SPRAWLING SPIKY ADENANTHOS

(*ADENANTHOS PUNGENS* SUBSP. *EFFUSUS*)

INTERIM RECOVERY PLAN

2000-2003

Rebecca Evans, Gillian Stack, Bethea Loudon, Mal Graham and Andrew Brown

Photograph: A. P. Brown

December 2000

Department of Conservation and Land Management
Western Australian Threatened Species and Communities Unit (WATSCU)
PO Box 51, Wanneroo, WA 6946

THE GOVERNMENT OF WESTERN AUSTRALIA

DEPARTMENT OF Conservation AND LAND MANAGEMENT
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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This Interim Recovery Plan will operate from December 2000 to November 2003 but will remain in force until withdrawn or replaced.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 replaced by a full Recovery Plan after three years.

This IRP was approved by the Director of Nature Conservation on 27 June 2001. The 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 at December 2000.

SUMMARY

Scientific Name:	***Adenanthos pungens* subsp. *effusus***
Common Name:	Sprawling Spiky Adenanthos
Family:	Proteaceae
Flowering Period:	August to November
CALM Region:	Wheatbelt
CALM District:	Katanning
Shires:	Tambellup, Kojonup
Recovery Team:	Katanning District Threatened Flora Recovery Team (KDTFRT)

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; Nelson, E. C. (1978). A taxonomic revision of the genus *Adenanthos* (Proteaceae). *Brunonia*, 1: 303-406; Obbens, F. and Cochrane, A. (1998). *Report on the experimental research burn on the Critically Endangered Adenanthos pungens* subsp. *effusus*. Unpublished report, CALM, File 1998F000530.

Current status: *Adenanthos pungens* subsp. *effusus* was declared as Rare Flora in May 1991 and was ranked as Critically Endangered (CR) in November 1998. It currently meets IUCN Red List (World Conservation Union, 1994) Category CR under Criteria A2c,e and B1+2c,e as the two populations are severely fragmented with plant numbers in serious decline, with continuing deaths and decline in habitat quality from dieback disease (*Phytophthora* spp.) at Population 1. The main threats are disease, weeds, road, rail and firebreak maintenance, rabbits, salinity, and inappropriate fire regimes.

Habitat requirements: *Adenanthos pungens* subsp. *effusus* appears to be very geographically restricted, known only from two locations in the Katanning and Tambellup areas. The subspecies is found in open scrub over lower mixed shrubs. The soil type is grey/white siliceous sand. Associated species are diverse and variable between the two sites and include *Banksia prionotes*, *B. violacea*, *B. oligantha, Conostylis drummondii*, and *Lechenaultia* sp. *Regelia cymbifolia* is common to both sites.

Critical habitat: The critical habitat for *Adenanthos pungens* subsp. *effusus* is all remnant vegetation in which it occurs, remnant vegetation immediately adjacent to the current habitat of the taxon, corridors of intact vegetation that are linked to the habitat of the subspecies and additional occurrences of appropriate habitat that do not currently contain the subspecies.

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

1. All land managers have been made aware of the threatened nature of the subspecies and its location
1. An A4 sized poster has been produced, which provides a description of the subspecies, and information about threats and recovery actions.
2. Recent tests have shown that plant deaths at Population 1 are due, at least in part, to dieback disease (*Phytophthora* spp.) and approvals for aerial phosphite spraying are being sought.
3. Herbicides were applied by Main Roads staff, under the supervision by Conservation and Land Management (CALM) staff, to the road edges at the site of Subpopulation 1a.
4. Declared Rare Flora (DRF) markers are installed at subpopulations 1a and 1b.
5. Dashboard stickers and posters that illustrate DRF markers and describe their purpose have been produced and distributed.
6. Staff from the Threatened Flora Seed Centre (TFSC) have collected seed from Population 1 and approximately 400 seeds have been placed in storage. Collecting seed has proved very difficult.
7. Staff of the Botanic Gardens and Parks Authority (BGPA) have achieved a cutting strike rate between 30% and 100%. In April 2000, BGPA held 95 plants, from five different clones, in its Nursery Collection Frames and in the parks Threatened Flora Garden.
8. Weed control trials are being conducted at Population 1, and initial results indicate that the plants that were subjected to the weed~~ing~~ treatment did marginally better than the control.
9. A trial burn was conducted in April 1998 at Population 1 in order to establish the regenerative characteristics of the subspecies.
10. The Katanning District Threatened Flora Recovery Team (KDTFRT) is overseeing the implementation of this IRP and will include it in its annual report to CALM's Corporate Executive and funding bodies.
11. CALM staff from the Katanning District Office are regularly monitoring the populations.

