



# Blue Mountains Water Skink (*Eulamprus leuraensis*) Recovery Plan



June 2001



Natural Heritage Trust  
*Helping Communities Helping Australia*

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**NSW National Parks and Wildlife Service Recovery Planning  
Program**

**Blue Mountains Water Skink**  
*(Eulamprus leuraensis)*

**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***

**June 2001**



## **Acknowledgments**

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The NPWS would like to thank the following for their contributions to the preparation of this recovery plan.

The Blue Mountains Water Skink recovery team 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.

Matthew LeBreton for providing data, maps, and photographic slides, as well as for his research and survey work, and ongoing commitment to the recovery of this species.

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Environment Australia for financial assistance towards the preparation of this recovery plan and Alistair Campbell (Environment Australia) for advice on matters relating to the EPBC Act.

## **Foreword**

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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 understanding of the Blue Mountains Water Skink (*Eulamprus leuraensis*), documents the research and management actions undertaken, and identifies the actions required and parties responsible to ensure the ongoing management of the taxon in nature.

The Blue Mountains Water Skink 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 the people involved for their efforts 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**

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### **Introduction**

Surveys suggest that the Blue Mountains Water Skink (*Eulamprus leuraensis*) is restricted to an isolated and naturally fragmented habitat of sedge and shrub swamps in the mid and upper Blue Mountains west of Sydney, NSW. It is known from only 30 sites extending from Newnes Plateau in the northwest to just south of Hazelbrook in the southeast. Potential habitat exists to the south and northwest of known sites, however further survey work is required to verify whether the species utilises these additional areas. Swamps where the Blue Mountains Water Skink is known to occur have boggy soils and appear to be permanently wet.

A medium sized, semi aquatic lizard, the Blue Mountains Water Skink is dark brown to black with light (often vivid yellow) contrasting markings. Little is known about the population dynamics, home range, habitat requirements or response to disturbance of the species.

Possible threats include urban development (some locations are almost completely surrounded by houses and other locations have land zoned for further development adjacent to them), pollution and sedimentation (including stormwater run-off), alterations to hydrological regimes (through construction of roads, tracks, plantations and mining subsidence), weed invasion, visitor disturbance and predation by cats.

This recovery plan describes our current understanding of the Blue Mountains Water Skink and documents the research and management actions undertaken to date. The plan also identifies actions required and the parties responsible for ensuring the ongoing viability of the species in the wild.

### **Legislative context**

The *Threatened Species Conservation Act 1995* (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.

The Blue Mountains Water Skink is also listed nationally under the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC 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. This recovery plan is based upon the best available information at the time of publication.

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 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, State Forests of NSW, Sydney Catchment Authority, and the City of Blue Mountains Council.

The EPBC Act states that the Commonwealth must implement a recovery plan on those areas that apply to Commonwealth lands. Those lands relevant to this recovery plan include Leura Park, Wentworth Falls Lake and Jamison Creek.

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

## **Current conservation status**

The Blue Mountains Water Skink is considered endangered in NSW and is listed on Schedule 1 of the TSC Act. The Blue Mountains Water Skink is also listed nationally as an endangered species under the Commonwealth's EPBC Act.

The Blue Mountains Water Skink is considered to be one of Australia's rarest lizards as it is only known from 30 locations in a restricted distribution between Newnes and Hazelbrook in the Blue Mountains of New South Wales.



## **Overall recovery objective**

The overall recovery objective of the plan is to prevent the extinction of the Blue Mountains Water Skink by protecting known populations from threats. Depending on the success of on-going management actions, targeted surveys and further studies, a further objective is to reassess the conservation status of the species and downlist to vulnerable if appropriate.

## **Overall recovery performance criteria**

The overall performance criteria of the recovery plan is that the risk of extinction of the Blue Mountains Water Skink is decreased through the location of additional populations and the protection of known populations.

## **Specific recovery objectives, performance criteria and actions**

### **Specific recovery objectives**

- To establish the full extent of the distribution of the Blue Mountains Water Skink.
- To improve our understanding of the population status of the Blue Mountains Water Skink by monitoring representative populations.
- To minimise the risk of the Blue Mountains Water Skink declining in the long term by the implementation of a range of activities to ameliorate the impact of factors considered to be detrimentally affecting the species and its habitat.
- To raise awareness of the conservation status of the Blue Mountains Water Skink and to involve the broader community and key groups such as landholders and managers, local and State government agencies, public authorities and researchers in the recovery program for the species.
- To improve the management of Blue Mountains Water Skink populations and habitat based on an improved understanding of its biology and ecology.
- To reassess the conservation status of the Blue Mountains Water Skink upon implementation of recovery actions.

### **Specific recovery performance criteria**

- Over a period of five years of targeted survey, a veritable indication of the full extent of the distribution of the Blue Mountains Water Skink will be able to be determined.
- Over a period of five years of repeated monitoring and analysis of results, the status of representative populations will be able to be determined.
- Within five years the impacts of factors detrimentally affecting the Blue Mountains Water Skink or its habitat are identified and reduced thereby increasing the long-term survival prospects of the species.

- Information is disseminated to Government agencies, land managers and the public about the conservation status and management issues affecting the Blue Mountains Water Skink and its habitat. The broader community and key groups are actively involved in the recovery program.
- More informed recovery and management strategies are developed by an increase in knowledge of the biology and ecology of the species.
- The National and State conservation status of the Blue Mountains Water Skink is reassessed, and if appropriate, a recommendation is made for downlisting the species from Endangered to Vulnerable.

### **Specific recovery actions**

- Identify potential Blue Mountains Water Skink habitat and assess potential habitat for the presence of the Blue Mountains Water Skink.
- Develop and implement a program to monitor the population status of Blue Mountains Water Skink populations at representative sites.
- Identify the factors detrimentally affecting the Blue Mountains Water Skink and its habitat, monitor the level of these factors at each site, and implement a range of activities to ameliorate the impact of these factors.
- Encourage and maintain public awareness and participation in the recovery and management of the Blue Mountains Water Skink.
- Encourage and facilitate scientific investigation of key aspects of the biology and ecology of the Blue Mountains Water Skink that are likely to provide information that is valuable to the recovery of the species or relevant to its management.
- Reassess the conservation status of the Blue Mountains Water Skink.

### **Estimated cost of recovery**

A summary of the funds required to implement this recovery plan is provided below. This recovery plan will be implemented over a five-year period. Many actions constitute minor amendment to existing responsibilities or actions carried out by relevant government authorities, and as a result, have not been assigned costs in this recovery plan. Total recovery plan cost is \$133,250. Average implementation cost per year will be approximately \$26,650.

## Estimated Cost of Recovery

Action	Description	Funds required (\$)
<b>10</b>	<b>Targeted survey</b>	
10.3.1	Identification of potential habitat	1750
10.3.2	Assessment of potential habitat	13750
<b>11</b>	<b>Population monitoring</b>	
11.3.1	Monitoring of population status	38000
<b>12</b>	<b>Threat and habitat management</b>	
12.3.1	Identification, monitoring and amelioration of threats at each site	39250
12.3.2	Environmental planning, impact assessment and development consent	*
12.3.3	Specific threat abatement actions	1
12.3.4	Management of cat predation	1
12.3.5	Management of fire	*
<b>13</b>	<b>Public awareness and involvement</b>	
13.3.1	Increasing community awareness	8000
13.3.2	Increasing community involvement in recovery efforts	15750
13.3.3	Informing and involving affected landholders and managers	1250
13.3.4	Informing and educating local and State government agencies and public authorities	2000
13.3.5	Informing and involving researchers and students	2
<b>14</b>	<b>Research</b>	
14.3.1	Encouragement of research	12500
14.3.2	Information dissemination	3
<b>15</b>	<b>Reassess conservation status</b>	
15.3.1	Reassess conservation status	1000
<b>TOTAL</b>		<b>\$133,250</b>

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

1 The costs of this action are incorporated into action 12.3.1

2 The costs of this action are incorporated into action 13.3.1 and 13.3.2

3 The costs of this action are incorporated into action 14.3.1

## Biodiversity benefits

The swamp habitat of the Blue Mountains Water Skink is unique, of limited extent and highly fragmented. The Blue Mountains swamps have important ecological and catchment functions (Washington 1999) and by conserving this regionally significant vegetation community there are significant flow-on biodiversity benefits.

Blue Mountains sedge and shrub swamps are highly biodiverse with nearly 200 plant species occurring in these swamps in total over the Blue Mountains (Smith and Smith 1996).

Apart from the Blue Mountains Water Skink, other threatened fauna species occurring in the same habitat include the endangered Giant Dragonfly (*Petalura gigantea*) and vulnerable Giant Burrowing Frog (*Heleioporus australiacus*) and Red-crowned Toadlet (*Pseudophryne australis*). The swamps also provide habitat for three regionally significant fauna species, the Southern Emu-wren (*Stipiturus malachurus*), Lewin's Rail (*Dryolimnas pectoralis*) and Buff-banded Rail (*Gallirallus philippensis*) (Washington 1999).

Plant species that are recognised as threatened and which occur in the habitat of the Blue Mountains Water Skink include *Carex klaphakei* (endangered), which is found in hanging swamp at Blackheath and is only known from three locations (Washington 1999), and the vulnerable species *Pultenaea glabra*.

Regionally significant species include *Xyris ustulata* (endemic from Mt Coricudgy to Budawang), *Almalaea incurvata* (endemic to Central Tablelands), *Acacia ptychoclada* (endemic between Woodford and Mt Victoria), *Grevillea acanthifolia* subsp. *acanthifolia* (endemic to Central Tablelands over 450 m) and *Symphionema montanum* (endemic to the Blue Mountains) (NPWS Atlas of NSW Wildlife).

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

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The Blue Mountains Water Skink, *Eulamprus leuraensis*, is a medium sized semi-aquatic lizard. It is one of Australia's rarest lizards, and has only been found in 30 locations in the middle and upper Blue Mountains in New South Wales. Surveys suggest that the Blue Mountains Water Skink is restricted to an isolated, highly fragmented habitat of sedge and shrub swamps that occur between Newnes in the north and west and Hazelbrook in the south and east. Potential habitat to the south and northwest of known sites may extend the range of this species, however further survey work is required to determine whether the species utilises these areas.

The small number and apparent isolation of known populations, in conjunction with the limited geographic distribution of the Blue Mountains Water Skink make it vulnerable to the operation of threatening processes. Clearing for urban development and associated disturbance to habitat has resulted in the reduction of the area of known and potential habitat and the apparent extinction from areas where this species previously occurred. The small size of some swamps increases the risk of loss of one or more of the populations, and recolonisation of disjunct areas appears unlikely (LeBreton 1994c).

Possible threats include urban development (some locations are almost completely surrounded by houses and other locations have land zoned for further development adjacent to them), pollution and sedimentation (including stormwater run-off), alterations to hydrological regimes (through construction of roads, tracks, plantations and mining subsidence), weed invasion, visitor disturbance (trail bikes, 4WD) and predation by cats.

This recovery plan describes our current understanding of the Blue Mountains Water Skink and documents the research and management actions undertaken to date. The plan also identifies the parties responsible for the management actions required to ensure the ongoing viability of the species in the wild.

## **2 Legislative context**

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### **2.1 Legal status**

The Blue Mountains Water Skink is listed as endangered in NSW on Schedule 1, Part 1 of the *Threatened Species Conservation Act 1995* (TSC Act). Reasons for its original listing on the TSC Act include: *Population severely reduced; threatening processes severe; ecological specialist.*

The Blue Mountains Water Skink is also considered endangered nationally and is listed on the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

### **2.2 Recovery plan preparation**

The TSC Act provides the 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 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), State Forests of NSW (SFNSW), Sydney Catchment Authority (SCA), and the City of Blue Mountains Council (BMCC).

The EPBC Act states that the Commonwealth must implement a recovery plan on those areas that apply to Commonwealth lands. Those lands relevant to this recovery plan include Leura Park, Wentworth Falls Lake and Jamison Creek.

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 the Blue Mountains Water Skink occur are either Crown Land managed by the City of Blue Mountains Council, State Forests NSW, 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)*;
- *Crown Lands Act (1989)*;
- *Rural Fires Act (1997)*; and
- *Forestry Act (1916)*.

## **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), the preparation of 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.

Critical habitat has not been declared for the Blue Mountains Water. At this stage, the identification of critical habitat is not considered to be a priority for the Blue Mountains Water Skink as the true extent of its distribution is still unknown and there are no individual sites that could be deemed critical to the persistence of this species.

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.

## **2.6 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.

As the area used by the Blue Mountains Water Skink covers several tenures, there are several relevant determining authorities including NPWS, SFNSW, SCA, BMCC. These determining and consent authorities must consider the conservation strategy outlined in this plan when considering any activity which may affect the Blue Mountains Water Skink. Any other action not requiring approval under the EP&A Act, and which is likely to have a significant impact on the Blue Mountain Water Skink 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 the Blue Mountains Water Skink is listed nationally under the EPBC Act, any person proposing to undertake actions likely to have a significant impact on the Blue Mountains Water Skink 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 the Blue Mountains Water Skink 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 Blue Mountains Water Skink or its habitat.

### 3 Conservation status

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The Blue Mountains Water Skink is considered to be one of Australia's rarest lizards as it is only known from 30 locations in a restricted distribution between Newnes and Hazelbrook in the Blue Mountains of New South Wales.

The species has been listed as Endangered for the following reasons. It is an ecological specialist and is restricted to a highly fragmented montane swamp habitat. Many populations appear isolated and the small size of some swamps makes them vulnerable to 'edge effects' and increases the risk of loss of one or more populations through chance events. The ability of the Blue Mountains Water Skink to recolonise an area in the event of a local extinction may be low as a result of the discontinuity of the habitat and the apparently limited scope for dispersal (LeBreton 1996). These factors in conjunction with the limited geographic distribution of the Blue Mountains Water Skink make it particularly vulnerable to the operation of threatening processes.

A substantial number of known sites are located wholly or partially in national park (17 locations). The most significant threat facing these populations may be further urbanisation of adjacent areas as several of the sites occur in close proximity to residential areas or areas zoned for residential development. Other threats may include disturbance by visitors, invasion by weeds, inappropriate fire regimes and predation by cats.

