INTERIM RECOVERY PLAN NO. 185

SCALY-LEAVED FEATHERFLOWER

(*VERTICORDIA SPICATA* SUBSP. *SQUAMOSA*)

INTERIM RECOVERY PLAN

2004-2009

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Photograph: Anne Cochrane

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DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos. 44 and 50.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

CALM is committed to ensuring that Critically Endangered taxa are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by the Minister.

This Interim Recovery Plan results from a review of, and replaces, No.49 *Verticordia spicata* subsp. *squamosa* (Phillimore and English, 1999). This Interim Recovery Plan will operate from October 2004 to September 2009 but will remain in force until withdrawn or replaced. It is intended that, if the taxon is still ranked Critically Endangered, this IRP will be reviewed after five years and the need for a full Recovery Plan assessed.

This IRP was given regional approval 9 November, 2004 and approved by the Director of Nature Conservation on 7 December, 2004. The allocation of staff time and provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Information in this IRP was accurate in October 2004.

ACKNOWLEDGMENTS

The following people have provided assistance and advice in the preparation of this Interim Recovery Plan:

Anne Cochrane	Manager, CALM's Threatened Flora Seed Centre
Andrew Crawford	Technical Officer, CALM's Threatened Flora Seed Centre
Elizabeth George	Verticordia specialist; Honorary Curator, WA Herbarium
Amanda Shade	Horticulturalist, Botanic Gardens and Parks Authority
Charles Strahan	Gardener and rare flora enthusiast, Shire of Three Springs

Thanks also to the staff of the W.A. Herbarium for providing access to Herbarium databases and specimen information, and CALM's Wildlife Branch for assistance.

SUMMARY

Scientific Name:	*Verticordia spicata* subsp. *squamosa*	**Common Name:**	Scaly-leaved featherflower
Family:	Myrtaceae	**Flowering Period:**	October-December
CALM Region:	Midwest	**CALM Districts:**	Moora, Geraldton
Shires:	Three Springs, Mingenew	**Recovery Teams:**	Moora District Threatened Flora Recovery Team and Geraldton District Threatened Flora Recovery Team

Illustrations and/or further information: Brown, A., Thomson-Dans, C. and Marchant, N. (Eds) (1998) *Western Australia's Threatened Flora*, Department of Conservation and Land Management, Western Australia; George, E.A. (2002) *Verticordia: the turner of hearts*, University of Western Australia Press, Western Australia in association with Australian Biological Resources Study, Australian Capital Territory; Ginger, D. (1999) *The Effects of Habitat Fragmentation on two Rare and Endangered Verticordias*, Honours Thesis, Curtin University of Technology, Western Australia.

Current status: *Verticordia spicata* subsp. *squamosa* was declared as Rare Flora in June 1995. It is currently ranked as Critically Endangered (CR) under the *Wildlife Conservation Act 1950*. The taxon is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It currently meets Red List (IUCN 2000) Category 'CR' under criteria A4c; Ba1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C2a(i); and D as there is a total of only 29 mature individuals in seven extant wild populations with continuing decline in the quality of habitat. The main threats include poor recruitment, weeds, edge effects, rabbits, road and fence maintenance and inappropriate fire regimes.

Description: *Verticordia spicata* subsp. *squamosa* is a dense bushy shrub usually 30-60 cm but sometimes to almost 1 m tall, and 60-100+ cm wide. It has rounded to elliptic leaves, 1.5 - 2 mm long with prominent oil glands. The leaves closely overlap and are pressed to the stem, providing the scaly appearance from which this subspecies derives its name (from the Latin *squamosus* - scaly). The flowers are produced in early summer and are closely packed, forming dense spikes on the ends of the branches. They open mauve-pink before the whole spike fades evenly to white with age, and they have a stronger perfume than *V. spicata* subsp. *spicata*. The fringed sepals are 3-4 mm long and the petals are 2.5 mm long, with a 1-2 mm fringe. The stamens and linear staminodes are hairless. The style is 4 mm long and bearded below the apex. (George 2002; Brown *et al*. 1998).

Habitat requirements: *Verticordia spicata* subsp. *squamosa* is known from nine populations in the Three Springs and Mingenew areas of Western Australia, occurring over a range of approximately 20 km. All of the populations are small and highly vulnerable to the effects of habitat fragmentation. Most populations are located on narrow road reserves, and others occur on private property. Seven of the nine populations contain three plants or less.

Verticordia spicata subsp. *squamosa* grows in open mallee over low scrub on deep yellow sands. Associated species include *Eucalyptus jucunda, Actinostrobus arenarius, Jacksonia* sp., *Verticordia comosa*, *V. monadelpha*, *V. densiflora* var. *stelluligera*, *V. eriocephala* and *Grevillea biformis*.

Critical habitat: The critical habitat for *Verticordia spicata* subsp. *squamosa* comprises the area of occupancy of the known populations; similar habitat within 200 metres of known wild and translocated populations; corridors of remnant vegetation that link populations, and additional nearby occurrences of similar habitat that do not currently contain the species but may have done so in the past and may be suitable for translocations.

Habitat critical to the survival of the species, and important populations: Given that this taxon is listed as Critically Endangered, it is considered that all known habitat for wild and translocated populations is habitat critical to its survival, and that all wild and translocated populations are important populations.

Benefits to other species or ecological communities: Three Priority flora are known from the habitat of *V. spicata* subsp. *squamosa*. These are *Acacia lanceolata* (Priority 2), *Calytrix purpurea* (Priority 2) and *Pityrodia viscida* (Priority 3). In addition, recovery actions such as weed control or buffer vegetation planting at *V. spicata* subsp. *squamosa* populations will help to protect the ecological community in which the populations are located.

International obligations: This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. *Verticordia spicata* subsp. *squamosa* is not specifically listed under any international treaty, and therefore this plan does not affect Australia's obligations under any other international agreements.

Role and interests of indigenous people: The Aboriginal Sites Register maintained by the Department of Indigenous Affairs does not list any significant sites in the vicinity of these populations. Implementation of recovery actions under this

plan will include consideration of the role and interests of indigenous communities in the region, and this is discussed in the recovery actions.

Social and economic impact: Some populations of *Verticordia spicata* subsp. *squamosa* occur on private land and liaison will continue with regard to the future management of these populations. The implementation of this recovery plan has the potential to have some social and economic impact, where populations are located on private property or other lands not specifically managed for conservation. The occurrence of this taxon on an unconstructed road reserve may affect whether a road can be constructed at that site in the future, and this may have some limited social impact. Recovery actions refer to continued liaison between stakeholders with regard to these areas.

