# National recovery plan for the Mt Emu she-oak
*Allocasuarina emuina*

Prepared by the Environmental Protection Agency for the *Allocasuarina emuina* recovery team.

Australian Government

Queensland Government
Queensland Parks and Wildlife Service

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**Prepared by:** Environmental Protection Agency for the *Allocasuarina emuina* recovery team.



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This plan is based on an original conservation assessment for *Allocasuarina emuina* by Halford (1993) and incorporates comments submitted by recovery team members and other stakeholders.

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# 1 Summary

## 1.1 Species

*Allocasuarina emuina* is an endemic, low-growing, slender flowering shrub restricted to the Sunshine Coast, Queensland. The first recorded sighting of the species was in 1938 by S.T. Black in the wallum flats of Caloundra. L.A.S. Johnson later described the species in 1989 from material collected by P.R. Sharpe from Emu Mountain (otherwise known as Mt Peregian). It is closely related to *A. thalassoscopica* and *A. littoralis*, which are also present in the Sunshine Coast region.

## 1.2 Species status

*Allocasuarina emuina* is one of 59 *Allocasuarina* species endemic to Australia, with a restricted geographic range between Beerburrum and Noosa on Queensland's Sunshine Coast. It was listed as 'endangered' in the *Nature Conservation (Wildlife) Regulation 1994* (subordinate legislation to the Queensland *Nature Conservation Act 1992* (NCA 1992)) in 1994 and as 'endangered' in July 2000 under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC 1999). The listing reflects a: (i) low number of populations; (ii) low number of individuals; and (iii) restricted distribution. The area of suitable habitat, number of populations and number of reproducing individuals has undergone dramatic declines over recent times as a result of habitat loss (Kruger, 2002) and fragmentation associated with urbanisation.

## 1.3 Distribution summary

*Allocasuarina emuina* is currently known from 11 populations on the Sunshine Coast with an approximate total of 14 000 plants (map 1). The species has a patchy distribution within heathland habitats with the majority of individuals occurring in low-lying areas and on the western and southeastern slopes of Mt Emu. Historically, it is likely that it had a wider distribution on the Sunshine Coast region (Kruger, 2002). Of the 11 remaining populations, nine occur on local and state government managed reserves (including national parks) and two occur on freehold land.

## 1.4 Threats

The threats to *A. emuina* are related to the alteration or loss of suitable habitat, including urbanisation, agriculture, establishment of pine plantations, transportation corridors and associated drainage projects. The key threats associated with these activities are altered fire regimes, increased storm water run-off and the establishment of exotic plant species. Appropriately managed fire regimes are required to ensure seed germination. Increased storm water run-off changes the hydrology of a site and increases soil nutrients and water availability. This encourages weed growth in heathland habitats, habitats that typically grow on low nutrient soils.

## 1.5 Recovery objectives

The long term objective of the ongoing recovery effort is to remove *A. emuina* from the threatened species listings under the NCA 1992 and the EPBC 1999. The overall objective of this recovery plan is to protect known populations of *A. emuina* in Queensland from further decline and maintain and/or enhance wild populations in the long term.

**Specific objectives**

The specific objectives of the plan in order to achieve the down listing of *A. emuina* are to:

- protect, restore and maintain known populations and locate and/or establish new populations of *A. emuina*;
- address and review the key threats to *A. emuina*;
- develop research programs that assist with the recovery and conservation of *A. emuina*; and
- promote community awareness and education in relation to *A. emuina*.

**Performance criteria**

The criteria for successfully achieving the objectives of the *A. emuina* recovery plan will be:

- secure protection and management of all known populations and establish new and translocated populations;
- put in place measures to reduce the impact of key threats to *A. emuina* and the potential future impacts are assessed;
- obtain information through research programs about the area of occupancy, abundance, response to fire and aspects of the biology and ecology that affect the conservation status and persistence of the species; and
- ensure community, industry and local and state government agencies become actively involved in *A. emuina* conservation programs as a result of the implementation of strategic community awareness campaigns.

## 1.6 Summary of recovery actions

**Action 1. Secure protection and management of all known populations**

1.1 Evaluate and implement measures to secure all populations and potential habitat on reserves and Environmental Protection Agency/Queensland Parks and Wildlife Service (EPA/QPWS) estate.

1.2 Protect and manage existing *A. emuina* populations, and populations identified in the future, on freehold land.

1.3 Maintain a representative collection of seed *ex situ* and develop efficient propagation and cultivation techniques in order to generate suitable stock for strategic *ex situ* and *in situ* plantings.

**Action 2. Minimise the impacts of key threats to *A. emuina***

2.1 Develop and implement a strategy for appropriate fire management practices.

2.2 Develop and implement a strategy to minimise storm water run-off into *A. emuina* habitat.

2.3 Implement weed management strategies at all known populations.

2.4 Design and implement an ongoing monitoring program to assess the effectiveness of management and rehabilitation strategies.

**Action 3. Develop research programs to assist the conservation of *A. emuina***

3.1 Undertake ground surveys to confirm the location and extent of all known populations and map the extent of potential habitat.

3.2 Investigate the response of *A. emuina* to fire.

3.3 Identify population parameters and aspects of the biology and ecology that affect the conservation status and persistence of *A. emuina.*

**Action 4. Increase community awareness and education in relation to *A. emuina***

4.1 Develop promotional/interpretive materials relating to the species.

4.2 Ensure the ongoing operation of the recovery team with appropriate and flexible representation.

4.3 Secure resources to support the recovery of *A. emuina.*

The recovery plan will be reviewed within five years of the date of publication.

# 2 General information

## 2.1 Description of species

*Allocasuarina emuina* is one of 59 *Allocasuarina* species within the family Casuarinaceae. *Allocasuarina* species possess long needle-like wiry branchlets and their leaves are reduced to whorls of small triangular teeth, occurring at regular intervals along the branchlets. Regions of branchlets, called articles, separate the leaf whorls characterised by longitudinal ridges separated by furrows. There are consistently as many ridges as teeth. Inflorescences consist of alternating whorls of tooth-like bracts. Within each bract are two lateral scale-like bracteoles and a single unisexual flower. Male inflorescences are short to elongated catkin-like spikes. Female inflorescences are small globose or ovoid heads on short lateral branchlets. The female inflorescence develops into a woody cone in which the two enlarged bracteoles of each flower form lateral valves and open to release the fruit (samara). The samara is a winged nut and appears like a seed (Barlow, 1981).

The following description of *A. emuina* has been adapted from Halford (1993) and Johnson (1989):

> Spreading shrub 0.5-2.5 m high with smooth bark and with male and female organs on separate plants. Branchlets up to 12 cm long ascend the branch; sectioned by small, smooth articles (4-8 mm long, 0.5-0.9 mm in diameter) with soft down in the furrows. Each ridge of the branchlet article has 6-8 teeth (0.3-0.7 mm long) erect to slightly spreading and not overlapping. Male flowers are unbranched and without stalks. They are approximately 1-3cm long with 8.5-9.5 whorls per centimetre. A small leaf-like structure, differing in form from the foliage leaves remain attached to the plant beyond the expected time of falling and is associated with the male flowers. The pollen bearing part of the flower can be 0.8-0.9 mm long. The cones are cylindrical and 12-28 mm long, 6-15 mm in diameter and with a sterile apex. The stalk is 3-13 mm long and slender. The seeds are dark brown to black and are 4.5-7.5 mm long.

Several species of *Allocasuarina* are widely distributed while many others are locally restricted (Wilson and Johnson, 1989) (map 2). Polyploidy (greater number of chromosomes), hybridisation (breeding from different varieties/species) and apomixis (asexual reproduction) are known to occur in the genus, which may have led to the development of a large number of locally endemic species (Wilson and Johnson, 1989). There are four taxa of *Allocasuarina* which are restricted to narrow geographic ranges within the Sunshine Coast region: *A. emuina*, *A. thalassoscopica* (NCA 1992: 'endangered'), *A. filidens* (NCA 1992: 'rare') and *A. rigida* subsp. *exsul* (NCA 1992: 'vulnerable') (Johnson, 1989). These four closely related taxa are placed in *Allocasuarina* section *Cylindropitys*, together with *A. littoralis*, which has a wide distribution throughout eastern coastal Australia (Wilson and Johnson, 1989). *Allocasuarina* species occurring on the Sunshine Coast are very similar morphologically and it can be difficult to distinguish between species (Halford 1993; Wilson and Johnson 1989). *A. emuina* can be distinguished from *A. thalassoscopica* by its shorter articles, longer anther, generally more rounded phyllichnia and less appressed teeth (Johnson, 1989). Some closely related species are clearly genetically and reproductively segregated, while other species may form hybrids with closely related species when their distributions overlap or are in close proximity (Cunningham, *et al.,* 2002). Hybridisation is suspected among *A. emuina* and its nearby congeners (Halford, 1993, Olsen 2002). A large component of phenotypic differences are in adult plant height, with the Sunshine Coast endemic species having relatively stunted adult forms (0.5-4 m) compared to *A. littoralis* (5-15 m). The taxonomic distinctiveness of *A. emuina* in relation to the closely related locally occurring species has been questioned (Halford, 1993; Olsen, 2002). Molecular markers have been recently used to distinguish between members of the Cauarinaceae including *A. emuina*, *A. thalassoscpica* and *A. littoralis* (Steane *et al* 2003). This study is supportive but not definitive with regard to species-level distinction of *A. emuina*. Thus the taxonomic distinctiveness of *A.emuina* and issues such as its potential to hybridise with its nearby close relatives are being further investigated.

## 2.2 Biological and ecological information

### Landform, soils and climate

*Allocasuarina emuina* has a restricted geographic range between Beerburrum and Noosa on Queensland's Sunshine Coast and has a distinct niche preference for heathland environments. It is located in relatively flat, low-lying coastal areas at elevations of between 5 and 70 m above sea level and on a range of inclinations from flat to slopes of 20 degrees (Halford, 1993). Studies indicate that the species prefers wet heath soils, distinguishing it from *A. thalassoscopica*, which occurs on predominantly dry heath soils (Olsen, 2002). The soils are usually light to medium clays or sandy loams with a weak acidic reaction (Halford, 1993; Olsen, 2002). It is also found in areas with surfaces of either Quaternary and Mesozoic sediments or fine-grained igneous rocks (Olsen, 2002). Slightly more fertile soil or contamination with increased nutrients may lead to the extinction of heath flora and replacement by savannah flora (Groves, 1981).

The climate experienced on the Sunshine Coast is subject to coastal influences, with average maximum and minimum temperatures in summer ranging between 19 to 29 degrees and 7 to 22 degrees in winter. The annual rainfall occurs predominantly in summer with more than 250 mm per month in the summer to less than 100 mm per month in winter. The climate is relatively humid, particularly in summer.

### Vegetation

Wet heath vegetation is dense and ranges in height from 1 to 1.5 m with some emergent trees reaching 6-8 m. Dominant species of heathland habitat where *A. emuina* occurs include *Ptilanthium deustum*, *Hakea actites* and *Banksia oblongifolia*. Trees such as *Eucalyptus bancrofti*, *Melaleuca quinquenervia*, *A. littoralis*, *E. racemosa* and *Corymbia intermedia* dominate the surrounding open woodland. Extensive eutrophication and degradation has occurred in the heathlands around Peregian Beach as a result of the release of stormwater rich in nutrients. Native heathland species are particularly sensitive to eutrophication, given their preference for the naturally nutrient-poor heathland soils (McKiernan, 1997). This increased nutrient load has resulted in an influx of weeds that, in turn, has increased mortality of native heathland species from conditions such as phosphorous toxicity and altered fire regimes (Kruger, 2002).

