National recovery plan for the fern *Chingia australis*

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Photographs courtesy of G. Sankowsky

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This recovery plan identifies threats and makes conservation recommendations for *Chingia australis*, a terrestrial arborescent fern endemic to the Wet Tropics region of northern Queensland.

Current species status

Chingia australis is listed as 'Endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act (*EPBC Act) and the Queensland *Nature Conservation Act 1992* (NCA).

Habitat and distribution summary

Chingia australis occurs in the Wet Tropics of northern Queensland. There are 12 known populations distributed between two areas, in and around the Wooroonooran National Park and in an area adjacent to the Daintree National Park. The total number of living individuals is estimated at less than 500.

Chingia australis is found in lowland and upland mesophyll vine forest and upland simple notophyll vine forest, on clay soil (basalt and mudstone), metamorphic and granite substrates. It is a moisture and light-loving fern dependent on surrounding rainforest habitat and disturbance processes that provide it with gaps in the rainforest canopy. These requirements appear somewhat paradoxical but indicate that the species is a specialist of small to medium sized gaps, responding specifically to newly formed mineral soil niches within rainforest ecosystems.

Threats summary

Chingia australis occurs in low numbers in just a few specific sites within rainforest habitat and requires surrounding rainforest or gully/creek communities to provide the local microclimate it needs to complete its lifecycle. The species is threatened by wide-scale rainforest clearing, and is also potentially threatened by redirection or damming of creeks. These threats are of particular significance to the six populations that occur outside of protected areas. Other threatening processes common to all populations are competition from weedy species, plant mortality due to roadside and pathway clearing, and habitat destruction and plant mortality caused by feral pigs.

Recovery Objectives

The primary objective of this recovery plan is to arrest the decline of *C. australis* in the wild and to maintain viable '*in situ*' populations. The specific objectives of this plan aim to protect *C. australis* populations from human interference, increase the size and number of populations, broaden the knowledge base of the species ecology and biology and increase public awareness about the species.

Summary of Actions

The recovery actions for *C. australis* include negotiating conservation agreements and defining appropriate land management practises for private landholders. This will help secure populations on private land and reduce the threat of habitat loss. Actions contributing to improved habitat management will enable current threats posed by invasive and feral pest species to be addressed and for current control/maintenance strategies to be reassessed. The establishment of a population monitoring program and genetics study will address the knowledge gaps for this species and the development of educational material and adoption of a common name for *C. australis* will increase public awareness of this species.

1. General Information

Conservation Status

Chingia australis is a fern with a highly restricted distribution. It is endemic to Australia, occurring in just 12 populations in the Wet Tropics Bioregion of northeast Queensland.

Chingia australis is listed as 'Endangered' under both Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Queensland *Nature Conservation Act 1992* (NCA).

International obligations

Chingia australis is not listed under any international agreements. This recovery plan is consistent with Australia's international obligations.

Affected interests

This plan details actions that may affect a range of stakeholders, including:

- Private Landholders
- Traditional Owners
- Regional Natural Resource Management Body, Terrain NRM (formerly Far North Queensland Pty Ltd)
- Queensland Government Departments:
  - Queensland Enviromental Protection Agency/Queensland Parks and Wildlife Service (EPA/QPWS)
    - Wooroonooran National Park
    - Daintree National Park
  - Queensland Department of Natural Resources, Mines and Water (NRMW)
  - Queensland Department of Main Roads (DMR)
- Wet Tropics Management Authority (WTMA)
- Aboriginal Rainforest Council (ARC)
- Local Councils:
  - Eacham Shire, Cairns City, Johnstone Shire, Douglas Shire
- Education and research institutions, for example:
  - Rainforest Cooperative Research Centre (RCRC) / Marine and Tropical Sciences Research Facility (MTSRF)
  - James Cook University (JCU)
  - CSIRO – Sustainable Ecosystems, Tropical Landscapes
- Community Groups, for example:
  - Society for Growing Australian Plants (SGAP) Regional Groups
- Private nurseries and botanical gardens, for example:
  - Heaton's fern nursery, Nambour
  - Flecker Botanic Gardens, Cairns

Consultation with Indigenous people

Indigenous groups of the Wet Tropics area likely to be affected by the plan were identified by consultation with the Aboriginal Rainforest Council, WTMA and Terrain NRM. Traditional owners of land where *C. australis* grows (or is likely to grow) were provided with the draft recovery plan for comment. No responses were received. Involvement of indigenous groups in the implementation of this recovery plan will be encouraged where appropriate.

Benefits to other species or communities
Biodiversity in the Wet Tropics World Heritage Area is very high with over 2840 recorded plant species, more than 700 (25 percent) of which are endemic to the area. The richest concentrations of ferns and fern allies in Australia are found in the Wet Tropics. More than 250 species occur in the area and 46 are endemic to the Wet Tropics (Wet Tropics Management Authority, 2006; Steve Goosem, pers.com.).

Plants of conservation concern that co-occur with *C. australis* include *Macaranga polyadenia* (Euphorbiaceae; 'Rare' under the NCA) and the fern *Plesioneuron tuberculatum* (Thelypteridaceae; 'Endangered' under the NCA). Other ferns listed under the NCA that occur in the Wet Tropics area include *Diplazium pallidum* (Athyriaceae; 'Endangered'), *Pneumatopteris costata* (Thelypteridaceae; 'Rare'), *Crepidomanes aphlebioides* (Hymenophyllaceae; 'Endangered') and the wig tree fern *Cyathea baileyana* (Cyatheaceae; 'Rare'). Many of these ferns occur in similar habitat to that occupied by *C. australis*.

