1. INTRODUCTION

This plan addresses the conservation of twelve threatened plant taxa in the genus *Epacris*. All taxa are endemic to Tasmania including eight species listed on the Schedules of Commonwealth and State threatened species legislation. Four additional taxa are yet to be formally described and meet criteria for possible inclusion on Commonwealth and State threatened species Schedules. The twelve taxa were selected for detailed analysis in the Tasmanian Comprehensive Assessment because: all are subject to identified threatening processes and/or occupy restricted habitats or ranges; all occur in forested landscapes or at least forest ecotones and are therefore subject to forest management practices; and because their shared several ecological attributes suggest that efficiencies may be achieved in survey and research techniques and the development of management strategies. This plan describes the morphology, distribution, habitat and life history of the twelve taxa, identifies major threatening processes and proposes strategies and actions for their conservation.

1.1 Description and Classification of Species

Epacris is a genus of about 40 species endemic to south-eastern Australia and New Zealand. *Epacris* belongs the family Epacridaceae which has a Gwondwanan distribution including Australia, south-east Pacific Islands, South America, Malesia and Indo-China. The Epacridaceae includes a group of genera (tribe Epacrideae), including *Epacris, Sprengelia, Richea, Andersonia* and *Dracophyllum,* distinguished by their dry dehiscent fruits that bear multitudinous tiny seeds. The other tribe within the family (Styphelieae) includes genera such as *Leucopogon, Styphelia, Trochocarpa, Acrotriche* and *Cyathodes,* characterised by indehiscent fleshy fruits bearing few seeds. The Epacridaceae is placed in the Order Ericales, along with one other family, Ericaceae, which is distributed principally in forests and heathlands of the northern hemisphere.

No formal subgeneric classification exists for *Epacris*. However, a number of informal subgeneric groups have been recognised. Nine of the twelve taxa addressed in this plan belong to the '*Epacris tasmanica* complex' (Crowden and Menadue 1990), as well as *E. stuartii*, an endangered species addressed in a separate recovery plan (Keith 1996a). The '*Epacris tasmanica* complex' is distinguished by convex lanceolate to ovate leaves, long glabrous styles bulbous below the middle, corolla tubes that scarcely exceed the sepals and relatively open racemose inflorescences. Formally described taxa dealt with in this plan include *E. apsleyensis, E. barbata, E. exserta* s.str., *E. glabella* and *E. virgata* s.str. The complex includes a further four taxa to which the following informal names are applied in this plan: *Epacris* sp. aff. *exserta* (Mt Cameron); *E.* sp. aff. *exserta* (Union Bridge); *E. virgata* (Kettering); and *E. virgata* 'var. autumnalis'. Crowden and Menadue (1990) distinguished the first two of these taxa from *E. exserta* s.str., but deferred formal description until further analyses were completed. The taxon referred to here as *E. virgata* (Kettering) was segregated as type 'A' from *E. tasmanica* s.str. (type 'B') by Crowden and Menadue (1990) and lumped within a broad taxonomic concept of *E. virgata*. In this plan *E. virgata* (Kettering) is maintained as separate from *E. virgata* s.str. (comprising only populations from the Beaconsfield area) pending further systematic analyses of additional characters. The fourth informal taxon, *E. virgata* 'var. autumnalis', is a variant of *E. virgata* (Kettering) yet to be described (R. Crowden, pers. comm.).

The three remaining taxa addressed in this plan, *E. acuminata, E. grandis* and *E. limbata*, are thought to be related to *E. marginata*. This group is distinguished by densely clustered concave lanceolate-cordate leaves, usually short styles, hairy sepals and densely clustered racemose inflorescences.

1.1.1 *Epacris apsleyensis*

Epacris apsleyensis is an erect multi-stemmed shrub growing up to 1.5 m tall. Its branches are slender, bearing thin convex lanceolate leaves, 5-9 mm long and 2-3 mm wide with short stalks (<1 mm long), a pungent apex and a conspicuous midvein on the lower surface. Flowering commences in January, peaks in autumn and continues sporadically until late spring. Flowers are white, solitary in the leaf axils, subsessile and mostly clustered at the ends of branches but occasionally spreading down longer lengths of new season's growth. The style (1.0-1.5 mm long) and anthers are enclosed within the throat the corolla tube which is 2-3 mm long and has five lobes 3-4 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits. The species is distinguished by its enclosed stamens and style and loose racemose inflorescences (Crowden 1986).