### Reproductive biology

It is likely that this species has a peak flowering period between late May and mid/late July, with evidence of reproductive effort in response to favourable climatic conditions throughout the entire year (Halford, 1993). The period from germination to first flowering may be as long as two seasons of growth. The period from crown removal (by fire) to seed production is shorter, with plants able to flower in the growing season immediately following fire (Halford, 1993). Effective reproduction of *A. emuina* is likely to be reliant on wind pollination like other members of the Casuarinaceae family (Halford, 1993).

Upon fertilisation, ovaries in the female flowers enlarge to form a cone, whereby the small leaf-like structures found on the flower stem modify into woody valves that enclose hardened winged seeds (McKiernan, 1997). It is thought that seeds may take at least six months to mature, given that Halford (1993) found seeds from the May to July 1983 flowering season, had not yet matured in December of that year. McKiernan (1997) found that *A. emuina* averaged 10-20 cones per plant and that each of these cones contained 30-36 seeds.

In general, most of the seed is released after the parent plant dies from old age, disease or from the effects of fire. A small proportion of seed may be continuously released from the canopy (seed rain) during the life of the plant. Alternatively, cones may remain closed and retain seed for a number of years (Wilson and Johnson, 1989). Given the low level of seedling recruitment observed under natural conditions (in the absence of fire), the species is likely to accumulate a persistent canopy seed bank.

To date, there is no available empirical information about the longevity or viability of canopy-stored seed except for a study on *Allocasuarina distyla* and *Allocasuarina nana* in the Sydney region (Pannell, 1990). Pannell (1990) reported a gradual decline in viability of seed retained in fruit of *A. distyla* and *A. nana* over a period of 12 years. Studies on *A. nana* found cones contained almost no viable seed 33 years after seed had set. This may be a result of granivory, fungal attack and senescence (McKiernan, 1997). Population size also appears to have an indirect effect on the viability of set seed, with smaller populations of *A. emuina* showing the lowest level of seed viability and the lowest mean number of seeds per cone (McKiernan, 1997). Seeds from small populations were also observed to germinate considerably later than seeds from larger populations (McKiernan, 1997).

The majority of *A. emuina* seed dispersal occurs only upon death of the above ground parts of the adult plant. There is no forceful ejection of the seed from the cones, but the flat papery wing assists wind dispersal once the cone valves have opened (Halford, 1993). Such dispersal distances are generally short, with most seedlings germinating within one metre of the adult plant. The glossy black cockatoo (*Calyptorhynchus lathami;* NCA 1992: 'vulnerable'), feeds almost exclusively on *Casuarina* fruit and has a beak specifically adapted for tearing apart the cones (Clifford and Drake, 1981). This species may contribute to seed dispersal. *A. emuina* regeneration may therefore be affected by reduction in density or distribution of this 'vulnerable' cockatoo species.

Studies by McKiernan (1997) indicated no effective seed dormancy and that germination began at day 12 of trials, with numbers declining towards day 20. The success of seedling establishment would depend highly on environmental variables and success in competing with other species of rootstock regenerators (Halford, 1993). Halford (1993) reported that from the 2500 seeds collected from six plants, an average of 63 percent were found to lack an embryo and consisted only of white woody tissue. This also occurred in *A. littoralis*. In the remaining seed, 94-100 pecent germination was reported, resulting in an average seed viability of 30-35 percent. Subsequent collection of *A. emuina* seed by Greening Australia Queensland has indicated that the majority of seeds contained an embryo.

**Growth and longevity**

*Allocasuarina emuina* is a perennial shrub (Halford, 1993) but little work has been undertaken on its longevity in the wild. It is possible that the ultimate age of these plants is determined by fire, including the frequency of fire (Warren and Associates, 2002). However, response to fire has not yet been fully investigated. Field observations suggest that individuals left unburnt could survive for at least 20 years (M. Lythall, pers. comm., 2003). Observations of cultivated specimens indicate the species is slow growing.

**Genetics**

The synchronicity of reproductive activity within and among populations of rare species significantly determines the likelihood of outcrossing and gene flow. Depending on the presence of self-incompatibility mechanisms or inbreeding depression within populations, the levels of outcrossing among populations may significantly alter the reproductive success of populations of an endangered species (Fischer and Matthies, 1997; Montalvo and Ellstrand, 2001; Stacy, 2001). In contrast, species that have had limited gene flow among populations and exhibit considerable variation among populations may suffer from reduced viability of offspring if individuals from differing populations are brought into contact. This is due to these individuals being less well adapted to their local environment and is known as outbreeding depression (Montalvo and Ellstrand, 2001).

Population enhancement can have either beneficial or harmful impacts on the viability and fitness of populations and needs to be undertaken with caution and consideration of the genetic impacts of such actions (Fischer and Matthies, 1997; Montalvo and Ellstrand, 2001; Shapcott, 2002). Little is known of the genetics of this family (Moore and Moran, 1989; Moran *et al.,* 1989; Schwencke *et al.,* 1998). As more studies are undertaken it has become increasingly clear that the genetics of rare species are not easily predictable based on population genetic theory, therefore cannot be easily extrapolated from previous studies (Gitzendanner and Soltis, 2000).

Due to the existing and anticipated pressures on the habitat of *A. emuina* an understanding of the genetic differentiation among populations of the same and adjacent species is vital for the recovery of *A. emuina*.

Active population creation or enhancement may be considered as recovery options. The creation of a new *A. emuina* population is planned to replace an anticipated population loss due to development (Envirobusiness Update, 2002). Thus it is important that the taxonomic distinctiveness of the species is confirmed and the genetic relationships among populations are understood so that the translocation of the existing population will not have unforeseen negative consequences.

Morphological variations in leaf and fruit have been observed between populations and require further genetic investigation.

**Response to fire**

Species in the family Casuarinaceae are generally obligate seed regenerators. Above-ground portions of *A. emuina* are fire sensitive and can be killed by fire. However, the species has two mechanisms of survival after fire. The retention of seed on cones until they open following fire provides a large source of seed for regeneration in the post fire habitat. Fire benefits, however, are dependent on the type, intensity, season and frequency of the burn. It is suggested that *A. emuina* requires a period of two growing seasons after germination before first reproduction, with these seeds requiring up to six months to mature (Halford, 1993). Plants surviving vegetatively may be capable of flowering in the growing season immediately following fire (Halford, 1993). If fire is too frequent, there may be insufficient time for a mature soil seed bank to accumulate and replace plants killed by the fire. By contrast, a low-intensity fire may not be sufficient to stimulate the opening of the cones (Halford, 1993). No seedlings of *A. emuina* have been observed in the wild under natural disturbance regimes, except following the passage of fire (Olsen, 2002).

Seasonal differences (for example, rainfall, soil temperatures, amount of sunlight and post-fire temperatures) are also likely to affect seedling recruitment after fire. Seasons of heavy rainfall, coupled with a post-fire habitat of bare soil, may facilitate erosion (Gill and Groves, 1981) and subsequent loss of seed. A burn before a cold winter season may adversely affect animal species dependent on heathland habitat, as it may lead to a shortage of food and shelter over the winter period (Gill and Groves, 1981).

Fire, while affecting the above-ground components of a community, also significantly affects the soil and its components. Studies by Adams (1994) indicated that fire significantly heats the top 2 cm of the soil profile, thus altering concentrations of essential nutrients. McKiernan (1997) found that within sites burnt regularly, higher levels of essential nutrients were present for the first year after the burn and then subsequently began to leach through the soil. Since *A. emuina* is a surface-rooting species, this evidence of nutrient changes resulting from dynamic fire frequencies could have a marked effect on nutrient availability and subsequent growth patterns (McKiernan, 1997). Tolhurst (1992) also noted that the benefit to seedlings following fire occurs during the first 100 mm of rainfall. Further rainfall leaches the mobile nutrients deeper into the soil profile, thus nutrients could be leached more quickly from the soil if fire occurs in the wetter months and will greatly affect the success of *A. emuina* seedlings (McKiernan, 1997).

Although the fire history of many *A. emuina* habitats is not recorded, the area's fire regime is known to have changed significantly as a result of encroaching development (McKiernan, 1997). Appropriate fire regimes for *A. emuina* should incorporate consideration of time taken to accumulate a seed bank and to regeneration of key species. Mosaic burns every 4-5 years in heathlands may promote a mosaic of communities of regenerating, maturing and senescing individuals (Groves, 1981). Annual species, especially grasses and herbs, are present only in the first year after fire and then dwindle. Shrub species, including *A. emuina*, are able to regenerate from seed and rootstocks and are present over the first 5-6 years after fire (Gill and Groves, 1981). Cooler fires in winter months every 5-7 years best suit the reproductive and vegetative recovery of the species (Olsen, 2002).

A positive response to fire has been observed within the Peregian Springs (Old Emu Mt Road) population, experiencing the largest known recruitment event for the species with 2000 individuals germinating after a burn in 2001 (Kruger, 2002). Also, the Finland Road population is exhibiting germination after a fire there in 2001. A positive germination response to recent fires is expected at a number of additional sites including Emu Swamp and Coolum sections of Noosa National Park and where evidence of vegetative growth is already present. A similar response is expected to benefit the existing moribund population at Finland Road (Marcoola Section North). Seedling establishment has not been observed in areas that have not been burnt recently, which suggests that *A. emuina* most likely requires a disturbance for seedling recruitment and establishment to occur.

Vegetative reproduction is highly developed in some heathland plants, presumably as a defence against repeated firing (Clifford and Drake, 1981). However, this ability may decline with age of the root system (Gill and Groves, 1981). *A. emuina* regeneration from rootstocks/lignotubers is known to be stimulated when above-ground portions are significantly damaged or completely destroyed (i.e. by fire) (McKiernan, 1997). It is uncertain at what age the plant is able to survive through vegetative regeneration alone (Halford, 1993; Kruger, 2002), although it may be affected by the severity of the above-ground damage, and by the health of the plant in accordance with its age and season (Gill and Groves, 1981). Following a fire in Peregian Springs in 2000, suckers were seen sprouting from the lignotubers of adult plants that had above-ground parts completely killed by the fire. This is also evident in the population in the Coolum section of Noosa National Park and Finland Road populations, where above-ground parts of plants were killed by fire in 2001 and regeneration from rootstocks has since been observed (R. Thomas, pers. comm., 2003).

Further research is needed to determine the optimal frequency, intensity and timing of fire to sustain and/or enhance *A. emuina* populations.

**Propagation and cultivation**

Two attempts have been made to cultivate *A. emuina*. Seed was collected from 10 plants from the Currimundi Conservation Park population in 1997 under the assumption that the species was *A. littoralis*. The species has since been confirmed as *A. emuina*. Cones were collected just before they became hard and woody. A 98 percent germination rate was recorded after two weeks. The propagation medium was one part peat, three parts Mary River sand, and one part perlite. Some of these plants are currently six years old and have reached a height of 0.6m in nursery pots. They are starting to flower and have a number of cones present from the previous flowering (S. Aspland, pers. comm., 2003). Plants from this collection are growing in a number of gardens in Caloundra. Also, a small, cultivated population of 75 plants has been established at the Greening Australia Queensland offices at Norman Park. Seed collected from about five parent plants of the Mt Emu populations were used to cultivate this population. By August 2003 they had attained a height of 1.9m, producing a small crop of fruit in 2002 and an abundance of flowers in 2003 (G. Borschmann, pers. comm., 2003).

