

# An assessment of the conservation status of *Senecio garlandii*, in the Central and South Western Slopes, New South Wales

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*Senecio garlandii* F. Muell. ex Belcher (Asteraceae) is a perennial subshrub found mainly on rocky outcrops in the South Western Slopes, New South Wales. It is listed as vulnerable in state, national and international listings. An assessment of its conservation status found i) *Senecio garlandii* has been recorded from about ten localities, ii) it has a relatively large (225 km) north to south distribution from Temora, NSW to Chiltern, Vic., iii) most populations were either within the reserve system (Ulandra, The Rock, Table Top Nature Reserves) or in areas managed for conservation, iv) large populations (> 30 000 individuals) were recorded at The Rock and Table Top Nature Reserves, v) the species appeared capable of regenerating in both the absence and presence of fire, and vi) the populations did not appear to be under direct threat.

However, the known localities were highly disjunct and only three localities had substantiated recordings of large populations, while others had very small populations (e.g. < 200 individuals at Ulandra Nature Reserve). In addition, the species was largely restricted to rocky outcrops and on these it was generally restricted to the upper parts of the east- to south-facing talus slopes, often immediately below cliff lines (a small area of occupancy). Application of the IUCN red list criteria would indicate that *Senecio garlandii* should not be classified as vulnerable. Monitoring is needed to determine whether the populations are in decline or otherwise.

## Introduction

*Senecio garlandii* F. Muell. ex Belcher (Asteraceae, common name Woolly Ragwort) is a perennial subshrub that grows to 1–2 m in height. It is a distinctive plant in the field, even when not flowering, with large (3–9 cm wide × 8–15 cm long) stem-clasping leaves that are dark glossy green on the upper surface, while the lower surface and the stems are densely covered in white, woolly hairs (Belcher 1986, Burrows 2001). Lawrence (1985) and Burrows (1995) provide information relevant to its biology and regeneration, while Ali (1968) and Radford and Cousens (2000) do likewise for *Senecio lautus*, another native, perennial, self-incompatible species of *Senecio* (Lawrence 1985).

A biogeographical analysis of the threatened flora of NSW has recently been published (Mokany & Adam 2000), with the South Western Slopes (SWS) containing significantly fewer threatened species than expected. Twenty-two threatened (endangered or

vulnerable), rare or poorly known plant species have been identified in the Rare or Threatened Australian Plant (ROTAP) listings for the SWS of NSW (Briggs & Leigh 1996, Burrows 1998). Of these 22 species, four are considered endangered, ten vulnerable, three rare and five poorly known. Six of the 22 species are considered extinct in the SWS and only *Pterostylis petrosa* (recorded at The Rock Nature Reserve) and *Senecio garlandii* (recorded at The Rock, Table Top and Ulandra Nature Reserves) are conserved in the region (Briggs & Leigh 1996).

*Senecio garlandii* is listed as vulnerable in the *NSW Threatened Species Conservation Act 1995* (TSCA), the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA), the ROTAP listings (Briggs & Leigh 1996) and in the *IUCN red list of threatened plants* (Walter & Gillett 1998). Briggs and Leigh (1996) recorded its risk code as 3VC-, meaning the species has a geographic range of greater than 100 km, is classified as vulnerable, and has at least one population within a conservation reserve but the population size of the reserved population is not known. They record the population at The Rock Nature Reserve as less than 1000 plants, and population sizes at Table Top and Ulandra Nature Reserves as unknown. The aim of this study was to document the distribution, abundance and conservation status of *Senecio garlandii*, probably the most conspicuous and well known threatened plant species in the South Western Slopes.