Eight populations are recorded at Newnes Plateau on land managed by SFNSW. These populations may also face threats from weed invasion, inappropriate fire regimes and predation by cats. They could also face threats associated with timber harvesting activities and mining subsidence.

The remaining five known populations, as well as several potential locations where the species may occur, are located in close proximity to human habitation (in some cases surrounded by houses) and are likely to be subject to a variety of immediate threats. These include direct disturbance, pollution, stormwater run-off, alteration to hydrology, weed infestation, predation by cats, and inappropriate fire regimes (LeBreton 1994c). Other swamps where the species may have occurred in the past have been cleared for urbanisation (e.g. above Megalong Street in Leura and areas in north Katoomba).

The isolation of known sites and the discontinuity of most known potential habitat raises questions regarding the genetic status of individual populations. Investigations of the genetic differences between populations of the Blue Mountains Water Skink may reveal that separate populations are unique.

## 4 Description

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### 4.1 Scientific Description

The Blue Mountains Water Skink is a medium sized lizard that reaches a maximum weight of approximately 10g and grows to a maximum total length of approximately 200mm, with a maximum snout-vent length of about 80mm (LeBreton 1996).

The body of the Blue Mountains Water Skink is much darker than the other species of *Eulamprus* found in the Blue Mountains. Across its back it is very dark brown to black with narrow yellow/bronze to white stripes along its length to the beginning of the tail and continuing along the tail as a series of spots (Figure 1). This gives the appearance of a distinctive dark dorsal stripe bordered by yellow lines. The limbs and sides are also dark brown to black with yellow to bronze streaks and small blotches. The head is brown to bronze with black flecks and there are short streaks on the side of the head between the ear and the front legs. The ventral surface and chin is cream to golden yellow with small dark blotches. There is occasionally a ventral green or bluish sheen, especially in juveniles and on the necks of some adults (LeBreton *pers. comm.* 1999). The limbs are well developed and all have five digits. The taxonomic description for this species can be found in Shea and Peterson (1985). The description of this species in Cogger (1996) includes a colour photograph.



**Figure 1.** The Blue Mountains Water Skink *Eulamprus leuraensis*

## 4.2 Taxonomy

The Blue Mountains Water Skink was described in 1984 from a specimen collected at Leura in 1969 (Wells and Wellington 1984). The genus *Sphenomorphus*, as then defined (sensu Cogger 1983), was recognised as composite and so the generic name *Eulamprus* Fitzinger, 1843, was elevated from synonymy for the 'water skink' species group when this new species was described. The Blue Mountains Water Skink had been known to be distinctive for a considerable period of time prior to its formal description and specimens had been lodged in museum collections from as early as 1943 (National Museum of Victoria - Shea and Peterson 1985). The break up of the genus *Sphenomorphus* and the use of the generic name *Eulamprus* took some time to gain acceptance in the general literature following the description of this species and as such the species has often been referred to as *Sphenomorphus leuraensis*.

## 5 Distribution and habitat

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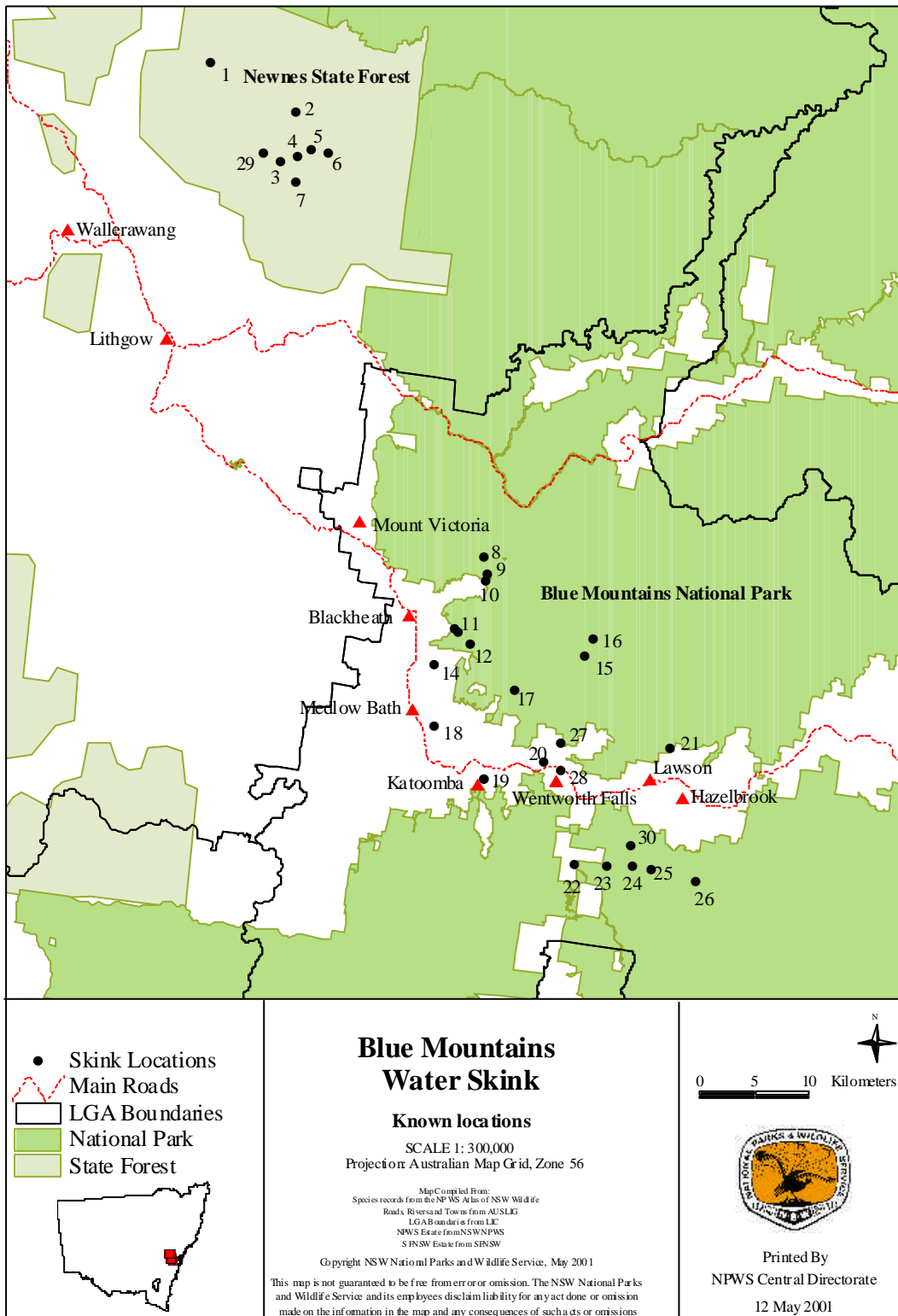
### 5.1 Current distribution

Surveys suggest that the Blue Mountains Water Skink occurs entirely within the mid and upper Blue Mountains west of Sydney, NSW (Figure 2). The holotype of the Blue Mountains Water Skink was collected at Leura in the Blue Mountains in 1969. Since then, the Blue Mountains Water Skink has been found at only 30 sites (Figure 2). A total of ten specimens are held in museum collections.

Despite the restricted nature of its distribution, no distribution boundaries have been established as yet. Examination of potential habitat beyond the present extremes, south and east of Hazelbrook (site 26) and on the Newnes Plateau (north and west of site 1), is yet to be undertaken. Furthermore, within the distribution, much potential habitat has not been surveyed, particularly in the area between the sites at Newnes Plateau and those at Blackheath.

LeBreton (1996) undertook an assessment of potential habitat using vegetation maps and aerial photos. He determined that suitable habitat occurs up to 10 km south and 1 km east of the most southern and most eastern sites respectively (from Keith and Benson 1988). Scattered swamps occurring further east, in the lower Blue Mountains (from Benson 1992), may also provide habitat. At Newnes Plateau there are scattered swamps extending up to 8 km north of the northernmost site, which may be suitable. A few swamps to the west of the western most sites may also comprise suitable habitat for the species. Other areas where the skink may occur include the Boyd Plateau, south of Jenolan Caves, the Lithgow Valley and south of Sydney (LeBreton 1996; M. LeBreton *pers. comm.* 1999). Typical habitat of the Blue Mountains Water Skink is shown in Figure 3 (see also Figures 4-6).





**Figure 2. Distribution of known populations of the Blue Mountains Water Skink**

## 5.2 Tenure and land-use zoning

Of the 30 known Blue Mountains Water Skink populations, all are located on land managed by local and State government agencies. However seven of these populations also occur in part on privately owned lands (sites 10, 11, 13, 19, 20, 22 and 27).

Of the 30 known populations of the Blue Mountains Water Skink:

- three occur primarily on Crown Recreation Reserves managed by City of Blue Mountains Council at Leura Park, Wentworth Falls Lake and Jamison Creek (sites 19, 20 and 28);
- two occur in water catchment areas that are declared Schedule 1 Special Area under the *Sydney Water Catchment Management Act* 1998 and are managed by Sydney Catchment Authority at Blackheath Special Area and Katoomba Special Area (sites 14 and 18);
- eight populations occur on the Newnes Plateau within Newnes State Forest and are managed by State Forests of NSW (sites 1-7 and 29);
- 16 populations occur primarily in the Blue Mountains National Park (sites 8, 9, 10, 11, 12, 13, 15, 16, 17, 21, 22, 23, 24, 25, 26 and 30); and
- seven sites occur in part on privately owned land, although in each case, the majority of the site is publicly owned (sites 10, 11, 13, 19, 20, 22 and 27).

Further populations may occur on land managed by the above agencies. Many areas of potential habitat have not been surveyed for the Blue Mountains Water Skink.

Most of the land-use zones in which the 30 populations of the Blue Mountains Water Skink occur have objectives that aim at the protection of the natural environment. These zones include National Park, Environmental Protection and Recreation-Environmental Protection (refer to Table 1 for individual site zoning).

However, small parts on the edges of some of the known sites, as well as many areas adjacent to known locations, are zoned for residential development. The zoning of land adjacent to and in the catchment of swamps in the Blue Mountains is an important factor in the stability and long term viability of populations. Sites 10, 11, 12, 13, 14, 19, 20, 21, 22 and 27 and/or land adjacent to these sites, have been zoned for residential development.

**Table 1. Summary of land-use zoning of sites containing the 30 known populations of the Blue Mountains Water Skink.**

Site number	Location	Land-use zoning	Tenure
1	Wolgan River, Newnes Plateau	SF	SFNSW
2	Carne Creek, Newnes Plateau	SF	SFNSW
3	Carne Creek, Newnes Plateau	SF	SFNSW
4	Carne Creek, Newnes Plateau	SF	SFNSW
5	Carne Creek, Newnes Plateau	SF	SFNSW
6	Newnes Plateau	SF	SFNSW
7	Bungleboori Creek, Newnes Plateau	SF	SFNSW
8	Bennett Gully, Blackheath	NP	NPWS
9	near Hat Hill, Blackheath	NP	NPWS
10	near Hat Hill, Blackheath	NP/EP	NPWS/private
11	near Govetts Leap Brook, Blackheath	NP/RES-BC/EP/ RES A1	NPWS/private
12	near Govetts Leap Brook, Blackheath	NP	NPWS
13	Hayward Gully, Blackheath	NP/RES-BC	NPWS/private
14	Blackheath Special Area	EP	SCA
15	Urella Brook, Mt Hay Range	NP	NPWS
16	Wirralie Brook, Mt Hay Range	NP	NPWS
17	near Henson Glen, Mt Hay Range	NP	NPWS
18	Katoomba Special Area	EP	SCA
19	Leura Park	REC-EP/RES A1/ RES-BC	Crown Recreation Reserve managed by BMCC/private
20	Wentworth Falls Lake	REC-EP/RES-BC	Crown Recreation Reserve managed by BMCC/private
21	Lawson	NP	NPWS
22	Kings Tableland, near Wentworth Falls	NP/EP	NPWS/private
23	Williams Ridge, south of Lawson	NP	NPWS
24	Williams Ridge, south of Lawson	NP	NPWS
25	Williams Ridge, south of Lawson	NP	NPWS
26	Williams Ridge, above Ingar picnic ground	NP	NPWS
27	Franks Creek, Wentworth Falls	NP/EP	NPWS/Crown Recreation Reserve managed by BMCC / private
28	Lawson Creek, Wentworth Falls		Crown Recreation Reserve managed by BMCC/private
29	Carne Creek Tributary, Newnes Plateau	SF	SFNSW

30	Bedford Creek Tributary, Blue Mountains National Park	NP	NPWS
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Key: SF- State Forest; NP- National Park; EP- Environmental Protection; REC-EP- Recreation-Environmental Protection; RES-BC- Residential Bushland Conservation; RES A1- Residential A1. (From BMCC LEP 1991 and BMCC LEP No. 4)

### 5.3 Climate

Annual average rainfall at Katoomba is 1392 mm and at Newnes Plateau is 1047 mm. The mean minimum temperature for the coldest month at Katoomba (July) is 2.6°C while the mean maximum temperature for the hottest month (January) is 23.6°C. At Newnes Plateau, for the same months, the mean minimum temperature is -1°C and the mean maximum temperature is 23.5°C (Bureau of Meteorology 1979).

### 5.4 Landscape and topography

The Blue Mountains Water Skink is a high elevation species and the lowest altitude recorded for this species is 560 m at Williams Ridge, NSW (site 26).

The Blue Mountains Water Skink is restricted to an isolated and naturally fragmented habitat of sedge and shrub swamps in the Blue Mountains. These swamps form on valley sides and floors where water-bearing strata, constrained by impermeable layers of rock are exposed (Holland 1972). They are characterised by sandy-peaty soil which averages 1.2-1.5 m in depth (Holland 1974 cited in Holland *et al.* 1992) and is permanently wet (Holland *et al.* 1992). They are primarily restricted to the high, dissected Narrabeen group sandstone plateau between Hazelbrook in the east, and Newnes in the west (Keith and Benson 1988, Benson and Keith 1990). However, a few are found at lower elevations further east in the mountains (Benson 1992). These swamps may be on slopes (perched headwater swamps such as at site 26, Figure 4) in narrow valleys (e.g. site 8, Figure 5) or in low-lying areas of flat or undulating plateaux (e.g. site 6, Figure 6).

