WHICHER RANGE DRYANDRA

(*DRYANDRA SQUARROSA* SUBSP. *ARGILLACEA*)

INTERIM RECOVERY PLAN

2004-2009

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Photograph: Greg Keighery

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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 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This Interim Recovery Plan will operate from July 2004 to June 2009 but will remain in force until withdrawn or replaced. It is intended that this IRP will be reviewed after five years and the need for a full Recovery Plan will be assessed.

This IRP was given regional approval on 16 July 2004 and was approved by the Director of Nature Conservation on 22 July 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 at July 2004.

ACKNOWLEDGMENTS

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

Anne Cochrane	Senior Research Scientist, CALM's Science Division
Andrew Crawford	Technical Officer, CALM's Science Division
Neil Gibson	Senior Research Scientist, CALM's Science Division
Greg Keighery	Senior Principal Research Scientist, CALM's Science Division
Amanda Shade	Horticulturalist, Botanic Gardens and Park Authority
Russell Smith	Botanist, CALM's Nature Conservation Division
Greg Voigt	A/Nature Conservation Program Leader, CALM's Blackwood District
Andrew Webb	Nature Conservation Officer, CALM's Blackwood District
Kim Williams	Program Leader Nature Conservation, CALM's South West Region

Thanks also to 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:	*Dryandra squarrosa* (R.Br.) subsp. *argillacea* A.S. George	**Common Name:**	Whicher Range dryandra
Family:	Proteaceae	**Flowering Period:**	June to November
CALM Region:	South West	**CALM District:**	Blackwood
Shire:	Shire of Busselton	**Recovery Team:**	South West Region Threatened Flora and Communities 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, A.S. (1996) New taxa and a new infrageneric classification in *Dryandra*. *Nuytsia* 10(3), 336; Western Australian Herbarium (1998) FloraBase - Information on the Western Australian Flora. Department of Conservation and Land Management, Western Australia. http://www.calm.wa.gov.au/science/.

Current status: *Dryandra squarrosa* subsp. *argillacea* was declared as Rare Flora in November 1997 under the Western Australian *Wildlife Conservation Act 1950*. The species is also listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation* Act 1999 (EPBC Act). It currently meets World Conservation Union (IUCN 2000) Red List Category Vulnerable (VU) under criteria B1ab(iii)+2ab(iii), C1 due to the severe fragmentation of populations, and a continuing decline in the quality of habitat and the number of plants. The main threats are: mineral exploration; dieback disease; mineral sand extraction; hydrological changes; grazing; trampling; inappropriate fire regimes; weed invasion; road; firebreak and track maintenance activities; drainage channel maintenance; rubbish dumping; gravel extraction; rabbits; and illegal firewood cutting.

Critical habitat: The critical habitat for *Dryandra squarrosa* subsp. *argillacea* comprises the area of occupancy of the known populations; similar habitat within 200 metres of known populations; remnant vegetation that surrounds or links populations; additional nearby occurrences of similar habitat that do not currently contain the taxon but may have done so in the past and may be suitable for translocations; and the local catchment for the surface and ground waters that provide the winter-wet habitat of the taxon.

Habitat critical to the survival of the species, and important populations: Given that this taxon is listed as Vulnerable it is considered that all known habitat is habitat critical and that all populations, including translocated populations, are important.

Benefits to other species/ecological communities: Most populations are located within occurrences of a Critically Endangered Ecological Community (TEC). Other listed and priority flora also occur in the wider habitat of the populations. Recovery actions implemented to improve the quality or security of the habitat of these populations are likely to improve the status of the TEC in which the populations are located, as well as the rare and priority flora that co-occur in the habitat.

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. The taxon is not listed under any specific international treaty, however, and therefore this IRP does not affect Australia's obligations under any other international agreements.

