Natural Heritage Trust

Helping Communities Helping Australia

A Commonwealth Government Initiative

Recovery plan for the endangered native jute species, *Corchorus cunninghamii* F. Muell. in Queensland (2001 - 2006)

(Photo: courtesy of Glenn Leiper)

Prepared by Marion Saunders on behalf of the Rainforest Ecotone Recovery Team (RERT) - 2001

Contents

1. Summary

1.1 Current species status

Corchorus cunninghamii is a herbaceous plant species with a restricted distribution occurring naturally within a 120 km region between Brisbane (Queensland) and Lismore (New South Wales). It is currently known from four locations in south-east Queensland (Brisbane Forest Park, Mt Cotton, Wongawallan and Ormeau) and two locations in northern New South Wales (Toonumbar, Bungabbee). In Queensland the species has an estimated total population size of around 6000 individuals (Parr, 2001) which is an increase from the 1032 individuals recorded the previous year (Simmonds, 2000). In New South Wales (N.S.W) the estimated population size is between 600-700 individuals (N.S.W. National Parks and Wildlife Service; 1999).

Its low numbers, natural rarity and restricted distribution all contribute to *C. cunninghamii* being listed as Endangered under the *Queensland Nature Conservation (Wildlife) Regulation, 1994* (Schedule 2, Part 2) and the *New South Wales Threatened Species Conservation Act, 1995* (Schedule 1). It is also listed as Endangered by the Commonwealth under the *Environmental Protection and Biodiversity Conservation Act, 1999*. A recovery plan for the species in N.S.W. is currently being prepared by the N.S.W. National Parks and Wildlife Service (1999).

1.2 Habitat requirements and limiting factors

C. cunninghamii occurs in the narrow ecotone between subtropical rainforest and open eucalypt forest. The species is generally located at low to mid elevations (110 - 430 metres), on upper hill-slopes or hill-crests that have a south-easterly or easterly aspect. Although it occurs primarily on upper hill-slopes the species may grow anywhere between the ridge and gully, depending on the position of the open forest-rainforest ecotone. There is no specific geology or soil type associated with the species as it occurs on both metamorphic and igneous substrates and on loam or clay soils (Halford, 1995a) and as such there does not appear to be a particular habitat that is critical to the survival of the species. In general the soils are shallow, stony and well drained and common canopy species occurring alongside *C. cunninghamii* include *Eucalyptus propinqua* (grey gum), *Lophostemon confertus* (brush box) and *Eucalyptus siderophloia* (grey ironbark). The density and composition of the understorey may be variable between sites, and introduced weed species such as *Lantana camara* (lantana), *Rivina humilis* (coral berry) and *Ageratina adenophora* (crofton weed) frequently occur in the shrub layer.

Whilst *C. cunninghamii* is a naturally rare plant species it is also directly threatened by loss of habitat due to development, genetic isolation, competition with introduced weed species, inappropriate fire and land management regimes, and forestry activities. Currently four of the ten existing populations have less than ten individuals and these are likely to disappear without effective management strategies. Other critical populations for the species include one site in Wongawallan that has more than 85 % of the total number of plants in southeast Queensland and another at Mount Cotton that is genetically distinct from those at other locations and as such may be necessary to preserve the genetic diversity of the species in the long-term.

1.3 Recovery objectives

The overall objective of this recovery plan is to protect known populations of *C. cunninghamii* in Queensland from further decline, and to maintain and/or enhance sustainable population levels in the wild, in the long-term with minimum management. Given current population numbers and improved management of individual populations it is foreseeable that within 10 years of implementing the current recovery plan that the conservation status of *C. cunninghamii* would be downlisted from 'endangered' to 'vulnerable'.

1.4 Recovery plan objectives

- Update and improve existing knowledge of the ecology and distribution of *C. cunninghamii* in south-east Queensland.
- Protect and/or enhance wild populations of *C. cunninghamii* and their habitat from further decline by developing management strategies for land managers.
- Increase community awareness and involvement in maintaining and enhancing populations of *C. cunninghamii*.
- Improve the conservation status of *C. cunninghamii* from 'endangered' to 'vulnerable' within 10 years and to double the number of plants in critical populations within 5 years.

1.5 Recovery criteria

- Achieve an understanding of population dynamics, reproductive biology, and the role of fire and disturbance in the life history of *C. cunninghamii*.
- Secure an appropriate level of protection for the habitat of existing populations of *C. cunninghamii*.
- Maintain or enhance existing populations of *C. cunninghamii*.
- Rehabilitate habitat where populations of *C. cunninghamii* currently exist.
- Develop sustainable land management strategies for *C. cunninghamii* populations based on monitoring and recovery programs.
- Increased community awareness of *C. cunninghamii* through the distribution of educational information on the species, through voluntary involvement in habitat recovery and monitoring programs, as well as consultation with indigenous groups regarding conservation of the species and the land on which it occurs.

1.6 Actions needed

- *Action 1:* Investigate population dynamics by tagging and monitoring the life history of individual plants in existing populations of *C. cunninghamii*.
- *Action 2:* Investigate the role of fire and weed disturbance on the ecology of individual plant populations.
- *Action 3:* Implement management programs (e.g. fire and weed disturbance regimes) that improve the habitat of known populations of *C. cunninghamii* and increase population numbers.

- *Action 4:* Consultation and involvement of indigenous groups that have an interest in land on which *C. cunninghamii* occurs.
- *Action 5:* Preparation and distribution of educational material (bookmarks and posters) highlighting the endangered status of *C. cunninghamii* to conservation groups and the general public.
- *Action 6:* Recruitment of community volunteers to participate in monitoring and habitat recovery programs.

1.7 Estimated costs of recovery

YEAR	Action 1	Action 2	Action 3	Action 4	Action 5	Action 6	TOTAL
2001 – 2002	$ 6,940	$ 5,640	$ 7,040	unknown #	$ 5,040	$ 3,540	$ 28,200
2002 – 2003	$ 6,560	$ 5,410	$ 9,110	unknown #	$ 1,860	$ 3,360	$ 26,300
2003 – 2004	$ 5,500	$ 5,000	$ 8,700	unknown #	$ 900	$ 2,000	$ 22,100
2004 – 2005	$ 4,000	$ 4,700	$ 8,300	unknown #	$ 600	$ 1,500	$ 19,100
2005 – 2006	$ 4,000	$ 4,600	$ 7,800	unknown #	$ 600	$ 1,500	$ 18,500
TOTAL	**$ 27,000**	**$ 25,350**	**$ 40,950**	unknown #	**$ 9,000**	**$11,900**	**$ 114,200**

Table 1: Costs involved in implementing the recovery plan for *Corchorus cunninghamii* in Queensland.
* The Project Co-ordinators salary and transport costs ($14,100 in 2001-2002; $14,700 in 2002-2003), which are funded through a Natural Heritage Trust (NHT) grant, have been distributed between Actions 1–5.
Other contributors (financial and inkind) to the recovery plan include Brisbane Forest Park, Gold Coast City Council, Redlands Shire Council and Brisbane City Council. This table does not include the volunteer labour contribution estimated at $17,500 for 2001–2002 and $18,900 for 2002-2003. Volunteer labour contributions would be divided between Actions 1, 2 and 3. Funding after 2003 has not been secured. The cost of implementing action 4 is unknown but is likely to be an inkind contribution provided by the Queensland Parks and Wildlife Service and Environmental Protection Agency.

1.8 Biodiversity benefits

Areas where *C. cunninghamii* populations occur in Queensland are of high nature conservation value as several other rare or threatened plant species are also present at these sites. These species include; *Choricarpia subargentea* (giant ironwood), *Endiandra floydii*, *Macadamia integrifolia* (macadamia nut), *Pouteria eerwah* (black plum), *Sophora fraseri* (brush sophora) and *Randia moorei* (spiny gardenia). A further benefit of implementing the recovery plan for *C. cunninghamii* in Queensland includes the protection and maintenance of biodiversity within the ecotonal areas that *C. cunninghamii* naturally occurs in. These ecotonal areas are particularly susceptible to invasion by exotic species such as *Lantana camara* (lantana), and a greater understanding of the role of fire and disturbance in these habitats will greatly assist in maintaining diversity of native species and controlling invasive exotic species.

2. Background

The genus *Corchorus* belongs to the family Tilaceae and includes approximately 100 individual species of herbs and sub-shrubs which are distributed world-wide, primarily in tropical and sub-tropical regions. Twenty-six species belonging to the genus *Corchorus* are found in Australia, twenty one of which are considered to be endemic.

C. cunninghamii F. Muell. is an endemic, perennial, flowering herbaceous shrub with small yellow flowers and soft leaves with serrated margins. The species was first described in 1862 from material collected from south-east Queensland by Baron Ferdinand von Mueller. More recently the species was thought to be extinct as it had not been collected in the wild for almost forty years (1944 to 1983). However, since 1983 populations of *C. cunninghamii* have been located in a limited area around south-east Queensland and north-eastern New South Wales.

In 1995 a conservation statement and draft recovery plan for *C. cunninghamii* was prepared by David Halford (1995a). This original plan provided the basis for the current plan and as such is acknowledged here.

2.1 Species description

C. cunninghamii is a herbaceous, perennial shrub which grows to a height of 1.5 metres in the wild but may grow to 2 metres when cultivated. The stems are often though not always reddish in colour, and either smooth or sparsely covered with minute hairs. Leaves are 5-15cm long, 1.5-5cm wide, attached to stalks (petioles) 1-2.5cm long. They are characteristically smooth, narrowly ovate to ovate or elliptic ovate, with a finely serrated margin and a tip that tapers to an obvious point. Leaves are three-veined from near their base and arranged in an alternate pattern around the stem. Stipules, the growths at the base of a leaf stalk or stem that resemble leaves, measure up to 1mm in length, are ovate, red, fleshy, hairless, and have a single nectar secreting pore under their surface.

The flowers are small, have four yellow, narrow, oval-shaped petals measuring 9-11mm long and 3-5mm wide. They may grow as a cluster of 2-7 flowers originating from a single stalk located at the side of an upper stem opposite a leaf, or singularly at leaf or flower nodes. Buds are pear-shaped with a diameter of 3-4mm. Four pale yellow to green pointed sepals 7-11mm long are evident at the base of the flower or bud. Flowers contain 60-80 stamens and a weakly, three or 4-ribbed ellipsoid ovary (1.5-3 mm long and 4-6 mm wide), consisting of three or four cells each with 18 to 21 ovules. Although the species has been recorded to flower throughout the year, the peak flowering period for *C. cunninghamii* is from November to May (Halford, 1995a; b).

Fruiting bodies form on the plant between December and May but they may also be found at other times of year. They are characteristically narrow, dark brown to black, ellipsoid-shaped capsules measuring 1.5-3.5cm long and 4-6mm wide. The capsules contain three or four chambers each with 2-22, elliptical or rounded, matt brown to black seeds 2-3mm in length. Unlike the fruiting bodies of other Australian members of the *Corchorus* taxa which split from the apex downward, the capsules of *C. cunninghamii* split longitudinally with the apex

of the fruit remaining intact. *C. cunninghamii* is closely related to others in its genus (*C. hygrophilus, C. reynoldsiae and C. thozetti)* but can be distinguished by its narrowly elipsoid capsule. The species is relatively easy to identify when flowering but at other times may be confused with other superficially similar species, including *Abutilon oxycarpum* (flannel weed) and *Trema tomentosa* (poison peach).