However, not all of the potential swamps in the Blue Mountains appear to support populations of the Blue Mountains Water Skink (LeBreton 1994a 1996). The size of the swamp appears to be an important determinant of the occurrence (presence) of the Blue Mountains Water Skink at a particular swamp. Soil moisture and distance to the next swamp with skinks are also important. LeBreton (1996) found that larger, wetter swamps which were closer to other sites with skinks were more likely to be occupied, whereas smaller (less than 0.7 ha), drier and more isolated swamps were less likely to be.



a)



b)

**Figure 3.** Typical habitat of the Blue Mountains Water Skink a) sedge swamp at Williams Ridge (site 26) b) shrub swamp at Newnes Plateau (site 4).



**Figure 4. Site 26. Example of perched headwater swamp habitat of the Blue Mountains Water Skink**



**Figure 5. Site 8. Example of narrow valley swamp habitat of the Blue Mountains Water skink**



**Figure 6. Site 6. Example of low-lying flat swamp habitat of the Blue Mountains Water skink**

## **5.5 Vegetation**

Keith and Benson (1988), Benson and Keith (1990), and Benson (1992) provide vegetation maps of the Blue Mountains and surrounding areas and plot a number of vegetation types which could be considered as potential habitat for the Blue Mountains Water Skink. Blue Mountains Sedge Swamps (26a) and Newnes Plateau Shrub Swamps (20a) probably make up the bulk of the habitat for the species. Boyd Plateau Bogs and Cox's River Swamps are other, less likely, but potential habitat. It should be noted that some swamps (including known sites for the Blue Mountains Water Skink) are not plotted on these vegetation maps due to their small size. More recently, Smith and Smith (1995) mapped the swamp vegetation of the Blue Mountains and their maps show many of the smaller swamps not plotted on the above maps.

Blue Mountains Sedge Swamps extend from the lower Blue Mountains through to the upper Blue Mountains where they are most numerous. The abundance of swamps appears to increase significantly at around 500-600 metres (Keith and Benson 1988). Cox's River Swamps are present in small numbers on the western side of the Blue Mountains and are usually found on flats in the deeper valleys. Newnes Plateau Shrub Swamps are largely restricted to the Newnes area. Boyd Plateau Bogs are generally restricted to the Boyd Plateau. The vegetation in these swamps typically takes the form of a sedgeland interspersed with shrubs, but may be a dense shrub thicket. Characteristic plant species in these swamps are *Gymnoschoenus sphaerocephalus* (Button Grass),

*Baeckea linifolia*, *Hakea teretifolia* (Dagger Hakea), *Grevillea acanthifolia*, *Tetrarrhena turfosa*, *Xyris ustulata*, *Empodisma minus* and *Lepidosperma limicola* (Blade Grass) (Keith and Benson 1988, LeBreton 1996). Not all swamps contain all of these species.

LeBreton (1996) found that the cover of *Tetrarrhena turfosa* and *Baeckea linifolia* were strongly related to the presence of the Blue Mountains Water Skink, with skinks occurring when the cover of both these species were higher. However, this does not necessarily indicate a direct relationship between the skink and these two plant species. It is possible that these plants rely on similar environmental condition to the Blue Mountains Water Skink or occur in areas of high food resources for the Blue Mountains Water Skink (LeBreton 1996).

## **5.6 Microhabitat**

Swamps where the Blue Mountains Water Skink is known to occur have boggy soils and appear to be permanently wet (LeBreton 1996).

Soil moisture and leaf litter depth appear to be important determinants of skink abundance when comparing sites where the Blue Mountains Water Skink is known to occur (LeBreton 1996). LeBreton (1996) found that skink biomass was related to leaf litter depth, with sites with deeper leaf litter having greater skink biomass. Trapping frequency was affected by soil moisture with sites with moister soil having a higher trapping frequency.



## 6 Biology and ecology

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Little is known about the biology and ecology of the Blue Mountains Water Skink.

The Blue Mountains Water Skink is semi-aquatic (Wells and Wellington 1985) and is active on warm sunny days from September to late April (LeBreton 1996). As with most reptiles, the Blue Mountains Water Skink is thought to hibernate during winter. Shea and Peterson (1985) collected two inactive specimens on the edge of the swamp at Wentworth Falls Lake (site 20) following winter rains. This may suggest that some individuals move out of the waterlogged areas of swamp into surrounding vegetation in the winter to take advantage of cover when available. Captures on the forest/swamp margin indicate that skinks may use part of the forest at times (LeBreton 1994b).

From scats collected at Wentworth Falls Lake it was established that Blue Mountains Water Skinks were feeding on grasshoppers, flies, moths, weevils and wasps. The remains of insects in the scats were predominantly from non-ground dwelling insects, which may indicate that the skinks are feeding mainly while active on the grasses above the ground. A small fruit with a seed was found in a scat at Leura (LeBreton 1992).

Females give birth to live young (ovoviviparous) in late December (LeBreton 1996). The adult sex ratio appears to be close to 1M:1F (LeBreton 1996). No specific information is available about the habitat requirements of the Blue Mountains Water Skink when breeding. Basking sites are likely to be important as skinks that bear live young are generally those which occur in cooler climates (Greer 1989). This may have evolved because embryonic development is temperature dependent, and in cooler climates the developing young are generally exposed to higher temperatures if they remain inside the female, who maintains an elevated body temperature through basking (Greer 1989).

When disturbed the Blue Mountains Water Skink rapidly takes shelter in dense grass tussocks or down holes. The Blue Mountains Water Skink has been known to use burrows constructed by yabbies (Shea and Peterson 1985), and possibly Giant Burrowing Frogs (LeBreton *pers. comm.* 1999). Burrow use may be an effective strategy for surviving fire events.

LeBreton (1996) found that leaf litter depth and skink biomass were related. This may be a result from increased abundance of invertebrates in deeper leaf litter, providing increased food resources. Additionally, deeper leaf litter may provide a more suitable microclimate or allow skinks to escape predators more easily.

The Blue Mountains Water Skink is most similar to the Alpine Water Skink, *E. kosciuskoi*. This species is similarly restricted to high elevations and wet habitats, however the distributions of the two species are allopatric (not overlapping). The Alpine Water Skink has a disjunct distribution with known populations occurring at the Barrington Tops Plateau and the Snowy Mountains of NSW and Victoria. Populations at these two areas may be genetically distinct, and in fact the Barrington Tops *E. kosciuskoi*

has been described as a separate species (*E. worrelli*) (Wells and Wellington 1985) although this has not been widely accepted.

## **7 Previous management actions**

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### **7.1 Blue Mountains Water Skink Recovery Team**

A recovery team was formed in 1999 to coordinate recovery efforts and guide the preparation of a recovery plan. The team comprises stakeholder representatives from the National Parks and Wildlife Service, State Forests of NSW, Sydney Catchment Authority, City of Blue Mountains Council, species experts and conservation groups.

### **7.2 Identification and survey of potential habitat**

There has been limited survey work undertaken for this species.

Three individuals were collected by the Australian Museum when carrying out a broad faunal survey of the Newnes Plateau/Colo River area (Kingston *et al.* 1979). The habitat where these individuals were collected was described as swampy heath, and sedge swamp/stream flowing over sandstone.

Limited survey was carried out in 1994 by LeBreton (1994a, b) in areas managed at the time by the Water Board. Two sites, (now managed by the Sydney Catchment Authority), were found to contain skinks.

LeBreton (1996) undertook the main survey work for this species. He identified potential swamps using vegetation maps (Keith and Benson 1988; Benson and Keith 1990) air photos and field reconnaissance. He then surveyed 32 swamps using pitfall traps. Only two of the 32 swamps had known populations of the Blue Mountains Water Skink when he commenced his surveys. Of these 32 swamps, 18 were found to have skinks, increasing the number of known locations by 16. LeBreton's work significantly increased the known distribution of the Blue Mountains Water Skink to the south (by approx. 6km) and east (by approx. 1km). The majority of these new populations were located on national park estate and away from the previously thought stronghold for this species around Leura and Wentworth Falls Lake.

LeBreton (1996) also derived equations capable of predicting the occurrence of the Blue Mountains Water Skink based on size of swamp, area, soil moisture and distance to the next swamp occupied by the Blue Mountains Water Skink. Additional equations were developed capable of evaluating swamp suitability from airphoto information. These equations require testing on an independent data set (sites that were not used to derive the equations).

The NPWS, SFNSW and BMCC have GIS layers depicting swamps in national park, state forest and other areas within the Blue Mountains. Combined, these layers encompass the known distribution of the Blue Mountains Water Skink.

Survey work has been carried out on the Newnes Plateau and in the southern Blue Mountains National Park by the NPWS during 2001. Two new sites were recorded which were in close proximity to known sites in these areas.

### **7.3 Research**

An honours thesis by Matthew LeBreton in 1996 identified the habitat and distribution of the skink. The use of pitfall trapping resulted in the capture of 166 skinks (69 females, 73 males, 24 sex not determined). Eleven skinks were recaptured. This study extended the known distribution of the Blue Mountains Water Skink significantly. It also provided predictive equations useful for assessing the suitability of swamps for this species.

### **7.4 Site assessments**

Each known population of the Blue Mountains Water Skink has been described and assessed (Appendix 3) (see also Figure 2).

Site information including tenure, location, elevation, and (in some cases) area have been recorded. An initial assessment has been made in terms of the habitat management issues relevant to each site.

### **7.5 Management**

The Blue Mountains National Park Plan of Management (NPWS 2000) sets out guidelines applicable to the management of the Blue Mountains Water Skink locations in national park. It contains objectives for conservation of wildlife with particular attention to threatened species, endangered populations, endangered ecological communities and their habitats. The development and implementation of specific conservation programmes for threatened species and their habitats is a priority within this plan, as is the implementation of recovery plan actions. Other policies relate to control and eradication of introduced species (with priority given to those posing a significant threat to threatened species), fire management, community liaison, and visitor use.

The Special Areas Strategic Plan of Management that was jointly prepared by the SCA and NPWS covers the management of the Blackheath Special Area and Katoomba Special Area (sites 14 and 18). This plan of management considers the protection of ecological integrity, including threatened species, such as the Blue Mountains Water Skink as a priority issue. The Sydney Catchment Authority has also developed a number of operational plans including a “Plant and Animal Pest Control Plan” designed to reduce the incidence of weeds and feral animals in these areas, and a “Fire Management Plan”, which acknowledges the unique habitat that upland swamps provide.

The planning process carried out by SFNSW ensures that the Blue Mountains Water Skink and its habitat are protected. Known populations are identified in plans of management and operational documents. Management of state forests at Newnes is subject to conservation protocols developed jointly between the NPWS and SFNSW

(NPWS and SFNSW 1996). These protocols contain principles for burning and grazing and specific provisions to protect riparian and heathland areas as well as ground habitat (including fallen timber). SFNSW and NPWS have also jointly developed weed control and feral animal control strategies that are implemented across state forests.

BMCC are currently drafting a Natural Areas Management Strategy that covers the management of locations at Leura Park and Wentworth Falls Lake (sites 19 and 20). These will include site plans that can be incorporated into Bushland Management Plans or Plans of Management. Substrategies of the Natural Areas Management Strategy will include a Vegetation Management Plan and other strategies for the management of bushfire risk, seed collection, recreational impacts, and feral animal and domestic pet impacts. Both Leura Park and Wentworth Falls Lake (sites 19 and 20) are likely to become high priorities for management actions, including weed programs, community education (re: dumping of garden refuse, companion animal curfews, etc), and improved stormwater and nutrient input controls.

## **7.6 Education**

A species profile has been produced by NPWS outlining the known biology of the Blue Mountains Water Skink. SFNSW have also produced species profile aimed at informing SFNSW operational staff about the biology and ecology of the skink.

## **8 Management issues**

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This section identifies the management issues affecting the Blue Mountains Water Skink including;

- limitations of our understanding of the biology and ecology of the Blue Mountains Water Skink,
- threats and reasons for decline,
- the potential of translocation,
- community awareness and involvement,
- social and economic factors which may influence the success or otherwise of the recovery plan, and
- ability of the species to recover.

### **8.1 Level of current understanding**

Our ability to manage threatened species is dependent on our knowledge of resources needed at different life history stages. As outlined in sections 5 and 6 of this plan, there is a limited understanding of the biology and ecology of this species. This is in part related to the restricted distribution of the Blue Mountains Water Skink, and its only recent identification as a separate species (Wells and Wellington 1984). Significant information gaps lie in the areas of life history, population dynamics, home range and movement patterns, habitat requirements, and response to disturbance.

Much potential habitat has not been surveyed and it is likely that more populations of the Blue Mountains Water Skink will be located through targeted survey.

At known populations, monitoring of population parameters is required to assess the effectiveness of the recovery actions and to provide a data source for the review of the recovery plan and recovery actions.

### **8.2 Threatening processes**

#### **8.2.1 Habitat loss**

Habitat loss is a primary cause of decline of many native fauna species in Australia. It is usually the direct result of various forms of development or activities that permanently remove areas used by a species. A number of swamps in the Blue Mountains have disappeared as a result of various development. Washington (1999) lists a number of areas of potential habitat that have been destroyed by urban development. It is not known whether the Blue Mountains Water Skink occupied these sites.

Within the Blue Mountains there is demand for residential development, however this is constrained by land-use zoning. Hence, further residential development of swamps is unlikely, as these areas have now been zoned environmental protection. However, development of areas adjacent to swamps and in their catchment has the potential to threaten Blue Mountains Water Skink populations and habitat in a number of ways including; pollution, erosion, sedimentation, invasion by weeds, predation by cats, alterations to hydrology, and direct disturbance.

A number of developments have recently been granted development consent or approval in areas around skink habitat. These include a residential subdivision upstream of site 20 (Wentworth Falls Lake) and residential development adjacent to sites 11 (Blackheath) and 19 (Leura Park). Further development may also occur near sites 10, 11, 12, 13, 14, 19, 20, 21, 22, 27 and 28 which have adjacent areas zoned to permit further development.

