EPACRIS STUARTII

RECOVERY PLAN

1996–2005

DEPARTMENT of PRIMARY INDUSTRIES, WATER and ENVIRONMENT
Tasmania

Natural Heritage Trust
Helping Communities Helping Australia

Environment Australia

Prepared by **David Keith** and **Mick Ilowski**

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In conjunction with the Epacris stuartii Recovery Team
Funded by Environment Australia
November 1999
ISBN: 0 7246 4290 0

ACKNOWLEDGEMENTS

Belinda Pellow, Wendy Potts, Tony Auld, Judy Scott and Brooke Craven assisted with fieldwork. Mark Fountain (Royal Tasmanian Botanical Gardens) assisted with collection of cuttings and successfully propagated the material. Stephen Harris provided advice and administrative support. Prof. Jamie Kirkpatrick made available laboratory space and equipment while I was a Research Associate of Department of Geography and Environmental Studies (University of Tasmania). Shauna Roche (Kings Park and Botanic Garden) supplied information, advice and materials for the germination experiment. Dr Phil Barker (Forestry Tasmania) made survey information available and participated in some fruitful discussion about the biology and management of *Phytophthora* in relation to *Epacris*. Tim Rudman (Parks and Wildlife Service) offered some very helpful ideas on management during and after a visit to the site. Transport to the site was assisted by the Lune River Youth Hostel and the Ida Bay Railway Company. This project was funded by the Australian Nature Conservation Agency under the Endangered Species Program (Project No. 423).

Front cover illustration by Wendy Potts.

Endangered Species Unit Project Number 423. Funded by the Endangered Species Program, a program of the Natural Heritage Trust, and administered by the Biodiversity Group, Environment Australia. The views expressed are those of the authors.

Citation: Keith, D.A and Ilowski, M. (1999) Epacris stuartii Recovery Plan 1996–2005. Department of Primary Industries, Water and Environment, Hobart.

CONTENTS

SUMMARY

Current Species Status

Epacris stuartii stapf. is classified as Endangered under both Tasmanian State and Commonwealth endangered species legislation. There is only one wild population of about 850 mature plants. The population has declined by approximately 20% between the beginning of 1994 and March 1996.

Habitat Requirements and Limiting Factors

Epacris stuartii is restricted to 0.3 ha of heathland on an exposed headland near Southport, south-east Tasmania. Plants occur in shallow soil or in crevices on outcrops of dolerite. Major threats are: disease epidemic caused by *Phytophthora cinnamomi*; fire regimes involving high frequency fires and/or fires followed by drought; and extreme storm events.

Recovery Objectives

To minimise the chance of extinction of *Epacris stuartii* by:

1. maintaining the wild population above a threshold of 500 mature individuals

2. minimising the chance of site invasion by *Phytophthora cinnamomi* and mitigating its impact if infection occurs

3. developing management techniques to restore the wild population should it fall below the threshold size

4. establishing and maintaining an *ex situ* collection of *E. stuartii* for the purpose of reintroduction if required.

Recovery Criteria

1. The population size is maintained above 500 mature individuals in perpetuity.

2. The site remains free of *Phytophthora cinnamomi* in perpetuity. Infected vegetation is treated immediately, in the event that *P. cinnamomi* invades the site.

3. Management techniques to increase the size of the wild population of *E. stuartii* are developed and implemented where appropriate.

4. A representative *ex situ* living collection of *E. stuartii* is established and maintained, and used as a source of material for reintroduction in the event that the wild population becomes extinct.

Recovery Actions

1.1 Population monitoring.

1.2 Habitat management to restore or avoid decline in wild population.

2.1 Annual site inspections to detect invasion of *Phytophthora cinnamomi*.

2.2 Promote and implement measures to ensure *Phytophthora* hygiene.

2.3 Development works to reduce the spread of infected mud: (a) re-direct access track and install footwear washdown station; (b) construct elevation walkway.

2.4 Treatment and quarantine of infected areas.

3.1 Determine seed longevity.

3.2 Develop management technique for seedling regeneration.

3.3 Develop decision support system for management.

4.1 Establish an ex situ population to an appropriate wild location and disperse plants to private gardens.

4.2 Reintroduce a representative sample of plants, should the wild population become extinct.

Estimated Cost of Recovery

Costs are in 1996 dollars. Costs for the seven years 1999–2005 are identical and quoted on a per annum basis.

Actions	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Total
1.1	7 190	2 710	2 710	2 710	2 710	2 710	2 710	2 710	2 710	2 710	31 580
1.2	Contingency actions: see main text for indicative costs										
2.1	Costs included in Action 1.1										
2.2	2.550	800	800	800	800	800	800	800	800	800	9 750
2.3	28 837										28 837
2.4	Contingency action: see main text for indicative costs										
3.1	16 024	10 988									27 012
3.2	11 994										11 994
3.3	5 052										5 052
4.1		26 575	48 700								75 275
4.2	34 728	16 579	16 579								67 886
Total	106 375	57 652	68 789	3 510	3 510	3 510	3 510	3 510	3 510	3 510	257 386

INTRODUCTION

Description and Classification of Species

Epacris stuartii Stapf. belongs to 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, Malaysia 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 bearing 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.

Epacris stuartii is an erect or semi-prostrate multi-stemmed shrub growing up to 1 m tall. Its branches are robust, bearing ovate-cordate (heart-shaped) leaves tending to ovate (oval-shaped) on young branches, 4-7 mm long and 3-5 mm wide with short stalks (<1 mm long). The leaves have a thick glossy cuticle, a pungent mucronate apex and three parallel veins on the lower surface. The flowers appearing in late winter - early spring are white, solitary in the leaf axils, subsessile and crowded along the upper parts of the branches. The style and anthers are prominently exserted from the corolla tube which is 3-4 mm long and has five lobes 3.5 - 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 (Curtis 1963, Crowden and Menadue 1990).

Epacris stuartii belongs to a group of about 10 closely related species known as the '*Epacris tasmanica* complex' (Crowden and Menadue 1990). This group is endemic to Tasmania and includes several other threatened species, including *E. barbata, E. virgata, E. apsleyensis, E. exserta* and *E. glabella*. Crowden and Menadue (1990) concluded from a morphometric analysis based on selected leaf and floral characters that *E. stuartii* was distinct from other taxa in the group. The analysis showed the closest relatives of *E. stuartii* to be *E. virgata* sens. str., *E.* sp. aff. *exserta* (Mt Cameron) and *E. tasmanica* (Group A), a small-flowered taxon more similar to *E. virgata* than *E. tasmanica* sens. str. which was placed in Group B (large flowers). *Epacris stuartii* was distinguished from these taxa in the analysis by its longer leaves and corolla lobes (petals). Several characters that were not included in Crowden and Menadue's (1990) analysis are likely to reaffirm the distinctness of *E. stuartii* from other taxa in the group. These include the thickness and luster of its leaves (thicker and more glossy in *E. stuartii* than other taxa in Group A), the length of its inflorescences (less elongated in *E. stuartii*), the width of its basal and ultimate branches (more robust in *E. stuartii*), and its habit (more usually semi-prostrate in *E. stuartii* cf. always erect in other taxa). The taxonomic status of some other members of the *Epcaris tasmanica* complex remains to be formally resolved (Crowden and Menadue 1990).

Conservation Status

Epacris stuartii is currently classified as an Endangered species under both Tasmanian state and Commonwealth endangered species legislation. It had previously been regarded as Vulnerable (Leigh *et al*. 1981, Briggs and Leigh 1988). The change in status appears to have resulted from a reappraisal of available information on its distribution and apparent threats, rather than evidence of recent decline in population size or range.

Distribution and Abundance

Distribution

Epacris stuartii has only ever been known from a single locality on Southport Bluff, about 6 km south-east of Southport township in far south-eastern Tasmania (Fig. 1, Appendix 1). The population occupies an area of approximately 0.3 ha over a range of about 300 m.

Searches of apparently similar habitat have been carried out by Dr R. K Crowden (University of Tasmania), Mrs K. Geeves (Society for Growing Australian Plants) and recently by Dr P. J. C. Barker (Forestry Tasmania). Searches carried out by Barker were part of a survey project funded by the Endangered Species Program (Project No. 508) and will be reported later in 1996. The searches have examined rocky dolerite coastline in the vicinity of Southport Bluff (Fig. 1). All searches were unsuccessful. Some similar habitats in the area, such as clifftop heath on South Bruny Island support *Epacris myrtifolia*, rather than *E. stuartii*, or no *Epacris* species at all. Therefore it seems unlikely that other populations of *E. stuartii* exist. However, areas of apparently similar habitat that remain to be searched occur along the inaccessible coastline between Cockle Creek and South East Cape.

