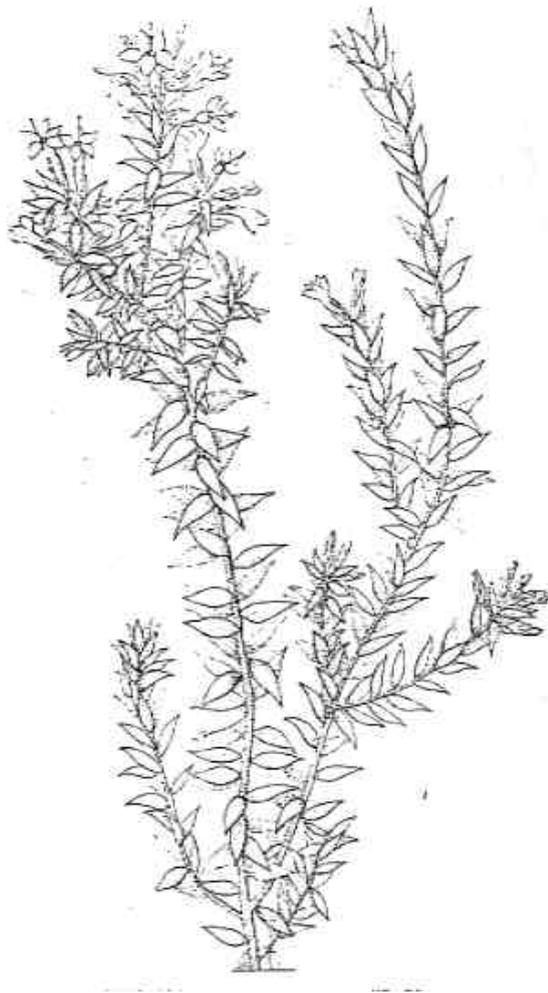




Epacris hamiltonii

Recovery Plan



June 2001



Natural Heritage Trust
Helping Communities Helping Australia

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Epacris hamiltonii
Recovery Plan

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

June 2001

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Janet Cohn (NPWS) for preparing the original recovery plan in 1993 for the former Australian Nature Conservation Agency (ANCA).

Ben Correy for his dedication to field monitoring and surveys.

The *Epacris hamiltonii* recovery team including representatives from City of Blue Mountains Council, Blue Mountains Rare and Endangered Species Group, Sydney Catchment Authority, Mt Tomah Botanic Gardens, Rural Fire Service, State Forests of NSW, Blue Mountains Conservation Society and NSW National Parks and Wildlife Service.

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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 *Epacris hamiltonii*, 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 *Epacris hamiltonii* Recovery Plan was prepared with the assistance of a recovery team comprising relevant land management and research interests, and was placed on public exhibition from August to October 2000. I thank these people 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

Mr A.A. Hamilton, a gardener at Centennial Park, Sydney, first discovered *Epacris hamiltonii*, at Blackheath in the Blue Mountains, in January 1900. The species was described by Maiden and Betche and named in his honour (Maiden and Betche 1900).

E. hamiltonii is a spreading shrub that grows on the cliff edges lining moist gullies in the Blue Mountains, west of Sydney. Until 1994, only one population was known to exist within a gully in the Blue Mountains National Park. Over four thousand plants are now known to occur over a range of five kilometres in three creek catchments of the upper Blue Mountains.

This revised recovery plan describes our current understanding of *E. hamiltonii*, 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.

Current Conservation Status

E. hamiltonii is listed as endangered in NSW on Schedule 1 of the Threatened Species Conservation Act 1995 (TSC Act) and as an endangered species under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Legislative Context

The TSC Act is NSW's legislative framework to protect and encourage the recovery of threatened species, populations and communities. Under the TSC Act, the Director-General of National Parks and Wildlife has 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 Recovery Plan has been prepared with the assistance of a recovery team, a non-statutory group of interested parties with relevant expertise, established to discuss and resolve issues relating to the plan. Components within the plan do not necessarily represent the views nor the official positions of all the individuals or agencies represented on the recovery team. The information in this Recovery Plan was accurate to the best of the 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 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 NSW National Parks and Wildlife Service (NPWS), Rural Fire Services, Sydney Catchment Authority, and the City of Blue Mountains Council.

The EPBC Act specifies that a Commonwealth agency must not take any action that contravenes a Recovery Plan.

Recovery Objectives

The overall recovery objective is to protect populations of *E. hamiltonii* from decline and develop a management regime, based on current knowledge, designed to promote the species conservation and evolutionary potential in nature.

Specific recovery objectives are to;

1. protect and maintain known populations of *E. hamiltonii* from declining in the long term by the implementation of *in situ* habitat conservation mechanisms,
2. enhance management of *E. hamiltonii* and its habitat based on an increased understanding of key aspects of the biology and ecology of the taxon,
3. increase knowledge of the distribution of *E. hamiltonii* and undertake an assessment of new populations,
4. raise awareness in the community about *E. hamiltonii*, and
5. determine the true conservation status of *E. hamiltonii*.

Performance Criteria

Performance criteria of this recovery plan are that;

1. populations of *E. hamiltonii* do not decline in the long term and appropriate management recommendations are discussed with land holders and managers,
2. key aspects of the biology and ecology of *E. hamiltonii* are further understood so as to guide the management of the species and its habitat,
3. a greater knowledge of *E. hamiltonii* distribution is achieved and applied to management,
4. a community awareness program is implemented targeting habitat protection through Total Catchment Management principles, and
5. conservation status is re-evaluated and if appropriate, a recommendation is made to downlist the species from Endangered to Vulnerable.

Recovery Actions

Recovery actions will be directed towards;

1. habitat management to ameliorate threatening processes and informed assessment of activities which may impact on *E. hamiltonii*,
2. continue investigations into key aspects of the biology and ecology of *E. hamiltonii*,
3. investigate the extent of potential habitat of *E. hamiltonii* by undertaking targeted surveys,
4. disseminate educational material and involve the community in the implementation of key aspects of the recovery plan, and
5. re-evaluate the conservation status of *E. hamiltonii*.

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 operations is identified below. Average implementation costs per year will be approximately \$7,900.

Action	Description	NPWS (\$)	BMCC, RFS, SCA	Unfunded (\$)
10	Habitat and Threat Management inc.: <ul style="list-style-type: none"> • recovery team coordination; • site reassessment¹ and rehabilitation ; • fire management; • development assessment and policy preparation; • habitat protection on private lands; • Critical Habitat² assessment 	(26,500) 2,500 20,000 * * 3,000 1,000	 * *	
11	Ecological & Biological Investigations			7,500
12	Targeted Survey ³	5,000		
13	Community Education			
14	Reassess Conservation Status	500		
	TOTAL (\$39,500)	32,000		7,500

* The costs of this action form part of the routine operations of these public authorities

1. Estimated site rehabilitation costs (if required)
2. This action will be implemented if required
3. The costs of this action are incorporated into action 1 and 3

Key: NPWS: The National Parks and Wildlife Service

BMCC: City of Blue Mountains Council

RFS: RuralFire Service

SCA: Sydney Catchment Authority

Biodiversity Benefits

The discovery of further populations of *E. hamiltonii* highlights the importance of habitat conservation and the integral role that national parks play in the conservation of biodiversity. It also shows the importance of conserving areas of diverse vegetation types. The conservation and study of *E. hamiltonii* will also benefit other species that share the same habitat and have similar biology.

Through awareness of *E. hamiltonii*, the profile of all threatened species is raised in the general community. This in turn leads to greater opportunities for the conservation of threatened species and increased protection of biodiversity.

A handwritten signature in black ink, reading "Brian Gilligan". The signature is written in a cursive, flowing style.

BRIAN GILLIGAN

Director-General

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1. Introduction

Mr A.A. Hamilton, a gardener at Centennial Park, Sydney, first discovered *Epacris hamiltonii* at Blackheath in the Blue Mountains in January 1900. The species was described by Maiden and Betche and named in his honour (Maiden and Betche 1900).

E. hamiltonii is a spreading shrub that grows on the cliff edges lining moist gullies in the Blue Mountains, west of Sydney. Until 1994, only one population was known to exist within a gully in the Blue Mountains National Park. Now over four thousand plants are now known to occur within a range of five kilometres in three creek catchments of the upper Blue Mountains.

Threats to *E. hamiltonii* include inappropriate fire regimes, altered moisture regimes, increased nutrient levels, weed invasion and unrestricted access to habitat.

This recovery plan describes our current understanding of *E. hamiltonii*, 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. Legislation Context

2.1 Legal Status

E. hamiltonii is listed as endangered in NSW on Schedule 1 of the Threatened Species Conservation Act 1995 (TSC Act).

E. hamiltonii is listed as an endangered species under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (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 include specific requirements for the matters to be addressed by Recovery Plans and the administrative process for preparing Recovery Plans.