Evaluation of the plan's performance: The Department of Conservation and Land Management in conjunction with the Geraldton District and Moora District Threatened Flora Recovery Teams will evaluate the performance of this IRP. In addition to annual reporting on progress with listed actions and comparison against the criteria for success and failure, the plan is to be reviewed within five years of its implementation.

Existing Recovery Actions: The following recovery actions have been or are currently being implemented:

1. Relevant land managers have been made aware of the location and threatened status of the taxon.
2. Declared Rare Flora (DRF) markers have been installed at Populations 1, 3, 6a and 7.
3. Populations 4b and 6b on private property were fenced in 1997 to prevent grazing and trampling of plants and habitat.
4. Juveniles at Populations 4b and 9T (translocated) have been protected from grazing within individual rabbit-proof enclosures.
5. Weed control has been undertaken at a number of populations on several occasions.
6. Cutting material was collected by Botanic Gardens and Parks Authority (BGPA) staff in 1995 for propagation.
7. Small quantities of seed have been collected from most populations over a number of years, and this is stored at CALM's Threatened Flora Seed Centre (TFSC).
8. Research has been conducted into the taxon's reproductive biology, seed bank dynamics and seed germination physiology, particularly the response to smoke.
9. Additional smoke trials have been completed.
10. A translocation was initiated in 2001, and a second planting undertaken in 2002.
11. An information sheet that describes and illustrates the taxon has been produced.
12. Staff from CALM's Moora and Geraldton Districts monitor all populations of the taxon.
13. The Moora District and Geraldton District Threatened Flora Recovery Teams are overseeing the implementation of this IRP.

IRP objective: The objective of this Interim Recovery Plan is to abate identified threats and maintain or enhance viable *in situ* populations to ensure the long-term preservation of the taxon in the wild.

Recovery criteria

Criteria for success: The number of individuals within populations and/or the number of populations have increased by ten percent or more over the five year period of the plan.

Criteria for failure: The number of individuals within populations and/or the number of populations have decreased by ten percent or more over the five year period of the plan.

Recovery actions

1. Coordinate recovery actions
2. Map critical habitat
3. Liaise with relevant land managers
4. Implement weed control
5. Implement rabbit control
6. Undertake watering if necessary
7. Stimulate regeneration
8. Monitor populations
9. Conduct further surveys
10. Collect seed
11. Continue translocation process
12. Seek long-term protection of habitat
13. Investigate possibility of land acquisition
14. Rehabilitate habitat
15. Develop and implement a fire management strategy
16. Promote awareness
17. Obtain biological and ecological information
18. Review the need for a full Recovery Plan

1. BACKGROUND

History

The first specimen of *Verticordia spicata* subsp. *squamosa* was collected north of Three Springs in 1951, and the subspecies was described in 1991 (George 1991). Additional populations have since been located, and a total of 34 mature plants are now known from eight wild populations and one translocated population. Seven of the populations contain three mature plants or less. Population 2 has been cleared and no plants have been seen at the site since 1992. It is extremely unlikely that any *V. spicata* subsp. *squamosa* propagules remain at this site, as soil-stored Verticordia seed typically declines in viability quite rapidly. The plant at Population 3 died only recently (November 2003), so there is a chance that some seed may still remain at this site. Ginger (1999) obtained seed viability results of 0% from this solitary plant during his tests, but attempts to stimulate germination in the area should nevertheless be made. Very little of this habitat type remains uncleared in the area, as the deep sands are suitable for agriculture. Most populations occur in tiny fragments of vegetation on narrow road verges or private property.

A translocation was initiated in 2001 in an attempt to establish a larger population in habitat in good condition. The taxon is extremely difficult to propagate as it has seed with relatively low viability, low survival rates of seedlings, and a low strike rates of cuttings. In addition, setbacks have been experienced with repeated watering system failures at the translocation site. It is likely that recovery of this taxon will require plantings into the first translocation site for a number of years, and eventually planting into other sites.

An Interim Recovery Plan (IRP) was developed for the subspecies in 1999 (Phillimore and English 1999). Information collected since that plan was completed has been incorporated into this plan and this document now replaces Phillimore and English (1999).

Description

Verticordia spicata subsp. *squamosa* is a dense bushy shrub usually 30-60 cm but sometimes to almost 1 m tall, and 60-100+ cm wide. It has rounded to elliptic leaves, 1.5 - 2 mm long with prominent oil glands. The leaves closely overlap and are pressed to the stem, providing the scaly appearance from which this subspecies derives its name (from the Latin *squamosus* - scaly). The flowers are produced in early summer and are closely packed, forming dense spikes on the ends of the branches. They open mauve-pink before the whole spike fades evenly to white with age, and they have a stronger perfume than *V. spicata* subsp. *spicata*. The fringed sepals are 3-4 mm long and the petals are 2.5 mm long, with a 1-2 mm fringe. The stamens and linear staminodes are hairless. The style is 4 mm long and bearded below the apex (George 2002; Brown *et al*. 1998).

Verticordia spicata subsp. *squamosa* differs from the typical subspecies in its smaller leaves and flowers. It has been known to hybridise with *V. comosa*, with which it occurs. These hybrids tend to retain the habit of *V. spicata* subsp. *squamosa*, but their dense spikes of creamy-white, strongly scented flowers are longer than those of either parent. They usually have spreading leaves 2-3 mm long, a hypanthium with shorter appendages, sepals with prominent auricles and a style 5 mm long with a more dense beard than that of *V. spicata* subsp. *squamosa* (George 2002).

Distribution and habitat

Endemic to the Three Springs and Mingenew areas of Western Australia, *V. spicata* subsp. *squamosa* is known from nine populations, most of which are located along narrow road reserves. Populations 4b and 6b occur on private property, and Population 9T is a translocated population established in remnant vegetation on private property. Population 5 occurs in a Shire gravel reserve, and Population 8 occurs on an undeveloped Shire road reserve. Only 29 mature plants and three juveniles are known in wild populations, with another three adult and 11 juvenile plants in the translocated populations. The taxon has a range of approximately 20 km.

V. spicata subsp. *squamosa* grows in open mallee over low scrub on deep yellow sands. Associated species include *Eucalyptus ebbanoensis*, *E. jucunda*, *Actinostrobus arenarius*, *Grevillea biformis*, *G. eriostachya*, *Jacksonia* sp., *Ecdeiocolea monostachya*, *Verticordia comosa*, *V. monadelpha*, *V. densiflora* var. *stelluligera* and *V. eriocephala*.