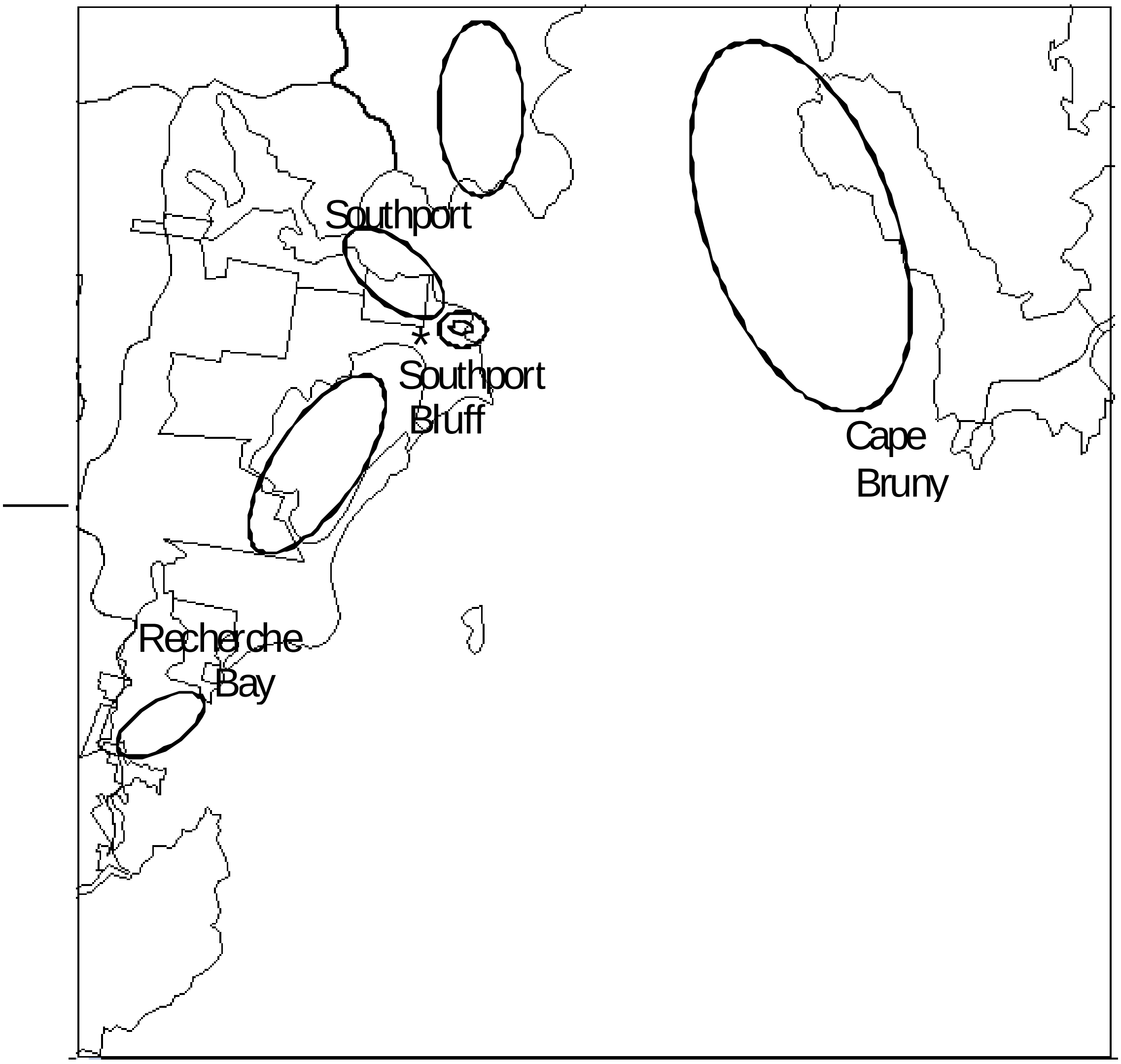

Figure 1: Distribution of *Epacris stuartii* (*) showing areas of coastline searched unsuccessfully for new populations (circled). The southern shores of Port Esperance, the coastline between Dover and Huon Point and at Fluted Cape (Bruny Island) were also searched unsuccessfully.

The population of *Epacris stuartii* is disjunct from populations of related taxa in the *E. tasmanica* complex. The closest known populations belong to the taxon described as *E. tasmanica* (Group A) by Crowden and Menadue (1990) and included by them within a broadened concept of *E. virgata*. These populations occur 30 km to the north-east near Adventure Bay on South Bruny Island and 45 km to the north between Snug and Kettering and are separated from *E. stuartii* by wide bodies of water (D’Entrecasteaux Channel and the Huon River estuary, respectively). Other taxa in the *E. tasmanica* complex occur on the east Tasmanian coast north from Hobart and at scattered locations in northern and western lowland Tasmania (Crowden and Menadue 1990). The geographic isolation of *E. stuartii* from related taxa, its very localised seed dispersal and the presumed small home range of its invertebrate pollinators may be major factors involved in its speciation.

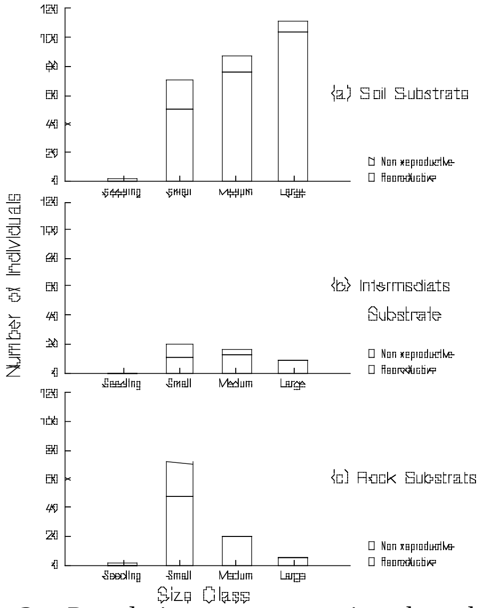

Figure 2: Population structure in the three micro-habitat types.

Population size and structure

In 1995 the population of *Epacris stuartii* at Southport Bluff was estimated to contain a total of *ca*. 1,000 plants, of which ca. 85% were estimated to be reproductively mature (Fig. 2). The estimate was derived from mean population density (3 plants per square metre) multiplied by the area of occurrence (300 m^2), which was mapped by foot traverse. The estimate was validated by an exhaustive census of plants within an area comprising about one-third of the total area occupied by the population. This census yielded 400 individuals.

The population of *E. stuartii* comprised plants that varied in size and reproductive status. Three size classes were defined for established plants by summing the length of all their basal stems (small: <50 cm, medium: 50-100 cm and large: >100 cm). Thus individuals were placed in the largest size class either if they had one or two long stems (erect growth form) or many short stems (semi-prostrate growth form). An additional size class was defined to include seedlings, recognised by their short (<10 cm) slender stems and small leaf size. In February 1995 less than 1% of the total population was represented by seedlings These were presumed to have emerged in the previous year. The population structure varied between substrates. On soil, more than 41% of plants were large, compared to 18% on intermediate substrates and 5% on rock substrates (Fig. 2). Conversely only 26% of plants on soil substrates were small compared to 36% on intermediate substrates and 72% on rock substrates (Fig. 2). The percentage of reproductive plants varied from 55-78% in the small size class, to 75-95% in the medium class, to 94-100% in the large size class (Fig. 2).

Habitat

Physical environment

Epacris stuartii occurs on an exposed dolerite headland at an elevation of 5 to 19 m above sea level. The headland is semi-circular in shape and has a flat top inclined gently to the west and terminating in a small interrupted cliffline around its northern, eastern and southern edges. *Epacris stuartii* is associated with seaward slopes and rocky outcrops. Plants are scattered mostly around eastern and southern aspects in numerous small subcatchments draining different parts of the headland. Despite the range of aspects, the entire population is exposed to onshore winds varying from slight to gale force.

Substrate microhabitat

There is small-scale variation in the substrate microhabitat of *E. stuartii*. The majority of the population occurs in shallow, well-drained, dark grey loam - sandy loam (Fig. 2). In this microhabitat soil depth varies up to *ca*. 20 cm and a scattering of dolerite rocks may protrude through the soil surface. A smaller, but significant proportion of the population occurs on massive rocky outcrops (Fig. 2), either in crevices with no visible soil, or in shallow depressions with up to 1-2 cm of soil or moss, presumably with roots penetrating cracks in the subsurface rock. On average, plants on rock substrates are smaller than those in shallow soil substrates (Fig. 2). Plants also grow in sites that may be regarded as intermediate microhabitats.