### **8.2.2 Habitat degradation**

#### **Weeds**

Weed invasion is almost always associated with other types of disturbance. Most of the known habitat is not suffering from weed infestation, although potential further development adjacent to habitat will increase the likelihood of weed infestation. Weeds are a serious problem at sites 11 (Blackheath), 19 (Leura Park), 20 (Wentworth Falls Lake) and 28 (Jamison Creek). These are sites that are already adjacent to or surrounded by urban development. Weeds occur along drainage lines from urban areas such as the drainage line from Waratah Rd urban area that drains into site 20 (Wentworth Falls Lake). These drainage lines carry nutrients, silt, and weed seeds into natural areas. Stormwater discharge points also encourage weeds. This is particularly a problem at site 20 where weeds have encroached at stormwater discharge points from Banksia Rd and Sinclair Crescent at Wentworth Falls.

Poor quality water leaking from inefficient septic absorption trenches can also pollute receiving waters, leading to eutrophication, which in turn encourages the growth of weed species.

Weed infestation is also a problem where access tracks are used to dump rubbish and garden waste.

Sites 5, 6 and 7 on Newnes Plateau are bordered by *Pinus radiata* (Radiata Pine) plantations, and are suffering encroachment by pine wildlings. Private land at Hat Hill Road, Blackheath, is covered with hundreds of pine wildlings. This area is adjacent to the Blue Mountains National Park, and sites 8, 9 and 10 may be threatened by pine wildlings encroachment from the adjacent private land.

### **Access and recreational vehicle use**

A network of fire trails has been established throughout the Blue Mountains. Many of the swamps containing populations of the Blue Mountains Water Skink are easily accessible via roads and tracks. Site 19 (Leura Park) is criss-crossed by unofficial tracks used by local residents. Site 20 (Wentworth Falls Lake) has a picnic area and formal walking tracks managed by BMCC. Several unofficial walking tracks are used by local residents. When site 21 (within national park) was last burnt in January 1994, trail bikes were observed riding across the swamp (LeBreton *pers. comm.* 1999). Track use may increase after burning when vegetation is sparse, allowing easier access.

Apart from direct disturbance, access may lead to arson, erosion, introduction of weeds (especially via horse dung) and rubbish dumping. Known sites in state forest (sites 1 to 7, and 29) occur near mazes of tracks and are vulnerable to access-related disturbances. Areas of potential habitat are also likely to be vulnerable. Similarly, the majority of the sites in the Blue Mountains National Park occur near tracks, and these may be vulnerable to impacts from visitors.

Another potential source of disturbance is illegal clearing of areas for dirt bike tracks. Such clearing involves earthworks to create jumps as well as felling of trees and removal of shrubs. These areas tend to be in bushland on the edge of urban areas.

### **Pollution**

Pollution is particularly a problem at sites 11 (Blackheath), 19 (Leura Falls Park), 20 (Wentworth Falls Lake) and 28 (Jamison Creek). These sites are adjacent to or surrounded by urban development and have residential and industrial activity in their catchments.

Pollution includes rubbish disposal, polluted water from stormwater and commercial runoff, and septic tank discharge which drain into swamps (e.g. sites 11 and 12 at Blackheath). Poor quality water leaking from inefficient septic absorption trenches can pollute receiving waters, leading to eutrophication and high levels of pathogens.

Industrial runoff from garages and industry into site 19 (Leura Falls Park) may be toxic as it is likely to contain petroleum compounds. Pollutants include detergents, fertilisers, animal and human waste, and oils and grease off roads.

Other sources of pollution may be herbicides and fertilisers used in pine plantations.

Ground water and surface runoff is retained by the peaty soils in most swamps due to the presence of shale or clay aquicludes underneath the soil (Holland *et al.* 1992). Invertebrate populations (potential food resources for the Blue Mountains Water Skink) and vegetation may be affected if these waters are polluted.



## **Sedimentation**

Sedimentation is particularly a problem at sites 11 (Blackheath), 19 (Leura Falls Park), 20 (Wentworth Falls Lake), and 28 (Jamison Creek). These sites are adjacent to, or surrounded by urban development. Sedimentation of swamps can occur as a result of runoff and poor erosion control mechanisms. Earthworks for establishment of sewage pipelines has led to serious sedimentation at Leura Falls Creek which runs through site 19 (Leura Park). Earthworks for pipeline maintenance has the potential to further increase the risk of sedimentation in those sites crossed by or occurring near pipelines.

Clearing may result in reduced water infiltration and channelling of surface water flow. This is exacerbated when hard surfaces are created in urban areas. Channelling results in higher, more focussed flows that create more erosion and may scour gullies.

The majority of sites occur near unsealed roads, hence sedimentation as a result of erosion and runoff from roads has the potential to affect these sites. Regular maintenance of tracks, as well as establishment of new tracks has the potential to increase sedimentation if appropriate sedimentation controls are not implemented.

Sedimentation resulting from logging operations may affect sites on or adjacent to state forest.

## **Altered hydrology**

A number of different activities have the potential to alter the hydrology of the Blue Mountains Water Skink habitat.

In urban and other cleared areas, reduced infiltration may lead to lowering of the water table and drying of swamps. Clearing of areas adjacent to or above swamps may result in stormwater being channelled into creeks rather than infiltrating the soil and recharging the groundwater feeding the swamps. Channelling also results in higher velocity discharge, which may cause erosion.

Roads, which cut across and interrupt areas of subsurface water flow, may lead to drying of swamps if residual water flow is insufficient to sustain the swamp (Porter 1984).

Similarly, plantations have the potential to reduce infiltration of water. This may affect sites 5, 6 and 7 at Newnes Plateau. However plantations have existed on the Newnes Plateau since the 1940s and it is likely that the range of hydrological impacts that one might expect have already been experienced in the catchments below.

Underground coal mining at Newnes Plateau may potentially affect the hydrology of all sites on the plateau. Subsidence and cracking of bedrock may lead to loss of moisture and drying out of these swamps.

## **Maintenance of service corridors/easements**

Sites 11, (Blackheath), 12 (Blackheath), 13 (Blackheath), 14 (Blackheath Special Area), 18 (Katoomba Special Area), 20 (Wentworth Falls Lake) and 27 (Wentworth Falls) are intersected by Integral Energy powerlines. Easements for these powerlines require

maintenance such as slashing, burning and spraying which may impact upon swamps. Spraying in particular may lead to pollution of water.

An underground sewage pipeline managed by Sydney Water runs through the centre of site 19 (Leura Falls Park) and a sewage pipeline also runs across site 20 (Wentworth Falls Lake). These pipelines require regular maintenance. Earthworks for maintenance of pipelines will cause disturbance and may lead to increased sedimentation and weed invasion.

### **Grazing**

Grazing by stock can lead to trampling of swamp vegetation and the action of hooves may cause soil compaction and erosion. Stock manure can spread weed species and may also cause nutrient changes in the soil.

At present there are no grazing leases across state forest with known Blue Mountains Water Skink populations, and other known sites are not zoned to allow grazing. However, grazing may be an issue in areas of potential habitat (Boyd Plateau, Ben Bullen State Forest, Lithgow Valley).

### **Firewood Collection**

The habitat requirements of the Blue Mountains Water Skink are not well understood. However, it is likely that fallen timber forms an important source of shelter, basking sites and invertebrate food. All sites that have reasonable access by the public (see above) are vulnerable to firewood collection.

### **Native forest harvesting**

Operations carried out in Newnes State Forest are formulated with regard to conservation protocols (NPWS and SFNSW 1996). These include provisions for swamps to be protected from harvesting operations by buffers. More serious consequences are likely to result from alterations to hydrology as a result of plantations and invasion of swamps by pine wildlings. These effects are discussed above.

#### **8.2.3 Predation by cats**

Feral cats (*Felis catus*) are known to eat lizards (Jones and Coman 1981). However, the impact of cats on populations of the Blue Mountains Water Skink is unknown.

Predation by cats is likely to be most severe at sites 11 (Blackheath), 19 (Leura Falls Park), 20 (Wentworth Falls Lake), 27 (Wentworth Falls) and 28 (Jamison Creek) those sites already adjacent to, or surrounded by residential areas.

#### **8.2.4 Fire management and inappropriate fire regimes**

The Blue Mountains is a fire prone area, and it is likely that the habitat of the Blue Mountains Water Skink has been subject to reasonably frequent fire events, both prescribed and wildfire.

Fire management is an important community issue in the Blue Mountains. Much urban development occurs on the edge of highly flammable bushland and hazard reduction burning is necessary 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 and arson.

Holland *et al.* (1992) observed the changes in vegetation following a fire event at site 17 that blackened the swamp to ground level, during the course of their eight year study of this swamp. They found that many species resprouted after the fire and the major pre-fire patterns of vegetation appeared to quickly re-establish. However, some species previously unrecorded were noted after the fire, while some other species occupied a wider range of sites.

Fire may play an important role in habitat maintenance. Exclusion of fire may lead to closing in of swamps by heathy vegetation, succession to heathland, and subsequent drying out of swamps (Pidgeon 1938). Closing in may also lead to a loss of basking sites for the skink. As a consequence, exclusion of fire from Blue Mountains Water Skink habitat may not be beneficial, especially in the absence of other disturbance regimes that encourage the regeneration of swamp vegetation. Accordingly, the prescription of a managed fire regime may be a useful tool in the maintenance of Blue Mountains Water Skink habitat.

It is unknown whether the Blue Mountains Water Skink is detrimentally affected by fire. The species has been observed in burnt habitats immediately after fire and appears to cope with individual fire events (LeBreton *pers. comm.* 1999). The Blue Mountains Water Skink uses burrows (Shea and Peterson 1985), which are known to be an effective strategy for surviving the immediate effects of fire events as soil is a good insulator of heat. The burrows in the swamps are usually filled with water and through submergence further protection from fire could be achieved (LeBreton 1996).

LeBreton (1996) found no direct effect of fire on the Blue Mountains Water Skink in terms of differences in the presence or abundance of skinks in swamps of different ages since fire. He speculated that because Blue Mountains Water Skink populations are restricted to isolated habitat patches, which tend to burn entirely, it would not be ecologically viable for the Blue Mountains Water Skink to require a specific post-fire vegetation structure.

However, the reduction in shelter resources in the post-fire environment may result in increased rates of predation. If a fire of sufficient intensity was to totally burn a swamp and to remove all individuals, then it may be some time, if ever, before the area is recolonised. Winter fires may also cause problems if inactive skinks are unable to find shelter if they are hibernating in tussocks rather than down burrows.

However, all evidence on the response of the Blue Mountains Water Skink to fire is observational or anecdotal. Further investigation is required on the role of fire in the ecology of this species in order to determine the most appropriate fire regime. Increased knowledge will enable land managers to prepare more informed fire management plans.

A patchy low intensity burn would appear to be optimal as this would ensure that shelter and other resources are always available, and reduce the risk of loss of the entire population. However, controlling the size of a prescribed burn is very labour intensive. Fires should be avoided during summer and after prolonged dry periods when the intensity of any fire event is likely to be higher and more destructive.

Fire management in the Blue Mountains is the responsibility of several different agencies and a coordinated cross boundary approach is needed.

### **8.3 Translocation**

Translocation includes the deliberate reintroduction of a species into an area where it once occurred or introduction of a species to an area where it never occurred. Translocation may also involve the supplementation of a declining population with new individuals. Captive breeding may be a component of a translocation program and be used as a source of animals for introduction or re-introduction into an area. Translocation programs are usually devised to assist in the conservation of a threatened species, within the context of a broader recovery strategy (NPWS 1998). Translocation programs can provide a measure of security for critically endangered populations in the event of catastrophes such as the impacts of fire or disease and also help protect a population against inbreeding depression.

Translocation may be necessary when populations are isolated and dispersal to recolonise areas from which populations have become extinct is very low or non-existent. The recovery team will need to discuss the need for any captive breeding or translocation in the event that one or more populations suffer a significant decrease. In considering whether a translocation program is feasible it is necessary to firstly understand the reasons for the decrease and be able to manage them. Consideration also needs to be given as to whether translocation is technically possible and whether the resources are available to undertake a translocation program. Genetic studies would be required to investigate the genetic distinctiveness of populations prior to initiation of any translocation programs.

At this stage it is not considered necessary to commence a captive breeding/translocation program either for the maintenance of Blue Mountains Water Skink populations or for any reintroduction into areas of suitable habitat. It is not known whether individual populations are declining or if individuals disperse and recolonise areas from which the species has become locally extinct. Further, a much better understanding of threatening processes is required before translocation could be considered.

### **8.4 Community awareness and involvement**

The key to the success of this recovery effort is an informed and supportive community.

Four target audiences have been identified and a range of actions is proposed in this plan to meet each group's specific needs.

1) The owners and managers of Blue Mountains Water Skink habitat are considered to be the most important audience. The informed support of land managers is the best way to achieve protection of most sites. Through participation on the recovery team, on-site assessments and ongoing liaison with the NPWS the owners and managers will be kept up-to-date on recovery initiatives and be involved in the recovery actions.

2) The second key audience are public authorities in local, State and Commonwealth Government. Authorities with approval responsibilities under the EP&A Act, *Native Vegetation Conservation Act 1997*, or other legislation, assess proposals that may impact on Blue Mountains Water Skink habitat. This sector of the community requires an understanding of the significance of the Blue Mountains Water Skink, its specific ecological requirements, and its sensitivity to impacts.

Many public authorities are also operational and may directly impact on sites through implementation of their day to day responsibilities. Local government, Roads and Traffic Authority, Rural Fire Service and the range of power, telecommunications and other utilities suppliers all need to be aware of the Blue Mountains Water Skink.

3) Researchers and students need to be informed and involved in the recovery effort. The lack of available information on the biology and ecology of the Blue Mountains Water Skink makes research a priority of this recovery plan.

4) The close proximity of a number of the Blue Mountains Water Skink sites to urban development means that community awareness and involvement could play a major role in the protection of these sites. Dissemination of information on the threats to the species may result in improved and increased community awareness and support is required for successful habitat restoration, survey and site monitoring programs.

## **8.5 Consideration of social and economic issues**

### **8.5.1 Social considerations**

The implementation of this recovery plan will have a social impact on the local communities and in particular the owners and managers of Blue Mountains Water Skink habitat.