**Table 1. The 10 localities, arranged from north to south, where *Senecio garlandii* has been recorded or observed (NR, Nature Reserve; SF, State Forest; SRA, State Recreation Area).**

	Locality	Additional locality information
1	Gidginbung/Trungley Hall	20 km N of Temora
2	Ulandra NR	7 km SE of Bethungra
3	Burrinjuck	in the vicinity of Burrinjuck NR and SRA
4	The Rock NR/Flowerpot Hill	4 km W of The Rock
5	Gregadoo Hills/Big Springs/Livingstone SF	10–30 km S of Wagga Wagga
6	Holbrook	50 km NE of Albury
7	Benambra SF	20 km WSW of Holbrook
8	Table Top NR	7 km ESE of Gerogery
9	Nail Can Range	5 km NW of Albury
10	Chiltern Regional Park	35 km WSW of Albury

### Previous records

*Senecio garlandii* has been recorded from 10 localities in Australia — eight in the South Western Slopes of NSW, one in the Central Western Slopes and one in Victoria (Table 1, Fig. 1). Notes on these records are as follows:

- 1) The Gidginbung record is based on a herbarium specimen collected in 1975 (NSW 153245, Schlunke 1975, 34°19'S, 147°28'E). *Senecio garlandii* had also been reported as occurring in the Trungley Hall area, 8 km NE of Gidginbung.

- 2) The Ulandra NR (34°49'S, 147°54'E) record is based on a 1992 collection by Levett (Burrows 1999).
- 3) The Burrinjuck record is based on a National Herbarium of NSW specimen collected in 1912 (NSW 457440, Cheel 1912, 35°00'S, 148°36'E).
- 4) While most records are based on a single herbarium collection, The Rock NR (35°16'S, 147°04'E) is represented by 26 herbarium sheets at the National Herbarium of NSW, and the Melbourne and Canberra herbaria. Whiting (1997) includes a map and description of *Senecio garlandii* distribution and abundance at The Rock NR. *Senecio garlandii* has also been recorded from Flowerpot Hill, 4 km SE of The Rock NR (NSW 279856, Burrows 1992, 35°16'S, 147°07'E).

