

Leionema lachnaeoides
Recovery Plan



July 2001

© NSW National Parks and Wildlife Service, 2001.

This work is copyright. Apart from any use as permitted under the *Copyright Act 1968*, no part may be reproduced without prior written permission from NPWS.

NSW National Parks and Wildlife Service

43 Bridge Street

(PO Box 1967)

Hurstville NSW 2220

Tel: 02 9585 6444

www.npws.nsw.gov.au

For further information contact

Threatened Species Unit, Central Directorate

NSW National Parks and Wildlife Service

P.O. Box 1967

Hurstville NSW 2220

Tel 02 9585 6678

Cover photograph: *Leionema lachnaeoides*

Cover photographer: Kersten Tuckey, NPWS Central Directorate

This plan should be cited as follows:

NSW National Parks and Wildlife Service (2001). *Leionema lachnaeoides* Recovery Plan. NSW NPWS, Hurstville.

ISBN Number: 0 7313 6323X

Leionema lachnaeoides

Recovery Plan

Prepared in accordance with the New South Wales
Threatened Species Conservation Act 1995 and the Commonwealth
Environmental Protection and Biodiversity Conservation Act 1999

July 2001

Note: Recent taxonomic revision¹ of *Phebalium* and related genera has resulted in a new generic classification of *Phebalium lachnaeoides* as *Leionema lachnaeoides*.

1. Wilson, P.G. (1998) New species and nomenclatural changes in *Phebalium* and related genera (Rutaceae) *Nuytsia* 12 (2): 267-288.

Acknowledgments

The NPWS wishes to acknowledge the following individuals and organisations for their contributions to the development of this recovery plan:

Wyn Jones (NPWS) who rediscovered the species in 1989 and assisted Janet Cohn in field surveys for the 1993 Conservation and Research Statement and Recovery Plan.

Janet Cohn (NPWS) prepared a Conservation and Research Statement and Recovery Plan for *Phebalium lachnaeoides* (1993) under the Commonwealth *Endangered Species Protection Act* 1992.

The content of the current plan (2001) is largely based on the 1993 plan.

Environment Australia (formerly the Australian Nature Conservation Agency) who provided funding to prepare the above mentioned recovery plan for *Phebalium lachnaeoides*. Alistair Campbell (Environment Australia) for advice on matters relating to the EPBC Act

The *Leionema lachnaeoides* Recovery Team members, including representatives from the NPWS Central Directorate, the NPWS Blue Mountains Region, State Forests of NSW, City of Blue Mountains Council, Sydney Catchment Authority, Blue Mountains Conservation Society, and the Blue Mountains Rare and Endangered Species Group.

NPWS personnel, particularly Maria Matthes, Geoff Robertson, Julie Ravallion, Robert Humphries, Janet Cohn and Christopher Lacey, who through discussion and review, contributed greatly to the preparation of the draft plan.

Leigh Taylor and Joan Hayden of the Bonnie Doon Fauna Survey Group who assisted Merrin Tozer by showing her the location of populations of *Leionema lachnaeoides* in their study area.

Graeme Errington (Mount Annan Botanic Garden) who provided information regarding the propagation of *Leionema lachnaeoides*. Paul G. Wilson (Western Australian Herbarium) provided parts of his forthcoming taxonomic account of *Phebalium* and *Leionema*.

The City of Blue Mountains Council who provided information about the zoning and tenure of *Leionema lachnaeoides* sites. The City of Blue Mountains Council and the Blue Mountains Rural Fire Service also provided advice on protection and management.

The National Herbarium of NSW who provided locality information extracted from their database.

Acknowledgments are also made to Malcolm Gill for use of the *National Register for the Fire Response of Plant Species*.

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

This plan describes our current understanding of *Leionema lachnaeoides*, documents the research and management actions undertaken to date, and identifies the actions required and parties responsible to ensure the ongoing management of the taxon in nature.

The *Leionema lachnaeoides* Recovery Plan was prepared with the assistance of relevant land management agencies, research interests and species experts, and was placed on public exhibition from August to October 2000. I thank the people involved for their efforts to date and I look forward to their continued involvement in the implementation of recovery actions identified in this plan.



BOB DEBUS MP
Minister for the Environment

Executive Summary

Introduction

Leionema lachnaeoides Cunn., Rutaceae, is a tall shrub to 2 m with narrow aromatic leaves. It displays yellow flowers between winter and late spring. *L. lachnaeoides* is only known from ten populations that occur on cliff tops in the Megalong and Jamison Valleys in the Blue Mountains, NSW.

This recovery plan describes our current understanding of *L. lachnaeoides*, 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.

Legislative Context

The *Threatened Species Conservation Act* 1995 (TSC Act) is NSW' legislative framework to protect and encourage the recovery of threatened species, populations and ecological communities. Under the TSC Act, the Director-General of National Parks and Wildlife has certain responsibilities including the preparation of recovery plans for threatened species, populations and ecological communities. This recovery plan has been prepared in accordance with the provisions of the TSC Act.

Preparation of Plan

This plan is a revised version of a species Conservation Research Statement and Recovery Plan written for *Phebalium lachnaeoides* under the former Commonwealth *Endangered Species Protection Act* 1992. This version of the recovery plan has been updated with the assistance of the City of Blue Mountains Council. The information in this recovery plan was accurate to the best of the National Parks and Wildlife Services (NPWS) knowledge on the date it was approved.

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

Implementation of Plan

The TSC Act requires that a government agency must not undertake actions inconsistent with an approved recovery plan. The main government agencies relevant to this plan are the NPWS, City of Blue Mountains Council and the Rural Fire Service. Consequently, the NPWS and the Council must, as the relevant land managers, manage the areas where *L. lachnaeoides* occurs in accordance with this plan. Relevant land management issues include up-slope disturbance and fire management. Accordingly the NSW Rural Fire Service must take into consideration the localities and management needs of *L. lachnaeoides* when developing fire management plans for this area.

Recovery Objectives

Overall Objective

The overall recovery objective of the plan, is to prevent the extinction of *L. lachnaeoides* by protecting known populations from threats and depending on the success of on-going management actions, targeted surveys and further studies, down-list the species to a vulnerable conservation status. To recover *L. lachnaeoides* is to protect *L. lachnaeoides* from human induced decline.

Specific recovery plan objectives are to:

1. ensure the long term protection of currently known populations of *L. lachnaeoides*,
2. establish the full extent of *L. lachnaeoides* distribution,
3. enhance future management of *L. lachnaeoides* by furthering our understanding of essential aspects of the biology and ecology of the species,
4. safeguard extinction of *L. lachnaeoides* by investigating the potential for *ex situ* cultivation,
5. raise awareness of the conservation status of *L. lachnaeoides* and involve the community in the recovery program, and
6. carry out re-evaluation of the conservation status of *L. lachnaeoides*.

Overall Performance Criteria

The overall performance criteria of the recovery plan is that the risk of decline of *L. lachnaeoides* is decreased through the protection of known populations, by the implementation of an appropriate management regime and the location of additional populations through targeted survey.

Specific performance criteria of the plan are that:

1. populations do not decline as a result of human induced disturbance;
2. potential habitat is surveyed and a greater knowledge of *L. lachnaeoides* distribution is acquired and applied to management;
3. management strategies are refined by an increased understanding of the biology and ecology of *L. lachnaeoides*;
4. necessity and efficacy of an *ex-situ* program is determined and established if required;
5. education material is disseminated and the community is involved in key aspects of the recovery program; and
6. conservation status has been re-evaluated and if appropriate, a recommendation has been made to down list the species from Endangered to Vulnerable.

Recovery Actions

In order to achieve the recovery objectives, a number of specific actions are identified in this recovery plan:

1. manage habitat to ameliorate threatening processes and conduct informed assessment of activities that may impact on *L. lachnaeoides*,
2. conduct targeted survey of *L. lachnaeoides* habitat,
3. investigate key aspects of the biology and ecology of *L. lachnaeoides*,
4. assess the need and efficacy of undertaking an *ex situ* cultivation program,
5. disseminate education material and involve the community in the implementation of key aspects of the recovery plan, and
6. carry out re-evaluation of the conservation status of *L. lachnaeoides*.

Estimated Costs of Recovery

This recovery plan will be implemented over a five-year period. A summary of the estimated implementation costs, in addition to the expenses of normal business is identified below. Total recovery plan cost is \$38,000. Average implementation cost per year is approximately \$7,600.

| Action | Description | NPWS | Un-funded |
|--------|--|----------|----------------------|
| 1. | Habitat and threat management | \$11,000 | |
| 2. | Targeted Survey | \$5,000 | |
| 3. | Investigate biology and ecology | | \$15,000 |
| 4. | Determine the need for <i>ex situ</i> storage | | \$6,000 ¹ |
| 5. | Community education and awareness ² | | |
| 6. | Reassess conservation status | \$1,000 | |
| | TOTAL (\$38,000) | \$17,000 | \$21,000 |

¹ The implementation of this action will be confirmed by the recovery team after completion of actions 2 and 3.

² Implementation costs for this action are embedded in action 1.

NPWS: The National Parks and Wildlife Service

Biodiversity Benefits

The rediscovery of *L. lachnaeoides* highlights the importance of habitat conservation. The conservation of the habitat occupied by *L. lachnaeoides* and surrounding areas is important for the conservation of all species that occur there. This includes those that have not yet been discovered/described and others that have been classified threatened and endangered in the same area (such as *Microstobos fitzgeraldii* also on Schedule 1 of the TSC Act).

A handwritten signature in black ink, reading "Brian Gilligan". The signature is written in a cursive style with a large initial 'B' and 'G'.

BRIAN GILLIGAN
Director-General

Table of Contents

| | |
|--|-----------|
| 1. INTRODUCTION..... | 1 |
| 2. LEGISLATIVE CONTEXT..... | 1 |
| 2.1 Legal Status..... | 1 |
| 2.2 Recovery Plan Preparation..... | 1 |
| 2.3 Recovery Plan Implementation..... | 1 |
| 2.4 Relationship to Other Legislation..... | 2 |
| 2.5 Critical Habitat..... | 2 |
| 2.6 Environmental Assessment..... | 2 |
| 3. CONSERVATION STATUS..... | 3 |
| 4. DESCRIPTION..... | 3 |
| 4.1 Taxonomy..... | 3 |
| 4.2 Scientific Description..... | 3 |
| 4.3 Distinguishing Features..... | 4 |
| 5. DISTRIBUTION AND HABITAT..... | 6 |
| 5.1 Current Distribution..... | 6 |
| 5.2 Historic Distribution and Potential Habitat..... | 6 |
| 5.3 Tenure and Land-Use Zoning..... | 8 |
| 5.4 Up-Slope Land-Use Zoning..... | 9 |
| 5.5 Habitat..... | 9 |
| 5.5.1 Landform and geology..... | 9 |
| 5.5.2 Vegetation..... | 9 |
| 5.5.3 Climate..... | 10 |
| 5.5.4 Natural disturbance - fire regimes..... | 10 |
| 6. BIOLOGY AND ECOLOGY..... | 12 |
| 6.1 Growth Rate and Longevity..... | 12 |
| 6.2 Phenology..... | 12 |
| 6.3 Reproductive Biology..... | 12 |
| 6.3.1 Vegetative reproduction..... | 12 |
| 6.3.2 Breeding system..... | 12 |
| 6.3.3 Flowering and pollination..... | 12 |
| 6.3.4 Fruit and seed..... | 12 |
| 6.3.5 Recruitment and population structure..... | 13 |
| 6.4 Fire Ecology..... | 13 |
| 6.5 Summary of Known Biology and Ecology..... | 14 |
| 7. PREVIOUS ACTIONS UNDERTAKEN..... | 15 |