The rainforest habitat in which *C. australis* occurs has been identified as critical to the survival of the southern cassowary (*Casuarius casuarius johnsonii*), a high profile bird species (Queensland Parks and Wildlife Service, 2001).

The conservation and management actions recommended within this recovery plan will not only protect *C. australis*, but also directly benefit plants and animals sharing the same habitat as *C. australis*.

Social and economic impacts
Implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts. The recovery plan may have social benefits for local communities through increasing public awareness and understanding of natural heritage values in the Wet Tropics World Heritage Area.

2. Biological information

Species description
Chingia, in the fern family Thelypteridaceae, is a small genus of about 20 species that are found throughout Malesia (south east Asian mainland and archipelagos stretching to New Guinea) and eastwards to Tahiti. *C. australis* is the only Australian representative of the genus and is endemic to northern Queensland.

The following species description is based on information drawn from Andrews (1990) and Bostock (1998) with supplementary information from the Wildnet (EPA/QPWS 2006) and Queensland Herbarium (EPA/QPWS) databases.

Chingia australis is a terrestrial arborescent fern with a rhizome forming an erect or prostrate trunk. The trunk grows up to 60cm tall and up to 10cm in diameter. The fronds are up to 2.6m long, 0.8m wide and bright green in colour, with a more or less erect stipe (stalk of the frond) and an arching somewhat lax lamina (the part of the frond excluding the stipe). The stipe is up to 0.5m long and is covered in minute capitate (enlarged, spherical tipped) hairs. The scales on the stipe are erect, often sticking out at right angles to the stipe, up to 10mm long, 1mm wide and are rather sparsely arranged above the base of the stipe. The lamina is ovate with up to 40 pairs of pinnae (divisions of the lamina). Basal pinnae grow up to 24cm long and are narrowed at their bases; the largest pinnae grow up to 33 cm long and 3cm wide, narrowly acuminate and lobed to a depth of 3-6mm. Lower surfaces of the pinnae are covered with many capitate hairs, 0.1-0.2mm long. A distinctive translucent

membrane (also known as the sinus membrane) joins the pinna lobes. Sori (containing the spores) are small with indusium (protective covering) very tiny or often lacking, arranged along and close to the midrib of the lobes. Spores are black.

Chingia australis can be identified by the sinus membrane, which is the most prominent membrane found in any member of the family in Australia. It can be distinguished from the superficially similar *Amphineuron queenslandicum* by its erect stipe scales and the many capitate hairs on the pinnae. The position of the sori (very close to the midrib of the pinna lobes) and the black colour of the spores are also very distinctive and may be used to differentiate *C. australis* from other fern species, particularly *Christella* species with which it may be confused.

The immature fronds of *C. australis* are sticky and produce a glandular secretion that has a distinctive spicy odour and is a mucous membrane irritant.

Life history and ecology

C. australis occurs in rainforest on steep creek banks and ridge slopes. It is an early successional gap specialist, reliant upon exposure of mineral soil (lacking organic matter). It may be somewhat shade-intolerant, often inhabiting naturally well-lit sites such as swampy ground in lowland forest or creek banks. Presence in such locations may be attributed to its high moisture requirements. Like all ferns, *C. australis* has a two-phase lifecycle involving a stage that is entirely dependent on the presence of water. Some populations are riparian (growing in or very close to water courses), all are dependant on surrounding rainforest habitat and the moist microclimate it provides. Populations are ephemeral (short-lived), responding to the kind of disturbance processes that typically remove topsoil, such as landslips, flood scouring, tree-falls and road cuttings.

C. australis produces large quantities of spore. It is not known whether new populations are established by airborne spores, or if spores persist in the soil for long periods of time only germinating when the right conditions are in place. Plants have been successfully cultivated (N. Sankowsky, pers. com.) and germination of spores has been achieved in cultivation (P. Bostock, pers. com.). However, at the time of writing there were no plants in cultivation.

Distribution

Holttum (1986) first described *C. australis* based on a single collection made in the Wooroonooran National Park. Since then the plant has been found in a further seven locations in the vicinity of the original collection (southern populations), but the continued existence of the original collection has not been confirmed. It has also been collected in five locations in the vicinity of the Daintree National Park (northern populations. One of these population is known to have become extinct since it was discovered in May 2000). Figure 1 shows the distribution of *C. australis* in Queensland and co-ordinate data for the location of populations is provided in a secure appendices.

Plant removal or destruction through inappropriate collection are threats to many plant species. The rarity of *C. australis* means that it is potentially of value to fern collectors. This threat is not considered to be of high significance, principally because of the inaccessibility of populations. The exact locations of populations are held by Queensland Herbarium (EPA/QPWS) to protect against unwanted collections.

Chingia australis is usually found in small numbers, although relatively large colonies (c. 100 plants) have been observed in the wild. The total number of extant (living) populations is estimated at 12 and the total number of individuals is estimated at less than 500.

Additional populations may exist but locating other new populations is problematic due to the difficulty in surveying this area (i.e. thick vegetation, deep creek lines). Surveying difficulties and the ephemeral nature of populations make it extremely difficult to determine the historical distribution of *C. australis* in Queensland's wet tropical rainforest.