Role and interests of indigenous people: According to the Department of Indigenous Affairs Aboriginal Heritage Sites Register, there are burial grounds and historical sites listed in the vicinity of the taxon. Input and involvement will be sought from any indigenous groups that have an active interest in areas that are habitat for *Dryandra squarrosa* susbp. *argillacea*, and this is discussed in the recovery actions.

Social and economic impacts: The implementation of this recovery plan has the potential to have some limited social and economic impact, as some populations are located on private property (Populations 1b, 3d, 8b). Areas on private land that are considered to be 'habitat critical' may be regarded as having potential for uses other than conservation by landholders. There are mineral exploration and extraction leases over the area of land containing Populations 3d, 4a and 4b, and Populations 10 and 15 of *Dryandra squarrosa* susbp. *argillacea*. Recovery actions refer to continued liaison between stakeholders with regard to these areas.

Evaluation of the Plans Performance: CALM, in conjunction with the Recovery Team will evaluate the performance of this IRP. The plan is to be reviewed within five years.

Habitat requirements: *Dryandra squarrosa* subsp. *argillacea* occurs near Busselton on the Swan Coastal Plain, in winter-wet clay over ironstone, in open to tall shrubland.

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

1. Relevant land managers have been notified of the location and threatened status of the taxon.
2. Liaison with the stakeholders at Population 4 is ongoing as the area is still under a Mineral Lease.
3. Declared Rare Flora (DRF) markers have been installed at Population 15.
4. Dashboard stickers and posters describing the significance of DRF markers have been produced and distributed.
5. Aerial spraying of phosphite has been undertaken in the habitat of some of the populations.
6. Disease hygiene measures are implemented at all locations, including limiting vehicle access to tracks.
7. Bollards were installed across the main access track into Population 4 in 1999, to prevent vehicle access.
8. Approximately 26 hectares of private property containing Subpopulation 3c of *Dryandra squarrosa* subsp. *argillacea* was purchased in 1998/99 and is under the care, control and management of the Conservation Commission.
9. The ironstone area containing Population 3d has been fenced by the land owners to protect the habitat.
10. A fire response strategy for areas containing the *Dryandra squarrosa* subsp. *argillacea* has been prepared and incorporated into CALM's Blackwood District's Fire Control Working Plan.
11. Implementation of the recovery actions outlined in the IRP for the community 'Shrublands on southern Swan Coastal Plain Ironstones' (English 1999) has commenced, and recovery actions that benefit the TEC habitat will also benefit *Dryandra squarrosa* subsp. *argillacea*.
12. A brochure about the values of Abba Plains vegetation (that includes the TEC habitat) has been produced by local catchment group Geocatch with Departmental assistance, in support of landholders protecting remnant vegetation on their land.
13. There have been several collections of seed from *Dryandra squarrosa* subsp. *argillacea*.
14. The South West Region Threatened Flora and Communities Recovery Team (SWTFCRT) is overseeing the implementation of this IRP.
15. Staff from CALM's Blackwood District monitor populations of this taxon.

IRP Objective: 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 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 period of the plan's adoption under the EPBC Act.

Criteria for failure: The number of individuals within populations and/or the number of populations have decreased by ten percent or more over the period of the plan's adoption under the EPBC Act.

Recovery actions

1. Coordinate recovery actions.
2. Map critical habitat.
3. Install Declared Rare Flora markers.
4. Formally notify land managers.
5. Conduct further surveys.
6. Maintain disease hygiene.
7. Continue to apply phosphite.
8. Fence Subpopulations 1b and 8b.
9. Restrict access.
10. Rehabilitate habitat.
11. Develop and implement a fire management strategy.
12. Develop and implement a drainage management strategy.
13. Develop a kangaroo management strategy.
14. Undertake weed control.
15. Control rabbits.
16. Remove rubbish.
17. Monitor populations.
18. Liaise with land managers.
19. Seek improved security for populations.
20. Promote awareness.
21. Obtain biological and ecological information.
22. Review the need for a full Recovery Plan.