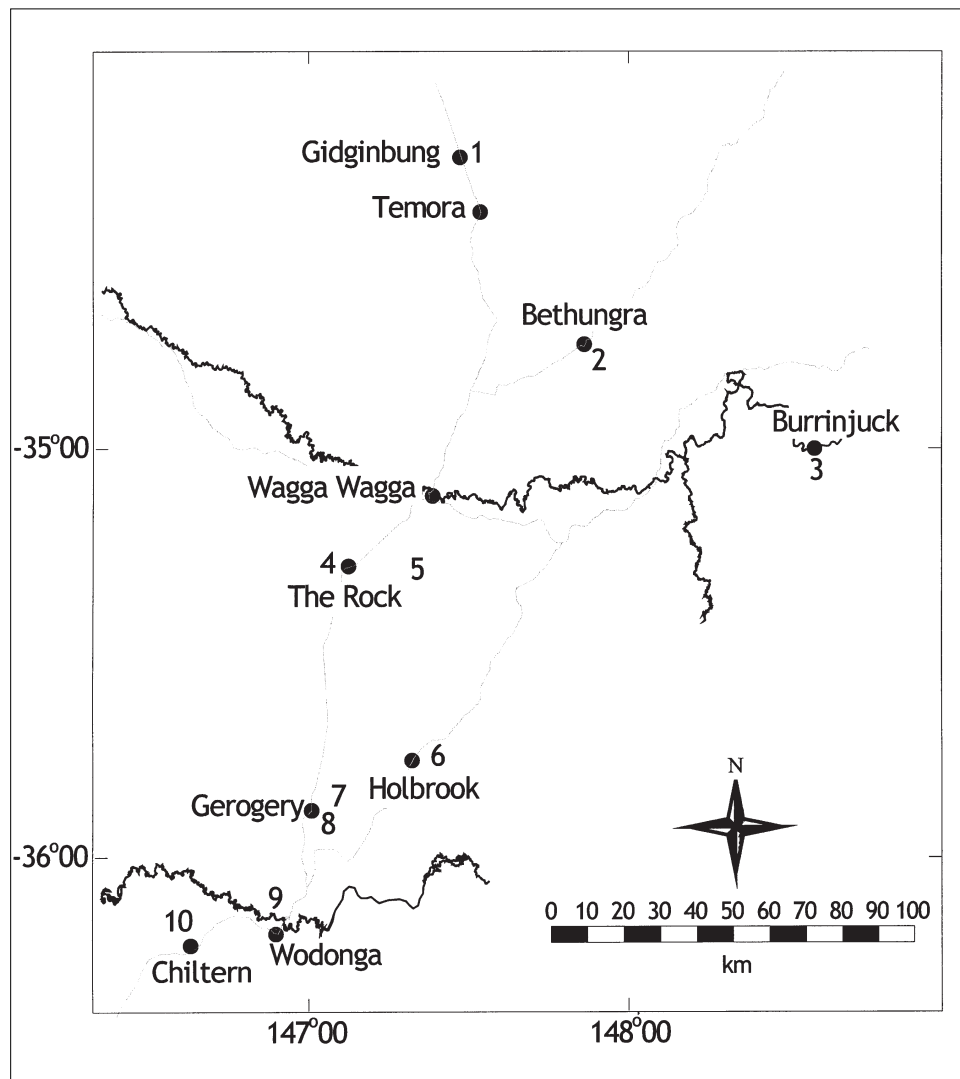


Fig. 1. Map of the 10 recorded localities of *Senecio garlandii*, numbered as in Table 1.

- 5) The Gregadoo Hills/Big Springs/Livingstone SF records are based on a herbarium record (MEL, Wilson 1971, 35°21'S, 147°21'E) for 'Big Springs', and recently reported recordings on private property on the western side of Livingstone SF and in the Gregadoo Hills.
- 6) The Holbrook record is based on a herbarium collection (NSW 117786, Skyes 1975, 36°06'S, 146°54'E).
- 7) Benambra SF (35°48'S, 147°05'E) is based on surveys of Johnston (1978, unpublished species list) and Marshall in 1994 (Burrows 1999).
- 8) Table Top is based on two Melbourne herbarium collections (Willis 1969, 35°49'S, 147°00'E), and the recordings of Johnston (1978, unpublished species list) and Marshall in 1992 (35°52'S, 147°04'E) (Burrows 1999).
- 9) Nail Can Range (36°03'S, 146°53'E) is based on recent sightings of a small scattered population (< 1000 individuals) on both private and public lands (Ian Davidson, pers. comm.).
- 10) Chiltern Regional Park is based on a single plant (Melbourne, Collins 1996, 36°09'S, 146°39'E). This plant has since died (Eileen Collins, pers. comm.).

### Survey methods

As noted *Senecio garlandii* is a large subshrub that is conspicuous for most of the year, especially during spring and early summer. Likewise seedlings, even when only 1–2 cm high, are distinctive because of the whitish stems and leaves. Thus, traverses, walked by a pair of people, were used to obtain a rapid and accurate recording of distribution and abundance. The species has an apparent habitat preference for the upper parts of south- to east-facing slopes of rocky outcrops in the SWS (Burrows 1995, 1999) and these were targeted when investigating distribution. A quadrat-based assessment was conducted at The Rock NR (see 4 below) and the results were used to estimate population sizes at all sites. During September to October 1999 survey work was carried out in five of the ten known localities. Botanical names follow Harden (1990–1993).

### Survey results

A summary of the survey results is provided in Table 2. Maps of *Senecio garlandii* distribution at Trungley Hall, Ulandra, The Rock and Table Top localities have been prepared and lodged with the NSW NP&WS, Threatened Species Unit, Queanbeyan. Results will also be available through the Atlas of NSW Wildlife database.