| | | |
|------------|--|-----------|
| 7.1 | Previous Recovery Plans and Implementation..... | 15 |
| 7.2 | Recovery Team..... | 15 |
| 7.3 | Survey for other Populations..... | 15 |
| 7.4 | Propagation of Material from Cuttings | 15 |
| 8. | MANAGEMENT ISSUES | 16 |
| 8.1 | Understanding of Biology and Ecology..... | 16 |
| 8.2 | Threats to <i>Leionema lachnaeoides</i> | 16 |
| | 8.2.1 Up-slope disturbance..... | 16 |
| | 8.2.2 Weed invasion | 16 |
| | 8.2.3 Fire management and inappropriate fire regimes | 16 |
| | 8.2.4 Site access..... | 16 |
| 8.3 | Social and Economic Issues | 17 |
| | 8.3.1 Intrinsic ecological value | 17 |
| | 8.3.2 Scientific value | 17 |
| | 8.3.3 Biodiversity value | 17 |
| | 8.3.4 Social effects | 17 |
| | 8.3.5 Economic consequences..... | 17 |
| 8.4 | Translocation..... | 17 |
| 8.5 | Species Ability to Recover..... | 18 |
| | 8.5.1 Species rarity | 18 |
| | 8.5.2 Species viability | 18 |
| | 8.5.3 Likelihood of recovery | 18 |
| 9. | OVERALL RECOVERY AIM AND RECOVERY STRATEGY..... | 20 |
| 9.1 | Overall Objective | 20 |
| 9.2 | Overall Performance Criteria | 20 |
| 9.3 | Recovery Actions | 21 |
| 10. | HABITAT AND THREAT MANAGEMENT..... | 22 |
| 10.1 | Objective | 22 |
| 10.2 | Recovery Actions | 22 |
| | 10.2.1 Establish recovery team..... | 22 |
| | 10.2.2 Site reassessment and ongoing monitoring | 22 |
| | 10.2.3 Fire management..... | 22 |
| | 10.2.4 Development assessment | 23 |
| | 10.2.5 Habitat protection on private lands | 23 |
| | 10.2.6 Critical Habitat assessment | 23 |
| 10.3 | Performance Criteria | 24 |
| 11. | TARGETED SURVEY..... | 25 |
| 11.1 | Recovery Objective..... | 25 |
| 11.2 | Recovery Actions | 25 |

| | | |
|------------|---|-----------|
| 11.3 | Performance Criteria..... | 26 |
| 12. | BIOLOGICAL AND ECOLOGICAL INVESTIGATIONS | 27 |
| 12.1 | Recovery Objective..... | 27 |
| 12.2 | Recovery Actions | 27 |
| 12.3 | Performance Criteria..... | 28 |
| 13. | CONTINGENCY ARRANGEMENTS: <i>EX SITU</i> CONSERVATION | 29 |
| 13.1 | Recovery Objective..... | 29 |
| 13.2 | Recovery Actions | 29 |
| 13.2.1 | <i>Ex situ</i> conservation..... | 29 |
| 13.3 | Performance Criteria..... | 29 |
| 14. | COMMUNITY EDUCATION, AWARENESS AND INVOLVEMENT . | 30 |
| 14.1 | Recovery Objective..... | 30 |
| 14.2 | Recovery Actions | 30 |
| 14.2.1 | Recovery Team..... | 30 |
| 14.2.2 | Species profile | 30 |
| 14.2.3 | Site assessment and restoration..... | 30 |
| 14.2.4 | Liaison with private land holders..... | 30 |
| 14.2.5 | Surveys for new populations | 30 |
| 14.3 | Performance Criteria | 30 |
| 15. | REASSESS THE CONSERVATION STATUS | 31 |
| 15.1 | Recovery Objective..... | 31 |
| 15.2 | Recovery Action..... | 31 |
| 15.3 | Performance Criteria | 31 |
| 16. | IMPLEMENTATION..... | 32 |
| 16.1 | Implementation Schedule..... | 32 |
| 17. | PREPARATION DETAILS..... | 33 |
| 17.1 | Date of Last Amendment | 33 |
| 17.2 | Review Date..... | 33 |
| 18. | CONTACTS..... | 33 |
| | REFERENCES..... | 34 |

APPENDIX

APPENDIX 1: DETAILED OBJECTIVES OF LAND-USE ZONES

APPENDIX 2: SITE REASSESSMENT AND SURVEY PROFORMAS

**APPENDIX 3: SPECIES PROFILES AND ENVIRONMENTAL IMPACT
ASSESSMENT GUIDELINES**

APPENDIX 4: RECOVERY PLAN IMPLEMENTATION COSTS

LIST OF FIGURES

- FIGURE 1:** Features of *Leionema lachnaeoides*
FIGURE 2: Clifftop habitat of *Leionema lachnaeoides*
FIGURE 3: Distribution of *Leionema lachnaeoides*

1. Introduction

Leionema lachnaeoides Cunn., Rutaceae, is a tall shrub to 2 m with narrow aromatic leaves. It displays yellow flowers between winter and late spring. *L. lachnaeoides* is currently known from only ten populations totalling approximately 400 adult plants that occur on cliff tops in the Megalong and Jamison Valleys in the Blue Mountains, NSW.

The low number of populations and individuals, in conjunction with the limited geographic distribution of *L. lachnaeoides* makes it vulnerable to the operation of threatening processes. Inappropriate fire regimes, lack of recruitment within populations, site access and up-slope disturbances are all potential threats to this species.

This recovery plan describes our current understanding of *L. lachnaeoides*, 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.

2. Legislative Context

2.1 Legal Status

L. lachnaeoides is listed as an endangered species on Schedule 1 of the *Threatened Species Conservation Act 1995* (TSC Act). The effect of the State listing is that a recovery plan must be prepared and consideration given to the species when assessing the impacts of developments and activities.

L. lachnaeoides is also listed as an endangered species under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). This recovery plan is eligible for adoption under the Commonwealth EPBC Act.

2.2 Recovery Plan Preparation

The TSC Act provides a legislative framework to protect and encourage the recovery of threatened species, endangered populations and endangered ecological communities in NSW. Under this legislation the Director-General of National Parks and Wildlife (NPW) has a responsibility to prepare recovery plans for all species, populations and ecological communities listed as endangered or vulnerable on the TSC Act schedules. Similarly, the EPBC Act requires that the Commonwealth Minister for the Environment must ensure the preparation of a recovery plan for nationally listed species and communities or adopt plans prepared by others including those developed by State agencies. Both Acts specify matters to be addressed by recovery plans and the administrative processes for preparing recovery plans.

This recovery plan has been prepared to satisfy both the requirements of the TSC Act and the EPBC Act and therefore will be the only recovery plan for the species. It is the intention of the Director-General of NPW to forward this recovery plan to the Commonwealth Minister for the Environment for adoption under the EPBC Act.

2.3 Recovery Plan Implementation

The TSC Act requires that a public authority must take any appropriate measures available to implement actions included in a recovery plan for which they have agreed to be responsible. Public authorities and councils identified as responsible for the implementation of recovery plan actions are required by the TSC Act to

report on measures taken to implement those actions. In addition, the Act specifies that public authorities must not make decisions that are inconsistent with the provisions of the Plan.

Public authorities responsible for the implementation of this recovery plan are the NPWS, City of Blue Mountains Council and the Rural Fire Service. Consequently, the NPWS, City of Blue Mountains Council and the Rural Fire Service must, as relevant land managers, manage the areas where *L. lachnaeoides* occurs in accordance with this plan.

The EPBC Act states that Commonwealth agencies must implement a recovery plan on those areas that apply to Commonwealth lands. Those lands relevant to this recovery plan include sites at Shipley Plateau and Double Echo Point.

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

2.4 Relationship to Other Legislation

The lands on which *L. lachnaeoides* occur are either City of Blue Mountains Council reserve land, Crown Land managed by the City of Blue Mountains Council, National Park or freehold. Relevant legislation for these populations are:

- National Parks: *National Parks and Wildlife Act 1974*;
- Blue Mountains Council: *Local Government Act 1993* and the *Environmental Planning and Assessment Act 1979*.

2.5 Critical Habitat

The TSC Act makes provision for the identification and declaration of Critical Habitat. Under the TSC Act, Critical Habitat may be identified for any endangered species, population or ecological community occurring on NSW lands. Once declared, it becomes an offence to damage Critical Habitat (unless the action is exempted under the provisions of the TSC Act) and a Species Impact Statement is mandatory for all developments and activities proposed within declared Critical Habitat.

Critical Habitat has not been declared for this species under the TSC Act. The level of information known about *L. lachnaeoides* and its distribution is not considered sufficient to declare Critical Habitat. Section 10.2.6 provides a cue for investigating the feasibility of declaring Critical Habitat when more information is known.

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

2.6 Environmental Assessment

The New South Wales *Environmental Planning and Assessment Act 1979* (EP&A Act) requires that consent and determining authorities, and the Director-General of National Parks and Wildlife, as a concurrence authority, consider relevant recovery plans when exercising a decision-making function under Parts 4 and 5 of the EP&A Act. Decision-makers must consider known and potential habitat, biological and ecological factors and the regional significance of individual populations.

The NPWS, City of Blue Mountains Council and Rural Fire Service, when considering any development or activity which may affect *L. lachnaeoides* or its habitat, must consider the conservation strategy and environmental impact assessment guidelines outlined in this plan. Any other action not requiring approval under the EP&A Act, and which is likely to have a significant

impact on *L. lachnaeoides* will require a Section 91 licence from the Director-General of NPW under the provisions of the TSC Act. Such a licence may be issued with or without conditions, or refused.

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

Administrative guidelines are available, from Environment Australia, to assist proponents in determining whether their action is likely to have a significant impact. In cases where the action does not require EPBC Act approval, but will result in the death or injury of a member of *L. lachnaeoides* and the member is in, or on a Commonwealth area, a permit issued by the Commonwealth Minister under the EPBC Act will be required.

The Environment Minister can also delegate the role of assessment and approval to other Commonwealth Ministers under a Ministerial Declaration, and to the States and Territories under bilateral agreements. The development of a bilateral agreement between NSW and the Commonwealth has not yet been completed.

3. Conservation Status

L. lachnaeoides is known from only 10 populations in the Blue Mountains between Blackheath and Katoomba. In April 2000 population size ranges from six to 108 individuals with a total population of only 412 individuals.

Due to the low number of populations and its limited distribution, *L. lachnaeoides* is considered as an endangered species in NSW and is listed on Schedule 1 of the TSC Act.

L. lachnaeoides is also listed as an endangered species at a national level under the Commonwealth EPBC Act.

4. Description

4.1 Taxonomy

This species was formally known as *Phebalium lachnaeoides*. Recent taxonomic revision of *Phebalium* and related genera by Wilson (1998) resulted in a new generic classification for the species, which is now described as *Leionema lachnaeoides*. This has been accepted by the Royal Botanic Gardens, Sydney (Peter Weston, *pers. comm.*).

4.2 Scientific Description

The following description of *L. lachnaeoides* is largely taken from Weston and Portners (1991).

L. lachnaeoides Cunn. (Family Rutaceae) is a tall shrub to 2 m high. New stems are whitish from a covering of stellate (star shaped) hairs. Its leaves are 0.5-1.5 cm long and 1 mm in diameter, placed alternately along the stems and linear-terete in shape. The leaf margin is strongly recurved so that the lower surface is only just visible. The leaf lamina is gland dotted and the petiole (leaf stalk) is flattened.

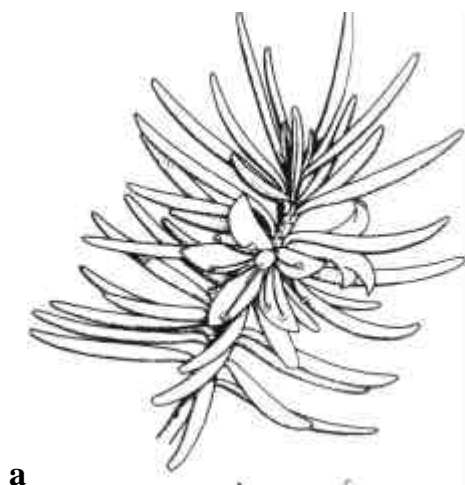
Flowers occur singly towards the ends of branches. Flowers are radially symmetric, bisexual and have five yellow petals, being approximately 5 mm long and gland dotted. The green sepals that hold the petal are fused into a calyx consisting of five triangular lobes. The flowers contain 10 free stamens. Fruits are schizocarps, that is, dry fruits which split into individual units called cocci (somewhat like segments of an orange). There are 1-5 cocci, 2-3 mm long, with rounded prominent

beaks. The seeds are released on maturation of the fruit. Figure 2 illustrates some of the features described above.

4.3 Distinguishing Features

L. lachnaeoides can be distinguished from other *Leionema* species by its short (0.5-1.5 cm long), linear, nearly terete leaves, with a fine stellate covering of hairs on the barely visible lower surface due to its recurved margins. *L. phyllicifolium* closely resembles *L. lachnaeoides* as it also has closely recurved leaves (Figure 1). However, *L. phyllicifolium* has a globose ovary covered in stellate hairs, whereas *L. lachnaeoides* has a narrowly ovoid ovary, which lacks hairs. In addition, their distributions do not overlap. *L. lachnaeoides* occurs only in the Blue Mountains, and *L. phyllicifolium* only occurs in Kosciusko National Park.

Figure 1. Features of *Leionema lachnaeoides*. a) Detail of flowers and leaves, b) detail of flowers and leaves of *L. phyllicifolium*. The closely recurved leaf margins are characteristic of both species. (Figures reproduced with permission from Harden (1991))



a



b

5. Distribution and Habitat

5.1 Current Distribution

There are ten known populations of *L. lachnaeoides* in the upper Blue Mountains, between Katoomba and Blackheath, NSW (Figure 3). All known sites occur within 12 kilometers of each other and are located on the southern side of the escarpment on cliff tops in the Megalong and Jamison Valleys (Figure 2).