Biology and ecology

The genus *Verticordia* is well known for its colourful, showy flowers and most taxa in the genus have horticultural potential. Few species have proved reliable in cultivation, however, and frequently a large percentage of seed is infertile and germination is low (Wrigley and Fagg 1979). Most species make excellent cut flowers and a considerable market has been established (Leigh *et al.* 1984).

A *Verticordia spicata* subsp. *squamosa* individual currently persisting in moderate condition was mature when seen in 1974, and this suggests that these plants can live for at least 35 years.

Propagation of Verticordias has been mainly from cuttings with a few grown from seed. In general, Verticordias produce only one seed per flower in the wild. Germination occurs from within old flowers that have fallen to the ground. Research by CALM's Threatened Flora Seed Centre (TFSC) has shown that seed set is generally low in Verticordias (less than 51%) and is variable between species, within the same species in different locations, and between different years at the same location (Cochrane and McChesney 1995). Observations of *V. spicata* subsp. *squamosa* recorded extremely abundant flowering in 1993, with plants appearing to 'buzz' as they were covered in native bees, moths, beetles, flies and ants. However, flowering was scant in 1994, and no insects observed. Although seed set was not studied in those years, it could be presumed to vary with the rates of flowering and insect visitation.

Verticordias are generally considered to be fire sensitive with post-fire regeneration occurring mainly from seed. A few species have a lignotuber and can resprout after fire (E. George[1] personal communication). The specific fire response of *Verticordia spicata* subsp. *squamosa* is unknown. Physical soil disturbance appears to have a mildly positive influence on germination of seed, with two seedlings germinating after roadworks at Population 1. There is also some suggestion that physical soil disturbance may foster the germination of hybrids of *Verticordia* species; hybrids are seen in greater numbers in physically disturbed (although not burnt) situations, and the mechanism for this is not understood (E. George, personal communication).

Verticordia species often hybridise readily. *Verticordia spicata* subsp. *squamosa* is known to hybridise with *V. comosa*, with which it occurs in the wild (George 2002).

Verticordia spicata subsp. *squamosa* was found to be highly susceptible to infection by the plant pathogen *Phytophthora cinnamomi* (dieback disease) when tested by CALM Science (C. Crane[2], personal communication). This finding is provisional as replication of the testing has necessarily been minimal, but the results nevertheless provide an indication of the taxon's susceptibility. The deep sands on which this taxon occurs are generally low risk for dieback infection, and the area of occurrence receives less than 400 mm rainfall per annum. There is no record of the disease surviving in these conditions, so the risk to this taxon *in situ* appears negligible.

There is a high level of exotic weed invasion and rabbit activity in the small remnants that contain *Verticordia spicata* subsp. *squamosa*. This is likely to be impacting on ecological processes at these sites, particularly with regard to recruitment of native taxa.

Research undertaken on *Verticordia spicata* subsp. *squamosa* in 1999 indicated that flower production is high, with individual plants producing on average approximately 47,000 flowers (Ginger 1999). However, an average of only 13% of these set viable seed, comparing poorly with *V. spicata* subsp. *spicata* which was found to have seed viability of 40% (Tyagi 1993, cited in Ginger 1999). Seed viability of *V. spicata* subsp. *squamosa* ranged from 21.7% at Population 4b (then 9 plants), through 9.6% at Population 6a (then 12 plants), 7.3% at Population 6b (then 7 plants) to 0% at Population 3 (then 1 plant) (Ginger 1999). The number of plants present in each population closely corresponds to the quality of habitat at each site. The trend of seed viability decline in association with smaller population size and habitat quality, to the extreme of nil seed set at Population 3, has obvious implications for management. These findings strongly suggest that larger populations in better quality habitat must be fostered to ensure their sustainability.

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[2] Colin Crane, Senior Technical Officer, *Phytophthora* research, CALM's Science Division

Ginger (1999) assessed the presence of a soil-stored seed reserve at two *Verticordia spicata* subsp. *squamosa* populations. Samples were collected from the drip-line around several plants at both sites, and an average of 649 fruits were found at one site, and an average of 462 fruits were found at the other. However, on average only 3.2 and 4.4 fruits respectively contained viable seeds.

Research has shown some patterns in the effects of smoking and seed age on the germination of seed across a wide range of species. Roche *et al.* (1997) found that seed ageing alone did not break dormancy in any of the five *Verticordia* species examined (*V. aurea, V. chrysantha, V. densiflora, V. eriocephala* and *V. huegelii*). In all five *Verticordia* species, smoking fresh seed after sowing improved the mean germination rates (0% in all controls; 16.7%-42.8% with smoke treatment).

The viability of soil-stored seed was found by Roche *et al.* (1997) to decline over 12 months and is likely to continue to decline with time. However, research indicates that the likelihood of the remaining viable seed in the soil germinating can be increased by smoking the seed after 12 months soil storage. In four species, smoking resulted in a dramatic improvement in germination as a percentage of seed viable at the time of testing (eg, 28.1% of smoked fresh seed as compared to 91.7% of smoked aged seed; an improvement of 63.6% for *V. densiflora*). The fifth species had nil germination in any of the aged seed treatments.

The decline in seed viability of five *Verticordia* species over a period of 12 months was examined by Roche *et al*. (1997). Viability declined from 60% initial viability to 40% viability after 12 months soil storage in *V. aurea* (ie. a one-third decline). A decline of 26% to 3% viability was noted in *V. huegelii* (ie. a decline of 90%). As seed viability declines over time, the dramatic improvement in germination with smoke-age may not yield the same level of improvement in number of germinants, but it is likely that the actual numbers will still be higher. The results of Ginger's and Chant's trials so far suggest that *V. spicata* subsp. *squamosa* is likely to follow the pattern of improved germination results with smoke application to slightly aged seed. Population 4b is the only population to produce seedlings *in situ*, and this is consistent with the comparatively high seed viability (21.7%) at that site. Four seedlings germinated in 2000 following summer rain. They occurred in a smoke trial area set up by D. Ginger.

In his research on this taxon Ginger (1999) applied aerosol smoke using a fumigation tent. He reported better response to smoking in May 1999 than in July 1998. This is in accord with Vigilante *et al*. (1998), who suggest that smoke is best applied from autumn to early winter, or generally when germination is most likely to naturally occur. Monitoring of the smoked sites in October 1999 reported 16 germinants at Population 4b, although these were later identified to be other species (eg, *Thryptomene* and *Scholtzia* species). Forty six germinants were also reported at Population 6b, but whether any of these were *Verticordia spicata* subsp. *squamosa* is unknown, as this site was affected by cyclonic flooding and all seedlings died. No *V. spicata* subsp. *squamosa* germinants were recorded from unsmoked soil at any site during the study. Subsequent smoke trials were conducted by Alanna Chant in 2000, but these failed to stimulate germination. Possible causes include low to nil levels of seed in the soil tested, and two successive very dry years in 2001 and 2002. It is hoped that another attempt followed by higher rainfall will provide better results.

