KAKADU THREATENED FLORA REPORT (Vol. 3)

Results of a survey of threatened flora

March, 2005

Report to Parks Australia North

from

Northern Territory Government
Department Infrastructure, Planning and Environment

prepared by

Ian Cowie
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Cover Photograph: *Dubouzetia australiensis*, a cliff-dwelling shrub endemic to sandstone areas of Kakadu – Western Arnhem Land and the only Australian representative of the genus.
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Abstract

Kakadu National Park and Western Arnhem Land, with more than 200 NT endemic plant species, contain by far the highest concentration of any region in NT. In excess of 180 of the endemic and disjunct species occurring in Kakadu are regarded as threatened or potentially threatened species and have formed the subject of a series of surveys. This report summarizes the results of a survey of Threatened Flora carried out in Western Arnhem Land and adjacent areas of Kakadu National Park (KNP) in August 2004 and is a supplement to the reports on work carried out in 2003 and March 2004 (Kerrigan 2003, 2004). It should be read in conjunction with them.

The aim of this survey was to improve knowledge of the distribution and abundance of targeted threatened flora to enable proper assessment of their status against IUCN criteria as well as to monitor populations of some species. Four plant species with a threatened status at either the Commonwealth or Territory level were targeted for survey over five days in the field (Boronia quadrilata, Cephalomanes obscurum Dichapetalum timoriense and Dubouzetia australiensis). An additional data deficient species, Boronia amplectens, known from just two locations and occurring in the same area was also targeted. Data on the number of individuals in sub-populations, area of occupancy, extent of occurrence and habitat were recorded for four of these species. Cephalomanes obscurum was not relocated. Permanent monitoring plots were established for two species (Dichapetalum timoriense and Dubouzetia australiensis). The permanent monitoring plot for Boronia quadrilata was reassessed and it was evident that there had been significant recruitment of juveniles during the past wet season with an increase of 24 individuals in the plot since March 2003. In addition, six other species of conservation interest were encountered during the course of the survey and data were collected on these. For Dichapetalum timoriense and Dubouzetia australiensis, the data collected indicated a downgrading of the IUCN status to Near Threatened was justified. Further survey of population sizes, area of occupancy, extent of occurrence and possible threats are required for most species considered here. The inadequacy of taxonomic knowledge of Boronia laxa and B. amplectens was highlighted by the survey.

For the threatened taxa considered in this study, highest priorities for further survey work were Cephalomanes and Boronia quadrilata whilst amongst the data deficient species the highest priorities were seen as Hibbertia sp. South Magela, Taenitis pinnata, Microcorys elliptica, and Hibbertia sp. Mt Howship. However, a more strategic analysis of priorities for further survey amongst all threatened and data deficient taxa in the region is needed.
<table>
<thead>
<tr>
<th>Species</th>
<th>Commonwealth Status (EPBC Act, 1999)</th>
<th>NT Status (TPWC Act, 2000)</th>
<th>Proposed NT Status</th>
<th>Recommendations</th>
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<tbody>
<tr>
<td>Kakadu/Arnhem Land Species</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Boronia laxa</em></td>
<td>V</td>
<td>NT</td>
<td>NE</td>
<td>Interrogate relevant Fire Plot data to identify changes in population density over time. Resurvey monitoring plot in 2005/6. Further survey in Western Arnhem Land to resolve taxonomic issues.</td>
</tr>
<tr>
<td><em>Dichapetalum timoriense</em></td>
<td>v</td>
<td>nt</td>
<td></td>
<td>Further survey of population sizes, area of occupancy, extent of occurrence to confirm status. Re-survey monitoring plot in 2009.</td>
</tr>
<tr>
<td><em>Grevillea rubicunda</em></td>
<td>DD</td>
<td>DD</td>
<td></td>
<td>Further survey of population sizes, area of occupancy, extent of occurrence.</td>
</tr>
<tr>
<td><em>Hibbertia sp. Mt Howship</em></td>
<td>DD</td>
<td>DD</td>
<td></td>
<td>Further survey of population sizes, area of occupancy, extent of occurrence.</td>
</tr>
<tr>
<td><em>Hibbertia sp. South Magela</em></td>
<td>Not coded</td>
<td>DD</td>
<td></td>
<td>Further survey of population sizes, area of occupancy, extent of occurrence.</td>
</tr>
<tr>
<td><em>Microcorys elliptica</em></td>
<td>DD</td>
<td>DD</td>
<td></td>
<td>Further survey of population sizes, area of occupancy, extent of occurrence.</td>
</tr>
<tr>
<td><em>Sauropus rimophilus</em></td>
<td>DD</td>
<td>DD</td>
<td></td>
<td>Further survey of population sizes, area of occupancy, extent of occurrence.</td>
</tr>
<tr>
<td>Arnhem Land Species</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Boronia amplectens</em></td>
<td>DD</td>
<td>NT</td>
<td></td>
<td>Further survey of population sizes, area of occupancy, extent of occurrence to confirm status and to resolve taxonomic issues.</td>
</tr>
<tr>
<td><em>Boronia quadrilata</em></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>Tag seedlings from population and monitor yearly. Further survey to determine extent of population. Establish research projects to investigate biology of species.</td>
</tr>
<tr>
<td><em>Cephalomanes obscurum</em></td>
<td>en</td>
<td>en</td>
<td></td>
<td>Further searching to relocate Arnhem Land population. Survey of population sizes, area of occupancy, extent of occurrence</td>
</tr>
<tr>
<td><em>Taenitis pinnata</em></td>
<td>dd</td>
<td>dd</td>
<td></td>
<td>Further survey of population sizes, area of occupancy, extent of occurrence.</td>
</tr>
</tbody>
</table>

**Table 1. Summary of recommendations.** (EN = endangered, V = vulnerable, NT = near threatened, DD = data deficient. Codes in upper case indicate the species is endemic to NT. Species in bold were specifically targeted during the survey whilst the other species were encountered incidentally. * Note: downgrading to V recommended after surveys by Kerrigan (2003, 2004))
Introduction and Methods

Kakadu National Park and Western Arnhem Land contain nearly 200 plant species endemic to that area, by far the highest concentration of any region in the NT (Woinarski et al., unpubl.). In addition, the region contains many relictual and highly disjunct species of limited distribution in NT but otherwise known from interstate or overseas. Most of the species from these groups are closely associated with sandstone of the Western Arnhem Land Plateau and escarpment. In excess of 180 of these species occurring in Kakadu are listed under NT legislation as threatened species, data deficient species or near threatened species. Seven of these species are currently listed under the Commonwealth EPBC Act (1999). Surveys of threatened flora in Kakadu National Park and the adjoining Arnhem Land escarpment have been carried out in 2003 and March 2004 and reported by Kerrigan (2003, 2004). This survey work was further extended in August 2004, following the same protocols and methods. This document relies heavily on the previous work.

<table>
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<th>Commonwealth Status</th>
<th>NT Endemic</th>
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<td><strong>Kakadu/Arnhem Land Species</strong></td>
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</tr>
<tr>
<td>Boronia laxa</td>
<td>NT</td>
<td>V</td>
<td>yes</td>
</tr>
<tr>
<td>Dichapetalum timoriense</td>
<td>v</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Dubouzetia australiensis</td>
<td>EN*</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>Grevillea rubicunda</td>
<td>DD</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>Hibbertia sp. Mt Howship</td>
<td>DD</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>Hibbertia sp. South Magela</td>
<td>Not coded</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>Microcorys elliptica</td>
<td>DD</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>Sauropus rimophilus</td>
<td>DD</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td><strong>Arnhem Land Species</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Boronia amplectens</td>
<td>DD</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>Boronia quadrilata</td>
<td>CR*</td>
<td>V</td>
<td>yes</td>
</tr>
<tr>
<td>Cephalomanes obscurum</td>
<td>en</td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Taenitis pinnata</td>
<td>dd</td>
<td></td>
<td>no</td>
</tr>
</tbody>
</table>

Table 2. Conservation status of plant species surveyed in August 2004. (EN = endangered, V = vulnerable, NT = near threatened, DD = data deficient. * Note: downgrading to V recommended after surveys by Kerrigan (2003, 2004). Species in bold were specifically targeted during the survey whilst the other species were encountered incidentally).