1. BACKGROUND

History

The first known collection of *Dryandra squarrosa* subsp. *argillacea*, housed at the Western Australian Herbarium, was made in 1954 by R. Royce, near Busselton. A number of additional collections have since been made with a number of new populations located during the floristic survey of the Southern Swan Coastal Plain (Gibson *et al*. 1994). This survey identified the taxon as being mainly restricted to ironstone areas. These ironstone soils are highly restricted and extensively cleared and additional new populations are most likely to occur on small remnants of vegetation on private property. Currently, *D. squarrosa* subsp. *argillacea* is known from 11 populations consisting of around 4260 plants.

Description

Dryandra squarrosa (R.Br.) subsp. *argillacea* A.S.George has 3 to 6 teeth on each side of the leaves, which are 5 to 9 mm wide. The individual flowers are 1.8 to 1.9 cm long on a 2 mm long hairless limb, and appear from June to November. The style is 2 to 2.5 cm long, and the pollen presenter is 0.8 to 1 mm long (Brown *et al*. 1998).

Dryandra squarrosa subsp. *argillacea* is distinguished from the species *D. squarrosa* subsp. *squarrosa* by its smaller perianth with a glabrous limb. The leaves are also usually smaller and more slender (George 1996).

Distribution and habitat

Dryandra squarrosa subsp. *argillacea* occurs near Busselton on the Swan Coastal Plain. The taxon occurs in winter-wet clay over ironstone in open to tall shrubland (George 1996). Some of the populations however, are found in lateritic gravel pits and not on ironstone. It is possible that these populations may have been introduced to the sites through movement of seed contained in soil.

Common species of the Busselton ironstone plant community include *Kunzea rostrata*, *Pericalymma ellipticum*, *Acacia stenoptera*, *Hakea varia*, *Hemiandra pungens*, *Viminaria juncea*, *Aphelia cyperoides*, *Centrolepis aristata*, *Borya scirpoidea*, *Caladenia marginata*, *Caustis dioica*, *Centrolepis drummondiana*, *Dampiera linearis*, *Drosera glanduligera*, *Drosera rosulata*, *Desmocladus fasciculata*, *Loxocarya magna*, *Phyllangium paradoxum*, *Opercularia vaginata*, *Philydrella pygmaea*, *Utricularia multifida*, *Schoenus odontocarpus*, *Stylidium calcaratum*, *Thelymitra antennifera* and *Thysanotus thyrsoideus* (Gibson *et al*. 1994).

Dryandra squarrosa subsp. *argillacea* is typically associated with a Critically Endangered ecological community (TEC) (English and Blyth 1999), the 'Shrublands on southern Swan Coastal Plain Ironstones (Busselton area), Swan Coastal Plain Community type 10b', as described in Gibson *et al.* (1994). The Busselton ironstone soils are highly restricted in distribution and there are 14 occurrences, totalling 91 hectares, remaining uncleared (Gibson *et al*. 2000). This IRP will be implemented in conjunction with the IRP for the 'Shrublands on southern Swan Coastal Plain Ironstones' (English 1999).

Habitat critical to the survival of the species, and important populations

Given that this taxon is listed as Endangered it is considered that all known habitat is habitat critical. In addition all populations, including translocated populations, are considered important to the survival of the taxon. Recovery actions include survey for additional populations, and this may lead to the identification of additional habitat critical.