## 2.3 International obligations

The species is not listed under any international agreements.

## 2.4 Affected interests

Several stakeholders have been identified as potentially affected by the implementation of recovery actions as the species occurs on local government and state government owned and managed lands and on private property. The stakeholders include:

- EPA/QPWS
- Caloundra City Council
- Maroochy Shire Council
- FKP Ltd
- Greening Australia Queensland
- Department of Natural Resources, Mines and Water
- Department of Main Roads and
- Interested community groups.

## 2.5 Consultation with Indigenous people

The draft interim recovery plan was circulated to all recovery team members and members of the Gubbi Gubbi Indigenous group for review and comment. Aboriginal community engagement is encouraged in the implementation of this recovery plan and membership of the recovery team.

## 2.6 Distribution of existing populations and land tenure

*A. emuina* populations occur across a restricted area of the Maroochy Shire and Caloundra City (map 1). All sites are located in a region that is subject to increasing urban development. Eleven populations of *A. emuina* are known over 35 km. The number of plants in these populations is summarised in table 1. Populations in the north Marcoola section of Mt Coolum National Park and the Coolum section of Noosa National Park are in decline because of inappropriate fire regimes (R. Thomas, pers. comm. 2003).

***Table 1. Summary of all known populations of A. emuina***

| Site | Location | Area | Land tenure | 1993 Population Estimate | 2003 Population Estimate |
|---|---|---|---|---|---|
| 1 | Currimundi Lake Conservation Park | 40$m^2$ | Conservation park** | 20 | 21 |
| 2 | Beerwah Forest Reserve | 2ha (within 330 ha block) | Forest reserve | - | 300 |
| 3 | Mooloolah River National Park | 1ha | National park | - | 300 |
| 4 | Emu Mountain | 5ha | National park*/Dept of Natural Resources | 10 450 | 10 450 |
| 5 | Emu Swamp | 3ha | National park* | 900 | 200 |
| 6 | Old Emu Mt Road (Peregian Springs) | 3ha | Freehold/Crown land | 816 | 2 000 |
| 7 | Finland Road (near airport) | 18ha (within 120ha block) | Council/national park/Main Roads | - | 1 000 |
| 8 | Coolum Ridges | 1.8ha | Freehold | - | 100 |
| 9 | Coolum section of Noosa National Park | 1ha (within 140ha block) | National park | - | 20 |
| 10 | Mt Coolum National Park - North | Within a 197ha block. | National park | - | 30 |
| 11 | Forestry Road | 300$m^2$ | Conservation area | - | 100+ |
| | **TOTAL** | | | **12 186** | **14 521** |

* These areas were crown land in 1993

** Tenure for this site was secured as National Park by the EPA/QPWS in 2002

**Site 1: Currimundi Lake Conservation Park**

This site was located in 1993 by David Halford (Queensland Herbarium) and is situated about 4.5 km north of the Caloundra central business district. Twenty plants were observed at this time within the 51 ha conservation park, with most plants occurring within a 40 square metres area in the south-west corner of the reserve near the lake edge. The site contains coastal heathland and beach ridge vegetation to one metre with dominant species including A*cacia suaveolens, Banksia oblongifolia, Melaleuca nodosa, Dodonaea triquetra* and *Austromyrtus dulcis.* The tenure of the site is crown land managed by the EPA/QPWS. The 2002 census recorded only four plants, and a subsequent visit in 2003 located at least 21 *A. emuina* that were flowering and fruiting. They are in the south-west corner of the park, located between the firebreak and the creek walk (R. Thomas, pers. comm., 2003). Additionally, two plants of *Acacia baueri* subsp. *baueri* (NCA 1992: 'vulnerable') have been located in the adjacent open heathland (R. Thomas, pers. comm., 2003).

The main fire trail/track out to the boardwalk/south-east corner beach access point is evident in aerial photos from the 1950s. It has been formalised as a cleared six-metre-wide fire management trail over the past three years. The Heath Circuit trail may have been a pre-existing lakeside access track, but was formally established along with initial boundary identification and cleanup work in the park between 1980 and 1985. Maintenance of the tracks by pruning of overgrowing vegetation occurs every three years. The plants by the walking track are buffered from the track by a stand of *A. littoralis* and are not likely to be impacted by any track work. The fire trail has gone through the edge of the population but 6-7 plants are more than a metre away from the edge. Galvanised steel posts have been placed on either side of the track to prevent any slashing of the plants in the future and to channel vehicles into the middle of the track.

This site has been burnt in a mosaic manner since 1978. The group of plants north of the six metre wide fire trail was burnt in 1998 (prescribed burn), 1991 (wild fire), 1987 (wild fire) and 1978 (wild fire). The area between the trails was burnt in 2000 (partial effect only, wild fire) and 1991 (wild fire) and the area south of the walking trail was burnt in 1991 (wild fire) and 1978 (wild fire). Seed has been previously harvested from this population under a wildlife harvesting licence. It has been propagated in the Caloundra City Council Nursery and is also growing in gardens at Greening Australia, Queensland.

Another site within the Currimundi Lake catchment was identified in the late 1990s. The site is located within the boundaries of the recreation camp and contains a number of plants.

**Site 2: Beerwah Forest Reserve (Scientific Area 1)**

This site is located about 4 km east of Beerwah. It was first identified in 1991 and a 2002 census recorded more than 300 plants. The population is dissected by a fire trail. Observations in July 2003 indicated that most plants were flowering and producing cones. Extensive surveys are required to determine the true extent of this population. The site is burnt about every five years.

Significant species at this site include *Eucalyptus conglomerata* (NCA: Endangered, EPBC: Endangered) and *Blandfordia grandiflora* (Christmas bells; NCA: Rare), *Schoenus scabripes (*NCA: Rare), and *Acacia attenuata* (NCA: Vulnerable, EPBC: Vulnerable).

**Site 3: Mooloolah River National Park**

This site comprises a population of about 300 individuals. Identified in May 2001, the population is located about 100 m east of Claymore Road. There is a small University of the Sunshine Coast monitoring site (5 m radius), directly adjacent to the population. The presence of *A. littoralis* has led to confusion over the accurate identification of *A. emuina*, however, the Queensland Herbarium has confirmed samples taken in 2003 as *A. emuina*. The north-west corner of this site was burnt by wildfires in 1977, 1981, 1987, 1991 and 2000.

Other species of conservation significance include *Acacia attenuata*, *Blandfordia grandiflora*, *Schoenus scabripes*, *Eucalyptus conglomerata* and *Boronia rivularis*

**Site 4: Emu Mountain (Mt Peregian)**

This site is located directly opposite Coolum State High School, 33 km north of Caloundra, in Maroochy Shire and is the largest extant population of *A. emuina*. Most of the site was purchased by the EPA in 2002 and is now known as the Mt Emu section of Noosa National Park. Part of the site is on Department of Natural Resources and Mines (DNRM) land. The vegetation consists of open and closed heath with nearby swampland. The area was burnt by wildfire in 1990 and has remained unburnt for more than 13 years. Several clumps of *Schoenus scabripes* have been located within the wet heath components, increasing the ecological significance of this site. The 2003 census recorded 10 450 *A. emuina* plants, 1,000 of which occur on the DNRM land. Plants have 'witches broom' infection, however, this is not genetic and is unlikely to affect the viability or longevity of the host plants. Common species at this site include *Banksia oblongifolia, Hakea actites*, *Ptilanthelium deustum, Cassytha pubescens, Themeda triandra* and *Notelaea ovata.* The area is also habitat for a number of threatened amphibians. Potential future development of the heathland retained by DNRM is likely to have an adverse impact on the population if measures are not put in place to minimise the impacts.

**Site 5: Emu Swamp section of Noosa National Park**

Accessible via Old Emu Mt Road, this 330 ha section of Noosa National Park purchased by the EPA in 1993 occurs on a low, undulating coastal plain, with closed heath intergrading into open woodland on higher ground. The vegetation at this site is not unlike that of Beerwah Forest Reserve. Common species at this site include *Hakea actites*, *Banksia oblongifolia, Persoonia virgata* and *Ptilanthelium deustum.* The surrounding open woodland is dominated by trees such as *Eucalyptus bancrofti, Eucalyptus intermedia* and *Melaleuca quinquenervia* with an understorey similar to the adjacent heathland. *A. emuina* plants at this site are relatively small, developing from vegetative regrowth since a winter burn in 2000. *A. littoralis* is also present. The decline from 900 *A. emuina* individuals in 1993 to 200 in 2002 is probably due to the construction of the adjacent Sunshine Motorway and associated earth works.

**Site 6: Peregian Springs (Old Emu Mt Road)**

This site occurs across freehold and crown land and is dissected by the Sunshine Motorway. The total population over this site has been estimated to be between 2500 and 3500 individual plants. A small part of the population occurs on road reserve (managed by the Department of Main Roads) between the motorway and Old Emu Mt Road. The remainder of the population occurs on freehold land to the south, where housing development approvals for the Peregian Springs development have been granted and construction commenced. The majority of the Mt Emu she-oak population will be conserved *in situ* within an 11.7 ha crown reserve to be managed by Maroochy Shire Council as bushland conservation reserve. The development, however, will impact upon a total of 839 plants.

In compliance with approval conditions specified by the Australian Government (referred under the EPBC Act 1999), the developer established an alternative, compensatory population of Mt. Emu she-oak about 1.7 km to the south within future Bushland Conservation Reserve as part of the neighbouring Coolum Ridges housing development (this does not negate the need for a clearing permit under the NCA 1992 for clearing of *A. emuina*). The recovery team has had direct input into the appropriate methodologies to be employed for such a project.

Habitat to be conserved within the 11.7 ha reserve on Peregian Springs is comprised of a mosaic of open forest woodland and open to closed heathlands occurring on a low undulating coastal plain. Dominant species at the site include *Melaleuca quinquenervia, A. littoralis* and sparse occurrences of *Eucalyptus bancrofti* and *Schoenus scabripes* (NCA 1992: 'rare'). Following a wildfire through the entire area in 1990, the population recovered to about 816 individuals (the size of the original population is unknown), then burnt again within the freehold tenure in winter 2001. After this burn came the largest regeneration event recorded for the species in recent times, with shoots sprouting from lignotubers. This site possesses the greatest density of reproductive adults.

**Site 7: Finland Road**

Located approximately 8 km south of Coolum and 2.5 km south-west of Marcoola, this 120 ha site occurs within the Maroochy Shire next to the western boundary of Maroochydore Airport. The site is currently dissected by the Sunshine Motorway and the tenure is council reserve and national park (South Marcoola section of Mount Coolum National Park) (acquired from Crown land in 2002) to the east of the Motorway and Crown land controlled by Main Roads to the west, with documented individuals sporadically scattered over the entire area. In 2001 the council reserve and national park experienced a severe wild fire. To monitor the effects of the burn, a 15 m x 15 m monitoring plot with photo points was established in the national park. Both seedling germination and vegetative reproduction from underground rootstocks has been observed post fire. The site had not experienced a fire in the ten years before the burn and most of the population was moribund. The site now reflects a mosaic of fire histories, with the Crown land unburnt for several years. The site is predominantly closed heath vegetation varying in height from 0.5-2m with large numbers of *Hakea actites*. The emergence of whisky grass (*Andropogon virginicus*) may threaten the site. Several fauna species of special interest or regional significance occur on the site including the ground parrot (*Pezoporus wallicus wallicus)*(NCA 1992: 'vulnerable') and three frog species: *Crinia tinnula* (NCA 1992: 'vulnerable'), *Litoria freycineti* (NCA 1992: 'vulnerable') and *Litoria olongburensis* (NCA 1992: 'vulnerable', EPBC 1999: 'vulnerable'). The value of this site is increased by the area's potential role in acting as a refuge for vertebrate species displaced by fire or other disturbance in similar habitat nearby, especially north of the airport.