**Table 2. *Senecio garlandii* population estimates for surveyed sites. NR: Nature Reserve, n.l.: not located.**

Locality	Latitude/Longitude	Population estimate
Trungley Hall:		
Government Hill	34°19'S 147°35'E	several hundred
Private property	-	> 10 000
Boginderra NR	34°16'S 147°38'E	n.l.
Ulandra NR:		
SE side of Mt Ulandra	34°49'S 147°54'E	< 200
Merrybundinah Creek	as above	n.l.
The Rock:		
The Rock NR	35°16'S 147°04'E	> 30 000
Little Rock	35°19'S 147°03'E	200
Flowerpot Hill	35°18'S 147°06'E	n.l.
Holbrook:		
Morgan's Ridge	35°43'S 147°24'E	n.l.
Table Top:		
Table Top NR	35°53'S–147°03'E	> 30 000
Pulpit Rock	as above	4000
Bimbadeen Point	as above	1–2000
Table Top Mt.	as above	5000
TOTAL		c. 81 000

### 1) Gidginbung/Trungley Hall

The herbarium specimen grid reference for Gidginbung places the location at the Gidginbung trig point, a low wooded rise. The lower slopes of this area were being used for the storage of gold mining waste and the area was not surveyed. The herbarium specimen label also mentions 'Big Bush'. The Big Bush NR is about 6 km south of the trig point but was not surveyed. A single plant of *Senecio garlandii* had been recorded on the property 'Carolees' (2 km E of Trungley Hall) and additional survey work was carried out in the Government Hill area. At Boginderra Hill NR in the Nurraburra Hills (6 km E of Trungley Hall), a loop was traversed around the Nurraburra trig point, concentrating on rocky east-facing slopes.

After relocating the single known *Senecio garlandii* on the eastern side of Government Hill, no additional specimens were found on the slopes and rock outcrops to the south. To the north several hundred plants, both adults and seedlings, were found over 100–200 m in amongst the boulders and rocky outcrops on the east-facing slope. Overstorey trees were *Eucalyptus macrorhyncha*, *Acacia doratoxylon* and *Brachychiton populneus*. In a nearby area (the location of which is confidential) *Senecio garlandii* grew as the dominant (more than 10 000 plants present) shrub species in a 500 m long × 50–100 m wide strip along the upper slopes of the western side of a rocky ridge. *Senecio garlandii* was not observed at Boginderra Hill NR, although some steep, rocky, east-facing slopes were traversed.

## 2) Burrinjuck

Not surveyed.

## 3) Ulandra Nature Reserve (3934 ha)

The slopes and ridges around Mt Ulandra were surveyed and the previously recorded population was located on the northern side of a gully on the SE side of Mt Ulandra, at approximately 600 m elevation. The population was small (less than 200 plants) with most plants immediately below some of the largest boulders in the area, while the remaining plants were scattered 100 m down from this point on the sides of the gully. The east-facing slope above Merrybundinah Creek, about 1 km west of the above population, was also surveyed but no *Senecio garlandii* plants were found, even though this area had almost identical slope, aspect, soil moisture, overstorey and understorey species and rock formations. During 1992 and 1993 more than 20 extensive flora survey trips were conducted in Ulandra NR (Burrows 1999) and only the population mentioned above was found. It is probable that this is the only population of *Senecio garlandii* in Ulandra NR.

### 4a) The Rock Nature Reserve (341 ha)

A transect consisting of six 10 × 10 m quadrats, spaced at 30 m intervals, was run down the east-facing slope below the main cliff face. This was replicated three times, with 10 m between each transect, and the number of *Senecio garlandii* plants per quadrat was counted. During October 1999 most of The Rock NR was covered in a number of traverses. Little Rock Hill (35°19'S, 147°03'E), 4.5 km south of The Rock NR, and Flowerpot Hill (35°18'S, 147°06'E) 4 km SE of The Rock NR were also traversed.

The quadrat survey indicated that at high densities of adult plants (greater than 75% foliage projective cover) there were about 3300 *Senecio garlandii* plants/ha and correspondingly fewer in less dense populations. A maximum of 52 adult plants was recorded in two quadrats, which would be equivalent to 5200 plants/ha. The Rock NR is based around a narrow north-south orientated ridge, the highest point of which is 554 m and about 340 m above the surrounding plains (NSW NPWS 2000). The main features of *Senecio garlandii* distribution and abundance were:

- i) on the eastern side of the ridge essentially no plants occurred below 300 m and very few (mainly directly below the main cliff face) were present below 370 m, hence *Senecio garlandii* did not occur over a large proportion of the reserve and was mainly restricted to the upper areas.
- ii) the main population was present in a narrow (50–100 m wide) band at the base of the east-facing cliffs, which extend for about 1.7 km within the Reserve. More than 30 000 plants were estimated to occur and in the main population areas *Senecio garlandii* was the dominant shrub and the dominant feature of the vegetation.
- iii) the western side of The Rock NR is predominantly steeply sloped, with rocky outcrops, and scattered plants were present over much of the northern half of this area. Few plants were observed in the southern extension of the reserve, while some dense populations were present on the slope to the SW of the main peak and in the gully leading NW from the main peak.

iv) small numbers of plants were growing on private property to the east and south of the southern extension, to the west of the main peak and near the NW corner.

In summary, a large number of plants were estimated to be present (more than 30 000) but they occupied a relatively small area (less than 50 ha) of a small (341 ha) reserve.

#### **4b) Little Rock Hill**

This area was a miniaturised version of The Rock NR, in terms of topography and *Senecio garlandii* distribution. A small population (less than 200 plants) grew on the SE side, below a cliff face. This area was private property, managed for its conservation values, and the *Senecio garlandii* population, although small and isolated, did not appear to be under direct threat.

#### **4c) Flowerpot Hill**

A population of less than 50 plants, growing under an overstorey of *Eucalyptus macrorhyncha* on a gentle slope, with few large rock outcrops, was recorded here in 1992 (Burrows 1999). During the 1999 survey this population was not relocated, nor were any new populations found, though it is considered that the site of the previous recorded population was not relocated, not that it had become extinct.

#### **5) Gregadoo/Big Springs/Livingstone State Forest**

No surveys were carried out in this area. The recordings to date are on private property in the vicinity of Livingstone SF, a relatively large and undisturbed area with a high diversity of native plant species (Burrows 1999). Livingstone SF could be expected to be a likely area of occurrence for *Senecio garlandii* but it has not been found in 10 previous survey trips (Burrows 1999).

#### **6) Holbrook**

The location of NSW 117786 is given as 'Holbrook, near Albury' but the grid reference (36°06'S, 146°54'E) places the location on the Murray River floodplain, between Albury and Wodonga. Assuming that the grid reference was incorrect the closest suitable *Senecio garlandii* habitat to Holbrook is Morgan's Ridge and the Cromer Hills, 7 km to the east. Several steep east- to south east-facing slopes with large exposed boulders and an overstorey of *Eucalyptus macrorhyncha*, centred on 35°43'S, 147°24'E, were traversed but no *Senecio garlandii* plants were found. No plants were found in a brief inspection of Woomargama SF, 20 km to the south.

#### **7) Benambra State Forest**

No surveys additional to Burrows (1999) were conducted. In 1994 and 1995 *Senecio garlandii* was recorded from the area of steep, east-facing slopes in the narrow southern extension (Burrows 1999 and unpublished data). Only 6 km of relatively uncleared land separates Benambra SF from Table Top NR and there may be populations that link the two areas, but few, steeply sloping, south- to east-facing slopes are present in the intervening distance.

### 8) Table Top Nature Reserve (103 ha) and Table Top Mountain Retreat

Table Top Nature Reserve and the ridgeline that extends south into 'Table Top Mountain Retreat' were surveyed. The topography of this area is unusual for the SWS in that several narrow east-west ridges extend west from the main north-south Table Top Ridge. Cliff lines are present on both the northern and southern sides of these smaller ridges and there are relatively extensive south-facing slopes that are shaded for much of the year. *Senecio garlandii* had an absolute habitat preference for the upper parts of these south-facing talus slopes and the cliffs above them.