Vegetation

Epacris stuartii occurs exclusively in heathland. The structure and composition of co-occurring vegetation varies with substrate microhabitat and fire history. On shallow soil substrates the heath may be dominated by a dense shrub stratum with *Leptospermum scoparium, Acacia verticellata, Westringia brevifolia* and *Banksia marginata* up to *ca*. 1 m tall. *Epacris stuartii* occurs mainly in gaps of the canopy of these larger shrubs, though some individuals occur beneath the canopy and others protrude through it. Smaller shrubs include *Pultenaea dentata, Epacris impressa, Bossiaea prostrata* and *Astroloma humifusum.* Groundcover species include *Stylidium graminifolium, Gonocarpus tetragynus, Helichrysum scorpioides, Viola hederacea, Deyeuxia densa, Microlaena stipoides, Danthonia pilosa, Poa poiformis and Lepidosperma* sp.. In recently burnt areas the cover of large shrubs is reduced and there is an almost continuous groundcover dominated by *Lomandra longifolia* and *Deyeuxia densa* with various other grasses and sedges. On rocky substrates the cover of vegetation is sparse, with scattered individuals of *Westringia brevifolia, Leptospermum scoparium, Poa poiformis, Baumea juncea, Selliera radicans* and the introduced grass *Aira caryophyllea*.

Fire History

The fire history of Southport Bluff and surrounds was established by examining fire reports prepared by the Parks and Wildlife Service, gathering observations during field inspections and by interviewing relevant personnel. Fire records for the George III Historic Site and the adjacent Southport Lagoon Wildlife Sanctuary extend back to 1978. Two fires have apparently burnt the population of *Epacris stuartii* on Southport Bluff between 1978 and 1996. The first fire occurred on 3rd February 1981. A detailed fire report (Skinner 1981) and recollections by Ranger R. R. Donnelly, who inspected the Bluff on 4th February 1981, both indicate that the fire was intense and that it burnt the entire population of *E. stuartii*. This description of the 1981 fire is supported by the remains of long dead shrubs, evidently killed in the 1981 fire, that are distributed around the cliffline and on the cliff face itself around the entire headland (pers. obs., 1995). It therefore seems reasonable to assume that virtually all *E. stuartii* plants were burnt in a high intensity fire, though it is impossible to tell whether a few individuals escaped the 1981 fire in small patches.

The second fire occurred on 2nd April 1994 (Bradley 1994). This fire apparently reached moderate intensity on the flat summit of the Bluff because the foliage of shrubs was entirely consumed (pers. obs., February 1995). Around the edges of the Bluff the fire was patchy. Scorched foliage remaining on plants around the cliffline (pers. obs.) suggest that the fire was generally less intense in these areas. Unburnt patches up to 50 m^2 in size were scattered around the north, east and south edges of the Bluff. The spatial pattern of burnt areas appeared to be unrelated to fuel density and rocky outcrops. Both microhabitats of *E. stuartii* (dense heath on shallow soil and open heath on rocky outcrops) each contained a mosaic of burnt and unburnt patches. On some of the rocky outcrops the fire had spotted between individual shrubs, some of which were quite small and separated by distances of a few metres.

Both the 1981 and the 1994 fires started several kilometres to the west between Southport Lagoon and the Ida Bay Railway. There is a very high frequency of ignitions in the vicinity of Southport Lagoon, though many of these occur to the west and south of the lagoon itself (Parks and Wildlife Service fire records). The causes include arson, unattended campfires, and activities connected with the operation of the railway and quarries. Although these ignitions have to date resulted in only a moderate frequency of fires at Southport Bluff, there is a potential for a more frequent fire regime which may threaten the population of *Epacris stuartii* (see below).

Life History and Ecology

As part of the Research Plan (Action 1) a census was established to examine the population dynamics of the *E. stuartii*. A sample of established plants stratified by plant size, substrate microhabitat, fire history and shading was permanently tagged with fire-resistant metal tags. Censuses were carried out in February 1995 and January 1996 to measure rates of survival, growth and reproduction. For each plant the following data were recorded: alive or dead; substrate microhabitat (soil, rock or intermediate); shading by canopies of adjacent plant (unshaded, shaded, intermediate); effect of 1994 fire (entirely burnt, partially burnt, entirely unburnt); number and lengths of basal stems; and number of infructescences produced in the current season. It was assumed that plants retaining dead foliage in February 1995 had died during 1994.

Epacris stuartii has a low background rate of mortality (<1% per annum) and is therefore likely to be long-lived. The life span of individual shrubs is unknown, but probably in the order of decades.

Mortality during 1994 -1996 occurred in two major episodes, April 1994 and February 1996, in addition to the low level of background mortality. The first episode of mortality was related to a fire and was essentially confined to plants on rock substrates. Almost all burnt plants on soil substrates survived and resprouted. The fire caused a decline in the population of established plants by 12%.

The second episode of mortality occurred suddenly 3 weeks after a severe storm which was followed by warm weather. This resulted in a further decline in the population of standing plants of at least 15% and up to 50%, depending on the fate of surviving plants that suffered varying levels of leaf tissue death. Several other shrub species at the site showed a similar response at the same time. These were *Leptospermum scoparium, Westringia brevifolia, Banksia marginata, Astroloma humifusum, Pultenaea dentata, Leucopogon parviflorus* and *Lomatia tinctoria.* Tests of soil and root samples failed to detect evidence of *Phytophthora cinnamomi*. It seems likely that plant mortality and dieback were a response to extreme salt levels deposited by high winds and seas during a storm event of rare and extreme severity. This interpretation is supported by observations at the same time of similar responses in other coastal heathlands of south-east Tasmania (e.g. on Tasman Peninsula and South Bruny Island).

Among the few plant deaths not associated with either episode of mortality, the symptoms and pattern of mortality were consistent with desiccation being the cause. Overall the population of established plants has declined by at least 20% between early 1994 and March 1996.

Flowering phenology, pollination and breeding system

In 1995 floral buds were initiated in January and February on new growth that emerged in the previous spring. Buds on five inflorescences on a sample of 36 plants were tagged and followed between March 1995 and February 1996. The first flowers were recorded early in August (Fig. 3), though scattered individuals were observed flowering, mainly on north-facing slopes, as early as late May. Flowering was complete by late October. Fruit dehiscence began late in December and was complete by early February 1996. The phenology of flowering and fruiting observed in 1995-96 was consistent with anecdotal observations (R. Crowden, pers. comm., K. Geeves pers. comm.) and herbarium records from previous years.

The pollinators of *Epacris stuartii* are large adult carrion flies (family Calliphoridae). Two species of flies were directly observed pollinating *E. stuartii* on several days during August and September 1995: *Calliphora* sp. (“metallic green abdomen” group) and *Calliphora hilli* (Dr P. B. McQuillan, pers. comm., Department of Geography and Environmental Studies, University of Tasmania). *Calliphora* is a widespread genus of flies in Tasmania (P. McQuillan, pers. comm.). *Epacris stuartii* was apparently the only local pollen source exploited by *Calliphora* spp. at this time of year and seems likely to be their first floral food source after emergence as adults. After flowering of *E. stuartii* was complete flies were observed visiting flowers of *Westringia brevifolia*, *Acacia verticillata* and *Leptospermum scoparium* which flowered in an overlapping sequence on the site through the summer months into autumn.

It seems unlikely that outcrossing within the *E. stuartii* population would be limited by pollinator movements because individual flies in genera such as *Calliphora* are capable of travelling several hundred metres in a single flight (P. McQuillan, pers. comm.).

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

Fruit Production

In 1995-96 fruit production depended on plant size, fire history and shading by the canopies of neighbouring plants, but was independent of substrate. A similar pattern was evident in 1994-95. Large plants produced more fruit than those in the small and medium size classes in the unburnt area (Fig. 4). Plants of comparable size produced similar numbers of fruits on rock and soil substrates (Fig. 4). However, overall fruit production was greater on soil substrates than on rock because the latter habitat supported very few plants in the large size class (Fig. 1). In the burnt area, fruit production was substantially reduced compared with the unburnt area (Fig. 4).

Overall about 30% of buds initiated in early 1995 produced viable fruit in early 1996. The causes of death of developing buds, flowers and fruits varied over time and in relation to fire history and shading by the canopies of neighbouring plants. The major cause of bud and fruit loss was spontaneous abortion. In the soil substrate spontaneous abortion of buds and developing fruits was greatest amongst those plants that were most shaded by the canopies of neighbouring plants. Less than 5% of buds produced viable fruits in plants that were entirely beneath the canopies of neighbouring plants (Fig. 5a) compared to *ca*. 60% in plants that were free from the canopies of neighbouring plants (Fig. 5c) and *ca*. 40% in plants that were partially beneath the canopies of neighbouring plants (Fig. 5b). On rock substrates and in the burnt area there was minimal shading by neighbouring plants, however, there were greater fruit losses to due wallaby grazing than in plants in soil in the unburnt area (Fig. 5d, e). Fruit losses caused by wallaby grazing were greatest in the burnt area where less than 10% of buds produced viable fruits (Fig. 5e). Predation by beetle larvae and damage due to physical agents such as wind and mammal trampling were minor causes of fruit loss (Fig. 5).

Seed Dispersal

Seed release occurs during January and February (Fig. 4). Seeds are dispersed passively and lack structures that may assist dispersal by wind or animals. Quantitative data on seed dispersal are lacking. However, very few seeds are likely to be dispersed more than a few metres from their parent plant. The clustering of seedlings within a metre of adult plants supports the inference that seed dispersal is very localised.