The aim of this survey was to improve knowledge of the distribution and abundance of targeted threatened flora to enable proper assessment of their status against IUCN criteria. A number of threatened taxa with distributions straddling the eastern Park boundary or in Arnhem Land near the Kakadu boundary had been previously identified and some of these have been surveyed in the past (Kerrigan, 2003, 2004; pers. comm.). Such species need to be managed within the context of the overall fire management program for the Park with common management practices employed across the shared landscapes. Four plant species with a threatened status at either the Commonwealth or Territory level were chosen for survey (those in bold in Table 2) from previously assigned priorities (Kerrigan 2003, 2004). Three of these had never been the subject of a species specific survey, while Boronia quadrilata had been identified as a high priority for further survey. A fifth species, Boronia amplectens, which was known from just two locations and occurred in the same area was also targeted. Informal habitat models were erected for each taxon using herbarium label data and previous survey results to enable targeting of survey effort in the appropriate habitat. A day in the field was nominally allocated to each species, although more than one species was encountered most days. Sites occupied by these species were readily accessible only by helicopter. Data on the number of individuals in sub-populations, area of occupancy, extent of occurrence, perceived threats and habitat were recorded for each species. Permanent
monitoring plots were established for two species (Dichapetalum timoriense and Dubouzetia australiensis) and the permanent monitoring plot for Boronia quadrilata was reassessed. In addition six other species of conservation interest (those not in bold in Table 2) were encountered during the course of the survey and where possible similar data were collected on these species. Information on distribution and numbers of plants in previously known populations was sourced from Kerrigan 2003 & 2004, the NT Herbarium specimen, plot and threatened plants data bases and the NT rainforest survey database. Except where indicated, photos were taken by the author.

**Results and Discussion**

Results and discussion of this survey are presented as a series of species by species accounts (below) with a summary of results for all species presented in Table 3. Descriptions, data, rationale for coding and recommendation for future monitoring are presented under each species. Background information on the IUCN coding scheme and survey methodology can be found in Anon (2001) and Kerrigan (2003). An ArcView GIS project including all species records and search path data as well as an MS Access database with floristic and structural data from permanent plots is provided on CD with this report. The location of permanent plot and potential seedling monitoring sites are recorded in Appendix 1.
<table>
<thead>
<tr>
<th>Species</th>
<th>No. of Locations(^1)</th>
<th>Extent of Occurrence(^1)</th>
<th>Area of Occupancy (this survey)</th>
<th>Direct Counts (this survey)</th>
<th>Density (this survey)</th>
<th>Inferred population (this survey only)</th>
<th>Current code(^2)</th>
<th>Recommended code(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boronia amplectans</td>
<td>1</td>
<td>56 km(^2)</td>
<td>10.75 ha</td>
<td>&gt;114</td>
<td>2769 ±992 /ha</td>
<td>14883 ±5332</td>
<td>DD</td>
<td>NT</td>
</tr>
<tr>
<td>Boronia laxa</td>
<td>18</td>
<td>1350 km(^2)</td>
<td>Not assessed</td>
<td>Not assessed</td>
<td>Not assessed</td>
<td>Not assessed</td>
<td>NT</td>
<td>NE</td>
</tr>
<tr>
<td>Boronia quadrilata</td>
<td>1</td>
<td>95 ha*</td>
<td>23 ha*</td>
<td>112</td>
<td>114 /ha</td>
<td>2644*</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Cephalomanes obscurum</td>
<td>3</td>
<td>743 km(^2)</td>
<td>Not found</td>
<td>Not found</td>
<td>Not found</td>
<td>Not found</td>
<td>en</td>
<td>en</td>
</tr>
<tr>
<td>Dichapetalum timorense</td>
<td>5</td>
<td>238 km(^2)</td>
<td>9.5 ha</td>
<td>203</td>
<td>428 ±108 /ha</td>
<td>2261</td>
<td>v</td>
<td>nt</td>
</tr>
<tr>
<td>Dubouzetia australiensis</td>
<td>8</td>
<td>294 km(^2)</td>
<td>3.5 km cliff</td>
<td>269</td>
<td>101 ±23 /km cliff</td>
<td>785 ±183</td>
<td>EN</td>
<td>DD</td>
</tr>
<tr>
<td>Grevillea rubicunda</td>
<td>14</td>
<td>3032 km(^2)</td>
<td>c. 2 ha</td>
<td>58</td>
<td>Not estimated</td>
<td>58</td>
<td>DD</td>
<td>DD</td>
</tr>
<tr>
<td>Hibbertia sp. Mt Howship</td>
<td>8</td>
<td>993 km(^2)</td>
<td>0.2 km cliff</td>
<td>48</td>
<td>44 ±30 /km cliff</td>
<td>48</td>
<td>DD</td>
<td>DD</td>
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<tr>
<td>Hibbertia sp. South Magela</td>
<td>1</td>
<td>100 ha</td>
<td>3 km cliff</td>
<td>c. 30</td>
<td>c. 30 /km cliff</td>
<td>100</td>
<td>Not coded</td>
<td>DD</td>
</tr>
<tr>
<td>Microcorys elliptica</td>
<td>7</td>
<td>240 km(^2)</td>
<td>3 km cliff</td>
<td>c. 30</td>
<td>c. 10 /km cliff</td>
<td>30</td>
<td>DD</td>
<td>DD</td>
</tr>
<tr>
<td>Sauropus rimophilus</td>
<td>15</td>
<td>4418 km(^2)</td>
<td>3 km cliff</td>
<td>c. 30</td>
<td>c. 10 /km cliff</td>
<td>30</td>
<td>DD</td>
<td>DD</td>
</tr>
<tr>
<td>Taenitis pinnata</td>
<td>2</td>
<td>&lt; 5ha</td>
<td>&lt;1 ha</td>
<td>c. 25</td>
<td>&lt;100</td>
<td>&lt;100</td>
<td>dd</td>
<td>dd</td>
</tr>
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</table>

Table 3. Estimates for distribution, density and population sizes for species surveyed in August 2004. Standard errors are given where these could be calculated. (Note: * figures include results from Kerrigan 2004; \(^1\) estimates use distributional data from this survey, NT Herbarium Holtze and plot databases and NT Rainforest survey data; \(^2\) capitals indicate NT endemic species.)
**Boronia amplectens** and **B. laxa** sens. lat.

**Description and habitat**

These species are annual or short-lived perennial, decumbent to erect subshrubs usually less than 50 cm tall. They are characterised by their simple, opposite leaves which are narrowly elliptic to elliptic, 10–45 mm long and 2.5–10 mm wide, with many armed (stellate) hairs on both surfaces. They have sepals equal to or larger than the petals and white to pink flowers (Fig. 1).

![Flower and leaves of Boronia amplectens.](image)

**Boronia amplectens** is apparently separated from **B. laxa** sensu stricto (i.e. in its narrowest sense) by its longer peduncle (lower part of the flower stalk) which is > 4 mm long, generally narrower leaves and sparse hairs on the leaves (Duretto, 1997). However, as discussed further below, these characters do not hold up for all populations of both species and morphological variation in **Boronia laxa** sens. lat. (i.e. in its widest sense) and **B. amplectens** is in need of further study.

These species occur in sandstone woodland and heath communities. **Boronia laxa** and **B. amplectens** are known from *E. gigantangion/E. phoenicea* woodland with *Triodia microstachya* understorey, and *E. miniata* and *E. miniata/E. tetrodonta* woodland with *Symplectrodia lanata* understorey, all on well stabilised sandstone scree (Fig. 2). Individual plants grow in sand and loam between the sandstone boulders, which in many areas are approximately 30 cm in diameter.