The possibility that more populations will be discovered in a targeted survey of the clifftop habitat is likely.

5.2 Historic Distribution and Potential Habitat

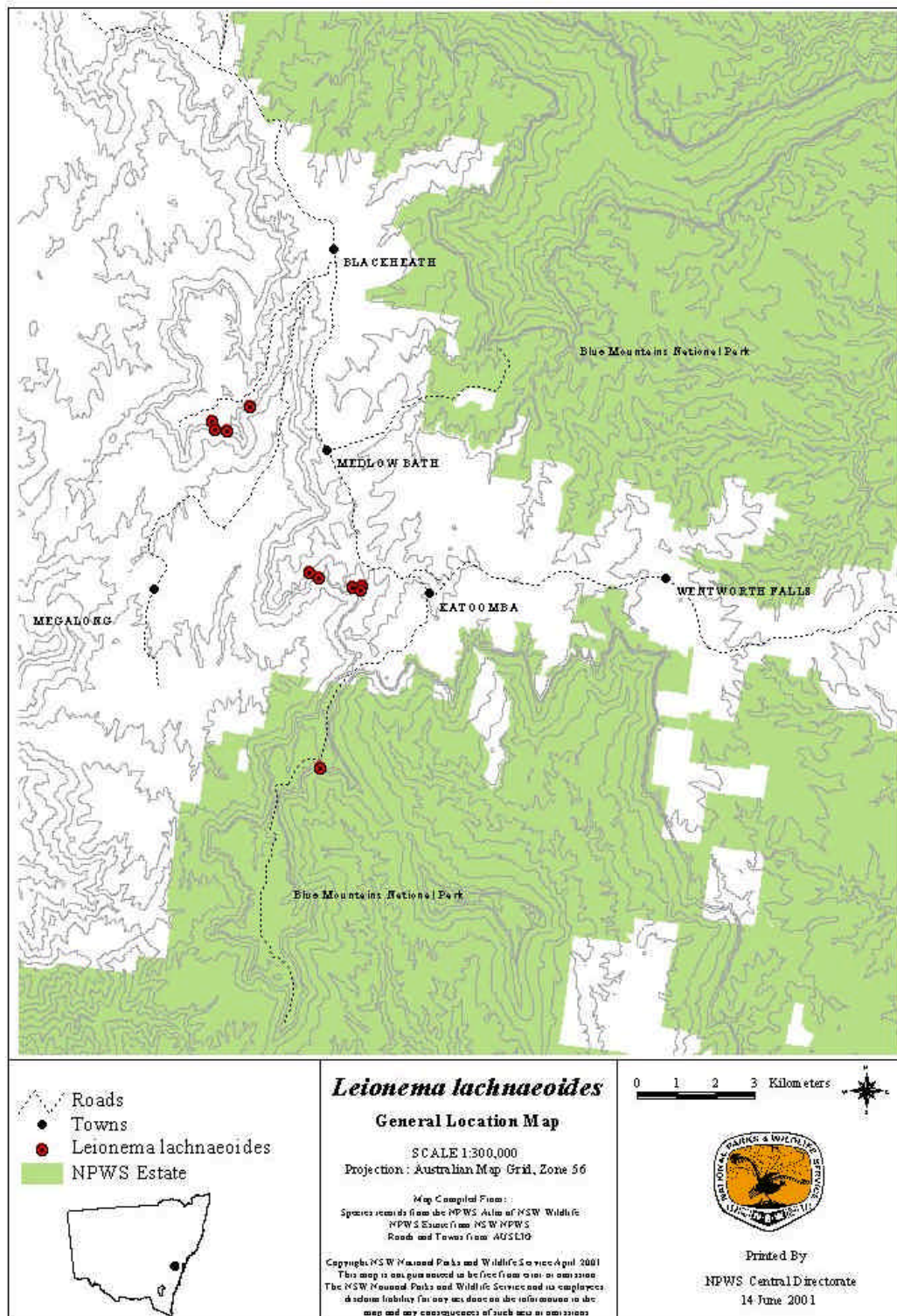
There is no information about the historic distribution of *L. lachnaeoides* and so it is unknown whether the species has undergone a decline. The original herbarium collection from the early 1800s included an imprecise specimen location (Wilson 1970). There were no known exact localities of *L. lachnaeoides* until Wyn Jones, a former officer of the NPWS, rediscovered the species in 1989.

Potential habitat is likely to occur throughout the Megalong and Jamison valleys, and possibly the Grose Valley. Section 12 focuses on identifying areas of potential habitat and carrying out targeted survey in these areas. Factors such as landscape position, soil type and vegetation communities will assist in the identification process. The Montane Heath Community (Keith & Benson 1988) in which *L. lachnaeoides* is known to occur, will be targeted for survey.

Figure 2. Clifftop habitat of *Leionema lachnaeoides* (Photograph K.Tuckey).



Figure 3. The distribution of *Leionema lachnaeoides* in New South Wales.



5.3 Tenure and Land-Use Zoning

The known populations of *L. lachnaeoides* and areas of potential habitat occur within the Blue Mountains Local Government Area (LGA). The City of Blue Mountains Council along with various State and Federal agencies are responsible for environmental assessment and approval in the Blue Mountains LGA. The City of Blue Mountains Council is also responsible for developing or modifying environmental planning instruments and approving environmental management plans in this area.

Of the ten known populations of *L. lachnaeoides*:

- one occurs in the Blue Mountains National Park (site 5);
- three occur in a City of Blue Mountains Council Recreation Reserves (sites 1, 7, and 8);
- two occur in privately owned land (site 2 and 3); and
- four occur in Crown Recreation Reserves (site 4, 6, 9 and 10) managed by City of the Blue Mountains Council.

The land-use zones in which the ten known populations of *L. lachnaeoides* occur, have objectives which aim at the protection of the natural environment (objectives from the City of Blue Mountain Council LEP (1991) are detailed in Appendix 1). These zones include: National Park, Regional Open Space, Environmental Protection, and Recreation-Environmental Protection (refer to Table 1 for individual site zoning). Six of the ten sites are affected by a Protected Area-Escarpment Area designation under the provisions of LEP (1991). The objective of this designation is to protect the visual significance of the escarpment system in the Blue Mountains LGA.

Table 1. Summary of the land-use zoning of sites at which *L. lachnaeoides* occurs.

| Site number | Location | Land-use Zoning | Tenure |
|-------------|-----------------------------------|--------------------------|--|
| 1 | Nellies Glen west | Regional Open Space | Council Reserve |
| 2 | Radiata Plateau East of Gully | Environmental Protection | Private |
| 3 | Radiata Plateau West of Gully | Environmental Protection | Private |
| 4 | Shiple Plateau, Double Echo Point | Environmental Protection | Crown Rec. Reserve: Managed by Council |
| 5 | Narrow Neck Plateau | National Park | National Parks and Wildlife Service |

| Site number Cont. | Location | Land-use Zoning | Tenure |
|-------------------|----------------------------------|---------------------------------------|-------------------------------------|
| 6 | Shiple Plateau, South of Mt Tosh | Recreation – Environmental Protection | Crown Rec. Reserve: Council Managed |
| 7 | Bonnie Doon west | Regional Open Space | Council Reserve |
| 8 | Bonnie Doon east | Regional Open Space | Council Reserve |
| 9 | Shiple Plateau, South of Mt Tosh | Recreation – Environmental Protection | Crown Rec. Reserve: Council Managed |
| 10 | Shiple Plateau, South of Mt Tosh | Recreation – Environmental Protection | Crown Rec. Reserve: Council Managed |

5.4 Up-Slope Land-Use Zoning

The zoning of land along the ridge and plateau tops in the Blue Mountains affects the likelihood of development and is an important factor in the stability and long term viability of the cliff top habitat. The zoning applied up-slope of the *L. lachnaeoides* populations includes those already described above, as well as Bushland Conservation (refer to Table 2). Unlike the zoning included in Table 1, Bushland Conservation allows a variety of developments such as agricultural industries, houses and retail nurseries.

Table 2: The land-use zoning of land up-slope of *L. lachnaeoides* populations.

| Site Number | Location | Zoning Up-slope |
|-------------|-----------------------------------|-----------------|
| 1 | Nellies Glen west | RES-BC, REC-EP |
| 2 | Radiata plateau, East of gully | BC |
| 3 | Radiata Plateau | BC |
| 4 | Shiple Plateau, Double Echo Point | EP |
| 5 | Narrow Neck Plateau | National Park |
| 6 | Shiple Plateau, S of Mt Tosh | EP * |
| 7 | Bonnie Doon west | RES-BC, REC-EP |
| 8 | Bonnie Doon east | RES-BC, REC-EP |
| 9 | Shiple Plateau, S of Mt Tosh | EP* |
| 10 | Shiple Plateau, S of Mt Tosh | EP* |

RES_BC Residential-Bushland Conservation

REC-EP Recreation-Environmental Protection

* Up-slope of site 6, 9 and 10 has been subdivided into three lots in which residential dwellings are allowed.

5.5 Habitat

5.5.1 Landform and geology

L. lachnaeoides occur on exposed cliff tops and terraces in the Megalong and Jamison valleys. The habitat occurs at 960-1000 m altitudes, and is SE to SW in aspect on the southern side of plateaus extending into the two valleys. The geology is predominantly sandstone of the Triassic Narrabeen Group (Geological Survey of NSW 1961).

5.5.2 Vegetation

L. lachnaeoides occurs in 'montane heath' communities (vegetation type 21c)(Keith & Benson 1988). Species in common to many of the sites include *Eucalyptus stricta*, *Allocasuarina nana*, *Dillwynia retorta*, *Epacris microphylla* and *Caustis flexuosa* (Cohn 1993). Other common species are listed in Table 3. The litter layer is usually several centimeters thick with sclerophyllous leaves or needles of *Allocasuarina nana* (Cohn 1993).

5.5.3 Climate

The Blue Mountains experiences low maximum summer and winter temperatures compared to the coastal areas of NSW due to its higher elevation. The Average daily maximum January temperature for Mt Victoria is 23°C (1050 m), and average minimum July temperatures range from 2-3°C for Wentworth Falls (900 m) (Keith and Benson 1988).

Average rainfall is 1400 mm at Leura. The driest months are generally July to September and the wettest are December to March (Keith and Benson 1988). *L. lachnaeoides* sites frequently experience heavy mists (Jones cited in Cohn 1993).

5.5.4 Natural disturbance - fire regimes

Sclerophyllous vegetation, such as that surrounding *L. lachnaeoides* populations, rely on the regular disturbance of fire for regeneration of their component species. However, the cliff top position of *L. lachnaeoides* is relatively well protected from fire by aspect and cliff morphology. The fire history of each known site of *L. lachnaeoides* is difficult to estimate. NPWS fire records indicate that most of the sites have rarely been subjected to fire. Sites 1, 3 and 5 were burnt in a 1957 wildfire. Site 2 has not been burnt since fire history records began in 1944 (Jones cited in Cohn 1993). Site 4 is included in an area burnt by a prescribed fire in 1978. However, counting the branch whorls on an old *Banksia cunninghamii* plant in site 4, yielded an approximate age of 30 years. It is difficult to know when sites were last burnt due to the patchy nature of fire (Cohn 1993).

Table 3. Species commonly associated with the habitat of *Leionema lachnaeoides* (Cohn 1993).

| Family | Species |
|---------------|---|
| CASUARINACEAE | <i>Allocasuarina nana</i> |
| CYPERACEAE | <i>Caustis flexuosa</i> |
| | <i>Gahnia sieberiana?</i> |
| EPACRIDACEAE | <i>Dracophyllum secundum</i> |
| | <i>Epacris microphylla</i> |
| | <i>Leucopogon hookeri</i> |
| | <i>L. muticus</i> |
| FABACEAE | <i>Acacia asparagoides</i> |
| | <i>A. obtusifolia</i> |
| | <i>Dillwynia retorta</i> |
| MYRTACEAE | <i>Darwinia taxifolia</i> subsp. <i>taxifolia</i> |
| | <i>Eucalyptus stricta</i> |
| | <i>E. sieberi</i> |
| | <i>Leptospermum morrisonii</i> |
| | <i>L. polyanthum</i> |
| | <i>L. rupicola</i> |
| | <i>L. trinervium</i> |
| PROTEACEAE | <i>Banksia cunninghamii</i> |
| | <i>B. ericifolia</i> |
| | <i>B. marginata</i> |
| | <i>B. serrata</i> |
| | <i>Hakea dactyloides</i> |
| | <i>Isopogon anemonifolius</i> |
| | <i>Petrophile pulchella</i> |
| RESTIONACEAE | <i>Restio fastigiatus</i> |
| STYLIDIACEAE | <i>Stylidium productum</i> |

THYMELEACEAE

Pimelea linifolia

XANTHORRHOEACEAE

Xanthorrhoea resinosa

6. Biology and Ecology

6.1 Growth Rate and Longevity

Very little is known about the growth rates and longevity of *L. lachnaeoides*. If the ages of the plants are related to the last fire, then these populations may be 20-50 years old. The most recent fire occurred in 1978 at site 4, and this is also the only site in which seedlings were observed in 1993. Fire records indicate that the other sites have not been burnt for 40-53+ years. Although fire records do not necessarily indicate that sites were burnt because of the patchy nature of fire, however they can provide a conservative indication of the minimum length of time since fire.