**Site 8: Coolum Ridges**

This site is located west of the Sunshine Motorway, south-south-west of Mt Emu. The plants are currently scattered across 1.8 ha of *Eucalyptus bancrofti* dominated heathland, surrounded by scribbly gum (*Eucalyptus racemosa*) forest. This site was protected from the fires of 2001 that occurred in surrounding areas by firebreaks maintained by the Rural Fire Brigade. The population has not experienced a burn for at least five years. This site is part of a property that has recently been approved for housing development. The area containing Mt Emu she-oak and adjacent buffer zones have been protected through the inclusion into open space as part of the approval. Maroochy Shire Council will maintain this area into the future as a Bushland Conservation Reserve. Management of the site to ensure the maintenance of the Mt Emu she-oak populations will be undertaken.

**Site 9: Coolum section of Noosa National Park**

This population lies immediately north of Coolum primary school. *A. emuina* was identified in 2003 over one hectare of this 140 ha block of *Eucalyptus bancrofti* low woodland. The site underwent high intensity fires in 1992, 1998 and 2001. Surveys in 2003 observed about 15-20 plants with no seed available. The frequency of fire is of concern for this population. Plants resprouting post-fire in 1998 did not have time to reach reproductive maturity before being burnt again in 2001. In addition, some of the plants were killed by the 2001 fire, having lost the ability to re-sprout.

**Site 10: Mt Coolum National Park – North Marcoola section**

This 197 ha block was acquired by EPA/QPWS from Crown land in 2002. About 30 plants are present at the site with the surrounding heath being similar to that found at the Beerwah Forest Reserve site. The population is beginning to senesce though at this point there are still many cones present on the plants. There is no exact fire history for this site, and it is thought to have been at least ten years since the last burn. There is potential for more plants to be found on the site. The area is also suitable habitat for the 'vulnerable' ground parrot and 'vulnerable' acid frog species.

**Site 11: Forestry Road population**

This population of currently more than 100 plants, was located in 1998. Of significance in this area are the presence of *Blandfordia grandiflora* (NCA 1992: 'rare') and *Grevillea leiophylla*. All plants have cones but brief observations indicate that many are unlikely to contain large quantities of viable seed as the cones appeared deformed, with only some valves maturing

(S. Aspland, pers. comm., 2003). This site forms part of the catchment for Ewen Maddock Dam and the soils in this location are typically moist to wet alluvial soils on a gentle slope falling to the dam. The vegetation is low closed heath dominated by numerous sedges and other herbaceous species, including *Leptospermum* sp., *Hakea actites, Banksia oblongifolia* and *Melaleuca nodosa*. While no intensive fauna survey has been carried out, some significant species that may be found in this site include *Crinia tinnula* (wallum froglet) and *Litoria oblongburensis* (wallum sedge frog).

Table 1 shows the population estimates based on a 1993 survey (Halford, 1993) together with current population estimates. Plant numbers vary considerably between locations. It was estimated in 1993 that only six of the total individuals were seedlings, all of which were reported to be at the one location (Halford, 1993; McKiernan, 1997). Current population estimates do not indicate the age structure of the populations.

## 2.7 Habitat critical for survival

The presence of naturally established plants usually indicates that local environmental conditions are suitable for maintaining the population dynamics of this species through all life history stages. The significant habitat of *A. emuina* may include:

- all areas where the species currently occurs;
- areas of heathland vegetation adjacent to known populations (providing potential habitat for natural recruitment);
- corridors of remnant vegetation that link populations with other nearby areas of apparently suitable habitat that do not currently contain the species; and
- areas of habitat that may be used for future translocation and reintroduction.

Further study is required to identify habitat characteristics critical to survival.

## 2.8 Important populations

Currently, all populations of *A. emuina* are considered important to the survival of the species. As part of this plan further investigation will be undertaken to determine the importance of individual populations.

## 2.9 Benefits to other species or communities

The habitat occupied by *A. emuina* is of high nature conservation value as several other rare, threatened and significant species are also present (appendix 3, table 6). Implementing the recovery plan will result in the protection and maintenance of biodiversity and improved conservation of other threatened, rare and poorly known species within the heathland habitat. Heathland remnants have been extensively cleared in Queensland as a result of expanding development and the plan will ensure greater protection and maintenance of these habitats. The habitat also supports a wide diversity of fauna. The vulnerable ground parrot, *Pezoporus wallicus wallicus*, is dependant upon many of the flora species known to be affected by nutrient pollution in heathlands. The parrot has been seen in at least one of the study sites and is known to use the heathland as an important food source (McFarland, 1991a) or source of nest materials, for example *Empodisma minus, Xanthorrhoea fulva* and/or *Banksia oblongifolia* (McFarland, 1991b) and nest sites. *Crinia tinnula* (wallum froglet) (NCA 1992: ‘vulnerable’) and *Litoria oblongburensis* (wallum sedge frog) (NCA 1992: ‘vulnerable’; EPBC 1999: ‘vulnerable’) are also found in many of these wallum remnants. The acidic pH of this ecosystem is critical for the survival of both these species (S. Aspland, pers. comm., 2003).

## 2.10 Threats

Currently nine of the 11 known populations of *A. emuina* are within protected areas, however, additional populations and potential habitat under freehold tenure are at risk.

**Development and disturbance**

The most significant potential threatening process to *A. emuina* stems from expanding coastal development and the resultant loss of suitable habitat (McKiernan, 1997). Altered fire regimes, altered hydrology, nutrient pollution and introduced weeds are the key threats affecting on the

long-term viability of *A. emuina* (Halford, 1993; McKiernan, 1997) (table 2). Currently nine of the 11 known populations of *A. emuina* are within protected areas, however, additional populations and potential habitat under freehold tenure are at risk. Existing populations at Peregian Springs and Coolum Ridges are under threat from habitat loss.

The development of the Sunshine Motorway and associated earthworks may have contributed to the decline of populations at Peregian Springs, Finland Road, Coolum Ridges and the Emu Swamp section of Noosa National Park (Kruger, 2002; McKiernan, 1997). Weed introduction and inadequate drainage (incorporating increased nutrients) resulting from the earthworks may have also facilitated this decline.

Recreational access to the Currimundi Conservation Park, while minimal in its disturbance, may also impact on this population. Walking tracks currently dissect the population, with individuals located close to the track. These plants may be adversely affected by track maintenance and vehicular traffic from national park, councils or fire authorities.

**Altered fire regimes**

Inappropriate fire regimes may affect the viability of *A. emuina* plants. Soil-stored seed requires fire to initiate germination.Frequent fires deplete stored seed banks, particularly before plants were able to reach maturity. Frequent fires could also deplete nutrients stored in the roots and therefore affect the capacity for plants to resprout (McKiernan, 1997). Infrequent fires are necessary for the replacement of mature plants. It has been postulated that uncontrolled (and inappropriate) fire in heathland sites may arise from cane farms adjacent to heathland sites (Drake, 1995). The most appropriate fire frequency and intensity for *A. emuina* populations requires further investigation.

**Impacts associated with introduced weeds and nutrients**

Weeds suppress native plant growth by competing for soil moisture, nutrients and light. Henderson (1995) suggests that the establishment of exotic vegetation on roadsides adjacent to heathlands provides a source of propagules that can invade the adjacent heathland communities. Vehicles accessing reserves or private landholdings to carry out maintenance have the potential to move and disperse seed of declared and environmental weeds into *A. emuina* sites. In addition, stormwater run-off from roads (and developments adjacent to heathland) increases soil moisture and nutrients encouraging growth of exotic plant species.

The impact of nutrient pollution, particularly phosphorous has been documented (Groves, 1981; McKiernan, 1997). Heathland seedlings exposed to unusually high levels of phosphorous succumb to phosphorous toxicity. Adult heath plants, including *A. emuina,* generally respond to increased phosphorous in the soil by increased growth, sometimes increased flowering, and a rapid lifecycle (dying many years earlier than usual) (McKiernan, 1997). Phosphorous toxicity in these nutrient deficient soils allows herbaceous species to invade the heathland and compete with heath species. Some of the species (native and exotic) observed to be invading in response to the nutrient impacts of road run-off at the site south-west of Mt Emu are shown in table 3. These may have implications for heathland ecosystems, which occur adjacent to agricultural and/or urban land (McKiernan, 1997).

**Hybridisation**

The taxonomic distinctiveness of *A. emuina* in relation to its very closely related locally occurring sister species *A. thalassoscopica* has been questioned and preliminary observations suggest that *A. emuina* may hybridise with *A. littoralis* (Halford 1993, Olsen 2002). Since these species co-occur the species could be at risk of losing its genetic integrity and thus becoming extinct due to hybridisation. There is a need to clarify if there is indeed a genetic basis to species differentiation, and if hybridisation can and has occurred between species (Wilson and Johnson 1989, Halford 1993).

**Genetic drift and inbreeding**

Reduction of genetic diversity can leave populations vulnerable to stochastic events and environmental change, while increased inbreeding in formerly outcrossing species can lead to reduction of reproductive viability and or reduced fitness due to inbreeding depression

(Montalvo and Ellstrand 2001, Frankhan *et al* 2002). It may be expected that where populations of rare species have suffered from reduction in size and increased isolation due to habitat fragmentation then genetic diversity will be lost due to drift and inbreeding levels may increase leading to the decline in long term viability (Frankhan *et al* 2002). Alternatively species with historically low gene flow among populations may exhibit considerable localised population differentiation. Translocations among such populations could lead to a reduction of fitness (Fischer and Matthies 1997, Shapcott 2002, Montalvo and Ellstrand 2001). Investigation to determine if *A. emuina* populations show evidence of declining genetic fitness which could affect their long-term viability is required. In addition it needs to be determined if population translocations are likely to affect the fitness of existing populations.