Seed dormancy and dynamics of seed bank

Seeds of *Epacris stuartii* are dormant, although a small fraction of each year's seed crop may be non dormant. Experimental investigation of the seed dormancy mechanism suggests that darkness, pre-heating and smoke derivatives may each have a role in breaking seed dormancy (Fig. 6). Low levels of germination in both light and dark where seeds were not treated with either heat or smoke derivatives suggests that *E. stuartii* has fire-related seed dormancy and a relatively small non-dormant seed fraction. The 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, the timing of seedling emergence suggests that *E. stuartii* is likely to have a persistent soil seed bank. Seedlings that emerged in 1995 were likely to have been derived from seeds released almost two years earlier in the fruiting season before the 1994 fire. Adult plants in the vicinity of seedlings were either killed by the fire or resprouted and failed to produce seeds in the only reproductive season before the seedlings emerged. The clustering of seedlings around their presumed parent plants suggests that seeds were unlikely to have been dispersed from plants in unburnt areas.

Seedling recruitment and establishment

The total number of seedlings emerging in 1994 and 1995 was small. The 412 recorded seedlings occurred in an area occupied by about 400 mature plants. Less than half of these seedlings survived beyond six months after emergence and seedling survival was higher on soil than on rock substrates (Fig. 7). The time it takes for seedlings to become mature and large enough to survive fire (in soil substrates) is unknown but likely to be several years.

Seedling emergence was almost entirely confined to the burnt area, more abundant on rock than on soil substrates and occurred almost exclusively in 1995 (Fig. 7). This spatial pattern of seedlings in relation to the burnt area is consistent with the existence of fire-related seed dormancy mechanisms and the production of a small fraction of non-dormant seeds. A similar relationship between fire and seedling emergence has been observed in other *Epacris* species (Keith 1991).

Seedling emergence was confined to the spring season in both 1994 and 1995, possibly reflecting the favourability of warmer, moist conditions for seed germination. The emergence of more seedlings in the second year after a fire than in the first year is unusual among heathland shrubs and may be in response to low soil moisture in the first post-fire year. Substantially more rainfall occurred in the spring and summer of 1995 than in the comparable seasons of 1994.

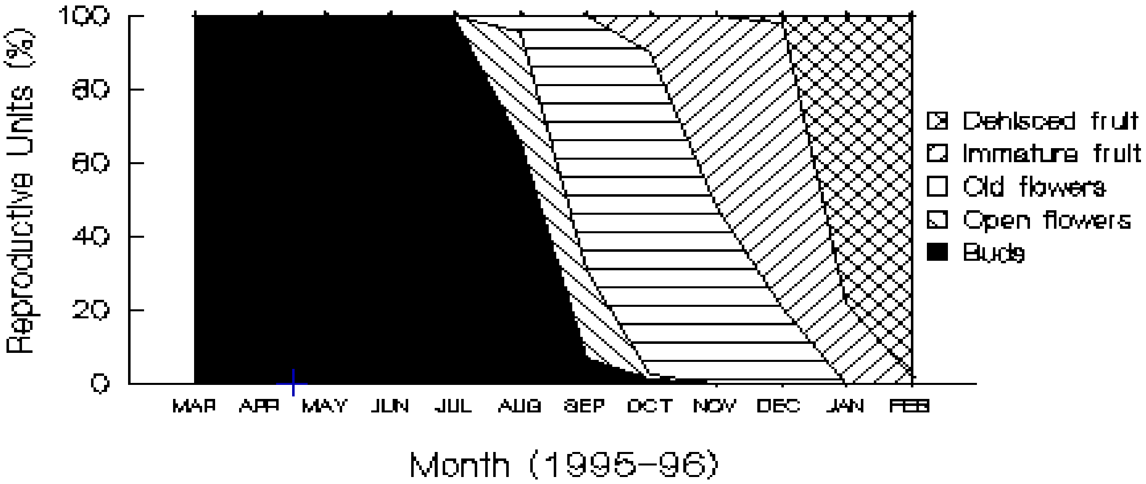

Figure 3: Reproductive phenology of *Epacris stuartii* in 1995-96.

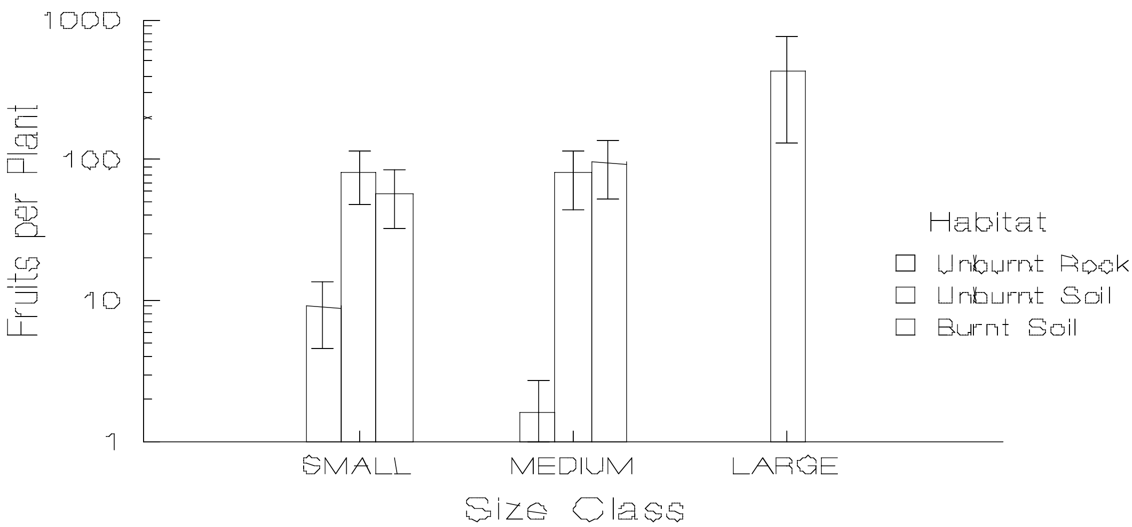

Figure 4: Fruit production of *Epacris stuartii* in 1995 in relation to plant size, substrate and fire history.

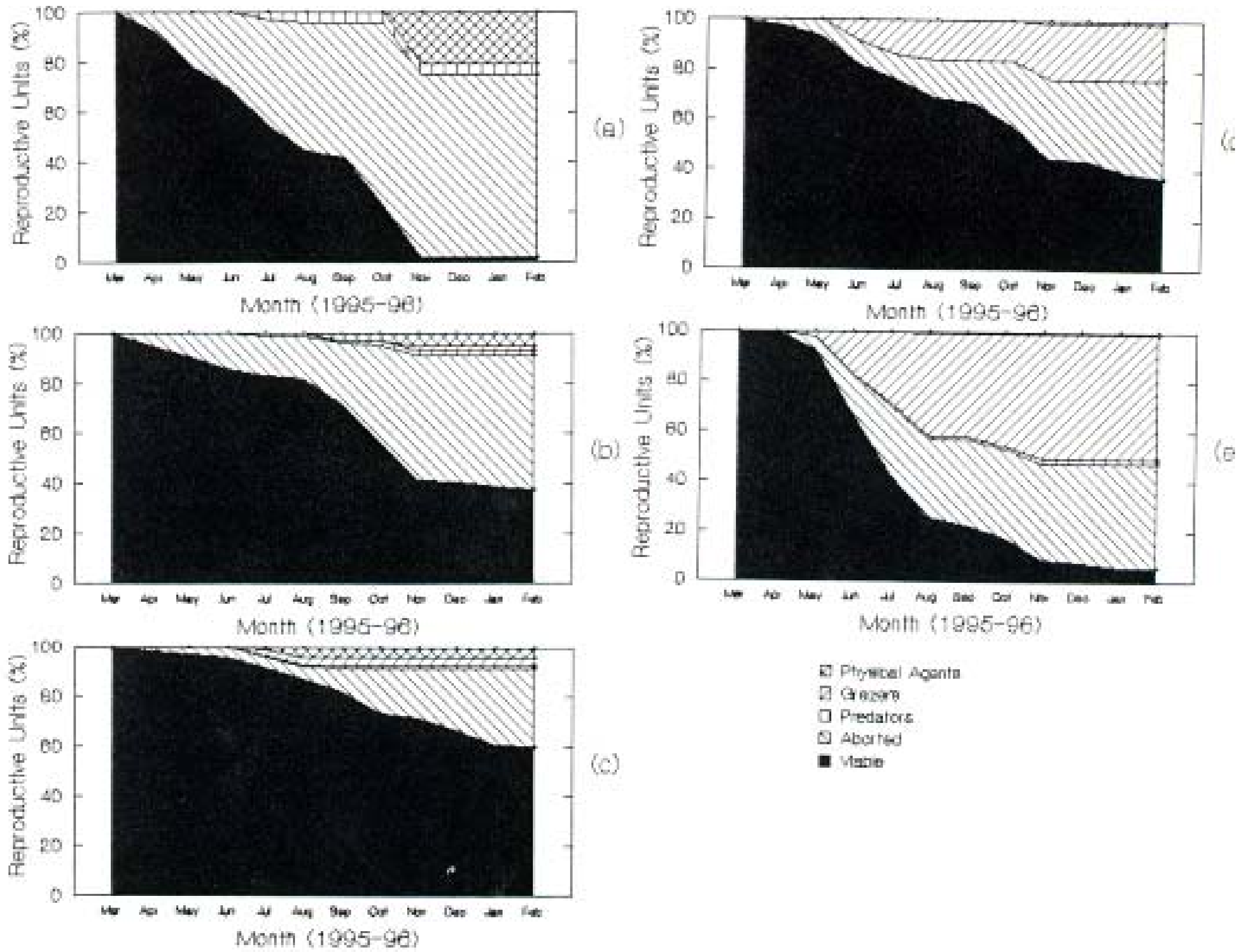

Figure 5: The fate of developing *Epacris stuartii* buds and fruits (viable, aborted, destroyed by fruit predators, destroyed by grazers or destroyed by physical agents).