Other descriptions of the species may be found in Stanley and Ross (1986), Harden (1990) and Halford (1995a; 1995b).

Figure 1: *Corchorus cunninghamii*. Diagram provided by the Queensland Herbarium

2.2 Distribution

Although some of the early records held by the Queensland Herbarium for *C. cunninghamii* have imprecise locations, it appears that the species was previously found in an area ranging from Brisbane in Queensland to Lismore in New South Wales (Halford, 1995a). Early Queensland specimens were recorded from the Moreton Bay region, Ithaca Creek, Peechey's Scrub and Enoggera areas. In 1932 and 1944 *C. cunninghamii* was recorded at Mount Cotton in Queensland and near Kyogle in New South Wales, respectively. These were the last collections of the species recorded until 1983 when it was found in Pullenvale, a western suburb of Brisbane. In 1988 another population was located south of Brisbane in the Darlington Range and in 1992 a single plant was recorded at Brookfield, a western suburb of Brisbane. More recently field work conducted by Halford, as part of a conservation statement and draft recovery plan (1995a), indicated that there were only four locations with extant *C.*

cunninghamii populations. These were at Brookfield, Ormeau (Darlington Range) and Wongawallan in Queensland, and at Toonumbar in N.S.W. Further information regarding existing populations of the species in N.S.W can be found in the N.S.W. recovery plan for *C. cunninghamii* (N.S.W. National Parks and Wildlife Service, 1999) and in Stewart (2000).

Figure 2: Distribution of *Corchorus cunninghamii* populations in Australia (from Parr, 2001).

Since 1995, populations of *C. cunninghamii* have also been identified at both Brisbane Forest Park (BFP) and Mount Cotton. Site information for the ten existing Queensland populations, the number of plants at each site (Table 2 and 3) and their size class distribution (Figure 3) are provided below. The Brookfield site has been omitted from the current recovery plan as only one plant existed at this site in 1993 and given the short lifespan and reproductive requirements of the species it is unlikely to exist today. In addition this plant existed on privately owned land, in a highly modified habitat and there was some doubt as to whether it was a natural occurrence of the species or whether it was accidentally introduced with other plants obtained from Pullenvale nursery, where the species was known to occur naturally and was cultivated (Halford, 1995a).

Site	1993 [1]	1998 [2]	2000 [2]	2001 [3]
1	262	not counted	44	562
2	69	not counted	14	63
3	5452	not counted	239	> 5000
4	28	not counted	14	8
5	8	not counted	4	4
6	unknown population	>100	604	50
7	unknown population	unknown population	17	153
8	unknown population	100	91	9
9	unknown population	unknown population	1	1
10	unknown population	8	4	28
TOTAL	**5, 819**		**1, 032**	**> 5, 878**

Table 2: Population numbers for *Corchorus cunninghamii* at Queensland sites. Population estimates obtained from: [1]Halford (1995a); [2]Simmonds (2000); [3]Parr (2001)

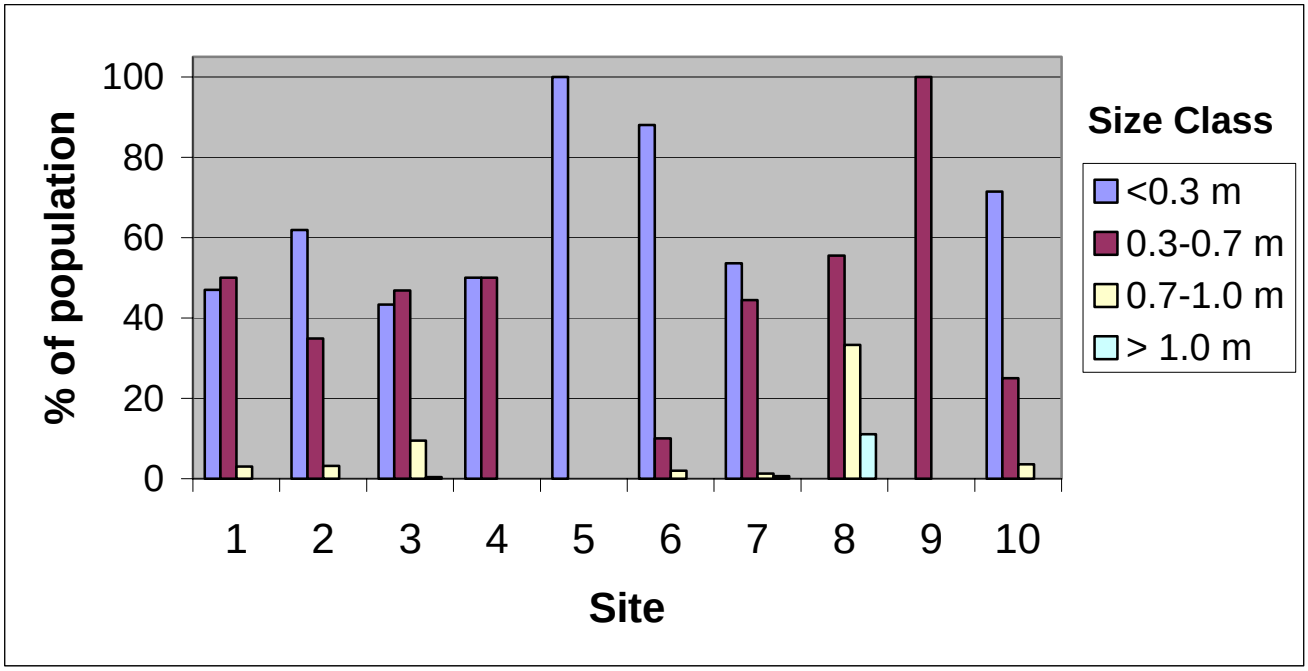

Figure 3: Size class structure of the Queensland populations (from Parr, 2001).

Wongawallan

Three populations, all within a 1km radius occur at the Wongawallan location, which is 16km south-east of Beenleigh and 8km north-east of Eagle Heights. The sites are contained within the Gold Coast City Council Shire and the Pimpama Creek catchment area. The Wongawallan location is 6km south of the Ormeau sites (Sites 4 and 5) and accessible from the Tamborine-Oxenford Road. Elevation at these sites is between 320 to 355m. Soil is derived from metamorphic rocks known as the Neranleigh-Fernvale Beds and is shallow, brown to black in colour and has a loam to medium clay texture.

The vegetation structure of the area is open forest with *Eucalyptus crebra* (narrow-leaved ironbark), *Eucalyptus propinqua* (grey gum), *Eucalyptus microcorys* (tallow wood) and *Eucalyptus acmenoides* (white mahogany) the predominant trees in the overstorey. The lower stratum is variable between sites and diverse in nature, although *Senna barclayana* (pepper leaf senna), *Lantana camara* (lantana), *Trema tomentosa* (poison peach), *Solanum stelligerum* (devil's needles), *Acalypha nemorum* (hairy acalypha) and *Abutilon oxycarpum* (flannel weed) are conspicuous understorey elements.

The number of plants at all three sites showed a substantial decline between the years 1993 and 2000. However, population counts conducted in 2001 showed that the population size had increased to levels similar to, or greater than those in 1993. This increase is likely to have been facilitated by a fire which passed through the area in November 2000. Apart from this fire and some recreational use of the area the Wongawallan sites have remained relatively undisturbed over recent years. Visits to the sites in 2001 showed that a dirt track which runs alongside Sites 1, 2 and 3 is also used by motorcyclists. However the level of use is currently low and *C. cunninghamii* seedlings continue to grow on the paths edge. Other rare or threatened plant species that are present at the Wongawallan sites include *Endiandra floydii, Sophora fraseri* (brush sophora), *Macadamia integrifolia* (macadamia nut) and *Randia moorei* (spiny gardenia).

Site 1: Wongawallan 1

Site 1 is located on the crest of ridge which runs in a north westerly/south-easterly direction and covers a 225m^2 area. Of the three Wongawallan sites, this site is drier and more open than the others. It also has a grassy understorey which contains *Hibiscus heterophyllus* (native hibiscus) and the weed species *Lantana camara* (lantana). Both of these species are likely to compete with *C. cunninghamii.* The number of plants at Site 1 increased from 44 in 2000 to over 562 in 2001. It would appear that the fire that passed through the area at the end of 2000 has stimulated germination of the seed bank at this site, given that a noticeably younger cohort was present in 2001 than in 2000. The population at Site 1 is currently on freehold land with the owners being aware of the presence of an endangered plant species on their property. It may be possible to secure protection of this site in the future though a voluntary conservation agreement (VCA) with the owners, via a parkland dedication if parts of the site are ever put forward for further development, or through the Gold Coast City Council purchasing this piece of land for conservation purposes, as it has done for Site 3.

Site 2: Wongawallan 2

This site is located on a hillcrest with a north easterly aspect, 1-2° slope and covers an area of approximately 225m^2. Compared to the other sites at this location it is more mesic and has a dense coverage of ferns such as *Hypolepis glandulifera* (downy ground fern), *Lastreopsis*

marginans (glossy shield fern), *Doodia aspera* (prickly rasp fern), *Calochlaena dubia* (false bracken) *and Pteris tremula* (tender brake fern). The number of individuals at Site 2 has increased from 14 individuals in 2000 to 63 in 2001, although this number is still less than that recorded in 1993. The population also appears to have expanded in area since 2000 as some individuals were found almost 5m away from the edge of this site, which was marked by tape previously. The small size class and single height cohort suggests seedling recruitment since 2000 has resulted from the fire that passed through the area recently. In addition, a large fallen log which currently divides the population is likely to have caused disturbance to the soil seed bank, as well as extending the area that *C. cunninghamii* covers at this site. Land tenure is Road Reserve, although the road is not constructed. The Gold Coast City Council is responsible for the management of the site.

Site 3: Wongawallan (Wilkies Scrub Conservation Area)

Site 3 is located on a hillcrest and hillslope with a south-easterly aspect, a 5° slope and covers 800m^2 of open forest. *C. cunninghamii* is the predominant plant species in the understorey at this site. In 1993 the size of the population was estimated at 5452 individuals, which was over 90% of the total number of plants in both Queensland and New South Wales at the time. It appeared from the similar age class of the individuals that some event, such as the fire which went through the area some time in 1991 or 1992 stimulated an increase in population numbers at this site. By 2000 the number of plants recorded at Site 3 had declined to only 239 individuals. Since this time another fire has passed through the area and the population has increased once again to over 5000 individuals. Of all the existing populations in Queensland this site continues to support the largest number of plants and is one of the most easily conserved and managed in the long-term. In 1995, when the original conservation statement and draft recovery plan for the species was written (Halford, 1995a), the land tenure of Site 3 was held in Freehold by a local farmer. On the 16th of June 2000, the property was acquired by the Gold Coast City Council under the Council's Open Space Preservation Levy and it is now considered Council Reserve. Other plant species of importance at Site 3 include the threatened ecotonal plant species *Endiandra floydii* and *Sophora fraseri* (brush sophora). Additional rare or threatened plant species occurring at the Wilkies Scrub Conservation Area include *Baloghia marmorata* (jointed baloghia), *Cryptocarya foetida* (stinking cryptocarya), *Cupaniopsis newmanii* (long-leaved tuckeroo), *Pararistolochia pravenosa* and *Randia moorei* (spiny gardenia).

