

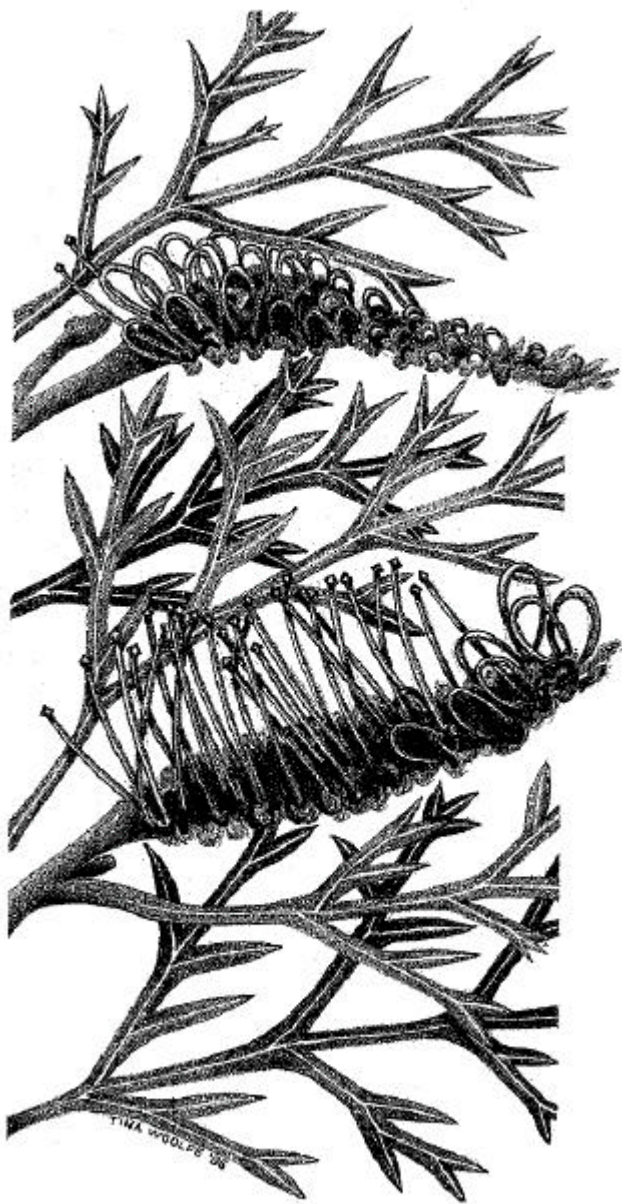
Approved NSW & National  
Recovery Plan

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*Grevillea beadleana*

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July 2004



Department of  
**Environment and Conservation (NSW)**



**Natural Heritage Trust**  
*Helping Communities Help Australia*  
A Commonwealth Government Initiative

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# Recovery Plan for the *Grevillea beadleana*

## Foreword

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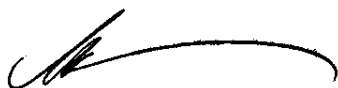
The New South Wales Government established a new environment agency on 24 September 2003, the Department of Environment and Conservation, which incorporates the New South Wales National Parks and Wildlife Service. Responsibility for the preparation of Recovery Plans now rests with this new department.

This document constitutes the formal New South Wales State Recovery Plan for the *Grevillea beadleana* and considers the conservation requirements of the species across its known range. It identifies the actions to be taken to ensure the long-term viability of the species in nature and the parties who will undertake these actions.

The *Grevillea beadleana* is included as Endangered on the NSW *Threatened Species Conservation Act* 1995, and Endangered on the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999. *Grevillea beadleana* is a single-stemmed spreading shrub up to 2.5 m high and 2 m wide. *Grevillea beadleana* is known from four disjunct localities in northern NSW, including the Binghi region to the north of Torrington, above the Macleay gorges escarpment near Enmore, the Guy Fawkes River National Park north of Ebor and the Chambigne Nature Reserve south-west of Grafton. *Grevillea beadleana* was previously known last century from near Walcha, however, despite searches, it has not been relocated in this area.

The future recovery actions detailed in this Recovery Plan include: (i) surveys; (ii) research; (iii) habitat protection; (iv) threat abatement and management; and (v) community awareness.

It is intended that this Recovery Plan will be implemented over a five year period. Actions will be undertaken by the New South Wales Department of Environment and Conservation.



**TONY FLEMING**

Acting Director-General



**BOB DEBUS MP**

Minister for the Environment

## Acknowledgments

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This Recovery Plan was prepared by Dr Caroline Gross of University of New England and Andrew Steed of New South Wales Department of Environment and Conservation, with assistance from members of the *Grevillea beadleana* Recovery Team. The Recovery Team comprised Dr Caroline Gross and Andrew Steed together with Rachel Bailey and Danny Corcoran and Peter Croft of New South Wales Department of Environment and Conservation and private landholders Barry and Leonie McWhinney. This document has substantially revised the original Recovery Plan prepared by John Benson of the Royal Botanic Gardens, and his contribution in preparing that plan is greatly appreciated. Andrew Leys reviewed and edited the Recovery Plan, providing valuable input.

Research undertaken in the last three years has been supported by the Biodiversity Group, Environment Australia's Endangered Species Program, University of New England and by the former New South Wales National Parks and Wildlife Service (now the NSW Department of Environment and Conservation). Data on the ecology and distribution of the species were collected by Dr Caroline Gross and University of New England students J. Streat, J.A. Smith and J. Durbin, working under permit number A1712. Additional data was gathered by P. Gilmour, M. Dwyer, D. Redman, D. Hardman, P. Croft and A. Steed of New South Wales Department of Environment and Conservation. Field assistance provided by P. Lisle, L. Copeland, J. Williams, K. McGregor and F. Quinn of University of New England, D. Mackey, D. Corcoran and A. Prior of New South Wales Department of Environment and Conservation, and N. Taws is gratefully acknowledged. J.A. Smith and P. Lisle helped to maintain the glasshouse collection of *Grevillea beadleana*.

Sarah Caldwell (Mole Creek Nursery) is thanked for providing cultivated specimens of *Grevillea beadleana* and for sharing her propagation methods which, along with suggestions from W. Sheather Quinn of University of New England, provided the basis for future research. Anne Blaxland-Fuad, Katrina McKay and Simon Ferrier of New South Wales Department of Environment and Conservation are thanked for assisting with the modelling. Neville Fenton, Alex Floyd, Greg Roberts and John Williams are thanked for sharing their knowledge of *Grevillea beadleana*. David Mackay is thanked for the drawing of *Grevillea beadleana* on page 4 and Dr Caroline Gross for the use of the University of New England's laboratory and glasshouses. Tina Woolfe is thanked for providing the cover drawing.

Mr Barry McWhinney, owner of the property Grevillea Downs in the Binghi area north of Torrington kindly allowed continued access to his property to undertake ecological research and distribution surveys. Without the support of Mr McWhinney and his family, the knowledge of *Grevillea beadleana* would not have advanced.

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## 1 Current Conservation Status

*Grevillea beadleana* McGillivray (Proteaceae) has been listed as Endangered on both the New South Wales (NSW) *Threatened Species Conservation Act*, 1995 (TSC Act) and the Commonwealth *Environmental Protection and Biodiversity Conservation Act*, 1999 (EPBC Act) because it is likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival and evolutionary development cease to operate. At two locations population sizes have been reduced to such a critical level, and the habitat has been so drastically altered, that the species is in immediate danger of extinction. The species is only known to occur in northern NSW.

## 2 Description and Taxonomy

### 2.1 Description

#### Form and Habitat

*Grevillea beadleana* is a single-stemmed spreading shrub up to 2.5 m high and 2 m wide. It generally grows in gritty loam among granite outcrops in open scrub or woodland at the tops of gorges or undulating terrain, and also along creek-lines. These are areas with hot, dry summers and cold, wet or dry winters where there is an average rainfall of approximately 800–1250 mm per annum (Olde & Marriott 1995). Flowers are produced in spring to late autumn with birds and the introduced honeybee being their most frequent visitors.

#### Leaves

The leaves are spreading, 8–17 cm long, 5–11 cm wide (Makinson 1991), and pinnatisect with secondary or sometimes tertiary divisions with oblong to triangular ultimate lobes 2–11 cm wide. The upper surface of the leaves is sparsely haired and carries the midvein as a sunken groove. The lower surface is white and hairy, with the mid- and lateral veins prominent and the leaf margins slightly curved backwards (Olde & Marriott 1995). The leaves on the specimen collected near Walcha in 1887 differ moderately from the material collected from the Guy Fawkes River National Park (McGillivray 1993) and resemble the material collected recently from near Enmore (L. Copeland pers. comm.).

#### Inflorescence and Flower

The burgundy flowers of *Grevillea beadleana* are borne on a 35–50 mm flower stem (Figure 1). The short stalk of the flower is up to 20 mm. The flower stem bears 20–90 flowers which open progressively from the base of the inflorescence upwards, with a fully-open

inflorescence resembling a toothbrush. Burgundy pollen is presented on the far end of the pistil (pollen presenter). The mature buds and flowers produce nectar (Smith unpublished data). Accounts of the floral morphology of *G. beadleana* can be found in McGillivray (1986, 1993).

#### Fruit and Seed

The fruit is about 9–10.5 mm long and 5 mm wide (Figure 1). It is ovoid, narrowing gradually at the end, dorsally concave and has a dense cover of intertwined hairs with conspicuous purple stripes and blotches over a green background. The fruit can contain two ellipsoidal seeds approximately 9 mm long and 4 mm wide, the outer face with tiny wrinkles, and the inner face channelled around a flat central portion (Olde & Marriott 1995). The seeds do not bear an obvious food appendage or dispersal mechanism. Fruits soon open, releasing the seeds to the ground.