*Senecio garlandii* was the dominant shrub on the main south-facing slope of Table Top NR extending in a band 1.2 km east-west and 100–150 m wide down from the base of the cliff line. While plants on an east-facing slope at The Rock NR were in full flower in mid-October and some individuals were releasing seed, in mid-November these heavily shaded plants at Table Top NR were only in bud. At an estimated average density of 2000 plants/ha, over an area of 12 ha, a population of 24 000 plants was present. In addition, several thousand more plants were present on the cliff face, growing on the many narrow ledges. *Senecio garlandii* was restricted to the cliff face and the upper part of the slopes, at the base of the cliffs. On the small, relatively flat ridge top and the northern and western slopes and cliffs the species was absent.

On the southern side of Pulpit Rock (Table Top Mountain Retreat) several thousand plants were present in a 50 m wide band at the base of the cliff line but no plants were present on the north-facing slope of Pulpit Rock. A further 1–2000 plants were present along the southern side of the ridge leading west from Bimbadeen Point. Some large plants were growing in the drainage line at the base of the slope, but not on the north-facing slope above the drainage line. This distribution pattern was repeated on the southern side of Table Top Mountain (i.e. the 2 km of east-west cliff line to the north of Yambula Basin). Several thousand plants were present, many growing on ledges in the cliff face, but the majority present in a narrow band at the top of the slope, at the base of the cliffs. Near the eastern end of the ridge several large, dense groups of plants were present several hundred metres down a gully. The overstorey was mainly *Eucalyptus macrorhyncha*, *Eucalyptus goniocalyx* and *Acacia implexa*. Few understorey shrubs were present apart from *Bracteantha viscosa*, *Senecio quadridentatus* and *Senecio garlandii* and the groundlayer of this part of the property was dominated by introduced pasture plants and occasionally grazed by cattle. No *Senecio garlandii* plants, including those away from the cliff line, showed any evidence of grazing.

### 9) Nail Can Range

Not surveyed.

### 10) Chiltern Regional Park

Not surveyed.



## Discussion

The main feature of the distribution and abundance of *Senecio garlandii* was its restricted area of occupancy, coupled with its dominance of the shrub layer in most of those areas where it occurred; i.e. the species was abundant, but only in its small area of occupancy.

*Senecio garlandii* has been recorded at ten localities, from around Trungley Hall in the north to Chiltern Regional Park in the south, a distance of about 225 km, though its east to west range was much smaller. Belcher (1986) recorded its distribution as 'Very local along the 147°E. meridian ...', but it is more of a gentle curve, roughly parallel to the Great Dividing Range. It is very much a species of the western slopes and, more specifically, the mid regions of these slopes.

*Senecio garlandii* was generally restricted to the upper slopes of the steeper and more rugged ranges and, with some exceptions, it was more abundant on the more mesic east- to south-facing slopes. From the relatively undisturbed populations at The Rock, Table Top and Ulandra Nature Reserves it can be assumed that this is the species' natural habitat, not an artefact of clearing, stock grazing or other human influence. This distribution has been to its conservation advantage in the extensively and intensively disturbed SWS (Burrows 1999).

*Senecio garlandii* shows little soil specificity and grows on soils that probably have a low nutrient content, especially phosphorus, and minimal organic matter. At Ulandra NR, The Rock NR and in the Table Top region *Senecio garlandii* grows on soils derived from Palaeozoic granites (NSW NPWS 1992), Ordovician metasediments/quartzites (NSW NPWS 2000) and conglomerates (pers. obs.), respectively.

For a species with relatively large and mesophytic leaves (Burrows 1995, 2001) the foliage showed little evidence of damage by herbivores. Most sites had a small number of leaves with minimal insect damage, while at Table Top NR and Table Top Mountain Retreat the leaves were untouched by feral goats and cattle, respectively.

Populations consisted mainly of mature plants, but a small number of seedlings and juvenile plants were present at most sites, though not at the densities recorded at The Rock NR after the 1991 fire (Burrows 1995). It has been suggested that plants could be relatively long-lived, going through repeated cycles of dying back at the end of summer/autumn, then resprouting from the base each winter/spring (Burrows 1995). Monitoring is needed to determine what percentage of the seedlings mature into adults and if populations are stable or otherwise.