Ormeau (Darlington Range Nature Refuge)

Two populations of *C. cunninghamii* occur at the Ormeau location, which is situated about 6km north of the Wongawallan sites and 10km south-east of Beenleigh. The sites occur within a radius of approximately 500m, cover a total area of 525m^2, and can be accessed via Cliff Barron's Road. The sites are contained within the Gold Coast City Council Shire and the Pimpama Creek catchment area. In 1995, when the conservation statement and draft recovery plan for *C. cunninghamii* was written, this land was owned by Readymix Quarry (CSR). Discussions between CSR, the Ormeau progress association and former Albert Shire Council have led to the area being set aside for the preservation of *C. cunninghamii* and the adjacent vine forest. The management of the Ormeau location is now undertaken by the Environmental Protection Agency and the land on which *C. cunninghamii* grows is owned by the Public Trustee and considered part of the "Edward Corbould Reserve and Nature Refuge" (Gazettal date; 18/10/96).

Although the *C. cunninghamii* populations at Ormeau occur in open forest with a sparse to mid-dense lower stratum they are closely associated with the open forest-subtropical rainforest ecotone. Elevation at the sites is between 160 to 180m and common overstorey trees include *Eucalyptus propinqua* (grey gum), *Lophostemon confertus* (brush box) and *Eucalyptus crebra* (narrow-leaved ironbark). A predominant shrub in the lower stratum at the Ormeau sites is the weed species *Lantana camara* (lantana). This weed species forms dense thickets in the rainforest and open eucalypt forest ecotone and is one of the threatening processes for *C. cunninghamii* at this location. The lower stratum is diverse and includes shrubs, ferns sedges and grasses such as *Polyscias elegans* (celery wood), *Astrotricha latifolia* (silver leaf), *Acalypha nemorum* (hairy acalypha), *Psychotria daphnoides* (smooth psychotria), *Acacia aulacocarpa* (brown sandalwood), *Adiantum hispidulum* (rough maidenhair-fern), *Oplismenus aemulus* (creeping shade grass), *Doodia aspera* (prickly rasp fern and *Carex declinata*. Several other rare or threatened floral species occur in the area adjacent to the *C. cunninghamii* populations at Ormeau. These include *Choricarpia subargentea* (giant ironwood), *Macadamia integrifolia* (macadamia nut), *Pouteria eerwah* (black plum) and *Randia moorei* (spiny gardenia).

Soil at the Ormeau site is derived from the metamorphic rocks known as the Neranleigh-Fernvale Beds which consists of greywacke, argillite, quartzite, chert, shale, sandstone and greenstone. It is shallow and stony, dark brown to black-brown in colour and medium clay in texture. The fire and disturbance history of the Ormeau sites is largely unknown and there is no evidence to suggest that the populations have been disturbed in recent times (May and July, 2001). In 1995, David Halford concluded that from the thickness of the leaf litter that fire had been absent for a very long time and from a personal communication with Glenn Leiper, Melanie Simmonds (2000) stated that the area had not been burnt for at least ten years. The continued presence of plants, though low in number, indicates that germination of seeds at this location has occurred independently of soil heating by fire. It is possible, as suggested by David Halford (1995) that germination of seedlings at this location is triggered by animal foraging.

Site 4: Ormeau 1

This site is located on an upper hillslope with a south-easterly aspect, a 20° slope and covers an area of approximately 300m^2. The number of *C. cunninghamii* plants at this site has declined from 28 individuals in 1993, to 14 in 2000. In July 2001 there was a further decline to only eight individuals. Without some form of intervention this population is likely to disappear given that it is a small isolated population, there is a thick vegetative cover of the introduced weed species *Lantana camara* (lantana), and there has been no fire or other obvious disturbance to the area for many years. The recovery of this population is dependent on the viability of the soil seed bank, which may have been severely diminished over time.

Site 5: Ormeau 2

Given the close proximity, there are obvious similarities between Site 4 and Site 5 with regard to their physical description and threats to the populations long-term viability. Both sites are located in open forest, have medium clay soils and are located on an upper hillslope with a 20° incline. In addition, Site 5 covers an area of approximately 225m^2 and has an easterly aspect. The population number at Site 5 has declined from eight individuals in 1993, to only four plants in 2000. Examination of the site in July 2001 revealed that there were still only four plants at this site. However, all of these individuals were seedlings and as such were not

the same plants observed in the 2000 census. As no other living plants were found at this site in 2001 it is possible that not all specimens were located, or that they had died and not been found. Nevertheless it is clear that this population, like that at Site 4 is in decline and is likely to disappear without some form of site management.

Brisbane Forest Park

Four populations of *C. cunninghamii* occur at Brisbane Forest Park (BFP), which covers an area of approximately 28, 500 hectares and is located in the foothills of the D'Aguilar Range, approximately 34km from the city of Brisbane. These populations were not identified until the late 1990's. The sites at which *C. cunninghamii* populations occur in BFP cover a total area of approximately 9, 400m^2 and are located less than 20km from each other. Elevation at the sites ranges between 100 and 170m. Soils from the three sites (Sites 6, 7 and 9) located around Enoggera Reservoir, are of a clay loam type and are derived from Bunya-Phyllite rock. At Site 8, which is the most westerly of the populations, soil has a loam consistency and is derived from the Neranleigh-Fernvale Group.

Since elevation, temperature and rainfall within the park vary greatly, vegetation is diverse. Populations of *C. cunninghamii* at sites 6 and 7 occur in an open forest/subtropical rainforest ecotone and populations at Sites 8 and 9 occur in an open forest/wet sclerophyll forest ecotone (Simmonds, 2000). A common canopy species at all sites is *Lophostemon confertus* (brush box) and other canopy species include *Eucalyptus siderophloia* (grey ironbark), *Eucalyptus propinqua* (grey gum), *Eucalyptus microcorys* (tallow wood) and *Corymbia citriodora* (spotted gum) (Parr, 2001). The introduced weed species *Lantana camara* (lantana*)* and *Rivina humilis* (coral berry) are present in the understorey.

Site 6: BFP 1 – Fursman's Scrub/Peninsula Site

This site is located north of Enoggera Reservoir and is contained in the Enoggera Creek catchment area, and of all the sites is located closest to BFP headquarters. The population is situated on a hillcrest with a south-easterly aspect, a 10° slope, and covers an area of 8,000m^2. It occurs on land held in 'water supply reserve', and is under Brisbane City Council control. Common canopy species at Site 6 include *Lophostemon confertus* (brush box) and *Corymbia citriodora* (spotted gum). The site was discovered by BFP staff in 1998, after a high intensity fire passed through the area in March of that year. A few months after this fire the *C. cunninghamii* population was estimated to be in excess of 100 plants and by November 1999 the number of plants had increased to 604. It should be noted that a high intensity fire probably occurred at this site in 1970. In 1999/2000 Site 6 contained the largest population of *C. cunninghamii* in Queensland (Simmonds, 2000). However since this time the population has shown a substantial decline to only 50 individuals (Parr, 2001). It is likely that this decline has resulted from a lack of disturbance in recent times. This is supported by the observation that the majority of individuals at this site are less than 30cm tall (Figure 1) and occur alongside a vehicle trail that separates the population. Slashers and bulldozers have been used infrequently to maintain this trail for four wheel drive access.

Site 7: BFP 2 - McDonald's Scrub Site

The McDonalds Scrub site is located on the west side of Enoggera Reservoir, is contained in the Enoggera Creek catchment area and covers and area of about 400m^2. This site, like Site 6, is held in 'water supply reserve' and is managed by the Brisbane City Council. The *C.*

cunninghamii population is located on a densely vegetated lower hillslope, with a 5° incline and faces a north-easterly direction. The species was originally identified at this site in 1997 by Kenneth MacClymont who works for the Brisbane City Council and is an active member of the Brisbane Rainforest Action Information Network (BRAIN). Site 7 differs from others at BFP in that it has undergone an active weed reduction program over recent years, and is the only population to have increased in number since 1999/2000. Weeds, particularly *Lantana camara* (lantana), have been removed by hand as part of a rainforest restoration project implemented by BRAIN at this site in 1996. Since 1996 weeding has occurred on another two occasions, the most recent of which was in June 2001. It is likely that this weeding program has contributed to the increase in *C. cunninghamii* numbers from 17 in 2000, to 152 in 2001. Other disturbances that are likely to have facilitated this population increase are a low intensity fire that passed through the area in August 2000, and the soil trampling that occurs as a result of individuals hiking through the area for recreation or other purposes. It should be noted that a high intensity fire has probably not occurred at this site since 1970.

Site 8: BFP 3 - Lake Manchester Site

Site 8 is located approximately 20km, in a south-westerly direction, from Sites 6, 7 and 9. It is located in land held by Brisbane City Council in 'Fee Simple' and covers an area of 1,000m^2. The site occurs in the Lake Manchester catchment area. The *C. cunninghamii* population at site 8 occurs on a hillcrest, with a south-easterly aspect and a 5° slope. This site is drier and than the other BFP sites and is the most densely populated by *Lantana camara* (lantana). *C. cunninghamii* was originally discovered near Lake Manchester by bushwalkers in mid 1998, a year or two after Brisbane City Council re-opened an existing but neglected fire break with slashers and four wheel drive tractors. Population numbers were estimated at 100 in 1998 and 91 in 1999/2000. Since this time the population has shown a substantial decline to only nine individuals. This decline is largely due to the site being over-run by lantana and a lack of disturbance. The most recent fire that occurred in the area was conducted by BFP and Forestry staff in April, 1997. This late summer burn was of low intensity and was thought to have missed the *C. cunninghamii* population. Although the population at Lake Manchester is in decline, recovery is possible if the site contains a viable seed bank.

Site 9: BFP 4 - Mount Aurum Scrub Site

The Mount Aurum Scrub site occurs on the north-west side of the Enoggera Reservoir, is contained in the Enoggera Creek catchment area and is located in 'Forest Reserve'. Characteristic canopy species include *Eucalyptus propinqua* (grey gum), *Eucalyptus microcorys* (tallow wood) and *Lophostemon confertus* (brush box). *C. cunninghamii* was originally discovered at Mount Aurum Scrub in November 1999 by BFP staff looking for gold mines in the area. At this time a single plant was located on a south-easterly facing hillslope with a 10° aspect. In 2001 this individual was once again located (Parr, 2001), however no additional plants were found at this time. Vegetation surrounding the plant has not been obviously disturbed in recent times, and although there have been plans to burn this site in the last two years weather conditions have not been suitable. The last recorded fire at this site was of low intensity and occurred in 1986. Of all *C. cunninghamii* populations in Queensland this one is most likely to disappear.