#### Similar and Related Species

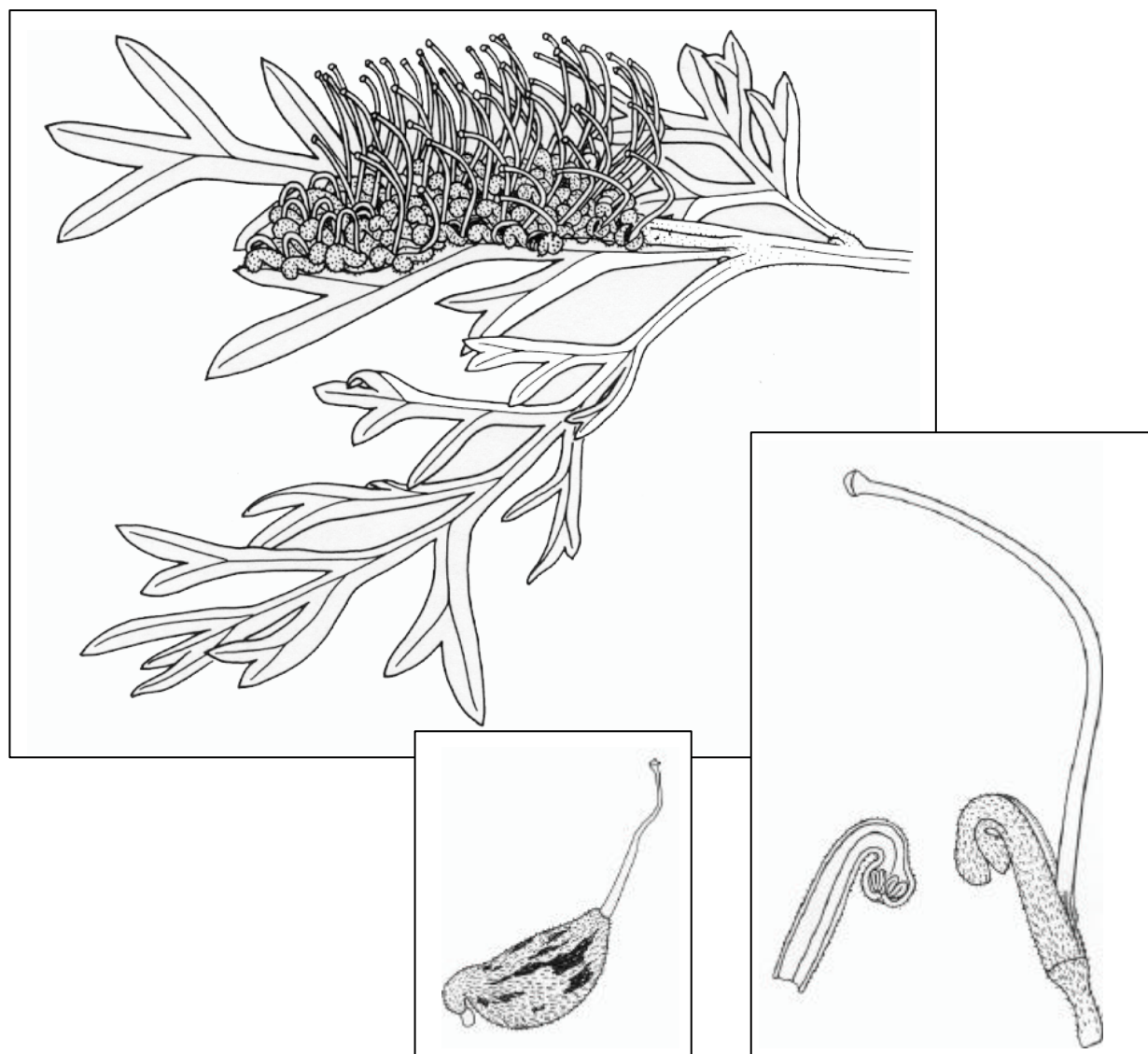
There are several species closely related to *Grevillea beadleana* including *G. caleyi*, *G. willisii* ssp. *willisii*, *G. acanthifolia* ssp. *acanthifolia* and *G. longifolia*. These species also belong to the “toothbrush inflorescence” group of *Grevillea*. *G. aspleniifolia* is another species that could be confused with *G. beadleana* as it has similar elongated, broadly linear, entire or toothed leaves. *G. willisii* ssp. *willisii* is vegetatively the most similar to *G. beadleana* but the species should not be confused in the field as they occur in widely-separated locations (McGillivray 1993). *G. beadleana* can also be confused in the vegetative state with *Lomatia silaifolia*.

### 2.2 Taxonomy

McGillivray (1986) published the name *Grevillea beadleana* in honour of Prof. Noel C. W. Beadle, the founding Professor of Botany at the University of New England. The holotype is lodged at the National Herbarium of NSW (McGillivray 1993).

### 2.3 Taxonomic significance

*Grevillea beadleana* is a member of the ancient Gondwanan family Proteaceae, which has had a presence in Australia for at least 65 million years (White 1994). The Proteaceae contains about 80 genera (1500 species) of which 50 genera (900 species) are found in Australia (Harden 1991). *Grevillea* is mostly restricted to Australia but is also found in New Guinea, Sulawesi and New Caledonia (Morely & Toelken 1983). Between 250 to 338 species of *Grevillea* are recognised as endemic to



**Figure 1. Inflorescence (x1.25), inner surface of tepals showing the anthers (x 5), flower and fruit (x 3.75) of *Grevillea beadleana*.**

Australia, with 53–68 species in NSW (Morely & Toelken 1983; Makinson 1991; Olde & Marriott 1995). *G. beadleana* is a member of the “toothbrush inflorescence” group of *Grevillea*. Several species within this group are threatened with extinction.

### 3 Distribution

*Grevillea beadleana* is known from four disjunct localities in northern NSW (Figure 2). The majority of plants are found in the Binghi region to the north of Torrington and west of the New England Highway. In this area, there are a number of separate populations over an area of about 30 km<sup>2</sup>, with an estimated total of about 40 000 plants. The next largest population is located on the tablelands above

the Macleay gorges escarpment near Enmore, 25 kms south-east of Armidale, in and adjacent to the Oxley Wild Rivers National Park. In Guy Fawkes River National Park, 30 kms north of Ebor, there are two populations, separated by about 20 kms and totalling 700 plants. The other population, consisting of only four plants, is located at Chambigne Nature Reserve 30 kms south-west of Grafton on an escarpment in the Orara River catchment. *G. beadleana* was previously known last century from near Walcha, however, despite searches, it has not been relocated in this area.



### 3.1 Collection history and geographical distribution

*Grevillea beadleana* was first collected in 1887 at Walcha (McGillivray 1993). The specimen from this collection has not been viewed in the preparation of the Recovery Plan, but it is apparently housed in the National Herbarium of Victoria (McGillivray 1993). The species has not been found again in the Walcha district despite searches for it in the early 1980s (J.B. Williams pers. comm.) and systematic searches more recently (P. Davies & P. Metcalfe pers. comm.).

In 1981 a *Grevillea beadleana* specimen was collected from the Guy Fawkes River National Park (N. Fenton pers. comm.). The type material was collected in June 1982 and was brought to the attention of the National Herbarium of NSW. It recognised that the species was allied to the specimen collected from Walcha and in 1986 it formally described as *G. beadleana*.

In 1988 a new population was discovered 15 kms north of Torrington and about 40 kms south of the Queensland border (Figure 2). The very extensive occurrence of *Grevillea beadleana* is referred to in this document as the Binghi population, although it is recognised that gene flow within the greater area may not be continuous.

In 1994, a small population was discovered 30 kms south-west of Grafton on land which has since become Chambigne Nature Reserve. In 1998 another small population was discovered in a recent western addition to the Guy Fawkes River National Park. In November 1999, a population of over 2 000 plants was located near Enmore south-east of Armidale.

The reasons for *Grevillea beadleana*'s rarity are largely unknown. It is likely that the populations within Guy Fawkes River National Park and Chambigne Nature Reserve were more extensive but have declined into refugia because of too frequent fires. Anecdotal information also suggests that the species, locally known as the "bottle-brush from the river banks", was common in the Torrington district 40 years ago but declined due to grazing pressures (S. Caldwell pers. comm.).

### 3.2 Population size

The first population census of the species was undertaken in 1989 at the eastern population within the Guy Fawkes River National Park (M. Dwyer pers. comm.). The site was traversed and it was estimated that 714 living plants were present in an area of about 4.25 hectares. Part of this population was surveyed in 1991 with 266 live plants being recorded in an area of three hectares (Benson 1991).

In August 1995, after a very intense fire in October 1994, 651 plants were counted, including 84 dead adults and only 62 reproductive adults, in an area roughly corresponding to the 1989 survey (Streat 1997). In March 1996 a further two adult plants had died and about 20% of the mature plants were coppicing (Gross unpublished data). At a new site near the Aberfoyle River, located in March 2000, it was estimated that 150 plants were present, with approximately 30 seedlings, 50 immature and 70 mature plants.

In 1991 the Binghi population was estimated at 4 000 plants over 20 hectares in two discrete groups: 5 hectares at "the Knoll" and 15 hectares at Oak Creek (Benson 1991). In 1996, based on transect counts and ground truthing, the population at the same two areas was estimated at 40 000 plants in 270 hectares and a corridor of plants was found linking the two areas (Streat 1997).