IRP Objective: The objective of this Interim Recovery Plan is to abate identified threats and maintain and/or enhance *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.

Criteria for failure: The number of individuals within populations and/or the number of populations have decreased.

Recovery actions

1. Coordinate recovery actions.
2. Undertake rabbit control.
3. Undertake weed control using proven, best practice methods.
4. Undertake *Phytophthora* control.
5. Monitor the impact of phosphite applications.
6. Develop and implement a fire management strategy.
7. Notify and liaise with relevant land managers.
8. Determine the genetic relationship of the two subspecies.
9. Monitor populations.
10. Continue monitoring the experimental burn and weed control trials.
11. Collect seed and cutting material, and propagate plants.
12. Conduct further surveys.
13. Obtain biological and ecological information.
14. Promote awareness.
15. Start the translocation process.
16. Write a full Recovery Plan.

1. BACKGROUND

History

Adenanthos pungens was declared are rare flora as early as 1980 but has subsequently been divided into two subspecies, *A. pungens* subsp. *pungens* (erect). and *A. pungens* subsp. *effusus* (prostrate). *A. pungens* subsp. *effusus* was declared as rare flora in May 1991 and ranked as Critically Endangered in November 1998.

There are eleven collections of *Adenanthos pungens* subsp. *effusus* held at the W.A. Herbarium, the earliest by R. D. Royce in 1972, which corresponds roughly with Population 1. Population 2 is not currently represented as a collection at the W. A. Herbarium. One collection of interest by H. Demarz in 1974 was taken from a location approximately 10 km south of Population 1. The area of this collection was extensively searched in 1987, concentrating on areas of deep sands along rail and road reserves and in bushland adjoining the Wansborough Nature Reserve, however no plants were found. This population was recorded as presumed to be extinct on 24 May 1988.

There has been one incident at Subpopulation 1b where vehicles entering the rail reserve damaged and killed several plants. No action was taken as it was not known who was responsible, however, contact was made with Westrail and the importance of preserving the subspecies reiterated.

Description

Adenanthos pungens is a sprawling shrub that has rigid, terete leaves with sharp tips. The leaves are up to 3 cm long and usually divide into three segments. Numerous pale-pink to red flowers are clustered on the ends of branchlets. The species is an attractive plant when in flower, and has horticultural potential. Two subspecies are recognised - *A. pungens* subsp. *pungens* and *A. pungens* subsp. *effusus*.

Adenanthos pungens subsp. *effusus* is a compact prostrate shrub, spreading to 5m in diameter and rarely exceeding 25 cm in height (in Population 1). The profuse flowers are pale pink. A full taxonomic description by Nelson (1978) is provided below. Although similar in leaf and flower shape, the prostrate habit and pale pink flowers of *A. pungens* subsp. *effusus* distinguish it from the type's erect habit and dark pink to red flowers.

Nelson recognised and described these two subspecies based on their respective habits and flower colour. However, erect, semi-erect and prostrate plants grow within a single population of *A. pungens* subsp. *pungens* at Lake Chinocup. Plants at Population 2 of *A. pungens* subsp. *effusus* have developed erect central branches that extend to approximately 1.5m. Additionally, several mature plants growing in a *Melaleuca* thicket at Population 1 have developed erect, central branches to about 1m. Genetic analysis of this separation into different subspecies is, therefore, warranted and will be undertaken by CALMScience in 2001.

Distribution and habitat

Adenanthos pungens subsp. *effusus* is endemic to Western Australia and is apparently confined to the Katanning and Tambellup areas. It is known from two populations containing less than 1200 plants in total.

At Population 1 the subspecies occurs in heath of *Regelia cymbifolia* (Priority 4) and *Leptospermum erubescens* over open dwarf scrub and open low sedges. Associated species include *Allocasuarina acuaria, Banksia attenuata, B. meisneri* ssp.

meisneri, Chordifex ornatus (Priority 2), *Conostylis aculeata, Hibbertia subvaginata and Patersonia occidentalis.* The soil type is white sand over yellow.