Mount Cotton

Site 10: Mt Cotton

C. cunninghamii plants were at identified at Mount Cotton in 1996, by a member of the Society for Growing Australian Plants (SGAP) while on a field trip. Although the species had previously been recorded at this location no plants had been collected from the wild, from this or any other location in Queensland from 1944 to 1983.

The Mount Cotton site is located about 26km south-east of the city of Brisbane and occurs in Redlands Shire Council and the Tingalpa Creek catchment area. It can be accessed from Mount View Road and is located on a hillcrest, with a south-easterly aspect, 230m elevation and 10° slope. Downhill from this site, on an adjacent property, is the privately owned "Rainforest Gardens", which has introduced large numbers of exotic plants to the area. The *C. cunninghamii* population occurs in open forest, on sandy loam soil derived from Neranleigh-Fernvale rock and covers an area of approximately 120m^2. Vegetation at the site is diverse and includes trees like *Eucalyptus propinqua* (grey gum), *Eucalyptus acmenoides* (white mahogany), *Corymbia intermedia* (pink bloodwood), *Acacia bakeri* (marblewood), *Acacia perangusta*, *Lophostemon confertus* (brush box), *Ficus fraseri* (sandpaper fig) and *Macadamia integrifolia* (macadamia nut). It also contains a large range of native shrubs, herbs, grasses, sedges, ferns, orchids and vines, in addition to a number of exotic species like *Lantana camara* (lantana), *Bidens pilosa* (cobblers pegs) and *Rivina humilis* (coral berry).

The number of *C. cunninghamii* plants at Mount Cotton has increased from four individuals in 2000, to 28 in July 2001. Most of these plants are seedlings less than 30cm tall (Figure 1) and are clustered in a 6m^2 area, on the edge of a path that provides access to a Telstra tower near the site. A region surrounding the path was cleared by brushcutters some time early in 2001 and it appears that this disturbance may have facilitated the germination of seeds. Other types of disturbance that have occurred in recent times are a fire that passed through the area in 1995 and the regular grazing of cattle. Although the recent census has shown that the number of plants has increased at this site the population is far from secure. Since the discovery of this population *Rivina humilis* (coral berry) has increased its dominance in the shrub layer and exotic plants, introduced to the area by the owners of "Rainforest Gardens", are growing up towards the *C. cunninghamii* population. These exotic plants and their associated garden clippings, as well as the dispersal of seeds from these non-native plants by animals or birds in the area, may eventually threaten the uniqueness of this site if not managed effectively. Similarly, inappropriate disturbances or ill-timed disturbances may be a problem if the site is not secured and grazing and brushcutting continue to occur in an *ad hoc* manner.

Of the 28 plants that exist at the Mount Cotton site, 22 plants occur on land that is held in 'Road Reserve' tenure and is managed by the Redlands Shire Council. The remaining six individuals are located on privately owned land. The owner has shown little interest having an endangered plant species on his property and has indicated that he may eventually build close to the site. Redlands Shire Council is now considering purchasing the portion of land on which these plants reside. A major reason for conserving the Mount Cotton population is that individuals at this site are genetically different to those at other Queensland locations (Simmonds, 2000), and as such may be valuable in enhancing the genetic variation of the species in the long-term.

Site	Location	Latitude/ Longitude	Land Tenure/Site Protection	Number of Plants (2001)	Threats
1 Wongawallan	Gold Coast City Council-Pimpama Creek Catchment	27°51'000S 153°14'018E	Freehold	**562**	Exotic weed invasion Inappropriate fire regime Possibly grazing and recreation
2 Wongawallan	Gold Coast City Council-Pimpama Creek Catchment	27°51'11S 153°14'00E	Road Reserve	**63**	Exotic weed invasion Inappropriate fire regime Possibly grazing and recreation
3 Wongawallan	Gold Coast City Council-Pimpama Creek Catchment	27°51'13S 153°12'52E	Wilkies Scrub Conservation Area-purchased by the Gold Coast City Council (2000)	**> 5000**	Exotic weed invasion Inappropriate fire regime Possibly grazing and recreation
4 Ormeau	Gold Coast City Council-Pimpama Creek Catchment	27°48'13S 153°12'30E	Part of the Edward Corbold Reserve and Nature Refuge (1996)	**8**	Low population number (inbreeding depression) Exotic weed invasion Inappropriate fire regime Possibly grazing
5 Ormeau	Gold Coast City Council-Pimpama Creek Catchment	27°48'30S 153°12'33E	Part of the Edward Corbold Reserve and Nature Refuge (1996)	**4**	Low population number (inbreeding depression) Exotic weed invasion Inappropriate fire regime Possibly grazing
6 Brisbane Forest Park	Brisbane City Council-Enoggera Creek Catchment	27°26'44S 152°55'17E	Water Supply Reserve under Brisbane City Council control	**50**	Exotic weed invasion Inappropriate fire regime Possibly grazing, recreation and damage from slashing alongside trails
7 Brisbane Forest Park	Brisbane City Council-Enoggera Creek Catchment	27°27'01S 152°54'12E	Water Supply Reserve under Brisbane City Council control	**153**	Exotic weed invasion Inappropriate fire regime Possibly grazing and recreation
8 Brisbane Forest Park	Brisbane City Council-Lake Manchester Catchment	27°28'26S 153°47'33E	Fee Simple land held by Brisbane City Council	**9**	Low population number (inbreeding depression) Exotic weed invasion Inappropriate fire regime Possibly grazing, recreation and damage from slashing alongside trails
9 Brisbane Forest Park	Brisbane City Council-Enoggera Creek Catchment	27°26'37S 152°53'55E	Forest Reserve	**1**	Low population number (inbreeding depression) Exotic weed invasion Inappropriate fire regime Possibly grazing and recreation
10 Mount Cotton	Redlands Shire Council-Tingalpa Creek Catchment	27°36'907S 153°12'847E	Road Reserve and freehold land	**28**	Exotic weed and non-native plant invasion Inappropriate fire regime Possibly clearing, grazing, recreation and damage from slashing alongside trails
TOTAL				**> 5, 878**	

Table 3: Site summary for *Corchorus cunninghamii* populations in Queensland (for further information see Section 2.2 and 2.4). Population estimates and latitude/longitude values obtained from Parr, 2001. All populations occur within the southeast Queensland bioregion.

2.3 Critical habitat and populations

In general populations of *C. cunninghamii* occur on upper hillslopes or hillcrests with a south-easterly or easterly aspect (Halford, 1995a; Simmonds, 2000). This aspect is moister, cooler and has less exposure to solar radiation than other aspects. The species is closely associated with the subtropical rainforest-open eucalypt forest ecotone and common canopy species that occur alongside *C. cunninghamii* include *Eucalyptus propinqua* (grey gum), *Lophostemon confertus* (brush box) and *Eucalyptus siderophloia* (grey ironbark). The vegetative composition and density of the understorey is variable between sites. However, at most sites introduced weed species such as *Lantana camara* (lantana), *Rivina humilis* (coral berry) and *Ageratina adenophora* (crofton weed) are present. The location of *C. cunninghamii* populations show no association with a particular elevation or geology, although soils are shallow, stony and well drained with a loam or clay consistency.

All existing populations of *C. cunninghamii* occur in the southeast Queensland bioregion (IBRA) with the Wongawallan sites occurring on land characterised by regional ecosystem (RE) 12.11.2 and the remainder of the populations by RE 12.11.5 (Sattler and Williams, 1999). Given that the conservation status of neither of these ecosystems is "of concern at present" and both are represented in protected areas, and the ten *C. cunninghamii* populations occur at sites with no particular physical characteristics in common, there would not appear to be critical habitat for the species. However, at least seven of the ten populations appear to be critical to the survival of the species (see individual site descriptions in Section 2.2 for specific information). Currently four (Sites 4, 5, 8 and 9) of the ten existing populations have less than ten individuals and are likely to disappear without effective management and one population (Site 6) has declined 12-fold since the 2000 census. Other critical populations for the species include one at Mount Cotton (Site 10) which is genetically distinct from those at other locations and as such may be necessary to preserve the genetic diversity of the species in the long-term and one site at Wongawallan (Site 3) which currently has more than 85% of the total number of plants in Queensland. Although this site would appear to be thriving presently, in recent years numbers have not been constant at this site. Population estimates declined from 5452 in 1992 to only 239 in 2000 and have now increased to over 5000 individuals. This fluctuation reflects how susceptible the species is to extinction at a particular site if not effectively monitored and managed.

2.4 Life History and Ecology

Lifespan and reproduction

C. cunninghamii is a perenial, herbaceous plant with a short lifespan of approximately three to four years (Halford, 1995a). The growth rate for newly emerged seedlings has been estimated at 11mm per day, while the average growth rate of young mature individuals (50-75cm in height) was 33cm per year (Simmonds, 2000). For mature plants the growth rate was higher during October to April than for the cooler months of the year (April-October). A previous

field study by Halford (1995a) indicated that of individuals that had germinated between March to May, 29% flowered and 12.5% had produced fruit in December of that year. Thus the species would appear to be capable of reproduction within a year of germinating. *C. cunninghamii* is not capable of vegetative reproduction and its propagation is dependent on the production of seed. Breeding studies/pollination trials indicate that the species is self-incompatible (Halford, 1995a; Simmonds, 2000), which is a problem for populations that are small and isolated. Effective reproduction of the species would appear to be reliant on pollinator activity of insects such as the introduced honey bee (*Apis mellifera*), native honey bees or stingless bees (*Trigona* sp.), sand wasps (*Bembix* sp.) and possibly ants (Halford, 1995; Simmonds, 2000).

Flowering and fruiting

In south-east Queensland *C. cunninghamii* produces its characteristic small yellow flowers primarily between the months of October and May, although some individuals appear to flower throughout the year (Halford, 1995a; Cameron, 1997). Plants in cultivation tend to flower for about two months at a time, and individual flowers remain open for only one day (Halford, 1995a).

Green, narrow, ellipsoid shaped fruiting capsules appear on the plant primarily between the months of December and May. As the capsule matures it darkens to a dark brown/black colour and splits longitudinally to release its seeds.

Seed dispersal and germination

Seeds of *C. cunninghamii* drop to the ground and are not forcibly ejected from the fruiting capsule and as such dispersal distances are generally short. Some seed dispersal is also likely to arise through the activity of foraging birds or animals and through the transport of seed in soil trapped in tyres of slashers, track graders or recreational vehicles (Stewart, 2000). It is also possible that seeds are transferred from one site to another on the soles of shoes.

C. cunninghamii seeds are released in a dormant state and appear to require some factor such as heat or other mechanical disturbance to facilitate their germination (Halford, 1995a; Cameron, 1997; Simmonds, 2000). Studies conducted by Halford (1995a) showed that most *C. cunninghamii* seeds are viable (82 and 98%) but that the proportion of dormant seeds was as high as 98%. Manually nicking the seed coat with a knife was effective in breaking the dormancy of 84% of seeds and oven temperatures of 80, 90, 100 and 107°C gave germination rates of 14, 47, 38 and 28% respectively. A similar effect was observed when boiling water was applied to seeds. In the absence of the boiling water pre-treatment only 1.3% of seeds germinated but when boiling water was applied 55% of seeds germinated (Cameron, 1997). Smoke in the presence of high temperatures has also been shown to facilitate seed germination (Simmonds, 2000). Given the low level of seedling recruitment that occurs under natural conditions the species is likely to accumulate a persistent soil seed bank. Germination studies have indicated that collected seeds remain viable for at least three years (Simmonds, 2000) but the longevity of soil stored seed is unknown.