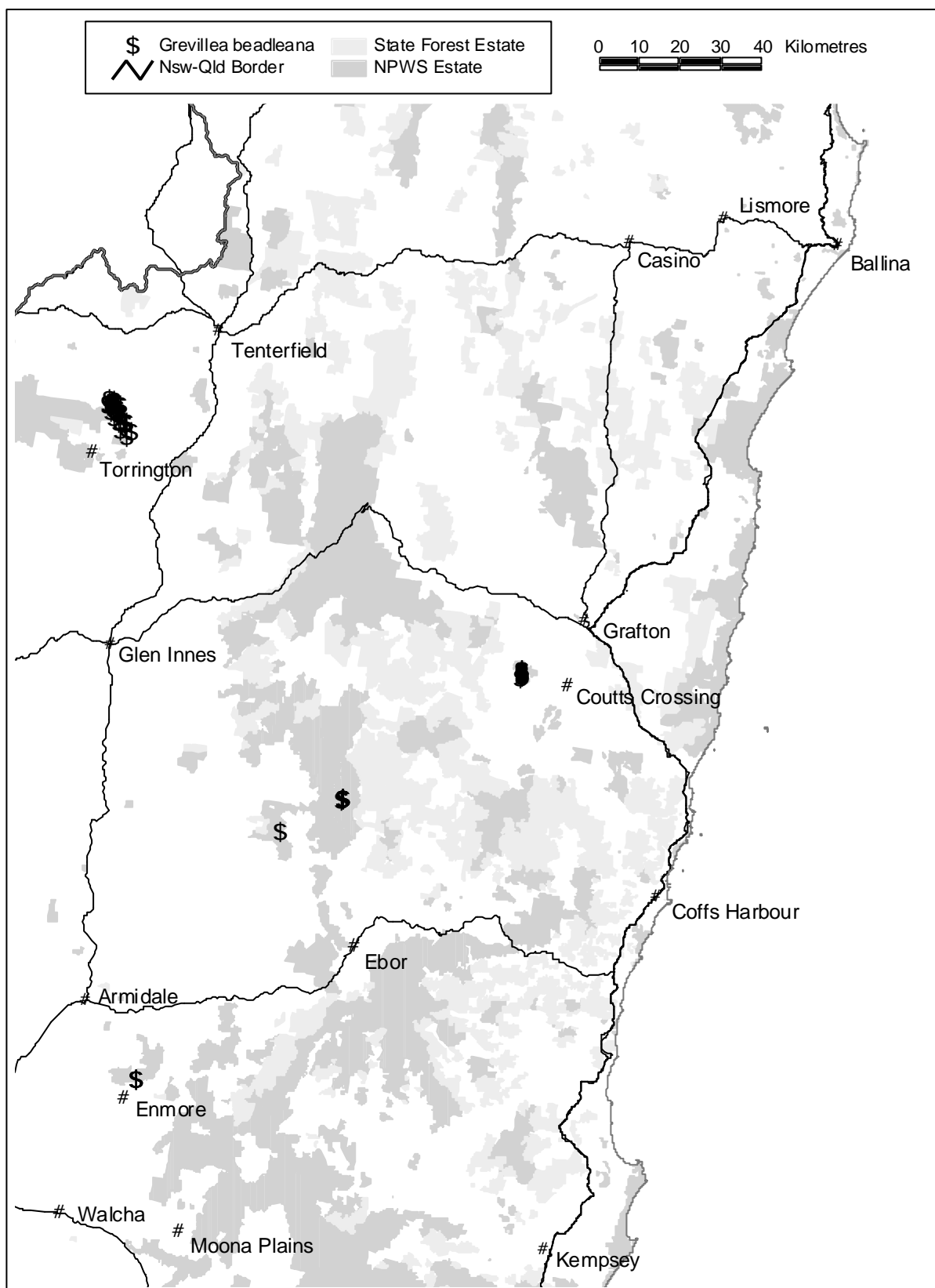
At the Chambigne Nature Reserve seven adult plants and two seedlings were found in 1994 (P. Sheringham pers. comm.). Only six of these plants were found again in both 1995 and in 1996. In 2000 nine plants were found (A. Steed pers. comm.) over a larger area than previously known.

A full census has yet to be undertaken at Enmore, however a preliminary assessment in May 2000 indicated the population to be over 2 000, with adults up to 2.5 m high and 4 m wide, with many seedlings present.

### 3.3 Tenure

The tenure and ownership of the sites of known populations of *Grevillea beadleana* is shown in Table 1. Four areas are reserved in the conservation reserve system and managed by the Department of Environment and Conservation (DEC). The largest occurrence of *G. beadleana*, at Binghi near Torrington, is present within a number of different tenures, including the Torrington State Recreation Area managed by DEC and Crown Leasehold land, with two outlying populations on freehold land.

Populations within National Parks are zoned as Existing National Parks, while those populations on private and leasehold land, State Recreation Area and Nature Reserves are currently zoned as General Rural. It is anticipated that the populations in State Recreation Area and Nature Reserves will be zoned as Existing National Park and Nature Reserves in the future.



**Figure 2. The general locations of *G. beadleana* populations in north east New South Wales.**

**Table 1. Land tenure and Local Environment Plan zoning at the known sites of *Grevillea beadleana*.**

Location	Tenure	Local Govt.	LEP zoning
<b>Chambigne Nature Reserve</b>	Nature Reserve	Nymboida	1(a) - General Rural
<b>Guy Fawkes River NP -east</b>	National Park	Nymboida	8(a) - Existing National Parks
<b>Guy Fawkes River NP - west</b>	National Park	Guyra	To be determined
<b>Torrington SRA</b>	State Recreation Area	Tenterfield	1(a) - General Rural
<b>Torrington leasehold</b>	Crown Leasehold	Tenterfield	1(a) - General Rural
<b>Torrington private land</b>	Freehold	Tenterfield	1(a) - General Rural
<b>Oxley Wild Rivers NP</b>	National Park	Dumaresq	8(a) - Existing National Parks
<b>Enmore private land</b>	Freehold	Dumaresq	1(a) - General Rural

### 3.4 Genetic variability

Because the loss of genetic diversity within a species, especially one that has never been abundant, can be catastrophic, and can cause inbreeding depression, the level of genetic diversity within and between the various populations of *Grevillea beadleana* is being investigated. Preliminary results from starch gel electrophoresis of young leaf material from plants cultivated at the University of New England (UNE) showed intra-population variation within the Binghi and Guy Fawkes River National Park populations. The Chambigne Nature Reserve population varied genetically from the other two but not within itself (C. Gross unpublished data).

### 3.5 Significant habitat

All areas of known potential habitat, in the Binghi and Enmore areas, Guy Fawkes River National Park and Chambigne Nature Reserve constitute significant habitat.

### 3.6 Critical habitat

All areas of known habitat in the Torrington State Recreation Area, Oxley Wild Rivers and Guy Fawkes River National Parks and Chambigne Nature Reserve areas require assessment to determine whether they are Critical Habitat within the meaning of the TSC Act.

## 4 Habitat

### 4.1 Binghi – Torrington State Recreation Area

The populations of *Grevillea beadleana* on the Crown Leasehold land (Figure 2) and within the Torrington State Recreation Area may be contiguous. Further survey work is required in the region. Binghi is the largest naturally vegetated region on the north-west slopes of New South Wales (Benson 1991). The main land-uses in the area include tin mining and rough cattle grazing. The National Parks Association of NSW proposed the area as a National Park in 1976. However, this application was withdrawn in response to opposition from local miners and graziers (Benson 1991). The area was identified as wilderness under section 6 of the *Wilderness Act* 1987 but has not been formally declared.

Fires are not frequent in the area of the Binghi population. The property owners at Grevillea Downs suggest that the last fire in the area was during the 1982–3 season (McWhinney pers. comm.) although Benson (1991) notes that "...on the knoll in the Binghi area, approximately half of the mature adults were killed in a 1988 fire". Few seedlings are present. Part of this area burnt in November 2002, however investigation of the response of *G. beadleana* to this event has yet to occur.

Many of the plants are estimated to be up to 30 years old, although the longevity of *Grevillea beadleana* is currently not known. This estimate is based on the time since the last large fire that burnt most of the area occupied by *G. beadleana* (1982–3) and the fact that large mature plants exist in unburnt areas in

1988. Goats have been seen throughout the area occupied by *Grevillea beadleana* (B. McWhinney pers. comm.), and while there was no evidence of goat or other stock grazing upon plants during research undertaken by Durbin in 1996, it is thought that the stunted apical areas and a multi-sided branch spreading structure of some plants may be indicative of goat grazing (C. Gross pers. comm.).

### Topography and elevation

The first populations surveyed in this region were found alongside Oak Creek and on a flat, rocky knoll 1 km to the west (Benson 1991). Since this work, plants have been found throughout the area at elevations ranging from 600 m to 900 m above sea level on undulating terrain, steep slopes and flat plateaux.

### Geology and soils

The parent material is Mole Creek Granite, which extends throughout the Binghi area. The rock is extremely siliceous, containing a greater than 75% silica content. The soil formed, is a relatively fine-grained loamy-sand mixture. The soil is poor in nutrients and is acidic (Benson 1991).

### Rainfall

Based on data from several nearby properties, the Binghi area receives approximately 800 mm of rain annually (Bureau of Meteorology in Benson 1991). This site would experience higher temperatures and thus greater evaporation rates than the Guy Fawkes River National Park population (Benson 1991).

### Associated vegetation

The vegetation at Binghi is woodland with a shrubby understorey component that is sparse on the rocky outcrops. Common trees include *Eucalyptus prava*, *E. andrewsii*, *E. subtilior*, *Callitris endlicheri* and *Angophora floribunda* (Clarke *et al.* 1998).

Common shrub and forb understorey species include *Acacia granitica*, *Baeckea densifolia*, *Leptospermum brachyandrum*, *L. brevipes*, *Notelaea linearis*, *Mirbellia speciosa*, *Persoonia terminalis* subsp. *terminalis* and *Phebalium squamulosum*. Grasses and sedges that frequently occur as mid-dense ground cover include *Schoenus ericetorum*, *Xanthorrhoea glauca*, *Lepyrodia leptocaulis*, *Lomandra longifolia*, *Aristida armata*, *Cymbopogon obtectus* and *Eragrostis brownii* (Benson 1991).

## 4.2 Guy Fawkes River National Park - eastern population

Guy Fawkes River National Park was gazetted in 1972. Prior to this the land was vacant Crown land with licensed occupancies for grazing in some parts (Reid *et al.* 1996). The eastern population of *Grevillea*

*beadleana* is located within an area declared in 1994 as wilderness under the *Wilderness Act* 1987. The population of *G. beadleana* is located north of Jordan's trail, along the rim of the gorge, and adjacent to the escarpment walking track. The population exists in an area of 4.25 hectares (Dwyer unpublished data; Gross *et al.* unpublished data; Streat 1997) with most of the older plants nestled among rocks and crevices that afford protection from fire. Many of the seedlings are growing in the loose scree between and below the rocky ridges. The scree substrate is active and plants are particularly vulnerable to disturbance from landslides.

### Topography and elevation

This population occurs at an elevation between 900 m and 1000 m on small rocky ridges and interstitial scree that form part of a steeply sloping bluff adjoining an undulating plateau.