This Recovery Plan has been prepared to satisfy 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 of 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 implementation 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 NSW National Parks and Wildlife Service (NPWS), Rural Fire Services, Sydney Catchment Authority, and the City of Blue Mountains Council.

The EPBC Act specifies that a Commonwealth agency must not take any action that contravenes a Recovery Plan.

2.4 Relationship with Other Legislation

The lands on which *E. hamiltonii* occur are either Crown Land managed by the City of Blue Mountains Council, Sydney Catchment Authority, NPWS or freehold. Relevant legislation for these populations includes:

- *National Parks and Wildlife Act* (1974);
- *Local Government Act* (1993);
- *Environmental Planning and Assessment Act* (1979);
- *Rural Fires Act* (1997); and
- *Sydney Water Catchment Management Act* (1998)

2.4 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 and the concurrence of the Director General of the National Parks and Wildlife Service is required before any approval is given.

To date, Critical Habitat has not been declared for *E. hamiltonii* under the TSC Act. This recovery plan recommends that the need to identify and declare Critical Habitat be assessed by the *E. hamiltonii* recovery team during the life of the plan.

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 on a Commonwealth area that will significantly damage Critical Habitat (unless the EPBC Act specifically exempts the action). Although this offence only applies to a Commonwealth area, any action that is likely to have a significant impact on a listed species is still subject to referral and approval under the EPBC Act.

2.5 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 public authorities relevant to this plan include NPWS, City of Blue Mountains Council, Sydney Catchment Authority and the Rural Fire Service. These

determining and consent authorities must consider the conservation strategy outlined in this plan when considering any activity that may affect *E. hamiltonii*. Any other action not requiring approval under the EP&A Act, and which is likely to have a significant impact on *E. hamiltonii* 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 *E. hamiltonii* 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 *E. hamiltonii* 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.

Appendix 2, Environmental Impact Assessment Guidelines, provides guidance for consent and determining authorities in the assessment of the effect of activities and developments on the *E. hamiltonii* or its habitat.

3. Conservation Status

E. hamiltonii has been listed as an endangered species on Schedule 1 of the TSC Act and as nationally endangered under the Commonwealth EPBC Act.

It is only known to occur in three creek catchments in the upper Blue Mountains, and has a range of only five kilometres.

Populations are potentially threatened by weed invasion, altered moisture regimes and inappropriate fire regimes.

4. Description

4.1 Scientific Description

E. hamiltonii is a flattened or matted shrub to one metre high, often with more than one stem (Beadle *et al.* 1982). The silky hairs on both surfaces of the leaves are very distinctive, and give the leaves a soft grey/green appearance. Leaves are broad-lanceolate to approximately 1 cm long (Beadle *et al.* 1982). The flower is white with a corolla-tube 0.7-1 cm long and 3-5 mm in diameter. The style is longer than the corolla tube. The fruit is a capsule approximately 2 mm in length (Harden 1991). It generally flowers from September to December. Fruits mature in January and are retained on the plant into the following season after dehiscing. The seed is very fine and dustlike.

4.2 Taxonomy

Study of this species assists the understanding of the evolutionary relationships within the genus *Epacris* and family Epacridaceae. The genus *Epacris* occurs in Australia and New Zealand, with 40 species known worldwide, of these, 38 occur in Australia and half within NSW (Powell 1992).

4.3 Distinguishing Features

E. hamiltonii can be distinguished from other Epacrid species that share common habitat, such as *E. longifolia* and *E. crassifolia*. The principal distinguishing feature is the long silky hairs, which occur on both surfaces of the leaves of *E. hamiltonii*. Other features include the shape of the leaves and length of sepals. It is recommended that an identification guide be used when initially distinguishing these species in the field.

5. Distribution and Habitat

5.1 Current and Historical Distribution

E. hamiltonii is only known to occur in the Blue Mountains, west of Sydney. The majority of the populations occur within the Blue Mountains National Park. Until 1994 the species was only known from one population. The range of *E. hamiltonii* has now been extended, with the species now known to occur within three creek catchments (Greaves Creek, Katoomba Creek, and Popes Glen and Govetts Creek) in the upper Blue Mountains. The creeks are all located on the northern side of the escarpment and flow into the Grose Valley. All known sites occur within a radius of approximately five kilometres. The current distribution of the species is shown in Figure 1.

Little information on historical distribution is available. Mr A.A. Hamilton's original 1900 site location is thought to be at Neates Glen. A later collection of the plant by Constable in 1959 appears to have been in the upper Greaves Creek area, this population has not yet been relocated, despite survey of the area.

All historical and present locations place *E. hamiltonii* within the Blackheath area. Therefore, it is likely that *E. hamiltonii* has always been rare, occurring within limited environmental parameters. Further searches may reveal other populations in nearby creek catchments.

5.2 Tenure

The majority of the known sites occur within the Blue Mountains National Park (48 sites). Several sites occur on Sydney Catchment Authority land, within catchment areas that are managed as water quality protection zones. A small number of sites also occur on land managed by the City of Blue Mountains Council and on freehold land (Table 1).

The security of national park tenure is governed by the provisions of *the National Parks & Wildlife Act 1974*. These areas are zoned National Park under the City of Blue Mountains Local Environmental Plan (LEP) 1991.

5.3 Habitat

E. hamiltonii appears to have specific habitat requirements, being found on, or adjacent to Narrabeen Sandstone cliffs alongside perennial creeks, often below plateau hanging swamps. These locations are adjacent to wet gully or swamp vegetation and associated with an altitude range of 810-940 m ASL. The presence of a perennial or virtually perennial source of water, in particular, cliff seepages, appears to be one of the factors determining the distribution of *E. hamiltonii*.

E. hamiltonii cannot be considered in isolation to its habitat, as maintenance of this habitat is expected to be essential in retaining this species persistence in the wild.

Figure 1. Distribution of *Epacris hamiltonii* in NSW

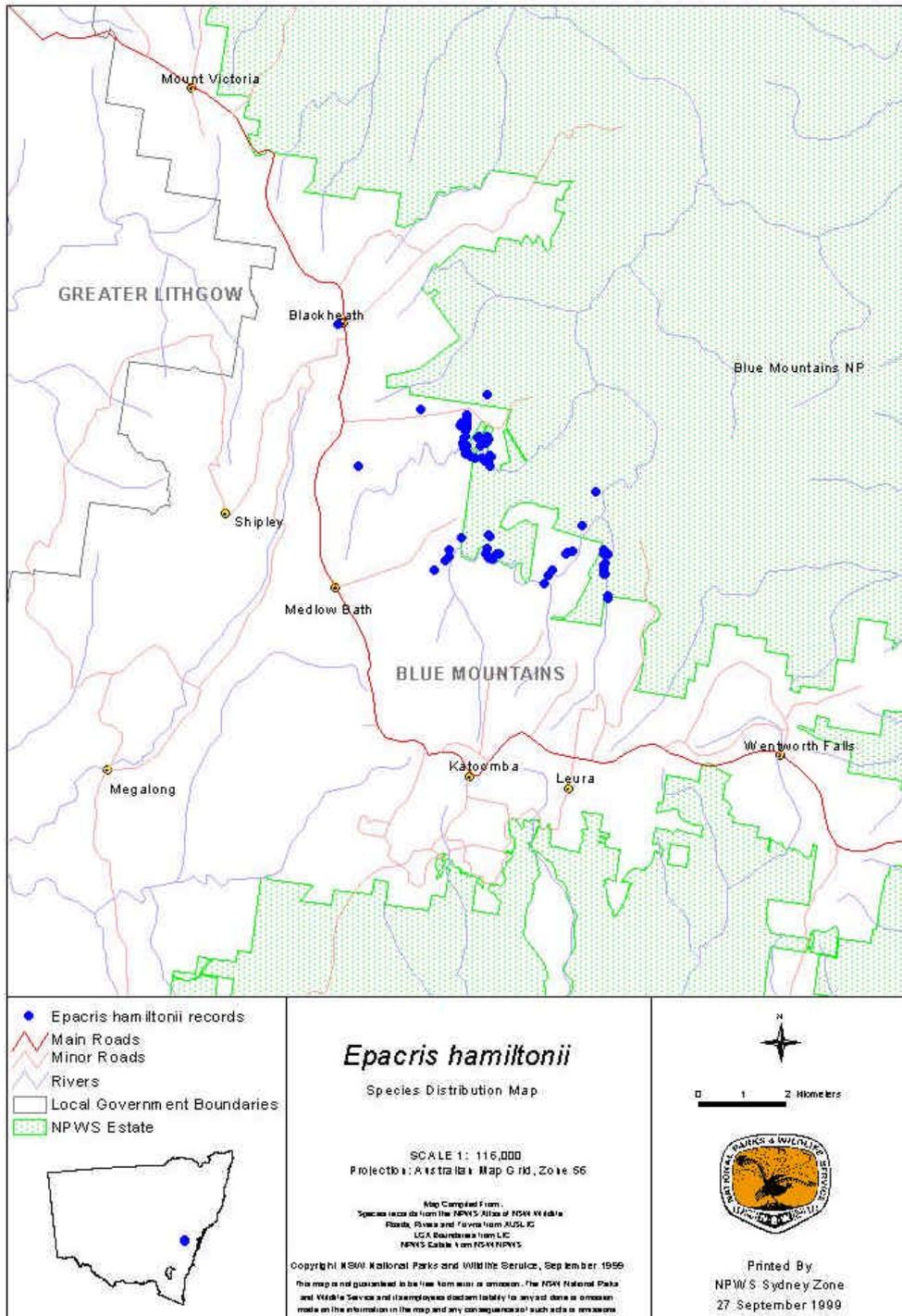


Table 1: Tenure of *Epacris hamiltonii* sites.