Adenanthos pungens subsp. *effusus* is found at Population 2 in open scrub of *Banksia oligantha* (ranked as Endangered) over heath of *Regelia cymbifolia* (Priority 4) and lower mixed shrub. The soil type is grey/white siliceous sand. Other associated species include *Banksia prionotes*, *B. violacea*, *Conostylis drummondii* (ranked as Endangered), *Lechenaultia* sp. and *Regelia cymbifolia* (Priority 4).

Critical habitat

Critical habitat is habitat identified as being critical to the survival of a listed threatened species or community. Habitat means the biophysical medium or media: (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) 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. (*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)).

The critical habitat for *Adenanthos pungens* subsp. *effusus* comprises:

- The habitat of known populations.
- Similar habitat within 200 metres of known populations (these provide potential habitat for natural recruitment).
- Corridors of remnant vegetation that link populations with other nearby areas of apparently suitable habitat that do not currently contain the subspecies.
- Areas of similar habitat that may be used for future translocation.

Explanatory Note: Adjacent uncleared vegetation linked to the known habitat of *Adenanthos pungens* subsp. *effusus* and additional occurrences of the habitat are potential areas for the taxon and provide opportunities for reintroduction or re-invasion.

Biology and ecology

Despite proliferous flowering and a field observation of continual achene production, actual production of viable seed appears low. Threatened Flora Seed Centre (TFSC) Staff have observed, over several years, a high abortion level at all stages of seed formation including bud, flower and fruit formation. A. Cochrane[1] estimated in 1994 that over 90% of seed appeared 'empty'. High insect predation levels were also recorded 1992.

Several *Adenanthos* species have been found to strike very easily from semi-hardwood cuttings. *A. pungens* subsp. *effusus* has been successfully propagated by the Botanic Gardens and Parks Authority (BGPA) with 30 to 100% success rate from cuttings.

A high number of plant deaths, due to infection by *Phytophthora* species, were reported in a population of *Adenanthos pungens* subsp. *pungens*. A similar high susceptibility has been recently verified for *A. pungens* subsp. *effusus* and continuing deaths at Population 1 have been attributed to *Phytophthora cinnamomi, P. cryptogea, P. drechsleri* and *Armillaria.* To date, there have been no recorded losses from disease at Population 2.

Field evidence suggested that the subspecies would benefit from both mechanical and a fire disturbance. Further investigations are needed to verify these observations.

Increasing salinity and waterlogging is thought to have contributed to the extinction of a population at Wansborough although land clearing for agriculture was no doubt the primary cause. The threat from salinity and waterlogging at known populations should be assessed.

There is some indication that the separation between the two subspecies is not well defined. Populations of *Adenanthos pungens* subsp *effusus* contain plants with both erect and prostrate habits. As the distinction between the two subspecies is largely based on habit, genetic studies are therefore needed to ascertain the relationship of the two taxa.

Threats

Adenanthos pungens subsp. *effusus* was declared as Rare Flora in May 1991 and was ranked as Critically Endangered (CR) in November 1998. It currently meets IUCN Red List (World Conservation Union, 1994) Category CR under Criteria A2c,e and B1+2c,e as the two known populations are severely fragmented, with total plant numbers in serious decline with

[1] Anne Cochrane, Manager, Threatened Flora Seed Centre, CALM

continuing deaths due to dieback and natural senescence. The main threats are disease, weeds, road, rail and firebreak maintenance, salinity, rabbits, and inappropriate fire regimes.

- **Disease** is a serious threat to both populations. Both subspecies of *Adenanthos pungens* were thought to be showing the effects of *Phytophthora* infection as early as 1973 and recent tests have shown that plant deaths at Subpopulation 1b of *Adenanthos pungens* subsp *effusus* is due, at least in part, to this disease. *Phytophthora cinnamomi*, *P. cryptogea* and *P. drechsleri* have all been shown to be present at this site. *Armillaria* sp. has also been identified at Population 1. No plant deaths from disease have been recorded to date at Population 2.