This study has provided population estimates for Ulandra and Table Top Nature Reserves, areas for which estimates were not previously available (Briggs & Leigh 1996). The study has also provided a much larger population estimate for The Rock NR than previously recorded (Briggs & Leigh 1996). Whiting (1997) recorded 3–4000 *Senecio garlandii* plants at The Rock NR but conducted the survey during a particularly dry autumn.

Various definitions of 'vulnerable' are employed by different conservation agencies and in various pieces of legislation. The definition given in the NSW TSC Act (which

is similar to that in the Commonwealth's EPBC Act), states 'A species is eligible to be listed as a vulnerable species if, in the opinion of the Scientific Committee, the species is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate.' In *Rare or threatened Australian plants* (Briggs & Leigh 1996) the definition of vulnerable emphasises threats, population levels in conservation reserves (usually less than 200 individuals for trees and shrubs) and risk due to specific biological or ecological factors. In the 1997 IUCN red list list of threatened plants (Walter & Gillett 1998) five criteria (decision rules) are given regarding a vulnerable listing. These criteria emphasise population reduction or fluctuation, small extent of occurrence or area of occupancy, fragmentation of populations, a small number of locations and small population size as reasons for a vulnerable listing. With regard to these criteria the following positive features are known about *Senecio garlandii*:

- i) it has been recorded over a relatively large area,
- ii) a relatively large total population has been recorded,
- iii) the three largest populations are widely spaced and thus a catastrophic event would be unlikely to affect them all,
- iv) previously unrecorded populations have been located in the last ten years and further surveys would probably continue to locate additional populations,
- v) a relatively large proportion of the total population is within protected areas. Two large populations (The Rock and Table Top Nature Reserves) and one smaller population (Ulandra NR) are in conservation reserves, several populations are in an area managed for ecotourism (Table Top Mountain Retreat), Benambra SF is soon to be declared a Nature Reserve, while other populations are protected from stock (Little Rock Hill) or were being protected from stock (Trungley Hall),
- vi) while further research is needed the species does not appear to need a specific fire regime to survive as there can be a large recruitment after fire (Burrows 1995) and there may be seedling establishment in its absence,
- vii) the species does not appear to be favoured by herbivores such as insects, stock or feral animals, and
- viii) none of the populations appear to be under direct threat, although the Gregadoo Hills population may eventually be affected by rural subdivision.

However, *Senecio garlandii* is known from only ten localities. The Burrinjuck recording dates from 1912, the Holbrook recording will be difficult to relocate, the Chiltern recording was based on a single plant, while the Ulandra NR and Nail Can Range populations were small. This leaves only three localities with large substantiated populations (Trungley Hall, The Rock NR, Table Top region) and two where further work is needed to record population sizes. Many of the populations are highly disjunct and given the species' relatively specific habitat requirements and the generally flat topography of the CWS and SWS intervening populations are unlikely to be present. As noted for The Rock NR, *Senecio garlandii* occupied a small proportion of a small reserve and the same was true at Table Top NR. In total *Senecio garlandii* probably does

not occur on more than 100 ha in NSW. It is this acute restriction in the area of occupancy that, according to Rule D (and also referred to in Rules B and E) of the *IUCN red list of threatened plants* (Walter & Gillett 1998), is the main feature indicating that *Senecio garlandii* should retain a vulnerable listing. However, while the area of occupancy of *Senecio garlandii* is two orders of magnitude less than that suggested in Rule D, this rule is only applicable to species that may become Critically Endangered or Extinct in a very short period. This would not appear to be the case for *Senecio garlandii*. In addition, the average area of occupancy for 112 of the 135 rare or threatened vascular plant species from south-eastern Australia examined by Keith et al. (2000) was about 30 ha (David Keith, pers. comm.). Thus, while the area of occupancy of *Senecio garlandii* was small it was not particularly low for a threatened species.

Application of the IUCN criteria and the ROTAP guidelines would indicate that *Senecio garlandii* should not be classified as vulnerable. This would have little influence on the species' conservation as a large percentage of its total population is within conservation reserves, though the Gidginbung and Trungley Hall populations, as they lie outside the reserve system and are by far the most northerly (Fig. 1), may need special consideration as endangered populations.