Threats

Verticordia spicata subsp. *squamosa* was declared as Rare Flora in June 1995. It is currently listed as Critically Endangered (CR) under the *Wildlife Conservation Act 1950* due to its restricted distribution, low numbers of plants and continuing decline in the quality of habitat. *V. spicata* subsp. *squamosa* is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It currently meets Red List (IUCN 2000) category 'CR' under criteria A4c; Ba1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C2a(i) and D.

Clearing for agriculture around the Three Springs area began early in the 1900s, and has resulted in extensive habitat loss. There has been additional widening of roads and clearing of road reserves in the Shires of Three Springs and Mingenew in the past 10 years. The road reserve at Population 2 was graded in 1990 resulting in the loss of several plants and significant reduction in the amount of available habitat. The main threats to the taxon are poor recruitment, weeds, edge effects, rabbits, road and fence maintenance and inappropriate fire regimes.

- **Poor recruitment** is apparent at all populations, with juvenile plants germinating recently only at Population 4b. It may be due to one or a combination of the following: low seed viability, an absence of

germination triggers such as fire or smoke, and the high level of weed competition or grazing. Seed viability has been found to be variable but is generally low, and is particularly low in the populations that consist of a single plant (Ginger 1999).

- **Weed invasion and competition** are threats to all populations. Weeds suppress plant growth and recruitment by competing for soil moisture, nutrients and light. They also exacerbate grazing pressure and increase the fire hazard as grassy weeds produce large amounts of fuel annually.

- **Edge effects** severely affect small populations, (especially narrow linear populations such as those on road reserves) by exposure to influences from adjacent cleared land. In addition to the proximity of a weed seed source, effects include increased wind speed, fertiliser and herbicide spray drift and runoff, modified hydrology and altered disturbance regimes, including fire.

- **Degraded habitat** is a threat to all populations. The lack of associated native vegetation increases the likelihood that pollinators will be infrequent or absent. In addition, the lack of available habitat for recruitment is of concern. Six of the nine populations occur on narrow road reserves in an extensively cleared landscape.

- **Rabbit warren construction** is causing soil disturbance at most roadside populations, in particular Populations 1, 3 and 6a. Population 6b occurs on private property and the habitat also contains rabbit warrens. Increasing nutrient levels and weeds introduced from rabbit droppings are also impacting on the habitat of the taxon. Grazing is likely to impact on the establishment of *Verticordia spicata* subsp. *squamosa* seedlings, thereby limiting natural recruitment.

- **Road, fence and firebreak maintenance activities** threaten plants and habitat at road reserve populations of *Verticordia spicata* subsp. *squamosa*. These include actions such as grading the road reserves, chemical spraying, constructing drainage channels and mowing the roadside vegetation to improve visibility. These disturbance events also often encourage weed invasion into adjacent habitat.

- **Inappropriate fire regimes** would adversely affect the viability of populations, as seeds of *Verticordia spicata* subsp. *squamosa* probably germinate following fire. If this is the case, the soil seed bank would rapidly be depleted if fires recurred before regenerating or juvenile plants reached maturity and replenished the soil seed bank. High fire frequency also results in a temporary increase in the availability of nutrients, and this favors weed establishment (Panetta and Hopkins 1991). However, it is likely that occasional fires are needed for reproduction of this taxon, but fire appears to be very infrequent in the habitat of the known populations.

Summary of population information and threats

Pop. No. & Location	Land Status	Year/No. plants	Condition	Threats
1. NNE of Three Springs	Shire road reserve	1992 2 1995 6 1995 2 2000 5 2003 1	Moderate	Road and fence maintenance activities, weeds, rabbits, agricultural chemical drift, grazing by stock through fences, drought
2. NE of Three Springs	Shire road reserve	1992 3 1999 0 2000 0	Cleared	
3. ENE of Yandanooka	Shire road reserve	1994 1 1995 1 1997 1 1999 1 2000 1 2001 1 2003 0 [1]	Poor	Road maintenance activities, weeds, agricultural chemical drift, rabbits, drought
4a. E of Yandanooka	Shire road reserve	1992 1 1995 0 1997 0 1999 0	Poor	Road maintenance activities, high level weed competition, agricultural chemical drift
4b. E of Yandanooka	Private property	1993 12 1995 10 1998 11 1999 4 2000 4 (2) 2001 5 (4) 2003 8 (2)	Moderate	Grazing by sheep, firebreak maintenance, shading, drought
5. NE of Three Springs	Shire reserve	1995 2	Moderate	Quarrying, weeds
6a. NE of Three Springs	Shire road reserve	1995 15 1999 10 2000 15 2002 15 2003 12	Moderate	Road maintenance activities, high level weed competition, agricultural chemical drift, rabbits, drought
6b. NE of Three Springs	Private property	1995 7 1999 7 2003 6	Moderate	Grazing by sheep, rabbits, degraded habitat, drought
7. ENE of Yandanooka	Shire road reserve	1996 1 1999 1 2001 1 2003 1	Poor	Road and fence maintenance activities, high level rabbit disturbance, drought, weeds, agricultural chemical drift, shading
8. E of Yandanooka	Shire (unconstructed) road reserve	2000 1 2002 1 2003 1	Moderate	Road construction, fence and firebreak maintenance activities, weeds, agricultural chemical drift, drought, rabbits
9T. N of Yandanooka	Private property	06.01 (8) 01.02 (8) 06.02 (6+21) 12.02 (4+19) 10.03 0+3 (3+8)	Moderate	Drought, rabbits

Numbers in brackets = number of juveniles. Plants in 9T listed by year of planting; ie, from 2001 planting + from 2002 planting.

Guide for decision-makers

Section 1 provides details of current and possible future threats. Any on-ground works (clearing, firebreaks, roadworks etc) in the immediate vicinity of *Verticordia spicata* subsp. *squamosa* will require assessment. On-ground works should not be approved unless the proponents can demonstrate that they will not have an impact on the taxon, its habitat or potential habitat.

Critical habitat
Critical habitat is habitat identified as being critical to the survival of a listed threatened species or listed threatened ecological community. Habitat is defined as the biophysical medium or media occupied (continuously, periodically or occasionally) by an organism or group of organisms or once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced (EPBC Act).