**Previous IUCN code and status**

**Boronia amplectens** has a coding of Data Deficient and is known only from the headwaters of the East Alligator River and south of Magela Falls.

**Boronia laxa** has a status of Near Threatened in the NT and is classified as Vulnerable at the Commonwealth level (Kerrigan, 2003).
There are some taxonomic issues regarding *B. laxa* and *B. amplectens* that need to be resolved. These two species are part of a complex of closely related taxa that are in need of further study to determine if in fact they are distinct. A specimen of *B. amplectens* collected from near Magela Falls in 1994 formed the original basis for this field survey in that area. However, all material collected from there during the current survey, although otherwise identical with the previously collected specimen, has shorter peduncles more consistent with *B. laxa*. In addition, specimens from South Magela Gorge (in 2003) and East Magela Gorge (this survey) are also intermediate, having the narrow leaves of *B. amplectens* but the denser hairs of *B. laxa*. Duretto (1997) himself recognises within *B. laxa* three entities - *B. laxa sensu stricto* described above, *Boronia affin. laxa* 1 which has a more erect growth habit, and slightly larger inflorescences and floral parts and *Boronia affin. laxa* 2 which has narrower leaves with a dense indumentum of short-armed stellate hairs, a smaller inflorescence and smaller floral parts. The specimens from South Magela Gorge and East Magela Gorge may represent a fourth entity. Further field examination and collection of populations of *B. laxa* and *B. amplectens* in Western Arnhem Land is required to enable species limits to be re-examined and clarified.

The *Boronia* from near Magela Falls, is here regarded as *B. amplectens* (under a slightly broadened concept of that species). A combination of transects and density quadrats were used to derive population estimates. Populations seen were large and extensive and it was not possible to define boundaries of these in the time available. More than 114 plants were counted directly on quadrats or transects, although this is an under estimate as after an initial period it was realised that plants were too numerous to count in a reasonable time and presence only was recorded. Density estimates from quadrats give a figure of 2769 ± 992 plants per hectare. Populations were recorded along a transect of 2.15 km (Fig. 3), and with apparently suitable habitat extending for at least 25 m either side for most of this transect a population in excess of 14883 ± 5332 plants is estimated. Extent of occurrence for the species is presently estimated at 56 km².
An additional population of *B. laxa sens lat.* was found in the East Magela Gorge, 4.8 km NNE of Magela Falls but was not surveyed because of lack of time. This collection was morphologically similar to the South Magela Gorge collection, with narrower leaves than *B. laxa* those from further west.

**Figure 3.** Distribution and search path for *Boronia amplectens* and *B. laxa sens. lat.* in Magela Falls area, Western Arnhem Land, Aug. 2004. (○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ↑ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia.

Populations in the survey area occurred in fire prone environments (*Eucalyptus miniata* and *E. miniata/E. tetrodonta* woodland with *Symplectrodia lanata*, all on well stabilised sandstone scree). Although there is little conclusive evidence, it is thought that the rockiness of this habitat probably reduces the natural fire frequency to something less than annual.

**Summary of population data and revised status**

The population of *B. amplectens* near Magela Falls is estimated as in excess of 14883 ± 5332 plants with the extent of occurrence for the species estimated at 56 km² (Fig. 4) It is recommended that *B. amplectens* be altered to NT, based on the large population size, area of occupancy and extent of occurrence. Further field examination of populations and collection of specimens in Western Arnhem Land are needed to resolve taxonomic issues regarding this species and *B. laxa*.

As Kerrigan (2003) notes, *B. laxa sens lat.* has an extent of occurrence of >1100 km² and relatively large population size. However, because up to four distinct entities are involved and the taxonomy of these needs further investigation, it is recommended that the status of the species overall be altered to Not Evaluated. Within the complex, most population estimates made over the past two years apply to *B. laxa sensu stricto* with densities of 4271 ± 767 plants per hectare near Nourlangie Rock and an extent of occurrence of 347km². The category of near threatened recommended by Kerrigan (2003) appears most appropriate for
this taxon. The other entities are most appropriately regarded as not evaluated, pending further investigation.

Figure 4. Distribution of all populations of *B. amplectens* and *Boronia laxa sens. lat.*, Kakadu – Western Arnhem Land. (□ - *B. amplectens* populations known before this survey; ■ - *B. amplectens* populations recorded during this survey; △ - *B. laxa* populations known before this survey; ▲ - *B. laxa* population recorded during this survey; ● - *B. aff. laxa* 1 populations; ⊱ - *B. aff. laxa* 2 population; grid lines are spaced at 1 km intervals; ⧢ - north) 1:100,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. www.ga.gov.au
**Boronia quadrilata**

**Description and habitat**

This plant is a single to multi-stemmed shrub up to 3 m tall which is endemic to Western Arnhem Land. Distinctive characters of the species include the sharply 4-angled stems and the broad, hairless, waxy, bright green leaves, both unusual in NT Boronias. The entire known population lies with a few square kilometres at the eastern end of the Magela Creek gorge system.

Plants grow in pockets of sand amongst sandstone outcrops, in crevices amongst dissected sandstone and on rocky scree slopes (Fig. 5). The species was absent from flatter sandstone country and from massive sandstone outcrops. The dominant vegetation in this country is characteristic of much of the region, that is *Corymbia arnhemensis* open woodland to shrubland with *Triodia microstachya* and a variable shrub layer.

![Habitat of Boronia quadrilata at the east end of Magela Creek gorge (latitude 12.74° S, longitude 133.12° E), Western Arnhem Land.](image)

**Previous IUCN code and status**

After the survey of 2003, this species was estimated to have a population of just over 1000 individuals with an area of occupancy of 9 ha (Kerrigan 2003). The extent of occurrence was then estimated at 39 ha. It was recommended that the status of the species be down graded from Critically Endangered to that of Vulnerable under the IUCN criteria now used in the NT.

**2004 Survey results**

Potential habitat to the south west of previously known populations was surveyed on foot and as a result the known range of the species was extended by c. 1 km, with the limits of the population not defined in this area (Fig. 6).

Direct counts of 112 adult plants were made over a relatively narrow transect of 5 m width (to enable seedlings to be seen) and 1.97 km in length through more or less suitable habitat, giving a density of 114 plants per hectare. This compares well with an estimated density of 100 plants per hectare derived independently in 2003 (Kerrigan, 2003). Of the land surveyed in Aug 2004, the area of suitable habitat is estimated from 1:50,000 topographic mapping and local knowledge at approx. 14 ha, giving a population estimate for that area of 1596 plants.
This gives a combined area of occupancy of 23 ha, when data from the 2003 survey are included. Total extent of occurrence after the two surveys is estimated at 94 ha. Combined population estimates from the two surveys gives a figure of more than 2644 plants. The total extent of the population is still not known as potentially suitable habitat to the south and south west remains to be surveyed. Further field work to the north east of the areas surveyed is also required (see Fig. 6). Country across the valley and to the west of this years survey was investigated briefly, but the habitat appeared generally unsuitable and no *Boronia quadrilata* plants were found.

**Permanent monitoring plot**

The permanent monitoring plot established in March 2003 was reassessed in August 2004. Plants on the permanent plot were of two growth forms, that is single stemmed plants that have apparently never resprouted and many-stemmed plants that have resprouted from the base, presumably after surviving fire in the past. At the time of survey, the plot had not been burned in the current dry season nor apparently in last years dry season. Figures for population and size classes are given in Table 4.

For the purposes of the survey definitions of classes were as follows:

- adults were defined as multi stemmed and single stemmed plants that were fertile and multistemmed plants that were resprouting;
- juveniles as single stemmed plants that were not reproductive;
- resprouting plants were multi stemmed plants resprouting after recent damage and plants were classed as ‘fertile’ where there was evidence that they had flowered or fruited in the past year (old flowers, old fruits or floral bracts present).