Role of fire and disturbance

Seed germination trials and field observations have indicated that disturbance in the form of heat/fire or mechanical disturbance is necessary to promote the germination of *C. cunninghamii* seeds. Disturbance benefits however, are dependent on the type, intensity and frequency of the disturbance. Monitoring studies conducted by Halford (1995a) revealed that a 80% of seedlings at the Ormeau in Queensland (Sites 4 and 5) occurred in areas where the ground had been disturbed by animals. This sort of natural disturbance, which is likely to occur continually, would over time produce a population with a mixed age structure. Other types of mechanical disturbance or activities that appear to have facilitated the germination of *C. cunninghamii* seeds at particular sites include brushcutters and tractors (Sites 6, 10), recreation (Sites 3, 7), weeding (Site 7), grazing (Site 10) and forestry (N.S.W. sites: Stewart, 2000).

A positive germination response to fire has also been observed at a number of Queensland populations, particularly Sites 1, 2, 3 and 6. Most noticeable is the change in population numbers observed at the Wongawallan 3 site (Table 2). A high-intensity fire passed through this area in sometime in 1991/1992 and again in November 2000. Population counts conducted one to two years after these fires indicated that more than 5,000 individuals occurred at this site. However the 2000 census, which was conducted prior to the 2000 fire, showed that the population had declined to 239 individuals over a period of eight years. These observations suggest that the fluctuation in population numbers recorded at this site was related to the fire history of the area.

As an obligate seed regenerator, persistence of the species after fire is dependent on the presence and germination of soil stored seed. If fires are too frequent plants may have insufficient time to build up the soil seed bank to replace plants that are killed in the fire. By contrast, a low intensity fire may be unable to stimulate the germination of seeds, particularly if they are buried deeply (Simmonds, 2000). The timing of the fire may be important as seasonal differences (e.g. rainfall, soil temperatures, amount of sunlight) are also likely to effect seedling recruitment (Stewart, 2000). Although the germination of *C. cunninghamii* seeds are facilitated by fire, further research is needed to determine what the optimal frequency, intensity and timing of these fires should be to sustain or enhance population numbers.

Threatening processes

Populations of *C. cunninghamii* are declining in both Queensland and New South Wales. Threatening processes such as clearing, habitat loss, weed invasion, inappropriate fire regimes, grazing, recreation and timber harvesting would all appear to be contributing to this decline. Clearing and habitat modification is likely to have been responsible for extinction of the species at Pullenvale and other locations in Queensland and N.S.W. For example, over the years the Pullenvale area has been subdivided into residential blocks and the vegetation has been cleared or substantially modified through the introduction of non-native plants by landowners. At all locations exotic weed species such as *Lantana camara* (lantana), *Ageratina adenophora* (crofton weed) and *Rivina humilis* (coral berry) pose a threat to *C. cunninghamii* through competition and habitat alteration. Given that relatively high temperatures are beneficial for the germination of *C. cunninghamii* seeds, tall dense thickets of lantana may also reduce fire intensity and frequency and this may in turn have a detrimental impact on the long-term survival of the species. Although many of the above-

mentioned factors are generally considered threatening processes, it should be noted that some disturbance is beneficial to the species and as such the impact of these threatening processes needs to be assessed on a site-by-site basis.

Genetics and morphology

Preliminary cytological studies indicate that *C. cunninghamii* is a natural tetraploid, with a chromosome number of 2n=28 (Halford, 1995a).

Isozyme studies have been used to determine the level of genetic diversity within and between populations of *C. cunninghamii* in Queensland and N.S.W (Simmonds, 2000). Individuals from all 13 known populations (10 in Queensland; 3 in N.S.W) were found to be homozygous at the 15 loci examined indicating that genetic diversity in this species is low. The mean expected panmictic heterozygosity (H_e) value for *C. cunninghamii* was 0.087, which is lower than that reported for other short-lived perennial herbaceous species (H_e= 0.116) but similar to that of other endemic species (H_e= 0.096). Of concern is the fact that the mean number of migrants (N_m) was determined to be 0.00. In general values greater than one are considered necessary to prevent local differentiation between populations due to genetic drift (Slatkin, 1987). Mean genetic distance between populations was 0.102 (range 0.0000-0.2624), which is high compared to some other Australian trees and woody shrubs (Sampson *et al.*, 1995). Unique alleles and loci identified in the Mount Cotton and Toonumbar (N.S.W) populations increased the genetic distance between the populations and revealed that the Mount Cotton site is genetically located between the other Brisbane populations and Toonumbar. These studies indicate that populations in Queensland and N.S.W will need to be conserved in order to maximise the genetic diversity of the species.

Morphological variations in leaf, fruit, flower and stem characteristics have been noted between populations of *C. cunninghamii* (Halford, 1995a). However, studies conducted by Simmonds (2000) indicated that leaf characteristics (width and length) were not significantly different between populations, and suggested that minor differences may be due to site microclimatic conditions. Morphological differences between populations requires further investigation.

Propagation and cultivation

Over the years *C. cunninghamii* has been cultivated by the Brisbane Botanic Gardens, North Coast Botanic Gardens in Coffs Harbour and the Australian National Gardens in Canberra (Halford, 1995a). In the 1990's, a population was established at the Brisbane Botanic Gardens from seeds previously collected from the Pullenvale area in Queensland. The species had been recorded at Pullenvale in 1983 but had not been seen at this site for many years before seeds, which had been stored by the North Coast Botanic Gardens, were provided to the Brisbane Botanic Gardens for germination and the eventual re-introduction of the species to the Pullenvale location. The effectiveness and status of this re-introduction program is currently unknown and needs to be investigated. *C. cunninghamii* plants established at Brisbane Botanic Gardens have also provided valuable information regarding the reproduction and growing condition requirements of the species (Cameron, 1997; Simmonds, 2000). Plants appear to prefer a sheltered site with sufficient sunlight and well-drained, cool soil since prolonged periods of soil moisture can lead to bacterial rot of stems and roots (Halford, 1995a; Cameron, 1997). In addition plants may be grown from soft or hard tip

cuttings, with the latter being a more successful method (Halford, 1995a). It should be noted that most of the cultivated material is likely to have originated from only a few individuals and populations, and as such should not be relied on to rescue the species from extinction.

2.5 Reasons for listing

C. cunninghamii is a naturally rare species due to its restricted geographical distribution, low level of seedling recruitment in the absence of fire or other mechanical disturbance, and the fact that the species has a short lifespan and is not self-compatible, requiring other individuals in close proximity in order to produce seed. Although the number of individuals currently in the wild is relatively high (approximately 6000 individuals) and the number of populations has increased since 1993 in Queensland, as recently as 2000 the total number of individuals was estimated at only 1032 individuals. This fluctuation reflects how susceptible this species is to extinction if populations are not effectively monitored and managed in the long-term. At some sites, population numbers are currently so low that they are likely to disappear unless some form of natural disturbance, or human intervention is able to facilitate the germination of seeds (if present) from the soil seed bank in the near future.

A further concern is that genetic diversity within populations of *C. cunninghamii* are very low. This may reduce individual fitness in the short-term and lower the populations viability and ability to adapt to change in the long-term.

The species is also threatened by weed invasion. Dense infestations of *Lantana camara* (lantana) and other introduced weed species threaten to displace surviving populations and alter the subtropical rainforest-open eucalypt forest ecotone that *C. cunninghamii* grows in.

2.6 Existing conservation measures

C. cunninghamii is listed as an endangered species in Queensland and New South Wales under the under the Queensland *Nature Conservation (Wildlife) Regulation, 1994* (Schedule 2, Part 2) and the New South Wales *Threatened Species Conservation Act, 1995* (Schedule 1) respectively. It is also listed as Endangered by the Commonwealth under the *Environmental Protection and Biodiversity Conservation Act, 1999*. As an endangered plant species it is an offence to, or to attempt to gather, pluck, cut, pull up, destroy, dig up, fell, remove or injure a protected plant or any part of a protected plant, other than under those exceptions listed under Sections 62 (1) and 89 (1).

Most of the known populations of *C. cunninghamii* occur in protected areas, or land that is secured by conservation agreements, ownership or tenure. In Queensland, the largest Wongawallan and both Ormeau sites have been secured since the original conservation statement and draft recovery plan was written in 1995 (Halford, 1995a). However, until sustainable land management strategies are implemented, with respect to fire and disturbance regimes, the species is far from secure.

New South Wales is also currently preparing a recovery plan for *C. cunninghamii* and conducting research into the life history, population dynamics and the role of fire and mechanical disturbance in the long-term management of the species. A shared interest in conserving *in-situ* populations of *C. cunninghamii* and the exchange of information between

states (Queensland and N.S.W) is likely to benefit the conservation of the species in the long-term.

3. Recovery objectives, criteria and actions

The overall objective of this recovery plan is to protect known populations of *C. cunninghamii* in Queensland from further decline, and to maintain and/or enhance sustainable population levels in the wild, in the long-term with minimum management. Given current population numbers and improved management of individual populations it is foreseeable that within 10 years of implementing the current recovery plan that the conservation status of *C. cunninghamii* would be downlisted from 'endangered' to 'vulnerable'.

3.1 Recovery objectives

- Update and improve existing knowledge of the ecology and distribution of *C. cunninghamii* in south-east Queensland.
- Protect and/or enhance wild populations of *C. cunninghamii* and their habitat from further decline by developing management strategies for land managers.
- Increase community awareness and involvement in maintaining and enhancing populations of *C. cunninghamii*.
- Improve the conservation status of *C. cunninghamii* from 'endangered' to 'vulnerable' within 10 years and to double the number of plants in critical populations within 5 years.

3.2 Recovery criteria

- Achieve an understanding of population dynamics, reproductive biology, and the role of fire and disturbance in the life history of *C. cunninghamii*.
- Secure an appropriate level of protection for the habitat of existing populations of *C. cunninghamii*.
- Maintain or enhance existing populations of *C. cunninghamii*.
- Rehabilitate habitat where populations of *C. cunninghamii* currently exist.
- Develop sustainable land management strategies for *C. cunninghamii* populations based on monitoring and recovery programs.
- Increased community awareness of *C. cunninghamii* through the distribution of educational information on the species, through voluntary involvement in habitat recovery and monitoring programs, as well as consultation with indigenous groups regarding conservation of the species and the land on which it occurs.

3.3 Recovery actions

- **Action 1:** Investigate population dynamics by tagging and monitoring the life history of individual plants in existing populations of *C. cunninghamii*.
- **Action 2:** Investigate the role of fire and weed disturbance on the ecology of individual plant populations.

- **Action 3:** Implement management programs (e.g. fire and weed disturbance regimes) that improve the habitat of known populations of *C. cunninghamii* and increase population numbers.
- **Action 4:** Consultation and involvement of indigenous groups that have an interest in land on which *C. cunninghamii* occurs.
- **Action 5:** Preparation and distribution of educational material (bookmarks and posters) highlighting the endangered status of *C. cunninghamii* to conservation groups and the general public.
- **Action 6:** Recruitment of community volunteers to participate in monitoring and habitat recovery programs.