Verticordia spicata subsp. *squamosa* is listed as Critically Endangered, and as such it is considered that all known habitat for wild and translocated populations is critical habitat. This includes:

- the area of occupancy of wild and translocated populations;
- areas of similar habitat within 200 metres of populations, i.e. open mallee over low scrub on deep yellow sands (these provide potential habitat for natural range extension);
- corridors of remnant vegetation that link populations (these are necessary to allow pollinators to move between populations and are usually road and rail verges); and
- additional occurrences of similar habitat that do not currently contain the species but may have done so in the past (these represent possible translocation sites).

Benefits to other species or ecological communities
Three Priority flora (Atkins 2003) species are known from the habitat of *Verticordia spicata* subsp. *squamosa*. These are *Acacia lanceolata* (Priority 2), *Calytrix purpurea* (Priority 2) and *Pityrodia viscida* (Priority 3). In addition, recovery actions such as weed control or planting of buffer vegetation at *V. spicata* subsp. *squamosa* populations will help to protect the ecological community in which the populations are located.

International obligations
This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. *V. spicata* subsp. *squamosa* is not specifically listed under any international treaty, and therefore this plan does not affect Australia's obligations under any other international agreements.

Role and interests of indigenous people
Indigenous communities interested or involved in the regions affected by this plan have not yet been identified. The Aboriginal Sites Register maintained by the Department of Indigenous Affairs does not list any significant sites in the vicinity of these populations. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region, and this is discussed in the recovery actions.

Social and economic impacts
Some populations of *Verticordia spicata* subsp. *squamosa* occur on private land and negotiations will continue with regard to the future management of these populations. The implementation of this recovery plan has the potential to have some social and economic impact, where populations are located on private property or other lands that are not specifically managed for conservation such as road reserves. Recovery actions refer to continued liaison between stakeholders with regard to these areas.

Evaluation of the plan's performance
CALM will evaluate the performance of this IRP in conjunction with the Geraldton District Threatened Flora Recovery Team and the Moora District Threatened Flora Recovery Team. In addition to annual reporting on progress with listed actions and comparison against the criteria for success and failure, the plan is to be reviewed within five years of its implementation.

2. RECOVERY OBJECTIVE AND CRITERIA

Objectives
The objective of this Interim Recovery Plan is to abate identified threats and maintain or enhance *in situ* populations to ensure the long-term preservation of the species in the wild.

Criteria for success: The number of individuals within populations and/or the number of populations have

increased by ten percent or more over the five year period of the plan.
Criteria for failure: The number of individuals within populations have decreased by ten percent or more over the five year period of the plan.

3. RECOVERY ACTIONS

Existing recovery actions
All relevant land managers have been notified of the location and threatened status of the taxon. The notification details the Declared Rare status of *Verticordia spicata* subsp. *squamosa* and the associated legal responsibilities.

Declared Rare Flora (DRF) markers have been installed at Populations 1, 3, 6a and 7. These alert people working in the area to the presence of significant flora, and help to prevent accidental damage. Awareness of the significance of these markers has been promoted to relevant land managers such as local government authorities.

Populations 4b and 6b on private property were fenced in 1997 to prevent sheep grazing and trampling plants and habitat. Rabbit-proof enclosures were installed over the juveniles at Population 4b in May 2000. These were replaced with larger enclosures in December 2003.

Spot weed control was undertaken at Populations 3 and 6a as part of a weed control research project (Obbens 1997). Both sites were spot sprayed with Fusilade in August 1996, achieving patchy but generally good control of target weeds including wild oats (*Avena* sp.) and annual veldt grass (*Ehrharta longiflora*). Care was taken to avoid herbicide drift on to non-target plants during spraying. No native species were damaged by the weed control, and this includes several monocot species and *Austrostipa elegantissima*, a native grass present in the habitat. Small outbreaks of broadleaf weeds occurred once grasses were reduced. Weed control with Fusilade and spotspraying of Roundup was implemented at Populations 3, 4a, 4b and 7 in May 2000. Some hand removal of wild oats has since been undertaken at Populations 3 and 7, and these populations were weed-free in January 2001.

Research into the reproductive biology, seed bank dynamics and seed germination physiology (particularly the response to smoke) was undertaken as part of an Honors project on *V. spicata* subsp. *squamosa* and *V. albida* (Ginger 1999). Details of his findings about number of flowers produced, seed viability, soil stored seed reserves and germination response to smoke were reported in his thesis.

In 2000 CALM staff from Geraldton District attempted to stimulate seed germination with the application of smoke granules in association with weed control. Quadrats were established around each plant in June 2000, and smoke granules applied. Seedlings were evident by August 2000, although by November it was apparent that none of these were of *V. spicata* subsp. *squamosa*. It is thought that germination failure is at least partially due to the dry winter experienced that year and the following year.

Approximately 3,700 seeds have been stored at CALM's Threatened Flora Seed Centre (TFSC), collected from Populations 1, 4b, 6a and 7 over the years 1996, 1997, 1998 and 2002. The initial germination rate of this seed was found to range from 7% to 100%, and after one year in storage ranged from 33% to 100% (unpublished data A. Cochrane[3]). More seed was collected in December 2003 from Populations 1, 4b, 6a, 6b and 8. Seed was unavailable for collection due to plant absence at Populations 2, 3 and 4a, a lack of flowering at Population 7, and plant immaturity at Population 9T. The quantity and viability of these seed collections is unknown as they have not yet been processed. The seed will be stored at the TFSC until sent to the Botanic Gardens and Parks Authority (BGPA) nursery to be propagated for translocation.

This taxon has proved very difficult to propagate. Trial grafting of *Verticordia spicata* subsp. *squamosa* onto rootstock of *Chamelaucium uncinatum* was undertaken in 1994, but none of the 58 grafts were successful. Only ten plants resulted from 916 cuttings struck by the BGPA nursery in 1999 and 2001. Seven of those died within 7 months, and the remaining three plants were planted into Population 9T in 2002. An unknown number of seeds have been sown and smoke treated, with 18 germinants surviving to juvenile stage. All of these were also

[3] Anne Cochrane, Manager, CALM's Threatened Flora Seed Centre

included in the translocation in 2002 (A. Shade[4], personal communication). Historically, some plants were planted into the Botanic Garden, but there is evidence that these were of the *V. comosa* x *spicata* subsp. *squamosa* hybrid (George 2002).