In the field, the apex of an upper leaf (single stemmed plants) or apicies of the upper leaves (multistemmed plants) were clipped to mark individual plants as counted and to avoid double counting or missing plants.
### Table 4. Population size/age classes of *Boronia quadrilata* on the permanent quadrat.
(at 12.7358°S;133.12548°E)

<table>
<thead>
<tr>
<th>Age Class</th>
<th>Adult</th>
<th>Juvenile</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproductive class</td>
<td>Sterile</td>
<td>Sterile</td>
<td>All</td>
</tr>
<tr>
<td>Growth habit (stems)</td>
<td>many</td>
<td>single</td>
<td>respouting</td>
</tr>
<tr>
<td>Number (Mar 2003)</td>
<td>39</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Number (Aug 2004)</td>
<td>41</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

It is clear that there has been an increase of 24 individuals in the plot since March 2003, primarily in the juvenile class. The most plausible interpretation of the data is that some of last years juveniles have moved into the adult class while others have remained as juveniles, with significant recruitment of juveniles over the last wet season. If correct, this would indicate a maximum growth rate for seedlings in excess of 50 cm in their first year, with the data suggesting that some plants may reach (limited) reproductive maturity in their second year. However, as plants are not marked or measured individually, it is not possible to say more with any certainty.

The species occurs in a fire prone environment which burns regularly, although the general rockiness of the habitat is likely to result in patchy fires with fragments remaining unburned. While *B. quadrilata* plants can resprout from the base after some fire events, it is not known what fire regimes favour or disadvantage the species. Apart from unfavourable fire regimes, the population is secure with few if any obvious threats.

**Summary of population data and revised status**

Although the area of occupancy and extent of occurrence for the species have been extended to 23 ha and 95 ha respectively, it is still known from essentially one locality, with a very limited area of occupancy and extent of occurrence. In most cases, a limited area of occupancy by itself has been regarded as a weak criterion for assigning a threatened status, however in this case the extent of occurrence is of a similar order of magnitude to the area of occupancy and both are small. Essentially, *B. quadrilata* with an extent of occurrence of <1 km² lacks the security from threats derived from spatial dispersion of populations as occurs in species like *Dichapetalum* and *Dubouzetia* where the extent of occurrence is of the order of 300 km². Although the estimated population has been increased to approximately 2644 plants, it its still relatively small. The species occurs in a fire prone environment and although it has some capacity to re-sprout from the base after fire, unfavourable fire regimes are seen as a possible threat to the species. Thus it is recommended that the status of Vulnerable (V) be maintained. Further survey of the extent of occurrence and area of occupancy are required. It also is appropriate at this stage to begin studies of the ecology and population biology of the species especially with respect to fire regime.
**Cephalomanes obscurum**

**Description and habitat**

A terrestrial filmy fern, with erect fronds to 20 cm tall. Fronds are 3-pinnate to 3-pinnate–pinnatifid, 5–15 cm long, 2–9 cm wide; clusters of spores (sori) are erect, borne and on short lobes in the axils of tertiary segments (Fig. 7).

In NT, this fern grows in moist, sheltered situations around waterfalls and is known only from Melville Island and upper Magela Creek. It also occurs in eastern Australia and overseas.

![Image of Cephalomanes obscurum]

**Fig. 7. Cephalomanes obscurum.**

**Previous IUCN code and status**

The Magela Creek population is recorded as consisting of just 4 individuals while the Tarracumbie Falls population on Melville Island consists of 100 plants (Kerrigan et al., 2001). A second population on Melville Island has not been relocated and assessed. The species is currently classified as endangered in NT. The extent of occurrence is estimated at 743 km².

**2004 Survey results**

Searches of waterfalls and associated seepages were undertaken at Magela Falls and in the main Magela Creek Gorge, but no populations were relocated (Fig. 8). Russell-Smith (pers. comm.) indicates that the population may be located further within one of the gorges surveyed or alternatively in a nearby gorge running north from the main Magela Creek Gorge.

A population of the data deficient fern, *Taenitis pinnata* and further populations of *Dichapetalum*, *Dubouzetia* and several other data deficient species were discovered during this part of the survey. These are discussed further elsewhere.
Permanent monitoring plot

No permanent plot was established.

Summary of population data and revised status

Population estimates for the species have not changed and it is recommended that it remain as endangered. Further survey of small gorges running north from the main Magela Creek gorge are required to relocate the Arnhem Land population.

Figure 8. Search path for *Cephalomanes obscurum*, Western Arnhem Land, Aug. 2004. (Δ - population known before this survey (location is not accurate); ● - survey search path; grid lines are spaced at 1 km intervals; ⊙ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. www.ga.gov.au
Dichapetalum timoriense

Description and habitat

In its juvenile growth form, it is a low perennial shrub c 0.7 m tall, ultimately becoming a vine with twining upper stems. Distinctive characters of the species include the oblanceolate, alternate leaves 7–18 cm long and 3–10 cm wide with a fine ‘drip’ tip, fine stipules, the appressed greyish hairs on young shoots, branchlets and petioles and the hollow young twining stems. The fruit are globose to ovoid, velvety hairy and golden brown when fresh. Fruits are borne in April and May.

Dichapetalum grows in Allosyncarpia dominated rainforest in protected sandstone gorges usually on scree slopes where there is some soil and leaf litter accumulated but no grass layer. It appears to favour moister and more protected sites (but is not riparian) and avoids the driest and more open Allosyncarpia forests such as occur at the heads of some gullies. Plants occurred from the base of the cliffs almost to the creek line in a number of places.

Previous IUCN code and status

The species is currently regarded as Vulnerable in the NT (Kerrigan 2004). At commencement of the survey the extent of occurrence was 238 km², with a population size estimated at < 1000 mature plants.

2004 Survey results

A combination of transects and density quadrats were used to derive population estimates at several populations (Fig. 8). The effective transect width for searches was determined as 2 m, both because plants needed to be scrutinised closely to be certain of their identity and because observers were frequently searching both cliff faces and adjacent Allosyncarpia forest concurrently for different plant species. Populations seen in both the main Magela Gorge and South Magela Gorge were extensive and it was not possible to define boundaries of these in the time available. Density estimates for transects are presented in Table 5.

<table>
<thead>
<tr>
<th>Area Surveyed</th>
<th>Juvenile (plants/ha)</th>
<th>Adult (plants/ha)</th>
<th>All plants (plants/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>main Magela Gorge (2 m x 1.5 km transect)</td>
<td>133</td>
<td>250</td>
<td>383</td>
</tr>
<tr>
<td>South Magela Gorge (2 m x 0.3 km transect)</td>
<td>150</td>
<td>300</td>
<td>450</td>
</tr>
<tr>
<td>Permanent Plot (0.04 ha plot)</td>
<td>540</td>
<td>160</td>
<td>700</td>
</tr>
<tr>
<td>Magela Falls (12 x 5 m plots)</td>
<td>540</td>
<td>160</td>
<td>700</td>
</tr>
<tr>
<td>Average</td>
<td>274 ±133</td>
<td>237 ±41</td>
<td>428 ±108</td>
</tr>
</tbody>
</table>

Table 5. Density of Dichapetalum timoriense by size/age class on plots and belt transects.

Direct counts (total numbers counted) were as follows: juvenile - 108; adults - 56; total (including an additional 39 plants not classified to age/size class) - 203. The proportion of juvenile plants was 66% and of adults 34%. For the purposes of this survey, juvenile plants were defined as those not climbing and without twining stems. It is thought that many of these juvenile plants were more than one year old. All plants were sterile at the time of the survey.

For the main Magela Gorge and South Magela Gorge populations, the width of suitable habitat along the transects was estimated to be more than 50 m. Thus, for the limited area of Allosyncarpia forest sampled in South Magela Gorge, the population is estimated at 575 plants while for the main Magela Gorge, the population is estimated at 1328 plants. In both these gorges much apparently suitable habitat remains unsurveyed.
At Magela Falls, densities of plants were high, where they were recorded, although the area of occupancy was relatively small at approximately 0.54 ha. The population there was estimated at 358 plants. The total of all these estimates is 2261 plants.