One of the main considerations in listing a species as vulnerable is population decline. With no previous measurements of *Senecio garlandii* population size at any of the localities it is impossible to determine if population sizes have declined or otherwise. It is worth noting that *Senecio garlandii* has been recorded as 'very common' to 'abundant' at The Rock NR on various herbarium sheets from 1967 to 1992. Qualitative assessments (Burrows 1995, Whiting 1997) indicate that the *Senecio garlandii* population at The Rock NR increased markedly in number, but not extent, after the 1991 fire.

## Conclusions

*Senecio garlandii* occurs discontinuously over 225 km from north to south. Most populations are either within the reserve system or in areas managed for conservation. Several large populations are known, seedling establishment would appear to occur in both the absence and presence of fire and the populations do not appear to be under immediate threat. However, there are only three known large populations and the populations are highly disjunct. The species has specific habitat preferences, a highly restricted distribution at each locality and a small area of occupancy. Application of the IUCN criteria would indicate that *Senecio garlandii* should not be classified as vulnerable, however monitoring is needed to determine if populations are in decline or otherwise.

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### References

- Ali, S.I. (1968) *Senecio lautus* complex in Australia. IV. The biology of the complex. *Phyton* 13: 53–62.
- Belcher, R.O. (1986) New or noteworthy taxa of *Senecio* (Asteraceae) in Australia, 1. *Muelleria* 6: 173–179.
- Briggs, J.D. & Leigh, J.H. (1996) *Rare or threatened Australian plants. 1995 revised edition.* (CSIRO: Melbourne).
- Burrows, G.E. (1995) Post-fire regeneration and growth of *Senecio garlandii* (Asteraceae) — a vulnerable plant of the South Western Slopes, NSW. *Cunninghamia* 4: 35–44.
- Burrows, G.E. (1998) Threatened flora of the South West Slopes. Pp. 15–19 in Stelling, F. (Ed.) *South West Slopes revegetation guide* (Murray Catchment Management Committee: Albury).
- Burrows, G.E. (1999) A survey of 25 remnant vegetation sites in the South Western Slopes, New South Wales. *Cunninghamia* 6: 283–314.
- Burrows, G.E. (2001) Comparative anatomy of the photosynthetic organs of 39 xeromorphic species from subhumid New South Wales, Australia. *International Journal of Plant Sciences* 162: 411–430.
- Harden, G.J. (Ed.) (1990–1993) *Flora of New South Wales*. Vols 1–4. (New South Wales University Press: Sydney).
- Keith, D.A., Auld, T.D., Ooi, M.K.J. & Mackenzie, B.D.E. (2000) Sensitivity analyses of decision rules in World Conservation Union (IUCN) red list criteria using Australian plants. *Biological Conservation* 94: 311–319.
- Lawrence, M.E. (1985) *Senecio* L. (Asteraceae) in Australia: reproductive biology of a genus found primarily in unstable environments. *Australian Journal of Botany* 33: 197–208.
- Mokany, K. & Adam, P. (2000) The biogeographical attributes of the threatened flora of New South Wales. *Cunninghamia* 6: 873–892.
- NSW National Parks and Wildlife Service (1992) *Ullandra Nature Reserve — Plan of Management.* (NSW National Parks and Wildlife Service: Sydney).
- NSW National Parks and Wildlife Service (2000) *The Rock Nature Reserve — Plan of Management.* (NSW National Parks and Wildlife Service: Sydney).
- Radford, I.J. & Cousens, R.D. (2000) Invasiveness and comparative life-history traits of exotic and indigenous *Senecio* species in Australia. *Oecologia* 125: 531–542.
- Walter, K.S. & Gillett, H.J. (eds) (1998). 1997 IUCN red list of threatened plants. (The World Conservation Union: Cambridge).
- Whiting, E. (1997) *Senecio garlandii* at The Rock Nature Reserve. Unpublished report, NSW National Parks and Wildlife Service, Griffith.