Site No.	Tenure	Zoning
1 to 3	Private Property	Environmental Protection
4 to 10	Private Property	Environmental Protection
11 to 14	Sydney Catchment Authority	Water Catchment
15 to 28	National Park	National Park
29 to 30	BMCC	Environmental Protection
31 to 39	National Park	National Park
40	Private Property	Environmental Protection
41 to 47	National Park	National Park
48 to 49	Private Property	Environmental Protection
50-62	National Park	National Park
63 to 67	Sydney Catchment Authority	Water Catchment
68-72	National Park	National Park

5.3.1 Vegetation

E. hamiltonii occurs only in the upper Blue Mountains, in the seepage lines found under sandstone overhangs adjacent to wet gullies. Plants found growing in association with *E. hamiltonii* reflect this habitat and include king fern (*Todea barbara*), rough tree fern (*Cyathea australis*) and coral fern (*Gleichenia rupestris*). Sundews (*Drosera binata*) are also common on the cliff face. Sites also occasionally occur beside small creeklines, which are vegetated with moist gully forest species (*Callicoma serratifolia*, *Doryphora sassafras* and *Ceratopetalum apetalum*). Other species commonly associated with *E. hamiltonii* are shown in Table 2.

5.3.2 Soil characteristics

The favoured substrate type for *E. hamiltonii* is moss or king fern (*Todea barbara*) root bole. This varies in thickness from a few centimetres up to approximately 80 cms in depth. The substrate generally has a spongy/peat-like consistency and moisture content is usually high due to constant seepage and shading from screen species and rock overhangs.

5.3.3 Climate

The high altitude of the Blue Mountains produces low maximum summer and winter temperatures, compared to the coastal areas of NSW. The average January maximum temperature for Mt. Victoria is 23°C (1000m) and the average July minimum temperature range from 2-3°C for Wentworth Falls (900m).

Average rainfall is 1400 mm at Leura. The driest months are generally July to September and the wettest are December to March.

Table 2. Species associated with the habitat of *Epacris hamiltonii*.

COMMON NAMES	SCIENTIFIC NAMES
sassafras	<i>Doryphora sassafras</i>
coachwood	<i>Ceratopetalum apetalum</i>
king fern	<i>Todea barbara</i>
rough tree fern	<i>Cyathea australis</i>
dagger hakea	<i>Hakea teretifolia</i>
swamp baeckea	<i>Baeckea linifolia</i>
black wattle	<i>Callicoma serratifolia</i>
pink swamp heath	<i>Sprengelia incarnata</i>
spreading rope rush	<i>Empodisma minus</i>
woolly tea tree	<i>Leptospermum lanigerum</i>
fuschia heath	<i>Epacris longiflora</i>
dog rose	<i>Bauera rubioides</i>
hard water fern	<i>Blechnum wattsii</i>
coral fern	<i>Gleichenia rupestris</i>
batswing fern	<i>Histiopteris incisa</i>
heath banksia	<i>Banksia ericifolia</i>
sundew	<i>Drosera binata</i>
	<i>Epacris crassifolia</i>

6. Biology and Ecology

6.1 Habit, Growth Rate and Longevity

Populations of *E. hamiltonii* tend to be dense, often having a matted appearance. Due to the habit of this species it is difficult to identify and count individual plants.

Previous research has linked mycorrhizal associations with species from the Epacridaceae family (Hutton *et al.* 1994; Hutton *et al.* 1996). Establishment and growth trials at Mt Tomah Botanic Gardens found that seedlings grown in soil from an *E. hamiltonii* site at Neates Glen site exhibit greater growth rates than seedlings grown in other soil media (Turton *et al.* 1997). This suggests that mycorrhizal fungi in the soil may be an influencing factor in growth for this species.

The longevity of individual plants is unknown at this stage, but appears to be in excess of 15 years. Recent inspections of *E. hamiltonii* monitoring sites has shown seedlings to take a number of years to mature, with seedlings germinating in 1994 still in a juvenile state in 2000.

6.2 Reproductive Biology

6.2.1. Vegetative reproduction

E. hamiltonii may be a clonal species with one plant capable of spreading over a wide area. However it is not known whether individual stems are capable of functioning independently of the parent stem. *E. hamiltonii* reproduces by basal sprouts, a soil stored seedbank and possibly via root suckers. Mature plants burnt in a severe fire in January 1994 have resprouted and prolific seedling growth has occurred.

6.2.2. Breeding system

To date only European honeybees (*Apis mellifera*) and eastern spinebill honeyeaters (*Acanthorhynchus tenuirostris*) have been identified utilising the flowers of *E. hamiltonii* and may therefore be pollinators of the species. Several species of mites belonging to the families Erythraeidae, Phytoseiidae, Tydeidae and Oribatoidea have also been found on *E. hamiltonii*. The role of these insects in the life cycle of the species is yet to be ascertained.

6.2.3. Seed production, phenology and fecundity.

E. hamiltonii flowers and produces seed annually. There appears to be a positive relationship occurring between number of flowers and fruit production. At one monitored site, approximately 75% of flowers developed into fruits (Turton *et al.* 1996). Any failure of flowers to develop into fruit is likely to be attributed to damage caused to the flower, rather than by a lack of pollination (Turton *et al.* 1996). Seed production in monitored individuals was prolific, with large amounts of the very fine seed being collected (Turton *et al.* 1996).

Visual checks of seed collected in 1994-95 revealed that 22% of seeds were either aborted or desiccated. Pre dispersal predation was not observed in any capsule (Turton *et al.* 1997). The time taken for seedlings to reach maturity and contribute to the soil seed bank is unknown (Turton and Matthes 1998).

6.2.4. Seed viability, longevity, dormancy and germination factors

Seed was collected from several plants from 1994 to 1996 at three sites, from separate populations along Greaves Creek. Seed viability was determined by the number of seeds that were white and fleshy under examination. The percentage of potentially viable seed was 78% (Turton *et al.* 1997).

Seed dormancy occurs in some *E. hamiltonii* seed, with a proportion of seed (20 %) germinating with no assistance other than water. *In situ* there is some evidence of seedling recruitment between fire events, although it is considered to be low in numbers. The NPWS and Mt Tomah Botanic Gardens (Smith *et al.* 1995) have undertaken germination trials incorporating the use of smoke and heat as stimulants to germination of *E. hamiltonii* seed. These techniques have been used with success for other *Epacris* species that have low germination rates (Dixon *et al.* 1995; Keith 1996, 1997). Results show that smoke enhances germination rates in *E. hamiltonii*. However, it appears that the smoke acts as a stimulant that accelerates germination rather than as a critical factor in germination. Keith (1996) found that there was an accumulative effect when smoking and heating were both used.

Seed heating trials were conducted to examine the effects of heat on different aged seed of *E. hamiltonii*. Results show that three years old seed had the highest germination rate and germinated at lower temperatures (40-90⁰C). Germination ceased after seed was exposed to temperatures over 110⁰C. Younger seed required higher temperatures to increase germination rates. Germination rates in one year old seed increased after being exposed to temperatures of 80-110⁰C (Turton *et al.* 1997).

These studies indicate a dormancy effect may be operating in *E. hamiltonii* and that germination rates increase in response to heat. The older seed appears to break dormancy at lower temperatures, possibly due to breakdown of the seed coat over time and its likely deeper position in the soil profile, where lower temperatures would be experienced. In contrast the younger seed may have a harder seed coating and at its higher position in the seedbank profile would experience higher temperatures. These responses may be a strategy to ensure seed from different years germinates as a response to a fire event, thus providing increased vigour in the new populations. Seed longevity is greater than three years as indicated in the germination and heating trials.