  Dieback (*Phytophthora* spp.) is a pathogen that invades the young roots of a plant, feeding on the tissues as it spreads up into the larger roots towards the crown of the plant. This direct attack on the root system causes them to rot, depriving the plant of access to nutrients and water, and resulting in dying back of branches, or the sudden death of the whole plant if severe enough. Girdling of major roots or the base of the stem can also occur.

  In response to the invasion of the root and stem tissue by the *Phytophthora*, the plant may produce outgrowths known as tyloses (from the xylem parenchyma) into the xylem vessels. This self-defence mechanism aims at preventing further movement of the pathogen up the vessels of the plant. As the severity of the attack increases, the production of the tyloses also increases often resulting in the vessels becoming blocked by these outgrowths. In effect, the plant actually contributes to its own death by means of drought stress by blocking the transport of water to its tips.

- **Weed invasion** is a threat to rail and road reserve populations, all of which are being invaded by weed seeds blown in from adjoining land. Weeds suppress early plant growth by competing for soil moisture, nutrients and light and also exacerbate grazing pressure. Populations that are restricted to narrow road and rail reserves (Population 1) experience high perimeter to area ratios. This results in virtually the whole corridor being subjected to influences of the adjacent land, commonly referred to as edge effect (Lynch 1987; Saunders *et al*. 1987; Taylor 1987). Effects include increased wind speed, increased fertiliser runoff, modified hydrology and altered disturbance regimes, including fire.

- **Road / track / firebreak maintenance activities** have threatened Population 1 in the past. Construction of drainage channels, grading activities and other road maintenance activities impact on road and rail reserve populations of *Adenanthos. pungens* subsp. *effusus*. Relevant landowners and managers have been informed of the populations and the need to preserve the subspecies. The adjacent landowners have also been informed of the subspecies presence, so as to reduce the risk of damage. This has resulted in the recent discovery of Subpopulation 1c, on private property.

- **Inappropriate fire regimes** would adversely affect the viability of populations of *Adenanthos pungens* subsp. *effusus*, as mature plants are killed and seeds are likely to germinate following fire. Given this, the soil seed bank would rapidly be depleted if fires recurred before juvenile plants reached maturity and replenished the soil seed bank. It is likely, however, that occasional fires are needed for recruitment from soil stored seed.

- **Rabbits** (**Oryctolagus cuniculus*). Rabbits have been reported at Population 1 and to a lesser extent at Population 2. Whilst they are not grazing the plants and their warrens do not appear to be interfering with root systems at present, there remains a strong potential for damage if the situation is not monitored and appropriate controls implemented as required. In addition, disturbance of soil by rabbit warren construction, increased nutrient levels from their droppings and the introduction of weeds may impact on the habitat of the subspecies. Grazing may also have an impact on the establishment of *Adenanthos pungens* subsp. *effusus* seedlings thus limiting the natural recruitment of the subspecies

- **Salinity and waterlogging** is thought to have contributed, in part, to the extinction of a population. These factors may also impact on the subspecies at both currently known populations and lead to degradation of habitat. Assessment and monitoring of the two sites is required.

Summary of population information and threats

Pop. No. & Location	Land Status	Year/No. plants	Condition	Threats
1a. S of Tambellup	MRWA road reserve	1999 128 (31) [19 dead]	Moderate	Disease, weeds, road and firebreak maintenance, rabbits, salinity and fire.
1b. S of Tambellup	Westrail railway reserve	1999 838 (2) [165 dead]	Moderate/ Poor	Disease, weeds, rail and firebreak maintenance, rabbits, salinity and fire.
1c. S of Tambellup	Private property	2000 2	Healthy	Disease, weeds, salinity, firebreak maintenance, rabbits and fire
2. W of Katanning	Aboriginal Lands Trust (Native Settlement)	1990 100 (15)	Healthy	Disease, weeds, salinity, rabbits, fire, track and firebreak maintenance.

Note: Numbers in brackets refers to seedlings.

Guide for decision-makers

Section 1 provides details of current and possible future threats. Any on ground works (firebreaks, roadworks etc) in the immediate vicinity of either of the two populations of *Adenanthos pungens* subsp. *effusus* will require assessment. On ground works should not be approved unless the proponents can demonstrate that they will not have an impact on the subspecies, its habitat or potential habitat, or on the local surface hydrology such that drainage in the habitat of the subspecies would be altered.

2. RECOVERY OBJECTIVE AND CRITERIA

Objectives

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

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

Criteria for failure: The number of individuals within populations and/or the number of populations have decreased.