In addition, *Dichapetalum* was recorded from *Allosyncarpia* forest near the *Boronia quadrilata* site in the East Magela Gorge, an extra locality over those previously known (Fig. 9, 10). Unfortunately there was not time to determine the size of this population.

The habitat of this species is naturally relatively protected and secure from fire, although occasional fires evidently occur (as indicated by fire scars on tree trunks). Indiscriminant burning or careless fire management (e.g. accidental fire bombing of *Allosyncarpia* forest from the air) is a potential threat to the community and species therein but is probably not a high risk. Apart from fire, there are few if any obvious threats.

**Permanent monitoring plot**

A permanent 0.04 ha monitoring plot for *Dichapetalum* was established in dense *Allosyncarpia* dominated rainforest near the base of Magela Falls, at 12.78409°S, 133.10071°E. Eleven adult plants, 1 resprouting adult plant and 6 juveniles were recorded.

**Summary of population data and revised status**

The plant is known from 6 broad localities while the extent of occurrence, at 238 km², has not changed as a result of the survey. A further population was detected within this range (Fig. 9) during the survey. A total of 203 plants were counted directly during the Aug 2004 survey of three of the known localities while populations in the habitat directly surveyed were estimated at 2261 plants with an area of occupancy of 9.5 ha. Average densities of *Dichapetalum* plants were estimated at: 274 ±133 juvenile plants per ha, 237 ±41 adult plants per ha with 428 ±108 adult and juvenile plants per ha. Several other populations and extensive areas of apparently suitable habitat within the extent of occurrence including the upper Magela Creek study area are yet to be surveyed (Fig. 13). Allowing for similar densities and numbers of plants at just a few other known localities or in other unsurveyed habitat would result in considerably larger population estimates. Given that numbers are estimated at > 1000 individuals and populations are spatially well dispersed and secure from known threats it is recommended that the species be downgraded to NT. Further counts, density measurements and population estimates are needed at different places through the range of the species to confirm the status.
Figure 9. Search path and populations of *Dichapetalum timorense* surveyed, Kakadu - Western Arnhem Land, Aug. 2004. (△ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; † - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. www.ga.gov.au
Figure 10. Distribution of all NT populations of *Dichapetalum timorense*, Kakadu - Western Arnhem Land, Aug. 2004. (Δ - populations known before this survey; O - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ↑ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
Dubouzetia australiensis

Description and habitat

This species is a multistemmed perennial shrub with erect to pendulous stems to 1.5 m long. Distinctive characters of the species include the alternate, ovate to elliptic leaves with a fine reticulate venation visible on the under surface and the yellowish velvety covering of hairs especially on the branchlets, petioles and leaf undersurfaces (see front cover). Plants have been observed regrown from a perennial base after fire damage. The showy cream coloured flowers are recorded in January, May and August to October. Fruiting plants have been recorded in May, October and December. It is endemic to Western Arnhem Land and Kakadu.

The plant is a cliff-face specialist, growing exclusively from fissures in sandstone cliffs, even in highly fire protected areas. It often occurs in cliffs adjacent to Allosyncarpia dominated rainforest, but near Magela Falls and at East Magela Gorge it was found in cliffs adjacent to Eucalyptus miniata open forest. In one gorge, plants were growing from cliffs adjacent to Acacia thicket. The plant usually occurs in sites that are shaded or partly shaded for up to half the day and rarely in sites that receive full sun for most of the day or that are very heavily shaded.

Previous IUCN code and status

This species is currently listed in the NT as Endangered although it has been recommended that it be down graded to a status of Vulnerable (Kerrigan, 2004). At commencement of the survey it was known from 6 broad localities predominantly in Arnhem Land but with one population just within the eastern boundary of Kakadu at South Magela Gorge (Fig 11). The extent of occurrence was estimated at 294 km², with a population of < 1000 individuals.

2004 Survey results

Transects surveys of cliff faces in the upper Magela Creek area were used to derive population estimates (Fig. 12). Populations seen were linearly extensive and it was not possible to define boundaries of these in the time available, so sections of cliff habitat were sub-sampled and complete counts of all individuals seen were made along these (Table 6). It should be kept in mind that because of the angle of cliff faces in some places, not all plants on transects may have been seen and figures are probably underestimates.

A new population of Dubouzetia was recorded at a locality west of the Boronia quadrilata population in East Magela Gorge (Fig.12), although this was not surveyed because of lack of time. Several other general areas of known occurrence were revisited and populations located.

Direct counts were made of 269 plants over all transects and at several points. An additional 84 plants were counted over a 500 m transect in South Magela Gorge in March 2004 (Kerrigan, 2004) giving a density for that population of 168 plants per km, at the high end of the range recorded here (Table 6). The area of occupancy was measured at approx. 3 km of cliff during the current survey with an additional 0.5 km recorded during the March survey (Kerrigan, 2004). Over all transects during the current survey, densities averaged 100.7 ± 23.4 plants per km of cliff face. Applying this density estimate to the full extent of cliff lines where the plant was seen during the survey (as opposed to those sub-sampled) gives a population estimate for the survey area of 785 ± 183 plants.

At the two populations where size/age and fecundity was assessed, the vast majority of plants were adults (96.7%), with 50 percent of individuals flowering. (Juveniles for the purposes of this study were plants that were regarded as pre-reproductive in size, although they may be far from young.) This may suggest that recruitment is episodic or that all
available niches (crevices, fissures) for establishment are filled and that recruitment of new individuals is dependent on death of adults to make space available. Population sizes appear to be limited by the extent of available cliff face habitat and numbers of suitable crevices, with very sunny and very shady sites not occupied.

<table>
<thead>
<tr>
<th>Area Surveyed</th>
<th>Transect length (km)</th>
<th>Adult fertile (no.)</th>
<th>All Adult (no.)</th>
<th>Juvenile (no.)</th>
<th>All plants (no.)</th>
<th>Plants per km of cliff</th>
</tr>
</thead>
<tbody>
<tr>
<td>main Magela Gorge (1)</td>
<td>0.68</td>
<td>25</td>
<td>40</td>
<td>0</td>
<td>40</td>
<td>58.8</td>
</tr>
<tr>
<td>main Magela Gorge (2)</td>
<td>0.31</td>
<td>na</td>
<td>49</td>
<td>3</td>
<td>52</td>
<td>167.7</td>
</tr>
<tr>
<td>SW of Magela Falls (1)</td>
<td>0.81</td>
<td>na</td>
<td>50</td>
<td>0</td>
<td>50</td>
<td>61.7</td>
</tr>
<tr>
<td>SW of Magela Falls (2)</td>
<td>0.085</td>
<td>na</td>
<td>13</td>
<td>0</td>
<td>13</td>
<td>154.8</td>
</tr>
<tr>
<td>South Magela Gorge (1)</td>
<td>0.25</td>
<td>na</td>
<td>39</td>
<td>0</td>
<td>39</td>
<td>156.0</td>
</tr>
<tr>
<td>South Magela Gorge (2)</td>
<td>0.41</td>
<td>na</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>4.9</td>
</tr>
<tr>
<td>South Magela Gorge (3)</td>
<td>0.40</td>
<td>na</td>
<td>40</td>
<td>0</td>
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<td>100.8</td>
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<td>Total</td>
<td>2.945</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.7±23.4</td>
</tr>
</tbody>
</table>

Table 6. Counts and density estimates for *Dubouzetia australiensis* on cliff face transects in Kakadu and the upper Magela Creek area. Only sections of cliff with populations are included, not all cliffs surveyed. (* na = not assessed)

The habitat of this species is naturally highly fire proof and secure from disturbance other than the occasional rock fall. In one place where a *Dubouzetia* population adjoined *Eucalyptus miniata* woodland, there was evidence that *Dubouzetia* plants had been scorched by fire and had regenerated from the base. Otherwise little is known about resistance of the species to fire. There are no other obvious threats.