A translocation was developed by staff from CALM's Geraldton District and implemented in cooperation with the Mingenew Herbarium Group, part of the Mingenew Land Conservation District Committee (LCDC). Assistance with funding was provided by the Threatened Species Network program of the World Wide Fund for Nature. The translocation site is on remnant vegetation on private property, which is protected by a Conservation Covenant. The owner of this land is associated with the Mingenew LCDC. The first planting of eight juveniles occurred in June 2001. All translocates are planted with individual rabbit-proof enclosures and drip-lines from a gravity-fed watering system that is switched on over summer. However, there have been repeated failures of the control box of this watering system, resulting in extended periods over summer with no delivery of water to translocates. Four direct seeding plots were also fenced and seeded. Treatments tested were smoke (applied as vermiculite), raking, and both smoke and raking. Seeded plots were not watered over summer. No seedlings were observed in the seeded plots at any time, although monitoring continued to October 2003. An additional 21 juveniles were planted in June 2002, all with individual rabbit-proof enclosures and driplines. Failures of the watering control box recurred over the summers of 2002 and 2003. The landowner supported the project with occasional manual watering at these times. Survival of the translocates is recorded in the following table.

Survival of *Verticordia spicata* subsp. *squamosa* after translocation

2001 plantings			2002 plantings		
Year	No. surviving	% survival	Year	No. surviving	% survival
Initial (Jun 2001)	8				
Jan 2002	8	100			
Jun 2002	6	75	Initial (Jun 2002)	21	
Dec 2002	4	50	Dec 2002	18	86
Oct 2003	3	38	Oct 2003	8	38

A double-sided information sheet has been produced, and includes a description of *V. spicata* subsp. *squamosa*, its habitat, threats, recovery actions and photos. This will be reprinted, and continue to be distributed to the community through local libraries, wildflower shows and other avenues. It is hoped that this may result in the discovery of new populations, and will raise community awareness of the value of native flora.

Staff from CALM's Moora and Geraldton Districts regularly monitor all populations of this taxon. Liaison with local residents led to the confirmation of a new population - Population 8.

The Moora District Threatened Flora Recovery Team and the Geraldton District Threatened Flora Recovery Team are overseeing the implementation of this IRP.

Future recovery actions

Where populations occur on lands other than those managed by CALM, permission has been or will be sought from appropriate land managers prior to recovery actions being undertaken. The following recovery actions are roughly in order of descending priority; however this should not constrain addressing any of the priorities if funding is available for 'lower' priorities and other opportunities arise.

1. Coordinate recovery actions

The Geraldton District and Moora District Threatened Flora Recovery Teams will coordinate recovery actions for *Verticordia spicata* subsp. *squamosa* and other Declared Rare Flora in their districts. They will include information on progress in their annual reports to CALM's Corporate Executive and funding bodies.

Action: Coordinate recovery actions
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams

[4] Amanda Shade, Horticulturalist, Botanic Garden and Parks Authority

Cost: $5,000 per year

2. Map critical habitat

It is a requirement of the EPBC Act that spatial data relating to critical habitat be determined. Although critical habitat is described in Section 1, the areas as described have not yet been mapped and that will be redressed under this action. If any additional populations are located, then critical habitat will also be determined and mapped for these locations.

Action: Map critical habitat
Responsibility: CALM (Moora and Geraldton Districts, WATSCU) through the Recovery Teams
Cost: $3,000 in the first year

3. Liaise with relevant land managers

Staff from CALM's Moora and Geraldton Districts will continue to liaise with relevant land managers and landowners to ensure that populations are not accidentally damaged or destroyed. Liaison with the land manager adjacent to Population 1 will need to highlight the importance of preventing grazing through that section of fenceline in times of drought. Input and involvement will also be sought from any Aboriginal groups that have an interest in areas that are habitat for *Verticordia spicata* subsp. *squamosa*.

Action: Liaise with relevant land managers
Responsibility: CALM (Moora and Geraldton Districts) through the Recovery Teams
Cost: $1,700 per year

4. Implement weed control

Most populations are badly affected by weeds (Populations 1, 3, 4a, 5, 6a, 7 and 8). Weeds impact on *Verticordia spicata* subsp. *squamosa* by competing for resources, degrading habitat, exacerbating grazing pressure, and increasing the risk and severity of fire. Recruitment is likely to be particularly effected. Weed control will be undertaken in consultation with the land managers. This will be by hand weeding or localised application of herbicide during the appropriate season to minimise the affect of herbicide on the species and the surrounding native vegetation. All applications of weed control will be followed by a report on the method, timing and success of the treatment against weeds, and the effect on *V. spicata* subsp. *squamosa* and associated native plant species.

Action: Implement weed control
Responsibility: CALM (Moora and Geraldton Districts) through Recovery Teams; relevant land managers
Cost: $2,200 per year

5. Implement rabbit control

Rabbits disturb soil by warren construction, introduce weeds and increased nutrient levels in their droppings and may eat seedlings at most populations (Populations 1, 3, 6a, 6b, 7, 8 and 9T). Rabbit control by annual 1080 baiting is therefore required. Baiting will be undertaken twice a year during summer in conjunction with the baiting programs run by relevant shires and local farmers.

Action: Implement rabbit control
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams
Cost: $1,000 per year

6. Undertake watering if necessary

Most plants have suffered various levels of drought stress over the last three years. Population 3, which died in November 2003, is an example of an established plant that has succumbed to drought stress. Others have dead branches and yellowing leaves. It is likely that the species has some level of summer dormancy as it has evolved with typically dry summers. However, plants require rainfall over autumn and winter to foster growth and flowering in spring. Occasional watering during a dry winter may help these plants persist, at least at sites that are accessible by a light fire unit.

Action: Undertake watering if necessary
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams
Cost: $1,200 per year

7. Stimulate regeneration

Poor recruitment is a major threat to most populations, as almost all individuals are old and a number are approaching senescence. Seven of the eleven subpopulations contain 2 plants or less. Localised areas of habitat will be disturbed to provide opportunities for regeneration in the habitat of Populations 1, 3, 4b, 5, 6a, 6b, 7 and 8, ensuring that live plants are not damaged in any way. Disturbance trials will be conducted to ascertain which methods are most effective, with experimental treatments including smoke treatment, burning and soil disturbance. A light fire unit will be present during the burning component of the trial. The possibility of scattering some seed in plots will be investigated, but as so little viable seed is available, great care must be exercised in its use. Seed will only be deliberately scattered in areas of habitat in good condition, where any resulting plants have the best chance of surviving and producing further seed. The possibility of occasional watering will be investigated if another dry winter is experienced after the trials. The trial areas will require rabbit-proof fencing, and follow-up weed control will be undertaken as necessary.

Monitoring of all trials will detail the general response of associated habitat as well as that of *Verticordia spicata* subsp. *squamosa*, and will also record any negative impacts such as the level of weed invasion and weed species involved. Monitoring of regeneration will continue for at least three years, and monitoring of *V. spicata* subsp. *squamosa* recruitment will continue as for other populations. If found to be beneficial, these methods will be implemented periodically on a small scale.