Benefits to other species/ecological communities

Dryandra squarrosa subsp. *argillacea* is typically associated with the 'Shrublands on southern Swan Coastal Plain Ironstones (Busselton area)', Threatened Ecological Community (TEC), which is listed as Critically Endangered in Western Australia, and Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999. Other listed and priority flora also occur in the TEC habitat of the populations (from Gibson *et al*. 2000). These include *Andersonia ferricola* ms (Priority 1), *Gastrolobium*

modestum (Vulnerable under both the *Wildlife Conservation Act* 1950 and EPBC Act), *Gastrolobium papilio* (Critically Endangered under the *Wildlife Conservation Act* 1950, Endangered under the EPBC Act), *Chamelaucium roycei* ms (Vulnerable under both the *Wildlife Conservation Act* 1950 and EPBC Act), *Darwinia* sp. Williamson (Critically Endangered under the *Wildlife Conservation Act* 1950, Endangered under the EPBC Act), *Grevillea elongata* (Endangered under the *Wildlife Conservation Act* 1950, Vulnerable under the EPBC Act), *Grevillea mccutcheonii* (Critically Endangered under the *Wildlife Conservation Act* 1950, Endangered under the EPBC Act), *Hakea oldfieldii* (Priority 3), *Lambertia echinata* subsp. *occidentalis* (Critically Endangered under the *Wildlife Conservation Act* 1950, Endangered under the EPBC Act), *Petrophile latericola* ms (Critically Endangered under the *Wildlife Conservation Act* 1950, Endangered under the EPBC Act), *Dryandra nivea* subsp. *uliginosa* (Endangered under both under the *Wildlife Conservation Act* 1950 and the EPBC Act), *Calothamnus* sp. Scott River (aff. *crassus*) (Priority 2), *Chordifex isomorphus* (Priority 4), *Loxocarya magna* (Priority 3) and *Brachyscias verecundus* (Critically Endangered under the *Wildlife Conservation Act* 1950). Recovery actions implemented to improve the quality or security of the habitat of populations of *Dryandra squarrosa* subsp. *argillacea* are likely to improve the status of the TEC in which the populations are located, as well as that of the other rare and priority flora.

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. The taxon is not listed under any specific international treaty, however, and therefore this IRP does not affect Australia's obligations under any other international agreements.

Role and interests of indigenous people

According to the Department of Indigenous Affairs Aboriginal Heritage Sites Register, there are burial grounds and historical sites listed in the vicinity of the taxon. Input and involvement will be sought from any indigenous groups that have an active interest in areas that are habitat for *Dryandra squarrosa* susbp. *argillacea*, and this is discussed in the recovery actions.

Social and economic impacts

The implementation of this recovery plan has the potential to have some limited social and economic impact, as some populations are located on private property (Populations 1b, 3d and 8b). Areas on private land that are considered to be 'habitat critical' may be regarded as having potential for uses other than conservation by landholders. Approaches that may minimise this potential impact could include covenants, management agreements or land acquisition. There are also mineral exploration and extraction leases over the area of land containing Populations 3d, 4a and 4b, and Populations 10 and 15 of *Dryandra squarrosa* susbp. *argillacea*. Recovery actions refer to continued liaison between stakeholders with regard to all of these areas.

Evaluation of the Plans Performance

CALM, in conjunction with the South West Region Threatened Flora and Communities Recovery Team will evaluate the performance of this Interim Recovery Plan. The plan is to be reviewed within five years of its implementation. Any changes to management / recovery actions will be documented accordingly.

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 (*Environment Protection and Biodiversity Conservation Act 1999*).

The critical habitat for *Dryandra squarrosa* subsp. *argillacea* comprises:

- the area of occupancy of known populations;

- areas of similar habitat within 200 metres of known populations, ie. winter-wet clay over ironstone in open to tall shrubland (these provide potential habitat for natural range extension);
- remnant vegetation that surrounds or links populations (this is to provide habitat for pollinators, and to allow them to move between populations);
- additional occurrences of similar habitat that do not currently contain the taxon but may have done so in the past (these represent possible translocation sites); and
- the local catchment for the surface and possibly ground waters that maintain the winter-wet habitat of the taxon (the taxon occurs on ironstone soils that are seasonally inundated and the vegetation on them is dependent on the local hydrology).

Biology and ecology

Dryandra squarrosa subsp. *argillacea* was named from the Latin *argillaceus* which means growing in clay. This refers to the soil type of the natural habitat of this subspecies, which contrasts to the lateritic gravel with which *D. squarrosa* subsp. *squarrosa* is usually associated (George 1996).