**Permanent monitoring plot**

A permanent monitoring plot was established in South Magela Gorge at 12.80802°S, 132.99608°E (helicopter landing at 12.80513°S, 132.99716°E). Six sterile adult plants and 12 flowering *Dubouzetia* plants were recorded on the plot which comprises 20 linear metres of cliff face to the full height of the cliff, estimated at 12 m. Only the cover of plants against the cliff was assessed.

The permanent plot for *Dubouzetia* contains populations of three other species of conservation interest (3 individuals of *Hibbertia* sp. South Magela, one individual each of *Microcorys elliptica* and *Sauropus rimophilus*).

**Summary of population data and revised status**

The extent of occurrence of the species is 294 km² and it is known from 7 broad localities. The inferred area of occupancy for the August 2004 survey of three of these localities is 8 km of cliff with a population estimate for that area of 785 ± 183 mostly adult plants with densities of 100.7 ± 23 plants per km of cliff. Including 50 plants counted at the site of an incidental collection made in the northern outliers near Ja Ja Billabong, and assuming that other unsurveyed populations are of a similar size and density to those seen there and during the recent survey, gives a population estimate from known sites of >1000. However, initial coding of the species was based on the assumptions that *Dubouzetia* was essentially a rainforest species and that rainforest was well surveyed, having been the subject of an intensive study in the NT (Russell-Smith, 1991). This and the relatively high level of botanical collecting in Kakadu and Western Arnhem Land appeared to offer a strong basis for concluding that the then current knowledge accurately reflected its restricted distribution and abundance. During a recent survey, it become apparent that the species is a cliff face specialist often not associated with rainforest and that records from the rainforest survey are likely to under represent the true distribution and abundance. As can be seen from Fig. 13, previous botanical field survey of cliff face habitats within the extent of occurrence is limited...
and quite patchy. Also, it is likely that the cliff face habitat (often located at the top of a steep rocky slope) is not frequently traversed by general botanical collectors, with four pre-survey records from an estimated 8 km of occupied cliff in the comparatively well surveyed upper Magela Creek area (Fig. 13). If even a very conservative 10% of the many kilometers of unsurveyed cliffs within the extent of occurrence hold *Dubouzetia* populations similar to those already known, then the total population will be well in excess of 1000. The plant grows in a relatively fire protected habitat, in generally sheltered situations with spatially well dispersed populations having no known threats and appears secure. On this basis and given the estimated population size it is recommended that the species be down graded in NT to Near Threatened. Further counts, density measurements and population estimates are needed at a number of places through the range of the species to confirm this status.
Figure 11. Distribution of all populations of *Dubouzetia australiensis*, Kakadu - Western Arnhem Land, Aug. 2004. (△ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ⬇️ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
Figure 12. Search path and populations of *Dubouzetia australiensis* surveyed, Kakadu – Western Arnhem Land, Aug. 2004. (Δ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ↑ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
Figure 13. Populations of *Dubouzetia australiensis* in relation to previous botanical field survey effort, Kakadu – Western Arnhem Land, Aug. 2004. (Δ - populations known before this survey; ▲ - populations recorded during this survey; 〇 - NT Rainforest Survey sites; ＋ - NT Herbarium collection localities; grid lines are spaced at 1 km intervals; ↑ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
**Grevillea rubicunda**

**Description and habitat**

An erect, open shrub to 2 m tall. Distinctive characters include the deeply divided leaves with 15–25 lobes each 4–10 cm long and 1.2–4 mm wide, white flowers, and woolly brown hairs densely covering the buds and inflorescence stem (Fig. 14). It can be separated from the closely related *G. dunlopii* by the leaf upper surface lacking glandular hairs, the style densely hairy throughout and the leaf veins decurrent and forming 3 conspicuous stem ridges below the leaf.

Typically grows on sandy flats and drainage depressions amongst sandstone outcrops.

![Fig. 14. Specimen of *Grevillea rubicunda*.](image)

**Previous IUCN code and status**

The species is currently coded in the NT as Data Deficient. The extent of occurrence for the species is estimated at 3032 km\(^2\).

**2004 Survey results**

A further locality for the species was found, increasing the number of known broad locations to 14 (Fig. 15). Direct counts of 58 individuals were made over an area of around 1 hectare. However, no attempt was made to search for further populations in the general area, as other survey work was in progress at the time.

**Summary of population data and revised status**

Although the species is known from 14 localities and an extent of occurrence of 3032 km\(^2\), little is known of population sizes or area of occupancy. It is recommended that the species remain coded as Data Deficient. Counts, density measurements and population estimates are needed at a number of places through the range of the species.
Figure 15. Distribution of all populations of *Grevillea rubicunda*, Kakadu - Western Arnhem Land, Aug. 2004. (△ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ‡ - north) 1:100,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. www.ga.gov.au
**Hibbertia sp. Mt Howship**

**Description and habitat**

An erect to scandent several stemmed shrub to 1.5 m tall. As for all *Hibbertia*, flowers are bright yellow and leaves are alternate. Distinguishing features include the stem clasping petioles, obovate leaves 15–45 mm long and 5–20 mm wide with long attenuate bases, the presence of sparse appressed simple hairs only and lack of scales or stellate hairs on the leaves and branchlets (Fig. 16).

It is closely related to *Hibbertia* sp. South Magela but can be distinguished by the much larger, lighter green leaves with sparse appressed simple hairs.

This plant is endemic to Kakadu NP and Western Arnhem Land. It grows from sandstone cliff faces in semi-shaded situations similar to but more open than those occupied by *Dubouzetia*. Adjoining vegetation included both *Corymbia arnhemensis* woodland and *Allosyncarpia* dominated rainforest.

![Figure 16. Specimen of Hibbertia sp. Mt. Howship.](image)

**Previous IUCN code and status**

The species is currently coded in the NT as Data Deficient. The extent of occurrence for the species is estimated at 993 km².

**2004 Survey results**

Transect surveys and population counts were made of cliff face habitat (Table 7). At least four new populations of the species were located and in total, 48 plants were counted during the whole survey (Fig. 17, 18).
<table>
<thead>
<tr>
<th>Area Surveyed</th>
<th>Transect length (km)</th>
<th>Adult fertile (no.)</th>
<th>All Adult (no.)</th>
<th>Juvenile (no.)</th>
<th>All plants (no.)</th>
<th>Plants per km of cliff</th>
</tr>
</thead>
<tbody>
<tr>
<td>main Magela Gorge (1)</td>
<td>0.68</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>4.4</td>
</tr>
<tr>
<td>main Magela Gorge (2)</td>
<td>0.31</td>
<td>2</td>
<td>13</td>
<td>0</td>
<td>13</td>
<td>41.9</td>
</tr>
<tr>
<td>SW of Magela Falls (1)</td>
<td>0.81</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SW of Magela Falls (2)</td>
<td>0.085</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>11.8</td>
</tr>
<tr>
<td>East Magela Gorge</td>
<td>0.2*</td>
<td>32</td>
<td>32</td>
<td>0</td>
<td>32</td>
<td>160</td>
</tr>
<tr>
<td>Total</td>
<td>2.085</td>
<td>2</td>
<td>17</td>
<td>0</td>
<td>17</td>
<td>43.6±30</td>
</tr>
</tbody>
</table>

Table 7. Counts and density estimates for *Hibbertia* sp. Mt Howship on cliff face transects in the upper Magela Creek area. (* estimate only, not measured by GPS)

Although 2.085 km of cliff were surveyed within the known range of the plant, populations were very scattered and densities were low at 43.6 ± 30 plants per km with only an estimated 200 m of cliff actually occupied by populations.

In the South Magela Gorge, this species is replaced by the related *Hibbertia* sp. South Magela.

The habitat of this species is naturally fire proof and secure from disturbance, although plants could be scorched by fires below. Little is known about resistance of the species to fire, although the plant is capable of resprouting from the lower stems after damage to the foliage. There are no other obvious threats.