Action: Stimulate regeneration
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams
Cost: $2,300 per year in first, third and fifth years

8. Monitor populations

Annual monitoring of factors such as habitat degradation (including plant diseases such as *Phytophthora cinnamomi*, weed invasion and salinity), population stability (expansion or decline), pollination activity, seed production, recruitment, longevity and predation is essential. The visibility of DRF markers will also be monitored to ensure they remain effective, and have not faded or been covered by vegetation. Population 5 has not been monitored for several years, and this will be a priority in the next flowering season. If the dead plant is still present at Population 3 when next monitored, the presence or absence of a lignotuber will be ascertained by digging up the plant.

Action: Monitor populations
Responsibility: CALM (Moora and Geraldton Districts) through the Recovery Teams
Cost: $2,300 per year

9. Conduct further surveys

Opportunistic surveys by Geraldton District, Moora District and Science Division staff have resulted in the location of several new populations of *V. spicata* subsp. *squamosa* over the last decade. Most large areas of remnant vegetation of appropriate habitat type within this taxon's range have been surveyed, but permission will

be sought to survey remaining areas of appropriate vegetation on private property. Reserves and other areas of native vegetation containing suitable habitat in the Shires of Mingenew and Three Springs will continue to be surveyed for the presence of the taxon for several years following disturbances such as fire, particularly during the flowering period of October-December. Records of areas surveyed will be sent to Wildlife Branch and retained at the districts, even if *V. spicata* subsp. *squamosa* is not located. Note will be made of any appropriate habitat that appears to be large enough and in good condition and may be suitable for future translocations.

Action: Conduct further surveys
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams
Cost: $900 per year in the first, third and fifth years

10. Collect seed

It is necessary to store germplasm as a genetic resource, ready for use in translocations and as an *ex situ* genetic 'blueprint' of the species. The germplasm stored will include seed and live plants in cultivation if possible. The viability of *V. spicata* subsp. *squamosa* seed collected by the TFSC has generally been very low, and survival of plants propagated from cutting material has been extremely poor. Further collections of seed are required, particularly to provide material for future translocations. This will be coordinated between the Moora District and Geraldton District Threatened Flora Recovery Teams.

Action: Collect seed and cutting material
Responsibility: CALM (TFSC, Geraldton and Moora Districts) through the Recovery Teams
Cost: $3,000 per year

11. Continue the translocation process

Translocation is essential for the conservation of this subspecies. The total number of extant plants is extremely low, most plants are now approaching senescence or are already senescing, and no populations are secure from threats. A translocation under an approved translocation proposal is underway, but has been hampered by the extreme difficulty of propagation and the repeated failure of the watering system. Plants will be translocated into other sites in the longer-term. When additional sites are considered, careful consideration will be given to this taxon's tendency to hybridise with *Verticordia comosa* and probably with *V. spicata* subsp. *spicata*. Areas that do not contain these taxa will be preferred.

Information on the translocation of threatened plants and animals in the wild is provided in CALM's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*. Monitoring of translocations is essential and will be continued, as specified in the translocation proposal.

Action: Continue the translocation process
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams
Cost: $10,300 in the first and second years, and $11,100 in subsequent years

12. Seek long-term protection of habitat

Ways and means of improving the security of populations and their habitat will be investigated. On private land (Populations 4b and 6b), this may include conservation covenants with a range of agencies or registration through the Land for Wildlife scheme. Population 9T is already protected by a conservation covenant and Land for Wildlife agreement. The possibility of avoiding road construction in the Shire road reserve at Population 8 will also be investigated.

Action: Seek long-term protection of habitat
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams
Cost: $900 in the first year

13. Investigate possibility of land acquisition

One of the major constraints on conservation of this taxon is a lack of appropriate habitat in good condition. If a suitable area of appropriate vegetation in good condition is located on private land, serious consideration will be given to land acquisition, as there are currently no reserves that contain appropriate habitat for *Verticordia spicata* subsp. *squamosa*. If such an area is located it would provide a suitable site for an additional translocated population.

Action: Investigate possibility of land acquisition
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams
Cost: $900 in the first year (costs of land acquisition to be determined)

14. Rehabilitate habitat

Plants at Population 6b occur in an old sandpit. They were healthy and flowered profusely in December 2003, but lack associated vegetation. This implies that other ecological resources including pollinators are also likely to be absent or reduced. The habitat of Population 6b will be scarified and rehabilitated using plant species native to the site.

Population 8 occurs in an uncleared road reserve. It is a narrow strip of vegetation, but the adjacent landholders have fenced an additional buffer strip and planted within that area. Some supplementary planting will improve the condition of the vegetation within the road reserve, as will the weed and rabbit control also recommended. With the permission and cooperation of the landholders, additional planting of a range of local species within their fenced off strip will greatly improve its value as a buffer against weed invasion, and enhance the diversity of the planted area.

Action: Rehabilitate habitat
Responsibility: CALM (Geraldton and Moora Districts) through the Recovery Teams
Cost: $21,000 in the second year, and $10,000 in the fourth year

15. Develop and implement a fire management strategy

It is thought likely that fire kills adult plants of the taxon and that regeneration occurs largely from seed. Frequent fire may prevent the accumulation of sufficient soil-stored seed for recruitment to occur. Fire also promotes the introduction and proliferation of weed species. However, occasional fire is likely to be beneficial for recruitment. Fire should therefore be prevented from occurring in the area of populations, except where it is being used experimentally as a recovery tool. A fire management strategy will be developed in consultation with land managers to determine fire control measures, fire intensity, seasonality, and frequency.

Action: Develop and implement a fire management strategy
Responsibility: CALM (Geraldton and Moora Districts) and land managers through the Recovery Teams
Cost: $2,400 in first year, and $1,400 in subsequent years

16. Promote awareness

The importance of biodiversity conservation and the need for the long-term protection of wild populations of this taxon will be promoted to the community through poster displays and the local print and electronic media. Formal links with local naturalist groups and interested individuals will also be encouraged. An information sheet has been produced, and includes a description of the plant, its habitat, threats, recovery actions and photos. This will be reprinted and will continue to be distributed to the public through CALM's Moora and Geraldton District offices and at the offices and libraries of the Shires of Three Springs and Mingenew. Such information distribution may lead to the discovery of new populations.