Negative impacts on private landholders are expected to be small as all known sites are either wholly or mostly publicly owned. However landholders with land adjacent to known sites may be affected and there is the potential that future sites may occur on private land. Negative impacts may result because some landholders may be reluctant to conserve habitat and view the recovery effort as an intrusion on their rights to manage their land. Personal and regular contact with landholders is a key strategy in encouraging awareness and involvement in the recovery effort.

Other negative social impacts may include public dissatisfaction with recovery plan actions that limit previously unregulated activities, such as general access to the areas of habitat.

Adaptive management of skink populations based upon consultation with the local public is a key to reduce some of these impacts.

In general, impacts are expected to be very positive. Local communities are usually quick to support the conservation efforts of such a local and identifiable species. Landholders have in general been enthusiastic in their management of threatened species on their properties. Increased awareness regarding the conservation of threatened species in an urban setting may help to bring about changes in social behaviour.

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 lines within the mountains (see references in Washington (1999)). The 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 the habitat of the Blue Mountains Water Skink is thus very important for the protection of the scenic value of the Blue Mountains. This, in turn, is very important to the economic wellbeing of the Blue Mountains community, which partly relies on tourists for income. The scenic value is also of benefit to the physical well being of the people who live there.

Continued liaison with the local community, affected landholders, and relevant government agencies will address and minimise social impacts arising from the conservation of the Blue Mountains Water Skink.

### **8.5.2 Economic considerations**

The economic consequences of this recovery plan relate to costs of implementation of recovery actions. The main costs of this recovery plan relate to habitat restoration, site assessments, targeted survey, population monitoring and research into the biology and ecology of the species. Expense will also be incurred from liaison and negotiation with landholders and managers. It is anticipated that many of the recovery actions (especially habitat restoration actions) will involve community groups and may be funded by grants received by these groups.

Management costs related to national parks should be reflected in the plans of management. These are costs associated with on-park pest species management, fire management, weed eradication, erosion control measures and habitat management. Similarly, management costs on other public lands are primarily activities required for the normal management of the land, such as fire management and weed control and as such are already budgeted for.

## **8.6 Species ability to recover**

'Recovery' in the context of this plan, is to prevent the extinction of the Blue Mountains Water Skink and, depending on the success of on-going management actions, targeted surveys and further studies, down-list the species to a vulnerable conservation status.

No data exist that clearly demonstrate the past or present status of the Blue Mountains Water Skink and it is not conclusively known whether Blue Mountains Water Skink populations are stable or in decline from factors such as habitat loss and habitat degradation. However, the combination of the fragmented nature of its habitat in conjunction with the loss of some swamps to development is indicative that the species is likely to have declined.

The ability of the Blue Mountains Water Skink to recover is limited by the available habitat. Known populations of the Blue Mountains Water Skink show it to be restricted to a specialised and highly fragmented habitat across a relatively small area entirely within the Blue Mountains of NSW.

Little is known of the ability of this species to recolonise areas from which it has become extinct. However, some evidence indicates that the Blue Mountains Water Skink may be restricted to swamps and that it does not appear to use adjacent woodland/forest habitat (LeBreton 1992). If this were the case, then dispersal through the surrounding habitats would most likely be extremely low. Dispersal may take place along creeklines; however, there is limited interconnection of creeks, with many in the upper mountains dropping over cliffs up to 200 m high.

The likelihood of down-listing the Blue Mountains Water Skink from endangered to vulnerable is dependent on the success of ongoing management actions and the results of survey and monitoring. The extent to which the known distribution is increased, the stability of populations, and the level of threat operating on populations will determine this. The reassessment of species status is outlined in action 15 and is scheduled to occur in the final year of recovery plan implementation.

## **9 Overall objectives and performance criteria**

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### **9.1 Overall objective**

The overall recovery objective of the plan is to prevent the extinction of the Blue Mountains Water Skink 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.

### **9.2 Overall performance criteria**

The overall performance criteria of the recovery plan is that the risk of extinction of the Blue Mountains Water Skink is decreased through the location of additional populations and the protection of known populations.

### **9.3 Specific recovery objectives, performance criteria and actions**

#### **9.3.1 Specific recovery objectives**

- To establish the full extent of the distribution of the Blue Mountains Water Skink.
- To improve our understanding of the population status of the Blue Mountains Water Skink by monitoring representative populations.
- To minimise the risk of the Blue Mountains Water Skink declining in the long term by the implementation of a range of activities to ameliorate the impact of factors considered to be detrimentally affecting the species or its habitat.
- To raise awareness of the conservation status of the Blue Mountains Water Skink and to involve the broader community and key groups such as landholders and managers, local and State government agencies, public authorities and researchers in the recovery program for the species.
- To improve the management of Blue Mountains Water Skink populations and habitat based on an improved understanding of its biology and ecology.
- To reassess the conservation status of the Blue Mountains Water.

#### **9.3.2 Specific recovery performance criteria**

- Over a period of five years of targeted survey, a true indication of the full extent of the distribution of the Blue Mountains Water Skink will be able to be determined.
- Over a period of five years of repeated monitoring and analysis of results, a true indication of the status of representative populations will be able to be determined.



- Within five years the impacts of factors detrimentally affecting the Blue Mountains Water Skink and its habitat are identified and reduced thereby increasing the long-term survival prospects of the species.
- Information is disseminated to Government agencies, land managers and the public about the conservation status and management issues affecting the Blue Mountains Water Skink and its habitat. The broader community and key groups are actively involved in the recovery program.
- More informed recovery and management strategies are developed by an increase in knowledge of the biology and ecology of the species.
- The National and State conservation status of the Blue Mountains Water Skink is reassessed, and if appropriate, a recommendation is made for downlisting the species from Endangered to Vulnerable.

### **9.3.3 Specific recovery actions**

- Identify potential Blue Mountains Water Skink habitat and assess potential habitat for the presence of the Blue Mountains Water Skink.
- Develop and implement a program to monitor Blue Mountains Water Skink population status at representative sites.
- Identify the factors detrimentally affecting the Blue Mountains Water Skink and its habitat, monitor the level of these factors at each site, and implement a range of activities to ameliorate the impact of these factors.
- Encourage and maintain public awareness and participation in the recovery and management of the Blue Mountains Water Skink.
- Encourage and facilitate scientific investigation of key aspects of the biology and ecology of the Blue Mountains Water Skink that are likely to provide information that is valuable to the recovery of the species or relevant to its management.
- Reassess the conservation status of the Blue Mountains Water Skink.

The above actions are presented in more detail in sections 10-15.

## **10 Targeted survey**

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### **10.1 Recovery objective**

The objective of conducting targeted surveys is to establish the full extent of the distribution of the Blue Mountains Water Skink to enable protection of sites from threats and assist in reassessing the conservation status of the species.

### **10.2 Performance criteria**

Over a period of five years of targeted survey, a true indication of the full extent of the distribution of the Blue Mountains Water Skink will be able to be determined.

### **10.3 Recovery actions**

Identify potential habitat and assess for the presence of the Blue Mountains Water Skink.

#### **10.3.1 Identification of potential habitat**

- Within one year the NPWS, with the assistance of species experts, will use aerial photographs, existing GIS layers, and vegetation maps to develop a model of potential habitat for the Blue Mountains Water Skink across all tenures.

#### **10.3.2 Assessment of potential habitat**

- Within two years the NPWS will develop a method for assessing the presence of the Blue Mountains Water Skink in potential habitat.
- Using this method the NPWS, with the assistance of staff from BMCC, SFNSW and SCA (where potential habitat is owned or managed by them) will systematically assess potential habitat (given that permission is granted by private landholders) defined by the GIS model for the presence of the Blue Mountains Water Skink.
- The NPWS will actively seek the involvement of community groups in the assessment of potential habitat.
- Assessments will be carried out when Blue Mountains Water Skinks are most likely to be active on warm sunny days between October and March.
- All new records of the Blue Mountains Water Skink and exact locations will be recorded within the NPWS Wildlife Atlas.

## **11 Population monitoring**

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### **11.1 Recovery objective**

The objective of conducting population monitoring is to improve our understanding of the population status of the Blue Mountains Water Skink by monitoring representative sites.

### **11.2 Performance criteria**

Over a period of five years of repeated monitoring and analysis of results, a true indication of the status of representative populations will be able to be determined.

### **11.3 Recovery actions**

Develop and implement a program to monitor Blue Mountains Water Skink population status at representative sites.

#### **11.3.1 Monitoring of population status**

- The NPWS will develop, implement and maintain a monitoring program at representative sites that is sufficiently rigorous to identify changes in population status.
- The NPWS will maintain a database of all monitoring activities.
- BMCC, SFNSW and SCA will provide staff to assist with the monitoring program if selected sites are under their management.
- The NPWS will actively seek the involvement of community groups in the monitoring program.
- The NPWS will investigate funding options for the continuation of the Blue Mountains Water Skink population monitoring program.

## **12 Threat and habitat management**

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### **12.1 Recovery objective**

The objective of threat and habitat management is to minimise the risk of the Blue Mountains Water Skink declining in the long term by the implementation of a range of activities to ameliorate or prevent impacts considered to be detrimentally affecting the Blue Mountains Water Skink and its habitat.

### **12.2 Performance criteria**

Within five years, the impacts of factors detrimentally affecting the Blue Mountains Water Skink or its habitat are identified and reduced thereby increasing the long-term survival prospects of the species.

### **12.3 Recovery actions**

Identify the factors detrimentally affecting the Blue Mountains Water Skink or its habitat, monitor the level of these factors at each site, and implement a range of activities to ameliorate or prevent the impact of these factors.

#### **12.3.1 Identification, monitoring and amelioration of threats at each site**

- The NPWS and staff from BMCC, SCA and SFNSW will undertake an initial assessment of each known Blue Mountains Water Skink site on land that is owned or managed by them in the first year of the recovery plan. The NPWS will carry out assessments for sites on any private land with the permission of the landholders. The aim of the site assessment is to identify any factors that may be detrimentally affecting the population at each known site. A site assessment datasheet is provided in Appendix 4.
- The NPWS in consultation with staff from BMCC, SCA and SFNSW will coordinate site re-assessments (monitoring) every two years of both known, and any new sites detected, for the life of the recovery plan. Monitoring will aim to record any changes to the condition of each site from recent fire, weed invasion, sedimentation and rubbish dumping, and other effects.
- Any immediate restorative actions identified from these assessments, will be discussed with the recovery team and undertaken in consultation with the responsible party and where appropriate, involve local community groups. Actions may include weed control and rubbish removal.

- Community groups (e.g. the Blue Mountains Conservation Society) will be encouraged and assisted by the NPWS to seek funding for restorative actions from a number of sources including the National Heritage Trust and Threatened Species Network.

### **12.3.2 Environmental planning, impact assessment and development consent**

- The NPWS, SFNSW, BMCC, SCA and any other relevant land managers will ensure that any relevant environmental policies, strategies, management plans and environmental planning instruments are prepared or reviewed with reference to the recovery plan and any future advice from the NPWS regarding the distribution, threats and ecology of the species.
- The NPWS, SFNSW, BMCC, SCA and any other relevant land managers will ensure that any necessary restorative actions, (identified in action 12.3.1), in Blue Mountains Water Skink sites under their management, are considered when setting priorities for management strategies such as weed control programs, Bushcare site strategies etc.
- Consent and determining authorities under the EP&A Act and/or the *Native Vegetation Conservation Act 1997* will ensure that development assessments, for development proposals affecting known or potential sites for the Blue Mountains Water Skink, are undertaken with reference to this recovery plan (including the environmental impact assessment guidelines included as Appendix 2) and any future advice from the NPWS regarding the distribution, threats and ecology of the species.
- BMCC and any other consent or determining authorities will ensure that development consent, issued for proposals on land adjoining known populations of the Blue Mountains Water Skink or which may impact on the species or its habitat, includes provisions to minimise or prevent these impacts.

### **12.3.3 Specific threat abatement actions**

- SFNSW will ensure that appropriate runoff control measures are maintained and implemented at pine plantations around sites 5, 6 and 7 to minimise impacts on Blue Mountains Water Skink habitat, and that control of feral pine seedlings within these three sites is considered when setting priorities for weed control programs.
- SFNSW will rehabilitate the ditch on the upper side of the road crossing at site 6 with local native species to minimise the impact of the ditch on the hydrological flow in the swamp.
- SCA will progressively rehabilitate the pine plantation at site 14 to native vegetation over the long-term.
- BMCC will ensure that site plans for Leura Park and Wentworth Falls Lake (sites 19 and 20) that will be developed as part of the Natural Areas Management Strategy will address those issues identified in the site assessments (action 12.3.1) as threatening

these two sites, particularly weed infestation, pollution, sedimentation and predation by cats.

- Using information derived from the site assessments (action 12.3.1) the recovery team will determine which sites may require restricted access through the use of gates or barriers. The NPWS will negotiate provision of such mechanisms with any agency responsible for management of the site.
- The NPWS, SFNSW, SCA and BMCC will actively discourage firewood harvesting and the removal of dead timber from areas within or adjacent to Blue Mountains Water Skink habitat.

#### **12.3.4 Management of cat predation**

- The NPWS in conjunction with BMCC will develop a leaflet for the community outlining the importance of protecting the Blue Mountains Water Skink and its habitat and listing cat predation as a factor that may be detrimentally affecting Blue Mountains Water Skink populations (as described in action 13.3.1). A second leaflet has already been produced by the NPWS on the impacts of cats on native fauna and responsible cat ownership. This leaflet, and the leaflet described above will be distributed to all houses around Blue Mountains Water Skink sites at Leura Park, Wentworth Falls Lake, Wentworth Falls and Blackheath (see action 13.3.1).
- BMCC will actively apply the provisions of the *Companion Animals Act 1998* and enforce the registration of domestic cats. BMCC will also encourage the de-sexing of domestic cats.
- Pending further knowledge on the impact of cat predation on the Blue Mountains Water Skink, the recovery team will consider making a recommendation to BMCC that residential areas surrounding Blue Mountains Water Skink habitat be zoned as Wildlife Protection areas under the *Companion Animals Act 1998*.