1.1.2 *Epacris barbata*

Epacris barbata is an erect multi-stemmed shrub growing up to 1.6 m tall. Its branches are robust, bearing thick convex lanceolate leaves, 7-9.5 mm long and 3-5 mm wide with short stalks (<1 mm long), a pungent apex and a conspicuous midvein on the lower surface. Flowering commences in early spring and is complete by late spring. Flowers are white, solitary in the leaf axils, subsessile and clustered at the ends of branches. The style (5-6.5 mm long) and anthers are exserted from the corolla tube which is 4-5.5 mm long and has five lobes 5-6.5 mm long. The sepals are densely pubescent. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits (Crowden and Menadue 1990). The species is distinguished by its pubescent sepals and large floral parts.

1.1.3 *Epacris exserta* sensu stricto

Epacris exserta s.str. is an erect single-stemmed shrub, sometimes branching near the base and growing up to 1.5 m tall. Its branches are minutely hairy, slender, bearing thick ovate-lanceolate convex-flat leaves, 3-7 mm long and 2-3 mm wide with short stalks (<1 mm long), an obtuse apex and inconspicuous venation. Flowering occurs in spring. Flowers are white, solitary in the leaf axils, subsessile and scattered along the upper parts of branches. The style (4-5 mm long) and anthers are prominently exserted from the corolla tube which is 3-4 mm long and has five lobes 4.0-4.5 long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits (Crowden and Menadue 1990). The species is distinguished by its non-pungent leaves, minutely hairy branches and prominently exserted floral parts.

1.1.4 *Epacris* sp. aff. *exserta* (Mt Cameron)

Epacris sp. aff. *exserta* (Mt Cameron) is an erect or semi-prostrate multi-stemmed shrub, growing up to 1.5 m tall. Its branches are divaricate and minutely hairy, bearing thick ovate-lanceolate convex leaves, 3-4.5 mm long and 2.5-3 mm wide with short stalks (<1 mm long), an acute apex and a conspicuous midvein on the lower surface. Flowering occurs in spring. Flowers are white, solitary in the leaf axils, subsessile and clustered at

the ends of branches. The style (3.5-5 mm long) and anthers are exserted from the corolla tube which is 3-4 mm long and has five lobes 3.5-4.0 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits (Crowden and Menadue 1990). The species is distinguished by its small broad leaves and divaricate branching.

1.1.5 *Epacris* sp. aff. *exserta* (Union Bridge)

Epacris sp. aff. *exserta* (Union Bridge) is a dense erect multi-stemmed shrub, growing up to 2 m tall. Its branches are minutely hairy, slender, bearing thin oblong-lanceolate convex-flat leaves, 7-9 mm long and 2-3 mm wide with short stalks (<1 mm long), an obtuse apex and inconspicuous venation. Flowering occurs in spring and is completed by early summer. Flowers are white, solitary in the leaf axils, subsessile and clustered in short racemes at the ends of branches. The style (5-5.5 mm long) and anthers are slightly exserted from the corolla tube which is 4.5-5.5 mm long and has five lobes 3-4 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits (Crowden and Menadue 1990). The species is distinguished by its soft, long narrow non-pungent leaves and its long corolla tube.

1.1.6 *Epacris glabella*

Epacris glabella. is an erect single-stemmed shrub, sometimes branching near the base and growing up to 2 m tall. Its branches are glabrous, slender, bearing thick ovate-elliptical flat leaves, 3.5-7 mm long and 2-3.5 mm wide with short stalks (<1 mm long), an obtuse apex and inconspicuous venation. Flowering occurs in spring. Flowers are white, solitary in the leaf axils, subsessile and scattered along the upper parts of branches. The style (2.5-4.5 mm long) and anthers are prominently exserted from the corolla tube which is campanulate, 2.5-3.5 mm long and has five lobes 3-5 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits (Jarman and Mihaich 1991). The species is distinguished by its flat, rounded, non-pungent leaves, glabrous branches and campanulate corolla tube.

1.1.7 *Epacris virgata* sensu stricto

Epacris virgata s.str. is an erect single-stemmed shrub, sometimes branching near the base and growing up to 2.5 m tall. Its branches are slender, bearing thick ovate convex-flat leaves, 4-6 mm long and 2-3 mm wide with short stalks (<1 mm long), an obtuse-acute apex and semi-conspicuous midvein on the lower surface. Flowering occurs in spring. Flowers are white, solitary in the leaf axils, subsessile and scattered sparsely along long new branches. The style (4.0-4.5 mm long) and anthers are prominently exserted from the corolla tube which is 2.5-3 mm long and has five lobes 3.5-4.2 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits (Crowden and Menadue 1990). The species is distinguished by its long virgate ultimate branches, non-pungent leaves and prominently exserted floral parts.