6.2 Phenology

Flowering has been recorded to occur in winter to late spring (Weston and Portners 1991). In October and November 1992 all known populations contained flowering plants (Cohn 1993).

6.3 Reproductive Biology

6.3.1 Vegetative reproduction

There is no evidence to suggest that *L. lachnaeoides* reproduces vegetatively. The plants do not appear to produce stems from rhizomes or stolons. Thus the species is likely to be wholly reliant on seed production and dispersal for its recruitment.

6.3.2 Breeding system

L. lachnaeoides is a monoecious species with bisexual flowers. There is no information known about its breeding system. Other species of *Leionema* have been reported to be generally self-incompatible (Armstrong 1979). If the biological and ecological studies proposed in Section 12 indicate that the species is producing little fruit and/or unviable seed, then the breeding system may require further investigation.

6.3.3 Flowering and pollination

The radially symmetrical yellow flowers suggest that *L. lachnaeoides* is insect pollinated (Armstrong 1979). The age when plants first flower is unknown.

6.3.4 Fruit and seed

The seed is released seasonally on maturity of the fruit rather than being stored on the plant. There have been no recorded observations of the extent and success of fruiting of *L. lachnaeoides*, or of the distance over which seed has been dispersed.

As the seed is not stored on the plant, it is expected that a soil seed bank exists. However, recent studies into the soil seedbank at four *L. lachnaeoides* sites indicate that the amount of viable seed remaining in the soil is low (Tuckey 2000 unpublished). Critical factors influencing the size of the seed bank include;

- the quantity of seed produced,
- the proportion of viable seed,
- the longevity of the seed,
- primary and secondary seed dispersal, and,
- post dispersal seed predation.

Based on life history factors and the fact that the species occurs in fire-prone sclerophyll heath, it is expected that the seed may exhibit dormancy, which is broken by the disturbance created by fire. However, there may also be a gradual breaking of seed dormancy over time, indicated by the few seedlings present at site 4 in 1993.

6.3.5 Recruitment and population structure

If the recruitment of populations is related to time since fire or some other disturbance, then the populations probably consist of even age stands. Of the 10 known populations only site 4 contains juveniles (Cohn 1993), this site is perhaps the most disturbed, as until recently it was a well-visited lookout. Site reassessment surveys carried out by NPWS in 2000 found that the demographics of the populations appeared to have changed little since the previous census (Tuckey 2000 unpublished). A summary of census information is provided in Table 4.

Table 4. Summary of *Leionema lachnaeoides* census information.

| Site Number | Location | Number of Plants | | Area (m ²) | Last Burnt |
|--------------|-----------------------------------|------------------|--------------------|------------------------|------------|
| | | Adults | Seedlings | | |
| 1 | Nellies Glen west | 47 _b | 0 | 340 | 1957 |
| 2 | Radiata Plateau east of Gully | 108 _a | 0 | 600 | 1944 |
| 3 | Radiata Plateau west of Gully | 74 _a | 0 | 163 | 1957 |
| 4 | Shiple Plateau, Double Echo Point | 50 _a | 8 (in 1993) | 400 | 1978 |
| 5 | Narrow Neck Plateau | 17 _b | 0 | 200 | 1957 |
| 6 | Shiple Plateau, south of Mt Tosh | 9 _b | 0 | approx. 20 | unknown |
| 7 | Bonnie Doon west | 7 _b | 0 | approx. 15 | unknown |
| 8 | Bonnie Doon east | 16 _b | 0 | 180 | unknown |
| 9 | Shiple Plateau, south of Mt Tosh | 76 _b | 0 | 320 | unknown |
| 10 | Shiple Plateau, south of Mt Tosh | 6 _c | 0 | | unknown |
| Total | | 412 | 8 (in 1993) | 2238 | |

^a Data from Cohn (1993)

^b Data from Tuckey (2000)

^c Data from Jones (1991)

6.4 Fire Ecology

The response of *L. lachnaeoides* to fire is unknown. Without further knowledge it is appropriate (and conservative) to assume that this species is killed by fire and that recruitment after fire will be dependent on the soil stored seed bank. Until further information is obtained then the appropriate fire regime for *L. lachnaeoides* may be that which is most appropriate for the habitat in which *L. lachnaeoides* occurs. Studies outlined in Section 12 may assist in formulating more specific guidelines.

The response of other species in the family Rutaceae family is variable. *Boronia parviflora* resprouts after fire (Keith 1991). Populations of *Leionema diosmeum* and *Phebalium squamulosum* have been observed to either resprout after fire or be 100% killed by scorching (Malcom Gill *pers. comm.*).

6.5 Summary of Known Biology and Ecology

Little information is known about the biology and ecology of *L. lachnaeoides*. Until more information is known the following assumptions are made. *L. lachnaeoides* is a shrub species with a life span of greater than 10 years. The age of *L. lachnaeoides* populations is likely to be linked to the time of the last fire event. Individuals are assumed to be killed by fire and regeneration of the species is reliant upon a soil stored seed bank. As *L. lachnaeoides* is found within sclerophyllous vegetation it is prone to the impacts of inappropriate fire regimes.

7. Previous Actions Undertaken

7.1 Previous Recovery Plans and Implementation

In 1993, a Conservation Research Statement and Recovery Plan was prepared for the then Commonwealth Australian Nature Conservation Agency (now Environment Australia) (Cohn 1993). The recovery actions specified in the 1993 plan have not been funded and only some have been implemented in an *ad hoc* manner outside the structure of the recovery plan.

This recovery plan is largely based on the 1993 but additionally includes negotiations and commitments with land managers as required by the TSC Act.

7.2 Recovery Team

A combined recovery team for *L. lachnaeoides*, *Epacris hamiltonii*, *Microstrobos fitzgeraldii* and the Blue Mountains Water Skink was formed in 2000 to coordinate recovery efforts and guide the preparation of the recovery plan. The team comprises stakeholder representatives from the National Parks and Wildlife Service, the City of Blue Mountains Council, Sydney Catchment Authority, State Forests of NSW, Blue Mountains Rural Fire Service, the Blue Mountains Rare and Endangered Species Group, the Blue Mountains Conservation Society, and species experts.

7.3 Survey for other Populations

The most recent census of seven of the known *L. lachnaeoides* populations was undertaken by NPWS in 2000 (Tuckey 2000 unpublished). Prior to this Cohn undertook a census of the six populations known in 1993. A census of two additional populations found in the Bonnie Doon Catchment was also undertaken in 1997 (L. Taylor & J. Hayden *pers. comm.* 1997). Wyn Jones has also undertaken survey work in the Bonnie Doon Catchment and at Shipley Plateau and Narrow Neck Plateau (Jones *pers. comm.* 2000).

The possibility that more populations being discovered in a targeted survey of the clifftop habitat is likely. Section 11 of this plan provides for additional survey.

7.4 Propagation of Material from Cuttings

Mt Annan Botanic Garden (Graham Errington formerly at Mt Annan Botanic Garden *pers. comm.*) has carried out two trials of propagation from cuttings. The current collection of cultivated plants consists of 15 clones. The first trial was unsuccessful, probably due to the type of cuttings and time of the year that the material was collected. The second trial was successful and although different techniques were applied, the time of collection of the material is thought to be the most significant factor. Propagation from seed is yet to be investigated.

Propagation from cuttings has proved to be unreliable, thus it may be preferable to store material *ex situ* using seed. However before it can be relied upon, research into seed longevity and viability in storage will be necessary. Section 13 provides a cue for discussion regarding the initiation of such a collection.

8. Management Issues

The following sections include a discussion of the threats operating on the known populations of *L. lachnaeoides*, the need for translocation, the ability of the species to recover and the social and economic factors relevant to the implementation of the recovery plan.

8.1 Understanding of Biology and Ecology

Our ability to manage threatened species is dependent on our knowledge of their habitat requirements and under what circumstance reproduction and death occur. As outlined in Sections 5 and 6 of this plan, the level of information known about *L. lachnaeoides* is very limited and only broad assumptions can be made. Only a small amount of additional investigation into the distribution of *L. lachnaeoides* has been carried out and it is highly likely that more populations of *L. lachnaeoides* will be located through systematic survey. Systematic survey (Section 11) will also provide greater insight into the habitat requirements of the species. Investigations into the biology of the species and in particular, its seed ecology, will enable populations of *L. lachnaeoides* to be managed so that they remain viable. This is addressed in Section 12 of the plan.

8.2 Threats to *Leionema lachnaeoides*

This section describes current threats to the known populations of *L. lachnaeoides*.

8.2.1 Up-slope disturbance

L. lachnaeoides occurs at the top of cliff lines at the base of steep slopes extending down from the plateau tops. Therefore, disturbance related to development up-slope of populations of *L. lachnaeoides* might have an impact on its habitat, depending on the size, position and vicinity of the disturbance. The potential impacts include alteration of drainage patterns, sedimentation, erosion, increased nutrient levels, introduction of weeds, and changes to fire regimes.

Sites 2,3, 4,6,9 and 10 are considered the most vulnerable to up-slope development.

8.2.2 Weed invasion

Most of the sites are not currently affected by weed invasion, although potential up-slope development will increase the likelihood of weed invasion.

Site 2 and 3 on Radiata Plateau are situated below a large plantation of *Pinus radiata*. There is some evidence of *Pinus radiata* seedlings dispersing into the surrounding vegetation (Cohn 1993). Increase in the density of *Pinus radiata* will potentially affect site factors such as water, shade and fire hazard (Cohn 1993).

8.2.3 Fire management and inappropriate fire regimes

Fire management is an important community issue in the Blue Mountains. Urban development occurs on the edge of highly flammable bushland and hazard reduction burning is used for the protection of life and property. The encroachment of urban development into remaining bushland areas is likely to increase the frequency of fire through hazard reduction burning, accidental ignition, and arson. Although cliff margins may be protected to some extent by their rocky nature, the increased burning up-slope may alter the plant community and habitat, which may impact on *L. lachnaeoides* populations.

If fire frequency is too high in *L. lachnaeoides* habitat then regenerating populations may not have time to produce seed between fire events. This is likely to lead to local extinction of *L. lachnaeoides* if the species relies on seed for regeneration. If *L. lachnaeoides* is found to resprout after fire, then the process of resprouting after frequent fires may take away resources required for producing seed. In either case, too frequent fires may adversely effect the survival of *L. lachnaeoides*.

If fire frequency is too low, then populations of *L. lachnaeoides* may senesce thereby relying on a seed bank for regeneration. Reliance on regeneration from the soil seed bank after a population has senesced is risky, as the soil seed bank will decrease over time if no new seed is added.

8.2.4 Site access

L. lachnaeoides is known from cliff-tops and thus may be vulnerable to impacts from rock climbers and other visitors. The expansion of the recreational and commercial rock climbing industry in the Blue Mountains region has the potential to impact on all *L. lachnaeoides* populations. Although,

only one of the known populations is presently affected (site 5), areas of potential habitat are likely to be vulnerable.

Site 5 occurs on Narrow Neck Plateau in the Blue Mountains National Park. There is a small walking track that leads to this population and occurs close to a number of individuals making this site most prone to access-related disturbance. A small section of the track will be relocated to reduce impacts on the species.

Site 4 (Shipley Plateau) occurs within a Crown Recreation Reserve. This site contains a lookout which was once frequently used, however access to this site has now been prevented by the owners of the adjoining property through which access is obtained. The closure of access tracks on this property has led to increased protection of this site.

8.3 Social and Economic Issues

8.3.1 Intrinsic ecological value

It is possible that *L. lachnaeoides* plays a crucial role in the habitat of other species, which may depend on it for survival. The rediscovery of *L. lachnaeoides* highlights the importance of conserving large, diverse, undisturbed habitat to provide opportunities for refuge of species from threatening processes.

8.3.2 Scientific value

As a member of a large genus, *L. lachnaeoides* has assisted taxonomists in understanding the evolutionary relationships between other members of its genus and family.

Conservation of *L. lachnaeoides* habitat means that these areas will also be available for future scientific studies particularly on biota, which have been poorly investigated.