3.3.1 Action 1 Investigate population dynamics.

To gain insight into the demography of this short-lived species a monitoring program is currently being undertaken. The total number of individuals, condition, age structure, and the number of flowering and fruiting individuals has been determined for each of the ten existing populations of *C. cunninghamii* in Queensland (Parr, 2001). Individual plants from five of these populations (Sites 2, 3, 7, 8 and 10) have been permanently tagged and further monitoring, to determine the life history of these individuals and the species in general, will be conducted on a six-monthly basis over the years 2001 and 2002. After this time monitoring will be conducted at these sites annually. In addition to monitoring individual plants a region surrounding the tagged individuals, ranging from 100–2500m^2, will also be examined to determine if the soil seed bank adjacent to the tagged individuals is viable, at what rate seedlings are being recruited and whether the population is stable, increasing or in decline. Results obtained from the monitoring program will be provided to the Queensland Herbarium and other interested parties (e.g. N.S.W National Parks and Wildlife Service), as well as being included in the monitoring reports, that will be submitted to the Natural Heritage Trust (NHT) in October 2001 (Parr, 2001) and October 2002.

3.3.2 Action 2: Investigate the role of fire and weed disturbance

Disturbance plays an important role in the normal life-cycle of *C. cunninghamii* (Halford, 1995a; N.S.W., 1999; Simmonds, 2000; Stewart, 2000), with both fire and mechanical disturbance promoting the germination of soil-stored seed. As part of the current recovery plan a variety of weed control regimes and methods, and prescribed burn regimes will be trialed at four to six (Sites 4, 5, 6, 7, 9 and 10) of the existing populations of *C. cunninghamii*. The disturbance regime trialled at each of these sites will be dependent on the value of the existing habitat for *C. cunninghamii* (i.e. the level of weed disturbance and number of individuals), safety factors, the previous disturbance history and/or management of the site and ownership, or other management constraints. The total number of *C. cunninghamii* plants in the recovery site, their condition, age structure, and the number of flowering and fruiting individuals will be determined prior to disturbance and bi-monthly thereafter. Vegetation surveys will also be conducted before and after disturbance so that changes in species diversity of flora at the site, and the effectiveness of a particular disturbance regime can be ascertained. Results obtained from the disturbance studies will be made available to the landholders/managers of sites where *C. cunninghamii* populations occur and be included in monitoring reports that will be submitted to the NHT in 2001 (Parr, 2001) and 2002.

3.3.3 Action 3: Implement management programs

Results obtained from recovery Actions 1 and 2 are necessary to determine how populations of *C. cunninghamii* may be most effectively managed and conserved in both the short and long-term. Action 3 of the recovery plan aims to implement fire and disturbance regimes that have been found to be effective in maintaining, increasing or extending the range of *C. cunninghamii* populations and the subtropical rainforest-open eucalypt forest ecotone that it occurs in. Dissemination of effective management strategies to landholders/managers in Queensland and New South Wales will be straightforward given that most of the known populations of *C. cunninghamii* occur in protected areas, or land that is secured by conservation agreements, ownership or tenure. In Queensland, the largest Wongawallan and both Ormeau sites have been secured since the original conservation statement and draft recovery plan was written in 1995 (Halford, 1995a). Individuals involved in the management of the four Queensland locations are all members of the recovery team (RERT), as well as being the main instigators of the recovery plan for *C. cunninghamii* in Queensland. These individuals will therefore be supportive and assist in implementing the recommended management regimes. Information about management strategies for *C. cunninghamii* are also likely to be well received in New South Wales, given that a recovery plan for the species is also being prepared in this state. An exchange of information, with respect to management and other issues, between states will benefit the conservation of *C. cunninghamii* in the long-term.

3.3.4 Action 4: Consultation and involvement of indigenous groups

Based on available information the species does not appear to have cultural significance for indigenous peoples. However, Action 4 aims to identify which groups have land claims at *C. cunninghamii* locations so, that if identified, they can be informed and their role, interests and knowledge can be accommodated and/or utilised in the current recovery plan. Two groups (the Turrabul and Gurrumngar tribes) may have an interest in the BFP location, however it is still necessary to confirm this. So far no groups have been identified with regard to the Wongawallan, Ormeau and Mount Cotton populations but this will require further investigation. Once groups are identified it will be necessary to consult and involve the relevant groups with regard to implementing the recovery plan actions and possibly identify additional actions. The Queensland Parks and Wildlife Service and Environmental Protection Agency currently has the expertise to identify and liaise with the indigenous groups and relevant Shire Councils, and will be responsible for implementing this action in conjunction with Shire Council officers and members of the recovery team.

3.3.5 Action 5: Preparation and distribution of educational material

Educational material has been prepared in an attempt to increase the awareness of the general public and targeted community groups to the presence and endangered status of *C. cunninghamii* in Queensland. To date a set of three posters, an identification brochure and identification bookmark have been produced. One poster provides information, photographs and diagrams that will aid in the identification of *C. cunninghamii,* as well as additional information on its habitat, distribution, status and the conservation measures needed to protect this species from further decline. The second poster describes the rainforest ecotone recovery team (RERT) and its plan to implement a monitoring and recovery program for *C. cunninghamii,* while the third poster identifies other rare or threatened ecotonal plant species. It was suggested by the Queensland Herbarium that *C. cunninghamii* be been given the common name Cunningham's Jute. This name has been adopted by the recovery team and has been included on all educational material. Educational material will be displayed and/or

distributed to: community conservation groups such as the Society for Growing Australian Plants (SGAP) and the Brisbane Rainforest Action Information Network (BRAIN), Brisbane Forest Park, selected nurseries and libraries, landholders, shire council or community display areas in regions where the species is likely to occur, and at organised events such as Threatened Species Day. The Project Co-ordinator and/or other members of the recovery team will speak about the project to interested community conservation groups and provide information for community group newsletters and the media. Increased community awareness resulting from the presentation and distribution of information about *C. cunninghamii*, will facilitate the recruitment of volunteers for the monitoring and habitat recovery programs (Action 6) and will assist in identifying additional populations of the species on both freehold and already protected land.

3.3.6 Action 6: Recruitment of community volunteers

Community volunteers will play an integral role in successfully implementing the recovery plan for *C. cunninghamii*. Volunteers are required to participate in the monitoring (Action 1) and habitat recovery (Action 2) programs, as well as assisting in disturbance regimes that will improve the habitat of known populations of *C. cunninghamii* (Action 3). It is estimated that approximately 1000 volunteer hours per year will be needed to achieve Actions 1, 2 and 3 of the recovery plan. Action 5 and the increased community awareness it provides will facilitate the recruitment of these volunteers. Volunteers have and will continue to be recruited directly through members of the recovery team, or through the actions of the Project Co-ordinator. These actions will include advertising in local newspapers, liaison with local community groups, school groups and recovery team members. The Project Co-ordinator and other members of the recovery team will be responsible for supervising and training the volunteers in species identification, monitoring populations, weed removal, habitat recovery and safety requirements. A valuable source of volunteers has been obtained from the already well-established volunteer program in operation at Brisbane Forest Park (BFP), where four of the ten populations of *C. cunninghamii* occur. Volunteer groups that currently assist in new projects and managing BFP's natural resources include Green Reserve Volunteers and Resource Volunteers. To date these groups have been involved in monitoring the *C. cunninghamii* populations at BFP and Wongawallan, as well as playing a role in the recovery of habitat at BFP. Given the number of BFP volunteers and other individuals that have already participated or shown interest in the project, the inability to recruit volunteers is unlikely to be a problem in implementing the current recovery plan.

3.4 Recovery team

The Rainforest Ecotone Recovery Team (RERT), which is responsible for instigating the current recovery plan for *C. cunninghamii* in Queensland, was formed in 1999. Members of the recovery team will meet every two to three months to review progress made towards implementing the recovery plan, review the outcome of actions and develop strategies to continue the actions identified in the recovery plan. The Project Co-ordinator, funded by an NHT grant (2000–2002), will co-ordinate the recovery meetings, liaise with stakeholders about project requirements, problems or changes to the monitoring or recovery program, implement recovery actions and prepare monitoring/progress reports. Representatives on the recovery team, individuals that have provided input into the current plan and authorities responsible for implementing the specific actions of this recovery plan include:

- Bruce Noble (Queensland Parks and Wildlife Service/Brisbane Forest Park)
- Jason Searle (Gold Coast City Council)
- Rosalie Eustace (Redlands Shire Council)
- Tina Manners (Brisbane City Council)
- Shannon Parr (RERT Project Co-ordinator)
- Wil Buch (Queensland Parks and Wildlife Service)
- Sylvia Millington (Queensland Parks and Wildlife Service)
- Dr William McDonald (Queensland Herbarium)
- David Halford (Queensland Herbarium)
- Klaus Querengasser (Brisbane Rainforest and Action Information Network (BRAIN)/ University of Queensland)
- Melanie Simmonds (University of Queensland)
- Dr Julia Playford (Queensland Parks and Wildlife Service/University of Queensland)
- Dr Marion Saunders (Queensland Parks and Wildlife Service/University of Queensland)
- Philip Cameron (Brisbane Botanic Gardens)

3.5 Implementation schedule

Action	Task description description	Priority	Feasibility (%)	Responsible Party	Time frame
1	Investigate population dynamics by tagging and monitoring the life history of individual plants in existing populations of *C. cunninghamii*.	1	100 %	Project Co-ordinator and Recovery Team in conjunction with volunteers.	Initial phase will be completed by Aug 2003, but will continue after this time on an annual basis.
2	Investigate the role of fire and weed disturbance on the ecology of individual plant populations.	1	100 %	Project Co-ordinator and Recovery Team in conjunction with volunteers and QPWS and BFP staff.	Initial phase will be completed by Aug 2003, but will continue after this time
3	Implement management programs (e.g. fire and weed disturbance regimes) that improve the habitat of known populations of *C. cunninghamii.*	2	90 %	Recovery Team in conjunction with the Project Co-ordinator, volunteers and QPWS and BFP staff.	Ongoing
4	Consultation and involvement of indigenous groups.	1	100 %	Queensland Parks and Wildlife Service and Environmental Protection Agency in conjunction with Brisbane City Council, Gold Coast City Council, Redlands Shire Council and Recovery Team members.	Initial approaches and consultations should be completed by 2003, but is likely to be ongoing
5	Preparation and distribution of educational material (bookmarks and posters) highlighting the endangered status of *C. cunninghamii* to conservation groups and the general public	1	100 %	Project Co-ordinator, Recovery Team and Redlands Indigiscapes Centre staff.	Preparation completed by Nov 2001. Distribution will be ongoing.
6	Recruitment of community volunteers to participate in monitoring and habitat recovery programs.	1	100 %	Project Co-ordinator and Recovery Team.	Ongoing

4. Acknowledgements

- The original conservation statement and draft recovery plan for *C. cunninghamii*, prepared by David Halford in 1995, provided the basis for the current recovery plan and as such is acknowledged here.
- We would like to thank Bill Faulkner (N.W.S NPWS) for providing us with a copy of the draft recovery plan for *C. cunninghamii* in N.S.W, and Dr. Barbara Stewart (Landmark Ecological Services Pty Ltd) for providing us with copies of Stage 1 and Stage 2 reports resulting from studies conducted on N.S.W populations of *C. cunninghamii*.
- The team would also like to acknowledge research done on the species by Melanie Simmonds as part of her Honours studies in 2000, and for providing us with copies of her thesis.
- The team would like to thank Glenn Leiper for allowing us to use his photographs in posters and educational material (recovery plan Action 4).
- Klaus Querengasser's input in generating vegetation species lists for the Queensland sites and his help in monitoring changes in floral diversity is greatly appreciated and acknowledged, as is Sylvia Millington's efforts with regard to the Ormeau sites.
- Funding for the Project Co-ordinators salary was provided though a Natural Heritage (NHT) Grant.
- This plan was written as a result of funding from Brisbane City Council, Gold Coast City Council, Redlands Shire Council and Brisbane Forest Park.