***Table 2: Summary of threats to known A. emuina populations***

| Location name | Co-ordinates (Lat/Long) | Population size (2003) | Land tenure | Potential threats | Current and future actions to reduce potential threats |
|---|---|---|---|---|---|
| Currimundi Lake | S26° 45′ 37.88″ E153° 07′ 52.02″ | 21 | Conservation park | Inappropriate fire regimes, weeds, increased nutrients, recreational track use, surrounding land use and hybridisation | Fire breaks installed Restricted vehicle use |
| Beerwah Forest Reserve (SA1) | S26° 51′ 30.00″ E153° 00′ 30.00″ | 300 | Forest reserve | Inappropriate fire regimes, weeds, increased nutrients, vehicle use and hybridisation | Fire breaks installed Restricted vehicle use |
| Mooloolah River National Park | S26° 51′ 30.00″ E153° 04′ 30.00″ | 300 | National park | Inappropriate fire regimes, weeds, increased nutrients, vehicle use, surrounding land use and hybridisation | Restricted vehicle use |
| Emu Mountain (Mt Peregian) | S26° 30′ 11.86″ E153° 05′ 02.04″ | 10 450 | Reserve/ national park | Inappropriate fire regimes, weeds, increased nutrients, vehicle use, surrounding land use and hybridisation | Restricted vehicle use |
| Emu Swamp | S26° 29′ 29.70″ E153° 05′ 02.00″ | 200 | national park | Inappropriate fire regimes, weeds, increased nutrients, vehicle use, surrounding land use and hybridisation | Restricted vehicle use |
| Old Emu Mt Road (Peregian Springs) | S26° 29′ 01.34″ E153° 04′ 07.54″ | 2,000 | Freehold/ Crown land | Estate development, inappropriate fire regimes, weeds, increased nutrients, vehicle use, surrounding land use and hybridisation | Development approval granted Translocated population of 850 viable individuals before development Protection for remaining *A. emuina* plants within estate |
| Finland Road | S26° 35′ 42.00″ E153° 04′ 39.00″ | 1,000 | Council/ national park/main roads | Airport development, inappropriate fire regimes, weeds, increased nutrients, | Restricted vehicle use Drainage channels |

| Location name | Co-ordinates (Lat/Long) | Population size (2003) | Land tenure | Potential threats | Current and future actions to reduce potential threats |
|---|---|---|---|---|---|
| | | | | vehicle use, surrounding land use and hybridisation | |
| Coolum Ridges | S26° 31′ 57.61″ E153° 04′ 36.74″ | 100 | Freehold | Estate development, inappropriate fire regimes, weeds, increased nutrients, vehicle use, surrounding land use and hybridisation | Restricted vehicle use Conservation areas containing the existing population are proposed |
| Coolum section of Noosa National Park | S26° 31′ 57.61″ E153° 04′ 36.26″ | 20 | National park | Inappropriate fire regimes, weeds, increased nutrients, surrounding land use and hybridisation | Restricted vehicle use |
| Mt Coolum National Park - North | S26° 18′ 50.08″ E153° 05′ 01.42″ | 30 | National park | Inappropriate fire regimes, weeds, increased nutrients, surrounding land use and hybridisation | Restricted vehicle use |
| Forestry Road | S26° 48′ 25.00″ E152° 59′ 06.00″ | 100+ | Conservation area | Inappropriate fire regimes, weeds, increased nutrients, vehicle use, surrounding land use and hybridisation | Restricted vehicle use Fire breaks installed Natural drainage line through adjacent site |
| **Total** | | **14 521** | | | |

***Table 3: Native and exotic* species that are invading in response to nutrient impacts near Mt Emu***

| Species name | Common name | Species name | Common name |
|---|---|---|---|
| **Chloris gayana* | Rhodes grass | **Melinis minutiflora* | Molasses grass |
| **Conyza canadensis* | | **Melinis repens* | Red natal grass |
| **Conyza sumatrensis* | Tall fleabane | **Panicum maximum* | |
| *Cynodon dactylon* | | **Paspalum dilatatum* | Paspalum |
| *Cyperus polystachyos* | | **Paspalum urvillei* | Vasey grass |
| **Desmodium intortum* | | **Pinus elliottii* | Slash pine |
| **Digitaria ciliaris* | Summer grass | **Saccharum officinarum* | Sugarcane |
| *Imperata cylindrica* | Blady grass | **Setaria sphacelata* | |
| *Indigofera hirsuta* | Hairy indigo | **Sida rhombifolia* | |
| **Lantana camara* | | **Sphagneticola trilobata* | |
| **Macroptilium atropurpureum* | Siratro | *Sporobolus elongatus* | |
| **Macroptilium lathyroides* | | **Tridax procumbens* | Tridax daisy |
| **Macrotyloma axillare* | | | |

## 2.11 Existing conservation measures

Nine of the *A. emuina* sites occur on conservation reserves, including national parks, managed by local and state agencies. This effectively protects the species at those sites from habitat removal. Management of these populations is the responsibility of relevant local and state governments and conservation agencies.

The Maroochy Shire Council currently administers a vegetation conservation levy through which the purchase of environmentally significant parcels of land are made. Freehold sites on which *A. emuina* occurs may be suitable for purchase under this scheme. Local planning schemes also protect all locations of endangered, rare or vulnerable species and conservation *in situ* is sought through the development assessment process. The Maroochy Shire Council is also currently mapping all known and potential habitats for endangered, vulnerable and rare species known to occur in the shire enabling significant environmental issues to be identified during planning and infrastructure development processes.

Currently Caloundra City Council staff training is being prepared to inform construction, conservation and project staff of the bioregional ecosystems and threatened species found within the city including heathlands and *A. emuina*. This training, in addition to the existing in-house assessment of major projects and use of Council's environmental permits and approval manual will assist in preventing any unintended vegetation damage during construction projects and management operation's occurring in or near this site. Both local councils have strategies in place to ensure there is no net loss of either area of occupancy or abundance of *A. emuina* populations.

There are also mechanisms that can be used to protect important habitats on freehold lands under state legislation and local laws. These are most often referred to as conservation agreements and include nature refuges, co-ordinated conservation areas, statutory covenants and tree preservation orders. Voluntary conservation agreements may also achieve conservation benefits for threatened species and their habitat.

## 2.12 Social and economic impact

It is expected that no organisations will be disadvantaged by the implementation of this plan. Any proposed future works or developments that are likely to have an impact on *A. emuina* should consider this plan when applying for state and commonwealth approvals (for example, the clearing of individual plants will require clearing permits under the *Nature Conservation Act 1992* and referral under the EPBC Act 1999). The detailed information provided in this plan on the location and distribution of *A. emuina* sites and the estimates of the number of individuals at each site may also be used to assist the assessment of development proposals that may impact on *A.emuina.*

# 3 Objectives and criteria

## 3.1 Overall objective

The overall objective of this recovery plan is to protect known populations of *A. emuina* in Queensland from further decline and maintain and/or enhance wild populations in the long term.

Ultimately, the objective of the ongoing recovery effort is to improve the conservation status of *A. emuina* from 'endangered' to 'vulnerable', or from 'endangered' to no longer requiring listing as a threatened species under the Queensland *Nature Conservation (Wildlife) Regulation 1994* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

## 3.2 Specific objectives

The specific objectives of the plan in order to achieve the down listing of *A. emuina* are to:

- protect, restore and maintain known populations and locate and/or establish new populations of *A. emuina*;
- address and review the key threats to *A. emuina*;

- develop research programs that assist with the recovery and conservation of *A. emuina*; and
- promote community awareness and education in relation to *A. emuina.*

## 3.3 Performance criteria

The criteria for successfully achieving the objectives of the *A. emuina* recovery plan includes:

- protection and management of all known populations and established new and translocated populations;
- expansion of population and area of *A. emuina* from known sites.
- re-establishment of *A. emuina* on suitable land.
- measures in place to reduce the impact of key threats to *A. emuina* and potential future impacts assessed;
- research programs that have obtained information about the area of occupancy, abundance, response to fire and aspects of the biology and ecology that affect the conservation status and persistence of the species; and
- community, industry and local and state government agencies are actively involved in *A. emuina* conservation programs as a result of the implementation of strategic community awareness campaigns.

## 3.4 Evaluation of recovery plan

Assessment of the success of management actions against the criteria described in this plan is essential to ensure the successful recovery of *A. emuina*.

***Table 4: Summary of relationship between specific objectives, performance criteria and actions***

| Specific objective | Performance criteria | Action |
|---|---|---|
| Objective 1<br>Protect, restore and maintain known populations and locate and/or establish new populations of *A. emuina.* | Criterion 1<br>Protection and management of all known populations and establish new and translocated populations. | Action 1.<br>Secure protection and management of all known populations.<br><br>1.1 Evaluate and implement measures to secure all populations and potential habitat on reserves and EPA/QPWS estate.<br><br>1.2 Protect and manage existing *A. emuina* populations, and populations identified in the future, on freehold land.<br><br>1.3 Maintain a representative collection of seed ex situ and develop efficient propagation and cultivation techniques in order to generate suitable stock for strategic ex situ and in situ plantings.<br><br>1.4 Identify suitable land for re-establishment of *A. emuina.* |
| Objective 2<br>Address and review the key threats to *A. emuina.* | Criterion 2<br>Measures in place to reduce the impact of key threats to *A. emuina* and potential future impacts assessed. | Action 2.<br>Minimise the impacts of key threats to *A. emuina.*<br><br>2.1 Develop and implement strategy for appropriate fire management practices.<br><br>2.2 Develop and implement strategy to minimise storm water run-off into *A. emuina* habitat. |

| Specific objective | Performance criteria | Action |
|---|---|---|
| | | 2.3 Implement weed management strategies at all known populations.<br><br>2.4 Design and implement an ongoing monitoring program to assess the effectiveness of management and rehabilitation strategies. |
| Objective 3<br>Develop research programs that assist with the recovery and conservation of *A. emuina.* | Criterion 3<br>Research programs that have obtained information about the area of occupancy, abundance, response to fire and aspects of the biology and ecology that affect the conservation status and persistence of the species. | Action 3.<br>Develop research programs to assist the conservation of *A. emuina.*<br><br>3.1 Undertake ground surveys to confirm the location and extent of all known populations and map the extent of potential habitat.<br><br>3.2 Investigate the response of *A. emuina* to fire.<br><br>3.3 Identify population parameters and aspects of the biology and ecology that affect the conservation status and persistence of *A. emuina.*<br><br>3.4 Clarify the taxonomic status and distinctiveness of *A. emuina* and its populations.<br>3.4.1 Determine the genetic and ecophysiological distinctiveness of *A. emuina* populations and other Sunshine Coast congeners.<br>3.4.2 Investigate the potential for hybridisation between *A. emuina* and congeneric species of *Allocasuarina* including *A. thalassoscopica.*<br>3.4.3 Define the species' genetic diversity between individuals, within populations and between populations. |
| Objective 4<br>Promote community awareness and education in relation to *A. emuina.* | Criterion 4<br>Community, industry and local and state government agencies are actively involved in *A. emuina* conservation programs as a result of the implementation of strategic community awareness campaigns. | Action 4.<br>Increase community awareness and education in relation to *A. emuina.*<br><br>4.1 Develop promotional/interpretive materials relating to the species.<br><br>4.2 Ensure the ongoing operation of the recovery team with appropriate and flexible representation.<br><br>4.3 Secure resources to support the recovery of *A. emuina.*<br><br>4.4 Establish community action groups to 'adopt' and manage sites. |

# 4 Recovery actions

The following is a detailed explanation of the actions under each performance criterion.

## Action 1. Secure protection and management of all known populations

### 1.1 Evaluate and implement measures to secure all populations and potential habitat on reserves and EPA/QPWS estate

Buffers need to be established to protect the species from vehicles, slashing and hazard reduction burning. A fire buffer already exists within the Currimundi Conservation Park. Revegetation of 4WD tracks through the Mt Emu section of Noosa National Park will prevent vehicle access to the summit and lower slopes as proposed in the Draft Management Plan for Noosa National Park (Weyba section). Vehicle access through known *A. emuina* sites should be restricted and additional walking or vehicle tracks should not be constructed through or within buffer zones of existing populations.