### Geology and soils

The rock outcropping on the bluff is silica-rich (> 75%), leucocratic, felsphatic granite and is part of a complex of granitic outcrops mapped as the Chaelundi Granite. Compared to another granitic rock specimen from Guy Fawkes Crags, 8 kms to the north (where *Grevillea beadleana* is absent), the rock has a low content of ferromagnesium minerals. The soil formed from this parent material is a skeletal, highly siliceous, sandy-loam substrate.

### Rainfall

The rainfall is estimated to be approximately 1000 mm per annum (Bureau of Meteorology in Benson 1991).

### Associated vegetation

The vegetation is sparse among the outcrops and currently large trees are dying as a result of unstable substrate conditions. In the upper stratum *Eucalyptus campanulata* and the rare *E. michaeliana* dominate with the occasional *Lophostemon confertus*. The middle stratum is dominated by a species of *Leptospermum*, *Allocasuarina littoralis* and *Notelaea microcarpa* along with *Grevillea beadleana*. Scattered clumps of grasses, herbs and sedges make up the ground stratum with the most common species being *Gonocarpus teucroides*, *Lepidosperma laterale*, *Poa sieberi*, *Stipa ramosissima*, *Pomax umbellata* and a species of *Aristida* (Benson 1991).

## 4.3 Guy Fawkes River National Park - western population

The area where *Grevillea beadleana* occurs was purchased for inclusion in the Guy Fawkes River National Park in 1997. Prior to this the land was vacant Crown land with licensed occupancies for

grazing in some parts (Reid *et al.* 1996). The area was identified as wilderness under section 6 of the *Wilderness Act* 1987 but has not been formally declared.

### Topography and elevation

The area where *Grevillea beadleana* occurs is on a small rocky cliff in the Aberfoyle River gorge at an elevation of approximately 500 m, with a predominantly southerly aspect. The surrounding escarpment rises steeply to over 1000 m, and the Aberfoyle gorge is aligned in a north-east to south-west direction.

### Geology and soils

The substrate where the western population occurs is reported to be skeletal soils over metamorphosed Permian sediments (P. Gilmore pers. comm.). These sediments include greywacke, slate siliceous argillite and pebbly mudstone (NSW Department of Mineral Resources 1969).

### Rainfall

The rainfall is estimated to be approximately 800 mm per annum (Bureau of Meteorology in Benson 1991).

### Associated vegetation

The associated vegetation in the area where the *Grevillea beadleana* plants were recorded includes open forest consisting of *Eucalyptus eugenoides*, *E. tereticornis*, *Angophora subvelutina*, *Allocasuarina littoralis*, *Hovea lanceolata*, *Jacksonia scoparia*, *Parsonsia straminea*, *Melichrus adpressus*, *Lomandra* sp., *Aristida* sp., and *Goodenia hederacea* ssp. *hederacea* (P. Gilmour pers. comm.).

## 4.4 Chambigne Nature Reserve

This site is located within Chambigne Nature Reserve south-west of Grafton, in the headwaters of Shannon Creek which forms part of the catchment of the lower Orara River. Although the land is managed by DEC access to the land is negotiated through private property. The population is located on a mesa-like outcrop. Six of the plants are huddled on the western side of the site on a rock ledge that probably affords protection from fire.

The Nature Reserve requires a thorough investigation for further occurrences of *Grevillea beadleana* and for a full floristic inventory. Surveys of the area in 1994 and 1995 revealed that there were only nine *G. beadleana* plants present over an area of about 2 hectares and later surveys only located six plants. A subsequent investigation in early 1998 found the population reduced to three adult plants and one seedling with the cause of the decline unknown.

### Topography and elevation

The area is an isolated plateau rising approximately 150–200 m above the adjacent valleys of Deep Creek to the west and Shannon Creek to the east. Cliffs and very steep slopes bound the area on the west and south, and more moderate slopes to the east and north. In places on the southern boundary the cliffs are up to 75 m high and are a series of broken ledges with numerous caves, overhangs and clefts. The top of the plateau is semi-circular, with a long ridge on the western side extending to the north. The plateau is relatively flat, with a number of high points rising to a maximum of 285 m above sea level. The area forms the upper catchment of an unnamed tributary of Shannon Creek.

### Geology and soils

The geology of the area comprises Jurassic Kangaroo Creek Sandstone, consisting of quartz sandstone and feldspathic quartz sandstone. This substrate produces a coarse-grained sandy soil, with free drainage. The high quartz content produces a soil of low fertility. Although no soil samples have yet been analysed, descriptions have been of poor, skeletal “sandy type” soil.

### Rainfall

The rainfall is approximately 1200 mm per year.

### Associated vegetation

The vegetation is dry open forest dominated by *Eucalyptus psammitica* and *Corymbia gummifera* with a dry shrub understorey. Pockets of mesic vegetation may be found in small areas, such as those with impeded drainage, at the base of cliffs or in fire-free areas such as cliff benches and clefts. The area contains populations of two Endangered Species (*Grevillea beadleana* and *Melichrus hirsutus*), one undescribed species (*Bertya* sp. nov.), one rare species (*Dodonaea hirsuta*) and one poorly known species (*Eucalyptus psammitica*) (Sheringham & Westaway 1995).

Other species recorded at this site include *Acacia concurrens*, *A. hispidula*, *A. venosa*, *Allocasuarina littoralis*, *Brachyloma daphnoides*, *Chloanthes parviflora*, *Daviesia wyattiana*, *Eriachne pallescens*, *Hibbertia acuminata*, *H. vestita*, *Hovea longifolia*, *Jacksonia scoparia*, *Leptospermum trinervium*, *Melichrus procumbens*, *Patersonia sericea*, *Phebalium woombye*, *Phyllanthus hirtellus*, *Platysace ericoides*, *Tetradlea thymifolia*, *Trachymene incisa*, *Xanthorrhoea johnsonii* (National Parks and Wildlife Service 1995). Further detailed surveys are required.

#### 4.5 Enmore - Oxley Wild Rivers National Park

This site, located on private property and within the Oxley Wild Rivers National Park, is 25 kms south-east of Armidale, in the catchment of the Macleay River. Access to the land is through private property and is currently being negotiated with the landowner. The area requires a thorough investigation for further occurrences of *Grevillea beadleana* and for a full floristic inventory. The area was identified as wilderness under section 6 of the *Wilderness Act* 1987 but has not been formally declared. This section of Oxley Wild Rivers National Park was included on the World Heritage List in 1994, as part of the Central Eastern Rainforest Reserves of Australia.

##### Topography and elevation

The area is on the edge of the New England tableland, at an elevation of 950 m above sea level. The slopes of the escarpment are very steep, falling away for 450 m to Salisbury Waters.

##### Geology and soils

A preliminary investigation revealed that the underlying bedrock is granite, producing a sandy loam substrate (L. Copeland pers. comm.). Geology maps for the area indicate that the granite type is Blue Knobby Ademellite, a biotite ademellite (Department of Mineral Resources 1988).

##### Rainfall

The estimated rainfall is 750 mm per year.

##### Associated vegetation

The vegetation is a layered woodland dominated by *Eucalyptus youmanii* and *E. bridgesiana* with a shrub understorey of *Leptospermum brevipes* and *Grevillea beadleana*. The ground cover consists of a well developed grass layer of *Themeda australis* and *Aristida* spp. Rare species recorded at the site include *Zieria* sp. nov, an undescribed species, *Eucalyptus magnificata* and *Acacia ingramii* (L. Copeland pers. comm.).

#### 4.6 Geographic Information System (GIS) Predictive Modelling

Durbin (1996) developed a predictive model for *Grevillea beadleana* that showed that the area between the Queensland-NSW border and Glen Innes contains the most suitable habitat for the species. The model selected current and historical sites and highlighted many other areas throughout the region that may contain suitable habitat for the species. The Binghi region was not included in the model due to inadequate data being available for this area.

## 5 Life History

### 5.1 Flowering and fruiting phenology

Flowering mainly occurs in late spring or summer, but with good rains it can continue into early winter (C. Gross pers. obs.). The basal flowers of the inflorescence are three times more likely to set seed than the distal flowers (Gross & Smith unpublished data).

### 5.2 Breeding system

*Grevillea beadleana* is a self-compatible species. All pollination treatments at Guy Fawkes River National Park in 1995 yielded lower fruit set than at Binghi which may be the result of a resource deficiency (eg. lack of water) at the former site (Gross & Smith unpublished data).

### 5.3 Floral visitors

*Grevillea* species are often abundant nectar producers with biotic pollen vectors being prominent as a result. A number of potential biotic pollinators have been recorded attending *Grevillea beadleana* flowers. At Binghi these include Yellow-tufted Honeyeater (*Lichenostomus melanops*), Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*), White-naped Honeyeater (*Melithriptus lunatus*), Brown-headed Honeyeater (*Melithriptus brevirostris*) and Fuscous Honeyeater (*Lichenostomus fuscous*). A small, unidentified native mammal was also briefly observed lapping at an inflorescence at this site (Smith pers. comm.). Crimson Rosellas (*Platycercus elegans*) were observed ripping flowers from inflorescences. At Guy Fawkes River National Park Eastern Spinebills (*Acanthorhynchus tenuirostris*) have been the only birds observed at inflorescences of *G. beadleana*. European Honeybees (*Apis mellifera*) and some native bees have been observed foraging for nectar at both locations. Honeybees rob nectar from unopened flowers that may potentially render these flowers unattractive to native pollinators.

### 5.4 Seed dispersal, predation and dormancy

The seeds of *Grevillea beadleana* are about 9 mm long and 4 mm wide and are held in the pods for about four weeks once the pods have developed. Indications are that there is little predation of the seed while it is still within the pod. At Guy Fawkes River National Park the seeds on the ground appear to have been eaten by rodents and a trapping program may be needed to investigate which species are eating the seed and the level of this predation. Significant seed predation levels would affect the amount of time needed for seedbank replenishment after a fire.