A fire burnt through parts of a Population 1 in 1994/95 and resulted in death of adult plants, and the subsequent germination of a large number of seedlings. This indicates that adult plants are killed by fire, and that fire acts as a stimulus for recruitment from seed.

A study of germination response of a number of threatened *Dryandra* species indicated that there was an increase in the germination of *Dryandra squarrosa* subsp. *argillacea* seed after storage for one year at -20ºC and at a moisture content of 5±1%. This indicates that *ex situ* seed storage under low moisture and temperature conditions is a possible means of long term maintenance of threatened *Dryandra* seed (Cochrane *et al*. 2002).

Like most other members of the genus, *Dryandra squarrosa* subsp. *argillacea* was found to be susceptible to the plant pathogen *Phytophthora cinnamomi* (dieback) (personal communication C.Crane[1]). This result was determined from the inoculation of 50 individuals with the disease in the nursery. The presence of the disease has been confirmed at Populations 1, 2 and 3, and a significant number of deaths have occurred in these populations. Plants at Population 1 have also shown signs of an aerial canker disease (Smith *et al*. 2002). A black sooty mould was also observed covering the plants at Population 14. It is not known how this may be affecting the plants, but there were no obvious signs of impacts noted during the 2003 monitoring.

Heavy bird and insect predation of *Dryandra squarrosa* subsp. *argillacea* foliage and seed has been observed at a number of populations (personal observation A. Cochrane[2]).

Threats

The taxon was declared as Rare Flora in November 1997 under the Western Australian *Wildlife Conservation Act 1950* and ranked as Endangered (EN) in November 1999. The species is also listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation* Act 1999 (EPBC Act). It currently meets World Conservation Union (IUCN 2000) Red List Category Vulnerable (VU) under criteria B1ab(iii)+2ab(iii) and C1 due to severe fragmentation of populations, and a continuing decline in the quality of habitat and the number of plants. The main threats are: mineral exploration; dieback disease; mineral sand extraction; hydrological changes; grazing; trampling; inappropriate fire regimes; weed invasion; road, firebreak and track maintenance activities; drainage channel maintenance; rubbish dumping; gravel extraction; rabbits; and illegal firewood cutting.

- **Mineral exploration** and extraction leases exist over the area of land in which Subpopulations 3d, 4a and 4b, and Populations 10 and 15 of *Dryandra squarrosa* subsp. *argillacea* occur.

- **Dieback disease** is a threat to all populations of *Dryandra squarrosa* subsp. *argillacea*. Dieback caused by the plant pathogen *Phytophthora* spp. causes the roots to rot and results in susceptible plants dying of drought stress. Testing has shown that the taxon is susceptible to the disease.

[1] Colin Crane, Senior Technical Officer, CALM's Science Division
[2] Anne Cochrane, Senior Research Scientist, CALM's Threatened Flora Seed Centre

- **Mineral sand extraction** has been approved within privately owned land adjacent to the area of State Forest that contains Population 4. Potential impacts include major modification of the hydrology of the area, and the proponent has installed an artificial recharge system to help maintain current hydrology and several piezometers for monitoring purposes.

- **Hydrological changes** have the potential to become threats to the wetland vegetation on the ironstone soil type with which *Dryandra squarrosa* subsp. *argillacea* is associated (Tille and Lantzke 1990). Extensive clearing for agriculture in the catchment is likely to have increased surface runoff and recharge of the groundwater. Waterlogging and salinity will require monitoring. Hirschberg (1989) measured levels of salinity in the groundwater in the Blackwood area, and found the water near the populations ranged between 200-400 milligrams per litre total dissolved solids, which is reasonably fresh. Adjacent land developments such as mining also have the potential to alter hydrological processes, and therefore to threaten the populations.