3. RECOVERY ACTIONS

Existing recovery actions

Westrail, Main Roads Western Australia (MRWA) and private property owners have been formally notified of the presence and threatened nature of populations of *Adenanthos pungens* subsp. *effusus* on their land. Adjacent landowners have also been made aware of the subspecies and its location. The notification details the Declared Rare status of the taxon and the associated legal responsibilities.

An A4 sized poster, which provides a description of the subspecies, and information about threats and recovery actions, has been produced for *Adenanthos pungens* subsp *effusus*. It is hoped that the poster will result in the discovery of new populations.

Weeds on the road verge at Subpopulation 1a have proven a continuing problem. In 1991 Main Roads, under the supervision of CALM's Katanning District staff, applied herbicides to the road shoulder area. Care was taken and there was no overspraying or apparent risk to the *Adenanthos* plants.

Declared Rare Flora (DRF) markers have been installed at subpopulations 1a and 1b. These alert workers of the presence of threatened flora and help prevent accidental damage during maintenance operations. An awareness of the markers is being promoted to relevant bodies such as MRWA and Westrail through dashboard stickers and posters. These illustrate DRF markers, inform of their purpose and provide a contact telephone number if such a marker is encountered.

Staff from the TFSC collected seed from Population 1 in December 1992, January 1994 and again in December 1997. Seed from *Adenanthos pungens* subsp *effusus* has proved very difficult to collect because of its prostrate nature. There also appears to be high levels of abortion at several stages of seed formation resulting in few viable seeds. The number of seeds collected by CALM's TFSC was 52 (1992), 63 (1994) and 332 (1997). The TFSC tests the viability of the seed after one

year in storage (at minus 18 degrees Celsius) and again after five years. The 1992 seeds were tested in May 1993 with 10% germination, then retested in January 1998 with 5% germination. The 1994 seeds were tested in January 1998 with 0% germination and have not been re-tested while the 1997 seeds were tested in January 1998 with 30% germination and re-tested in March 1999 with 20% germination. It appears that viability decreases with time/storage and a new strategy for effective long-term seed storage is required.

BGPA have achieved excellent results with cuttings with a strike rate from 30% to 100%. In April 2000, BGPA held 45 plants in its Nursery Collection Frames. As seed collection and germination is proving difficult propagation from cuttings may be the better alternative.

Weed control trials were conducted at Population 1 during 1998-1999, with three treatments – no control, weed control and weed control plus disturbance involving raking. Results are not finalised, however, data suggest that plants that had weed control did marginally better than those with no control. Weed control included spraying with Fusilade for narrow-leaf grass weeds, followed by hand weeding or wicking broad leaf weeds with Roundup (personal communication F. Obbens[2]).

A trial burn was also conducted at Population 1 in April 1998 in order to establish the regenerative characteristics of the subspecies. Three plots (2 m x 2 m), each containing one to two dead plants, were covered with dry litter then burnt. Regenerative results are outlined in the following table. Death of seedlings has been attributed to dieback. Monitoring will continue in order to establish seedling survival rates (Obbens and Cochrane, 1998).

Regenerative characteristics of *Adenanthos pungens* subsp. *effusus* after burn treatment

	Number of seedlings					
	Live			**Dead**		
	Plot 1	**Plot 2**	**Plot 3**	**Plot 1**	**Plot 2**	**Plot 3**
Jul-98	2	23	0			
Nov-98	5	108	0		1	
Jan-99	3	80	2	2	29	

The Katanning District Threatened Flora Recovery Team (KDTFRT) is overseeing the implementation of this IRP and will include it in its annual report to CALM's Corporate Executive and funding bodies.

CALM staff from the Katanning District Office are regularly monitoring the populations.

Future recovery actions

Where populations occur on lands other than those managed by CALM, permission has been or will be sought from the appropriate land managers prior to recovery actions being undertaken.

1. Coordinate recovery actions

The KDTFRT will continue to coordinate the implementation of recovery actions for *Adenanthos pungens* subsp. *effusus* and will include information on progress in its annual report to CALM's Corporate Executive and funding bodies.