Research on the biology and ecology of this species will increase our understanding of the way in which species function and interact with their habitat. This knowledge will assist land managers in managing our natural resources.

8.3.3 Biodiversity value

Microstobos fitzgeraldii (also included on Schedule 1 of the TSC Act 1995) inhabits rock faces in the same catchment as *L. lachnaeoides* sites 7 & 8 (L. Taylor & J. Hayden *pers. comm.* Keith & Benson 1988). The maintenance of *L. lachnaeoides* will assist in the protection of *M. fitzgeraldii* and other species in this area.

8.3.4 Social effects

The conservation of the habitat in which *L. lachnaeoides* occurs provides the protection of scenic value of the escarpment area. The scenic value of the Blue Mountains is very important to the economic viability of the Blue Mountain community, which relies on tourism as a major source of income. The scenic value is also of benefit to the physical well being of the people who live there.

8.3.5 Economic consequences

The economic consequences of the implementation of the recovery plan for *L. lachnaeoides* are low. The direct costs result from further survey and research into the biology and ecology of the species. Expense will also be incurred from liaison and negotiations with landholders and managers.

Depending on the results of the recovery actions, long-term costs may also include those associated with seed storage and the declaration of Critical Habitat.

The implementation of this recovery plan may affect the pattern of development in areas up-slope from *L. lachnaeoides* populations, if the proposed development is determined to have a significant effect on the species or its habitat.

8.4 Translocation

Translocation, “the deliberate transfer of plants or regenerative plant material” (ANPC 1997), is often considered in the process of recovering endangered species. Translocation is a lengthy process with a high chance of failure. It is usually only considered when the species is in immediate danger of extinction. At this stage, translocation is not considered necessary for the survival of the species given the current lack of knowledge about its biology and ecology. However, as a contingency against the possibility of extinction, this recovery plan does recommend an investigation into the potential for *ex-situ* cultivation should the need for translocation of *L. lachnaeoides* arise (Section 13).

8.5 Species Ability to Recover

8.5.1 Species rarity

L. lachnaeoides is considered a threatened species due to its limited distribution and abundance, which consist of only ten known populations and around 400 individuals. There is no evidence to suggest that this narrow distribution is the result of a decline (human-induced or otherwise). As the species occurs in relatively undisturbed habitat, its rarity may be the result of environmental or biological factors restricting its distribution. For example, *L. lachnaeoides* may be restricted to a particular niche or it may exhibit low seed production, which may have restricted its dispersal into more diverse habitats. Alternatively, the result of targeted survey (Section 11) may show *L. lachnaeoides* to have a broader distribution than currently known.

8.5.2 Species viability

A viable species is one that is successfully self-replacing in the wild. That is, it consists of reproductive individuals which produce germinable, non-hybrid seed, that seedlings establish from this seed under natural conditions, and that these seedlings mature to reproductive adults which produce germinable, non-hybrid seed, and so on into the future.

The viability of *L. lachnaeoides* is unknown. The species may be rare due to low recruitment rates, or specific habitat requirements. Information needed to assess the viability of the species includes that relating to fecundity, seed dynamics, population dynamics (recruitment, death) and response to fire. These factors are prioritised for investigation under Section 12.

8.5.3 Likelihood of recovery

'Recovery' in the context of this plan, is to maintain the current endangered status of *L. lachnaeoides*, or if appropriate, down list the species to vulnerable, and to prevent the species from moving to a less desirable conservation status (TSC Act: Schedule 1, Part 4 presumed extinct).

Fire management is a critical factor in determining the likelihood of extinction of *L. lachnaeoides* and its potential for recovery. The recovery plan has discussed how an inappropriate fire regime is likely to have significant consequences for the species (Section 8.2.3). Other major factors affecting the likelihood of recovery include the ability of land managers to prevent the degradation of habitat through environmental planning controls and the ability to identify reproductive requirements of the species.

To secure the recovery of *L. lachnaeoides*, the recovery plan advocates a management program that:

- favours *in situ* management of *L. lachnaeoides*, including recommendations for fire management and environmental impact assessment (Section 10);
- extends knowledge of the distribution of *L. lachnaeoides* (Section 11);
- provides a greater understanding of the biology and ecology of the species that can guide future management (Section 12);
- investigates safeguards against extinction in the event of catastrophic disturbance (Section 13); and
- educates and involves the community in the implementation of recovery actions (Section 14).

The likelihood of recovery (down-listing *L. lachnaeoides* from endangered to vulnerable) is dependent on the results of additional survey and the success of ongoing management actions. This will be determined by the extent to which the known distribution is increased, the abundance of individuals at each new population and the level of threat. Although there is a high probability that some new populations will be found, it is unlikely that a significant number will be found to change the status of the species. The reassessment of species status is outlined in Section 14 and is scheduled to occur in the final year of recovery plan implementation.

As many of the populations of *L. lachnaeoides* are senescing and/or not recruiting new individuals, the consequences of not implementing this recovery plan are such that the probability of extinction of *L. lachnaeoides* is high. Without the co-operation of land managers and planners, *L. lachnaeoides* is likely to be adversely affected by inappropriate fire management activities and uninformed development. Without further survey potentially unknown populations may be adversely affected and the true importance of existing populations will remain unknown. Without further biological and

ecological investigations, the key aspects of the species fecundity, seed dynamics and response to fire will remain unknown and management decisions will not be able to consider them. The success of this plan also depends on the ability of land managers and regulators to integrate recovery actions into existing general management actions and allocate financial resources to ensure full implementation of recovery actions.

9. Overall Recovery Aim and Recovery Strategy

9.1 Overall Objective

The overall objective of the recovery plan is to prevent the extinction of *L. lachnaeoides* in nature by protecting known populations and, depending on the results of targeted surveys and the success of management, down-list the species to vulnerable.

Specific recovery plan objectives are to:

1. ensure the protection of known populations of *L. lachnaeoides*;
2. establish the full extent of *L. lachnaeoides* distribution;
3. enhance future management of *L. lachnaeoides* by furthering our understanding of essential aspects of the biology and ecology;
4. prevent extinction of *L. lachnaeoides* by investigating the potential for *ex situ* cultivation;
5. raise awareness of the conservation significance of *L. lachnaeoides* and involve the community in the recovery program; and
6. carry out re-evaluation of the conservation status of *L. lachnaeoides* using all available information.

9.2 Overall Performance Criteria

The overall performance criteria of the recovery plan is that the risk of extinction of *L. lachnaeoides* is decreased through the protection of known populations, by the implementation of an appropriate management regimes and the location of additional populations through targeted survey.

Specific performance criteria of the plan are that:

1. populations do not decline as a result of human induced disturbance;
2. potential habitat is surveyed to obtain a greater knowledge of the distribution of *L. lachnaeoides* which is applied to management;
3. management strategies are refined as a result of an increased understanding of the biology and ecology of *L. lachnaeoides*;
4. necessity and efficacy of an *ex-situ* program is evaluated and established if required;
5. educational material is disseminated and the community is involved in the implementation of recovery actions; and
6. conservation status has been re-evaluated and if appropriate, a recommendation be made to downlist the species from endangered to vulnerable.

9.3 Recovery Actions

In order to achieve these objectives, a number of specific actions are recommended in this recovery plan:

1. manage habitat to ameliorate threatening processes and conduct informed assessment of activities that may affect on *L. lachnaeoides*,
2. conduct targeted survey of potential *L. lachnaeoides* habitat,
3. investigate key aspects of the biology and ecology of *L. lachnaeoides*,
4. assess the need and efficacy of undertaking an *ex situ* cultivation program,
5. disseminate education material and involve the community in the implementation of key aspects of the recovery plan, and
6. re-evaluate the conservation status of *L. lachnaeoides*.

10. Habitat and Threat Management

10.1 Objective

The objective of this component of the recovery plan is to minimise the risk of *L. lachnaeoides* declining by the implementation of *in situ* habitat conservation. This will involve a combination of both long-term strategic planning and short-term operational activities, to mitigate or prevent actual and potential threatening process.

10.2 Recovery Actions

This recovery plan recommends the following actions be undertaken to manage habitat and assess activities that may threaten the long-term survival of the species.

10.2.1 Establish recovery team

A combined recovery team has been established for the threatened species *L. lachnaeoides*, *Epacris hamiltonii*, *Microstrobos fitzgeraldii*, and the Blue Mountains Water Skink. The team consists of representatives from the NPWS, City of Blue Mountains Council, Rural Fire Service, State Forests of NSW, Sydney Catchment Authority, the Blue Mountains Rare and Endangered Species Group, the Blue Mountains Conservation Society, and species experts.

The primary role of a recovery team is to provide advice and support to the Director-General of NPW regarding *L. lachnaeoides*. In particular, the team will oversee and provide advice on the implementation of the *L. lachnaeoides* recovery plan. The team will evaluate current management activities and the success of the recovery actions included in the plan. The recovery team will operate over the life of the plan.

10.2.2 Site reassessment and ongoing monitoring

The NPWS has undertaken an initial reassessment of seven of the known *L. lachnaeoides* sites and will conduct ongoing monitoring of both known and any new sites detected during the life of the recovery plan (Appendix 2).

The reassessment of the known *L. lachnaeoides* sites was conducted in 2000. The aim was to verify the previous population census information and to record any changes to the condition of each site. Ongoing monitoring of the status and condition of each population will continue in the first, third and fifth year of recovery plan implementation.

Any immediate restorative actions identified through site reassessment will be discussed with the recovery team and undertaken in consultation with the relevant manager, and where appropriate, involve local community groups. Actions may include weed control, rubbish removal and modification of access to sensitive sites.

10.2.3 Fire management

The NPWS, City of Blue Mountains Council, Blue Mountains Bush Fire Risk Management Committee and the NSW Rural Fire Services will assist in the management of *L. lachnaeoides* by ensuring that:

- NPWS, when preparing fire management plans for the Blue Mountains National Park will provide for known habitat of *L. lachnaeoides* to be included in heritage management zones where feasible ; and the
- Blue Mountains Bush Fire Risk Management Committee, when preparing the Blue Mountains Bush Fire Risk Management Plan, provide for known habitat of *L. lachnaeoides* to be included in conservation zones where feasible;

In addition, it is recommended that both NPWS and the Blue Mountains Bush Fire Risk Management Committee construct fire breaks around populations of *L. lachnaeoides* when carrying out fuel reduction works in areas not designated heritage management or conservation zones.

NPWS, City of Blue Mountains Council and NSW Rural Fire Service will ensure that the distribution and ecological requirements of *L. lachnaeoides* be considered in the planning and implementation of hazard reduction activities (including track maintenance and construction). In order to give this effect:

- public authorities will ensure that the assessment of hazard reduction works will be undertaken with reference to the recovery plan, environmental assessment guidelines (Appendix 3) and any future advice from the NPWS resulting from increased knowledge in the distribution or ecology of *L. lachnaeoides*; and
- when a delegated officer is issuing a notice or a permit relating to hazard reduction, or any activity which may impact on the species or its habitat, the distribution of known habitat will be considered in relation to the notice or permit.

10.2.4 Development assessment

This recovery plan becomes a relevant consideration under the Parts 4 & 5 of the EP&A Act. Accordingly the City of Blue Mountains Council and NPWS are required to assess effects of developments and activities on the species.

In order to give this effect, City of Blue Mountains Council will ensure that:

- development applications are assessed with reference to this recovery plan, environmental assessment guidelines (Appendix 3) and any future advice from the NPWS regarding the distribution, threats, biology and ecology of *L. lachnaeoides*;
- development consent issued on land in the vicinity of known populations of *L. lachnaeoides* and which may impact on the species, incorporates appropriate stormwater and sediment control measures to prevent increases in nutrients, sedimentation runoff and weed propagules; and
- any environmental policies, management plans and environmental planning instruments relevant to the species or the land on which it occurs are prepared or reviewed with reference to the recovery plan and any future advice from the NPWS regarding the distribution and ecology of the species.

In addition, the NPWS will ensure that:

- A Review of Environmental Factors (REF) will be undertaken in accordance with the EP&A Act for any activities proposed in the Blue Mountains National Park which may affect *L. lachnaeoides* and its habitat.
- Any management plans relevant to the species or the land on which it occurs are prepared or reviewed with reference to this recovery plan.

10.2.5 Habitat protection on private lands

The NPWS will liaise with private landholders to convey the conservation significance of populations of *L. lachnaeoides* on or adjacent to their properties.

The NPWS will seek to secure sympathetic management of *L. lachnaeoides* habitat by private landholders. In order to achieve greater protection of populations on private land, the NPWS recognises that a range of mechanisms are available (e.g. property management plans and voluntary conservation agreements). The precise nature of management arrangements will depend largely on the circumstances and co-operation of private landholders.