#### **12.3.5 Management of fire**

- The NPWS, SFNSW, SCA and BMCC will ensure that fire management activities at Blue Mountains Water Skink sites under their management, are planned, approved and effected in cognisance of the known ecological requirements of the Blue Mountains Water Skink and any future advice from the NPWS regarding the effect of fire on the Blue Mountains Water Skink.
- Bush Fire Management Committees will ensure that known populations and habitat of the Blue Mountains Water Skink are considered in Bush Fire Risk Management Plans. Consideration will include reference to this recovery plan and include any future advice from the NPWS regarding the effect of fire on the Blue Mountains Water Skink.
- To ensure appropriate fire management of known Blue Mountains Water Skink sites and potential habitat, the NPWS, BMCC, SFNSW and SCA will liaise and cooperate with the Rural Fire Service in association with the relevant Bush Fire Management Committees.

## **13 Community awareness and involvement**

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### **13.1 Recovery objective**

The objective of public awareness and involvement is to raise awareness of the conservation status of the Blue Mountains Water Skink and to involve the broader community and key groups such as landholders and managers, local and State government agencies, public authorities and researchers in the recovery program for the species.

### **13.2 Performance criteria**

Information is disseminated to Government agencies, land managers and the public about the conservation status and management issues affecting the Blue Mountains Water Skink and its habitat and the broader community and key groups are actively involved in the recovery program.

### **13.3 Recovery actions**

Encourage and maintain public awareness and participation in the recovery and management of the Blue Mountains Water Skink.

#### **13.3.1 Increasing community awareness**

- The NPWS will produce and disseminate a species profile (Appendix 1) to provide information about the conservation status and management issues affecting the Blue Mountains Water Skink and its habitat. The species profile will be displayed on the NPWS internet website, and will be available from NPWS offices at Blackheath, the Rocks and Hurstville and the offices of BMCC. The species profile will be distributed to key groups such as affected landholders, local and State Government agencies, community groups and relevant authorities including the Rural Fire Service, RTA and utilities suppliers.
- The NPWS will ensure that information about the Blue Mountains Water Skink and progress on the implementation of this recovery plan is readily available to the community. This will be presented through presentations to community groups and preparation of articles for inclusion in the local media, in community conservation group newsletters, at Council and NPWS offices and in the NPWS Threatened Species Recovery Program Newsletter.
- The NPWS, with the assistance of the Blue Mountains Conservation Society and BMCC, will co-ordinate the erection of a sign at site 20 (Wentworth Falls Lake) indicating that this site contains endangered species habitat that requires protection.

- The NPWS in conjunction with BMCC will develop a leaflet for the community outlining the importance of protecting the Blue Mountains Water Skink and its habitat and listing factors, (such as rubbish dumping, cat predation and firewood collection), that detrimentally affect the Blue Mountains Water Skink and its habitat.
- BMCC will distribute the above leaflet to all houses around Blue Mountains Water Skink sites at Leura Park, Wentworth Falls Lake, Wentworth Falls and Blackheath.

### **13.3.2 Increasing community involvement in recovery efforts**

- The NPWS will continue to coordinate the Blue Mountains Water Skink recovery team, which includes community group representation.
- The NPWS will encourage and coordinate the involvement of community-based groups in the implementation of recovery actions.
- BMCC and the NPWS will ensure that any Bushcare Groups operating in the vicinity of Blue Mountains Water Skink sites or habitat are aware of the recovery plan and any actions identified in site assessments (action 12.3.1), such as weed control and rubbish removal, that need to be undertaken to protect known Blue Mountains Water Skink habitat.
- The recovery team, BMCC and the NPWS will actively encourage conservation groups such as the Blue Mountains Conservation Society, Blue Mountains Rare and Endangered Species Group and various Bushcare groups to seek funding for, and include in their activities, any restorative actions identified by site assessments (action 12.3.1).

### **13.3.3 Informing and involving affected landholders and managers**

- The NPWS will produce, and disseminate to affected landholders, a species profile (Appendix 1) to provide information about the conservation status and management issues affecting the Blue Mountains Water Skink and its habitat (see action 13.3.1).
- The NPWS will liaise with affected landholders to emphasise the conservation significance of populations of the Blue Mountains Water Skink occurring on or adjacent to their properties and to provide advice about species ecology, threatening processes, and ameliorative actions.
- The NPWS will seek to secure sympathetic management of Blue Mountains Water Skink habitat by private landholders. NPWS will liase with landholders to discuss management options, such as property management plans and voluntary conservation agreements, and sources of management incentives.

### **13.3.4 Informing and educating local and State government agencies and public authorities**

- The NPWS will produce and disseminate to local and State government agencies a species profile (Appendix 1) about the conservation status and management issues affecting the Blue Mountains Water Skink and its habitat, and environmental impact



assessment guidelines (Appendix 2) for the Blue Mountains Water Skink (see action 13.3.1).

- The NPWS will disseminate to affected local government councils and State government agencies a description of the known sites of the Blue Mountains Water Skink within the relevant local government area, or area of management responsibility.
- BMCC, SFNSW, and SCA will review the process of information dissemination within their agency to ensure that all relevant sections of their organisations are informed of the role of their organisation in the recovery of the Blue Mountains Water Skink.
- BMCC will place a notation about the presence of the Blue Mountains Water Skink on hard and electronic files relating to land adjacent to known skink sites to ensure that the Blue Mountains Water Skink is specifically considered when assessing any proposals relating to that land.
- The NPWS will produce and disseminate a species profile (Appendix 1) to relevant authorities (including the Roads and Traffic Authority, Rural Fire Service and the range of power, telecommunications and other utilities suppliers), for the advice of their field operators, on the conservation status and management issues affecting the Blue Mountains Water Skink and its habitat. The NPWS will inform these authorities about this recovery plan (see action 13.3.1).
- The NPWS, SFNSW, BMCC and SCA will ensure that relevant authorities (including the Roads and Traffic Authority, Rural Fire Service and the range of power, telecommunications and other utilities suppliers), whose day to day activities may impact on the Blue Mountains Water Skink are aware of the location of Blue Mountains Water Skink sites and habitat.

#### **13.3.5 Informing and involving researchers and students**

- The NPWS will promote awareness of the research needs of the Blue Mountains Water Skink among the scientific and academic community.
- The NPWS will encourage involvement of researchers and students in the Blue Mountains Water Skink recovery effort particularly in habitat survey, population monitoring and research.

## **14 Research**

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### **14.1 Recovery objective**

The objective of the research of the Blue Mountains Water Skink is to improve the recovery and management of the species and its habitat based on an enhanced understanding of its biology and ecology.

### **14.2 Performance criteria**

Future recovery and management strategies are carried out in an informed manner as a result of an increased understanding of the biology and ecology of the species.

### **14.3 Recovery actions**

Encourage and facilitate scientific investigation into key aspects of the biology and ecology of the Blue Mountains Water Skink that are likely to provide information that is valuable to the recovery of the species or relevant to its management.

#### **14.3.1 Encouragement of research**

- The NPWS will seek avenues to raise additional funds through sponsorship and public appeals to support research projects that are not funded.
- The NPWS will encourage and facilitate research and investigations into the following priority areas:
  - **Impact assessment/response to disturbance**
    - Impacts of threatening processes (described in Section 8.2) on Blue Mountains Water Skink populations and habitat. In particular the impacts of different fire regimes, pollution, sedimentation, alterations to hydrology, predation by cats, grazing and firewood collection.
  - **Home range and movement patterns**
    - Individual home ranges and movement within the home range.
    - Use of adjacent habitat.
    - Dispersal between populations and potential for recolonisation of sites that become locally extinct.
    - Test predictive equations developed by LeBreton (1996)

- **Key habitat components**

- Identification of habitat components that constitute key resources for breeding, shelter (especially wintering sites), foraging, basking etc.

- **Population dynamics**

- Determination of normal fluctuations in population size and composition.

- **Genetic analyses**

- Genetic variation between populations and what this implies about dispersal rates and connectivity of populations.
- Identification of populations that may be genetically distinct and important for maintenance of genetic variability within the species.

#### **14.3.2 Information dissemination**

- The NPWS will ensure that any new information resulting from research is disseminated to the recovery team, land managers, relevant government agencies and public authorities and that this knowledge is incorporated into revisions of this recovery plan.

## **15 Reassess conservation status**

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### **15.1 Recovery objective**

Reassessment of the conservation status of the Blue Mountains Water Skink upon implementation of recovery actions.

### **15.2 Performance criteria**

The national and State conservation status of the Blue Mountains Water Skink is reassessed, and if appropriate, a recommendation is made for downlisting the species from endangered to vulnerable.

### **15.3 Recovery actions**

Reassess the conservation status of the Blue Mountains Water Skink.

#### **15.3.1 Reassess conservation status**

- The NPWS and the recovery team will reassess the National and State conservation status of the Blue Mountains Water Skink once the success of habitat management and ongoing assessment actions have been evaluated (Section 12.3) and the true distribution, number of populations and status of populations has been established (sections 10.3 and 11.3).
- This action will be undertaken in the final year of recovery plan implementation.

## 16 Implementation

### 16.1 Implementation schedule

Table 2 allocates responsibility for the implementation of recovery actions specified in this plan to relevant government agencies for the five-year life of this plan.

**Table 2. Implementation schedule**

Action	Description	Responsibility	Timeframe
<b>10</b>	<b>Targeted survey</b>		
10.3.1	Identification of potential habitat	NPWS	Year 1
10.3.2	Assessment of potential habitat	NPWS	Life of plan
<b>11</b>	<b>Population monitoring</b>		
11.3.1	Monitoring of population status	NPWS	Life of plan
<b>12</b>	<b>Threat and habitat management</b>		
12.3.1	Identification, monitoring and amelioration of threats at each site	NPWS, BMCC, SFNSW, SCA	Years 1, 3 & 5 with ongoing amelioration subject to funding
12.3.2	Environmental planning, impact assessment and development consent	D/C Authorities, NPWS, SCA, SFNSW, BMCC	Ongoing as required
12.3.3	Specific threat abatement actions	NPWS, SFNSW, SCA, BMCC	Life of plan
12.3.4	Management of cat predation	NPWS, BMCC, Recovery Team	Life of plan
12.3.5	Management of fire	BMCC, NPWS, SFNSW, SCA, BFMC	Ongoing as required
<b>13</b>	<b>Public awareness and involvement</b>		
13.3.1	Increasing community awareness	NPWS, BMCC	Life of plan
13.3.2	Increasing community involvement in recovery efforts	NPWS, BMCC, Recovery Team	Life of plan
13.3.3	Informing and involving affected landholders and managers	NPWS	Life of plan
13.3.4	Informing and educating local and State government agencies and public authorities	NPWS, BMCC, SFNSW, SCA	Life of plan
13.3.5	Informing and involving researchers and students	NPWS	
<b>14</b>	<b>Research</b>		
14.3.1	Encouragement of research	NPWS	Life of plan
14.3.2	Information dissemination	NPWS	Life of plan
<b>15</b>	<b>Reassess conservation status</b>		Life of plan
15.3.1	Reassess conservation status	NPWS, Recovery Team	Year 5

Key: D/C Authorities- determining and consent authorities under the EP&A Act; NPWS- National Parks and Wildlife Service; SFNSW- State Forests of NSW; BMCC- City of Blue Mountains Council; SCA- Sydney Catchment Authority; BFMC- Blue Mountains Bush Fire Management Committee.

## 16.2 Implementation costs

The recovery actions and recommendations identified in this plan state what must be done to ensure the recovery of the endangered Blue Mountains Water Skink *Eulamprus leuraensis*. Table 3 identifies the costs needed to implement those actions that require funding for implementation.

**Table 3. Implementation costs**

Action	Description	Year of implementation					Total	Source of funding					
		1	2	3	4	5		NPWS Blue Mtns Region <sup>1</sup>	NPWS Central Directorate <sup>2</sup>	BMCC <sup>3</sup>	SFNSW <sup>4</sup>	SCA <sup>5</sup>	Unfunded
10	Targeted survey	6,500	2,250	2,250	2,250	2,250	15,500	2,500	9,250	1,250	1,250	1,250	
11	Population monitoring	10,000	7,000	7,000	7,000	7,000	38,000		30,500	2,500	2,500	2,500	
12	Threat and habitat management*	9,750 <sup>α</sup>	5,000 <sup>α</sup>	9,750 <sup>α</sup>	5,000 <sup>α</sup>	9,750 <sup>α</sup>	39,250	3,750	7,500	750	1,500	750	25,000
13	Public awareness and involvement	10,400	4,150	4,150	4,150	4,150	27,000	1,250	17,250	3,000	2,500	2,500	500
14	Research	2,500 <sup>β</sup>	2,500 <sup>β</sup>	2,500 <sup>β</sup>	2,500 <sup>β</sup>	2,500 <sup>β</sup>	12,500						12,500
15	Reassess conservation status					1,000	1,000		1,000				
	<b>Total</b>	39,150	20,900	25,650	20,900	26,650	133,250	7,500	65,500	7,500	7,750	7,000	38,000

Key:

\* Much of action 12 has no direct cost, as it is part of normal day to day operations.

<sup>α</sup> Site restoration works are estimated at \$5000 per year, but costs are likely to vary from year to year.

<sup>β</sup> \$2,500 is allocated towards research each year but costs are likely to vary from year to year.

<sup>1</sup> Recurrent regional operational funds

<sup>2</sup> Central Directorate recurrent funds

<sup>3</sup> BMCC operational funds

<sup>4</sup> SFNSW operational funds

<sup>5</sup> SCA operational funds

## **17**                    **Preparation details**

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Deborah Ashworth and Kersten Tuckey prepared this recovery plan in consultation with the Blue Mountains Water Skink Recovery Team.

### **17.1**                    **Date of last amendment**

This document is the first recovery plan for the Blue Mountains Water Skink. No amendments to the plan have been made.

### **17.2**                    **Review date**

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

## **18                      Contacts**

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**THREATENED SPECIES INFORMATION**



# Blue Mountains Water Skink

*Eulamprus leuraensis* (Wells and Wellington, 1984)

**Other common names:** Leura Skink, Blue Mountains Swamp Skink

## Conservation status

The Blue Mountains Water Skink is listed as an **endangered species** on Schedule 1 Part 1 of the New South Wales *Threatened Species Conservation Act 1995* (TSC Act). The species is also listed as an **endangered species** on the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*.