1.1.8 *Epacris virgata* (Kettering)

Epacris virgata (Kettering) is an erect multi-stemmed shrub, sometimes branching near the base and growing up to 2 m tall. Its branches are slender, bearing thick lanceolate-ovate convex leaves, 4-6 mm long and 2-3 mm wide with short stalks (<1 mm long), an acute, usually pungent-pointed apex and conspicuous midvein on the lower surface. Flowering occurs in spring. Flowers are white, solitary in the leaf axils, subsessile and scattered along the upper branches. The style (4.0-5.5 mm long) and anthers are prominently exserted from the corolla tube which is 3-4 mm long and has five lobes 3.8-4.7 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits (Crowden and Menadue 1990). The species is distinguished by its slender branches, lanceolate usually pungent-pointed leaves and small flowers with prominently exserted floral parts. The taxon was segregated from *E. tasmanica* s.str. and subsequently lumped with *E. virgata* s.str. by Crowden and Menadue (1990). However, in this study it has been treated as a separate taxon, pending further study of morphological variation.

1.1.9 *Epacris virgata* 'var. autumnalis'

Epacris virgata 'var. autumnalis' is an erect multi-stemmed shrub, sometimes branching near the base and growing up to 2 m tall. Its branches are slender, bearing thick lanceolate-ovate convex leaves, 4-6 mm long and 2-3 mm wide with short stalks (<1 mm long), an acute, usually pungent-pointed apex and conspicuous midvein on the lower surface. Flowering occurs in autumn. Flowers are white, solitary in the leaf axils, subsessile and scattered along the upper branches. The style (4.0-5.5 mm long) and anthers are prominently exserted from the corolla tube which is 3-4 mm long and has five lobes 3.8-4.7 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits. The species is very similar to *E. virgata* (Kettering), but distinguished by its different flowering season (Crowden, pers. comm.).

1.1.10 *Epacris acuminata*

Epacris acuminata is an erect single-stemmed shrub, usually branching near the base and growing up to 1.5 m tall. Its branches are slender, bearing thin ovate-cordate concave stem-clasping leaves, 4-9 mm long and 3-5 mm wide with short stalks (<1 mm long), an acuminate pungent-pointed apex and 5-7 veins conspicuous on the lower surface. Flowering occurs in spring. Flowers are white, solitary in the leaf axils, petiolate and densely clustered along the terminal branches. The style (5-8 mm long) and anthers are exserted from the corolla tube which is 4-6 mm long and has five lobes 4-6 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits. The species is distinguished by its prominently concave leaves without hyaline margins and prominently exserted styles (Curtis 1963).

1.1.11 *Epacris grandis*

Epacris grandis is an erect single-stemmed shrub, rarely branching near the base and growing up to 3 m tall. Its branches are robust, bearing thin lanceolate slightly concave leaves, 10-15 mm long and 3-4 mm wide with short stalks (<1 mm long), an aristate, usually pungent-pointed, sometimes inflexed apex and 5 veins conspicuous on the lower surface. Flowering occurs in late spring. Flowers are white, solitary in the leaf axils, petiolate, enclosed in hirsute bracts and sepals and densely clustered along the terminal branches. The style (ca. 2 mm long) is enclosed within and anthers are exserted from the

corolla tube which is 4-5 mm long and has five lobes 5-6 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits. The species is distinguished by its tall robust growth form, long leaves, hairy bracts and sepals and short styles (Crowden 1986).

1.1.12 *Epacris limbata*

Epacris limbata is an erect single-stemmed shrub, sometimes branching near the base and growing up to 2 m tall. Its branches are long slender and ascending, bearing thin ovate-cordate concave stem-clasping leaves, 4-8 mm long and 3-5.5 mm wide with short stalks (<1 mm long), hyaline margins, an acuminate pungent-pointed apex and 5-7 veins conspicuous on the lower surface. Flowering occurs in late spring to summer. Flowers are white, solitary in the leaf axils, petiolate, enclosed in ciliate bracts and sepals and densely clustered along the terminal branches. The style (1.0-1.5 mm long) is enclosed within and anthers are exserted from the corolla tube which is 2-3.5 mm long and has five lobes 3-6 mm long. Fruits are capsules up to 2 mm long and enclosed until dehiscence within imbricate whorls of sepals and bracts. The seeds are tiny and numerous within the fruits. The species is distinguished by its slender ascending branches, prominently concave leaves with hyaline margins, ciliate bracts and sepals and short styles (Williams and Duncan 1991).

1.2 Conservation Status

Table 1 summarises the current conservation status of the 12 *Epacris* taxa. Entries under the Commonwealth Endangered Species Act (1991) and Tasmanian Threatened Species Protection Act (1995), and the ANZECC Endangered Flora Network (EFN) list are as listed at May 1996. Entries under ROTAP are as reported by Briggs and Leigh (1996). Assessments using the RARE scheme (Keith and Burgman in press) were carried out in 1997 after announcement of new conservation reserves under the Tasmanian Regional Forest Agreement but prior to resolution of areas to be assessed by the Public Land Use Commission.