Habitat critical to the survival of the species

Chingia australis occurs in the Wet Tropics of Queensland in lowland and upland mesophyll vine forest and upland simple notophyll vine forest, on clay soil (basalt and mudstone), metamorphic and granite substrates. It is a moisture and light-loving fern dependent on surrounding rainforest habitat and disturbance processes that provide the necessary gaps in the rainforest canopy. These requirements appear somewhat paradoxical but indicate that the species is a specialist of small to medium sized gaps, responding specifically to newly formed mineral soil niches within rainforest ecosystems.

Important populations

All populations are considered essential because of the limited numbers (12 in total). An understanding of the genetic diversity present within individual populations compared to that present in the species as a whole may make it possible to prioritise populations for conservation actions.

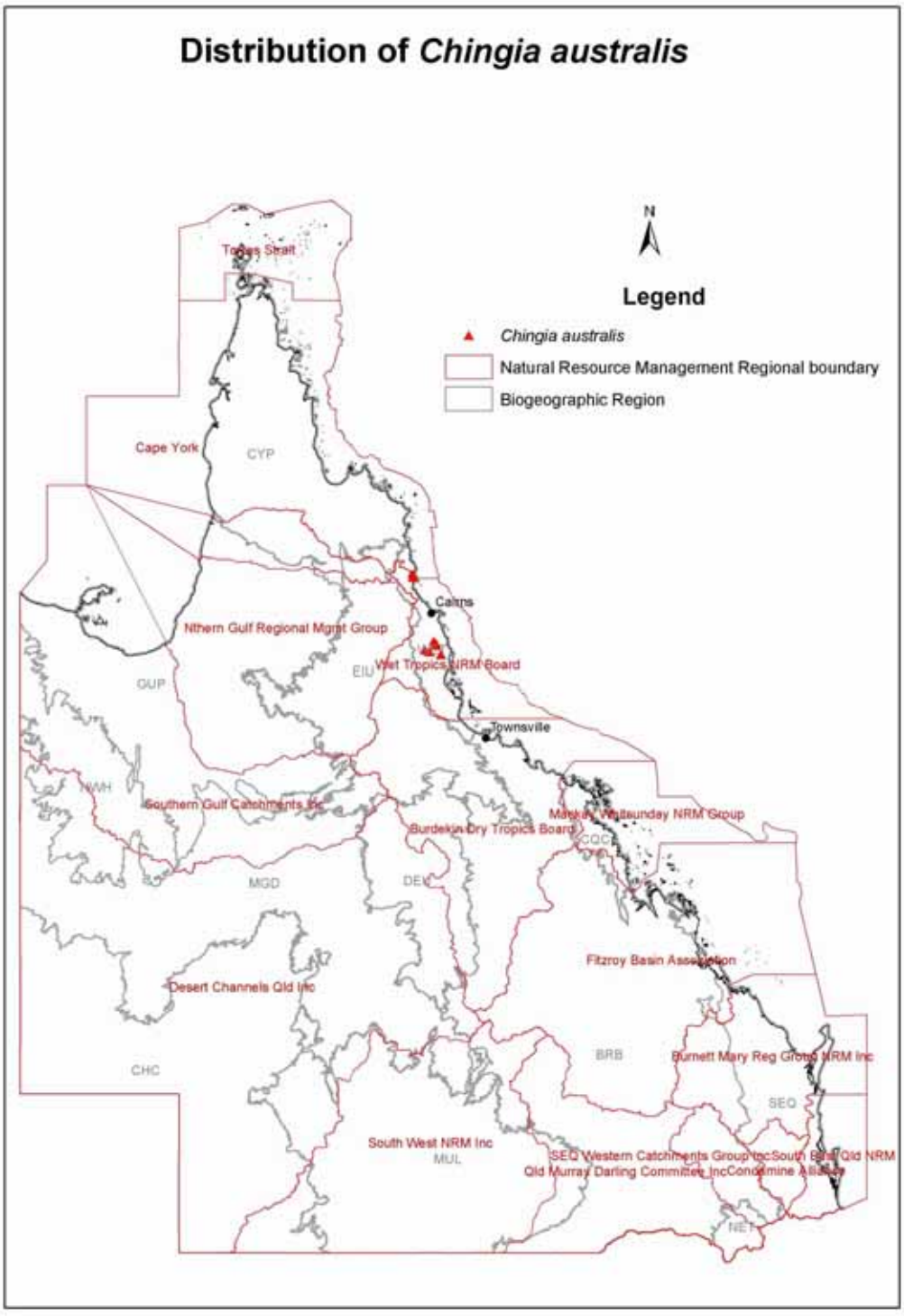

Figure 1. Map showing the distribution of *C. australis*. Map produced by Tony Eeles, Spatial Systems Technical and Support Unit, Parks Division (EPA/QPWS)

3. Threats

Biology and ecology relevant to threats
Pristine rainforest habitat with natural hydrological regimes and natural disturbance processes are key to the survival of *C. australis*. Any activities that negatively impact on this are likely to threaten *C. australis*.

Like all other ferns, the lifecycle of *C. australis* involves a stage that is entirely dependent on the presence of water. As a result, *C. australis* requires surrounding rainforest or gully/creek communities to provide the local microclimate it needs to complete this stage of the lifecycle. Therefore, clearing of rainforest trees is a threat, as is any redirection or damming of creeks.

Species like *C. australis* that respond to gaps in the rainforest canopy are likely to have high light requirements. As a result, such plants are vulnerable to overshading by weedy species that may also respond quickly to wet and light conditions.