## Description

The Blue Mountains Water Skink is a medium sized lizard that reaches a maximum weight of approximately 10g. It grows to a maximum total length of approximately 200mm, with a maximum snout-vent length of about 80mm (LeBreton, 1996).



**Gatenby 1999**

The body of the Blue Mountains Water Skink is much darker than the other species of *Eulamprus* found in the Blue Mountains. Across its back it is very dark brown to black with narrow yellow/bronze to white stripes along its length to the beginning of the tail and continuing along the tail as a series of spots. This gives the appearance of a

distinctive dark dorsal stripe bordered by yellow lines. The limbs and sides are also dark brown to black with yellow to bronze streaks and small blotches. The head is brown to bronze with black flecks and its underside is cream to golden yellow with small dark blotches. The limbs are well developed and all have five digits.

## Distribution

Surveys to date suggest that the distribution of the Blue Mountains Water Skink occurs entirely within the Blue Mountains (middle and upper) west of Sydney, NSW. It is currently known from 30 locations extending from Newnes Plateau in the north and west to just south of Hazelbrook in the south and east.

It is possible that additional locations will be identified, and these may lie outside the currently known distribution.

## Occurrences in conservation reserves

Of the 30 known locations, 16 occur primarily in the Blue Mountains National Park. The remainder occur primarily on land managed by other local and State Government agencies. A total of seven locations occur, in part, on privately owned land.

## Habitat

The Blue Mountains Water Skink is a high elevation species and at present the lowest altitude recorded for this species is 560m at Williams Ridge, south of Hazelbrook, NSW. Surveys to date suggest that the Blue Mountains Water Skink is restricted to an isolated and naturally fragmented habitat of sedge and shrub swamps (Keith and Benson, 1988) that have boggy soils and appear to be permanently wet (LeBreton, 1996). The vegetation in these swamps typically takes

the form of a sedgeland interspersed with shrubs, but may be a dense shrub thicket.

## Ecology

Little is known about the biology and ecology of the Blue Mountains Water Skink. It is semi-aquatic (Wells and Wellington, 1985) and is active on warm sunny days from September until late April (LeBreton, 1996). From scats it has been established that skinks feed on grasshoppers, flies, moths, weevils and wasps. A small fruit with a seed was found in a scat at Leura (LeBreton, 1992).

Females give birth to live young (ovoviviparous) in late December (LeBreton, 1996). When disturbed the Blue Mountains Water Skink rapidly takes to shelter in dense grass tussocks or down holes.

## Threats

The small number and apparent isolation of populations in conjunction with the limited geographic distribution of the Blue Mountains Water Skink make it vulnerable to the operation of threatening processes. Clearing for urban development as well as associated disturbance to habitat has resulted in the reduction of the area of known and potential habitat as well as the apparent extinction from areas where this species previously occurred.

Possible threats include urban development (some locations are almost completely surrounded by houses and other locations have adjacent land zoned for further development), pollution and sedimentation (including stormwater run-off), alterations to

## For Further Information contact

Threatened Species Unit, Central Directorate, NSW NPWS PO Box 1967, Hurstville NSW 2220  
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## References

- Keith, D.A. and Benson, D.H. 1988. Natural vegetation of the Katoomba area. *Cunninghamia* **2**: 107-143.
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- Wells, R.W. and Wellington, C.R. 1985. A classification of the Amphibia and Reptilia of Australia. *Australian Journal of Herpetology Supplementary Series No. 1*. Pp. 1-61.

hydrological regimes (through construction of roads, tracks, plantations, mining subsidence), weed invasion, visitor disturbance (trail bikes, 4WD) and predation by cats.

## Management

Management should initially be directed at protecting known sites from threats through, for example, appropriate weed, pollution and stormwater runoff control. Further survey in potential habitat, and monitoring of the status of representative populations is also needed to identify the full distribution of the species and allow application of appropriate management. A public education program needs to be undertaken to raise awareness of the conservation status of the skink and the processes that threaten it.

Further research is needed to investigate key areas of the biology and ecology of the skink that are likely to provide information that is valuable to the recovery of the species or relevant to its management. These include research into the life history, population dynamics, home range and movement patterns, habitat requirements and response to disturbance.

## Recovery Plans

The Minister for the Environment approved the recovery plan for the Blue Mountains Water Skink in August 2001. Copies may be viewed at [www.npws.nsw.gov.au](http://www.npws.nsw.gov.au)

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**ENVIRONMENTAL IMPACT  
ASSESSMENT GUIDELINES**



# Blue Mountains Water Skink

*Eulamprus leuraensis* (Wells and Wellington, 1984)

**Other common names:** Leura Skink, Blue Mountains Swamp Skink

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

Current knowledge suggests Blue Mountains sedge swamps and Newnes Plateau shrub swamps as described and mapped in Keith and Benson (1988), Benson and Keith (1990) and Benson (1992) make up the bulk of the habitat for the species.

These swamps occur primarily between Newnes Plateau in the north and west and Hazelbrook in the south and east. However, scattered habitat occurs beyond these areas (LeBreton, 1996).

Boyd Plateau Bogs and Cox's River swamps are other, less likely, but potential habitat.

Characteristic plant species in these swamps are *Gymnoschoenus sphaerocephalus* (Button Grass), *Baeckea linifolia*, *Hakea teretifolia* (Dagger Hakea), *Grevillea acanthifolia*, *Tetrarrhena turfosa*, *Xyris ustulata*, *Empodisma minus* and *Lepidosperma limicola* (Blade Grass) (Keith and Benson 1988; LeBreton, 1996) although not all swamps contain all of these species.

The Blue Mountains Water Skink can be distinguished from the other species of *Eulamprus* found in the Blue Mountains by its much darker body and the yellow/bronze to white contrasting markings. In particular, it has the appearance of a distinctive dark dorsal stripe bordered by yellow lines.

Surveys should be carried out in suitable habitat when skinks are most likely to be active on warm sunny days between September and late April. Surveys should be conducted in cognisance of factors affecting activity, particularly weather conditions. Blue Mountains Water Skinks have been successfully surveyed using pitfall traps (LeBreton, 1996).

## Life cycle of the species

Little is known about the biology and ecology of the Blue Mountains Water Skink. As a result limited information is available on key resources required for different activities including breeding, foraging, basking, shelter, hibernation and dispersal.

Soil moisture and leaf litter depth appear to be important determinants of skink abundance, with skinks preferring areas with wetter soils and deeper leaf litter (LeBreton, 1996).

As with most reptiles, the Blue Mountains Water Skink is thought to bruminate during the winter. Shea and Peterson (1985) collected two inactive specimens on the edge of the swamp at Wentworth Falls Lake following winter rains. This may suggest that some individuals move out of the waterlogged areas of swamp into surrounding vegetation in the winter to take advantage of cover when available.

No specific information is currently available about the habitat requirements of the Blue Mountains Water Skink when breeding. Basking sites are likely to be important to elevate body temperatures, especially for breeding females.

The Blue Mountains Water Skink has been known to use burrows constructed by yabbies (Shea and Peterson, 1985), and possibly Giant Burrowing Frogs (M. LeBreton pers. comm., 1999). Nothing is known of how (or even if) this species disperses between swamps. Dispersal may take place along creeklines (R. Wells pers. comm., 1999).

## **Threatening processes**

The *Threatened Species Conservation Act* 1995 lists a number of key threatening processes relevant to the Blue Mountains Water Skink. These include:

- Fox Predation,
- High Frequency Fire, and
- Cat Predation.

Processes generally accepted as adversely affecting the species are discussed below.

Habitat loss and alteration caused by urban development. Associated threats includes weed invasion, access related disturbances, pollution and sedimentation, alterations to hydrological regimes, predation by cats and altered fire regimes. Maintenance of service corridors and easements for utilities, and associated alterations to habitat may pose a significant threat at swamps that are crossed by such easements.

Grazing, firewood collection, native forest harvesting, and inappropriate fire regimes are other processes that disturb the habitat of the Blue Mountains Water Skink and may pose a threat to populations.

## **Viable local populations**

The viability of local populations is likely to be threatened by those processes mentioned above. Populations should be considered viable if resources are available for populations to continue to carry out lifecycle processes (i.e. young are successfully recruited into the adult population and commence breeding).

Consideration also needs to be given to the ability of individuals to disperse between populations. LeBreton (1996) found that distances between swamps with skinks were important determinants of whether skinks occupied potential habitat. This may indicate that maintenance of connectivity between populations is very important for the long-term viability of local populations.

## **A significant area of habitat**

Given that the Blue Mountains Water Skink is known from only 30 locations within a highly restricted and fragmented distribution, any loss of habitat should be considered significant. This includes direct loss, as well as alteration to habitat.

Accordingly, protection not just of known sites but also potential habitat is very important. Even if skinks do not appear to presently use a site, it may become an important refuge when other sites are degraded or when climatic conditions alter the suitability of swamps in other areas.

## **Isolation & fragmentation**

The distribution of the Blue Mountains Water Skink is highly fragmented. At present there is limited information on how skinks use areas outside the swamp itself or the extent of movement of individuals between populations.

However maintenance of contiguous habitat, and protection of streams between populations should be considered important, as should the prevention of activities that alter the existing hydrological regimes of swamps.

## **Regional distribution**

The TSC Act defines region as the regions defined in the Interim Biogeographic Regionalisation of Australia. The known distribution of the Blue Mountains Water Skink is confined to the South Eastern Highlands region.

## **Limit of known distribution**

The known distribution of the Blue Mountains Water Skink occurs within the Blue Mountains (middle and upper) between Newnes Plateau in the north and west and Hazelbrook in the south and east.

Further survey of potential habitat may identify additional populations and range extensions.



## **Representation in conservation reserves**

The species appears reasonably well represented in conservation reserves. Of the 30 known locations, 16 occur primarily in the Blue Mountains National Park. A further eight populations occur within State forest and are protected from harvesting activities by riparian buffers. The majority of other swamps containing populations are zoned Environment Protection. Further potential habitat also occurs within National park and this may contain additional populations of the Blue Mountains Water Skink.

However, it is not known whether the species' genetic variation is adequately reserved. Individual populations are likely to vary genetically as a result of the isolation of habitat and apparently limited scope for dispersal between populations.

## **Critical habitat**

There is currently no critical habitat declared for the Blue Mountains Water Skink.

## **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](http://www.npws.nsw.gov.au)

## **References**

- Benson, D.H. 1992. Natural vegetation of the Penrith 1:100 000 map sheet. *Cunninghamia* **2**: 541-596.
- Benson, D.H. and Keith, D.A. 1990. Natural vegetation of the Wallerawang area. *Cunninghamia* **2**: 305-335.
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- Shea, G.M. and Peterson, M. 1985. The Blue Mountains Water Skink, *Sphenomorphus leuraensis* (Lacertilia: Scincidae): A redescription with notes on its natural history. *Proceedings of the Linnean Society of NSW* **108**: 141-148.

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### **Appendix 3. Description of sites with preliminary site assessment data**

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#### **Site 1 Newnes Plateau, Wolgan River**

##### **Location**

Map Sheet 8931-3-N Cullen Bullen

AMGE 236000

AMGN 6308000

##### **Altitude**

1000

##### **Previous records**

Kingston *et al.* 1979 (trapped)

##### **Tenure**

State Forest

##### **Description**

shrub swamp

##### **Possible threats**

Mining subsidence

#### **Site 2 Newnes Plateau, Carne Creek**

##### **Location**

Map Sheet 8931-3-N Cullen Bullen

AMGE 241000

AMGN 6305000

##### **Altitude**

1060

##### **Previous records**

Kingston *et al.* 1979 (trapped)

##### **Tenure**

State Forest

##### **Description**

Very dry, steep sloping

Forest encroaching into swamp

Low shrubland

##### **Possible threats**

Drying out

Risk of high intensity burn if dry

Encroachment of forest if remains dry

Mining subsidence

### **Site 3 Newnes Plateau, Carne Creek (NP5)**

#### **Location**

Map Sheet 8931-3-S Lithgow

AMGE 240200

AMGN 6302200

#### **Altitude**

1080

#### **Previous records**

1996 M. LeBreton (trapped), relative abundance 0.25

#### **Tenure**

State Forest

#### **Description**

Low shrubland

#### **Possible threats**

Mining subsidence

### **Site 4 Newnes Plateau, Carne Creek (NP6)**

#### **Location**

Map Sheet 8931-3-S Lithgow

AMGE 241100

AMGN 6302600

#### **Altitude**

1070

#### **Previous records**

1994 M. LeBreton (observed)

1996 M. LeBreton (trapped), relative abundance 0.08

#### **Tenure**

State Forest

#### **Description**

Low shrubland

#### **Possible threats**

Mining subsidence

### **Site 5 Newnes Plateau, Carne Creek (NP4)**

#### **Location**

Map Sheet 8931-3-S Lithgow

AMGE 242000

AMGN 6302900

#### **Altitude**

1050

#### **Previous records**

1996 M. LeBreton (trapped), relative abundance 0.24

**Tenure**

State Forest

**Description**

Pine plantation in catchment

Low shrubland

**Possible threats**

Encroachment of pine

Altered hydrology

Runoff from roads

Mining subsidence

**Site 6 Newnes Plateau (NP1)****Location**

Map Sheet 8931-3-S Lithgow

AMGE 242900

AMGN 6302600

**Altitude**

1060

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.07

**Tenure**

State Forest

**Description**

Built up road intersects swamp

Bordered right to edge of swamp in eastern, northern and western sides by pine plantation

Pines sprouting in swamp

Low shrubland

**Possible threats**

Altered hydrology- road cuts off a headwater tributary, pine plantation

Encroachment of pine

Mining subsidence

**Site 7 Newnes Plateau, Bungleboori Creek****Location**

Map Sheet 8931-3-S Lithgow

AMGE 241000

AMGN 6300000

**Altitude**

1100

**Previous records**

Kingston et al. 1979 (trapped)