Studies on seed predation of the closely-related, fire-sensitive and endangered shrub *Grevillea caleyi* found

**Table 2. *G. beadleana* seed germination results (Durbin 1996).**

Temperature °C	Percentage Germination	Sample Size	Percentage Viability
23	57	23	100
50	48	23	58
100	72	29	88
165	14	28	50

that replenishment of the soil seedbank is severely retarded by mammal seed predation, with seed loss levels reaching 90% at sites that were recently burnt (Auld & Denham 2001). Auld and Denham (2001) also argued that as seed production is lower in younger plants, seed accumulation in the seedbank would not occur for 4–6 years after a fire. With further depletion of the seedbank due to seed predation in the post-fire period, it was estimated that after a fire *G. caleyi* should be protected from the risk of a future fire well beyond three times the primary juvenile period in the species or local extinction will occur (Auld & Denham 2001). Thus a fire-free interval of around 15 years would be required to allow accumulation of seed in the soil. It is considered that such findings and implications are likely to apply to *Grevillea beadleana* and thus a fire-free interval of 15 years is considered to be an appropriate strategy to minimise the risk of ongoing depletion of the soil seedbank and the likelihood of local population extinction.

Research into *Grevillea caleyi* estimated a seed half-life of between 6 and 10 years and found that seeds exhibited a seasonal pattern of non-dormancy, possibly due to temperature or darkness explaining why non-dormant seeds do not germinate in the field (Auld & Bradstock 2000). It is likely that *G. beadleana* exhibits similar characteristics, although insufficient research has been undertaken to determine whether this is the case.

## 5.5 Germination

Heat has a positive effect upon the germination of a variety of species within the Proteaceae (Leigh *et al.* 1984; Edwards & Whelan 1995; Bradstock *et al.* 1996). This fire-triggered germination is a factor associated with innate dormancy, a characteristic of many Australian plant species (Edwards & Whelan 1995).

Durbin (1996) investigated the effects of heat on *G. beadleana* seeds collected from the seedbank at Binghi. Four samples of seed were heated for 10 minutes at 23°C (as a control), 50°C, 100°C and 165°C respectively then transferred to a growth cabinet and monitored for germination which occurred after about 20 days (Table 2).

Seeds do not need to be exposed to high temperatures for germination although rates may be enhanced by an appropriate heating event. At the end of the germination experiments ungerminated seeds were tested for viability (tetrazolium and indigocarmine) and many were shown to be still viable, ranging from 100% viability for the 23° control group to 50% for the 165° group (Table 2).

The harvesting of seeds in the seedbank using a trowel and sieving to separate them from the soil may have inadvertently scarified them, thereby assisting the uptake of water and promoting germination at abnormal temperatures. Such scarified seeds may also respond differently to the heat treatments (e.g. by being killed by very hot temperatures). The effect of heat on germination needs to be investigated using seeds harvested “passively” from bushes, and replicated using a larger sample size to investigate the trends apparent in the data, ie. that 100°C is an optimal temperature to trigger germination and that 165°C may kill seeds.

## Seed longevity

*Grevillea beadleana* seeds were excavated from the leaf litter layer and soil beneath the litter to a depth of 4 cm. About 40 seeds per m<sup>2</sup> were encountered in the soil layer, compared with about 9.5 seeds per m<sup>2</sup> in the leaf litter layer. Intact seeds from both the litter and soil layers were found to be viable using tetrazolium and indigocarmine.

## 5.6 Response to fire and regeneration

*Grevillea beadleana* plants are very often killed by fire, although coppicing does occur, but mainly from young plants (Dwyer unpublished data; Gross pers. comm.). *G. beadleana*'s regeneration strategy is very similar to that of other obligate seeding species such as *G. caleyi* and *G. barklyana*. These species must replenish seed numbers before the next fire if populations are to be maintained, as the mature plant is usually killed by fire (Gill 1975; Auld *et al.* 1993; Edwards & Whelan 1995; Scott *et al.* 1995). In the closely related endangered shrub *Grevillea caleyi*, it was found that plants were killed by fire, which also promoted the breaking of seed dormancy in the soil seedbank (Regan *et al.* 2003). Regan *et al.* (2003) found that where seed predation levels remain high, the optimal fire management strategy is longer than when seed predation levels are reduced by 20–30%.

In 1988 fire burnt 1.5 hectares of the 4.25 hectares containing the eastern population in Guy Fawkes River National Park and killed 321 plants out of 647 leaving 326 live plants. In 1989, 388 seedlings were present in the burnt area and 21 in the unburnt area (Dwyer unpublished data). In the same area in August 1995 after a very intense fire nine months earlier, 84 dead mature plants, 117 plants greater than 2 years old and 450 seedlings were recorded (Streat unpublished data). Thus in six years the population had been reduced from 735 to 567 as a result of two fires occurring in the area within those six years.

A survey in March 1996 of about 3.5 hectares of the eastern population in Guy Fawkes River National Park revealed two dead adults, 59 plants greater than two years old and 389 seedlings (Gross unpublished data). Drought stress appeared to be the cause of some of the plant deaths recorded by Gross *et al.* (1995). It would appear that less than 20% of the population might be capable of flowering and fruiting in the two to three years after a fire (Gross unpublished data).

In contrast to the fire prescription required at Guy Fawkes River National Park, a fire would be beneficial in some parts of the Binghi population where seedling recruitment is poor and adults appear to be senescent. Durbin's (1996) work reported that a seedbank of viable seeds exists in at least one of these senescent demes.

Frequent fires are also likely to lead to a narrowing of the genetic base if only a small proportion of the population is contributing seeds to the seedbank. This, in combination with the time required for juvenile plants to reach maturity and the likely increased seed predation levels after a fire, indicates that a fire frequency of around one in 15 years is considered likely to be optimal to allow the

maturation and expansion of the population while avoiding dominance of senescent age classes.

The population in Chambigne Nature Reserve is so small that it is particularly vulnerable to fire and other stochastic events. It is not known how large the seedbank is at this site although the lack of soil on the rock ledge suggests that the seedbank would be limited to a few seeds in the rock crevices. It is considered that the risks to the very few plants at this site are too great to employ a control burn at this stage. Such a control or managed burn would at this stage be likely to kill existing plants, some of which may not have reached maturity and would also further deplete the existing seedbank. A control burn may, at some future stage, provide an appropriate management strategy to prevent unplanned fire entering the site, but the risk of burning the site during such a burn is currently considered unacceptable. Extinction of genotypes from this population due to wildfires and other events has been partially avoided by the successful propagation of material from four individuals at this site (see propagation section below).

## 6 Relevant Legislation

### 6.1 Recovery Plan preparation and implementation

#### Recovery Plan preparation

The TSC Act requires that the Director-General of NSW Department of Environment and Conservation 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 the Commonwealth Minister for the Environment ensure the preparation of a Recovery Plan for Nationally listed species and communities or adopt plans prepared by others including those developed by state agencies. Both Acts include specific requirements for the matters to be addressed by Recovery Plans and the process for preparing Recovery Plans.

This Recovery Plan has been prepared to satisfy the requirements of the TSC Act, *Threatened Species Conservation Amendment Act 2002* and the EPBC Act. It is the intention of the Director-General of DEC to forward the final version of this Recovery Plan to the Commonwealth Minister for the Environment for adoption, once it has been approved by the NSW Minister for the Environment.

Local Aboriginal Land Councils, Elders and other groups representing indigenous people in the areas where the *Grevillea beadleana* occurs have not yet been identified. It is the intention of DEC to consider



the role and interests of these indigenous communities in the implementation of the actions identified in this plan.

The *Threatened Species Conservation Amendment Act* 2002 states that an approved Recovery Plan must include a summary of advice given by the Scientific Committee with respect to the plan, details of any amendments made to the plan to take account of that advice and a statement of the reasons for any departure from that advice. This summary is provided in Appendix 2.

### **Recovery Plan implementation**

The TSC Act requires that a government agency must not undertake actions inconsistent with a Recovery Plan. The government agency responsible for actions in this plan is DEC. Where *G. beadleana* occurs on private property (eg. Enmore) and on permissive occupancy or leasehold lands (eg. Binghi), the implementation of the recovery plan will largely depend on co-operative management of the species between the title holder and DEC.

In some cases, where further approvals may be needed under the *Native Vegetation Conservation Act* 1997 (NVC Act) or the *Environmental Planning and Assessment Act* 1979 (EP&A Act), other public authorities may be involved as part of their core legislative responsibilities. Public authorities, other than DEC, with core legislative responsibilities relevant to the protection of *Grevillea beadleana* and its habitat are listed in Table 6.

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

## **6.2 State legislation**

### ***National Parks and Wildlife Act 1974 and Threatened Species Conservation Act 1995***

The *National Parks and Wildlife Act* 1974 (NPW Act) is administered by DEC. Under this Act it is an offence to 'harm', 'pick' or knowingly 'damage the habitat of' *Grevillea beadleana*. Certain circumstances may provide a defence from prosecution, including where actions are approved under the EP&A Act or licensed by DEC under the NPW Act or TSC Act.

The NPW Act allows for the reservation of areas as national parks, nature reserves and other categories of protected area under the management of DEC.

Owners of private properties with significant habitat values for *Grevillea beadleana* may enter into Voluntary Conservation Agreements (VCAs) under the NPW Act whereby DEC can provide assistance in the protection and management of these values on

the property. Properties under VCAs may qualify for rate exemptions.

The TSC Act makes provision for identification and declaration of Critical Habitat for species, populations and ecological communities listed as Endangered. Once declared, it becomes an offence to damage Critical Habitat and a Species Impact Statement is mandatory for all developments and activities proposed within Critical Habitat. Nomination of Critical Habitat for *G. beadleana* will only be considered as a management option where other, more co-operative, approaches are unavailable.

### ***Environmental Planning and Assessment Act 1979***

When considering any development or activity within known or potential habitat of *Grevillea beadleana*, local councils and determining authorities are encouraged to consider the conservation strategy set out in this plan.

### ***Native Vegetation Conservation Act 1997***

The purpose of the NVC Act is the conservation and sustainable management of native vegetation and in particular the protection of native vegetation of high conservation significance. Under this Act, approval from the Department of Infrastructure, Planning and Natural Resources (DIPNR) is a prerequisite for vegetation clearance unless a Vegetation Management Plan has been approved or unless the clearance is exempt from the requirements of the Act. There remains potential for significant and cumulative clearing to occur under these exemptions. The Act requires that the Director-General of NSW Department of Environment and Conservation be consulted in the matter of threatened species and their habitat. Landholders may enter into Property Agreements with DIPNR whereby government assistance can be provided to protect native vegetation under the Native Vegetation Incentive Fund. No Regional Vegetation Management Plan or Property Agreements relating to the habitat *Grevillea beadleana* have yet been prepared.