Chingia australis populations grow in response both to natural disturbance processes (for example, landslips, cyclone damage, tree falls) and anthropogenic (human created) processes (for example, road cuttings). As a result, populations tend to be small and highly localised. Like other early successional species, this fern is likely to be relatively short-lived and populations appear to be ephemeral (R. Jago, pers. com.). These features mean that populations are threatened by chance events such as landslips or cyclone damage, but these processes are not a significant threat to the species as a whole. In fact, such events are likely to be key to the survival of this species by creating niches into which the plants can disperse.

Small population size is significant in relation to the threat posed by feral pigs (*Sus scrofa*). *Chingia australis* is eaten by feral pigs (R. Jago, pers. com.), which can destroy entire populations. This threat is more significant to the few populations that occur on level ground, but even those populations that occur on very steep banks are vulnerable to destruction by pigs.

Identification of threats
The major threats to *C. australis* are listed below in order of significance from most threatening to least threatening.

- **Logging/clearing for agriculture, urban development, road building and redirection/damming of creeks**

Chingia australis occurs in specific sites within rainforest habitat and requires surrounding rainforest or gully/creek communities to provide the local microclimate it needs to complete its lifecycle. Therefore, it is threatened by wide-scale clearing of land, particularly along creek lines. In addition, several populations are riparian and could be potentially threatened by redirection or damming of creeks. These threats are of particular significance to populations outside of protected areas. **High**

- **Weed invasion**

Chingia australis is likely to have high light requirements. As a result, it is vulnerable to overshading by weedy species that may respond quickly to wet and light conditions. In the southern part of its range, *C. australis* is threatened in this way by bramble (*Rubus alceifolius*; P. Bostock pers. com.). The northern populations are threatened by *Miconia calvescens* and *Hiptage benghalensis* (both Class 1 declared weeds; Wet Tropics Management Authority, 2004; A. Hedges, pers. com.), which are a particular threat in the Daintree area and are especially likely to invade watercourses. **High**

- **Roadside and path clearing/weed control**

Chingia australis is an early successional gap specialist species and, as such, can occur on roadside verges and pathways. In these circumstances, it is threatened by clearing and weed control carried out as part of routine maintenance practices. This is a particular threat to populations outside of protected areas but may also be a threat within National Parks. **Medium**

- **Feral pigs**

Chingia australis is threatened by feral pigs (Class 2 declared pest; Land Protection, 2005), both indirectly (through habitat degradation) and directly. This threat is most significant to the few populations that occur on level ground although all populations are potentially threatened in this way. Feral pigs have the potential to become a major threat for the species in the event that several populations were to be destroyed before plants reach sexual maturity (approx. 1 year; P. Bostock pers. com.). In such circumstances the regeneration capacity of the species could be severely affected. This threat is present throughout the natural distribution of *C. australis*. **Medium**

Areas under threat

Across the species geographic range, the distribution of threats is uneven. Areas where *C. australis* populations are most at risk are those outside of protected areas, both in the northern and southern regions of the species range where the potential for land clearing and redirection or damming of creeks exists.

Populations under threat

Threats facing populations are listed in Table 1. Most populations occur within the Wooroonooran and Daintree National Parks and are further protected by inclusion in the WTWHA. However, some populations of *C. australis* are found on lower hill slopes below the boundary of the WTWHA. Those populations that are not covered by any conservation agreements are most threatened because they are vulnerable to land clearing. All four populations in the northern range of the species are unprotected and two populations in the southern area of the distribution are unprotected. These latter two populations occur on land that has already been cleared so that the possibility of expansion into new areas nearby is highly unlikely.

Table 1: Threats summary

Location number	Status	Regional Ecosystem classification	Population size estimate	Land tenure	Type of threat	Current actions to reduce threats*
1.	Unprotected	7.11.1a	4	Private	Weed invasion Creek redirection/damming [P]	Northern populations: 1.Daintree NP pig eradication program. 2.EPA/QPWS and Douglas Shire weed eradication program.
X.	Extinct	7.11.1a	0 (formerly c.2)	Douglas Shire Council	N/A	
2.	To be protected[a]	Unknown	12	State of Queensland	Weed invasion Creek redirection/damming [P]	
3.	Unprotected	Unknown	6	Private	Weed invasion Creek redirection/damming [P]	
4.	Unprotected	Unknown	6	Private	Weed invasion Creek redirection/damming [P]	
5.	Protected	7.11.1a	24	Wooroonooran NP	Feral pigs Weed invasion	Southern populations: 1.Wooroonooran NP pig monitoring program (includes testing various eradication techniques but does not constitute a control program at present).
6.	Protected	7.11.1a	150	Wooroonooran NP	Feral pigs Weed invasion	
7.	Unprotected	Cleared	100	Private	Logging/land clearing Creek redirection/damming [P]	
8.	Protected	Cleared or adjacent to cleared land	100 (unconfirmed)	Wooroonooran NP	Feral pigs Weed invasion	
9.	Protected	7.8.2a	20	Wooroonooran NP	Feral pigs Weed invasion	
10.	Protected	7.12.16a	3	Wooroonooran NP	Feral pigs Weed invasion Roadside clearing/weed control	
11.	Protected	7.12.16a	12	Wooroonooran NP	Feral pigs Weed invasion Roadside clearing/weed control	
12.	Unprotected	Disturbed	2	Private	Logging/land clearing Creek redirection/damming [P]	

* Note that current actions are being carried out on Council and/or State owned land only. [a] Land allocated for National Park status but process not yet complete. [P] Potential threat only

4. Recovery Objectives

Overall objective
The primary objective of this recovery plan is to arrest the decline of *C. australis* in the wild and to maintain viable '*in situ*' populations.