Table 1: Conservation status of 12 *Epacris* taxa according to various lists. Status categories: CR- Critically Endangered; EN & E- Endangered; VU & V- Vulnerable.

Taxon	C'wth Legislation	ANZECC EFN list	Tasmanian Legislation	ROTAP list	RARE assessment
E. acuminata	-	V	V	V	VU
E. apsleyensis	V	V	V	V	EN
E. barbata	V	E	E	E	CR
E. exserta s.str.	-	-	V	V	EN
E. sp. (Mt Cameron)	-	-	-	-	EN
E. sp. (Union Bridge)	-	-	-	-	EN
E. glabella	V	V	V	V	EN
E. grandis	V	V	V	V	VU
E. limbata	V	V	V	V	EN
E. virgata s.str.	V	V	V	-	EN
E. sp. (Kettering)	-	-	-	-	EN
E. virgata 'autumnalis'	-	-	-	-	CR

1.3 Distribution and Abundance

1.3.1 Distribution and Habitat

Figures 1-12 show the known distributions of the 12 *Epacris* taxa. All populations have been confirmed in the field within the last five years. All taxa are endemic to Tasmania and have distributional ranges of various sizes in the south-east, east, north and west of the island. Linear geographic ranges vary from 5 km (*E. limbata*) to 140 km (*E. acuminata*). *Epacris barbata, E. grandis* and *E. limbata* have restricted mutually exclusive distributions on the central east coast. *Epacris glabella* is restricted to two areas on the west coast. *Epacris exserta* s.str., *E.* sp. aff. *exserta* (Mt Cameron), *E.* sp. aff. *exserta* (Union Bridge) and *E. virgata* occur in the north and north-east, while *E. virgata* (Kettering) and *E. virgata* 'var. autumnalis' occur in the Channel and Peninsula districts of the south-east. *Epacris acuminata* has the most widespread distribution, occurring from the Channel district in the south east to the eastern edge of the Central Plateau.

The 12 *Epacris* taxa span a range of habitats from sea level to over 1,000 m elevation in dry forests, gallery forests and riparian scrub, heathland, rocky outcrops and swamps. They occur variously on dolerite, granite, serpentinite and sedimentary parent materials. Table 2 summarises the habitat details for each taxon.

Table 2: Physical habitat of 12 *Epacris* taxa.

Taxon	Geology	Elevation	Landform	Vegetation
E. acuminata	dolerite	30-1100m	river banks and mountain tops	dry sclerophyll forest, dry scrub and subalpine forest
E. apsleyensis	dolerite	20-250m	sheltered mid slopes	dry sclerophyll forest
E. barbata	granite	30-500m	ridges and midslopes some rocky outcrops	heath, scrub and ecotonal dry forest
E. exserta s.str.	dolerite and alluvium	10-600m	swamp margins and river banks	riparian scrub, shrub-swamp and ecotonal dry forest
E. sp. Mt Cameron	granite	90-750m	rocky outcrops on exposed summits and midslopes	heath, scrub and ecotonal dry forest
E. sp. Union Bridge	alluvium	150-400m	river banks	wet gallery forest, riparian scrub
E. glabella	serpentinite	300-500m	ridges and midslopes	heath, dry sclerophyll forest
E. grandis	dolerite	30-400m	sheltered upper and mid slopes, river banks	dry sclerophyll forest
E. limbata	dolerite	200-350m	flats on edge of swamps	dry sclerophyll forest, wet heath
E. virgata s.str.	serpentinite	40-100m	undulating terrain	dry sclerophyll forest
E. sp. Kettering	dolerite, mudstone	10-300m	upper and midslopes	dry sclerophyll forest
E. virgata autumnalis	dolerite	50-420m	ridges, dry slopes and flats	dry sclerophyll forest

Epacris acuminata occurs in an area between the Channel district in south-east Tasmania, the Midlands district and the eastern edge of the Central Plateau. It is found on Jurassic dolerite, either in subalpine heathy woodland on mountain summits at 600-1100 m elevation or in riparian dry sclerophyll forest at 30-590 m elevation. Exceptions include populations found at Goat Hills, Knights Creek and Serat on hill slopes and plateaus.

Epacris apsleyensis is restricted to the middle reaches of the Apsley River catchment, west of Bicheno on the east coast. It occurs in dry sclerophyll forest on moderately sheltered flats, lower slopes and midslopes on Jurassic dolerite at 20 to 250 m elevation.

Epacris barbata is restricted to the Freycinet Peninsula and Schouten Island on the east coast. It occurs exclusively on Devonian adamellite-granite in open heathland, heath-woodland and heath-forest in hilly and low-lying terrain from 30 to 500 m elevation. A form apparently intermediate with *E. tasmanica* occurs further north near Moulting Lagoon on alluvial flats derived from dolerite.