a) Unshaded by neighbouring plants in unburnt vegetation on soil substrate.

b) Partially shaded by neighbouring plants in unburnt vegetation on soil substrate.

c) Fully shaded by neighbouring plants in unburnt vegetation on soil substrate.

d) Unshaded by neighbouring plants in unburnt vegetation on rock substrate.

e) Unshaded by neighbouring plants in burnt vegetation on soil substrate.

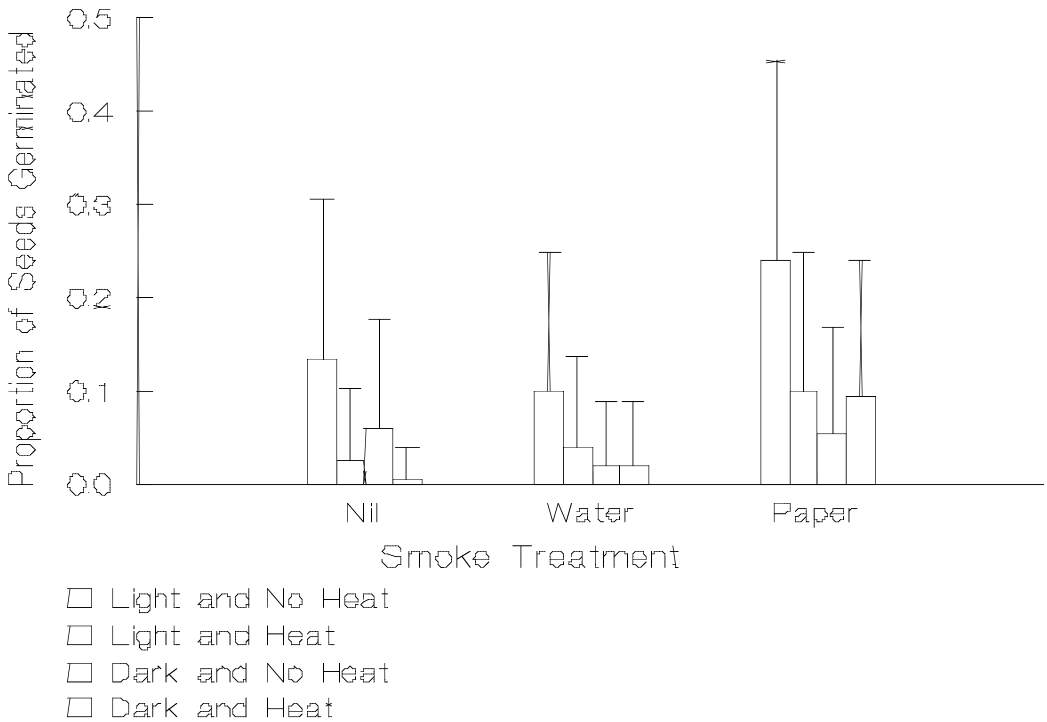

Figure 6: Germination of *Epacris stuartii* seed under combinations of light, pre-heating to 90C for 10 minutes and treatment with smoked water and smoked filter paper. Data indicate preliminary results of a continuing experiment.

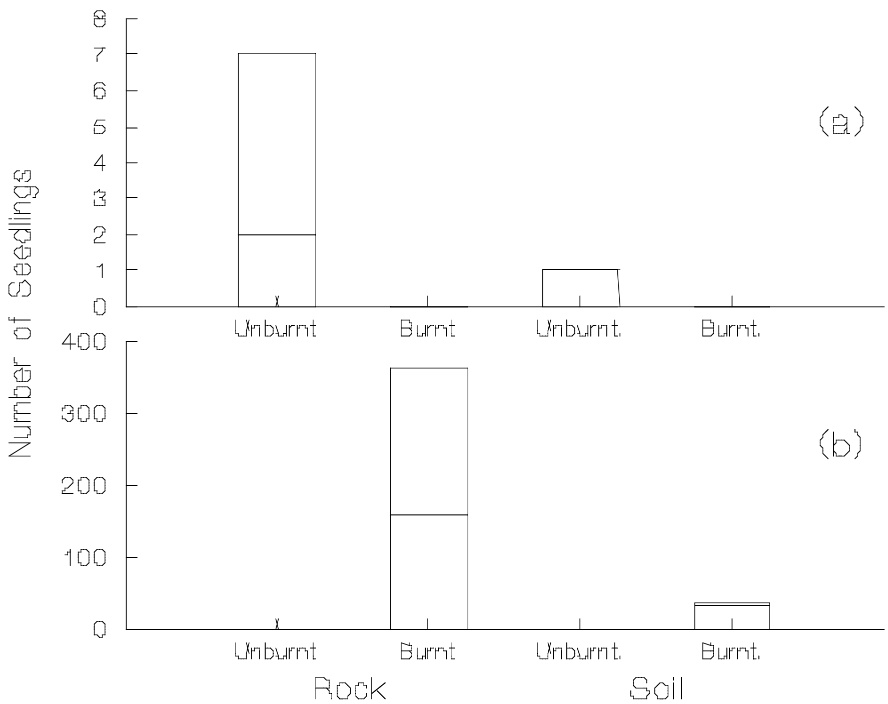

Figure 7: Emergence of *Epacris stuartii* seedlings in (a) 1994 and (b) 1995 in areas of different fire history on rock and soil substrates. Solid bars indicate numbers of seedlings surviving at 6 months after emergence. Hatched bars indicate numbers of seedlings that failed to survive their first 6 months after emergence.

Propagation

Propagation of *Epacris stuartii* has been carried out successfully from cuttings collected in May 1995. The cuttings consisted of new growth on older wood. Three methods of cutting treatment were tested: basal dipping in undiluted ESI ROOT (ER); basal dipping in professional strength Clonex; and immersion in 0.35% ESI ROOT solution followed by basal dipping in professional strength Clonex. The two basal dipping methods were most successful in striking cuttings, yielding greater than 80% strike and survival at 18 weeks after propagation (Fig. 8). Dunking in diluted ESI ROOT and subsequent basal dipping in Clonex was a significantly less successful propagation technique, yielding 30% strike and survival rate (Fig. 8).

It appears possible to propagate *Epacris stuartii* from seed, although germinants have not yet been grown on beyond cotyledon stage. If the success of germination as a propagation technique is confirmed, it may prove to be a more cost-effective method of establishing and maintaining an *ex situ* living collection than propagation by cuttings.

Reasons for Listing

Epacris stuartii is listed as an endangered species by the Australian and New Zealand Environment and Conservation Council and in Schedule 1, Part 1 of the Commonwealth Endangered Species Protection Act (1992). It is also gazetted as an endangered species under the Tasmanian Rare and Vulnerable and Endangered Species Protection Act (1996). The principal reasons for its endangered status include: its extremely restricted natural geographic range; its small and recently declining population size; imminent threats posed by disease epidemic, certain fire regimes and extreme weather events; and its limited capacity for regeneration.

Epacris stuartii is known only from an area of 0.3 ha and has a total population of about 850 mature plants, which has declined by 20% over two years since early 1994. Seedling recruitment over this period has been very localised and insufficient in magnitude to maintain population stability.

Epacris stuartii is known to be susceptible to the fungal pathogen, *Phytophthora cinnamomi* (Barker and Wardlaw 1995), which is associated with disease epidemics causing extreme declines in populations of related *Epacris* species on the east coast of Tasmania (Keith 1995, unpubl. data). *Phytophthora cinnamomi* has been recorded along the walking track within 1 km of the *E. stuartii* population and, given current usage of the track by bushwalkers, is highly likely to invade the site in the near future.