Specific Objectives
To achieve the overall objective the following specific objectives need to be met:

1. Ensure populations of *C. australis* are not negatively affected by human interference.

2. Increase the total number of populations and individuals of *C. australis* in the wild.

3. Enhance understanding of the ecology and biology of *C. australis*.

4. Increase public awareness of *C. australis*.

5. Recovery Performance Criteria and Actions

This section details the actions necessary to achieve the objectives stated above and gives performance criteria against which progress can be measured.

Objective 1: Ensure populations of *C. australis* are not negatively affected by human interference.

Performance Criterion 1.1
The number of populations of *C. australis* under protection is increased.

Action 1.1.1: Negotiate a conservation agreement with private landholders or custodians to protect *C. australis* populations.

Aim
To protect populations that are not currently in national parks, state forest or conservation reserves.

Justification
Conservation agreements such as Nature Refuges will ensure that landholders are aware of the significance of the populations on their property and ensure continued protection of the plants in the long term. Conservation agreements will significantly enhance the conservation of this species in the northern-most part of its distribution where all known populations occur outside of protected areas.

Method
Several options exist for protection of threatened flora on private land. These include Nature Refuge (administered by EPA/QPWS under the *Nature Conservation Act 1992*) and Voluntary Conservation Agreement (administered by Local Councils under the *Queensland Land Title Act 1994*). The specifications of the agreement will depend on the specific attributes of the land, the needs of the landholder and the threats to the population in question and will be negotiated with the landholder by the relevant authority. Through the Nature Refuge program, landholders will be provided with practical management advice from EPA/QPWS extension officers and incentives to encourage the protection of the natural assets on their property. For example,

financial assistance in the form of Transfer Duty and Land Tax reimbursement is available through the NatureAssist program. A conservation agreement will facilitate dialogue regarding appropriate management practices for the land.

EPA/QPWS is in the process of negotiating land purchases in the Daintree area, which will be converted to National Park status once the program is complete. One of the currently unprotected northern populations has been bought under this program and it is possible that others will be bought in the future. This process has the potential to protect current and future populations of *C. australis* and is consistent with the recommendations of this plan.

The two populations on private land in the southern-most part of the distribution of *C. australis* require further investigation to confirm continued existence of the fern in these locations and to negotiate agreements with the landholders.

Potential contributors
Private landholders, Local Councils, EPA/QPWS, NRMW, WTMA

Estimated cost
$26,000 for salary for one staff officer to conduct negotiations over course of 6 months.

Action 1.1.2: Define and implement appropriate management practices for private landholders and custodians.

Aim
To provide landholders and custodians with management guidelines that will ensure the continued survival of the species on their land.

Justification
Guidelines will make landholders aware of the impact of various management practices on the plants on their land, and give advice on the most appropriate management practices to benefit *C. australis*. Implementation of the appropriate management practices will significantly enhance the conservation of this species on private land.

Method
Management guidelines will be developed based on current knowledge of the ecology and life history of the species. Preliminary guidelines for the management and protection of *C. australis* are provided in Section 7. These are based on the understanding that populations are often riparian and all populations are dependant on surrounding rainforest habitat and the moist microclimate that it provides. These guidelines will be disseminated to land holders (individuals and local councils) with populations of *C. australis* on their land and to land holders of properties considered likely to support *C. australis* now or in the future.

Potential contributors
Private landholders, Local Councils, EPA/QPWS, WTMA.

Estimated cost
$6,500 for salary for one staff officer to contact appropriate stakeholders and provide literature and guidance over the course of two months.

Performance Criterion 1.2
Appropriate habitat management guidelines are established for protected populations of *C. australis.*

Action 1.2.1: Define and implement appropriate management practices for path and roadside clearing/weed control.

Aim
To provide park rangers, contractors and others with management guidelines and training that will ensure the continued survival of existing populations and specifically to ensure that *C. australis* plants are protected from management practices for roadside maintenance and weed control.

Justification
Implementation of the appropriate management practices will significantly reduce the risk of accidental loss of individual plants.

Method
Specific management guidelines will be developed to minimise accidental damage to, or removal of, *C. australis* plants when undertaking track and roadside maintenance. Guidelines will include information on identification and the species ecology and life history and will be presented in a format similar to the Species Management Profiles produced by the EPA/QPWS. Guidelines and supporting information will be delivered to land managers and contracted works teams through training programs that provide skills in native plant identification and options for alternative track and roadside maintenance practices, such as targeted weed eradication programs.

Potential contributors
EPA/QPWS, WTMA, DMR, Local Councils.

Estimated cost
$20,000 a year for training and associated materials over five years.

Action 1.2.2: Control weed species.

Aim
To reduce the probability that weeds will invade *C. australis* habitat.

Justification
Control of weed plants, particularly those invading watercourses, will significantly enhance the survival of existing populations of *C. australis* and enhance the chances of new populations becoming established.

Method
Weed control programs are in place in the Daintree National Park for a variety of weed species including two that have been highlighted here as a significant threat to *C. australis* (see Section 3). The WTMA's Conservation Strategy highlights the importance of weed eradication (Wet Tropics Management Authority, 2004). Using the techniques of existing weed eradication programs, new programs will be developed to target areas where weed-invasion threatens *C. australis* populations and/or habitat suitable for *C. australis*.

Focussing on weed species that invade watercourses will directly benefit populations of *C. australis* and is consistent with the WTMA's Conservation Strategy which emphasises the importance of conservation management of riparian and wetland ecosystems (Wet Tropics Management Authority, 2004).