Epacris exserta s.str. is associated with the headwaters and lower reaches of streams in northern and eastern Tasmania from Mole Creek to the St Pauls area. Some populations of *Epacris exserta* s.str. were found in the north on alluvium associated with river banks at 10-300 m elevation. Alluvial soils in these riparian sites usually contained transported

dolerite material. Other populations in the east and north-east occurred on Jurassic dolerite around the margins of headwater swamps at 400-600 m elevation.

Epacris sp. aff. *exserta* 'Mt Cameron' occurs among hills on the Mt Cameron range, Mt Stronach and south of Rossarden in north-eastern Tasmania. It is locally restricted to skeletal soils on rocky outcrops of Devonian granitics, usually on summits, in heath and dry scrub-forest at 90-720 m elevation.

Epacris sp. aff. *exserta* 'Union Bridge' occurs along the middle reaches of the Mersey and Meander Rivers in the mid-northern Tasmanian lowlands. The species is found exclusively on alluvium derived from quartzwacke sometimes with dolerite or limestone debris along the banks of major streams in wet gallery forest or scrub at 150-400 m elevation.

Epacris glabella is restricted to Cambrian serpentinite in two areas of north-west Tasmania: one south of Rosebury; and another east of Savage River mine. It occurs on hilly terrain in heath, woodland and dry sclerophyll forest at 300-470 m elevation.

Epacris grandis is restricted to a small area in foothills on Tasmania's east coast near Bicheno. It occurs in dry sclerophyll forest on sheltered slopes above the Apsley and Douglas Rivers and along the banks of the Douglas River on Jurassic dolerite at 30 to 530 m elevation.

Epacris limbata occurs within a small range in the foothills of the Eastern Tiers of south-west of Bicheno. The species is restricted to damp soils on Jurassic dolerite in heathy forest on flats associated with headwater swamps and drainage lines at 200-320 m elevation.

Epacris virgata s.str. is restricted to a small area in the foothills of the Dazzler range near Beaconsfield on Tasmania's north coast. The species is restricted to dry sclerophyll forest on serpentinite in undulating terrain at 40-80 m elevation.

Epacris virgata 'Kettering' occurs among foothills around D'Entrecasteaux Channel and on Tasman Peninsula in south-eastern Tasmania. The species occurs in dry sclerophyll forest on hilly terrain at 10-300 m elevation mainly on Jurassic dolerite, though sometimes close to the geological boundary of dolerite and Permian mudstone (Deep Bay Formation).

Epacris virgata 'var. autumnalis' is restricted to a small range on Tasmania's east coast south of Orford. The species occurs on foothills and flats on Jurassic dolerite in dry sclerophyll forest at 50-400 m elevation.

1.3.2 Population Size and Structure

A comprehensive survey of all 12 taxa was carried out in 1996. Table 2 summarises information on physical habitat. Data on number and sizes of populations are shown in Table 3. The number of confirmed locations varied from 2 for *E. virgata* s.str. to 27 for *E. acuminata*, though most taxa had 10 or less locations. The data show that population sizes are highly skewed. Conservation at the species level must therefore address

protection and management of key large populations. The size of populations varied enormously both within and between taxa. *Epacris* sp. aff. *exserta* (Union Bridge), *E. grandis* and *E. virgata* 'var. autumnalis' had the smallest total populations (ca. 1000 mature plants), while *E. virgata* s.str. and *E.* virgata (Kettering) had the largest total populations (>100,000 mature plants). With the exception of *E. limbata*, the largest population accounted for a high proportion (>50%) of the total population and most of the remaining populations were comparatively small. In most taxa, the smallest populations contained less than 10 mature plants. Mature plants generally accounted for a high proportion of populations in all taxa, except those occupying frequently disturbed habitats (e.g. riparian populations of *E.* sp. aff. *exserta* (Union Bridge) and *E. grandis*, or roadside populations of *E. virgata* 'var. autumnalis') and *E. barbata* whose populations are moribund due to infection by *Phytophthora cinnamomi*.

Table 3: Number and size of populations of 12 threatened *Epacris* taxa. Estimates of population sizes are lower 90% confidence limits for the number of mature individuals.

Taxon	number of populations	% mature plants in population	total population size	largest population	smallest. population
E. acuminata	27	91	16136	8590	1
E. apsleyensis	5	90	50126	47632	37
E. barbata	10	68	44014	38088	5
E. exserta s.str.	10	86	4878	3836	1
E. sp. Mt Cameron	6	70	3061	2475	17
E. sp. Union Bridge	10	52	1215	567	5
E. glabella	4	92	30915	22481	9
E. grandis	5	78	943	657	5
E. limbata	5	94	18081	8805	80
E. virgata s.str.	2	99	108009	67427	40582
E. sp. Kettering	18	95	136817	100441	1
E. virgata autumnalis	3	66	938	725	6

1.4 Life History and Ecology

1.4.1 Survival and Growth of Established Plants

Established plants of *Epacris* have a low background rate of mortality (<1% per annum) and are therefore likely to be long-lived (Keith 1995 & unpubl. data). Populations of *E. glabella* and *E.* sp. aff. *exserta* (Mt Cameron) that have apparently remained unburnt for 25-30 years have mortality rates of 10-23% per year (Keith, unpubl. data). The maximum life span of individual shrubs is therefore probably in the order of 30-40 years.