**Summary of population data and revised status**

The extent of occurrence remains unchanged at an estimated 993 km² whilst the known area of occupancy has been increased to 200 m of cliff face for the 5 populations surveyed in August 2004. Although the species is now known from 8 broad localities, known populations are sparse with only 48 individuals counted over 2 km of cliff. Assuming other known populations have similar densities and area of occupancies, then the total population is currently estimated at <1000 individuals and the area of occupancy at < 500 m of cliff. As many kilometres of habitat within the extent of occurrence remain to be surveyed, it is recommended that the species remain coded as Data Deficient. Cliff face counts, density measurements and population estimates are needed at a number of places through the range of the species.
Figure 17. Distribution of all populations of *Hibbertia* sp. Mt Howship, Kakadu – Western Arnhem Land, Aug. 2004. (△ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ↑ - north) 1:100,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
Figure 18. Search path and populations of *Hibbertia* sp. Mt Howship surveyed, Kakadu – Western Arnhem Land, Aug. 2004. (△ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ↑ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
**Hibbertia** sp. South Magela

**Description and habitat**

A pendulous multi-stemmed subshrub with stems to 0.5 m long. As for all Hibbertia, flowers are bright yellow and leaves are alternate. Distinguishing features include the stem clasping petioles, oblanceolate to obovate leaves 5–15 mm long and 2–5 mm wide with long attenuate bases, with dense spreading simple hairs only on both surfaces and on branchlets (Fig. 19). Scales or stellate hairs are completely absent.

Closely related to *Hibbertia* sp. Mt Howship but distinguished by the small densely hairy, dark green leaves.

This plant is endemic to Kakadu NP and adjoining Western Arnhem Land and appears restricted to South Magela Gorge (Fig. 20). It grows from sandstone cliff faces in semi-shaded situations similar to those occupied by *Dubouzetia*.

![Fig. 19. Specimen of *Hibbertia* sp. South Magela.](image)

**Previous IUCN code and status**

The species was not recognised as distinct from *Hibbertia* sp. Mt Howship before this survey and was not coded.

**2004 Survey results**

As a result of this survey, this species was recognised at NT Herbarium as distinct from *Hibbertia* sp. Mt Howship. It is also recognised as a distinct species by Helmut Toelken, the specialist who is revising the genus (H.Toelken pers. comm.). The entire known population is restricted to South Magela Gorge, with plants seen on both the east and west sides.

Although populations were not counted, plants were distinctly less abundant than *Dubouzetia* on the same transects with perhaps 20–30 plants seen over the 1.06 km of cliff face surveyed. The extent of occurrence is estimated at 100 ha whilst the area of occupancy within this range is estimated at approx 3km of cliff face. On these figures, population numbers are estimated at less than 100 individuals and potentially only a few hundred if all cliffs in the valley are occupied.

The habitat of this species is naturally fire proof and secure from disturbance, although plants could be scorched by fires in adjacent vegetation. Little is known about resistance of the species to fire. There are no other obvious threats.
Permanent monitoring plot

A permanent monitoring plot was not established, although one plant is located on the *Dubouzetia* permanent monitoring plot.

Summary of population data and revised status

The extent of occurrence is estimated at 100 ha whilst the area of occupancy within this range is estimated at approximately 3km of cliff face. The population is presently estimated at circa 100 plants. However, based on the very limited extent of occurrence and sparse populations the total population is unlikely to be more than 1000 plants. A code of data deficient is currently recommended, although present indications are that the species is a geographically restricted, Western Arnhem Land endemic, a limited area of occupancy, extent of occurrence and relatively small population size. Further survey of extent of occurrence in South Magela Gorge and nearby gorges as well as cliff face counts, density measurements and population estimates are needed.

Figure 20. Search path and all populations of *Hibbertia* sp. South Magela, boundary of Kakadu – Western Arnhem Land (latitude 12.80153° S, longitude 133.00000° E), Aug. 2004. (▲ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ⚖ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
**Microcorys elliptica**

**Description and habitat**

A pendulous subshrub with stems to 0.5 m long (Fig. 21). Leaves are in whorls of 3, bright green, very narrowly elliptic to narrowly elliptic, 12–30 mm long, 2–8 mm wide, with sparse short erect to appressed hairs. Flowers are borne 2–3 in the leaf axils, white, 2-lipped, with a yellow throat.

Previously known only from Mt Brockman and one place on the Northern Outliers, as a result of this survey, this NT endemic plant is now known to also occur on the main escarpment in adjoining Western Arnhem Land in the upper Magela Creek area (Fig. 22). It grows from sandstone cliff faces in semi-shaded situations (neither full sun all day nor heavy shade) similar to those occupied by *Dubouzetia*.

![Fig. 21. Specimen and habit of Microcorys elliptica.](image)

**Previous IUCN code and status**

The species is currently coded in the NT as Data Deficient. At commencement of the survey, the species had an extent of occurrence estimated at 70 km$^2$ and was known from Mt Brockman and one location in the Northern Outliers. The number of recorded populations on Mt Brockman is uncertain, as geocoding of collections is inaccurate but is between 1 and 4.

**2004 Survey results**

Although populations were not counted, plants were much less abundant than *Dubouzetia* with perhaps 30 individuals seen at four places (representing three locations) during the survey of over 3km of cliff face. Densities are estimated at approximately 10 plants /km of cliff, with area of occupancy low due to the small dispersed population. The extent of occurrence is now estimated at 240 km$^2$. If collections from Mt Brockman are assumed to represent one population, the plant is now known from five localities in total (Fig. 22).

The habitat of this species is naturally fire proof and secure from disturbance, although plants could be scorched by fires occurring within adjacent vegetation. Little is known about resistance of the species to fire. There are no other obvious threats.

**Permanent monitoring plot**

Three adult individuals were recorded in the permanent plot set up to monitor *Dubouzetia* in South Magela Gorge.
Summary of population data and revised status

Although the extent of occurrence is relatively large and the habitat secure, populations seen during the survey were both sparse and scattered. A coding of Data Deficient is recommended. Cliff face counts, density measurements and population estimates are needed at a number of places through the range of the species.

Figure 22. Search path and all populations of _Microcorys elliptica_, Kakadu – Western Arnhem Land, Aug. 2004. (▲ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ↑ - north) 1:50,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
**Sauropus rimophilus**

**Description and habitat**

A dioecious shrub (male and female flowers are on separate plants) with pendulous stems up to 1 m long. This species has alternate, hairless to sparsely hairy, ovate leaves (Fig. 23). It can be separated from the closely related (and sometimes sympatric) *S. filicinus* by the more robust growth habit, larger sepals and anthers of the male flowers and from *S. gracilis* by the broader leaves.

*Sauropus rimophilus* grows from sandstone cliff faces. The species is scattered across sandstone areas of Kakadu – Western Arnhem Land, extending from Kombolgie Creek to Nabarlek and Mt Borradaile (Fig. 24).

![Fig. 23. Growth habit of Sauropus rimophilus. (Photo D.Liddle)](image)

**Previous IUCN code and status**

This species is presently coded in the NT as Data Deficient. Hunter and Bruhl (1999) classified the species as endangered, although the species has no threatened status at a national level.

**2004 Survey results**

While no counts were made of this species, it was recorded in three separate places and the known range was extended to the east of the previous known localities (Fig. 24). Populations were sparser than *Dubouzetia*, and similar in density to *Microcorys* though more scattered. Herbarium collections were made enabling the differences between *S. rimophilus* and *S. filicinus* as given by Hunter and Bruhl (1999) to be further evaluated and clarified.

The habitat of this species is naturally fire proof and secure from disturbance. Plants could be scorched by fires occurring within adjacent vegetation, although little is known about resistance of the species to fire. There are no other obvious threats.
Permanent monitoring plot

One plant was recorded in the permanent plot set up to monitor *Dubouzetia*.

Summary of population data and revised status

The species is known from 15 localities, with a relatively large extent of occurrence of 4418 km$^2$. However, populations both in the upper Magela Creek area and on Mt Brockman are very sparse and little population data exists. It is recommended that the species remain coded as Data Deficient. Further cliff face counts, density measurements and population estimates are needed at a number of places across its range.