Epacris stuartii may be threatened by fire regimes that comprise fires repeatedly followed by drought conditions and fires recurring at high frequency. A fire caused the *Epacris stuartii* population to decline by about 15% in 1994. The reasons for this decline appear to be associated with weather conditions in the year after the fire, which were apparently too dry to support seedling recruitment. Thus, post-fire seedling recruitment was insufficient to offset the number of established plants killed by fire. It is also likely that *Epacris stuartii* is adversely affected by high frequency fire regimes, since these have been implicated in population declines of a wide range of woody shrub species (Keith 1996). Although the population has not experienced high fire frequencies in recent times, the potential for this to occur in future is underscored by the extremely high frequency of ignitions associated with recreational use of the adjacent Southport Lagoon Wildlife Sanctuary and surrounding lands.

Epacris stuartii may also be threatened by severe storms though physical damage and excessive salt loads. Such an event in February 1996 apparently caused the death of numerous plants and severe defoliation in about two-thirds of the population. The frequency of severe storm events associated with this level of mortality and defoliation is unknown. When combined with other threats (disease epidemic and adverse fire regimes) and the limited capacity for regeneration in the *E. stuartii* population, the impact of severe storms may be substantial.

Existing Conservation Measures

The only population of *Epacris stuartii* is protected within a reserve of secure tenure, George III Historic Site. No active management is carried out on the reserve other than the monitoring of fires. A management plan is currently in preparation for the adjacent Southport Lagoon Wildlife Sanctuary. The plan will address issues such as recreational usage, visitor access and fire management that are relevant to conservation of *E. stuartii*.

Access to the site is currently by foot along 5 km of undeveloped walking track or by boat and foot from nearby beaches. Vehicular access to the northern side of Southport Lagoon and thence George III Historic Site was closed in 1994 and the prohibition of vehicular access is likely to be continued when the management plan is adopted. Signs direct walkers from the Ida Bay Railway terminus at Deep Hole to George III Historic Site. The walk is currently promoted in an *ad hoc* manner by the Ida Bay Railway Company and the Lune River Youth Hostel. The existence and significance of *E. stuartii* is not publicised.

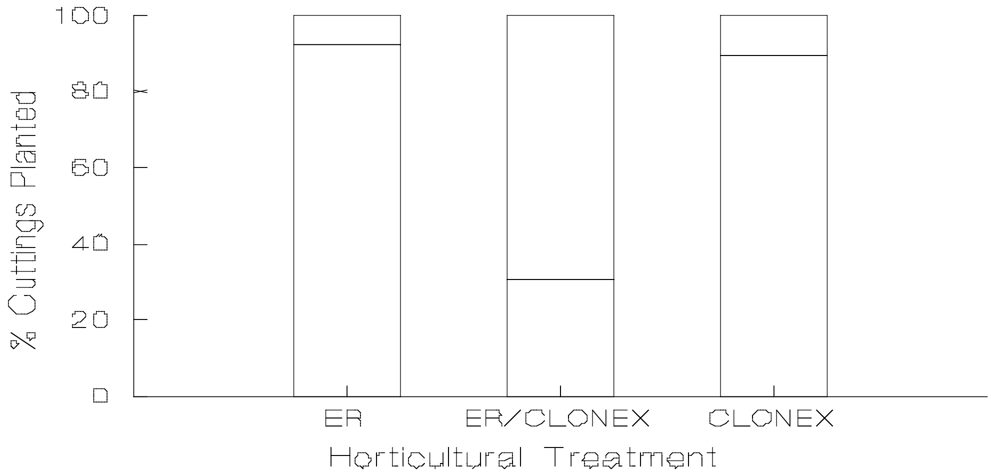

Figure 8: Strike and survival rate of *Epacris stuartii* cuttings collected and propagated in May 1995. Solid bars indicate cuttings that struck and survived to 18 weeks. Grey shaded bars indicate cuttings that failed to strike or survive. A total of 146 cuttings were tested from 14 genets in the wild population (data courtesy of M. Fountain, Royal Tasmanian Botanic Gardens).

A monitoring program based on a sample of 250 plants has been established in 1995 as part of the Research Plan and is proposed to continue in the strategy for conservation.

A small *ex situ* living collection of *E. stuartii* was established in 1995 and is held at the Royal Tasmanian Botanic Gardens. The collection consists of approximately 90 individuals raised from cuttings collected from 13 plants in the wild population. The *ex situ* collection is unlikely to be a very comprehensive representation of genetic variability in the wild population and will require expansion if it is to function as an adequate safety net for the wild population.

Strategy for Conservation

This Recovery Plan will run for a term of 10 years from 1996 to 2005 inclusive. The major threat to *E. stuartii* is a disease epidemic caused by *Phytophthora cinnamomi*, which is expected to infect the population during the term of this Plan. Other risk factors such as fire regimes and the timing of critical weather events (drought and storm) may contribute to the overall threat at various times. Three strategies for conservation of *E. stuartii* will be implemented concurrently to address these threats:

(i) preventative measures to minimise the chance of invasion by P. cinnamomi through access management, monitoring and early detection;

(ii) remedial measures to restore the wild population or limit its decline through habitat management and disease treatment; and

(iii) a safety net to allow reintroduction, should the wild population become extinct.

OBJECTIVES AND CRITERIA FOR RECOVERY

The overall objective of this Recovery Plan is to minimise probability of extinction of *Epacris stuartii* in the wild. This is unlikely to entail down listing the species' status from Endangered because of its naturally restricted range and the limited area of suitable habitat.

Specific Objectives

1. To maintain the wild population of *E. stuartii* above a minimum threshold size of 500 mature individuals.
2. To minimise the chance of invasion of George III Historic Site by *Phytophthora cinnamomi* and mitigate its impact on vegetation should infection occur.
3. To develop management techniques to restore the wild population of *E. stuartii* should it fall below the minimum threshold size.
4. To establish and maintain an *ex situ* collection of *E. stuartii* that represents, to an appropriate level, the variation within the wild population for the purpose of reintroduction should *E. stuartii* become extinct in the wild.

Criteria

1. The population size is maintained above 500 mature individuals in perpetuity.
2. Southport Bluff remains free of infections of *Phytophthora cinnamomi* in perpetuity. Infected vegetation in the vicinity is treated immediately, in the event that *P. cinnamomi* invades the site.
3. Management techniques to increase the size of the wild population of *E. stuartii* are developed and implemented if the population falls below 500 mature individuals.
4. A representative *ex situ* living collection of *E. stuartii* is established and maintained, and used as a source of material for reintroduction if the wild population becomes extinct.

RECOVERY ACTIONS

Implementation of the Recovery program will be overseen by the Recovery Team consisting of a botanist from Parks and Wildlife Service, a land manager from Parks and Wildlife Service (Esperance District), an officer from the Royal Tasmanian Botanical Gardens, an officer from the Endangered Species Unit (Environment Australia), the Tasmanian representative of the Tasmanian Conservation Trust and representatives of local business and/or community interests as appropriate. The text below describes the recovery actions, justifies their need and provides estimated costs in 1996 dollars.

1. Maintenance of Population Above Threshold Size

1.1 Population monitoring

An up to date knowledge of the status of the population is an essential basis for future decisions for management of fire, access, etc. Prior to 1995 the population had not been visited regularly or assessed in a systematic manner. In 1995 a monitoring program was established as part of the implementation of the Research Plan. It is essential that monitoring continue so that population declines may be detected and their cause be identified as early as possible.

The existing monitoring program is based on a sample of 250 established plants. The plants are marked permanently with numbered brass tags on stainless steel stakes in an area south of George III Monument. Monitoring will continue to be carried out annually in January and will involve a census of survival and fruit production of existing plants and a search for new seedlings, which will be tagged. Fires occurring in the preceding year will be mapped on a detailed site plan with reference to Departmental fire records. It is essential that monitoring occur in January of each year when fruits are mature. Annual monitoring will continue for 10 years under this Plan. In addition, it will be necessary to carry out monitoring on a monthly basis in 1996 to assess recovery of individual plants suffering dieback, apparently as a consequence of the storm in February 1996. The fate of these plants, which represent a high proportion of the total population, is critical to future management options.

ESP funds are required for employment of a project officer for 2 weeks in January of each year and two days per month in 1996 to carry out field work and evaluation and management of data. Funds are also required to meet minor costs of materials and travel allowance. Parks and Wildlife Service will contribute vehicular transport, training and supervision time.

Year	Yr 1	Yr 2	Yr 3	Yr 4-10	Total
Cost	7 190	2 710	2 710	2 710	31 580

NB: In Year 1 a project officer, vehicle and office accommodation is required for 5 weeks.

1.2 Habitat management to restore or avoid decline in wild population

Management actions directed at restoring the size of the population will be required if substantial population declines are detected in the monitoring program. A decline in the number of plants in the monitoring sample from 250 to 180 will be taken as an indication that the total population is approaching the critical management threshold of 500 mature plants. This will be verified by inspection of the entire population.