These findings are preliminary and further investigations are required to substantiate the trends observed and determine the relative importance of smoke and heat in stimulating germination and maintaining *E. hamiltonii* populations. As soil heating is spatially variable, by area as well as depth, it is unlikely that the entire seedbank will be depleted after a single fire event.

6.2.5. Seed dispersal, seedling establishment and growth

The seed of *E. hamiltonii* is extremely fine, round and 'dust-like'. Most seedlings have been found germinating directly underneath or downslope from parent plants. It is likely that the majority of seed disperses over a limited area relying on gravity, slope and the action of wind and water for dispersal. Evidence of dispersal by animal species has not been recorded, however, the fine nature of the seed would enable it to be caught in the hair of mammals such as wallabies.

Seedling establishment after fire is prolific with seedlings constituting at least 50% of the plants at burnt sites (Turton and Matthes 1998). The removal of light blocking overstorey and understorey species may assist in the high degree of seedling recruitment after fire by increasing seedling exposure to sunlight. Seedling densities were higher on the more exposed ledges with densities generally decreasing quickly in a downslope direction from the adult plants.

Monitoring of seedlings has shown that spatial competition occurs in seedlings with seedling numbers reducing over time (Turton and Matthes 1998). Post-dispersal predation of seed, the rates of seed decay in the soil and seed longevity are unknown at this stage.

The growth rates of monitored seedlings have been relatively slow, with a seedling height maximum of 11cm after three years of growth (Turton and Matthes 1998). Growth rates vary between site locations and accompanying environmental conditions.

6.2.6. Population structure

The number of plants is estimated at approximately 4000 adult plants at 72 sites within three creek catchments. It is difficult to establish the exact number of plants within a population due to the degree of potential clonality exhibited by the species. However many populations appear to consist of several hundred mature stems. These stems may represent varying recruitment stages. Some sites contain only one or a few individuals.

Seedlings have been found in significant numbers on burnt sites, with only a few seedlings being recorded at unburnt sites. Individuals at some sites appear to be senescing.

6.2.7. Herbivory and seed predation

No herbivores have been observed on this plant. However crimson rosellas (*Platycercus elegans*) have been observed nipping the flowers off and feeding on nectar. No seed predators, either pre or post-dispersal have been recorded.

Several species of mites have been found on *E. hamiltonii*, these included individuals from the families Erythraeidae, Phytoseiidae and Oribatoidea, all of which are predatory mites that feed on other small insects. Another family of mites (Tydeidae) was also found on *E. hamiltonii*, these insects are thought to be fungal detritus feeders. The role of these insects in the life cycle of *E. hamiltonii* is not known.

6.3 Fire Ecology

Fire and its effects on vegetation communities is highly complex with much remaining to be understood. The habitat of *E. hamiltonii* indicates that regular fire events are unlikely due to the moisture regimes and proliferation of mesic species.

E. hamiltonii has the following strategies to cope with individual fire events:

- Adult plants killed by fire are capable of resprouting from the rootstock and from basal suckers;
- Resprouting plants begin to contribute to the seedbank within four years after a fire event; and
- A viable soil seed store is maintained. The seed has a positive heat response, such as experienced in a fire, which promotes germination.

A percentage of plants are killed by fire. The time taken for seedlings to develop fire resistant rootstocks is not known.

Apart from the direct impacts, fires also have indirect physical impacts on vegetation communities. After some fires, a layer of black ash and partially burnt organic material can be found on the soil surface, this material may alter the thermal properties of the soil (Auld and Bradstock 1996). Seeds that did not have their dormancy broken by soil heating during the passage of the fire, may have their dormancy broken in the days following the fire through soil heating effects. This is caused by increased levels of solar radiation on the blackened soil surface where an opening in the canopy has occurred (Raison *et al.* (1986) cited in Auld and Bradstock 1996).

Thermal properties are affected by season of fire, as fires occurring at cooler times of year may not reach sufficiently high temperatures to break seed dormancy. Post-fire conditions such as moisture levels, increased exposure to light and heat due to removal of canopy cover, and altered nutrient levels may also influence the success of seedling establishment, survival and growth.

The location in which *E. hamiltonii* grows (wet cliff faces) would perhaps offer protection from the effects of a severe fire, with the wet moss providing protection of underground root systems, as well as protecting soil seed banks from extreme temperatures.

7. Previous Actions Undertaken

7.1 Establishment of Species Recovery Team

A recovery team was established in 1994 to supervise and monitor all recovery actions for this species. The recovery team has overseen the implementation of the original recovery plan.

7.2 Original Recovery Plan Actions

A recovery plan for the species was prepared in 1993. Environment Australia, formerly known as Australian Nature Conservation Agency has funded recovery actions from 1994 to 1999, including:

- monitoring selected populations of *E. hamiltonii* to determine flowering and fruiting status of plants, and tagging plants at some new populations;
- bag and collect seed from selected populations of *E. hamiltonii*;
- laboratory trials into seed viability and germination;
- liaison with the Botanic Gardens and document *ex situ* cultivation;
- fencing works to restrict public access to the site;
- surveys of suitable habitat in the upper Blue Mountains to determine the presence of *E. hamiltonii*;
- preparation of a pamphlet to distribute to landholders in catchment adjacent to *E. hamiltonii*; and
- preparation of an interim fire management plan for *E. hamiltonii* and its habitat.

These actions have been completed and described in the annual reports for the project (Nash and Turton 1995; Turton, *et al.* 1996; Turton, *et al.* 1997; Turton and Matthes 1998). The results of actions investigating the reproductive biology of the species are described in Section 6.2.

7.3 Fire Management

The Blue Mountains is a fire-prone environment, comprised of flammable eucalypt forest and heath communities located amidst very rugged steep terrain. Research carried out on the effects of heat and smoke on *E. hamiltonii* seeds has contributed to the understanding of fire ecology and has allowed recommendations to be made regarding fire management in the habitat of *E. hamiltonii*.

As inappropriate fire regimes are considered to be a potential threat to *E. hamiltonii*. It is important that fires occur at frequencies that will ensure the long term survival of the species *in situ*.

It is likely that some of the populations of *E. hamiltonii* will be affected by future hazard reduction programs particularly those incorporating regular prescribed burning regimes. It would be expected that a short inter-fire interval would be detrimental to *E. hamiltonii*. Therefore, it is essential that the optimum fire interval

for sustainability of this species be determined and incorporated into management actions.

Liaison with the City of Blue Mountains Council and the Rural Fire Service was initiated in 1997 to discuss fire management strategies to conserve *E. hamiltonii*. Current efforts should continue to develop strategies these strategies to ensure the conservation of *E. hamiltonii* populations (Section 10.2.3). This will include the distribution of interim fire management guidelines prepared by Turton and Matthes (1998).

7.4 Site Protection

Fences have been constructed in several areas alongside the track descending into Neates Glen to protect *E. hamiltonii* populations from trampling. The fences have been successful at restricting access to sites and erected signs have alerting walkers to the delicate wet gully habitat.

7.5 Genetic Analysis

A preliminary genetic analysis of *E. hamiltonii* from three populations (Neates Glen, Upper Greaves Creek and Katoomba Creek) was carried out as part of a study on Epacridaceae. No differences between the three *E. hamiltonii* populations were detected in these studies (Taylor Dept. Ag. *pers. comm.*). However, further genetic research would be necessary to clarify this, as the technique used is not considered sensitive enough to pick up genetic variation within or between populations, but is better designed to detect differences between species.

Results of the analysis of members of the genus *Epacris* show consistent differences between *E. hamiltonii* and other *Epacris* species. This implies a long period of genetic isolation and that *E. hamiltonii* is a distinct species (Taylor *pers. comm.*).

7.6 Current Ex-situ Programmes

Cultivation of *E. hamiltonii* clones at both Mt. Tomah and Mt. Annan Botanic Gardens (Appendix 1) has been successful, with the plants propagating easily from cuttings. *E. hamiltonii* was also cultivated successfully from seed. Voucher specimens held at the National Herbarium of NSW have been documented and additional specimens have been collected for inclusion in this collection.

7.7 Community Education and Involvement

Community education has been considered a priority in the recovery of this species. Interpretative signs and an interpretative leaflet have been produced. The leaflet has been distributed to all neighbours adjoining the catchments, as well as being distributed through libraries, City of Blue Mountains Council and NPWS Heritage Centre (Blackheath).

Talks on this species have been presented to meetings of the Australian Network for Plant Conservation, Bushcare networks and local conservation groups.