Figure 24. Distribution of all populations of *Sauropus rimophilus*, Kakadu – Western Arnhem Land, Aug. 2004. (▲ - populations known before this survey; ○ - populations recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; † - north) 1:100,000 topographic map base courtesy Geoscience Australia, Canberra. Copyright Commonwealth of Australia, Geoscience Australia. [www.ga.gov.au](http://www.ga.gov.au)
**Taenitis pinnata**

**Description and habitat**

A terrestrial fern with creeping rhizomes bearing rigid, reddish brown, shiny bristles. Fronds are simple to 1-pinnate, in NT to 40 cm long with 2–5 lobes, each 5–20 cm long and 1–3 cm wide. Sori are scattered in numerous irregular short oblique lines along the lateral veins (Fig. 25).

When sterile, readily confused with the more common *Taenitis blechnoides* but distinguished by the often fewer pinnae in *T. pinnata* and arrangement of the sori, which in *T. blechnoides* are in two long continuous lines, one either side of the midrib but slightly nearer the margin.

*Fig. 25. Taenitis pinnata* frond and under surface showing sori.

Grows in heavy (near 100%) shade in seepage areas either in fissures in south-facing sandstone cliffs or under over hangs at the base of sandstone cliffs. In NT, only known from the main Magela Creek Gorge (Fig. 26).

**Previous IUCN code and status**

This species is currently coded in the NT as data deficient and was known from only one NT locality.

**2004 Survey results**

A population of approximately 25 plants was located in an overhanging, south-facing cliff in the main Magela Creek Gorge at 12.76923°S, 133.07985°E (Fig. 26). Several other similar sized populations of what are thought to be this species were also seen in the area (between 12.77027°S, 133.07696°E and 12.76795°S, 133.08257°E) but were sterile, so their identity could not be confirmed. However, no population estimates were made at these places as they were seen before the fertile population was found. All these populations were in almost 100% shade with a south facing aspect. Similar habitat extends to the west for another 1.2 km and it is likely that populations also occur there. The population discovered during the present survey extends the range of this species by 6.6 km to the west of the previously known population.
The habitat of this species is naturally fire proof although adjacent vegetation may burn occasionally and plants in the main population could suffer from scorching. Other populations tentatively identified as this species occurred in sandy seepage areas at the base of overhangs with little other vegetation nearby. These latter populations showed signs of disturbance by wet season runoff. Also, they are so localised as to be susceptible to disturbance by ground dwelling vertebrates, although the habitat may be inaccessible to most feral vertebrates. There are no other obvious threats.

Permanent monitoring plot

*Taenitis pinnata* is not located in a permanent monitoring plot.

Summary of population data and revised status

It is recommended that the species remain as data deficient. Although the current survey adds to the known extent of occurrence, area of occupancy and population size (> 25 plants in 2-several populations), the species is not well surveyed. Sterile plants are easily confused with the more common *T. blechnoides*. Because of an apparent requirement for very shady, permanently moist cliff-associated sites, the area of occupancy is likely to be small. A coding of data deficient is regarded as appropriate. Further survey of cliffs (especially those with a southerly aspect) along the main Magela Gorge is recommended.

![Figure 26. Distribution of all NT populations of *Taenitis pinnata*, Western Arnhem Land, Aug. 2004.](figure26.png)  
(△ - population known before this survey; ○ - population recorded during this survey; ● - survey search path; grid lines are spaced at 1 km intervals; ↑ - north)  
Conclusions

The survey resulted in improved knowledge of the distribution, abundance and threats for 11 taxa of conservation significance (either threatened or data deficient). New distributional records were made for all taxa except *Cephalomanes* with significant range extensions for *Microcorys elliptica* and *Taenitis pinnata* in particular. Data collected were sufficient to result in a recommendation for the downgrading of *Dichapetalum timorense* and *Dubouzetia australiensis* to near threatened. Further survey of population sizes, area of occupancy, extent of occurrence and possible threats are required for most species considered here. The inadequacy of taxonomic knowledge of *Boronia laxa* and *B. amplectens* was highlighted by the survey.

Fire Management. Several of the species studied during the survey (*Boronia quadrilata*, *B. amplectens*, *B. laxa* and *Grevillea rubicunda*) occur in fire prone habitats and either can resprout from the base (*B. quadrilata*) or are obligate seeders (*B. amplectens*, *B. laxa* and *Grevillea rubicunda*). These species may be vulnerable to unfavourable fire regimes, probably high fire frequencies, although further research is necessary to clearly establish what these undesirable fire frequencies may be. *Dichapetalum timorense* occurs in *Allosyncarpia* dominated forest patches which are naturally fire protected by their location in gorges, proximity to cliffs and permanent creeks and by their remoteness from most human access. However, the habitat is not fire proof and may be vulnerable to inappropriate fire regimes. Some six species (*Dubouzetia australiensis*, *Hibbertia* sp. Mt Howship, *Hibbertia* sp. South Magela, *Microcorys elliptica*, *Sauropus rimophilus* and *Taenitis pinnata*) are cliff-face specialists. Although individuals in some locations may be subject to fire scorch when nearby vegetation burns, the habitat is generally highly fire protected, with few if any obvious threats. Certainly, *Dubouzetia australiensis* and *Dichapetalum timorense* showed some evidence of an ability to resprout from stem bases after fire damage although the extent of their fire tolerance is not known.

Priorities for further work. *Cephalomanes*, with a status of endangered, is probably the highest priority for further research. Further effort needs to be put into relocating the Western Arnhem Land population. *Boronia quadrilata* with a restricted area of occupancy and a possible fire threat is in need of further survey of area of occupancy and extent of occurrence. Ongoing monitoring and research into population biology and fire ecology of the species are also needed. *Hibbertia* sp. South Magela is currently data deficient but present data indicate that the species is a geographically restricted, Western Arnhem Land endemic with a limited area of occupancy, extent of occurrence and small population size. Further survey of population sizes, area of occupancy and extent of occurrence is needed. *Taenitis pinnata* is presently data deficient but current data indicate that the species is geographically restricted, probably with a very limited area of occupancy, limited extent of occurrence and small population size. However, in contrast with *H*. sp. South Magela, *Taenitis* is not endemic and as is characteristic of ferns, diaspore dispersal is likely to be highly effective. Among the data deficient species considered here, the highest priorities after *Hibbertia* sp. South Magela and *Taenitis pinnata* are regarded as *Microcorys elliptica*, and *Hibbertia* sp. Mt Howship. A more strategic analysis of priorities for further survey amongst all threatened and data deficient taxa in the region (and NT) is needed. Such an analysis is probably best undertaken as part of the periodic review of the IUCN status of all NT plant species. This could involve ranking species through consideration of factors such as known extent of occurrence, number of occurrences, habitat, life form, endemism and known or likely threats to the species or habitat. By definition, area of occupancy, population data or other critical information are lacking for data deficient species.
Acknowledgments

Kris Brooks, Beth Crase (commiserations on the injured knee) and Dave Liddle provided enthusiastic assistance with field work. Rod Kennett, Raelee Kerrigan, Fiona Peek and John Woinarski checked and made constructive comments on the report whilst Raelee also patiently discussed coding of species and many aspects of the survey.

References


Appendix 1. Location of permanent monitoring plots. Latitude and longitude are recorded in decimal degrees using WGS 84 datum.

<table>
<thead>
<tr>
<th>Species</th>
<th>Latitude (°S)</th>
<th>Longitude (°E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boronia quadrilata</td>
<td>12.7358</td>
<td>133.12548</td>
</tr>
<tr>
<td>Dichapetalum timorense</td>
<td>12.78409</td>
<td>133.10071</td>
</tr>
<tr>
<td>Dubouzetia australiensis</td>
<td>12.80802</td>
<td>132.99608</td>
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</tbody>
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