Liaison with private land holders will commence in the first year of the plan and, depending on the results of the targeted survey action (Section 11) and interest shown in conservation agreements, continue into the second and third years of the plan. Blue Mountains Council will be informed of any management agreements and the information will be recorded on Councils property information system.

10.2.6 Critical Habitat assessment

A declaration of Critical Habitat ensures a high level of environmental assessment (through a mandatory species impact statement and concurrence from the Director-General of NPW) and approval is required prior to activities being conducted in areas of Critical Habitat.

The level of knowledge of *L. lachnaeoides* is insufficient to declare areas of habitat that are critical to the survival of the species. Targeted survey (Section 11) and the completion of biological and ecological investigations (Section 12) will provide additional information, which may enable Critical Habitat for *L. lachnaeoides* to be defined.

Where recommended management arrangements fail to adequately prevent threats and adequately conserve *L. lachnaeoides*, and result in a decline in the number of individuals, the Director General of NPWS will reassess Critical Habitat as a conservation option for this taxon.

The completion of this action is dependent on the conclusions reached from biological research and survey results. As such Critical Habitat can be assessed from the third year of implementation of this plan.

10.3 Performance Criteria

The criteria with which success of this action will be measured are that populations of *L. lachnaeoides* do not decline.

11. Targeted Survey

11.1 Recovery Objective

The objective of this component of the recovery plan is to establish the full extent of the distribution of *L. lachnaeoides*.

To make confident land management decisions, it is essential that managers of *L. lachnaeoides* habitat have an accurate understanding of the actual and potential distribution of the species. Section 5 of the recovery plan described the known distribution of the species and identifies other areas of potential habitat. There is therefore a need to conduct further surveys in areas of suitable habitat not yet surveyed, to assist with future management decision making.

11.2 Recovery Actions

The recovery action is to investigate the extent of potential habitat of *L. lachnaeoides* by undertaking targeted surveys.

Sites for *L. lachnaeoides* systematic survey will include:

- The cliff terrace throughout the Megalong and Jamison Valleys. As some of these cliff terraces are difficult to access and at times dangerous, the surveyor(s) should be experienced in cliff scrambling and rock climbing.
- Montane Heath Communities described by Keith & Benson (1988). This community is mapped on the plateau edges on the northern side of the Grose Valley and also on the southern side of the Grose Valley, south of Govetts Gorge.

The optimum time for survey will be during flowering (winter until late spring). Surveyors should be aided by binoculars to assist with finding plants in locations that are difficult to access. These surveys will be coordinated by the NPWS and take place during the first and second (if necessary) flowering seasons of the plan.

Surveys for *L. lachnaeoides* will be conducted in such a way that:

- Targets areas of potential habitat, during optimum survey conditions. The identification of potential habitat will take into account factors such as landscape position, soil type and vegetation communities.
- Involves all of the authorities responsible for managing the land on which the species occurs and involves community groups and local experts.
- Seeks to maximise the efficient communication of results to land management authorities.

To ensure that survey results are satisfactorily communicated;

- all site information and exact site locations will be recorded with the NPWS Wildlife Atlas, and
- a fully documented voucher specimen will be lodged with the National Herbarium of NSW.

At each new *L. lachnaeoides* site, an estimate of the area of habitat occupied, number of adult plants and seedlings present, fire history and any threats to the population, and details regarding site accessibility will be made. A site visit proforma is provided in Appendix 2.

The extent to which the known distribution is extended, the size of the new populations and the level of threat experienced by each population, will assist in determining whether the species can be downlisted to vulnerable.

11.3 Performance Criteria

The criteria with which success of this action will be measured are that a greater knowledge of *L. lachnaeoides* distribution is achieved and applied to management.

12. Biological and Ecological Investigations

12.1 Recovery Objective

The objective of this component of the recovery plan is to improve management of *L. lachnaeoides* based on an improved understanding of its biology and ecology.

An enhanced knowledge of key aspects of the biology and ecology of *L. lachnaeoides* will be essential for land managers to make informed judgements as to the conservation requirements and viability of populations of the species.

As stated in Section 6 of the plan, little information is known about particular fecundity, seed dynamics and the species response to fire. This objective seeks to implement a program of biological and ecological investigation, which focuses on life cycle stages of the species. Given the low numbers of *L. lachnaeoides*, it is possible that some stage of the life cycle may be limiting population size and geographic distribution. These investigations will evaluate the viability of *L. lachnaeoides* by assessing the success of life history stages.

The program aims to;

- investigate biological and ecological attributes relevant to the practical management of *L. lachnaeoides* and its habitat or that increases understanding of the evolutionary potential of the species,
- be coordinated by NPWS and involve the input of research institutions to maximise outcomes and ensure valid scientific conclusions, and
- keep land managers such as NPWS and City of Blue Mountains Council and other stakeholders informed of advances in knowledge.

12.2 Recovery Actions

The recovery action is to undertake an investigation of key areas of the biology and ecology of *L. lachnaeoides*.

Key areas for scientific investigation of *L. lachnaeoides* are identified below. An asterisk indicates those attributes that are of high priority (*).

- Population dynamics*;
 - the rate of recruitment and mortality;
 - the rate of seedling mortality, and
 - time taken for a seedling to mature and begin producing viable seed.
- Fecundity*: - Flowering and seed production;
 - extent to which populations of *L. lachnaeoides* flower and produce fruit, and
 - effectiveness of pollination.

- Seed dynamics*;
 - seed viability including rate of viability loss over time,
 - seed dormancy breaking mechanisms,
 - seed longevity,
 - evidence of pre- or post- dispersal seed predation,
 - fate of seed stored in the soil, and
 - optimum seed storage conditions relevant to possible future *ex situ* storage of the species.
- Response to fire*:
 - The response of *L. lachnaeoides* to fire (i.e. resprouting vs obligate seed regenerator).
 - The effect of fire on population dynamics. If a population of *L. lachnaeoides* is not burnt by wildfire, an experimental approach may be needed to investigate the response of *L. lachnaeoides* to fire.
- Genetic composition:
 - If it is apparent from the biological studies that the populations are suffering from genetic inbreeding, then it may be necessary to implement a program of genetic investigation to determine the genetic variation in the populations. Small populations are often inbred resulting in breeding difficulties. Expert advice will be sought after preliminary investigations are completed.

Studies into fecundity and seed dynamics are considered to be of high priority as they provide an indication of the vitality of the species. Investigating both the extent to which the species is flowering and producing viable seed, and the existence of a soil seed bank, will allow an assessment as to whether or not there are biological or ecological factors inhibiting the distribution of the species. The response of *L. lachnaeoides* to fire is also of high priority because it will assist in the development of an adaptive fire management strategy for the species.

The above investigations will be implemented during the first three years of the plan. The results of the initial investigations will determine the need for ongoing, additional work on other aspects of the species biology and ecology, which are not considered to be of high priority at this stage.

12.3 Performance Criteria

The criteria with which success of this action will be measured, is that future management strategies are improved by an increase in knowledge of the biology and ecology of the species.

13. Contingency Arrangements: *ex situ* conservation

13.1 Recovery Objective

The objective of this component of the recovery plan is to safeguard populations of *L. lachnaeoides* against extinction in nature as a result of catastrophic disturbance.

The establishment of a representative *ex situ* collection may be necessary as a contingency to safeguard the population against extinction. *Ex situ* conservation is designed to preserve genetic diversity.

The NPWS currently considers that the establishment of a broader *ex situ* conservation program for *L. lachnaeoides* is not necessary for the conservation of this taxon. However, depending on the results of target surveys and biological studies and the possibility of catastrophic disturbance, the NPWS recommends that contingency arrangements be investigated for an *ex situ* collection of *L. lachnaeoides*.

13.2 Recovery Actions

13.2.1 *Ex situ* conservation

The NPWS will coordinate a program to determine the need for and the most appropriate *ex situ* storage method of *L. lachnaeoides*.

In order to give this effect, the NPWS will:

- review, in consultation with the recovery team and relevant experts, the results of targeted surveys (Section 11) and investigations into seed dynamics (Section 12); and
- seek the involvement of research institutions and universities.

Previous management actions have shown that propagation of *L. lachnaeoides* from cuttings to be problematic. It is more likely that storage of genetic material *ex situ* is more efficiently achieved through seed storage. Section 12 will investigate the efficacy of long term seed storage. Should seed storage be inappropriate, then tissue culture may be necessary and under these circumstances, tissue culture techniques will need to be investigated.

In the event that a future translocation program is deemed both feasible and necessary, the NPWS will seek funding to initiate and maintain an *ex situ* collection of *L. lachnaeoides* and negotiate with an appropriate Botanic Garden to maintain the *ex situ* collection.

This action will commence after the third year of recovery plan implementation when the results of actions 11 and 12 (discussed in Sections 11 and 12) are known.

Initiating *ex-situ* storage of *L. lachnaeoides* germplasm may assist in the conservation of the species if threats to the known populations increase and recommended surveys fail to locate additional populations of the species.

13.3 Performance Criteria

Contingency arrangements are implemented, where and when appropriate, in the event of population declines, which imminently threaten the survival of *L. lachnaeoides*.

14. Community Education, Awareness and Involvement

14.1 Recovery Objective

To raise awareness of the conservation status of *L. lachnaeoides* and to involve the broader community in the recovery program for the species.

14.2 Recovery Actions

Education and awareness actions to be implemented are:

14.2.1 Recovery Team

The NPWS will seek to maintain the participation of local community group members in the recovery team for the species.

14.2.2 Species profile

The NPWS has produced a species profile to provide information about the conservation status and management issues affecting *L. lachnaeoides* (Appendix 3). The profile will be updated as needed and distributed to private landholders with *L. lachnaeoides* on their properties and be displayed on the NPWS Internet homepage.

14.2.3 Site assessment and restoration

The NPWS will utilise the skills of local community groups for site reassessment, monitoring and restoration actions where appropriate (as described in Section 10.2.2).

14.2.4 Liaison with private land holders

The NPWS will liaise with private landholders to emphasise the conservation significance of populations of *L. lachnaeoides* occurring on or adjacent to their properties (as described in Section 10.2.5).

14.2.5 Surveys for new populations

When undertaking targeted surveys for *L. lachnaeoides* populations, the NPWS will, where practical, seek the involvement of community groups in the survey effort (as described in Section 11).

14.3 Performance Criteria

Criteria for the successful implementation of education actions are:

- Information is disseminated to the community, in particular private landholders, of the conservation status and management issues affecting *L. lachnaeoides* and its habitat; and
- The community is actively involved in key aspects of the recovery program.

15. Reassess the Conservation Status

15.1 Recovery Objective

The objective of this component of the recovery plan is to determine the conservation status of *L. lachnaeoides* upon implementation of recovery actions.

15.2 Recovery Action

The recovery action is to reassess the conservation status of *L. lachnaeoides*.

The national and State conservation status of *L. lachnaeoides* will be reassessed once the success of habitat management and ongoing assessment actions have been evaluated (Section 10.2), and additional survey (Section 11) and biological and ecological studies (Section 12) have been completed.

Knowledge of the results of each of the above actions will be required before an accurate assessment of conservation status can be made. The success of habitat management actions will stabilise the effect of threatening processes on *L. lachnaeoides*, targeted survey will clarify the extent of the species distribution, and biological and ecological investigations will provide a clearer assessment of species viability.

This action will be undertaken in the final year of recovery plan implementation.

15.3 Performance Criteria

The national and State conservation status of *L. lachnaeoides* is reassessed and, if appropriate, a recommendation is made for downlisting the species from endangered to vulnerable.

16. Implementation

16.1 Implementation Schedule

The following table allocates responsibility for the implementation of recovery actions specified in this plan (identified in Sections 10-15) to relevant government agencies over a five-year period. A breakdown of the costs of each action is provided in Appendix 4.

Table 5. Implementation schedule

| Action | Description | Responsibility | Timeframe | Priority |
|--------|--|---------------------------|--------------------|------------------|
| 10 | Habitat management and ongoing assessment. | | | |
| 10.2.1 | Establish and coordinate recovery team; | NPWS; | ongoing from yr. 1 | Essential |
| 10.2.2 | Site reassessment and ongoing monitoring | NPWS | years 1,3 and 5 | Essential |
| 10.2.3 | Fire management; | NPWS, BMCC, RFS, BMBFRMC; | ongoing from yr.1 | Essential |
| 10.2.4 | Development assessment; | NPWS, BMCC; | ongoing from yr. 1 | Essential |
| 10.2.5 | Habitat protection on private lands | NPWS; | ongoing from yr. 1 | Highly Desirable |
| 10.2.6 | Critical Habitat assessment; | NPWS | Year 3 | Desirable |
| 11 | Target survey of <i>L. lachnaeoides</i>. | NPWS | Years 1 and 2 | Essential |
| 12 | Investigate essential aspects of the biology and ecology of <i>L. lachnaeoides</i>. | NPWS | Year 1-3 | Essential |
| 13 | Determine the need for <i>ex situ</i> storage. | NPWS | Year 3* | Highly Desirable |
| 14 | Community education, awareness and involvement. | NPWS | ongoing | Essential |
| 15 | Reassess conservation status | NPWS | Year 5 | Desirable |

* - This action may be ongoing depending on the results surveys and investigations.