***Potential contributors*** EPA/QPWS and local government.

### 1.2 Protect and manage existing *A. emuina* populations, and populations identified in the future, on freehold land

Habitat protection can be achieved by land acquisition or by negotiating conservation agreements under the *Nature Conservation Act 1992*. Negotiations between private landholders of sites where *A. emuina* occurs and the EPA/QPWS should be undertaken to seek conservation agreements where appropriate to protect the species and its habitat in the long term. If significant populations of *A. emuina* are discovered on private lands, every effort should be made to increase awareness and encourage landholders to consider and become involved in voluntary conservation agreements or acquire lands for conservation. Funding for this may be obtained from the introduction of environmental levies administered by local governments.

***Potential contributors*** EPA/QPWS, local government and private landholders.

### 1.3 Maintain a representative collection of seed *ex situ* and develop efficient propagation and cultivation techniques in order to generate suitable stock for strategic *ex situ* and *in situ* plantings

EPA/QPWS will establish *ex situ* storage of *A. emuina* seed material within the Department of Primary Industries storage facilities at Beerwah and Indooroopilly. The seed will be used for propagation of individuals for establishment of new (and enhancement of existing) populations when required, revegetation and genetic research. Collections will be carried out in accordance with Florabank Guidelines, the Nature Conservation (Protected Plants) Conservation Plan 2000 and the Code of practice for the taking and use of protected plants.

Seed used for propagation of plants for a specific planting site should originate from an area in the vicinity of the planting site. Every effort will be made to ensure that material collected from *A. emuina* hybrids should not be used in propagation and establishment of new populations. Application of current best-practice nursery hygiene should minimise risks of translocation of weed species and other detrimental soil-borne organisms to planting sites (see appendix 4 for population establishment and translocation guidelines).

***Potential contributors*** EPA/QPWS, relevant state agencies, local government and conservation groups.

## Action 2. Minimise the impacts of key threats to *A. emuina*

### 2.1 Develop and implement a strategy for appropriate fire management practices

The development of a strategic approach to the implementation of appropriate fire management practices is required. This must include liaison with local governments, fire authorities and landholders to consider issues related to hazard reduction burning adjacent to residential developments and perceived and potential impacts associated with fire management. A

strategic approach may include developing fire management plans for each population that collates fire history data, identifies appropriate fire regimes and monitors the impact of fire on the viability of *A. emuina* populations.

***Potential contributors*** EPA/QPWS, local government, fire authorities and private landholders.

### 2.2 Develop and implement a strategy to minimise storm water run-off into *A. emuina* habitat

Develop a strategy that minimises storm water run-off from road and residential developments into areas of heathland that contain *A. emuina* populations. This will include consultation with local government and other relevant government authorities to identify appropriate storm water management controls that could be implemented for existing and potential future developments.

***Potential contributors*** EPA/QPWS, local government, developers and relevant state agencies.

### 2.3 Implement weed management strategies at all known populations

Implement weed management strategies on populations on reserve and EPA/QPWS estate to minimise the competitive impacts of exotic species on *A. emuina*. Weed control should commence immediately with on-going control implemented every six months. Care needs to be taken not to harm *A. emuina* seedlings where they occur and the use of chemical controls is discouraged. It is recommended that weed control measures for populations on freehold land be incorporated into conservation agreements.

***Potential contributors*** EPA/QPWS, local government and private landholders.

### 2.4 Design and implement an ongoing monitoring program to assess the effectiveness of management and rehabilitation strategies

An important component of the management of *A. emuina* populations is assessing the response of *A. emuina* populations to management and rehabilitation strategies and modifying management if required. To ensure that this occurs, a monitoring program, including monitoring the status of site conditions and individual plants, needs to be developed to assess the effectiveness of management and rehabilitation strategies for all populations.

Monitoring of extant populations and recently established and translocated populations should occur at six-monthly intervals, and at monthly intervals for recently established and translocated populations (each new planting site should be recorded and the source of the material noted). It is recommended that monitoring programs include:

- regular surveys to estimate the number of individuals in each population;
- health assessments of individual plants and populations;
- determining establishment and survival of seedlings to maturity;
- recording populations producing flowers and developing fruit; and
- monitoring the status of recently established populations.

New information that becomes available from research programs should be used to review and modify management and rehabilitation strategies where the modification is likely to benefit to the conservation status of the species. This is an ongoing action throughout the life of the plan.

***Potential contributors*** EPA/QPWS, research institutions, developers, conservation and community groups.

## Action 3. Develop research programs to assist the conservation of *A. emuina*

### 3.1 Undertake ground surveys to confirm the location and extent of all known populations and map the extent of potential habitat

A systematic survey of known *A. emuina* populations will be conducted to confirm the location and size of existing populations. This will include determining the area each population occupies and the number of individuals present. This information, combined with information obtained

from aerial photography, including landscape features, soil type and associated species, will be used to assist mapping of potential *A. emuina* habitat. Once mapped, additional sampling of the potential habitat areas will also be conducted in an attempt to locate additional populations and suitable sites for establishment of new populations.

***Potential contributors*** Research institutions, EPA/QPWS, local government and conservation and community groups.

### 3.2 Investigate the response of *A. emuina* to fire

To ensure that appropriate fire regimes are developed to conserve *A. emuina* populations, an investigation into the species' response to fire is required. Information obtained from this research would allow fire management strategies to be modified, if required, as part of the monitoring process. It is important to determine the parameters of burns (for example, fire frequency, intensity) that promote optimal persistence of *A. emuina* populations, as this information is currently not adequately known. The Finland Road population has been used to monitor (and will continue to be monitored) the effects of a burn that occurred in 2001.

***Potential contributors*** EPA/QPWS, fire authorities, research institutions and SEQ Natural Resource Management regional body.

### 3.3 Identify population parameters and aspects of the biology and ecology that affect the conservation status and persistence of *A. emuina*

A research program is required that identifies important population parameters and investigates aspects of the biology and ecology affecting persistence of the species including (and not restricted to):

- the timing and duration of reproductive activity and receptivity of both male and female flowers, as there is presently little information available on the reproductive biology of *Allocasuarina*;
- seed viability, germination and dispersal, as knowledge of these aspects of *A. emuina* ecology will assist with the management of existing and establishment of new populations;
- longevity, age structure, life cycles and physiological profiles, as this will assist with determining the environmental requirements of the species and therefore, assist with prioritising populations that require intensive management;
- microbial root associations that may affect growth of *A. emuina* species, as this will have implications for the establishment (and survival) of new and translocated populations; and
- the genetic distinctiveness (taxonomic status) of the species and the potential for hybridisation with other *Allocasuarina* species, as this may affect its genetic identity.

The information obtained from these research programs should be provided to the recovery team when appropriate to incorporate relevant information into the monitoring processes of management and rehabilitation strategies.

***Potential contributors*** Research institutions, EPA/QPWS, local government, conservation and community groups and SEQ Natural Resource Management regional body.

### 3.4 Clarify the taxonomic status and distinctiveness of *A. emuina* and its populations by:

#### 3.4.1 Determine the genetic and ecophysiological distinctiveness of *A. emuina* populations and other Sunshine Coast congeners

A key approach is to use genetic markers to determine whether populations of *A. emuina* are genetically distinct from each other and from *A. thalassoscopica*, *A. filidens*, *A. rigida* subsp*. exsul* and their closely related and common congener, *A. littoralis,* or if, in fact, they are morphologically different forms of *A. littoralis*, reflecting a response to differing environmental variables. This study will compare ecophysiological parameters of *Allocasuarina* species *in situ* and *ex situ*. Populations will be assessed to evaluate if differences in ecophysiological characteristics provide a physiological basis for the differing form and distribution of these species. The physiological profile will help to identify specialist ecological requirements of the endangered species. The study will use the protocols for physiologically profiling rare species successfully developed by these researchers (Richards *et al.,* 2003).

***Potential contributors*** Universities, Greening Australia, FKP Ltd

#### 3.4.2 Investigate the potential for hybridisation between *A. emuina* and congeneric species of *Allocasuarina* including *A. thalassoscopica*

A key focus of this action is to determine if *A. emuina* has the potential to or is currently hybridising with geographically overlapping *Allocasuarina* species, *A. littoralis* and *A. thalassoscopica*. If so, *A. emuina* could be at risk of losing its genetic identity and thus becoming extinct due to hybridisation. Genetic markers will confirm the presence of hybrid taxa. The synchronicity of reproductive activity within and among populations of *A. emuina*, *A. littoralis* and *A. thalassoscopica* will significantly determine the likelihood for outcrossing and gene flow and hence their population viability (Shapcott, 2003). Controlled pollinations will be undertaken between *A. emuina* and other local Sunshine Coast *Allocasuarina* species to determine if viable seed is set after hybridisation. All known and accessible populations of the Sunshine Coast *Allocasuarina* species will be extensively sampled. The location of *A. emuina* populations in relation to *A. thallassoscopica* will be evaluated geographically to determine potential hybridisation zones if the species are found to have the potential to hybridise.

***Potential contributors*** Universities, Greening Australia, FKP Ltd

#### 3.4.3 Define the species' genetic diversity between individuals, within populations and between populations

Information derived from the genetic diversity between individuals, within populations and between populations can be used to make informed decisions regarding the gene flow between these populations and how to best sample the genetic diversity when developing new populations. Considerations need to be taken for the impacts of gene flow from new populations on existing populations. The amount of genetic variation, how it is partitioned within and among populations and the genetic relationships among the existing populations will be determined. It will also be investigated whether there is evidence of increased levels of inbreeding within populations. The geographic /genetic relationships among populations will be determined and hence patterns and extent of past gene flow among populations evaluated. This information will be useful for making management decisions especially if it is planned to either enhance depauperate extant populations or alternatively create new populations of *A. emuina*.

***Potential contributors*** Universities, Greening Australia, FKP Ltd

## Action 4. Increase community awareness and education in relation to *A. emuina*

### 4.1 Develop promotional/interpretive materials relating to the species

Promotional and interpretive materials, including brochures, pamphlets, posters, websites and multimedia displays, will be designed for use at community events, schools, and display at reserves and EPA/QPWS estate. The promotional material will be used to identify the species, outline the recovery process and enhance community knowledge, understanding and participation in the conservation of *A. emuina*. Information on the conservation issues related to the species can be distributed to schools and local area residents through existing local government promotional activities (for example, newsletters, magazines etc). Promotional material will be updated with relevant information from research programs as it becomes available.

Conditions for future developments near areas where *A. emuina* occurs may include landscaping and promotional gardens (and other materials) as examples to the community of 'healthy heath' landscaping. School groups may assist the promotional work by becoming involved in 'healthy heath' programs.

***Potential contributors*** The recovery team, schools, local government and community groups and SEQ Natural Resource Management regional body.

### 4.2 Ensure the ongoing operation of the recovery team with appropriate and flexible representation

The implementation of the recovery plan as specified here is the responsibility of the recovery team. There is a need for the team to communicate to stakeholders on a regular basis to ensure the objectives of the plan are being met and the actions implemented. The *A. emuina* recovery team will comprise members from relevant state agencies, local governments, conservation groups and other relevant stakeholder groups considered appropriate. Representatives of potentially affected Indigenous groups will be invited to join the recovery team. The team will be responsible for prioritising actions and co-ordinating implementation of recovery actions. Any changes to the team composition will be included in annual reports. This recovery plan will be reviewed five years after the date of publication.