**Tenure**

State Forest

**Description**

Bordered by pine plantation on western side

Small pines sprouting in swamp

Adjacent to maze of roads

Steep sided into swamp

**Possible threats**

Encroachment of pine

Altered hydrology

Low-medium shrubland

Coal mining subsidence

**Site 8 Bennett Gully, Blackheath (BH2)****Location**

Map Sheet 8930-1-N Mount Wilson

AMGE 252100

AMGN 6278600

**Altitude**

910

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.17

**Tenure**

National Park

**Description**

Wet

Steep sided

Low vegetation

**Site 9 near Hat Hill, Blackheath (BH3)****Location**

Map Sheet 8930-1-N Mount Wilson

AMGE 252300

AMGN 6278000

**Altitude**

960

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.57

**Tenure**

National Park

**Description**

Very wet with north easterly and south westerly aspect

Adjacent to road

Low vegetation

**Possible threats**

Erosion from road drains

Altered hydrology from road

**Site 10 near Hat Hill, Blackheath (BH4)****Location**

Map Sheet 8930-1-N Mount Wilson

AMGE 252200

AMGN 6277500

**Altitude**

950

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.5

**Tenure**

National Park/private

**Description****Large****Low grassy vegetation**

Localised sedimentation on edges

Good condition

**Possible threats**

Residential development in adjacent or nearby areas

**Site 11 near Govetts Leap Brook, Blackheath (BH7)****Location**

Map Sheet 8930-1-S Katoomba

AMGE 250400

AMGN 6275100

**Altitude**

980

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.28

**Tenure**

National Park/private

**Description**

High shrubs and sedges

Underscrubbed in private property with exotic gardens abutting and in swamp at western (upper) end

Intersected by powerline

Houses and road to edge of swamp, one residence actually in western end of swamp

Blackberry in swamp

Sediment erosion into swamp

Weeds are a serious problem

**Possible threats**

Weed invasion

Pollution

Stormwater runoff

Further clearing to build houses

Sedimentation

Residential development in habitat and adjacent areas

Predation by cats

Disturbances associated with maintenance of service corridors/easements

**Site 12 near Govetts Leap Brook, Blackheath (BH5)**

**Location**

Map Sheet 8930-1-S Katoomba

AMGE 250600

AMGN 6274500

**Altitude**

970

**Previous records**

1994 M. LeBreton (trapped)

1996 M. LeBreton (trapped), relative abundance 0.75

**Tenure**

National Park

**Description**

Fairly small swamp extending parallel and intersected by powerline corridor

High shrubs and sedges

Sediment impacts associated with easement

Burnt in 1994 (backburn). Localised sedimentation on edges

Some rubbish dumping along powerline corridor

**Possible threats**

Pollution from septic tanks

Residential development in adjacent or nearby areas

Disturbances associated with maintenance of service corridors/easements

Access related disturbances, signs of frequent use



## Site 13 Hayward Gully, Blackheath (BH6)

### Location

Map Sheet 8930-1-S Katoomba

AMGE 251300

AMGN 6273800

### Altitude

950

### Previous records

1996 M. LeBreton (trapped), relative abundance 0.25

### Tenure

National Park/private (small part)

### Description

Intersected by powerline and degraded road at south west end

High shrubs and sedges

### Possible threats

Residential development in adjacent or nearby areas

Disturbances associated with maintenance of service corridors/easements

## Site 14 Blackheath Special Area

### Location

Map Sheet 8930-1-S Katoomba

AMGE 249200

AMGN 6272600

### Altitude

980

### Previous records

1994 M. LeBreton (trapped- 13 individuals)

### Tenure

Sydney Catchment Authority Special Area

### Description

Button Grass (*Gymnoschoenus sphaerocephalus*) is the dominant plant and has formed a dense cover in the swamp. *Lepidosperma limicola* and *Leptospermum juniperinum*, *Baeckea linifolia* and *Grevillea acanthifolia* occur as well and usually grow from amongst the Button Grass. The margin of the swamp grades to open forest with *Eucalyptus piperata* and *E. sieberi* the dominant species. Exotic pine trees (*Pinus radiata*) have been planted extensively nearby and in some places these plantations abut the swamp. Pine trees have colonised parts of the open forest and the occasional individual is growing in the swamp.

Surrounded by forest, some large shrubs in amongst sedges (invading swamp)

Very high tussocks

Intersected by powerline corridor

**Possible threats**

Access

Runoff from roads

Disturbances associated with maintenance of service corridors/easements

Residential development in adjacent or nearby areas

**Other comments**

Invasion of heath

**Site 15 Urella Brook, Mt Hay Range (MH7)**

**Location**

Map Sheet 8930-1-S Katoomba

AMGE 258000

AMGN 6273200

**Altitude**

800

**Previous records**

1995 M. LeBreton

1996 M. LeBreton (trapped), relative abundance 0.25

**Tenure**

National Park

**Description**

Large swamp

Surrounded by *Melaleuca* forest

High sedges, wet

**Site 16 Wirralie Brook, Mt Hay Range (MH6)**

**Location**

Map Sheet 8930-1-S Katoomba

AMGE 258600

AMGN 6274200

**Altitude**

760

**Previous records**

1995 M. LeBreton

1996 M. LeBreton (trapped), relative abundance 0.27

**Tenure**

National Park

**Description**

Very large swamp

Intersected by forest in many areas

Heath also in parts of swamp

High sedges in part of swamp  
Surrounded by *Melaleuca* forest

#### **Site 17 near Henson Glen, Mt Hay Range (MH4)**

##### **Location**

Map Sheet 8930-1-S Katoomba

AMGE 253900

AMGN 6271200

##### **Altitude**

910

##### **Previous records**

1995 M. LeBreton

1996 M. LeBreton (trapped), relative abundance 0.21

##### **Tenure**

National Park

##### **Description**

Good condition, not overgrown with weeds or heath

Quite wet, surrounded by forest. Low sedges and shrubs

#### **Site 18 Katoomba Special Area**

##### **Location**

Map Sheet 8930-1-S Katoomba

AMGE 249250

AMGN 6269050

##### **Altitude**

980

##### **Previous records**

1994 M. LeBreton (trapped- 3 individuals)

##### **Tenure**

Sydney Catchment Authority Special Area

##### **Description**

Intersected by powerline, cleared under powerline- but overgrown

Overgrown with high impenetrable heath

##### **Possible threats**

Access and disturbances associated with maintenance of service corridors/easements

##### **Other comments**

Invasion by heath

#### **Site 19 Swamps bordering Leura Falls Creek, Leura Park**

##### **Location**

Map Sheet 8930-1-S Katoomba

AMGE 252000  
AMGN 6266000

**Altitude**

920

**Previous records**

1991/1992/1994 M. LeBreton (Observed/trapped 1-5/17 individuals)

**Tenure**

Crown Recreation Reserve managed by Blue Mountains City Council/edges private

**Description**

Long unburnt

Permanent creek running north drains S. Katoomba industrial area.

Not very much heathy vegetation along creek edges

Subject to heavy runoff after rain, rather than slow seepage

Patches of sedge vegetation in places along creek edges

Overgrown with exotics/weeds especially along creekline and behind houses (incl. Blackberry, Broome, Privet, Honeysuckle, deciduous trees, Ivy, Montbretia, Cherry Laurel)

Degraded

Major earthworks and alterations to drainage e.g. dirt fill has been dumped in swamp

Intersected by main road

Surrounded by houses

Encroached on all sides by urbanisation

Criss-crossed by unofficial tracks used by local residents

Intersected by underground sewerage pipeline- sewer main, old pipes, joints failing, full of tree roots

**Possible threats**

Residential development in adjacent or nearby areas

Access related disturbances, informal walking track formation

Stormwater runoff from residential and industrial lands into catchment upslope.

Erosion and sedimentation

Rubbish dumping

Pollution- rubbish dumping, urban run-off, leaking sewer pipes

Weed invasion, especially along watercourse and around former sewerage line

Changed hydrology

Predation by cats

Disturbances associated with maintenance of service corridors/easements

Prescribed burning and perimeter slashing for bushfire risk management

**Site 20 Wentworth Falls Lake**

**Location**

Map Sheet 8930-1-S Katoomba

AMGE 255600

AMGN 6267000

**Altitude**

980

**Previous records**

1985 Shea and Peterson (observed)

1989 M. LeBreton (observed)

**Tenure**

Crown Recreation Reserve managed by Blue Mountains City Council/edges private

**Description**

Long unburnt, except part of swamp near Bass Road burned in early 90s (hazard reduction burn)

Adjacent to picnic area and formal walking tracks, as well as unofficial tracks used by local residents/fishermen

Overgrown with high impenetrable heath

Powerline corridor at western edge of lake has been slashed at tree zone

Intersected by above ground sewerage pipeline

Some infestation of weeds (incl. Willow, Broome, Honeysuckle, Blackberry, Erica, Buttercups, Montbretia) especially along drainage line from Waratah Rd urban area and at stormwater discharge points (esp. Banksia Rd, Sinclair Cres.).

**Possible threats**

Residential development in adjacent or nearby areas

Erosion and sedimentation

Weed invasion, especially along drainage lines off surrounding developed area.

Disturbances associated with maintenance of service corridors/easements

Stormwater runoff

Rubbish dumping

Pollution

Access related disturbances

Predation by cats

Arson fires

Informal track formation, breaking down of lake banks

**Other comments**

Invasion by high heath

**Site 21 Lawson****Location**

Map Sheet 8930-1-S Katoomba

AMGE 263000

AMGN 6268000

**Altitude**

660

**Previous records**

1994 M. Vaarwerk (observed)

**Tenure**

National Park

**Description**

Large swamp

Quite large sedgy grasses- less shrubby

**Possible threats**

Residential development in adjacent or nearby areas

Access related disturbances

**Site 22 Kings Tableland, near Wentworth Falls (KT1)****Location**

Map Sheet 8930-11-N Jamison

AMGE 257400

AMGN 6260900

**Altitude**

780

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.42

**Tenure**

National Park/private

**Description**

Some infestation by blackberry and pampas grass along edge of road.

Invaded in part by high impenetrable heath

High sedges and shrubs

**Possible threats**

Residential development in adjacent or nearby areas

Weed invasion

**Other comments**

Invasion by heath

**Site 23 Williams Ridge, south of Lawson (WF6)****Location**

Map Sheet 8930-11-N Jamison

AMGE 259400

AMGN 6260800

**Altitude**

710

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.64

**Tenure**

National Park

**Description**

Quite patchy heathy vegetation, interspersed with Button Grass

**Site 24 Williams Ridge, south of Lawson (WF7)****Location**

Map Sheet 8930-11-N Jamison

AMGE 260900

AMGN 6260800

**Altitude**

680

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.6

**Tenure**

National Park

**Description**

Swamp interspersed with high heath

High shrubs and sedges in places

Surrounded by forest

**Other comments**

Invasion by heath

**Site 25 Williams Ridge, south of Lawson (WF5)****Location**

Map Sheet 8930-11-N Jamison

AMGE 261900

AMGN 6260600

**Altitude**

630

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.88

**Tenure**

National Park

**Description**

Surrounded by forest

Heath overtaking swamp in parts

**Possible threats**

Invasion by heath

**Site 26 Williams Ridge, south of Hazelbrook, above Ingar Picnic Ground (WF1)****Location**

Map Sheet 8930 Jamison

AMGE 264600  
AMGN 6259900

**Altitude**

560

**Previous records**

1996 M. LeBreton (trapped), relative abundance 0.05

**Tenure**

National Park

**Description**

High heath interspersed with, and surrounded by open forest

**Possible threats**

Invasion by heath

**Site 27 Franks Creek, Wentworth Falls**

**Location**

Map Sheet 8930-1-S Katoomba

AMGE 256700

AMGN 6268050

**Previous records**

2 adult and 2 juvenile skinks observed 2/2/00 (Ashworth)

**Tenure**

National Park/private/ Crown Recreation Reserve managed by Blue Mountains City Council

**Zoning**

EP/National park

Reserve number 42185

**Description**

Large swamp intersected by powerline

**Possible threats**

Residential development around swamp

Pollution

Weed invasion

Stormwater runoff and sedimentation

Predation by cats

Disturbances associated with maintenance of service corridors/easements

Altered hydrology in stream (spring water bottling)

**Site 28 Jamison Creek, Wentworth Falls**

**Location**

Map Sheet 8930-1-S Katoomba

AMGE 256600

AMGN 6266400



**Altitude**

850

**Previous records**

2001, Turton and Johnson, 1 skink observed

**Tenure**

Crown Land

**Description**

Observed sunning on bridge over swamp vegetation

Surrounded by forest and urban development

**Possible threats**

Residential development around swamp

Pollution

Weed invasion

Stormwater runoff and sedimentation

Predation by cats

**Site 29 Carne Creek Tributary, Newnes Plateau****Location**

Map Sheet 8931-3-S Lithgow

AMGE 239150

AMGN 6302750

**Altitude**

1080

**Previous records**

2001, Tuckey, 1 skink observed

**Tenure**

State Forest

**Description**

Swamp interspersed with high heath, surrounded by forest

High shrubs and sedges in places

**Possible threats**

Mining subsidence

**Site 30 Bedford Creek Tributary, Blue Mountains National Park****Location**

Map Sheet 8930-11-N Jamison

AMGE 260900

AMGN 6260800

**Altitude**

680

**Previous records**

Feb 2001, Tuckey, 1 skink observed, Sept 2001 Tuckey, 1 skink observed

**Tenure**

National Park

**Description**

Swamp interspersed with high heath

High shrubs and sedges in places

Surrounded by forest

Burnt September 2001



scale of disturbance      none    localised    throughout area but in small patches    throughout area in large patches  
comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Commercial runoff**      yes    no  
scale of disturbance      none    localised    throughout area but in small patches    throughout area in large patches  
comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Septic tanks**      yes    no      Comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Garden escapes**    yes    no  
scale of disturbance      none    localised    throughout area but in small patches    throughout area in large patches  
Comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Pine plantations**    yes    no  
proximity to swamp \_\_\_\_\_ pines invading swamp?    yes    no  
scale of disturbance      none    localised    throughout area but in small patches    throughout area in large patches  
comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Logging**      yes    no  
scale of disturbance      none    localised    throughout area but in small patches    throughout area in large patches  
comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Sedimentation**      yes    no  
scale of disturbance      none    localised    throughout area but in small patches    throughout area in large patches  
comments (include reason for sedimentation, how widespread it is) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Grazing**      yes    no  
scale of disturbance      none    localised    throughout area but in small patches    throughout area in large patches  
comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Mining subsidence**      yes    no      comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Firewood collection**      yes    no      comments \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Other** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



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