Action: Coordinate recovery actions
Responsibility: KDTFRT
Estimated Cost: $600 per year

2. Undertake rabbit control

Rabbits have the potential to cause major damage to the subspecies. Where identified as a need during monitoring CALM will initiate control using the most appropriate method in cooperation with land owners and managers. It is noted that there are legislative restrictions on the use of 1080 Poison by CALM staff on land not under direct CALM management.

Action: Undertake rabbit control
Responsibility: CALM (Katanning District) through the KDTFRT
Estimated Cost: $900 per year

3. Undertake weed control using proven, best practice methods

[2] Frank Obbens, Consultant, CALMScience

Weeds are a major threat to subpopulations 1a, b and c and, to a lesser extent, Population 2.

1. Weed invasion on road and rail reserves and in land adjacent to areas cleared for agriculture is a major ongoing threat to *Adenanthos pungens* subsp *effusus.* Experience and research to date in similar situations has shown that the use of selective herbicides to control grasses may result in infestation by broad leaf weeds. There are currently no herbicides available for broad leaf weeds that can be used in a non-selective way without killing or severely affecting the threatened flora. Therefore, care must be taken when implementing control.
2. Broad spectrum, non-residual herbicides, e.g. glyphosate, can be used for spot control of weeds utilising techniques such as direct application or the use of temporary spray shields. Generally these techniques have been under-utilised in respect to threatened flora and practical methods of application in the field require further development. Such methods will be labour intensive on an annual basis and should only be implemented in extreme situations.
3. Hand weeding is a labour intensive, ongoing option that has the potential to increase weed levels (at least temporarily) as a result of soil disturbance. The labour to undertake this option, even with the use of volunteers, is unlikely to be available in the Katanning District.
4. Within the three-year scope of an IRP weed control will be a short-term protective measure. Long term conservation of populations of CR flora will require further habitat rehabilitation including the replacement of weeds with appropriate native species, including the threatened taxon.

Action: Undertake weed control using proven, best practice methods
Responsibility: CALM (Katanning District, CALMScience) through the KDTFRT
Estimated Cost: $900 per year

4. Undertake *Phytophthora* control

Research conducted from 1992 to 1997 indicates that the application of phosphite is a very effective tool in controlling *Phytophthora* (Murray, 1997). On that basis, CALM has sought approval to apply Phosphite on Population 1 of the subspecies.

Acton: Undertake *Phytophthora* control
Responsibility: CALM (Katanning District, Dieback Disease Coordinator) through the KDTFRT
Estimated Cost: $1,100 for the first and third years

5. Monitor the impact of phosphite applications

The impact of Phosphite treatment on *Adenanthos pungens* subsp. *effusus* and its effectiveness in controlling *Phytophthora* species will be monitored.

Action: Monitor the impact of phosphite applications
Responsibility: CALM (Katanning District, Dieback Disease Coordinator) through the KDTFRT
Estimated Cost: $700 per year

6. Develop and implement a fire management strategy

Fire appears to kill adult plants of *Adenanthos pungens* subsp. *effusus* with any subsequent recruitment likely to be from soil-stored seed. Frequent fire may prevent the accumulation of sufficient seed for this to happen. Fire should therefore be prevented from occurring in the area of populations, at least in the short term, until a fire management strategy is developed which determines fire control measures and fire frequency.

Action: Develop and implement a fire management strategy
Responsibility: CALM (Katanning District) through the KDTFRT
Estimated Cost: $2,400 in the first year, and $1,000 in subsequent years

7. Notify and liaise with relevant land managers

Land managers, owners and adjacent landowners of both Populations have been officially notified of the occurrence of the subspecies. Staff from CALM's Katanning District will continue to liaise with the current land managers and adjacent landowners to ensure the populations are not damaged or destroyed accidentally. Land managers and landowners at Population 1 have also been advised of the occurrence of 'dieback' *(Phytophthora* spp.*)* at the site.

Action: Notify and liaise with relevant land managers
Responsibility: CALM (Katanning District) through the KDTFRT
Estimated Cost: $600 per year

8. Determine the genetic relationship of the two subspecies

Populations of *Adenanthos pungens* subsp. *effusus* contain both erect and prostrate forms. As the main distinction between the two subspecies is in their respective growth habits, research will be conducted to determine their genetic relationship.