***Potential contributors*** The recovery team.

### 4.3 Secure resources to support the recovery of *A. emuina*

The actions outlined in this plan will require funding over the five-year life of the plan as outlined in Table 5. Corporate sponsorship and community environmental grant funding can potentially be used to ensure the actions are implemented.

***Potential contributors*** The recovery team and SEQ Natural Resource Management regional body.

### 4.4 Promote active community involvement in conservation efforts for *A. emuina*

The area within which *A. emuina* occurs is currently undergoing high rates of population growth and urban development. Urban development is impacting directly upon known populations in some circumstances. There are opportunities to harness community interest within these new communities to ensure ongoing community conservation efforts are aimed at maintaining and enhancing *A. emuina* populations in the area. Community grants offered by various levels of government may be accessed to support conservation efforts by groups or schools given appropriate empowerment through education.

***Potential contributors*** Community groups, schools, universities, the recovery team, developers, EPA/QPWS, local government.

# 5 Cost of recovery

***Table 5: Annual cost of recovery***

| Action no. | Action description | Priority | Cost Estimates ($) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2006 | 2007 | 2008 | 2009 | 2010 | Total |
| 1 | Secure protection and management of all known populations | 1 | 15 000 | 15 000 | 15 000 | 10 000 | 5 000 | **60 000** |
| 2 | Minimise the impacts of key threats to *A. emuina* | 1 | 32 500 | 18 000 | 5 000 | 5 000 | 5 000 | **65 500** |
| 3 | Develop research programs to assist the conservation of *A.emuina* | 1 | 51 500 | 30 000 | 32 900 | 5 000 | - | **119 400** |
| 4 | Increase community awareness and education in relation to *A. emuina* | 1 | 32 000 | 13 400 | 13 400 | 13 400 | 18 000 | **90 200** |
| **TOTAL** | | | **131 000** | **76 400** | **66 300** | **33 400** | **28 000** | **335 100** |

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# 7 Appendices

## 7.1 Appendix 1 – Recovery team

The EPA/QPWS will co-ordinate implementation of this recovery plan as the lead agency for environmental management in Queensland. This suggested representation identified below is not meant to limit the potential involvement of other individuals or organisations in the recovery process. The membership of the recovery team at the time of printing the recovery plan includes representatives from the following organisations:

Maroochy Shire Council
Coolum Coast Care
FKP Ltd
University of the Sunshine Coast
Greening Australia Queensland
Queensland Herbarium (EPA/QPWS)
EPA/QPWS
Maroochy Landcare
Caloundra City Council
Gold Coast City Council

The recovery team is a forum and focus group of government, community and industry representatives which meets at least four times each year to guide, evaluate and review the implementation of recovery actions and recommendations arising from monitoring and research. The recovery team will conduct a review every two years to assess progress towards the implementation of the recovery plan and success in achieving the plan's objectives. The review should ensure that successes and failures in implementation are identified and that an agreed process to overcome failures is documented. In the fourth year of the plan, the team will commence planning for the revised recovery plan (2011–2015). The outcomes of the recovery actions conducted within the timeframe of this plan will be used to guide the development of recovery actions in the revised plan.

## 7.2 Appendix 2 – FKP Ltd role

One of the largest remaining *A. emuina* populations (containing about 2 000 plants) occurs at Peregian Springs, next to the Sunshine Motorway. Part of this population occurs on freehold land owned by the development company FKP Ltd, earmarked for the development of Peregian Springs residential estate. Development is occurring as a result of a 1989 rezoning approval by council. A clearing permit under the *Nature Conservation (Protected Plants) Conservation Plan 2000* will be required and has not yet been approved.

In March 2001 stages 5-14 of the Peregian Springs estate development were declared as a controlled action under the EPBC Act. Under sections 18 and 18A of the Act, the controlling provisions are listed threatened species and communities. In July 2002, the Commonwealth approved the taking of the controlled action subject to a number of conditions that FKP Ltd must fulfil, including:

- retention of existing natural vegetation in the conservation zone and open space areas of the estate, including a buffer of at least 40m of existing natural vegetation around identified stands of *A. emuina* in the Conservation Zone;
- participation in the development and implementation of a recovery plan for *A. emuina*;
- establishment of *ex situ* nursery facilities to propagate *A. emuina*; and
- before carrying out any works in precinct five of the proposed estate, establishment of a viable population of *A. emuina* at a site agreed in writing by the Minister, containing at least 850 individuals. Arrangements must be put in place for the ongoing management of the population and it must be demonstrated that the population is capable of reproducing and likely to survive in the long term. Works in precinct five cannot commence until FKP Ltd receives written notice that the Minister is satisfied that this condition has been met.

As a result, FKP Ltd is contributing a total of $80 000 towards the recovery of the species. These funds are predominantly allocated to three activities:

- development of a recovery plan;
- genetic research (as an industry partner to an Australian Research Council linkage grant through the University of the Sunshine Coast); and
- establishment of a population of at least 850 individuals of *A. emuina* (involving seed collection, propagation and planting).

## 7.3 Appendix 3 – Associated significant species of heathland habitat

*Table: Associated significant species of the heathland habitat*

| Common name | Scientific name | Conservation status | |
|---|---|---|---|
| | | NCA 1992[1] | EPBC Act[2] |
| **Fauna** | | | |
| ***Birds*** | | | |
| Common sandpiper | *Actitis hypoleucos* | LC | |
| Grey teal | *Anas gracilis* | LC | |
| Fork-tailed swift | *Apus pacificus* | LC | |
| Great egret | *Ardea alba* | LC | |
| Cattle egret | *Ardea ibis* | LC | |
| Sharp-tailed sandpiper | *Calidris acuminata* | LC | |
| Red knot | *Calidris canutus* | LC | |
| Curlew sandpiper | *Calidris ferruginea* | LC | |
| Red-necked stint | *Calidris ruficollis* | LC | |
| Glossy black-cockatoo | *Calyptorhynchus lathami* | V | |
| Doubled-banded plover | *Charadrius bicinctus* | LC | |
| Lesser sand plover | *Charadrius mongolus* | LC | |
| White-winged black tern | *Chlidonias leucopterus* | LC | |
| Eastern reed egret | *Egretta sacra* | LC | |
| Black-necked stork | *Ephippiorhynchus asiaticus* | R | |
| Red goshawk | *Erythrotriorchis radiatus* | E | V |
| Beach stone-curlew | *Esacus neglectus* | V | |
| Nankeen kestrel | *Falco cenchroides* | LC | |
| Australian hobby | *Falco longipennis* | LC | |
| Latham's snipe | *Gallinago hardwickii* | LC | |
| White-bellied sea-eagle | *Haliaeetus leucogaster* | LC | |
| Grey-tailed tattler | *Heteroscelus brevipes* | LC | |
| White-throated needletail | *Hirundapus caudacutus* | LC | |
| Barn swallow | *Hirundo rustica* | LC | |
| Bar-tailed godwit | *Limosa lapponica* | LC | |
| Black-tailed godwit | *Limosa limosa* | LC | |
| Rainbow bee-eater | *Merops ornatus* | LC | |
| Eastern curlew | *Numenius madagascariensis* | R | |
| Little curlew | *Numenius minutus* | LC | |
| Whimbrel | *Numenius phaeopus* | LC | |
| Ground parrot | *Pezoporus wallicus wallicus* | V | |
| Pacific golden plover | *Pluvialis fulva* | LC | |
| Black-throated finch | *Poephila cincta cincta* | V | E |
| Honey blue eye bony fish | *Pseudomugil mellis* | V | V |
| Wedge tailed shearwater | *Puffinus pacificus* | LC | |
| Short-tailed shearwater | *Puffinus tenuirostris* | LC | |
| Lewin's rail | *Rallus pectoralis* | R | |
| Painted snipe | *Rostratula benghalensis* | R | |
| Arctic jaeger | *Stercorarius parasiticus* | LC | |
| Little tern | *Sterna albifrons* | E | |
| Brown booby | *Sula leucogaster* | LC | |
| Common greenshank | *Tringa nebularia* | LC | |
| Marsh sandpiper | *Tringa stagnatilis* | LC | |
| Terek sandpiper | *Xenus cinereus* | LC | |

[1] Nature Conservation Act 1992
[2] Environment Protection and Biodiversity Conservation Act 1999
E = Endangered; V = Vulnerable; R = Rare; LC = Least concern; NL = Not Listed

| Common name | Scientific name | Conservation status | |
|---|---|---|---|
| | | NCA 1992[1] | EPBC Act[2] |
| ***Reptiles*** | | | |
| Blind snake | *Ramphotyphlops silvia* | R | |
| ***Frogs*** | | | |
| Tusked frog | *Adelotus brevis* | V | |
| Wallum froglet | *Crinia tinnula* | V | |
| Cooloola sedgefrog | *Litoria cooloolensis* | R | |
| Wallum rocketfrog | *Litoria freycineti* | V | |
| Wallum sedgefrog | *Litoria olongburensis* | V | V |
| ***Mammals*** | | | |
| Grey-headed flying-fox | *Pteropus poliocephalus* | LC | V |
| ***Fish*** | | | |
| Oxleyan pygmy perch | *Nannoperca oxleyana* | V | E |
| ***Insects*** | | | |
| Richmond birdwing butterfly | *Ornithoptera richmondia* | V | |
| | | | |
| **Flora** | | | |
| N/a | *Acacia attenuata* | V | V |
| N/a | *Acacia baueri* subsp*. baueri* | V | |
| Scented Acrinychia | *Acronychia littoralis* | E | E |
| N/a | *Allocasuarina thalassoscopica* | E | E |
| Chain fruit | *Alyxia magnifolia* | R | |
| N/a | *Aristolochia praevenosa* | R | |
| Hairy-joint Grass | *Arthraxon hispidus* | V | V |
| Christmas Bells | *Blandfordia grandiflora* | R | |
| Wide bay boronia | *Boronia rivularis* | R | |
| Minature Moss-orchid | *Bulbophyllum globuliforme* | R | V |
| N/a | *Carex breviscapa* | R | |
| Stinking cryptocarya | *Cryptocarya foetida* | V | V |
| Swamp stringybark | *Eucalyptus conglomerata* | E | E |
| N/a | *Glycine argyrea* | R | |
| N/a | *Gompholobium virgatum* var *emarginatum* | R | |
| N/a | *Leptospermum leuhmannii* | R | |
| N/a | *Macarthuria complanata* | R | |
| Rusty vine | *Marsdenia hemiptera* | R | |
| Lesser Swamp-orchid | *Phaius australis* | E | E |
| Greater Swamp-orchid | *Phaius tancarvilleae* | E | E |
| Wallum leek orchid | *Prasophyllum wallum* | V | V |
| N/a | *Schoenus scabripes* | R | |
| Hairy hazelwood | *Symplocos harroldii* | R | |

## 7.4 Appendix 4 – Translocation of *Allocasuarina emuina*

**Proposal for creation of a translocated population of *Allocasuarina emuina* derived from Peregian Springs population**

Prepared by the recovery team subgroup working party: Alison Shapcott (USC), Geoff Borschmann (GAQ), Megan Thomas (Queensland Herbarium).

The team noted that the draft recovery plan and other documents indicate that the 'Peregian Springs' population represents the last and largest 'stronghold' for *Allocasuarina emuina* populations. Therefore until further genetics studies are carried out, it could be anticipated that this population, given its size, contains a large portion of genetic variation. Any newly created population designed to replace a portion of this population should therefore be aimed at conserving the range of genetic variation present within the current population.