Episodic mortality of established plants in excess of the background rates occurs in response to fire and disease infection. Some of the taxa have been demonstrated to be susceptible to the fungal root rot disease, *Phytophthora cinnamomi* (Barker and Wardlaw 1996), while others may be presumed to be susceptible to varying degrees. Infection leads to population decline at rates of 5-25% per year. Populations of *E. barbata* have declined to 10% of their original size 4 years after infection by the disease (Keith, unpubl. data), while infected populations of *E. limbata* are declining at a slower rate. Mortality due to fire varies between taxa and probably depends on fire intensity. Some taxa (e.g. *E. limbata*) are known to be obligate seeders (i.e. all plants subject to 100% leaf scorch are

killed), while others (e.g. *E. apsleyensis*) are facultative resprouters (i.e. some proportion of plants survive 100% leaf scorch). Post-fire survival data are available for selected taxa (Table 4). Inferences from growth form suggest that most of the remaining taxa are obligate seeders.

Table 4: Rates of post-fire survival among established plants of four *Epacris* taxa. All fires were low intensity resulting in 100% leaf scorch. (Data for *E. stuartii* from Keith 1995).

Taxon	Site	Survival mean(se)%	n
E. virgata 'autumnalis'	The Thumbs	98(1)	68
E.apsleyensis	Blindburn	48(7)	50
	Ferndale	73(7)	40
E.stuartii	Southport soil	94(4)	33
	Southport rock	2(2)	68
E. limbata	Stringybark Ck 5c	0(0)	21
	Stringybark Ck 5d	0(0)	97
	Stringybark Ck 5e	0(0)	198

Data on seedling mortality rates are scarce, but rates are markedly higher than those for established plants. Mortality rates for *E. stuartii* in the first two years since emergence were 45% per year in soil substrates and more than 75% on skeletal lithosols, while a cohort of *E. limbata* suffered 63% mortality in the first year since emergence. Rates of mortality are likely to decline over 3-5 years as seedlings become established.

1.4.2 Flowering Phenology, Pollination and the Breeding System

All taxa except *E. apsleyensis, E. limbata* and *E. virgata* 'var. autumnalis' have their peak flowering in spring and release their seeds in late summer. Floral initiation is in mid-late summer. In taxa that span large altitudinal ranges (e.g. *E. acuminata*), populations at low elevation flower before those at high elevations. *Epacris limbata* reaches peak flowering in early summer and releases seeds in autumn. *Epacris apsleyensis* and *E. virgata* 'var. autumnalis' reach peak flowering in late summer - early autumn and may continue flowering through winter until late spring. Their seeds are released continuously from late autumn through to summer.

The known pollinators of the *Epacris* taxa considered here include a variety of large adult carrion flies (families Tabanidae, Muscidae and Calliphoridae). Species of flies directly observed pollinating *Epacris* taxa include: *Dasybasis* spp., *Halina* sp. *Calliphora* sp. ("metallic green abdomen" group) and *Calliphora hilli* (Dr P. B. McQuillan, pers. comm). It seems likely that other species of large flies would also function as pollinators.

There are no data available on the breeding system for any of the taxa in this plan. However, experimental investigations on *E. stuartii* ('*E. tasmanica* group') have failed to detect any limitation in seed set due to self pollination or due to limited availability of pollinators. Application of self or cross pollen and exclusion of pollinators had no significant effect on the proportion of fruit set (Keith 1996). Even though these results

suggest that *E. stuartii* has a self-compatible breeding system, a slightly higher fruit set on cross-pollinated plants relative to self-pollinated plants suggests that the species may be preferentially outcrossing.

1.4.3 Fruit Production

Fruit production varies between taxa and depends on plant size, fire history and shading by the canopies of neighbouring plants. Although less than half the flowers produced will develop into seed-bearing fruits, large individuals that are not shaded by neighbouring plants and have not been burnt in recent years have a high likelihood of producing several thousand seeds each year. In resprouting taxa, fruit production may be reduced for several years after fire. Fruit production is substantially reduced in shaded plants even though flowering is not necessarily curtailed. In such cases there are high rates of abortion among developing fruits. Others fruit losses may result from predation, browsing herbivores and mechanical damage.