Information has also been published in local tourist newspapers and two articles published in the Newsletter for the Australian Network for Plant Conservation, *Danthonia* (vol. 4, no. 2; vol 6, no 4).

8. Management Issues

8.1 Threats

E. hamiltonii is an intrinsically rare plant. Limited knowledge of its historical distribution makes an assessment of whether the species is in decline difficult. However, due to the species extremely restricted habitat within limited environmental parameters, its survival is still considered to be under threat.

8.1.1 Unrestricted access

E. hamiltonii grows in areas adjacent to popular bushwalks and although the populations are not situated directly on walking tracks, people straying from the marked tracks could potentially cause damage either directly by breaking the fragile, brittle stems, or indirectly by causing erosion on the steep slopes.

8.1.2 Inappropriate fire regimes

Inappropriate fire regimes are the major potential threat to this species. Plant populations may decline to extinction whenever fire regimes deplete the pool of individuals within different life stages by mortality without replacement over an appropriate time scale (Keith 1996). Therefore, should fire occur in *E. hamiltonii* habitat at frequencies more regularly than the time it takes for seedlings to establish fire resistant rootstock (and thus replace adults that died) populations of *E. hamiltonii* could be expected to decrease.

Inappropriate fire regimes can alter ecosystem processes, leading to changes in species presence and abundance, population demographics and structure, as well as affecting other associated factors such as pollinators and mycorrhizal fungi, which may affect the health of *E. hamiltonii* and its habitat.

8.1.3 Altered moisture regimes

E. hamiltonii favours moist sheltered gullies under overhangs, and is dependent upon water seepage through the sandstone cliffs. As the hanging swamps above feed these seepages, they are persistent even in short dry periods. A prolonged drought event, with accompanying low rainfall and high temperatures, will reduce or stop seepage from swamps (Holland *et al.* 1992) and therefore have the potential to affect *E. hamiltonii* and other wet gully species. Groundwater aquifer extraction also has the potential to affect the survival of the species and its habitat, as does development that impacts on groundwater movement above *E. hamiltonii* sites.

8.1.4 Increases in nutrient levels

The nutrient enrichment of ground and surface water due to increased urbanisation of the Blue Mountains plateau can affect *E. hamiltonii* directly or indirectly by encouraging weed growth and altering soil and water chemistry. Sources of ground and surface water contamination such as sewage and storm water runoff also pose potential threats.

8.1.5 Weed invasion

Weed species are invading some areas, especially in Katoomba Creek and Govetts Creek where, Scotch broom (*Cytisus scoparius*), blackberry (*Rubus fruticosus*) and ivy (*Hedera helix*) are threatening populations of *E. hamiltonii*. These species thrive in the moist creeklines where *E. hamiltonii* grows.

8.2 Social and Economic Consequences

8.2.1 Social considerations

The implementation of this recovery plan will have a social impact on the local community, in particular the owners and managers of *E. hamiltonii* habitat. In general the impact should be positive.

Implementation of actions from the original recovery plan prepared by Cohn (1993) for the former Australian Nature Conservation Agency, focussed on raising awareness of the issues surrounding the conservation of the species. This included the distribution of a information leaflet to all neighbours adjoining catchments containing the species as well as being distributed through libraries, City of Blue Mountains Council and NPWS (Blue Mountains Region) Information Centres. These efforts have raised awareness of the plight of the species and catchment management principles as a whole.

Minor negative social impacts may also occur. Some landholders are reluctant to conserve habitat and view the recovery effort as an intrusion on their rights to manage land. While these opinions are in the minority, they certainly constitute a challenge for the recovery program.

8.2.2 Economic considerations

The economic costs of the plan are identified in Appendix 4. These direct costs will be the responsibility of the NPWS and are associated with likely site rehabilitation actions at selected *E. hamiltonii* sites and continued survey. Costs to other public authorities will be minor and form part of their normal operations or statutory responsibilities.

A major economic consideration in the protection of this species, is that protection of *E. hamiltonii* and its habitat also enhances protection of surface and ground water supplies in the catchments in which it occurs. Weed control established in the upper creeks also saves expensive, labour intensive weed control campaigns lower in the catchment areas.

E. hamiltonii is an attractive plant, which, if grown commercially could be of horticultural value. However the commercialisation of *E. hamiltonii* is not encouraged due to the potential impact on wild populations from unauthorised collecting; the difficulty associated in managing the commercialisation of threatened flora species; and the potential ecological repercussion of its commercialisation.

8.2.3 Biodiversity benefits

Hanging swamp and wet gully communities are unique and fragile habitats and are a vital component of the Blue Mountains ecosystems. Swamps have important hydrological functions, in that they act something like a sponge, soaking up and storing water in wet times and releasing it slowly at other times. They also serve to purify the water flowing into them, and they protect stream banks during peak water flows (Smith and Smith 1995, 1996). Ridge-top swamps provide a steady source of water to many of the main creek within the Blue Mountains. The continued health of many ecological communities such as waterfall communities, aquatic macroinvertebrate communities in creeks, rainforests and wet cliff faces relies on the dry weather water supply of upland swamps. The conservation of *E. hamiltonii* also protects these habitats. Other significant plant species occupy these areas, such as *Adenochilus nortonii*, *Almaleea incurvata*, *Acacia ptychoclada*, *Celmisia longifolia*, *Olearia quercifolia* and pink swamp heath (*Sprengelia monticola*).

Spotted-tailed quolls (*Dasyurus maculatus*) are also known to inhabit the wet gully habitats of the Blue Mountains, and have been recorded from several locations where *E. hamiltonii* occurs. Spotted-tailed quolls are classified as vulnerable on Schedule 2 of the TSC Act.

8.3 Species Ability to Recover

E. hamiltonii requires very specific environmental conditions to exist, which probably accounts for the species current restricted known distribution. The limiting factors of this species appear to be the availability of habitat and the presence of moisture in the cliff seepage lines.

It is not known whether *E. hamiltonii* has always been naturally uncommon due to its highly specific habitat requirements or whether it has reduced its range over time. The long term persistence of this species *in situ* will depend on the application of appropriate fire regimes to maintain ecological processes. Maintenance of water quantity and quality through appropriate management of creek and hanging swamp systems is also of the highest priority.

The finding of previously unknown populations of this species in three creek catchments has decreased the risk of the species becoming extinct.

To secure the recovery of *E. hamiltonii*, this recovery plan advocates a management regime that:

- favours *in situ* management of *E. hamiltonii*, including recommendations for fire management and environmental impact assessment (Section 10);
- provides a greater understanding of the biology and ecology of the species that can guide future management (Section 11);
- increases current knowledge of the distribution of *E. hamiltonii* (Section 12);
- increases community awareness and involves the community in the implementation of recovery actions (Section 13).

The consequences of not implementing this recovery plan are such that the probability of extinction of *E. hamiltonii* in nature is medium to high. Without the cooperation of land managers and planners, *E. hamiltonii* is likely to be adversely affected by inappropriate fire management activities and land management decisions. Without further survey currently unknown populations may be adversely affected and the importance of existing populations will remain unknown. Without further biological and ecological investigations key aspects of the species, genetic and reproductive biology and response to fire will remain unknown and may result in the implementation of management actions detrimental to the maintenance of the species.

9. Overall Recovery Aim and Recovery Strategy

9.1 Recovery Objectives

The overall recovery objective of this plan is protect the population of *E. hamiltonii* from decline, and develop a management regime, based on the most up to date information on the species, designed to promote the species conservation and evolutionary potential in nature.

Specific recovery objectives are to;

1. protect and maintain populations of *E. hamiltonii* by the implementation of *in situ* habitat conservation methods,
2. enhance management of *E. hamiltonii* and its habitat based on an increased understanding of key aspects of the biology and ecology of the taxon,
3. increase knowledge of the distribution of *E. hamiltonii* and undertake an assessment of new populations,
4. raise awareness in the community about *E. hamiltonii*, and
5. carry out a re-evaluation of the conservation status of *E. hamiltonii*.

9.2 Performance Criteria

Performance criteria of this recovery plan are that:

1. populations of *E. hamiltonii* do not decline and appropriate management recommendations are discussed with land holders and managers;
2. key aspects of the biology and ecology of *E. hamiltonii* are further understood so as to guide the management of the species and its habitat;
3. a greater knowledge of *E. hamiltonii* distribution is achieved and applied to management;
4. a community awareness program is implemented targeting habitat protection through Total Catchment Management principles; and
5. conservation status is re-evaluated and if appropriate, a recommendation is made to downlist the species from endangered to vulnerable.