***Recommendations*:**
1. The proposed 'new' relocated population/s designed to represent this population be derived solely from individuals from the Peregian Springs population.
2. The focus on representing the individuals in the section planned for destruction should be a priority at this stage.

Seed collections to date have only been able to sample from 37 plants out of an estimated population of 2000 plants due to recent fires and plant maturity. Given the importance of this population to the species as potential source of genetic diversity (due to its size) it was deemed that this sample size was not adequate to conserve and represent the genetic composition of the plants of this population in any reconstructed population. It is also expected that the effect of the fire on the population may have biased the sampling of genetic variation during this single, immediately post fire, sampling effort.

***Recommendation*:**
1. A second collection of seed be made next reproductive season, targeting individuals not sampled this year to supplement: a) the total number of seeds collected from the population and b) the range of genetic diversity representing the population.

FKP Ltd is required to establish a 'viable' population of 850 plants to replace the population of plants to be destroyed during development. The recovery team interprets viable to mean that the plants have successfully reached reproductive maturity and have demonstrated they can/have produced viable offspring and thus the population is capable of sustaining itself. FKP Ltd has indicated that it proposes to establish two populations of 850 plants on potentially suitable habitat thus safeguarding the possibility that either may fail due to a variety of possible causes. The working party commends this strategy.

***Recommendations*:**
1. This risk-reduction approach is adopted in time as well as space for the newly created populations. This would provide a safeguard against unexpected environmental conditions (that is, fire, insect attack, disease), provide less uniform age structure in the population, and supplement the genetic diversity captured and conserved by the replacement populations.
2. Therefore we propose that two-thirds (2/3) to three quarters (3/4) of the seeds required to establish the desired final populations be propagated and planted from seeds collected in the 2002-03 season in the first planting event (anticipated to be undertaken in 2003). The remaining seeds required to achieve the final population would be collected in the next reproductive season (2003-04) and propagated and planted in 2004.

Greening Australia Queensland has estimated from experience that expected survival rates of seedlings of *A. emuina* would be in the order of 95 percent providing an appropriate maintenance regime is applied at the planting site. Episodic risks such as fire and disease will also require management consideration. For a population of 850 plants this would mean 900

seedlings would need to be planted in each of the two proposed 'new' populations, requiring a total of 1800 seedlings.

***Recommendations*:**
1. We adopt a slightly more conservative estimate of 90 percent success requiring 935 seedlings per population (to produce 850 plants) thus requiring a total of 1870 seedlings to be propagated.
2. Thus in year 1 (approx. 70 percent of population planted) 1310 seedlings would be required (655 per site); year 2 (approx. 30 percent of population planted) 560 seedlings planted; 280 per site.

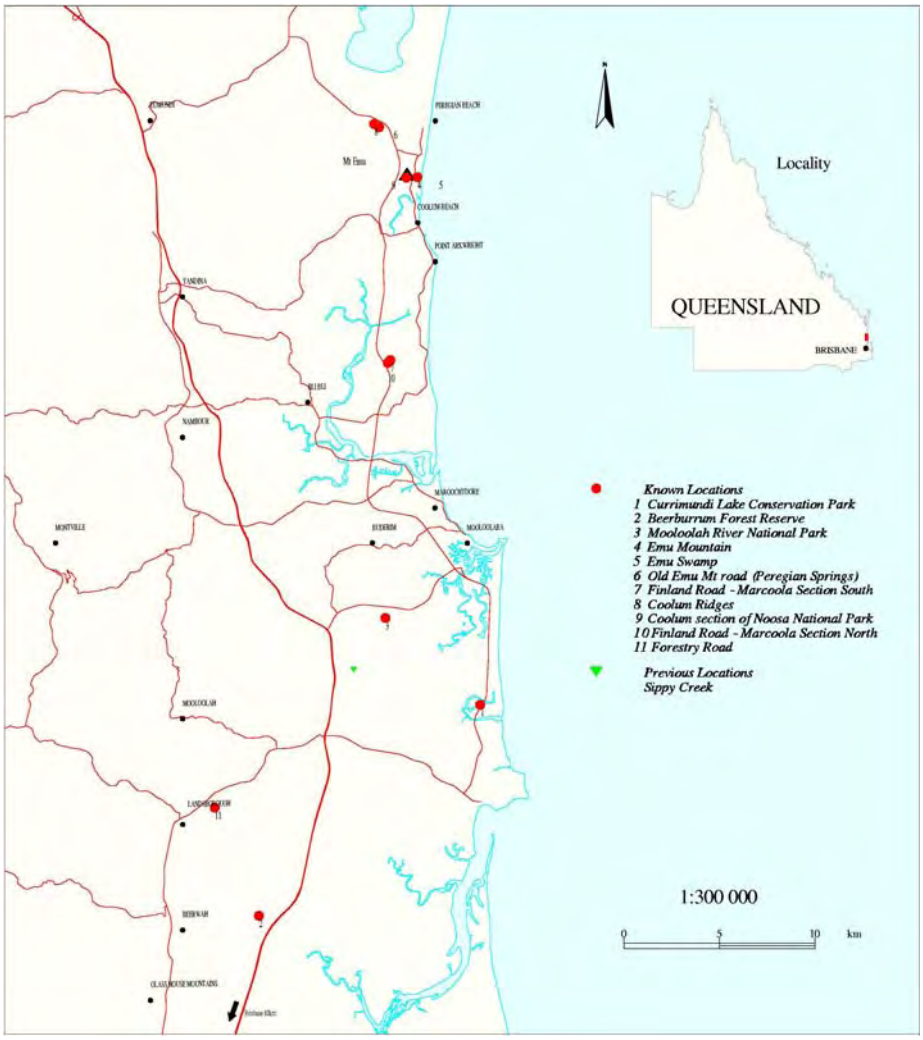
The strike-rate query-report database results reported ranged from 0 percent, 20 percent and 70 percent. All were reported to have germinated from seed that was several years old (as opposed to our fresher seed).

***Recommendations*:**
1. Based on these data plus other evidence we recommend a predicted 60 percent germination success rate from the seed collected by GAQ for this planting.
2. Therefore we predict that we will need 3117 seeds germinated to obtain 1870 seedlings. This translates to 2184 seeds in the first season's planting to produce 1310 seedlings and 933 seeds in the second season's planting.

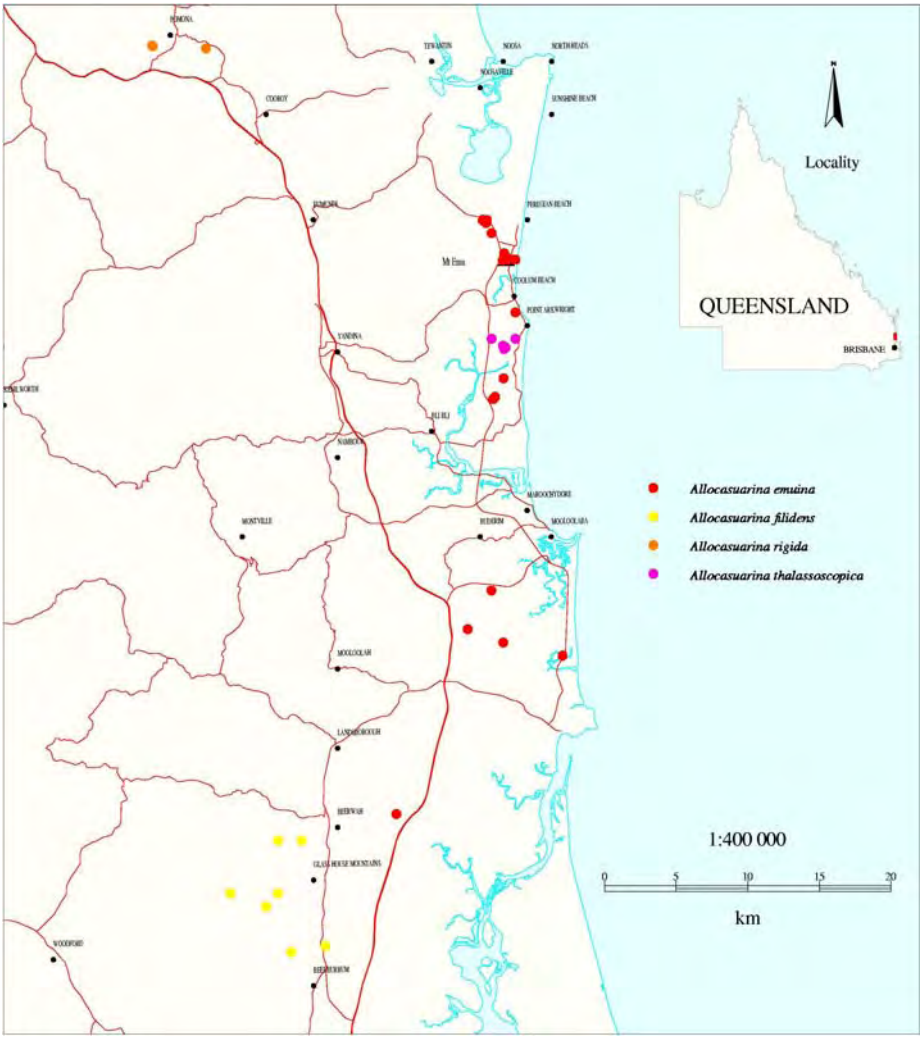
Seed numbers obtained during the first season's collections are based on the weight of seeds collected per plant and the average seed weight determined from a sub sample (100 seeds =0.22g). Fruit size, hence weight, was found to be highly variable among plants, possibly related to the affects of recent fire and other environmental effects plus plant age. From these data, the estimated weight of seeds required for this proposal could be calculated. The number of seeds collected per plant was also highly variable between plants. Based on estimates of seed numbers collected at present approximately 7000 *A. emuina* seeds have been collected from Peregian Springs sufficient for this proposal. Thus, on average, about 59 seeds from each of the 37 parent plants collected would be needed. Some parent plants did not yield this many seeds but many produced greater than this number of seeds.

***Recommendations:***
1. 4.80g *A. emuina* seeds required in year 1 planting
2. 2.05g *A. emuina* seeds required in year 2 planting
3. Seeds from all Peregian Springs plants in the collection are used for seedling stock of new populations.
4. A higher proportion of seeds from those plants proposed for destruction is included in the year 1 seed mix (due to proposed loss).
5. First priority of use for seed be given to use for creation of new populations; second priority to genetics studies which can be undertaken on a focussed subsample; third priority to seed preservation in vitro via seed banks.
6. Given the naturally unequal representation of some individual parent plants in the seed pool, it would not be unrealistic to supplement seed numbers required for the project from the more fecund parents to compensate for low seed numbers from some parents. But priority should come from plants to be destroyed.

## 7.5 Appendix 5 – Maps




*Map 1: Distribution of Allocasuarina emuina on the Sunshine Coast, Queensland*




*Map 2: Distribution of Allocasuarina species on the Sunshine Coast, Queensland*. *Queensland Conservation Status: A. filidens* (NCA 1992: 'rare'); *A. littoralis* (NCA 1992: 'Least concern'); *A. rigida* (NCA 1992: 'Least concern'); *A. thalassoscopica* (NCA 1992: 'endangered'; EPBC Act: 'endangered'); *A. torulosa* (NCA 1992: 'Least concern').