Potential contributors
EPA/QPWS, WTMA, Local Councils, Terrain NRM.

Estimated cost
$90,000 a year over five years (may be greater if further weed species are found to be threatening *C. australis* populations).

Action 1.2.3: Control feral pigs.

Aim
To reduce the probability that feral pigs will destroy existing populations of *C. australis*.

Justification
Control of feral pigs will help to maintain current levels of diversity in *C. australis* by preserving existing populations and protecting surrounding habitat.

Method
A pig eradication program is in place in the Daintree National Park and a community based feral pig-trapping program was in effect in the WTWHA until recently. These programs typically employ trapping and hunting techniques to attempt to eradicate feral pigs. *C. australis* usually occurs in small populations located in discrete areas so fencing to protect plants from feral pigs is an appropriate action in addition to these wider ongoing actions. Fencing will initially be focused on the few populations that occur on reasonably level ground (those populations that are most readily accessible to pigs). This method of pig control is relatively expensive but is highly effective and for this reason it is recommended, where possible, for all populations.

Caution must be practised when installing exclusion fencing around riparian populations to minimise disturbance to stream bank vegetation. Excessive disturbance may trigger erosion responses and promote stream bank instability. Additionally, low impact strategies for fence retrieval must be developed and applied if threats posed by feral pigs, is eventually removed from these sites.

Potential contributors
EPA/QPWS, WTMA, NRMW, Terrain NRM.

Estimated cost
$60,000 (GST inclusive) one-off cost of erecting fencing for all 12 populations.

Objective 2: Increase the total number of populations and individuals of *C. australis* in the wild.

Performance Criterion 2.1
The number of wild populations of *C. australis* is maintained at or above previous levels.

Action 2.1.1 Establish a population monitoring program for *C. australis.*

Aim
To monitor population change over time and make it possible to respond to new threats as they are observed.

Justification
Population monitoring is essential both to the understanding of natural population dynamics and the assessment of effectiveness of protection measures for existing populations. This information will inform management guidelines and facilitate evaluation of the current plan.

Method
Observations will be made of as many accessible populations as possible. Following initial data collected for the genetic survey (Action 3.1.1), additional data will be collected on numbers of individuals, age/size of plants and site-specific threats. Data will be collected on an annual basis during the lifetime of this plan. Tagging of certain plants within several populations will permit demographic monitoring, a time and cost efficient method for collecting information about populations (Playford and Murray, 2000). It may be possible to recruit community volunteers to participate in population monitoring, given appropriate guidance. Traditional Owners may also be an appropriate group to be involved in this process. The monitoring process should be led by an appropriate agency with the resources to accumulate and process data over a five-year period.

Ongoing monitoring will make it possible to identify new threats to populations as they occur, so that appropriate action can be taken at an early stage, minimizing negative effects on *C. australis*.

Population monitoring may be expanded to include targeted surveys to improve knowledge of the distribution of *C. australis*.

Potential contributors
WTMA, Terrain NRM, Local Councils, ARC, Traditional Owners, Local NGOs.

Estimated cost
$10,000 for the first year, $5,000 for subsequent years.

Objective 3: Enhance understanding of the ecology and biology of *C. australis*.

Performance Criterion 3.1
Understanding of aspects of the genetics, biology and ecology complimentary to conservation of *C. australis* is improved.

Action 3.1.1 Undertake a population-level genetic survey of *C. australis*

Aim
To enhance understanding of the genetic diversity of *C. australis*.

Justification
Population genetic studies can provide information about evolutionary change within populations. Evolutionary processes should be considered along with ecological processes in conservation planning. A genetic survey of *C. australis* will provide

important information about genetic diversity present within the entire species and look at whether populations differ significantly from one another. Such information makes it possible to prioritise populations for conservation actions.

Method
A population-level genetic survey of the species will be undertaken, sampling from all known populations and as many individuals as possible. The sampling process will provide useful information about current population sizes and demography (age range of individuals); this will also serve the valuable purpose of confirming and improving the accuracy of existing location data. Genetic markers may be developed based on a small subset of the samples, then screening and analysis of all samples could be undertaken. The results of such a study will make it possible to assess clonality (i.e. degree to which plants reproduce asexually) and inbreeding depression (loss of genetic diversity due to inbreeding). It will also provide information to help identify target populations from which to collect spore and/or young plants if translocation proved to be an appropriate future action. This study would be suitable for an Honours student to carry out in the course of a 1-year project and it is anticipated that it would be published in a peer-reviewed journal.

Potential contributors
Education and research institutions, for example RCRC/MTSRF, JCU, CSIRO.

Estimated cost
$8,000 for one year.

Action 3.1.2 Perform greenhouse trials to increase understanding of ecology and life history traits of *C. australis.*

Aim
To enhance understanding of key aspects of the ecology and life history of *C. australis* for conservation purposes.

Justification
A better understanding of the biology of a species enhances the chances of success of a conservation program targeting that species. Currently, little is known about *C. australis*. Information about germination, longevity of spores and life span of individuals is critical to the successful conservation of this species.

Method
A number of small-scale studies will be carried out in greenhouse conditions to investigate ecology and life history traits such as germination, longevity of spores in soil and lifespan of individuals. The knowledge gained from these studies will compliment that gained from population monitoring and the genetic study (Actions 2.1.1 and 3.1.1). It will be used to contribute to the production of management guidelines (Actions 1.1.2 and 1.2.1) and inform future conservation actions.