### ***Rural Fires Act 1997***

Bush Fire Management Committees must prepare draft Bush Fire Risk Management Plans for their respective rural fire districts and are obliged to consider threatened species conservation. These plans may restrict or prohibit the use of fire and other fire hazard reduction activities in all or specified circumstances or places to which the plan applies. In particular, an adopted Bush Fire Risk Management Plan may modify or prohibit hazard reduction activities in threatened species habitat.

### ***Rural Fires and Environmental Assessment Legislation Amendment Act 2002***

The NSW *Rural Fires and Environmental Assessment Legislation Amendment Act 2002* amends the *Rural Fires Act 1997* and several environmental assessment-related Acts. This Act provides for mapping bush fire prone lands and the development of a Bush Fire Environmental Assessment Code. This code is aimed at streamlining the assessment process for hazard reduction works. To this end, the Code will include general ameliorative prescriptions and, in some cases, species specific prescriptions. Threatened species and their habitats are one of the items considered in the code.

### ***Forestry and National Park Estate Act 1998***

The *Forestry and National Park Estate Act 1998* puts into effect the outcomes of the Government's Regional Forest Agreement. The agreement outlines licence conditions for threatened species within State Forests of NSW estate. These include a specific licence condition that a standard 20 m exclusion zone is to be applied around 90% of all *Grevillea beadleana* plants. It is recommended that these conditions also be included in Regional Vegetation Management Plans being prepared by DIPNR under the NVC Act.

## **6.3 Commonwealth legislation**

### ***Environment Protection and Biodiversity Conservation Act 1999***

The EPBC Act provides a legislative framework for the protection of Endangered and Vulnerable species across Australia. An important role of the EPBC Act is to facilitate the preparation and implementation of Recovery Plans for species listed under the Act in co-operation with the States in which populations of listed species occur. The Act also seeks to impose the obligation (arising from the listing) for responsible agencies (particularly Commonwealth) to adopt protective measures. This Recovery Plan will be submitted to the Commonwealth for approval under the EPBC Act.

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

species is still subject to referral and approval under the EPBC Act.

As *Grevillea beadleana* is listed Nationally under the EPBC Act, any person proposing to undertake actions likely to have a significant impact on this species should refer the action to the Commonwealth Minister for the Environment for consideration. The Minister will then decide whether the action requires EPBC Act approval. This is in addition to any State or Local Government approval requirement specified for the NSW EP&A Act.

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 species and the member is in, or on, a Commonwealth area, a permit issued by the Commonwealth Minister under the EPBC Act will be required.

## **7 Management Issues**

### **7.1 Threats**

The threats operating or potentially operating at each of the five population locations differ in their type, extent and severity, however, the major threat that affects or is likely to affect all populations is inappropriate fire frequency. Other known and potential threats include grazing, small population size, seed predation and illegal collection.

#### **Guy Fawkes River National Park**

The eastern population is threatened, in order of importance, by:

1. too frequent fires;
2. small population size;
3. damage to plants by cattle; and
4. illegal harvesting of plant material for propagation.

The western population is threatened primarily by inappropriate fire regimes. However the location of the population on a cliff line above the river greatly reduces this threat. The small population size is also an inherent long term threat.

#### **Binghi**

Sections of these populations are threatened by:

1. low fire frequency; and
2. possible grazing by goats.

Much of the area where *Grevillea beadleana* occurs at Binghi is on leasehold land and if the current lessees change, then the population could be jeopardised by unsympathetic management practices. Another possible threat is tin mining and fossicking, which occur throughout the region.

### Chambigne Nature Reserve

This population is threatened, in order of importance, by:

1. lack of recruitment;
2. small population size;
3. too frequent fires; and
4. uncertain neighbour attitudes.

### Enmore–Oxley Wild Rivers National Park

The Enmore–Oxley Wild Rivers National Park population is potentially threatened by inappropriate fire regimes (L. Copeland pers. comm.). However the evidence of recent recruitment and large adult plants indicates that this threat is not currently severe. Further investigations of the site are required to make a full assessment of current and potential threats.

## 7.2 Biodiversity benefits

If a conservation agreement could be negotiated in the Binghi area, then the associated benefits would include protection of several other rare plant species; *Prostanthera staurophylla*, *Hibbertia* sp. aff. *obtusifolia*, *Acacia torringtonensis*, *A. granitica* and *Persoonia terminalis* ssp. *terminalis* as well as the *Eucalyptus prava* - *E. subtilior* - *E. andrewsii* association, which is not represented in any conservation reserve.

The protection of *Grevillea beadleana* at Guy Fawkes River National Park from too frequent fires and uncontrolled grazing by stock will allow sympatric species to regenerate which in turn may benefit the Brush-tailed Rock Wallaby (*Petrogale penicillata*) and Glossy Black-Cockatoo (*Calyptrorhynchus lathamii*), both listed as Vulnerable under the NSW TSC Act.

The Chambigne Nature Reserve area contains important populations of *Melichrus hirsutus*, an Endangered Species, one undescribed species (*Bertya* sp. nov.), one rare species (*Dodonaea hirsuta*) and one poorly known species (*Eucalyptus psammitica*) (Sheringham & Westaway 1995). It is likely that there are a number of fauna species, including the Vulnerable Species Brush-tailed Rock Wallaby, present in the area.

At the Enmore–Oxley Wild Rivers National Park population, one Endangered Species (*Eucalyptus magnificata*) and two ROTAP species have been found, including *E. youmanii* and *Acacia ingramii*.

Other threatened flora possibly occurring in the area include *E. nicholii*. The discovery of a new plant species *Zieria* sp. nov is significant as this species is likely to be restricted to the area (L. Copeland pers. comm.).

## 8 Previous Actions Undertaken

As a result of the implementation of appropriate actions within the *Grevillea beadleana* Recovery Plan during 1994–97, new information has been acquired about the distribution, habitat requirements and ecology of the species. Particular effort has been made to reduce or eliminate existing threats to *G. beadleana*, and to monitor population size and health.

Research at UNE, which has provided valuable information about the ecology of the species, including population structure, seed ecology and pollination ecology, is still continuing.

As a result of targeted surveys new populations have been discovered at Chambigne Nature Reserve, in recent additions to Guy Fawkes River National Park, and additional locations were found in the Binghi area. Surveys were, however, unsuccessful in locating *Grevillea beadleana* at the original collection place in the Moona Plains area near Walcha. Predictive modelling of potential habitat indicates where to concentrate further distribution surveys.

At Guy Fawkes River National Park, a fence has been erected to exclude straying cattle damaging the *Grevillea beadleana* stand. Plants were propagated at UNE from material obtained from the Guy Fawkes River National Park population. These plants will be replanted in the woodland adjacent to the gorge rim in an effort to increase the population size. An interpretive display on *G. beadleana* has been placed at the nearby Misty Creek camping ground.

Cuttings have been the most cost-effective method of producing large numbers of plants of *Grevillea beadleana*. Short-tip cuttings treated with a 5 ppm NAA/IBA hormone dip, placed in sharp sand in a hot bed with automatic misting, results in a propagation strike-rate of 65–80% (Gross *et al.* 1995).

In 2001 a targeted survey was undertaken in northern NSW, with an emphasis on potential *Grevillea beadleana* habitat and areas where no previous surveys had been undertaken. No new *G. beadleana* populations were located during the surveys, however extensive data about locations where *G. beadleana* is known not to occur was obtained. This data will be used to revise the predicted distribution of *G. beadleana*.

## 9 Species' Ability To Recover

In view of the population size at Binghi, there is no doubt that the species is capable of expansion, provided optimum conditions are available for the successful germination of seeds and maturation of plants. A high fire frequency ie. more than one in fifteen years, appears to be the critical factor limiting the natural recovery of the species. Successful recovery of the species relies on appropriate management of existing and potential threats with particular regard to the fire regime at *Grevillea beadleana* sites.

## 10 Alternative Management Strategies

If no active management strategies are implemented for *Grevillea beadleana* there is a significant likelihood that the species may become extinct at Guy Fawkes River National Park and Chambigne Nature Reserve. Further surveys should be undertaken to locate any new populations of *G. beadleana* that may otherwise be inadvertently destroyed or degraded. Failure to conduct these surveys and locate new populations may also preclude the collection of important ecological information and diverse genetic material that is not available from known sites.

Until more information is known about the reproductive ecology and genetics of the species, it is difficult to implement specific management strategies (eg. translocations) aimed at recovering the species. Any consideration of reintroduction and/or translocation programs must take into account relevant guidelines such as those prepared by DEC (in prep) or the Australian Network for Plant Conservation (Australian Network for Plant Conservation 1997).

## 11 Consideration of Social and Economic Consequences

### 11.1 Consideration of economic costs

The estimated cost over five years of the implementation of this Recovery Plan is \$135 800 (Table 3). This cost includes surveys, land reservation and/or protection, ecological and genetic research, threat and disturbance assessment, community involvement and, if appropriate, population enhancement and/or *ex situ* programs. Because *Grevillea beadleana* occurs on land generally regarded as unsuitable for agriculture, protection of its habitat will have little impact in terms of benefits forgone, even where the protected population is on private land.

### 11.2 Consideration of economic benefits

It is necessary to consider the economic benefits of the proposal in order to determine the net economic cost or benefit to society. The following effects, although difficult to quantify in financial terms, are likely economic benefits to society as a result of implementation of the recovery plan:

- provision of protected habitat for threatened and other significant flora and fauna species in protected *Grevillea beadleana* habitat;
- increased value of the protected land through habitat enhancement and intrinsic value of the threatened plant community;
- increased value of private/leasehold property through habitat protection; and
- meeting the government's commitment to biodiversity conservation.

### 11.3 Consideration of social costs

The prevention of tin mining in the areas of *Grevillea beadleana* habitat at Binghi has a potential social cost by limiting the potential for local job creation. This is likely to have a limited impact since tin mining has previously occurred in the area and economically viable deposits have probably been mined previously.