1.4.4 Seed Dispersal

The timing of seed release varies between taxa. In most taxa seed release peaks in late summer and is complete by early autumn. In *E. limbata* seed release occurs in mid-late autumn, while in *E. apsleyensis* and *E. virgata* 'var. autumnalis' seed release peaks in late autumn - early winter and may continue through until late spring. Seeds are dispersed passively and lack structures that may assist dispersal by wind or animals. Quantitative data on seed dispersal are lacking. However, in non-riparian habitats very few seeds are likely to be dispersed more than a few metres from their parent plant. The clustering of seedlings in recently burnt sites within a metre of adult plants supports the inference that seed dispersal is very localised. Seeds of taxa occurring in riparian habitats (*E. acuminata, E. exserta* s.str., *E.* sp. aff. *exserta* (Union Bridge) and *E. grandis*) are potentially dispersed several kilometres downstream.

1.4.5 Seed Dormancy and Dynamics of the Seed Bank

Epacris taxa produce a fraction of dormant and non-dormant seeds each year and therefore accumulate a persistent seed bank. The size of the dormant fraction may vary between taxa, between populations and between seed crops of different years (Keith, unpubl. data). Experimental investigation of the seed dormancy mechanism suggests that darkness, heat shock and smoke derivatives may each have a role in breaking seed dormancy (Keith in press), although the relative importance of these cues may also vary between taxa, between populations and between seed crops of different years (Keith, unpubl. data). A germination response to heat shock and smoke derivatives results in seedling emergence being cued to the occurrence of fire. Fires may vary in the extent to which they meet germination requirements. A germination response to darkness suggests that seeds buried in the soil are more likely to germinate than those lying on or near the soil surface. Germination is therefore likely to be curtailed until seed burial occurs and this is likely to influence the fate of emerging seedlings. Seedlings emerging from sites relatively deep in the soil profile are more likely to survive dry weather conditions during their establishment phase than seedlings emerging from seeds on or near the soil surface (Bell *et al.* 1995).

The longevity of seeds is unknown. However, inferences drawn from patterns of seedling emergence suggest that appreciable numbers of seeds survive for two years after release into the soil seed bank.

1.4.6 Seedling Recruitment and Establishment

In non-riparian habitats seedling recruitment is cued to the passage of fire. Seedlings rarely emerge in sites where the most recent fire was more than 2 years ago. Seedling recruitment apparently occurs more continuously in riparian populations and may be linked to the occurrence of floods. In selected non-riparian populations that have been burnt recently, seedling recruitment levels were low relative to the annual seed output and, in some cases, were inadequate to compensate mortality among established plants (Keith, unpubl. data).

1.4.7. Maturation and Development

The primary juvenile periods of the 12 *Epacris* taxa are not known. Seedlings of *E. limbata* (an obligate seeder) emerging after a fire in November 1994 had not produced any fruit by March 1997 (Keith, unpubl. data). Although their first seed crop is likely to be produced in the fourth fruiting season after fire, it may be 6-8 years before a seed bank of sufficient size has accumulated to ensure sufficient seedling recruitment after a subsequent fire. Continued monitoring is necessary to validate these estimates. Resprouting taxa are likely to require longer fire-free intervals for maturation (Keith 1996b). The time required for seedlings of resprouters to develop fire resistance is not known, but other woody species require 5-15 years between fires (Keith 1996b).

1.4.8. Propagation

Propagation of several *Epacris* taxa has been carried out successfully from cuttings by horticultural staff of the Royal Tasmanian Botanical Gardens (M. Fountain, pers. comm.). The most successful techniques involve basal dipping of cuttings in undiluted ESI ROOT (ER) or in professional strength Clonex. *Epacris* taxa have also been successfully propagated from seed.

1.5 Reasons for Listing

The 12 *Epacris* taxa are listed or proposed to be listed as threatened for varied reasons. Most of the taxa have small distributions, restricted habitats and a large proportion of their total population occurs at one or a few locations. A few taxa (*Epacris* sp. aff. *exserta* (Union Bridge), *E. grandis* and *E. virgata* 'var. autumnalis') also have small total populations.

All taxa are potentially threatened by high frequency fires that interrupt the maturation (for obligate seeders) or the development of fire-resistant basal stems (for resprouters) in juvenile plants. Some populations of taxa may also be threatened by long fire-free intervals, particularly those occurring on rocky outcrops (*E. barbata, E.* sp. aff. *exserta* (Mt Cameron)) or in fragmented remnant vegetation (*E. acuminata, E. exserta* s.str., *E.* sp. aff. *exserta* (Union Bridge), *E.* virgata (Kettering) and *E. virgata* 'var. autumnalis'). The effects of adverse fire regimes may be compounded by failure of seedling recruitment, as has been observed in some populations after recent fires.