Key: NPWS - National Parks and Wildlife Service

BMCC - City of Blue Mountains Council;

RFS - Rural Fires Service;

BMBFRMC - Blue Mountains Bush Fire Risk Management Committee

17. Preparation Details

Merrin Tozer, Ron Haering and Kersten Tuckey prepared this recovery plan. It is based on the Conservation Research Statement and Recovery Plan prepared by Janet Cohn in 1993 for the then Australian Nature Conservation Agency (now Environment Australia).

17.1 Date of Last Amendment

This is the first recovery plan for *L. lachnaeoides* based on the requirements of the TSC Act. No amendments have been made.

17.2 Review Date

This recovery plan will be reviewed within five years of the date of publication. The plan will be reviewed by the NPWS in conjunction with the *L. lachnaeoides* recovery team.

18. Contacts

NPWS – Central Directorate, Threatened Species Unit, National Parks and Wildlife Service, PO Box 1967, HURSTVILLE, 2220. (02) 9585 6678.

NPWS - Blue Mountains Heritage Centre, Govetts Leap Road, PO Box 43, BLACKHEATH 2785 (02) 4787 8877.

City of Blue Mountains Council, PO Box 189 KATOOMBA 2780 (02) 4780 5000.

References

- Armstrong, J.A. (1979). Biotic pollination in the Australian flora - a review. *New Zealand Journal of Botany* **17**: 467-508
- Briggs, J.D. and Leigh, J.H. (1996). *Rare or Threatened Australian Plants*. CSIRO Publishing, Collingwood.
- City of Blue Mountains Council (1991). *Local Environmental Plan (1991)*. City of Blue Mountains Council.
- Bradstock, R.A., Keith, D.A. and Auld, T.D. (1995). Fire and conservation: imperatives and constraints on managing for diversity. In R.A. Bradstock, T.D. Auld, D.A. Keith, R.R. Kingsford, D. Lunney and P. Sivertson (Eds.) *Conserving Biodiversity: Threats and Solutions*, pp. 323-333, Surrey Beatty & Sons, Chipping Norton.
- Cohn, J. (1993). Conservation research statement and recovery plan (research and management) for *Phebalium lachnaeoides* Cunn. Prepared for the Australian National Parks and Wildlife Service, Endangered Species Program Project No. 251.
- Geological Survey of NSW (1961) *Sydney 1:250 000 Geological Series Map sheets S1 56-5*. Bureau of Mineral Resources, Geology and Geophysics, Canberra.
- Harden, G.J. (1991). (Ed.) *Flora of New South Wales*, Vol. 2, pp. 255-263. New South Wales University Press, Sydney.
- Jones.W. (1991) NPWS Wildlife Atlas records
- Keith, D.A. (1991). *Coexistence and species diversity in upland swamp vegetation - the roles of an environmental gradient and recurring fires*. PhD Thesis. School of Biological Sciences, Sydney University.
- Keith, D.A. & Benson, D.H. (1988). The natural vegetation of the Katoomba 1:100 000 map sheet. *Cunninghamia* **2**(1): 107-144.
- Tuckey.K. (2000) Blue Mountains Threatened Species Recovery Action Progress Report. Prepared for NSW National Parks and Wildlife Service
- Weston, P.H. and Portners, M.F. (1991). *Phebalium*. In Harden, G.J. (Ed.) *Flora of New South Wales*, Vol. 2, pp. 255-263. New South Wales University Press, Sydney.
- Wilson, P.G. (1970). A taxonomic revision of the genera *Crowea*, *Eriostemon* and *Phebalium* (Rutaceae). *Nuytsia* **1**: 1-155.
- Wilson, P.G. (1998). New species and nomenclatural changes in *Phebalium* and related genera (Rutaceae). *Nuytsia* **12**(2): 267-288

Appendix 1: Detailed objectives of land-use zones

Detailed objectives of land use zones in which *P. lachnaeoides* occurs (City of Blue Mountains Council 1991) are outlined below.

Recreation- Environmental Protection (R-EP):

- a) Ensure protection of environmentally sensitive land and areas of high scenic value in the city.
- b) Provide a buffer around areas of natural ecological significance.
- c) To restrict development on land that is inappropriate by reason of physical characteristics or high bushfire hazard.
- d) To encourage the restoration of disturbed bushland areas.
- e) To provide for passive recreational activities that are compatible with the land's environmental characteristics.

Environmental Protection (EP)

- a) Protect environmentally sensitive land areas of high scenic value in the city from development.
- b) Provide a buffer around areas of natural ecological significance.
- c) To restrict development on land that is appropriate by reason of physical characteristics or high bushfire hazard.
- d) To encourage the restoration of disturbed bushland areas.

Regional Open Space (R)

- a) Enhance and protect the unique natural and scenic environment of the Blue Mountains.
- b) Provide greater opportunities for passive recreation in the Blue Mountains.
- c) Provide for acquisition of this land.

Escarpment Area (5c)

- a) To preserve and enhance the natural environmental and visual significance of the escarpment system of the Blue Mountains.
- b) To limit the presence of buildings and works in the escarpment area and limit the impact of buildings on the perception of the escarpment as a significant natural feature.
- c) To limit the proportion of hard surfaces in the escarpment area and to provide for the restoration of all degraded areas and their return to a natural habitat.

Residential Bushland Conservation (RES-BC)

- a) To allow a range of residential types in the City subject to appropriate levels of servicing.
- b) To ensure that residential development and subdivision is environmentally sensitive and site responsive.
- c) To ensure that the form and siting of buildings, colours, landscaping and building materials are appropriate for and harmonise with the bushland character of the area.
- d) To ensure that bushfire protection measures are contained within a perimeter road or property boundaries (and do not cause an adverse environmental impact on Water Supply Catchment Areas or an environmentally sensitive vegetation unit).

- e) To encourage the re-establishment of bushland in areas of high visual significance, including escarpment areas. (to encourage landscaping and regeneration of natural bushland in residential areas characterised by sparse tree or canopy cover).
- f) To ensure that non-residential land uses are compatible with the residential character of the area.

Appendix 2: Site Reassessment and Survey Proformas

Site Reassessment and Monitoring

Site reassessment and monitoring of *Leionema lachnaeoides* populations will be undertaken during the first, third and fifth years of recovery plan implementation.

The attached proforma (Appendix 1) has been designed to verify and assess the number of plants and condition of each site in a systematic and consistent manner. Upon completion, this proforma should be returned to the *L. lachnaeoides* recovery team coordinator, Threatened Species Unit, Central Directorate.

An appropriately skilled and experienced NPWS officer should undertake the site reassessment and monitoring program. The NPWS officer must be able to recognise the species and be competent in making general observations of habitat condition. Only experienced and qualified persons should undertake surveys in hazardous locations. Site reassessment should preferably be undertaken during flowering (winter until late spring).

Notes on Site Condition:

Describe and/or quantify the following parameters.

Number of adult plants and seedlings: make an approximate count of the number of adult plants and seedlings. Note whether the identity of seedlings have been confirmed by a relevant expert;

Approximate area of the population: make an approximate assessment of the area covered by the population;

Breeding Status: Note whether the species has Buds (B), Flowers (Fl) or Fruit (Fr);

Evidence of Fire: Note whether there is recent evidence of fire and the percentage area of the population affected;

Weeds infestation: Identify the species and extent of area affected by weed invasion;

Pollinators: Record any possible pollinators;

Other threatened species: Note any other threatened species (fauna or flora) found on the site;

Sedimentation and erosion: Note any impacts from sedimentation and erosion;

Tracks: Note any new tracks or eroded tracks and where they are located; and

Rubbish: Note presence of any sort of rubbish from litter or large objects.

Map Recording

It may be useful to draw a sketch map of each site indicating the extent of any observed disturbance such as encroaching weeds or areas of erosion etc. attach the map to the proforma.

Targeted Survey

Targeted surveys for *L. lachnaeoides* will be undertaken during the first two flowering seasons.

The attached proforma (Appendix 2) has been designed to ensure surveys are undertaken in a systematic and consistent manner that captures all relevant data. Upon completion, this proforma should be returned to the *L. lachnaeoides* recovery team coordinator, Threatened Species Unit, Central Directorate. All site information and exact site locations should be recorded with the NPWS Wildlife Atlas.

An appropriately skilled and experienced NPWS officer should coordinate the target surveys in association with a local community group (if practical). The NPWS officer must be able to recognise the species and be competent in making general observations of habitat condition. Only experienced and qualified persons should undertake surveys in hazardous locations. Surveys should preferably be undertaken during flowering (winter until late spring).

Attachment 1: *Phebalium lachnaeoides* Site Reassessment and Monitoring Sheet

Date:

Name of Recorder:

| Site No. | Site Name | Number of Plants | | Approx. Area (m ²) | Breeding Status Buds/Flower/Fruit | Evidence of Fire (Y/N) | | Weed Invasion | |
|----------|-------------------------------------|------------------|-----------|--------------------------------|--------------------------------------|---------------------------|---------------------------|---------------|------------------------|
| | | Adults | Seedlings | | | (Y/N) | Area (m ²) | Name(s) | Area (m ²) |
| 1 | Nellies Glen West | | | | | | | | |
| 2 | Radiata Plateau (east of gully) | | | | | | | | |
| 3 | Radiata Plateau (west of gully) | | | | | | | | |
| 4 | Shipley Plateau (Double Echo Point) | | | | | | | | |
| 5 | Narrow Neck Plateau | | | | | | | | |
| 6 | Shipley Plateau (south of Mt. Tosh) | | | | | | | | |
| 7 | Bonnie Doon (west) | | | | | | | | |
| 8 | Bonnie Doon (east) | | | | | | | | |
| 9 | Shipley Plateau (south of Mt. Tosh) | | | | | | | | |
| 10 | Shipley Plateau (south of Mt. Tosh) | | | | | | | | |

Identity of seedlings confirmed: (Y/N)

Site Condition details i.e. ground cover, other threatened species, pollinators, sedimentation and erosion, tracks and rubbish. Note any ameliorative work required.

.....

.....

.....



Attachment 2: *Leionema lachnaeoides*

Targeted Survey Sheet

DATE: SITE NO: RECORDER NAME:
LOCATION: SCALE:
MAPSHEET: SCALE:
GRID REFERENCE:
LOT: PORTION: PARISH:
GEOLOGY: SOIL:
Texture: sand/loam/clay
Drainage: waterlogged/damp/well drained dry/well drained moist
Depth: skeletal/shallow/deep (cm)
Disturbance: intact/top soil removed/landfill/other

ASPECT: SLOPE: ALTITUDE:
LAND TENURE: local/state/federal govt./freehold/National Park/other

SITE DESCRIPTION:

Topography: ridge/upper slope/mid slope/gully/wetland/other
Area of Reserve/Remnant: <1ha/1-5ha/6-25ha/26-100ha/>100ha
Length and width of Reserve/Remnant:
Understorey Structure:
Health of Site: dieback/insect attack/new vegetative growth/resilience
Past land Use: Time Since last Fire:
Associated Species¹:

THREATS:

Weeds²: % abundance
Trampling/Grazing: feral/domestic/native
Erosion: Rubbish dumping:

POPULATION DETAILS (follow with an E if an estimate)

Number of Plants (adult):

Number of Plants (seedlings):

Area covered by Population:

Plant distribution: small-scattered clump/large continuous clump/other:

Breeding Status: buds/flowers/fruit

Plant Height: Estimated age of Plants:

Fauna Interactions (pollinators, grazing, parasites)

OTHER RECORDS

Collection Made: Yes/No

Type of Collection: seed /cutting

Photographs Taken: Yes/No

¹ List major associated species (inc: threatened species on back of survey sheet)

² List weed species on back of survey sheet;

Extent of Survey: complete/incomplete/unknown
OTHER OBSERVATIONS

Appendix 3: Species Profile and Environmental Impact Assessment Guidelines

THREATENED SPECIES INFORMATION



Leionema lachnaeoides

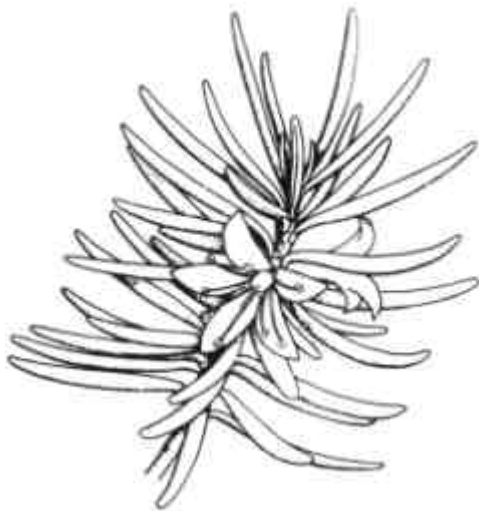
Formerly known as *Phebalium lachnaeoides*

Conservation Status

Leionema lachnaeoides is listed as an **endangered species** on Schedule 1 of the New South Wales *Threatened Species Conservation Act 1995*. The species is also listed as an **endangered species** on the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*.