5. References

Cameron, P.M. (1997). Towards the preservation and conservation of *Corchorus cunninghamii F. Muell.:* an endangered species in southeast Queensland. *Danthonia* **6**: 6-7.

Halford, D.A. (1995a). Conservation statement and draft recovery plan *for Corchorus cunninghamii F. Muell.* Tiliaceae. Australian Nature Conservation Agency, Endangered Species Program, Project No. 515.

Halford, D.A. (1995b). Notes on Tiliaceae in Australia, 2. A revision of the simple-haired species of the genus *Corchorus* L. *Austrobaileya* **4**: 297-320.

Harden, G.J. (1990). Tiliaceae. *In* "Flora of New South Wales" Volume 1. N.S.W. University Press. 318-319.

N.S.W. National Parks and Wildlife Service (1999). *Corchorus cunninghamii* F. Muell. Draft recovery plan.

Parr, S. (2001). Recommended recovery actions for *Corchorus cunninghamii* and the rainforest ecotone in south-east Queensland. Stage 1 report. Submitted to the Natural Heritage Trust (NHT).

Sattler, P. and Williams, R. (1999). The conservation status of Queensland's bioregional ecosystems. Published by the Environmental Protection Agency, Brisbane.

Simmonds, M. (2000). The ecology and conservation of the endangered *species Corchorus cunninghamii* F. Muell. Honours Thesis. University of Queensland.

Slatkin, M. (1987). Gene flow and the geographic structure of natural populations. *Science* **236**, 787-792.

Stanley, T.D. and Ross, E.M. (1986). Tiliaceae. *In* "Flora of South-eastern Queensland" Volume 2. Queensland Herbarium and Department of Primary Industries. 60-62.

Stewart, B. (2000). Population dynamics and disturbance regime requirements of *Corchorus cunninghamii.* (Stage 1 report). Prepared for the N.S.W. National Parks and Wildlife Service by Landmark Ecological Services Pty Ltd.

Appendix

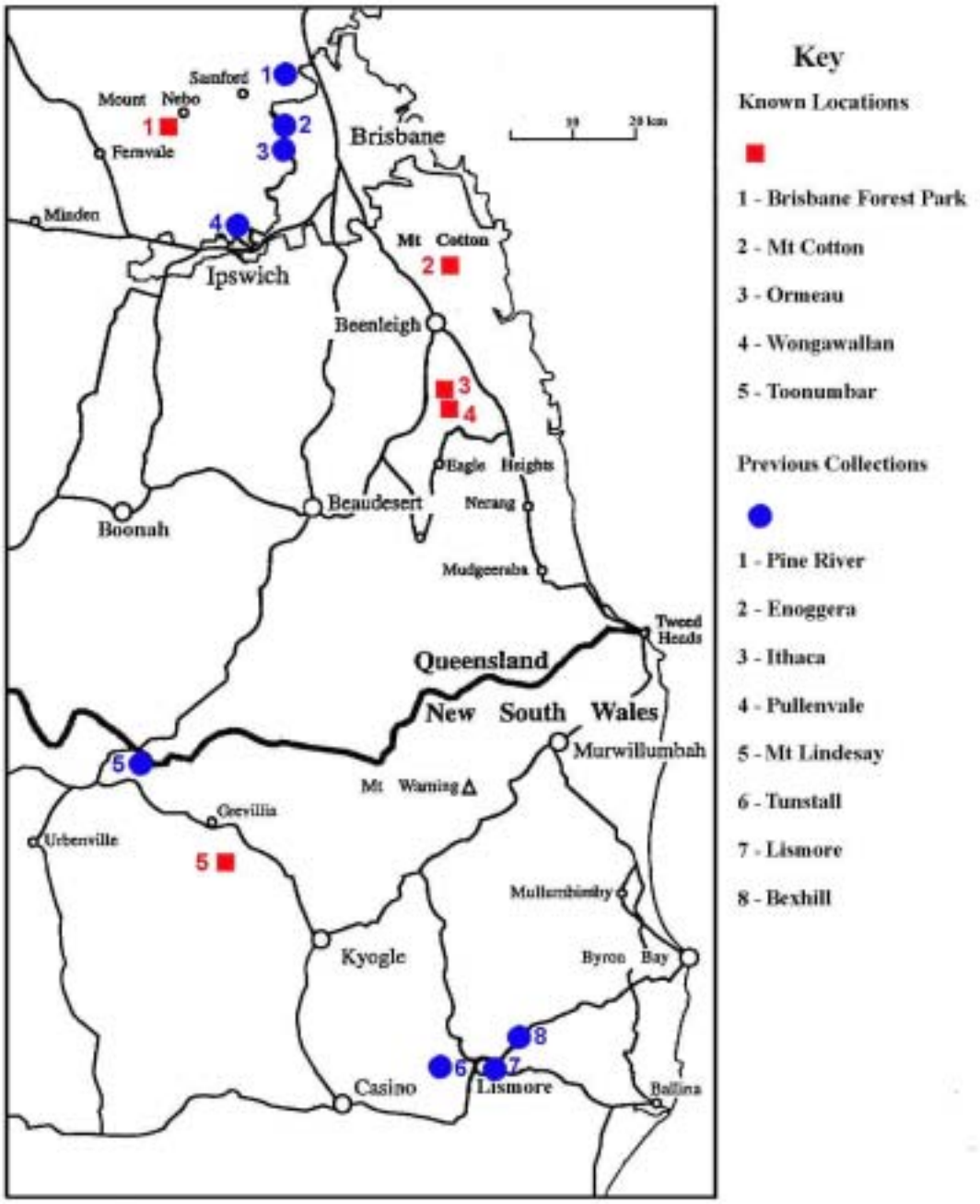

Figure 1: Locations of currently known and previous collections of *Corchorus cunninghamii*. (Map provided by Dr J. Playford)

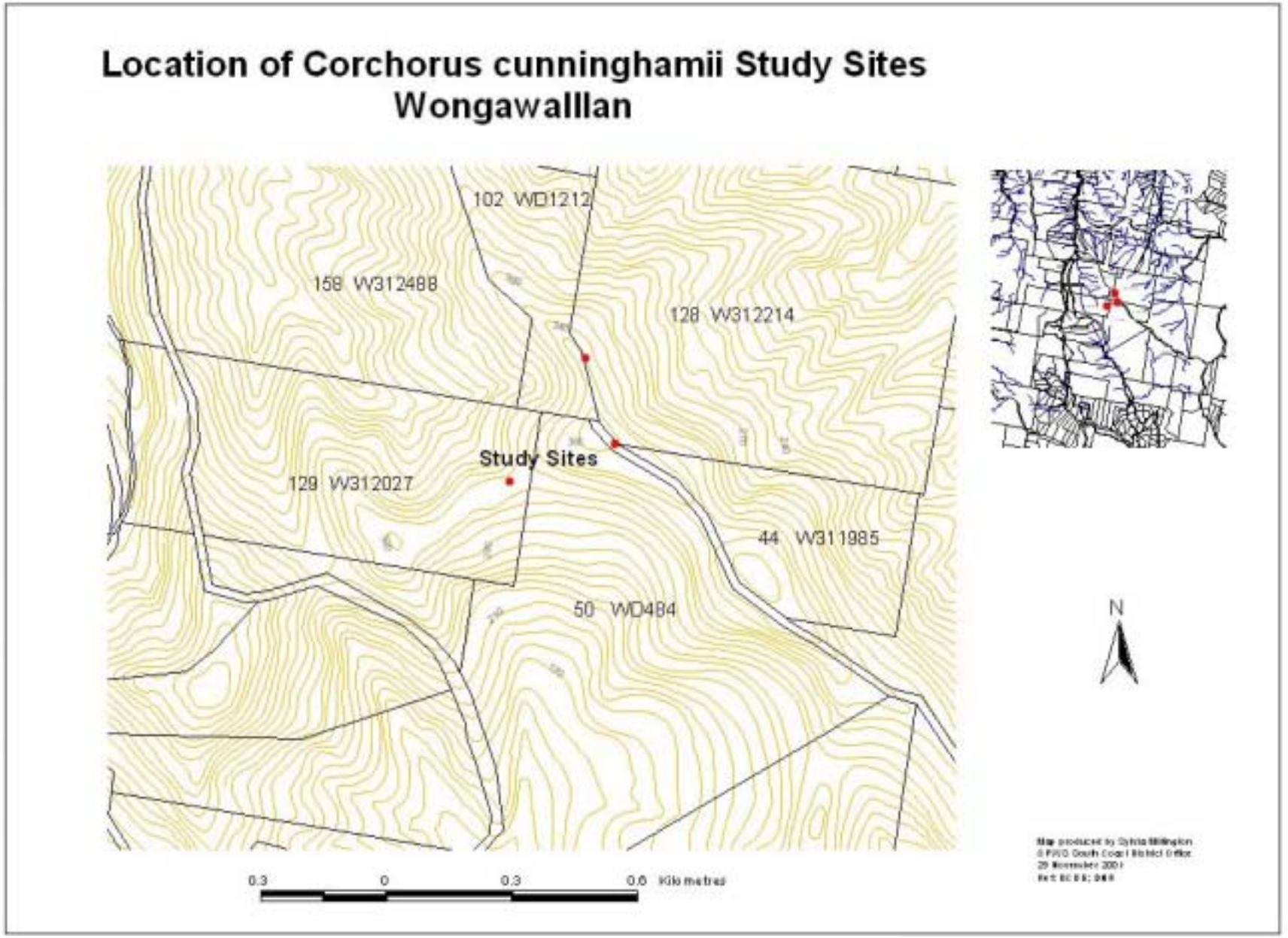

Figure 2: Wongawallan population locations (Map provided by S. Millington)