Action: Determine the genetic relationship of the two subspecies
Responsibility: CALM (Katanning District, CALMScience) and BGPA, through the KDTFRT
Estimated Cost: $3,500 in year 1

9. Monitor populations

Monitoring of factors such as weed invasion, habitat degradation, salinity levels and population stability (expansion or decline), pollinator activity, seed production, recruitment, and longevity is essential. Although monitoring took place and an accurate count was done at Population 1 in September, 1999, Population 2 still needs to be surveyed thoroughly. Both populations will be inspected annually with special attention given to salinity levels and it's impact. Soil salinity and pH readings will be taken annually during winter and summer.

Action: Monitor populations
Responsibility: CALM (Katanning District) through the KDTFRT
Estimated Cost: $600 per year

10. Continue monitoring the experimental burn and weed control trials

CALM will continue monitoring the experimental burn and weed trials that were conducted at Population 1.

Action: Continue monitoring the experimental burn and weed control trials
Responsibility: CALM (CALMScience, Katanning District) through the KDTFRT
Estimated Cost: $700 per year.

11. Collect seed and cutting material, and propagate plants

A small quantity of seed has been collected from Population 1, however, further seed collections are required and collections should also be made from Population 2. Due to the difficulty in hand collection of seed by one or two people and in using seed traps for this low growing subspecies, CALM will, with the help of community groups and ACTV, implement a seed collection program that will enable collection of large amounts of seed over a period of 4 to 6 weeks. Cuttings will also be collected to establish a living collection of genetic material at BGPA.

Action: Collect seed and cutting material and propagate plants
Responsibility: CALM (Katanning District, TFSC) and BGPA, through the KDTFRT
Estimated Cost: $8,000 per year

12. Conduct further surveys

Further surveys, supervised by CALM staff and with assistance of local volunteers and wildflower society members, will be conducted during the flowering period (August to November) of *Adenanthos pungens* subsp. *effusus*.

Action: Conduct further surveys
Responsibility: CALM (Katanning District) through the KDTFRT
Estimated Cost: $1,600 per year

13. Obtain biological and ecological information

Increased knowledge of the biology and ecology of the subspecies will provide a scientific basis for management of *Adenanthos pungens* subsp. *effusus* in the wild. Investigations will include:

1. Investigation of the pollination biology of *Adenanthos pungens* subsp. *effusus*.
2. A study of the soil seed bank dynamics and the effect of disturbance, competition, rainfall and grazing on recruitment and seedling survival.
3. Determining reproductive strategies, phenology and seasonal growth.
4. Investigation of population genetic structures, levels of genetic diversity and minimum viable population size.
5. Investigation of the impacts of dieback disease and control techniques on both *Adenanthos pungens* subsp. *effusus* and its habitat.
6. The impact of salinity on *Adenanthos pungens* subsp. *effusus* and its habitat.

Action: Obtain biological and ecological information
Responsibility: CALM (CALMScience, Katanning District) through the KDTFRT
Estimated Cost: $16,700 per year

14. Promote awareness

The importance of biodiversity conservation and the need for the long-term protection of *Adenanthos pungens* subsp *effusus* in the wild will be promoted to the public through the local print, electronic media and poster displays. An information sheet that includes a description of the plant, its habitat type, threats and management actions has been produced. Formal links with local naturalist groups and interested individuals will also be encouraged.

Action: Promote awareness
Responsibility: CALM (Katanning District, Corporate Relations) through the KDTFRT
Estimated Cost: $500 once in the second year

15. Start the translocation process

Translocation may be essential for the long-term conservation of *Adenanthos pungens* subsp. *effusus*, as the total number of extant plants is quite low and the area inhabited by the plant quite small. Although translocations are generally undertaken under full Recovery Plans, it is possible to develop a translocation proposal and start propagating plants within the three-year time frame of an Interim Recovery Plan. Information on the translocation of threatened animals and plants in the wild is provided in CALM Policy Statement No. 29 *Translocation of Threatened Flora and Fauna.* All translocation proposals require endorsement by the Director of Nature Conservation.

Action: Start the translocation process
Responsibility: CALM (CALMScience, Katanning District) through the KDTFRT
Estimated Cost: $3,700 in third year

16. Write a full Recovery Plan

At the end of the second-year of this IRP, the need for further recovery will be assessed. If *Adenanthos pungens* subsp. *effusus* ms is still ranked Critically Endangered at that time a full Recovery Plan will be developed that prescribes actions required for the long-term recovery of the species.

