and assist in projects to remove invasive weeds, restore degraded habitat and erect fences around sensitive areas. Most importantly, by living close to areas where *Z. prostrata* occurs, you are in an ideal position to assist in the conservation and protection of the species. This might be ensuring that the general public are making appropriate use of the reserves where *Z. prostrata* occurs or by informing the NPWS of any potential threats to the species.

If you are visiting Moonee Beach Nature Reserve please observe the National Parks and Wildlife Service standard code of behaviour at all times:

- stay on the established walking tracks;
- take your rubbish home with you;
- leave your pets at home;
- leave rocks, shells and native animals and plants as you find them;
- leave firearms at home; and
- do not light fires except in designated fireplaces.

If you or your organisation would like to discuss ways in which you can be involved in the conservation of these important headlands and their species, then please contact either the Dorrigo District of the National Parks and Wildlife Service on telephone (066) 572 309 or the Threatened Species Unit at National Parks and Wildlife Service Northern Zone office on (066) 515 946.

For further information about the Endangered Species in NSW contact:

Manager Threatened Species,
NSW NPWS Northern Zone
Telephone: (066) 515 946.

Artwork by Tanya Wilson.



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Zieria prostrata

This attractive prostrate plant, which has small star-shaped pink and white flowers, is restricted to just three kilometres of headlands on the far north coast of NSW near Coffs Harbour. The species is probably more common in cultivation than it is in the wild.

Zieria prostrata, as its scientific name suggests, spreads close to the ground amongst kangaroo grass tussocks in harsh windswept conditions close to rocky coastal cliffs. In locations sheltered from salt-laden winds, the plant can grow as a small shrub.

In recent times, all populations of *Z. prostrata* have been affected by habitat degradation caused by uncontrolled vehicle and pedestrian access and displacement by exotic plants such as Bitou Bush and Lantana. It is much depleted at some locations due to activities that have damaged the natural vegetation.

Ongoing research and management activities are critical to prevent *Z. prostrata* from becoming extinct in the wild in the foreseeable future. The Australian National University is currently conducting an important research program into the ecology and genetics of the species.

The Recovery Program

The Recovery Plan for *Zieria prostrata* is funded by the Endangered Species Program of the Environment Australia, Biodiversity Group and the NSW National Parks and Wildlife Service. It aims to maintain and enhance the populations of *Zieria prostrata* in the wild. A recovery plan has been prepared for the species and a recovery team established.

Implementation of the recovery plan involves research into the distribution, habitat, ecology, and genetics of the species and management tasks to eliminate or minimise identified threats to the species. The recovery team is given the role of overseeing the implementation of the recovery plan in order to halt the decline of the species. The achievements of the plan so far are:

- Location of a population of *Z. prostrata* on a headland where it had not been previously recorded.
- Addition of important habitat of *Z. prostrata* to the Moonree Beach Nature Reserve in late 1995.
- Removal of vehicular traffic and invasive weeds has allowed the habitat of *Z. prostrata* to regenerate, but further removal of invasive plants is critical to maintain the integrity of the habitat.

Studies have begun into the ecology, genetics and population dynamics of *Z. prostrata* so that informed management decisions can be made about the species' response to disturbance.

- Increased community awareness and participation has helped to reserve areas of important habitat for *Z. prostrata* and slow weed invasion, but the continued successful implementation of these tasks requires the help and co-operation of a number of land management agencies and concerned members of the local community.
- Genetic studies being done by the Australian National University will provide important information for possible enhancement of the population.
- Cultivation of the *Z. prostrata* for sale through nurseries with part of the proceeds from sales going directly into the recovery program.

Collectively, these actions have improved the conservation status of *Z. prostrata*, but still more work needs to be done to ensure the species' survival in the wild in the long term.

Appendix B: Detailed costing of recovery actions

Note: All figures are estimates only and given as at 1998.

Tasks	Priority	Funding	Year 1	Year 2	Year 3
1.1.1 Systematically survey potential <i>Zieria prostrata</i> habitat and assess threats. *	1	secured	2,500	-	-
1.1.2 Lodge voucher specimens from all locations with herbaria.	1	secured	a	a	-
1.1.3 Notify all appropriate land managers of known locations.	1	secured	b	b	-
1.1.4 Secure reservation for the whole of all <i>Zieria prostrata</i> locations.	1	secured	-	b	-
1.1.5 Consider Critical Habitat for <i>Zieria prostrata</i> under TSC Act	1	secured	-	-	b
2.1.1 Search potential locations for <i>Zieria</i> sp. aff. <i>smithii</i> and assess threats. *	1	secured	2,500	-	-
2.2.1 Conduct genetic analysis of <i>Zieria</i> sp. aff. <i>smithii</i> .	1	secured	4,000	-	-
2.2.2 Conduct morphometric of <i>Zieria</i> sp. aff. <i>smithii</i> .	1	secured	4,000	-	-
2.2.3 Assess conservation status of <i>Zieria</i> sp. aff. <i>smithii</i> .	1	N/A	a	-	-
3.1.1 Conduct research on <i>Zieria prostrata</i> population biology.	2	unsecured	8,000	8,000	4,000
4.1.1 Develop priority plan for weed control and regular weed monitoring	1	N/A	c	c	c
4.2.1 Assess effectiveness of current vehicle control measures and take appropriate action as required to control vehicle access.	3	N/A	c	c	c
4.3.1 Assess impact of existing tracks on <i>Zieria prostrata</i> and modify location of tracks where necessary.	2	N/A	c	c	c
4.4.1 Evaluate historical changes to vegetation communities.	3	unsecured	500	-	-
4.4.2 Summarise existing information on disturbance regimes.	3	unsecured	500	-	-
5.1.1 Update and distribute educational brochure	4	unsecured	1,000	-	-
6.1.1 Assess need for an <i>ex-situ</i> cultivation program and review success of previous cultivation programs.	5	N/A	-	-	d
6.1.2 Investigate the potential for seed storage and need for population enhancement program	5	N/A	-	-	d
Annual costs of implementing Recovery Plan.			23,000	8,000	4,000
Total cost of implementing Recovery Plan.			35,000		

Notes:

* to be undertaken concurrently.

a - undertaken as part of tasks 1.1.1 and 2.1.1

b - undertaken by NPWS Northern Zone within existing funding

c - undertaken by NPWS Dorrigo District as part of works program

d - costs to be determined following assessment of need.



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