9.3 Recovery Actions

Recovery actions will be directed towards:

1. habitat management to ameliorate threatening processes and informed assessment of activities which may impact on *E. hamiltonii*;
2. continued investigations into key aspects of the biology and ecology of *E. hamiltonii*.
3. investigate the extent of *E. hamiltonii* distribution by undertaking targeted survey;

4. disseminate educational material and involve the community in the implementation of recovery actions; and
5. re-evaluate the conservation status of *E. hamiltonii*.

10. Habitat and Threat Management

10.1 Recovery Objective

The objective of this component of the recovery plan is to protect and maintain populations of *E. hamiltonii* by the implementation of *in situ* habitat conservation actions. 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 Action

This recovery plan proposes to implement a number of actions targeted at the amelioration and prevention of threatening processes and informed assessment of activities, which may impact on *E. hamiltonii*. These actions include:

- incorporating the *E. hamiltonii* recovery team into the Blue Mountains threatened species combined recovery team;
- implementation of site reassessment and rehabilitation procedures;
- implementation of appropriate fire management practices;
- provision of information to ensure the appropriate assessment of developments likely to affect on *E. hamiltonii*;
- liaison with private land holders to convey the conservation significance of populations of *E. hamiltonii* on, or adjacent to their properties; and
- provision for Critical Habitat assessment.

10.2.1 Recovery team

This recovery plan recommends the continuation of the Blue Mountains threatened species combined recovery team. The composition of the team will reflect the conservation requirements of the species and include representatives from the NPWS, Sydney Catchment Authority, City of Blue Mountains Council, Mt Tomah Botanic Gardens, the Blue Mountains Conservation Society and the Blue Mountains Rare and Endangered Species Group. When appropriate, the recovery team will also invite relevant guests to discuss specific management issues.

10.2.2 Site reassessment and rehabilitation

Monitoring will be undertaken to assess the ongoing effects of weed invasion, and fence and signage damage at selected *E. hamiltonii* sites. Monitoring of all sites will occur in the first and fifth year of the plan. Monitoring will also be carried out in the third year at sites in Katoomba Creek where weed infestation occurs, and at sites that have been disturbed as disturbances occur (e.g. fire and access related disturbance). Monitoring will be carried out in conjunction with ongoing fire management assessments described in Section 11.2. A site visit proforma is provided in Appendix 2.

Any restorative actions such as weed management programs, fence and sign replacement will be discussed with the recovery team and undertaken in consultation with the responsible party and where appropriate involve local community groups.

Sydney Catchment Authority will ensure that known and potential populations of *E. hamiltonii* are considered when preparing and undertaking weed control programs.

10.2.3 Fire management

The consideration and implementation of appropriate fire management practices is essential to the management of *E. hamiltonii*. Appropriate fire management will require liaison and cooperation of a number of government agencies such as NPWS, City of Blue Mountains Council, Sydney Catchment Authority and the Rural Fire Services in association with the Blue Mountains Bush Fire Management Committee. This recovery plan recommends the following actions be implemented to achieve appropriate fire management:

- NPWS, when preparing fire management plans for Blue Mountains National Park, will provide for known habitat of *E. hamiltonii* to be included in heritage management zones where feasible and subject to a minimum 15-20 year planned fire interval.
- Blue Mountains Bush Fire Risk Management Committee will, in preparing the Blue Mountains Bush Fire Risk Management Plan, provide for known habitat of *E. hamiltonii* to be included into conservation zones where feasible and subject to a minimum 15-20 year planned fire interval.
- City of Blue Mountains Council ensure that known and potential *E. hamiltonii* habitat adjacent to new subdivisions not exceed a 15-20 year fire interval;
- NPWS and the Rural Fire Services when developing fire management plans for *E. hamiltonii* assess the feasibility of incorporating exclusion zones around sites burnt within a 15 year period;
- NPWS, City of Blue Mountains Council and Rural Fire Services undertake hazard reduction and associated fire management activities with reference to the recovery plan and any future advice from the NPWS regarding knowledge of the species and its fire ecology;
- When a delegated officer of the Rural Fire Service is issuing a notice or a permit relating to hazard reduction, or any activity which may affect on the species or its habitat, the distribution of known and potential habitat will be considered in relation to the notice or permit.
- Sydney Catchment Authority will ensure that the location of known and potential *E. hamiltonii* populations be considered when preparing fire management plans;
- NPWS will distribute interim fire management guidelines prepared by Turton and Matthes (1998). NPWS will, in liaison with the recovery team and relevant public authorities, seek to finalise the interim fire management guidelines, following the completion of fire research actions identified in Section 11.2 of this plan (after year three of plan implementation).

10.2.4 Development assessment and environmental planning instruments

City of Blue Mountains Council, Sydney Catchment Authority and NPWS will appropriately assess developments to avoid or minimise impacts on the species.

In order to give this effect:

- City of Blue Mountains Council will ensure that development consent issued on land in the vicinity of potential and known *E. hamiltonii* habitat and that may affect the species, incorporates appropriate stormwater and sediment control measures to avoid increases in nutrients, weed propagules and sediments;
- City of Blue Mountains Council will ensure that development consent issued on land in the vicinity of potential and known *E. hamiltonii* habitat ensure that natural water regimes and flows are not affected by the proposal;
- City of Blue Mountains Council will ensure that Local Environmental Plans, Development Control Plans and other relevant policies and plans are reviewed with reference to this recovery plan and any future advice from the NPWS regarding the distribution, threats, biology and ecology of *E. hamiltonii*; and
- City of Blue Mountains Council, Sydney Catchment Authority and NPWS will ensure that development assessments are undertaken with reference to this recovery plan, attached environmental assessment guidelines (Appendix 3) and any future advice from the NPWS regarding the distribution, threats, biology and ecology of *E. hamiltonii*.

10.2.5 Habitat protection on private lands

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

The NPWS will seek to secure sympathetic management of *E. hamiltonii* habitat by private landholders. In order to achieve greater protection of populations on private land, the NPWS recognises that a range of options may be utilised (e.g. property management plans and voluntary conservation agreements). The suitability of utilising these management options on private lands will depend on the circumstances of private landholders.

Liaison with private landholders will commence in the first year of the plan.

10.2.6 Critical Habitat assessment

A declaration of Critical Habitat ensures a high level of environmental impact assessment (through mandatory species impact statement and NPWS concurrence) prior to activities being approved in sensitive areas of habitat.

The NPWS and the recovery team will identify and assist in the preparation of a recommendation for Critical Habitat for *E. hamiltonii*. This action will be implemented where management actions are shown to inadequately manage threats and conserve known and potential habitat of the species.

10.3 Performance Criteria

The performance criteria in which success of this action will be measured are that populations of *E. hamiltonii* do not decline in the long term and appropriate management recommendations are discussed with land holders and managers;

11. Biological and Ecological Investigations

11.1 Recovery Objective

The objective of this component of the recovery plan is to improve management of *E. hamiltonii* and its habitat based on an enhanced understanding of the biology and ecology of the taxon.

11.2 Recovery Action

The aim of the recovery action is to undertake and continue investigations into key areas of the biology and ecology of *E. hamiltonii*.

These investigations encompass ongoing field monitoring programs at selected sites and include:

- Seedling survivorship and establishment
 - seedling survival monitoring
 - length of time for seedlings to mature and rootstock to become fire resistant

This data will determine the optimum fire interval for population sustainability. Seedling monitoring may be extended into the adult phase to look at adult survival rates.

- Fecundity
 - ascertain plant age at first flowering and fruiting
 - ascertain the time to sufficiently replenish the seed bank (soil and canopy)
- Effects of fire on the species
 - optimum fire regime for the species
 - potential variability in fire response at different sites

This recovery plan also proposes to determine genetic variation within known *E. hamiltonii* populations in different catchments. The results from this work would contribute to the management of the species by focusing management actions on maintaining genetic diversity within the species. However it is not considered essential for its management. This aspect would be considered ideal for a University honours or masters thesis. It is recommended that the project 'Genetic variation of *E. hamiltonii* between populations' be investigated.

The NPWS will encourage the involvement of research institutions and universities in this action.

11.3 Performance Criteria

A greater understanding of *E. hamiltonii* biology and ecology is achieved and applied to management.

12. Targeted Survey

12.1 Recovery Objective

The objective of this component of the recovery plan is to increase knowledge of the distribution of *E. hamiltonii* and undertake an assessment of new populations.

To make confident land management decisions, it is essential that managers of *E. hamiltonii* 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 identified other areas of potential habitat.

12.2 Recovery Actions

The recovery action is to investigate the extent of potential habitat of *E. hamiltonii* and undertake targeted surveys.