All taxa are likely to be susceptible to the fungal root rot disease, *Phytophthora cinnamomi. Epacris barbata, E. limbata* and *E. apsleyensis* are most threatened by the disease because their populations are already infected and declining. The disease is spread by running water and mud transported on footwear, vehicles and animal fur. Chemical treatments to mitigate disease symptoms have so far proven to be ineffective.

Several taxa distributed primarily on private land are threatened by continuing land clearance, habitat degradation, weed invasion (by gorse, blackberry, exotic grasses and *Erica* spp.) and trampling and grazing by stock. These include lowland populations of *E. acuminata*, riparian populations of *E. exserta* s.str., *E.* sp. aff. *exserta* (Union Bridge), *E.* virgata (Kettering) and *E. virgata* 'var. autumnalis'.

1.6 Existing Conservation Measures

Representation of the 12 *Epacris* taxa in conservation reserves varies from *E. grandis* and *E. barbata*, which are entirely represented within nationals parks, to *E. virgata* 'var. autumnalis', *E. virgata* (Kettering) and *E. exserta* s.str. in which a small proportion of populations and/or individuals are represented in less secure reserve tenures (Table 5). Under the Regional Forest Agreement, the reservation of certain populations has been formalised by upgrading various forms of temporary protection, although the main changes in reserve boundaries affect taxa already relatively well reserved (notably *E. barbata*). Several significant locations for *E. glabella, E.* sp. aff. *exserta* (Mt Cameron) and *E. acuminata* remain to be resolved by the Tasmanian Public Land Use Commission. It should be noted that most of the numerous Tasmanian reserve tenures do not preclude mineral exploration and extraction which is an important threatening process for spread of disease and localised habitat destruction.

Fire management plans for Freycinet and Douglas Apsley National Parks prescribe measures to minimise the incidence of adverse fire regimes at locations known to support populations of *E. barbata, E. grandis* and *E. limbata*. A number of *Epacris* populations occurring on State Forest fall within special management zones from which logging is excluded. Other known populations are protected by prescriptions detailed in harvesting plans that are negotiated with the Department of Environment and Land Management. Protocols also exist on State Forest to provide for protection of currently unknown populations of threatened plants. However, rare plant populations on State Forest and numerous categories of reserve may not be protected from localised earthworks and disease infection associated with access construction, mineral exploration and development.

Table 5. Representation of 12 threatened *Epacris* taxa in conservation reserves. Data are number of populations with estimated minimum number of individuals in parentheses. Areas proposed under the Regional Forest Agreement are assumed to be dedicated. Secure reserves are legislated National Parks, State Reserves and Flora Reserves. Other reserves include Protected Areas, Conservation Areas, Coastal Reserves, River Reserves. * includes partially reserved population.

Taxon	Total	Secure Reserves	Other Reserves
E. acuminata	27 (16136)	1 (22)	8 (12353)
E. apsleyensis	5 (50126)	1 (2205)	0 (0)
E. barbata	11 (44014)	11 (44014)	0 (0)
E. exserta s.str.	10 (4878)	2 (502)	2 (16)
E. sp. Mt Cameron	6 (3061)	2 (450)	0 (0)

E. sp. Union Bridge	10 (1215)	2 (50)	1 (25)
E. glabella	4 (30915)	0 (0)	0 (0)
E. grandis	5 (943)	5 (943)	0 (0)
E. limbata	5 (18081)	1 (80)	0 (0)
E. virgata s.str.	2 (108009)	1.8 (98251)*	0 (0)
E. sp. Kettering	18 (136817)	0 (0)	0.03 (94)*
E. virgata autumnalis	3 (938)	0 (0)	0 (0)

Conservation measures on private land are generally limited. Land clearance is not regulated in Tasmania as it is in some other states. Conservation Covenants may bind present and future landholders to retain native vegetation on their properties, however these have not yet been implemented to protect the habitat of any threatened *Epacris* taxa. The Threatened Species Protection Act (1995) provides for Interim Protection Orders where a population of a listed species is known to be under imminent threat of destruction. However, these orders apply for a maximum duration of 30 days and their effectiveness is further constrained by procedural caveats as well as limited resources. The legislation also provides some resources for government co-ordination of community involvement in threatened species conservation programs.

Individual landholders may voluntarily manage their land for conservation of *Epacris* populations. For example, one landholder in Kettering is fostering regeneration of partially cleared forest supporting *E. virgata* (Kettering) by excluding stock and implementing bush regeneration techniques. These measures rely on the resources and goodwill of landowners and are subject to changes in ownership.

Ex situ collections of *Epacris* are held at the Royal Tasmanian Botanic Gardens in Hobart (Table 6). These collections are for display purposes and represent a small sample of wild populations. They may therefore be of limited value as a gene bank. In most cases only one replicate is maintained per genet, although several collections have 2-7 replicates and one has 17 replicates.