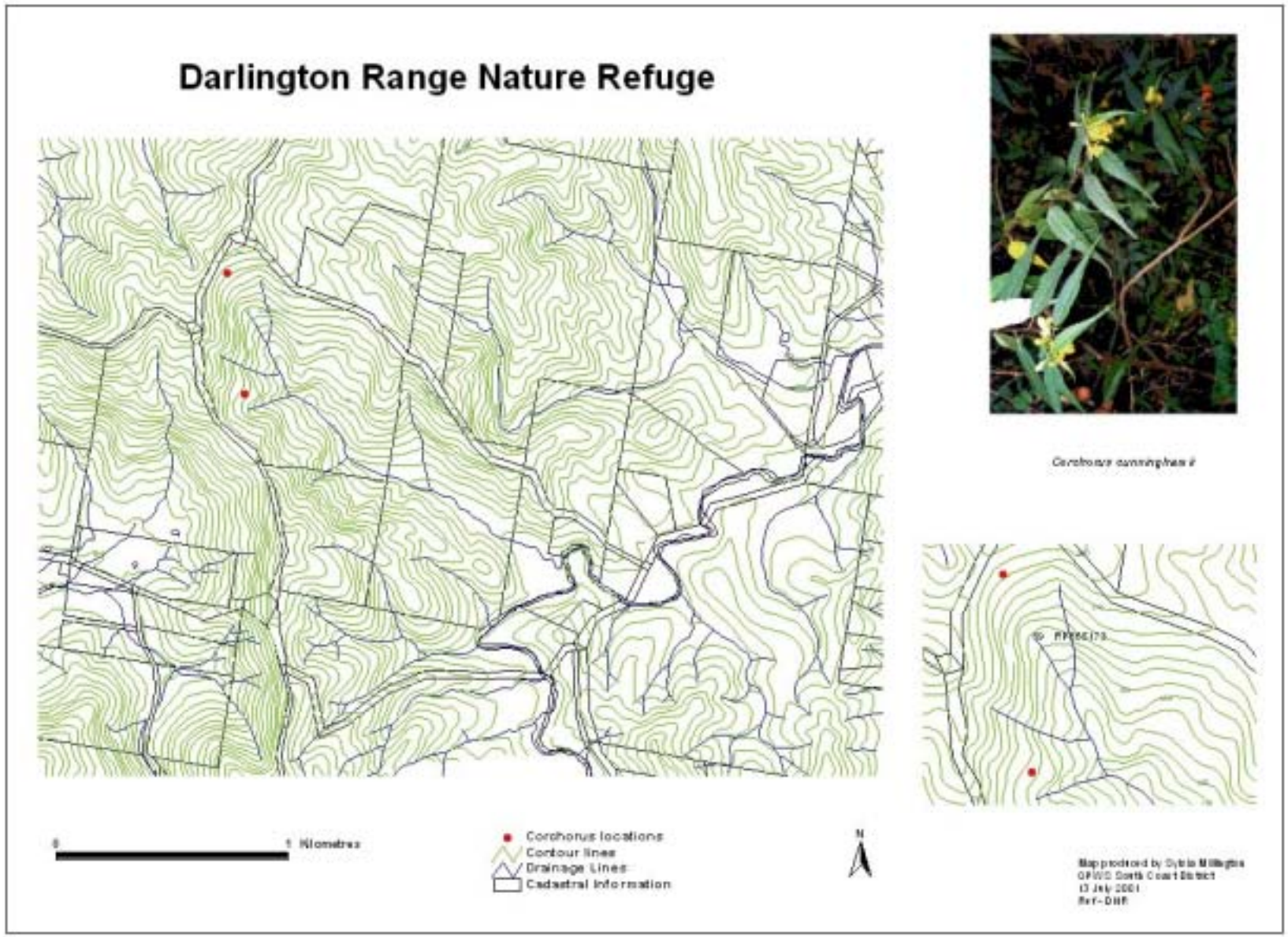

Figure 3: Ormeau (Darlington Range) population locations (Map provided by S. Millington)

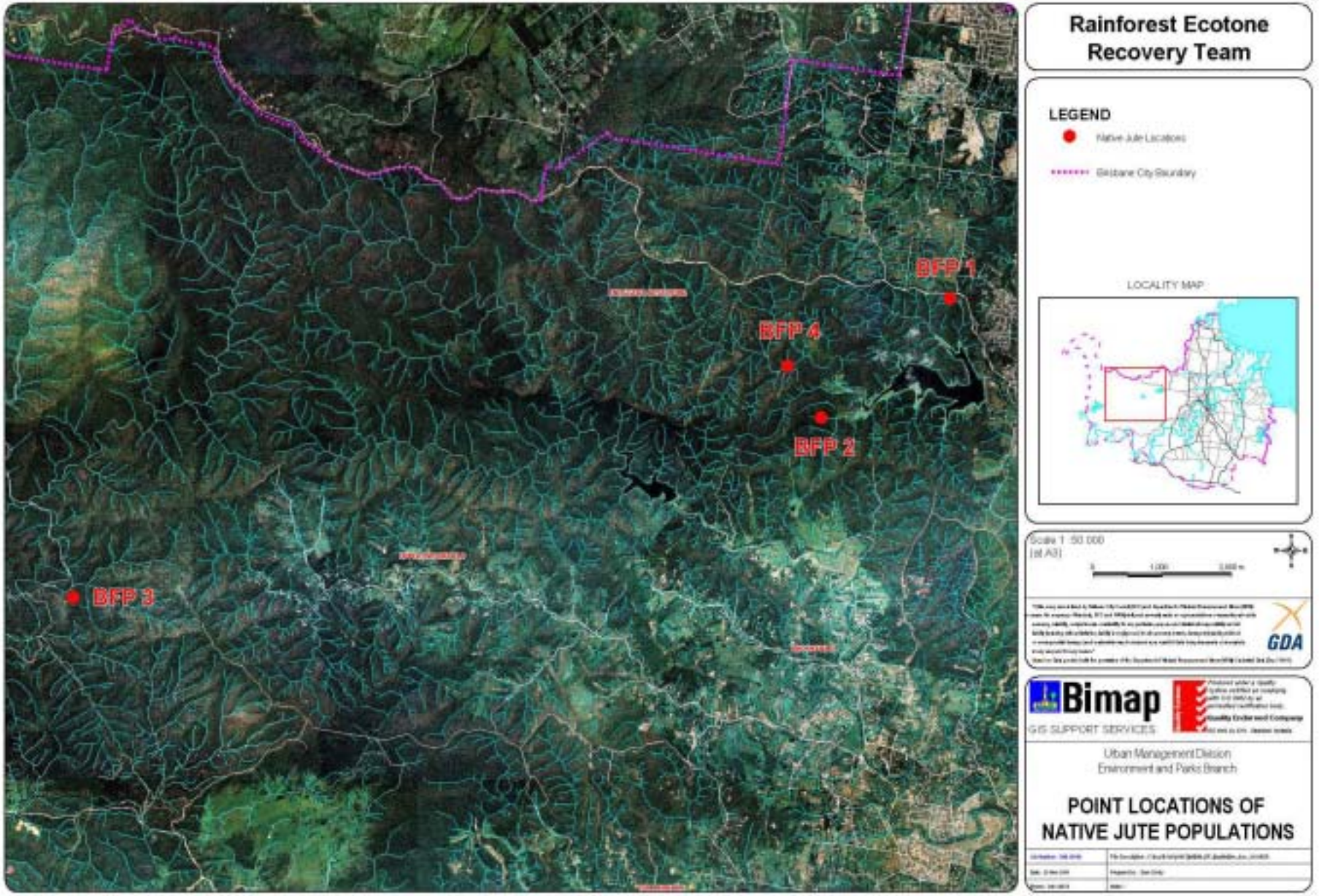

Figure 4: Brisbane Forest Park population locations (Map provided by T. Manners)

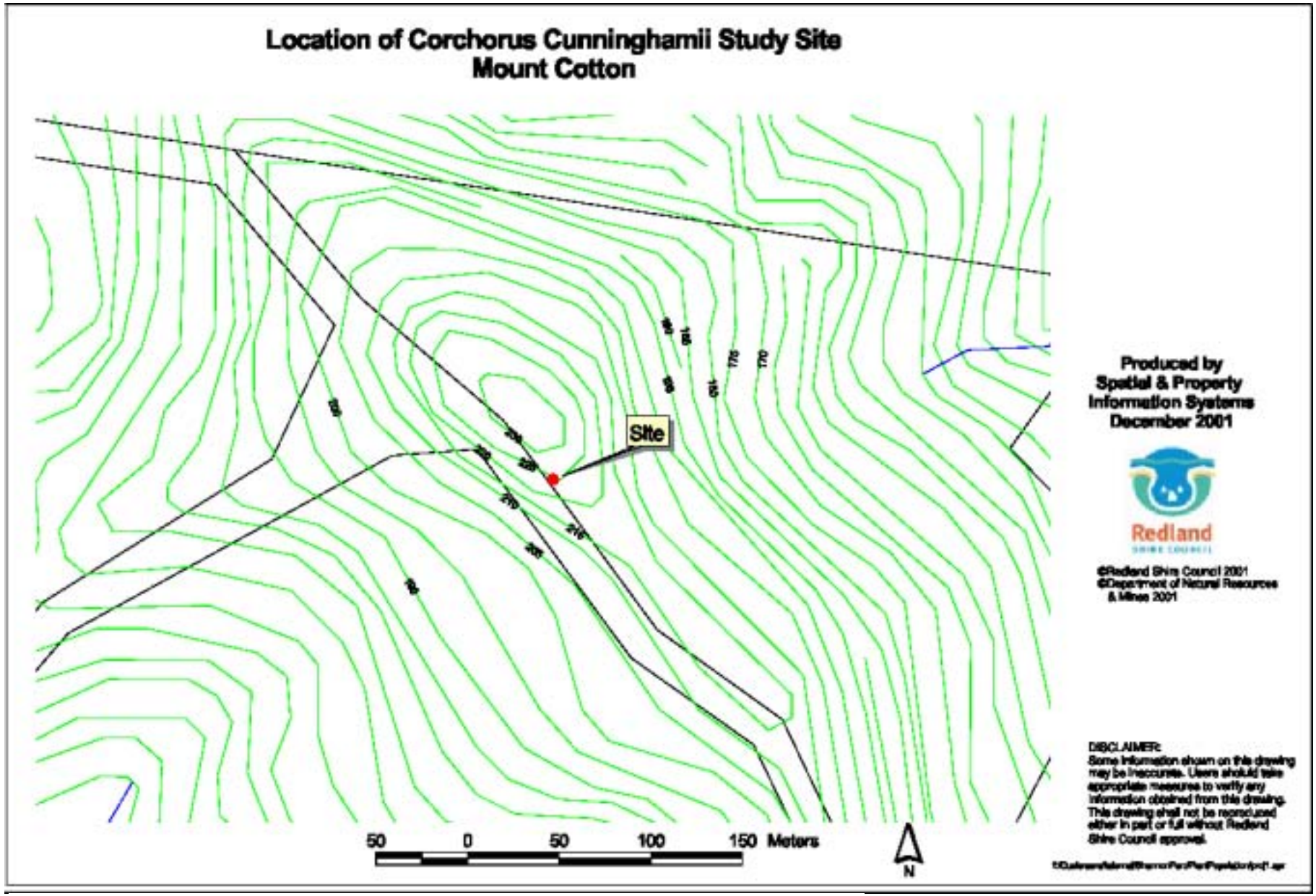

Figure 5: Mount Cotton population location (Map provided by C. Psenicnik)