The use of protected plants for scientific research purposes is regulated under the *Nature Conservation Act 1992* (NCA). Groups intending to take/use this species for research purposes will be required to obtain a scientific purposes permit from EPA/QPWS. Contact EPA/QPWS Ecoaccess Customer Service Unit for further information or visit the following website:
http://www.epa.qld.gov.au/ecoaccess/plants_and_animals/scientific_research_or_educational_activities/scientific_purposes/

Potential contributors
Education and research institutions such as RCRC/MTSRF, JCU and CSIRO.

Estimated cost
$250 per year to maintain 20 plants and perform greenhouse and laboratory trials, for five years.

Objective 4: Create public awareness of *C. australis.*

Performance Criterion 4.1
Community awareness of *C. australis* is increased

Action 4.1.1 Selection of a common name for *C. australis.*
Aim
To provide *C. australis* with an appropriate common name.

Justification
By selecting a common name for the species it will be possible to forge links with members of the local community and enable members of the local community and the general public to more easily engage with the species.

Method
Indigenous groups will be approached to establish whether *C. australis* has a traditional name. If not, then a common name will be sought. The selection of a common name for the species will serve two purposes. Firstly, by asking local interested parties such as Traditional Owners to nominate a name for the plant, the importance of community involvement in the recovery of this species will be highlighted. Secondly, common names are a useful way of enabling the general public to more easily engage with a species that they are not familiar with, this is particularly important for less charismatic species.

Potential contributors
EPA/QPWS, WTMA, Terrain NRM, ARC, Traditional Owners.

Estimated cost
Negligible.

Action 4.1.2 Preparation and dissemination of educational materials.

Aim
To provide accessible information about *C. australis* and ferns in general to stakeholders, local community groups and the general public.

Justification
Recovery of *C. australis* is possible only through the co-operation and involvement of stakeholders and the wider community. Dissemination of educational materials is an appropriate way to raise the profile of biodiversity issues and foster an interest in plant life.

Method
A brochure and web-based fact sheet such as a Species Management Profile as produced by EPA/QPWS, with photographs and information on *C. australis*, in

combination with details of other threatened ferns of the WTWHA, will be produced and distributed to the public through a variety of local and state agencies (i.e. EPA/QPWS website).

Information about ferns will also be targeted at visitors to the WTWHA through the development of a fern 'glade' (area rich in fern diversity) visitor node or boardwalk where visitors are directed to specimen plants with interpretational signs. Both the brochure and interpretational signs will combine biological information with details about the history of ferns in a geological context. Indigenous input will be sought from Traditional Owners to provide information about the cultural significance of the species. The Palmerston Forest Reserve is a potential site for such an enterprise with good public access and a naturally high diversity of fern species. This action will benefit a number of fern species including *C. australis*.

Potential contributors
EPA/QPWS, WTMA, Terrain NRM, Local Councils, ARC, Traditional Owners.

Estimated cost
$700 to produce 1000 brochures. No costs envisaged for EPA/QPWS web-based fact sheet. Cost for interpretational signs to be determined.

Objectives, Performance Criteria and Actions Summary:

Overall objective: The primary objective of this recovery plan is to arrest the decline of *C. australis* in the wild and to maintain viable '*in situ*' populations.

Specific objectives:

Objective	Performance criteria	Action	Potential Contributors	Priority
Objective 1 Ensure populations of *C. australis* are not negatively affected by human interference.	Criterion 1.1 The number of populations of *C. australis* under protection is increased.	Action 1.1.1 Negotiate a conservation agreement with private landholders or custodians to protect *C. australis* populations	Private Landholders Local Councils EPA/QPWS NRMW WTMA	High
		Action 1.1.2 Define and implement appropriate management practices for private landholders and custodians	Private Landholders Local Councils EPA/QPWS WTMA	High
	Criterion 1.2 Appropriate habitat management guidelines are established for protected populations of *C. australis.*	Action 1.2.1 Define and implement appropriate management practices for path and roadside clearing/weed control	EPA/QPWS WTMA DMR Local Councils	High
		Action 1.2.2 Control weed species	EPA/QPWS WTMA Local Councils Terrain NRM	High
		Action 1.2.3 Control feral pigs	EPA/QPWS WTMA NRMW Terrain NRM	Medium
Objective 2 Increase the total number of populations and individuals of *C. australis* in the wild.	Criterion 2.1 The number of wild populations of *C. australis* is maintained at or above previous levels.	Action 2.1.1 Establish a population monitoring program for *C. australis*	Local Councils WTMA Terrain NRM ARC Traditional Owners Local NGOs	Medium

Objective	Performance criteria	Action	Potential Contributors	Priority
Objective 3 Enhance understanding of the ecology and biology of *C. australis.*	Criterion 3.1 Understanding of aspects of the genetics, biology and ecology complimentary to conservation of *C. australis* is improved.	Action 3.1.1 Undertake a population-level genetic survey of *C. australis*	Education and research institutions (RCRC/MTSRF JCU, CSIRO)	Medium
		Action 3.1.2 Perform greenhouse trials to increase understanding of ecology and life history traits of *C. australis*	Education and research institutions (RCRC/MTSRF JCU, CSIRO)	Medium
Objective 4 Create public awareness of *C. australis.*	Criterion 4.1 Community awareness of *C. australis* is increased.	Action 4.1.1 Selection of a common name for *C. australis*	EPA/QPWS WTMA ARC Traditional Owners Terrain NRM	Low
		Action 4.1.2 Preparation and dissemination of educational materials	EPA/QPWS WTMA Local Councils ARC Traditional Owners Terrain NRM	Low