Description

L. lachnaeoides is in the family Rutaceae. It is a tall shrub to 2 metres high with short (0.5-2.0 cm long) narrow aromatic leaves placed alternately along the stem. It displays yellow flowers, which contain 10 free stamens (Weston and Portners 1991).



Distribution

L. lachnaeoides is known to occur at 10 sites in the Upper Blue Mountains, between Katoomba and Blackheath, NSW. All sites occur within 12km of each other. Potential habitat to occurs throughout the Megalong and Jamison Valleys.

Recorded occurrences in conservation reserves

One population is known to occur in Blue Mountains National Park. Three populations occur in a Blue Mountains City Council Recreation Reserve. Four populations occur on a Crown Recreation

Reserve managed by the City of Blue Mountains Council. A further two populations occur on private property.

Habitat

Known populations of *L. lachnaeoides* occur on exposed cliff tops and terraces, at 960-1000m altitude, SE to SW in aspect. The geology is predominantly sandstone. The vegetation structure is 'montane heath' (Keith and Benson 1988) and commonly includes *Eucalyptus stricta*, *Allocasuarina nana*, *Dillwynia retorta*, *Epacris microphylla* and *Caustis flexuosa* (Cohn 1993).

Ecology

L. lachnaeoides has a life span greater than 10 years. Flowering has been recorded to occur in winter to late spring. The age when plants first flower is not known. Pollination is thought to occur by insects (Armstrong 1979). Seed is released seasonally on maturity. Seed viability is not known.

Fire is likely to be an important factor in the life cycle of this species. It is thought that fire might kill individuals, but produce a flush of germination from seed stored in the soil. The number of individuals at a site may then declines with time since fire, as the surrounding vegetation develops (Auld *et al.* 1991).

Threats

Known threats include habitat degradation from inappropriate fire regimes and impacts from alterations to drainage patterns, sedimentation, erosion, increased nutrient status and weeds as a result of development up-slope of *L. lachnaeoides* populations (NPWS 2000).

Management

Management should ameliorate known threats. Developments undertaken in potential and known habitat should ensure appropriate measures to minimise impacts resulting in habitat degradation.

Recovery Plans

The Minister for the environment approved the recovery plan for *L.*

lachnaeoides in August 2001. Copies may be viewed at www.npws.nsw.gov.au

For further information contact

Threatened Species Unit, Central Directorate, NSW NPWS PO Box 1967, Hurstville NSW 2220. Phone 02 9585 6678 or visit our website at www.npws.nsw.gov.au

References

Armstrong, J.A. (1979). Biotic pollination in the Australian flora - a review. *New Zealand Journal of Botany* 17: 467-508.

Auld T.D., Bradstock R.A. & Keith D.A. (1991). *Germination of rare plants in relation to fire*. Project P154 Final Report for World Wide Fund for Nature Australia. NSW National Parks and Wildlife Service, Hurstville.

Cohn, J. (1993). Conservation research statement and recovery plan (research and management) for *Leionema lachnaeoides* Cunn. Prepared for the Australian National parks and Wildlife Service, Endangered Species program project No. 251.

Keith, D.A. & Benson, D.H. (1988). The natural vegetation of the Katoomba 1:100000 map sheet. *Cunninghamia* 2(1): 107-144.

NSW NPWS (2001). *Leionema lachnaeoides* Recovery Plan. NSW NPWS, Hurstville.

Westen, L.H. and Portners, M.F. (1991). *Leionema*. In Harden, G.J. (ed). Flora of New South Wales, Vol. 2, pL. 255-263. New South Wales University press, Sydney.

Wilson, P. (1998) New species and nomenclatural changes in *Phebalium* and related genera (Rutaceae) *Nuytsia* 12(2): 267-288

IMPORTANT DISCLAIMER

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



Leionema lachnaeoides

Formerly known as *Phebalium lachnaeoides*

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

Survey

Surveys for *L. lachnaeoides* can be conducted at any time of the year, though the species is easier to detect when flowering. It can be distinguished from other *Leionemas* by its short (0.5-2.0 cm long), linear, nearly terete leaves with a fine coverage of hairs on the lower leaf surface.

The number of visible individuals located, probably represents an under estimate of total population size. Depending on the fire history of the site, a potentially larger number of individuals may exist in the seed bank.

Life cycle of the species

Fire is likely to be an important factor in the life cycle of this species. If a proposal is likely to result in frequent fires, then this is likely to lead to declines in the population, since an adequate seedbank will not be able to develop between fire events. Alternatively, if a proposal is likely to reduce the incidence of fire, this may also lead to declines from reduced opportunity for recruitment.

Physical disturbance can also affect the life cycle of this species. *L. lachnaeoides* is not known to reproduce vegetatively, being totally reliant on

sexual reproduction. Disturbance, resulting in physical damage will, no doubt, reduce the ability of this species to sexually reproduce.

Threatening processes

“High frequency fire resulting in the disruption of life cycle processes in plants and animal and loss of vegetation structure and composition” is a key threatening process listed under the TSC Act. This process is relevant to this species.

Other generally recognised threats include habitat degradation caused by alteration to drainage patterns, sedimentation, erosion, increased nutrient status and weeds. Such threats may be the result of development up-slope of *L. lachnaeoides* populations (NSW NPWS 2001).

Viable local population

Viable refers to the ability of this species to successfully maintain a local population capable of recruiting individuals in the wild.

There is currently no information about the viability of *L. lachnaeoides* populations or the number of individuals that constitute a viable population. Information needed to more accurately assess viability include fecundity, seed dynamics, population dynamics (recruitment, mortality) and response to fire. Investigations into key aspects of the biology and ecology of *L. lachnaeoides* is one action of the draft recovery plan.

Fire is one of the most important factors that affect the viability of a population. A population may not be viable in the long term if a proposal is likely to reduce the opportunity for an appropriate fire regime to be imposed.

A significant area of habitat

The full extent of *L. lachnaeoides* habitat is yet to be fully determined. However, the largest and most significant populations currently known, include two sites at Radiata Plateau (which constitute approximately 48% of the known area of habitat) one site at Shipley Plateau, Double Echo Point and another at Nellies Glen West (which respectively constitute 25% and 21% of the known area of habitat)(NPWS 2000).

The following factors should be considered in relation to determining whether a significant area of *L. lachnaeoides* habitat exists:

- whether identified *L. lachnaeoides* habitat is present (NPWS 2000);
- whether the habitat in question is located within or outside of the current distributional limits;
- whether the habitat in question contains *L. lachnaeoides* individuals, and the number, density and population dynamics (age) of the individuals occurring there (including potential individuals which may exist in the seed bank);
- the proximity of the habitat in question to existing *L. lachnaeoides* populations;
- whether the habitat in question is continuous between existing *L. lachnaeoides* individuals and facilitates pollinator movement;
- whether the habitat in question is subject to threat and the likelihood of ameliorating any existing threatening processes;
- whether the habitat in question will be modified or removed.

Isolation & fragmentation

All currently known *L. lachnaeoides* populations occur within 12km of each other.

An assessment of isolation and fragmentation effects on this species should consider whether the proposal:

- will lead to a breakdown in the pollination and dispersal processes of the species;
- is likely to create a fire regime which is likely to be detrimental to the species.

Regional distribution

The distribution of *L. lachnaeoides* is confined to the Upper Blue Mountains between Katoomba and Blackheath, NSW. Targeted surveys prescribed in the draft recovery plan may result in a range extension for this species.

Limit of known distribution

Potential habitat is likely to occur in the Megalong, Jamison and possibly Grose Valleys.

The draft recovery plan recommends additional surveys of potential *L. lachnaeoides* habitat so as to establish the full extent of the distribution of this species (NPWS 2001).

Adequacy of representation in conservation reserves

L. lachnaeoides is not currently considered to be adequately represented in conservation reserves. While 6 of the 8 known populations, occur within conservation reserve or similar protected areas, the majority of adult individuals (61%) occur on private land

Critical habitat

Critical habitat has not been declared for this species.

For further information contact

Threatened Species Unit, Central Directorate, NSW NPWS, PO Box 1967, Hurstville NSW 2220. Phone: 9585 6678 or visit our website at www.npws.nsw.gov.au

References

- Armstrong, J.A. (1979). Biotic pollination in the Australian flora - a review. *New Zealand Journal of Botany* **17**: 467-508.
- Auld T.D., Bradstock R.A. & Keith D.A. (1991). *Germination of rare plants in relation to fire*. Project P154 Final Report for World Wide Fund for Nature Australia. NSW National Parks and Wildlife Service, Hurstville.
- Cohn, J. (1993). Conservation research statement and recovery plan (research and management) for *Leionema lachnaeoides* Cunn. Prepared for the Australian National parks and Wildlife Service, Endangered Species program project No. 251.
- Keith, D.A. & Benson, D.H. (1988). The natural vegetation of the Katoomba 1:100000 map sheet. *Cunninghamia* **2**(1): 107-144.
- NSW NPWS (2001). *Leionema lachnaeoides* Recovery Plan. NSW NPWS, Hurstville.
- Westen, L.H. and Portners, M.F. (1991). *Leionema*. In Harden, G.J. (ed). Flora of New South Wales, Vol. 2, pL. 255-263. New South Wales University press, Sydney

Wilson, P. (1998) New species and nomenclatural changes in *Phebalium* and related genera (Rutaceae) *Nuytsia* 12(2): 267-288

IMPORTANT DISCLAIMER

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

Appendix 4: Recovery Plan Implementation Costs

| Action | Description | Year of Implementation | | | | | | Source of Funding | | | |
|--------|--|------------------------|--------|--------|---------|-------|--------|-------------------|---|---------------------------------|-----------------------|
| | | 1 | 2 | 3 | 4 | 5 | Total | NPWS ¹ | City of Blue Mountains Council ² | Rural Fire Service ³ | Unfunded ⁴ |
| 1 | Habitat Management | | | | | | | | | | |
| 1.1 | Establish and coordinate recovery team | 500 | 500 | 500 | 500 | 500 | 2,500 | 2,500 | | | |
| 1.2 | Site assessment and ongoing monitoring | 1,500 | | 1,000 | | 1,000 | 3,500 | 3,500 | | | |
| 1.3 | Fire management | | | | | | | ✓ | ✓ | ✓ | |
| 1.4 | Development assessment | | | | | | | ✓ | ✓ | | |
| 1.5 | Habitat protection on private lands | 2,000 | 2,000 | | | | 4,000 | 4,000 | | | |
| 1.6 | Critical Habitat | | | 1,000* | | | 1,000 | 1,000 | | | |
| 2 | Undertake targeted survey | 2,500 | 2,500 | - | - | - | 5,000 | 5,000 | | | |
| 3 | Investigate essential aspects of the biology and ecology of <i>L. lachnaeoides</i> | 5,000 | 5,000 | 5,000 | - | - | 15,000 | - | | | 15,000 |
| 4 | Determine the need for ex situ storage and establish if necessary | - | - | 1,000 | 5,000** | - | 6,000 | - | | | 6,000 |
| 5 | Community education, awareness and involvement*** | | | | | | | | | | |
| 6 | Reassess conservation status | | | | | 1,000 | 1,000 | 1,000 | | | |
| | TOTAL (\$38,000) | 11,500 | 10,000 | 8,500 | 5,500 | 2,500 | 38,000 | 17,000 | | | 21,000 |

* - The \$1000 cost for undertaking a Critical Habitat assessment is dependent on results of targeted survey biological investigations.

** - The \$5000 cost for establishing an *ex situ* collection is dependent on the results of targeted survey biological investigations and consultation with the recovery team and relevant experts.

*** - Community education and awareness is funded by NPWS predominantly from actions 1.1, 1.2, 1.5 and 2.

1. Funded by National Parks Wildlife Service.

✓ . Recurrent NPWS Upper Mountains Area operational funds.

2. City of Blue Mountains Council ongoing operational funds;

3. Rural Fire Services ongoing operational funds.

4. These actions are yet to receive secure funding.



**NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE**

43 Bridge Street
Hurstville 2220
(02) 9585 6444