Action: Write a full Recovery Plan
Responsibility: CALM (WATSCU, Katanning District) through the KDTFRT
Estimated Cost: $16,700 once in the final year

4. TERM OF PLAN

This Interim Recovery Plan will operate from December 2000 to November 2003 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 replaced by a full Recovery Plan after three years.

5. 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
Frank Obbens	Former Consultant, CALMScience
Robyn Phillimore	Project Officer, Western Australian Threatened Species and Communities Unit

We would like to thank the staff of the W.A. Herbarium for providing access to Herbarium databases and specimen information, and CALM's Wildlife Branch for their extensive assistance.

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7. TAXONOMIC DESCRIPTION

Nelson, E. C. (1978). A taxonomic revision of the genus *Adenanthos* (Proteaceae). Brunonia, 1: 303-406

Adenanthos pungens
Erect, or prostrate shrub without a lignotuber. Branches erect or prostrate, when young with white short appressed hairs, becoming glabrous. Leaves densely sclerified, rigid, terete, to 30 mm long, 1-2 mm in diameter, entire or segmented, glabrous, usually with a few scattered sunken glands on surface, apex eglandular with pungent mucrone; if segmented usually trifid, very rarely bifid; segments terete, undivided, *c.* 10 mm long; petiole canaliculate on upper surface, *c.* 20 mm long. Inflorescences aggregated at tips of branchlets, numerous; peduncles *c.* 4 mm long, ebracteate, densely villose with short appressed white hairs; involucral bracts *c.* 6, innermost largest, not closely imbricate, ovate triangular, to 3.5 mm long, hirsute on exterior, glabrous interiorly, eglandular, margin entire, ciliate, apex obtuse. Flowers pale pink to bright red-pink; in bud perianth tube only slightly swollen above bracts, limb ± obtuse, recurved. Tepals *c.* 30 mm long, densely villose on exterior, glabrous interiorly; claw *c.* 26 mm long; lamina *c.* 3 mm long, with long hairs inside behind the anther. Anthers *c.* 3 mm long. Nectaries triangular, *c.* 1.5 mm long, attached to base of perianth for about 0.3 mm, apex emarginate. Ovary *c.* 1 mm long, glabrous; style, *c.* 40 mm long, glabrous or with long spreading hairs on distal portion; style-end *c.* 1 mm long. Fruit *c.* 5 mm long, glabrous. Initial leaves of seedling sessile, entire, not sclerified, lanceolate, ± laminar, *c.* 15 mm long, *c.* 2 mm broad, with long divaricate hairs. Many of these leaves are produced before adult sclerified leaves appear.

Two subspecies of *Adenanthos pungens* are recognised in the following key.

1. Shrubs erect, to 3 m tall, leaves mostly trifid, flowers dark pink ..... subsp. *pungens*

2. Prostrate shrubs, rarely reaching 0.25 m tall, forming mats up to 3 m in diameter, leaves entire or trifid, flowers pale pink ..... subsp. *effusus*

Adenanthos pungens* subsp. *effusus
A prostrate, spreading shrub forming large mats up to 3 m in diameter. Branches prostrate or ascending. Leaves entire or trifid. Flowers pale pink.

Distribution: Western Australia, only known from a small area south of Tambellup townsite, north of the Stirling Range.

Ecology: Where the vegetation has not been disturbed the plants form low undershrubs in *Melaleuca* scrub, in deep siliceous sand. Flowers August to November.

Notes: A. pungens is easily distinguished from all other species, as it possesses densely sclerified leaves that have a pungent, mucronate apex. The leaves of *A. gracilipes* are also densely sclerified but they have more laciniae than *A. pungens* and the apices are not mucronate and pungent.

The only known population of subsp. *effusus* contains plants that have either entire or trifid leaves, or occasionally both types of leaves. The leaves in subsp. *pungens* are usually trifid and only very rarely do entire leaves occur. The remarkable prostrate habit of subsp. *effusus*, and the profusion of blossoms during its flowering season, make plants a spectacular sight; the subspecies is potentially of horticultural value.

Etymology: Pungens (piercing) refers to the mucronate leaf apex; *effusus* (spread out) refers to the mat-like prostrate habit.