As the other areas where *Grevillea beadleana* occurs are in national parks, nature reserves or on land zoned for environmental protection, the protection of *G. beadleana* in these areas will not involve any limitation of land uses and therefore will have a negligible social cost. The eastern site in Guy Fawkes River National Park is in close proximity to a walking track, which traverses the area that has previously been fenced to prevent grazing by cattle. To date, no interference with *G. beadleana* plants by people has been observed, however if interference is observed, it may be necessary to relocate the walking track away from the area where *G. beadleana* occurs. All other sites are considered to be relatively inaccessible to members of the public, and therefore it is not considered feasible or necessary to exclude people from these areas.

### 11.4 Consideration of social benefits

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

The proposed public education program will increase awareness of rare plants and their significance in the region, and promote community involvement in the recovery process. The recovery of *Grevillea beadleana* to a level of viability in nature, and downlisting of the

species to a Vulnerable or rare status, is considered to be a social benefit to the community.

### 11.5 Consideration of net social and economic benefits to society

While social and economic costs and benefits may be difficult to quantify in financial terms, DEC considers that the benefits to society of implementation of the Recovery Plan outweigh the costs of the proposal.

In terms of the social and economic benefits of recovery of *Grevillea beadleana* and the associated benefits for conservation of other rare and threatened species and communities that form the habitat of the species, DEC considers that implementation of the Recovery Plan would result in a net benefit to society. Community education is expected to generate a positive attitude toward recovery planning, and a genuine concern in the community for conservation of threatened species.

Successful implementation of the Recovery Plan would involve community participation in the recovery, so the community would have a sense of achievement by meeting the recovery objectives, and a sense of ownership of the results.

## 12 Community Involvement

As *Grevillea beadleana* occurs on leasehold and private land in the Binghi and Enmore areas, it is essential that the landowners are actively involved in the implementation of the Recovery Plan. During the implementation of the previous Recovery Plan (Benson 1991) and preparation of this Recovery Plan, a good working relationship has been established with members of the local communities, including membership of the *Grevillea beadleana* recovery team. To date, private landowners at Binghi and Enmore have co-operated with DEC to permit ongoing visitations on their land to access *G. beadleana* sites for surveys and research.

Community groups that have been involved with the *Grevillea beadleana* Recovery Plan include the Hernani Public School and the Armidale Plant Society. Students at UNE have undertaken research projects into *G. beadleana* and the draft Recovery Plan has been used in teaching exercises. Landowners adjacent to the Chambigne Nature Reserve and Guy Fawkes River National Park have also permitted access through their properties and will also need to be involved in order to assist in reducing the fire frequency affecting this area. It is anticipated that such community involvement will continue to be an important part of the successful implementation of the Recovery Plan.

## 13 Recovery team

A Recovery Team for *Grevillea beadleana* has been established to provide advice on the implementation of the Recovery Plan and to co-ordinate the undertaking of the management actions detailed in the plan. The Recovery Team is comprised of Caroline Gross, (UNE), Andrew Steed (DEC), Rachel Bailey and Danny Corcoran (DEC Dorrig), Peter Croft (DEC Glen Innes) and Barry and Leonie McWhinney (private landholders). The future membership of the Recovery Team should be flexible to ensure appropriate people are on the Recovery Team, depending on what actions are being implemented.

Membership should include representatives of government departments and non-government organisations, and individuals who have a direct interest or role in the management of *Grevillea beadleana*. Private landowners with *G. beadleana* on their property should also be invited to participate in the Recovery Team. The Recovery Team should be co-ordinated by a representative of DEC and should meet at least twice annually. Meetings should be held in the Armidale–Glen Innes area to facilitate regular field inspections of *G. beadleana* and its habitat.

## 14 Objectives of the Recovery Plan

### 14.1 Overall objective

The overall objective of the Recovery Plan is to reduce the risk of extinction and to recover the species such that a change in the current status of *Grevillea beadleana* (under the TSC Act and the EPBC Act) from Endangered to Vulnerable within 10 years is achieved.

#### Objective 1: Increase knowledge of extant populations through further surveys of known populations and identification of new populations.

The five known *Grevillea beadleana* populations are significantly different in location, accessibility, population size and extent, age and vulnerability and therefore require individual site-specific management strategies. It is important that population surveys and threat assessments occur on an annual basis to ensure that appropriate management strategies are being implemented. Potential habitat areas, such as the escarpments of the Oxley Wild Rivers National Park, should be assessed for the likelihood of the occurrence of *G. beadleana*. Those areas that are considered as likely to contain *G. beadleana*, should be surveyed. It is important that all land managers and owners are aware of the location of *G. beadleana* in order to appropriately manage the sites for the long term protection of the species. Where *G. beadleana* is

critically threatened with local extinction, consideration should be given to declaring the area as Critical Habitat within the meaning of the TSC Act.

#### Action 1.1

*Undertake surveys and threat assessment at known populations and those areas likely to contain Grevillea beadleana.*

Performance criteria: Surveys and threat assessment are undertaken at known *Grevillea beadleana* populations within 12 months of the commencement of the plan and then annually for the duration of the Recovery Plan. Those areas considered likely to contain *G. beadleana* are surveyed as opportunities arise for the duration of the Recovery Plan.

#### Action 1.2

*Inform all relevant land managers and owners of Grevillea beadleana locations and hold discussions to protect all populations.*

Performance criteria: Land managers and owners are aware of *Grevillea beadleana* populations on their land, the threats to each population, their responsibilities to protect them and the assistance that DEC can provide to manage the populations by the end of year two of the Recovery Plan.

#### Action 1.3

*Assess known Grevillea beadleana sites to determine whether declaration as Critical Habitat within the meaning of the TSC Act is warranted.*

Performance criteria: All known *Grevillea beadleana* sites should be assessed to determine whether they require being declared as Critical Habitat and appropriate action taken if required throughout the life of this Plan.

### **Objective 2: Improve ecological understanding of Grevillea beadleana**

Various aspects of research into population and seedbank dynamics, reproductive ecology and response to fire has been undertaken over the last seven years at UNE. This research has provided important information that assists in the conservation management of *Grevillea beadleana*, however further ecological research is needed to develop long term management strategies to prevent ongoing decline and the risk of extinction.

An *ex situ* conservation program should be developed to manage *Grevillea beadleana* plants that have been propagated for glasshouse research studies. A feasibility study should be undertaken to determine the need for re-introduction at sites where a severe

decline in population size is observed or there is a likelihood of local extinction.

#### Action 2.1

*Continue population studies into Grevillea beadleana at all known sites.*

Performance criteria: Population size and dynamics are assessed at each site on an annual basis for a minimum of three years and reviewed during year four of the Recovery Plan.

#### Action 2.2

*Continue research into the seedbank and fire ecology of Grevillea beadleana.*

Performance criteria: Research into the seedbank and fire ecology of *Grevillea beadleana* is undertaken in the first three years and reviewed during year four of the Recovery Plan.

#### Action 2.3

*Develop appropriate management strategies and make recommendations about the need for further research programs following a review of actions 2.1 and 2.2.*

Performance criteria: The results of the actions 2.1 and 2.2 are reviewed, management strategies are revised and implemented, and recommendations for additional research are made during year four of the Recovery Plan.

#### Action 2.4

*Prepare and implement a Grevillea beadleana ex-situ conservation program and conduct a re-introduction feasibility study.*

Performance criteria: An ex-situ conservation plan study is prepared and implemented for plants that have been propagated for glasshouse research during year four of the Recovery Plan. A re-introduction feasibility study is conducted during year four of the Recovery Plan.

### **Specific Objective 3: Protect populations on private and leasehold land with the co-operation of the landowner or lessee.**

Private landowners and lessees of areas supporting *Grevillea beadleana* populations are supportive of the conservation of *G. beadleana* and the research projects undertaken on their land. Previous discussions regarding conservation management have been productive and should continue. Relationships between DEC and landowners and lessees of any areas containing new populations of *G. beadleana* need to be nurtured with a view to obtaining the best outcome for conservation and the landowners and lessees.

*Action 3.1*

*Investigate options for protecting Grevillea beadleana populations on private and leasehold land.*

Performance criteria: All options for protecting *Grevillea beadleana* populations on private and leasehold land are fully investigated by year three of the Recovery Plan.

*Actions 3.2*

*Undertake discussions with landowners and lessees about the protection of Grevillea beadleana populations on private and leasehold land.*

Performance criteria: Discussions with landowners and lessees are undertaken to protect populations of *Grevillea beadleana* on private and leasehold land for the duration of the Recovery Plan.

**Objective 4: Promote persistence of *Grevillea beadleana* within current range by reducing or removing threats.**

The primary threat to all *Grevillea beadleana* populations is the occurrence of frequent fires that kill existing plants and result in ongoing depletion of the seedbank. It is estimated that about 15 years between fires is required to allow plants to develop to full maturity and for the seedbank to be replenished. Other threats such as grazing, drought and illegal collection should be dealt with on a site-specific basis as the need is assessed. Existing weed and pest control programs should continue.

It is important to ensure that specific location information on wild populations is not freely available to members of the public. In order to maintain confidentiality of site data, specific reports generated throughout the implementation of the plan should remain for internal use only. Where there is a need to divulge specific location information, for instance to local fire control officers or local councils, the importance of maintaining confidentiality must be stressed to those who receive the information.

*Action 4.1*

*Reduce or eliminate the threat of frequent fire regimes to Grevillea beadleana by implementing appropriate planning mechanisms.*

Performance criteria: Protection of *Grevillea beadleana* is included as a specific objective of all relevant DEC Reserve Fire Management Plans by year three of the Recovery Plan. Private landowners and lessees have been informed of the need to reduce the incidence of frequent fires by the end of year two of the Recovery Plan.

*Action 4.2*

*Apply appropriate management strategies to eliminate or reduce site-specific threats identified during population surveys and ecological research.*

Performance criteria: The impact of other threats identified at each *Grevillea beadleana* population is assessed and addressed according to the specific need for the duration of the Recovery Plan.