Priority areas for survey are areas of potential habitat in adjacent catchments, which share similar altitudinal, aspect and preferred habitat criteria. These include:

- Popes Glen and Govetts creeks;
- completion of the Katoomba Creek survey initiated by Turton *et al.* (1997); and,
- gullies on the southern escarpment in the Blackheath area.

The optimum time of the year for undertaking this survey is during the spring flowering period. Surveyors will be aided by binoculars to assist with finding plants in locations that are difficult to access. This action will be coordinated by the NPWS with assistance from community groups and local experts.

To ensure that survey results are satisfactorily communicated:

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

At each new *E. hamiltonii* locality, a site assessment will be undertaken that estimates the number of adult plants and seedlings, any threats to the population and details regarding site accessibility. A site visit proforma is provided in Appendix 2

12.3 Performance Criteria

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

13. Community Awareness and Involvement

13.1 Recovery Objective

The objective of this component of the recovery plan is to raise awareness of the conservation status and management issues affecting *E. hamiltonii*, and to involve the broader community in the recovery program. Total Catchment Management principals will be applied to the conservation of this species habitat.

13.2 Recovery Actions

The NPWS will disseminate educational material and involve the community in the implementation of key recovery actions.

13.2.1 Recovery team continuation

The NPWS will continue to service Blue Mountains threatened species combined recovery team, which includes community representation (as described in Action 1 in Section 10.2.1).

13.2.2 Species profile

The NPWS has produced a species profile to provide information about the conservation status and management issues affecting *E. hamiltonii* (Appendix 2). The profile will be distributed to private landholders with *E. hamiltonii* on or adjacent to their properties and be displayed on the NPWS Internet homepage.

13.2.3 Site assessment and restoration

The NPWS will utilise the skills of local community and community groups for site reassessment, monitoring and restoration actions where appropriate (as described in Action 1 in Section 10.2.2).

13.2.4 Liaison with private land holders

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

13.2.5 Surveys for new populations

When undertaking targeted surveys for *E. hamiltonii* populations, the NPWS will, where practical, seek the involvement of the local community and community groups in the survey effort (as described in Section 12).

13.3 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 *E. hamiltonii* and its habitat; and
- The community is actively involved in key aspects of the recovery program.

14. Reassess Conservation Status

14.1 Recovery Objective

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

14.2 Recovery Action

The national and State conservation status of *E. hamiltonii* will be reassessed once the success of habitat management and ongoing monitoring actions have been evaluated (Section 10); and biological and ecological studies (Section 11) and additional survey (Section 12) have been completed.

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 or reduce the effect of threatening processes to *E. hamiltonii*, additional survey will clarify the species distribution, and biological and ecological investigations will assist assessment of species viability and guide management actions.

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

14.3 Performance Criteria

The national and State conservation status of *E. hamiltonii* is reassessed and if appropriate, a recommendation is made for downlisting the species from Endangered to Vulnerable.

15. Implementation

15.1 Implementation Schedule

The following table allocates responsibility for the implementation of recovery actions specified in this plan (identified in sections 10 to 14) to relevant government agencies over a five year period. A breakdown of the costs of each action is provided in Appendix 4.

Table 3. Implementation table for all actions over the five-year life of the plan.

Action	Description	Responsibility	Timeframe	Priority
10	Habitat management and ongoing assessments			
10.2.1	recovery team coordination	NPWS	Ongoing from Year 1	Essential
10.2.2	Site reassessment and rehabilitation	NPWS, SCA	Year 1, Year 3 and Year 5 (or as disturbance to populations occurs)	Essential
10.2.3	Fire management	NPWS, BMCC, RFS, SCA	Ongoing from Year 1	Essential
10.2.4	Development assessment and env. policy preparation	NPWS, BMCC, SCA	Ongoing from Year 1	Essential
10.2.5	Habitat protection on private lands	NPWS	Ongoing from Year 1	Highly Desirable
10.2.6	Critical Habitat assessment	NPWS	Year 5 (if required)	Essential
11	Biological and ecological investigations <ul style="list-style-type: none"> • seedling survivorship; • fecundity; • genetics 	NPWS	Ongoing from Year 1	Essential; Essential; Desirable
12	Targeted survey	NPWS	Years 1-3 (ongoing if necessary)	Desirable
13	Community awareness strategy	NPWS	Ongoing from Year 1	Essential
14	Reassess conservation status	NPWS	Year 5	Essential

NPWS: The National Parks and Wildlife Service

BMCC: City of Blue Mountains Council

RFS: Rural Fire Services

SCA: Sydney Catchment Authority

16. Preparation Details

Margaret Turton (Blue Mountains Rare and Endangered Species Group), Maria Matthes, Ron Haering and Kersten Tuckey (Senior Threatened Species Officers, NPWS) prepared this recovery plan in conjunction with the *E. hamiltonii* recovery team. It is based on a draft plan written by Janet Cohn (1993) for the Australian Nature Conservation Agency and implemented by Margaret Turton, Maria Matthes and Sharon Nash.

16.1 Date of Last Amendment

No amendments have been made.

16.2 Review Date

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

17. Contacts

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ph. (02) 4787-8877.

City of Blue Mountains Council
Civic Place, Great Western Hwy, Katoomba. 2780
ph: (02) 4782-5000.

NSW Rural Fire Service
PO Box 189, Katoomba. 2780
Ph: (02) 4782-2159.

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Appendix 1: *Epacris hamiltonii* Collections

***Epacris hamiltonii* collections**

Mt. Annan Botanic Gardens

June 1997

22 records of Propagation mainly from one population using material supplied by Wyn Jones from NSW NPWS. Most accessions failed in propagation.

Living accessions	AB 910668	Greaves Ck.	1 plant in nursery	HA1
	910668	Greaves Ck.	1 plant in nursery	Bed 10
	910667	Greaves Ck.	1 plant in nursery	PS2

***Epacris hamiltonii* collections**

Mt. Tomah Botanic Gardens

June 1997

Living accessions	AC 971253	Neates Glen	2 plants in nursery	205e
	AC 941338	Neates Glen	5 plants in nursery	205e
	AC 960028	Neates Glen	4 plants in nursery	205e

Appendix 2: Site Reassessment and Survey Proformas

Site reassessment of *Epacris hamiltonii* populations will be undertaken during the first, third and fifth years of recovery plan implementation or as disturbances occur.

Attachment 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 *E. hamiltonii* 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 (July to October).

Notes on Site Condition:

Describe and/or quantify the following parameters.

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;

Fence and signs: Note the condition of any protective fences and signs;

Weeds infestation: Identify the name 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 to large objects.

Map Recording

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

Targeted Survey

Targeted surveys for *E. hamiltonii* will be undertaken during the first two flowering seasons.

Attachment 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 *E. hamiltonii* 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 site 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: *Epacris hamiltonii* Site Reassessment Sheet

Name of Recorder:

Date:

Site No.	Site Name	Approx. Area (m ²)	Breeding Status Buds/Flower/Fruit	Evidence of Fire (Y/N)		Weed Invasion		Fence and Sign Damage
				(Y/N)	Area (m ²)	Name(s)	Area (m ²)	

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.

Site No:

Site No:.....

Site No:.....

Weeds²: % abundance **Trampling/Grazing: feral/domestic/native**

Erosion: **Rubbish dumping:**

Other:

POPULATION DETAILS (follow with an E if an estimate)

Local Abundance: frequent/occasional/rare

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:

OTHER RECORDS

Collection Made: Yes/No **Type of Collection: seed cutting/plant**

Photographs Taken: Yes/No

Extent of Survey: complete/incomplete/unknown

OTHER OBSERVATIONS:

² List weed species on back of survey sheet;

Appendix 3: Species Profile and Environmental Assessment Guidelines

THREATENED SPECIES INFORMATION

Epacris hamiltonii



Maiden & Betch

Conservation Status

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

Description

Epacris hamiltonii (Epacridaceae) is a shrub to one metre high. The silky hairs on both surfaces of the leaves are very distinctive, and give the leaves a soft grey/green appearance. The tube-shaped flower is white and the fruit is a small capsule 2mm long.



Distribution

E. hamiltonii only occurs in the Blue Mountains, west of Sydney. Previously only known from one population, the range of *E. hamiltonii* has now been extended, with the species occurring at 72 sites within three creek catchments. The creeks are associated with an altitude range of 810-940 m ASL and are all located on the northern side of the escarpment and flow into the Grose Valley. All

June 2001

known sites occur within a radius of approximately 5 km.

Recorded occurrences in conservation reserves

The majority of the known *E. hamiltonii* sites occur in Blue Mountains National Park. Several sites occur on Sydney Water land, within catchment areas that are managed as water quality protection zones.

Habitat

Epacris hamiltonii appears to require a very specific habitat, being found on or adjacent to Narrabeen Sandstone cliffs alongside perennial creeks, often below plateau hanging swamps. The soil substrate generally has a spongy/peat-like consistency, with a very high moisture content.