Action: Promote awareness
Responsibility: CALM (Moora and Geraldton Districts) through the Recovery Teams
Cost: $1,600 in first year, and $1,000 in subsequent years

17. Obtain biological and ecological information

Improved knowledge of the biology and ecology of *V. spicata* subsp. *squamosa* will provide a scientific basis for its management in the wild. An understanding of the following is necessary for effective management:

1. The causes of low levels of viable seed production.
2. Seed ageing requirements for the breaking of seed dormancy.
3. The role of various disturbances (including fire), competition, rainfall and grazing in germination and recruitment.
4. The soil moisture, nutrient and mychorrhizal requirements for long-term persistence.
5. The pollination biology of the subspecies.
6. The requirements of pollinators.
7. The reproductive strategies, phenology and seasonal growth of the subspecies.
8. The presence or absence of a lignotuber, enabling the recovery of adult plants from physical destruction of above-ground parts.
9. The population genetic structure, levels of genetic diversity and minimum viable population size.

Action: Obtain biological and ecological information
Responsibility: CALM (Science Division, Moora and Geraldton Districts) through the Recovery Teams
Cost: $12,000 per year in the second, third and fourth years

18. Review the need for a full Recovery Plan

At the end of the fourth year of its five-year term this Interim Recovery Plan will be reviewed and the need for further recovery actions will be assessed. If the species is still ranked as Critically Endangered at that time a full Recovery Plan may be required.

Action: Review the need for a full Recovery Plan
Responsibility: CALM (WATSCU, Geraldton and Moora Districts) through the Recovery Teams
Cost: $20,300 in the fifth year (if full Recovery Plan required)

4. TERM OF PLAN

This Interim Recovery Plan will operate from October 2004 to September 2009 but will remain in force until withdrawn or replaced. If the taxon is still ranked Critically Endangered after five years, the need to review this IRP or to replace it with a full Recovery Plan will be determined.

5. REFERENCES

Atkins, K. (2003) *Declared Rare and Priority Flora List for Western Australia.* Department of Conservation and Land Management, Western Australia.

Brown, A., Thomson-Dans, C. and Marchant, N. (Eds). (1998) *Western Australia's Threatened Flora*. Department of Conservation and Land Management, Western Australia.

CALM (1990 onwards) *Threatened Flora Database (DEFL)*. Wildlife Branch, Perth, Western Australia. Accessed 2003.

CALM (1992) Policy Statement No. 44 *Wildlife Management Programs*. Perth, Western Australia.

CALM (1994) Policy Statement No. 50 *Setting Priorities for the Conservation of Western Australia's Threatened Flora and Fauna*. Perth, Western Australia.

CALM (1995) Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*. Perth, Western Australia.

CALM (2003 onwards) *Western Australian Herbarium FloraBase 2 – Information on the Western Australian Flora*. Perth, Western Australia. Accessed 2003. http://www.calm.wa.gov.au/science/

Cochrane, A. and McChesney, C. (1995) Verticordia Seed. *Australian Plants* 18 (145): 206-207.

George, A.S. (1991) New taxa, combinations and typifications in *Verticordia* (Myrtaceae: Chamelaucieae). *Nuytsia* 7 (3): 231-394.

George, E.A. (2002) *Verticordia: the turner of hearts*. University of Western Australia Press, Western Australia in association with Australian Biological Resources Study, Australian Capital Territory.

Ginger, D. (1999) *The Effects of Habitat Fragmentation on two Rare and Endangered Verticordias*. Honours Thesis, Curtin University of Technology, Western Australia.

IUCN (2000) *IUCN red list categories prepared by the IUCN Species Survival Commission, as approved by the 51st meeting of the IUCN Council*. Gland, Switzerland.

Leigh, J., Boden, R. and Briggs, J. (1984) *Extinct and endangered plants of Australia*. Macmillan, South Melbourne.

Obbens, F. (1997) *Monitoring and Preliminary Weed Control on Populations of Critically Endangered Flora*. Department of Conservation and Land Management, Western Australia.

Panetta, F.D. and Hopkins, A.J.M. (1991) Weeds in Corridors: Invasion and Management. Pp 341-51 in *Nature Conservation 2: The Role of Corridors*. D.A. Saunders and R.J. Hobbs (eds). Surrey Beatty & Sons, New South Wales.

Patrick, S. and Brown, A. (2001) *Declared Rare and Poorly Known Flora in the Moora District*. Department of Conservation and Land Management, Western Australia.

Phillimore, R. and English, V. (1999) Interim Recovery Plan No. 49 *Verticordia spicata* subsp. *squamosa* 1999-2002. Department of Conservation and Land Management. Perth, Western Australia.

Roche, S., Dixon, K.W. and Pate, J.S. (1997) Seed Ageing and Smoke: Partner cues in the amelioration of seed dormancy of selected Australian native species. *Australian Journal of Botany* 45: 783-815.

Shearer, B.L., Crane, C.E. and Cochrane, A. (submitted) Quantification of the susceptibility of the flora of the South-West Botanical Province, Western Australia to *Phytophthora cinnamomi*. *Australian Journal of Botany*.

Vigilante, T., Dixon, K., Sieler, I., Roche, S. and Tieu, A. (1998) *Smoke Germination of Australian Plants*. Rural Industries Research and Development Corporation, Australian Capital Territory.

Wrigley, J.W. and Fagg, M. (1979) *Australian Native Plants*. Collins, Sydney.

6. TAXONOMIC DESCRIPTION

George, A. S. (1991). New combinations and typifications in *Verticordia* (Myrtaceae: Chamelaucieae). *Nuytsia* 7 (3): 368-69.

Two subspecies of *Verticordia spicata* are recognised in the following key.

Style 6.5 to 9 mm long; sepals 5 to 5.5 mm long; petals 4 to 4.5 mm long, the lamina 2 mm wide; leaves mostly 2 to 3.5 mm long……..subsp. *spicata*
Style 4 mm long; sepals 3 to 4 mm long; petals 3 mm long, the lamina 1.5 mm wide; leaves mostly 1.5 to 2 mm long…….subsp. *squamosa* A.S. George

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George, E.A. (2002). *Verticordia: the turner of hearts*. University of Western Australia Press, Western Australia in association with Australian Biological Resources Study, Australian Capital Territory.

Subsp. *squamosa* is a dense bushy shrub usually 30-60 cm but sometimes to almost 1 m tall and 60 cm to more than 1 m wide. **Leaves** are smaller than those of typical subsp. *spicata* and scale-like with erose to shortly ciliate margins. **Flowers** also are smaller, almost sessile in dense elongating spike-like groups, opening mauve-pink before uniformly fading to white. Their perfume is stronger than that of the typical subspecies attracting a wider range of insects. **Sepals** are 3.5 mm long, **petals** are 2.5 mm long and the **style** is 4 mm long.