In the event that the population does decline to threshold size, appropriate management actions to encourage seedling recruitment will be considered. These potentially include implementation of regeneration fires, protection from wildfire, smoke treatment, water supplementation and fencing to exclude macropod grazers. At present there is insufficient knowledge to determine the conditions under which each of these actions should be implemented Research is required to determine the details of implementation (Action 3.3). With the exception of fire protection, none of the management actions listed should be implemented without further research.

The timing of population management actions cannot be forecast, since it is dependent upon when and if the wild population declines to the threshold size. Indicative costs of implementing actions are provided for one year as a guide for possible funding requirements. The Recovery Team may or may not submit funding applications to Environment Australia for these or related actions during the term of this Plan, depending on the status of the wild population.

a) Fire protection: May be required to prevent population decline due to high frequency fire. The most feasible management option for fire protection is to create a firebreak near the western boundary of the Historic Site and to burn back in a westerly direction. Costs include labour for planning, slashing, burning and post-fire patrol, consumables and boat hire. Repeat burns may be required at appropriate intervals. Costs are for one treatment.

b) Regeneration fire: May be required to stimulate seedling regeneration. Costs as for previous action, but without creation of firebreak.

c) Smoke treatment/water supplementation: May be required to stimulate and sustain seedling regeneration. Field apparatus for smoke treatment has been developed by Kings Park and Botanic Garden. Costs include apparatus, labour for planning, treatment and follow-up monitoring/watering and travel.

d) Fencing: May be required to exclude macropods and prevent grazing of seedlings and resprouting plants. Costs include materials, transport and labour.

Management Action	Cost
Fire protection	2 203
Regeneration fire	1 523
Smoke treatment/water supplementation	11 935
Fencing	5 980

2. Disease Avoidance and Management

2.1 Undertake annual site inspections to detect invasion of Phytophthora

Early detection of *P. cinnamomi* is essential if the impact of a disease epidemic on *E. stuartii* is to be mitigated. Annual monitoring is necessary to ensure that invasion of the pathogen and disease symptoms are detected early because death rates of *Epacris* species in infected areas may exceed 50% in the first year that symptoms become evident (Keith, unpubl. data).

Monitoring will entail a site inspection throughout the full extent of the population to record symptoms of disease. Soil samples will also be collected for analysis from any sites suspected to be infected and several representative apparently uninfected sites. The precise location of sample collection points will be recorded to assist with data interpretation. Monitoring will be carried out in January of each year because disease symptoms are most likely to be expressed by this time of year.

Disease monitoring will be integrated with population monitoring (Action 3.1.1), to be carried out at the same time of year. Integration of the two monitoring programs allows cost savings to be achieved. Costs of Action 3.2.1 are included within the estimates for Action 3.1.1.

2.2 Promote and implement *Phytophthora* hygiene measures

The major risk of disease introduction to George III Historic Site is through transport of infected mud on footwear of visitors including tourists, management staff and researchers. For this reason, visitation to the Historic Site will not be encouraged or promoted.

The Parks and Wildlife Service will ensure that all staff and external researchers follow hygienic procedures when visiting the site. These procedures include washdown or change of footwear at appropriate sites. The Recovery Team will distribute educational material to and seek the co-operation of local tourist ventures to encourage recreational bushwalkers to follow hygienic procedures when visiting the area. Key ventures to be targeted include the Ida Bay Railway Company and the Lune River Hostel. The educational material will include a brochure describing the impact and spread of the disease, describe hygienic washdown procedures and notify intending visitors that they will be required to change or washdown footwear at designated points. An existing brochure, “Phytophthora Root Rot ... the plant killer” prepared by Parks and Wildlife Service with assistance from Environment Australia includes much of the necessary information. Funds will be required to prepare an insert with information locally applicable to the Southport area and George III Historic Site.

Appropriate signs designating washdown points will be erected at the Deep Hole Railway terminus, Southport boat ramp and at a location topographically suitable for washdown near the western boundary of George III Historic Site.

Parks and Wildlife Service and relevant research institutions will bear the costs of hygienic procedures for their own staff. Liaison with local tourist ventures will be carried out by local Service staff. Funds will be required for production of education material and signage.

Year	Yr 1	Yr 2	Yr 3	Yr 4-10	Total
Cost	2 550	800	800	800	9 750

2.3 Development works to reduce spread of infected mud

Development of the access route to George III Historic Site will reduce the spread of infected mud and hence the risk of disease in the *E. stuartii* population. The current access track has developed in an unplanned manner determined by previous movements of vehicles and walkers. The aims of future access management will be to minimise the transport of mud to the Historic

Site from elsewhere and to confine walker traffic within the Historic Site to a defined pathway. The preferred strategy is to redirect the existing access track, install a footwear washdown station and construct an elevated walkway within the Historic Site. Careful planning of these works is essential to ensure that the potential for invasion of *P. cinnamomi* is minimised.

The re-routed access track will direct walkers into an uninfected area which will serve as an 'clean' buffer zone through which all walkers are directed on their way to the Historic Site. A footwear washdown station with appropriate signage will be installed at the beginning of the new section of track to minimise the transport of infected mud into the buffer zone. The buffer zone should be as wide as possible, to minimise the transport of infected mud across its entire breadth, as a precaution against failure of walkers to effectively wash down their footwear. The new section of track required will therefore be up to 3 km in length and will be located to include a suitable washdown site and avoid areas likely to become muddy. The washdown station must be located at a topographically suitable site with permanently available water. A ground survey is necessary to locate sites of *P. cinnamomi* infection along the existing access route and to evaluate options for a new track route and a suitable site for the washdown station.

The purpose of the walkway is to confine walker movements to a single route within the Historic Site and to direct people away from significant stands of *Epacris stuartii*, thus minimising the chance of infection. The walkway will extend for up to 400 m from the western boundary of the Historic Site, across a drainage depression and across the headland summit to the George III Monument. With the co-operation of visitors, these works offer the best possible option for minimising the chance of introduction of *P. cinnamomi* into the Historic Site and, in the event that introduction occurs, containing the infection to a single route and hence minimising the chance of spread through *E. stuartii* habitat.

Planning and design of the works will be undertaken by Parks and Wildlife Service staff in consultation with the Recovery Team. Parks and Wildlife staff will carry out the ground survey and soil testing. Funds will be required to meet salary costs of a track cutter and labourers and purchase materials. Re-routing of the walking track and installation of the washdown station (a) will receive higher priority than construction of the elevated walkway (b).

Year	Yr 1	Yr 2	Yr 3	Yr 4-10	Total
Cost	28 837				28 837

2.4 Treatment and quarantine of infected areas

George III Historic Site will be quarantined at times considered appropriate by local management staff. Quarantine restrictions may be required when infections are evident in the vicinity of *E. stuartii* and when weather conditions pose a high risk of spread. If disease symptoms are reported within George III Historic Site and the presence of *P. cinnamomi* is confirmed (Action 3.2.1), infected vegetation and adjacent sites will be treated with phosphonate as soon as weather conditions are suitable. Initially, two treatments of phosphonate may be required, several weeks apart. Follow up treatments will be implemented at appropriate intervals. Parks and Wildlife Service has the capacity for rapid response to treat small areas to minimise the impact of disease.

Phosphonate is applied by spray to plant foliage and acts systemically to increase plant resistance to infection. It does not act directly on the pathogen. There is a possibility that phosphonate may elicit a toxic response when plants are exposed to multiple applications over time. There is no evidence of a toxic response in related *Epacris* species after one application (P. Barker, pers. comm. Forestry Tasmania), however there are no data on responses to multiple applications. It may therefore be necessary to monitor foliage of treated and control plants. The timing of, and necessity for phosphonate application will be determined by the appearance of the disease on site. Indicative costs are given for two treatments.

Management Action	Cost
Treatment and quarantine	4 688

3. Research into Regeneration Ecology for Population Management

3.1 Determine seed longevity

An understanding of the longevity of the soil seed bank is an essential basis for population management in the event of a major population decline. Existing germination data suggest that the population size could be restored through a regeneration fire to stimulate seed germination. However, the presence and activity of *Phytophthora cinnamomi* will determine the optimum timing of such a fire. If *P. cinnamomi* is active, new seedlings emerging after the fire will simply be exposed to the disease and die. The net result will be depletion of the soil seed bank. However, with time since the initial disease epidemic the activity of *P. cinnamomi* is known to decline. Thus seedlings may avoid disease if they emerge after the activity of the pathogen has declined. A delay of several years in implementing a regeneration fire may therefore be beneficial, so long as sufficient seeds remain viable in the soil over that time. Knowledge of seed longevity will establish the limits of flexibility to the timing of regeneration fires. There will also be spin off benefits for *ex situ* conservation. If seeds prove to be long-lived, seed storage would prove to be a cost-effective means of maintaining a very large genetically diverse *ex situ* collection.

A seed burial experiment will be carried out over two years to determine the longevity of seed in the soil. The Parks and Wildlife Service will provide supervision, vehicular transport and arrange use of laboratory facilities. Funds are required to meet the cost of salary, travel and consumables.