E. hamiltonii sites show a preference for the sheltered base of cliffs adjacent to wet gully or swamp vegetation and The presence of a perennial or virtually perennial source of water, in particular, cliff seepages, appears to be one of the factors limiting the distribution of *E. hamiltonii* (NPWS, 1997).

Plants found growing in association with *Epacris hamiltonii* reflect this habitat and include King fern (*Todea barbara*), Rough tree fern (*Cyathea australis*) and Coral fern (*Gleichenia rupestris*). Sundews (*Drosera binata*) are also common on the cliff face. *E. hamiltonii* also occasionally occur beside small creek lines that are vegetated with moist gully forest species (*Callicoma serratifolia*, *Doryphora sassafras*, *Ceratopetalum apetalum*).

Ecology

E. hamiltonii appears to be a clonal species with one plant capable of spreading over a wide area. It reproduces via root suckers, basal sprouts and a soil stored seedbank. Population sizes of *E. hamiltonii* vary from a few isolated stems to hundreds of stems covering an area of several square metres.

E. hamiltonii flowers from August to December, potential pollinators include European Honeybees (*Apis mellifera*) and Eastern Spinebill Honeyeaters (*Acanthorhynchus tenuirostris*). The seed of *E. hamiltonii* is very fine and dust like. It is likely that seed dispersal occurs over a limited area relying on gravity, slope and the action of wind and water for dispersal, though it may also get caught in the fur of mammals.

The seeds appear to have a dormancy effect that is only broken by disturbance. Field monitoring of regrowth and seedlings have shown that *E. hamiltonii* has mechanisms to persist after fire. Seedling establishment after fire is prolific. Some adult plants may also resprout after fire.

Fire appears to stimulate germination, either by direct heating of the soil seed bank or by a complex interaction of heat/smoke and nutrient influxes.

For Further Information contact

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

References

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Increases in exposure to light due to canopy removal and the increased nutrient release into the soil may also be a factor in post fire seedling establishment. The maturation period for this species and the time for seedlings to become fire resistant is unknown.

The longevity of individual plants is unknown at this stage, but appears to be in excess of 15 years.

Threats

E. hamiltonii is listed on the final determination of high frequency fire as a Key Threatening Process, as a species likely to be adversely affected by that Process.

Other known threats for *E. hamiltonii* include direct threats through trampling by walkers, and indirect threats through habitat degradation by altered moisture regimes, increases in stream nutrient levels, weed invasion.

Management

Management actions for this species include liaison with authorities and landholders to implement threat control measures.

Recovery Plans

The Minister for the Environment approved the recovery plan for *E. hamiltonii* in August 2001. Copies may be viewed at www.npws.nsw.gov.au



Epacris hamiltonii

Maiden & Betch

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) and with the accompanying species profile.

Survey

Surveys for *E. hamiltonii* can be conducted at any time of the year. The plant is easily identified by its grey/green colouration and hairy leaves and branchlets, however it is easier to locate while the white flowers are visible from August to December.

Surveys should be conducted along creek lines at the cliff/slope interface within the range of this species. Where *E. hamiltonii* is present, population details and location should be recorded

Life cycle of the species

The biology of *E. hamiltonii* is described in the recovery plan and summarised in the attached profile. The lifecycle of *E. hamiltonii* is likely to be disrupted should any of the following occur:

- Inappropriate fire regimes are the major threat to the lifecycle of this species, with the potential to affect all lifecycle stages. Should fire occur in *E. hamiltonii* habitat at frequencies greater than the time taken for seedlings to establish fire resistant rootstock (and thus replace adults which died), flower and produces seed, populations of *E. hamiltonii* can be expected to decrease in size. An intense fire could destroy the soil seed bank of this species.
- Habitat alteration and degradation directly impacts upon the lifecycle of *E. hamiltonii*. This species is dependent upon water seepage through the sandstone cliffs. As these areas are water-fed from the hanging swamps above, they are perennial even in short dry periods. Due to this dependence a prolonged drought event, with accompanying low rainfall and high temperatures will reduce or stop discharge from swamps and has the potential to affect *E. hamiltonii* and other wet gully species. Groundwater aquifer extraction also has the potential to affect the survival of this species and its habitat.

The nutrient enrichment of water sources due to increased urbanisation of the Blue Mountains Plateau can affect the lifecycle of *E. hamiltonii* directly or indirectly by encouraging weed growth and establishment. Sources of ground and surface water contamination such as sewerage and

storm water runoff also pose potential threats.

Threatening processes

E. hamiltonii is listed on the final determination of high frequency fire as a Key Threatening Process, as a species likely to be adversely affected by that process. Additional threatening processes include trampling by walkers, habitat degradation by altered moisture regimes, increases in stream nutrient levels and weed invasion.

Viable local population of the species

There is little information available that would allow accurate determination of whether a population of *E. hamiltonii* is viable. In the absence of detailed population viability analysis all population should be considered viable, until further information becomes available.

A significant area of habitat

The habitat of *E. hamiltonii* is restricted to deeply dissected creek lines on the plateau of the upper Blue Mountains. As this habitat is very limited and highly vulnerable to impacts, all of the known habitat of *E. hamiltonii* should be considered significant.

Isolation/fragmentation

The aim in conservation management is to minimise fragmentation and disintegration of habitats within an area to maximise the species distribution and dispersal processes.

Isolation of populations will occur if a development restricts pollinator movement and seed dispersal between populations. For example, ridgetop development between known populations may reduce pollinator movement or seed dispersal by mammals (though some contact may still be maintained along creek lines).

Regional distribution of the habitat

The regional distribution of the habitat is confined to the distribution of the dissected creek lines on the northern side of the Blue Mountains.

Limit of known distribution

The distribution of *E. hamiltonii* is limited to 3 Creeks in the upper Blue Mountains, within a radius of 5 km.

Adequacy of representation in conservation reserves or other similar protected areas

Forty-three (48) sites occur within the Blue Mountains National Park, other sites occur in Sydney Water (9 sites) and Council reserves (2 sites), which also provides some level of protection. The remaining sites on private land (13 sites) are zoned Environmental Protection and are also afforded a degree of protection. As 80% of this species known populations occur within conservation reserves, with the remainder protected with zoning restrictions, it is thought to be adequately represented within these areas.

Critical habitat

Critical habitat has not been declared for *E. hamiltonii*.

For further information contact:

Threatened Species Unit, Central Directorate, NSW NPWS, PO Box 1967, Hurstville NSW 2220. Phone: 9585 6678.

www.npws.nsw.gov.au

References

- Holland, W.N, Benson, D.H. & McCrae, H.D. (1992) Spatial and Temporal Variation in a Perched Headwater Valley in the Blue Mountains: Geology, Geomorphology, Vegetation, Soils and Hydrology. *Proceedings of the Linnean Society*, 113:4.
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Appendix 4: Recovery Plan Implementation Costs

Action	Description	Year of Implementation						Source of Funding		
		1	2	3	4	5	Total	NPWS	BMCC, RFS, SCA,	Unfunded ⁴
10	Habitat Management:									
10.2.1	Recovery team coordination	500	500	500	500	500	2,500	2,500		
10.2.2	Site assessment and rehabilitation ¹	10,000		5,000		5,000	20,000	20,000		
10.2.3	Fire management ²								r	
10.2.4	Development assessment/policy prep. ³								r	
10.2.5	Habitat protection on private lands	1,500	1,500			1,000	3,000	3,000		
10.2.6	Critical Habitat assessment (if required) ⁴						1,000	1,000		
11	Investigate essential aspects of the biology and ecology	1,500	1,500	1,500	1,500	1,500	7,500			7,500
12	Undertake targeted survey	2,500	2,500				5,000	5,000		
13	Community education, awareness and involvement ⁵									
14	Reassess conservation status					500	500	500		
	TOTAL (\$39,500)	16,000	6,000	7,000	2,000	8,500	39,500	32,000		7,500

Key:

1. Site reassessment will be undertaken in conjunction with field monitoring programs identified in Action 2. Costs represent future weed removal, fence and signage maintenance (if required);
2. Fire management will be funded from recurrent (r) NPWS Blue Mountains Region City of Blue Mountains Council (BMCC), Rural Fire Services (RFS) and Sydney Catchment Authority (SCA) operating expenses.
3. Development assessment will be funded from recurrent NPWS Blue Mountains District, City of Blue Mountains Council and Sydney Catchment Authority operating expenses.
4. Critical Habitat assessment will only be undertaken if required and agreed by the recovery team.
5. Community education and awareness is funded by NPWS through habitat management and targeted survey actions



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