*Action 4.3*

*Maintain confidentiality of all Grevillea beadleana locations.*

Performance criteria: Confidentiality of locations of *Grevillea beadleana* is maintained at all times.

**Objective 5: Increase community awareness of the species and its management.**

In order to improve community education and co-operation in areas where *Grevillea beadleana* is known or is likely to occur, an information leaflet should be prepared that is available for interested local landowners from relevant Regional DEC offices and local Councils. The leaflet should outline the habitat, distribution and threats to *G. beadleana*, the responsibilities of landowners for its conservation and appropriate management practices that landowners can implement to assist in the protection of *G. beadleana*.

*Action 5.1*

*Prepare and distribute an information leaflet to landowners in areas where Grevillea beadleana is considered as highly likely to occur and place on display at relevant Regional DEC offices and local Councils for other interested local landowners.*

Performance criteria: An information leaflet is prepared and distributed to landowners in areas where *Grevillea beadleana* is considered as highly likely to occur and also made available for other interested local landowners by the end of year one of the Recovery Plan.

**Objective 6: Co-ordinate implementation of the Recovery Plan**

*Action 6.1*

*Convene annual Recovery Team meetings to co-ordinate and review the implementation of the actions in this Recovery Plan.*

Performance criteria: Annual Recovery Team meetings are held to co-ordinate population surveys, ecological research, threat management and to consider the results of these activities so that management strategies are applied and revised as required.

## 15 Implementation

Table 3 outlines the implementation of recovery actions specified in this plan for the period of five years. DEC is responsible for the implementation of the Recovery Plan.

## 16 Preparation Details

### 16.1 Persons responsible for the plan preparation

This is the second Recovery Plan for *Grevillea beadleana* and was prepared by Dr C. Gross (UNE) and Mr A. Steed (DEC). The first Recovery Plan was written by Mr J. Benson in 1991.

### 16.2 Date of last amendment

The Recovery Plan was last amended in October 2003.

## 17 Review Date

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

## 18 Contacts

The Recovery Plan for *Grevillea beadleana* is co-ordinated by the *G. beadleana* Coordinator, Threatened Species Unit, Conservation Programs and Planning (North East Branch) Department of Environment and Conservation, 24 Moonee Street Coffs Harbour, NSW 2450. Ph (02) 66515 946 Fax (02) 66516 187. All inquiries about *G. beadleana* should be directed to this office.

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## 20 List of Abbreviations

DEC	The Department of Environment and Conservation
EPBC Act	Commonwealth <i>Environmental Protection and Biodiversity Conservation Act</i> , 1999
EP&A Act	<i>Environmental Planning and Assessment Act</i> 1979
DIPNR	Department of Infrastructure, Planning and Natural Resources
NPW Act	<i>National Parks and Wildlife Act</i> 1974
NPWS	National Parks and Wildlife Service
NSW	New South Wales
NVC Act	<i>Native Vegetation Conservation Act</i> 1997
ROTAP	Rare or Threatened Australian Plants
TSC Act	<i>Threatened Species Conservation Act</i> 1995
UNE	University of New England
VCAs	Voluntary Conservation Agreements

## Appendix 1: Estimated Cost of Implementation

Action	Action Title	Priority	Estimated Cost/year (\$)					Total Cost (\$)	Responsible Party	In-Kind (\$)	Cash (\$)
			Year 1	Year 2	Year 3	Year 4	Year 5				
1.1	Undertake surveys and threat assessment at known populations and those areas likely to contain <i>Grevillea beadleana</i> .	1	\$8,000	\$16,000	\$8,000	\$8,000	\$8,000	\$48,000	DEC	\$40,000	\$8,000
1.2	Inform all relevant land managers of <i>Grevillea beadleana</i> locations and hold discussions to protect all populations.	1	\$400	\$400				\$800	DEC	\$800	
1.3	Assess known <i>Grevillea beadleana</i> sites to determine whether declaration as Critical Habitat within the meaning of the TSC Act is warranted.	1	\$400	\$400	\$400	\$400	\$400	\$2,000	DEC	\$2,000	
2.1	Continue population studies into <i>Grevillea beadleana</i> at all known sites.	1	A	A	A	A	A	-	DEC	\$0	
2.2	Continue research into the seedbank and fire ecology of <i>Grevillea beadleana</i> .	1	\$5,000	\$5,000	\$5,000			\$15,000	DEC	-\$0	\$15,000
2.3	Develop appropriate management strategies and make recommendations about the need for further research programs following a review of actions 2.1 and 2.2.	2				\$2,000		\$2,000	DEC	\$2,000	
2.4	Prepare and implement a <i>Grevillea beadleana</i> ex-situ conservation program and conduct a re-introduction feasibility study.	2				\$2,000		\$2,000	DEC	\$2,000	
3.1	Investigate options for protecting <i>Grevillea beadleana</i> populations on private and leasehold land.	1	\$2,000	\$2,000	\$2,000			\$6,000	DEC	\$6,000	
3.2	Undertake discussions with landowners and lessees about the protection of <i>Grevillea beadleana</i> populations on private and leasehold land.	1	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000	DEC	\$10,000	
4.1	Reduce or eliminate the threat of frequent fire regimes to <i>Grevillea beadleana</i> by implementing appropriate planning mechanisms.	1	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$25,000	DEC	\$25,000	
4.2	Apply appropriate management strategies to eliminate or reduce site-specific threats identified during population surveys and ecological research.	2	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000	DEC	\$10,000	
4.3	Maintain confidentiality of all <i>Grevillea beadleana</i> locations.	2	-	-	-	-	-	-	DEC	\$0	
5	Prepare and display an information leaflet at relevant District DEC offices and local Councils for interested local landowners.	2	\$5,000					\$5,000	DEC	\$5,000	
6	Convene annual Recovery Team meetings to co-ordinate and review the implementation of the actions in this recovery plan.	1	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$10,000	DEC	\$10,000	
Total			\$31,800	\$34,800	\$26,400	\$23,400	\$19,400	<b>\$135,800</b>		\$112,800	\$23,000

A – undertake concurrently with surveys of known sites in year 1

**Appendix 2 Summary of Advice from the NSW Scientific Committee**

Submission	Comment	Amendments made to Recovery Plan
NSW Scientific Committee	The plan is in a different format from the plans prepared by DEC Southern	Noted.
	The plan lacks the paragraphs about Aboriginal involvement.	The Recovery Plan was prepared and exhibited prior to the recent TSC Act amendments. Indigenous communities involved in the regions affected by this plan have not yet been identified. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.
	The plan needs to consider seed predation work conducted on the closely related <i>G. caleyi</i>	Text amended to incorporate additional information.
	The plan needs to consider research on <i>G. caleyi</i> in determining appropriate fire-free intervals for <i>G. beadleana</i> . The mixed messages regarding fire frequency need clarification in the light of existing knowledge on <i>G. caleyi</i> .	Text amended to incorporate additional information.
	No current intention to declare Critical Habitat?	Critical habitat to be considered following completion of additional surveys. No amendment.
	Reintroduction actions mentioned on Page 15 should make reference to either the DEC Translocation guidelines or the Australian Network for Plant Conservation Guidelines	Text amended to incorporate additional information.
	In Action 4, it seems that an understanding of seed bank dynamics would be a more important issue, particularly as this is the basis for Action 6.	Research into seedbank dynamics included as part of Action 4.
	Page i – final paragraph: Are four populations partly or wholly within conservation reserves?	Text amended to incorporate additional information.
	Page ii – 2 <sup>nd</sup> last paragraph: Change “Increase known population size” to “Estimate current population size more accurately”	Text amended.
	Page iii – para 3: bullet point “Protect all populations...” be more explicit about means of protection	Text amended.
	Page 3 – para 2 & 3: remove ROTAP details, out of date	Deleted
	Page 6 – para 3: How was estimate of plant age made? Also, do plants show signs of browsing by goats?	Text amended to incorporate additional information.
	Page 8 - 4.3 - <i>Corymbia gummifera</i> rather than <i>E. gummifera</i> .	Text amended.

	Page 10 – para 3: Insert data for number of viable seeds after trials.	Text amended to incorporate additional information.
	Page 10 – para 4: germination trials require replication as well as larger sample size	Text amended.
	Page 10 – para 5: How was age of seeds determined?	Text deleted as reference was not found to contain this statement.
	Page 10 – para 7: Does this mean there was overlap between successive fires?	Text amended to make situation clear.
	Page 11 – para 2: Does “...how healthy the seedbank is” mean how large it is? Also, it is said that the “...risks to the very few plants is too great to employ a control burn...” Why would a control burn be a desirable action?	Text amended.
	Page 13 – para 6: threats need a brief explanation. Also, may need to add seed predation (see major comments above)	Text amended.
	Page 15 – para 3, 4 and 5: Is this text relevant to this section?	Text deleted.
	Page 16 – 11.3 para 2: Will there be any access restrictions to habitat?	Text amended to provide additional clarification.
	Page 16 – final para: What relationship currently exists with community?	Text amended to provide additional clarification.
	Page 17: Is it possible to be more specific about the identity of these individuals (if known).?	Text amended to provide additional clarification.
	Page 18 – para 1: remove “to rare”. Overall aim would include to reduce risk of decline/extinction	Text amended.
	Page 18 – para 2: Specific or Secondary objectives? Also, change “Increase known...” to “Increase knowledge of extant...”. Finally, include number of populations, with size and location in next para beginning “Secure populations in conservation....”.	Text amended.
	Section 15: change “Criteria” to “Criterion” where relevant.	Text amended.
	Page 21 – Outcome 3 change “...dynamics...understood” to “changes in population size are assessed”.	Text amended.
	Page 22 – Perform. criteria 5: remove first few words and begin with “Adoption of Voluntary...by owners..”.	Text amended.
	Page 23 – Funding action 5. There seems to be no budget for funds to develop management plans under Vol agreements?	Depending upon which type of conservation mechanism is adopted, plans may not be required.
	Page 24 – Performance criteria 7: needs an experimental design.	The intention is to visually assess grazing before determining whether an extensive and ongoing monitoring program is required. If ongoing monitoring is required, experimental design would be a key component of the program.





Department of  
**Environment and  
Conservation (NSW)**