Year	Yr 1	Yr 2	Yr 3	Yr 4-10	Total
Cost	16 024	10 988			27 012

3.2 Develop management technique for seedling regeneration

Existing data indicate that seedling regeneration is limited by fire-related germination cues. Nonetheless, regeneration fires may fail to stimulate substantial seedling regeneration, as was the case after the 1994 fire. Laboratory experiments on *E. stuartii* seed and field trials on other species (Dixon *et al*. 1995) suggest that seedling regeneration may be enhanced in the field by application of smoke treatment followed by supplementary watering if soil moisture is limiting. If feasible, this may be an important management technique for restoring population size and one that is substantially more cost effective than reintroduction of *ex situ* stock. It is important that a regeneration technique is developed before the need arises to reverse a substantial decline in the wild population.

An experiment to test the effect of smoke treatment and supplementary watering on seedling establishment will be carried out in the field. The methodology will be developed in consultation with Western Australian researchers. Funds are required to meet the salary costs of a project officer, materials and travel costs. PWS will meet the costs of supervision, vehicular transport and use of office space and equipment.

Year	Yr 1	Yr 2	Yr 3	Yr 4-10	Total
Cost	11 994				11 994

3.3 Develop management decision support system

The are a potentially complex range of scenarios involving fire, disease epidemic and weather conditions to which management must respond to maintain *Epacris stuartii* above the population threshold. There is also a range of management responses available to restore population size, depending on the cause of decline (Action 3.2.1). A decision support system is required to assist wildlife and field staff to determine the most appropriate management response to various scenarios. Funds are required to meet the salary cost of a project officer for one month to develop the decision support system.

Year	Yr 1	Yr 2	Yr 3	Yr 4-10	Total
Cost	5 052				5 052

4.0 *Ex Situ* Safety Net

4.1 Establish an *ex situ* population

Under the worst case scenario, *Epacris stuartii* could decline to extinction in the wild during the term of this Plan. The development and maintenance of a genetically representative *ex situ* living collection is essential insurance against such an outcome. The principal requirements of such a collection are: (i) genetic representativeness; (ii) commitment to maintenance in perpetuity; and (iii) security against disease infection and vandalism. Genetic representativeness can only be assured by a genetic survey of the wild population. In the absence of such a survey, genetic representativeness may be approximated by stratified sampling of the population. Material for propagation should thus be collected from plants scattered throughout the entire population and from both microhabitat types.

The options proposed by Keith for *ex situ* conservation collection of *Epacris stuartii* are: (A) establishment and maintenance of a secure living collection at the Royal Tasmanian Botanical Gardens; (B) establishment of a living collection on other land; (C) establishment of a semi-natural population in suitable bushland; and (D) dispersal of propagated material through the community for cultivation in home gardens.

Option (A) was the preferred option for *ex situ* conservation but is the most expensive. A cheaper and possibly more cost effective alternative is a combination of options (C) and (D). Option (C), the establishment of an *ex situ* population on other land, was also proposed by Barker (1994) to be undertaken on Southport Island, adjacent to the wild population on Southport Bluff and consequently environmentally similar. Southport Island offers the security of an isolated population particularly with regard to *Phytophthora cinnamomi* infection.

Before proceeding with Southport Island as an *ex situ* site the island will be surveyed for botanical and zoological values. An assessment will be made with regard to the potential impacts of translocation of *E. stuartii*. The assessment will be undertaken with due regard to the guidelines endorsed by the Australian Network for Plant Conservation. If other Epacris species are found on the island the potential impacts of hybridisation will also be closely studied. Details of the translocation will be lodged with the Threatened Species Unit at Environment Australia. Another location will be sought and assessed if Southport Island turns out to be unsuitable.

Since an *ex situ* wild population would not be closely monitored further security could be gained by also dispersing propagated material through the community for cultivation in home gardens (option D). These plants would be a source of material in the event of loss of the wild and *ex situ* populations.

Year	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4-10**	**Total**
Cost		26 575	48 700		75 275

4.2 Reintroduction should wild population become extinct

If *Epacris stuartii* becomes extinct in the wild, reintroduction will be necessary. To minimise site disturbance, unnecessary alteration to genetic composition of the population and costs, reintroduction from cultivated stock will not be considered until. Reintroduction will be attempted only when (i) extinction of the wild population is confirmed; (ii) attempts have been made to restore the wild population through management (e.g. stimulating regeneration from the soil seed bank); and (iii) when threatening processes that caused the decline of the wild population have been abated. A reintroduction project will follow guidelines endorsed by the Australian Network for Plant Conservation.

Extinction of the wild population is not expected during the term of this Plan. However, indicative costs are provided in the event that a funding application for reintroduction is required. A part-time project officer will be required for three years to plan the reintroduction project, co-ordinate planting and undertake monitoring and maintenance. If and when the need arises, funds will be sought to meet the cost of salary, travel and consumables. The Parks and Wildlife Service and Royal Tasmanian Botanical Gardens will meet costs of propagation, supervision, vehicles and office equipment and accommodation.

Year	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4-10**	**Total**
Cost	34 728	16 579	16 579		67 886

IMPLEMENTATION SCHEDULE

Task	Task Description	Priority	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Total
1	**Maintence of Population Above Threshold Size**												
1.1	Population monitoring	1	7 190	2 710	2 710	2 710	2 710	2 710	2 710	2 710	2 710	2 710	31 580
1.2	Habitat management to restore or avoid decline in wild population	Contingency action											
2	**Disease Avoidance and Management**												
2.1	Undertake annual site inspections to detect invasion of Phytophthora	Costs included in Action 1.1											
2.2	Promote and implement Phytophthora hygience measures	1	2 550	800	800	800	800	800	800	800	800	800	9 750
2.3	Development works to reduce spread of infected mud	1-2	28 837										28 837
2.4	Treatment and quarantine of infected areas	Contingency action											
3	**Research into Regeneration Ecology for Population Management**												
3.1	Determine seed longevity	1	16 024	10 988									27 012
3.2	Develop management technique for seedling regeneration	2	11 994										11 994
3.3	Develop management decision support system	1	5 052										5 052
4	**Ex Situ Safety Net**												
4.1	Establish an ex situ population	1-2		26 575	48 700								75 275
4.2	Reintroduction should wild population become extinct	2	34 728	16 579	16 579								67 886

			106 375	57 652	68 789	3 510	3 510	3 510	3 510	3 510	3 510	3 510	257 386

REFERENCES

Barker, P.J.C. and Wardlaw, T. J. (1995). Susceptibility of selected Tasmanian rare plants to *Phytophthora cinnamomi*. *Australian Journal of Botany* ***43***, 379-386.

Bell, D.T., Rokich, D.P., McChesney, C.J. and Plummer, J.A. (1995). Effects of temperature, light and gibberellic acid on the germination of seeds of 43 species native to Western Australia. *Journal of Vegetation Science* **6**, 797-807.

Bradley, P. (1994). 'Fire report - Southport Lagoon, 2 April 1994.' Unpublished report. Tasmanian Parks and Wildlife Service.

Briggs, J.D. and Leigh, J.H. (188). 'Rare or threatened Australian plants.' Special Publication No. 14. Australian National Parks and Wildlife Service, Canberra.

Crowden, R.K. and Menadue, Y. (1990). Morphometric analysis of variation in the '*Epacris tasmanica* complex' (Epacridaceae). *Australian Systematic Botany* **3**, 253-264.

Curtis, W.M. (1963). 'Flora of Tasmania. Part 2.' Tasmanian Government Printer.

Dixon, K., Roche, S. and Pate, J.S. (1995). The promotive effect of smoke derived from burnt native vegetation on seed germination of Western Australian plants. *Oecologia* **101**, 185-192.

Keith, D.A. (1991). 'Coexistence and species diversity in upland swamp vegetation: the roles of environmental gradients and recurring fires.' PhD thesis. University of Sydney.

Keith, D.A. (1995). Surviving fire and fungal pathogens: are there life-history solutions for threatened species of *Epacris*? In 'Bushfire '95: Proceedings of the fifth Australian Bushfire Conference' (Eds. T. Blanks, M. Chladil, R. Chuter and K. Green). (Forestry Tasmania, Parks and Wildlife Service, Tasmania Fire Service: Hobart)

Keith, D.A. (1996). Fire-driven extinction of plant populations: a review of theory and evidence from Australian vegetation. *Proceedings of the Linnean Society of New South Wales* **115**, in press.

Leigh, J.H., Briggs, J.D. and Hartley, W.M. (1981). 'Rare or threatened Australian plants.' Special Publication No. 7. Australian National Parks and Wildlife Service, Canberra.

Skinner, A.D. (1981). 'Southport Lagoon Conservation Area - Fire February 1981.' Unpublished report. Tasmanian Parks and Wildlife Service.

EPACRIS STUARTII RECOVERY PLAN: 1996-2005
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