6. Costs of recovery

Action	Description	Estimated cost per year				
		Year 1	Year 2	Year 3	Year 4	Year 5
Action 1.1.1 Negotiate a conservation agreement with private landholders or custodians to protect *C. australis* populations	Salary for one staff officer to conduct negotiations over course of 6 months; meetings and administration (1st year only)	*$26,000*	*N/A*	*N/A*	*N/A*	*N/A*
Action 1.1.2 Define and implement appropriate management practices for private landholders and custodians	Salary for one staff officer to contact appropriate stakeholders and provide literature and guidance over the course of two months.	*$6,500*	*N/A*	*N/A*	*N/A*	*N/A*
Action 1.2.1 Define and implement appropriate management practices for path and roadside clearing/weed control	Administration Training	*$20,000*	*$20,000*	*$20,000*	*$20,000*	*$20,000*
Action 1.2.2 Control weed species	Herbicide/mechanical clearing; disposal of plant material/burning; $30, 000 per species per year	*$90,000*	*$90,000*	*$90,000*	*$90,000*	*$90,000*
Action 1.2.3 Control feral pigs	Materials $2,500 (GST inclusive) per kilometre for fencing (multiplied by an estimated 2 kilometres per population, multiplied by total number of populations); monitoring/maintenance	*$60,000*	*N/A*	*N/A*	*N/A*	*N/A*
Action 2.1.1 Establish a population monitoring program for *C. australis*	Monitoring, approx. $1000 per day, over 10 days to assess all known populations in detail (1st year) Monitoring over 5 days (subsequent years)	*$10,000*	*$5,000*	*$5,000*	*$5,000*	*$5,000*
Action 3.1.1 Undertake a population-level genetic survey of *C. australis*	Travel and field costs approx. $1500; laboratory work and analysis approx. $5500-6500 for DNA extraction, amplification and analysis of up to 200 samples (1 year)	*$8,000*	*N/A*	*N/A*	*N/A*	*N/A*

Action	Description	Estimated cost per year				
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Action 3.1.2 Perform greenhouse trials to increase understanding of ecology and life history traits of *C. australis*	$50 per year for germination, cultivation and maintenance of c.20 plants; $200 per year for greenhouse/laboratory studies over the course of five years.	*$250*	*$250*	*$250*	*$250*	*$250*
Action 4.1.1 Selection of a common name for *C. australis*	Negligible cost	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Action 4.1.2 Preparation and dissemination of educational materials	Administration; production of 1000 brochures (1st year only); cost for interpretation signs additional (not included).	*$700*	*N/A*	*N/A*	*N/A*	*N/A*
Total		**221, 450**	**115,250**	**115,250**	**115,250**	**115,250**

Total estimated cost for implementation of this recovery plan over a five-year period - $682,450

7. Management practices

Appropriate management practices are critical to the survival of *C. australis*. Pristine rainforest habitat with natural hydrological regimes and natural disturbance processes are key to the survival of *C. australis*. The following management guidelines should be considered to augment a policy of minimal interference. These guidelines may be modified as knowledge of the ecology and threats to *C. australis* improves.

- Halt clearing of habitat in the vicinity of *C. australis* populations.
- Prevent watercourse redirection or damming in the vicinity of *C. australis* populations.
- Manage road verge maintenance activities, particularly weed eradication, to ensure individuals are not damaged or removed.
- Manage invasion of habitat by weed species, particularly those that thrive along watercourses.
- Where practical, fence populations that are threatened by feral pigs.
- Promote management practices that encourage natural rainforest processes to ensure continued opportunities for *C. australis* colonisation.

8. Evaluation of recovery plan

Assessment of the success of management actions against the criteria described in this plan is essential to ensure the successful recovery of *C. australis*. Annual reviews will be carried out in consultation with affected stakeholders. The plan actions and outcomes will be evaluated within 5 years of the plan being adopted.

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References

Andrews, S. B. 1990. *Ferns of Queensland*. Queensland Department of Primary Industries, Brisbane. p. 406-407.

Bostock, P. D. 1998. Thelypteridaceae. In *Flora of Australia* 48: 327-358.

Environmental Protection Agency/Queensland Parks and Wildlife Service (EPA/QPWS). 2006. *WildNet* [Database]. Environmental Protection Agency, Brisbane. (Date accessed: 16th February 2006).

Holttum, R. E. 1986. New Thelypteroid ferns in Queensland. *Kew Bulletin* 41: 518.

Land Protection. 2005. *Feral pigs in Queensland – distribution, ecology and impact. Fact Sheet PA6.* Queensland Government Natural Resource and Mines, Brisbane.

Playford, J. and Murray, R. 2000. *Threatened Plants: Active Bushcare*. The Centre for Conservation Biology, The University of Queensland, Brisbane. p.39

Queensland Parks and Wildlife Service. 2001. *Recovery plan for the southern cassowary* Cauarius casuarius johnsonii *2001-2005*. Queensland Parks and Wildlife Service, Brisbane.

Wet Tropics Management Authority. 2004. Wet Tropics Conservation Strategy: the conservation, rehabilitation and transmission to future generations of the Wet Tropics World Heritage Area. WTMA, Cairns.

Wet Tropics Management Authority. 2006. http://www.wettropics.gov.au/pa/pa_plants_info.html (Date accessed: 16th February 2006)