- **Grazing** by kangaroos and illegal cattle access is a potential threat to Subpopulations 1b, 3a, 6 and 8b. If boundary fences on adjoining properties are not maintained by their owners, cattle can cause damage to the vegetation. Cattle prints have already been observed along the northern boundary of the Nature Reserve containing Population 6. Grazing by kangaroos could also potentially impact on the establishment of young plants of *Dryandra squarrosa* subsp. *argillacea* thereby limiting natural recruitment. Grazing animals impact on the habitat by digging, trampling and breaking foliage when moving through the area. Increased nutrient levels in the soil from droppings is also likely and may result in increased weed invasion.

- **Inappropriate fire regimes** would affect the viability of the populations, as *Dryandra squarrosa* subsp. *argillacea* appears to be an obligate seeder that germinates 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. However, occasional fires or other disturbances are likely to be required for the taxon to propagate from soil stored seed.

- **Weed invasion** is a threat to a number of populations. Infestations of Gladiolus are present at Subpopulation 7b and introduced grasses at Population 15. Many populations are, however, relatively weed free. Weeds suppress early plant growth by competing for soil moisture, nutrients and light. They also exacerbate grazing pressure and increase the fire hazard due to the easy ignition of high fuel loads, which are produced annually by many weed species.

- **Road, firebreak and track maintenance activities** threaten Populations 1a, 2a, 3a, 3b, 5, 7a, 8a, 14 and 15. Threats include grading, chemical spraying, construction of drainage channels and the mowing of roadside vegetation. Several of these actions also encourage weed invasion.

- **Drainage channel maintenance** threatens Subpopulation 2a. A Water Corporation Drain Reserve including a drainage channel and its maintenance track run parallel to the road reserve that contains *Dryandra squarrosa* subsp. *argillacea*. During maintenance scouring of the channel to alleviate flooding of agricultural lands and the existing road, removed soil is mounded upon the maintenance track. This disturbs vegetation and exacerbates weed invasion into the adjacent narrow road reserve. Initial discussions indicate it may be possible to have the maintenance track established on the northern side of the drainage channel between the channel and private property fence, thereby effectively increasing the vegetated width of the road reserve.

- **Rubbish dumping** is a minor threat to Subpopulations 1a, 6, 7b, 8a and 8b. Apart from being visually unappealing, rubbish, in particular garden waste, introduces weed seeds into the bushland as well as creating a fire hazard.

- **Gravel extraction** is a threat to Subpopulations 1b, 8a, 8b and Population 14. Gravel is no longer being extracted at Population 10 and the area is being rehabilitated.

- **Rabbits** (*Oryctolagus cuniculus*) have been observed at Populations 6, 7 and 8, and although there is no evidence that the *Dryandra squarrosa* subsp. *argillacea* is being grazed, rabbits are impacting on the habitat by causing soil disturbance. Increased nutrient levels in the soil from rabbit droppings is also likely, and this results in increased weed invasion. Grazing may have an impact on the establishment of young shoots of *D. squarrosa* subsp. *argillacea* thereby limiting natural recruitment.

- **Illegal firewood cutting** is a minor threat to Subpopulation 1a located in State Forest. As well as disturbing the habitat, disease may be bought in to the area on contaminated shoes, vehicles and machinery. There is only a small amount of sporadic firewood cutting currently occurring at this site and this should eventually be prevented as the road is to be realigned (personal communication Kim Williams[3]).

Summary of population information and threats

Pop. No. & Location	Land Status	Year/No. plants	Condition	Threats
1A. S of Busselton	State Forest	1993 500 1996 100+(1000+) [100+ dead] 1998 1000+ [1000+ dead] 2001 95 [8 dead] 2003 1000+	Moderate	Dieback, firewood cutting, fire, rubbish dumping, road maintenance
1B. S of Busselton	Private Property	2002 100+ 2003 100+	Poor	Dieback, grazing, gravel extraction
2A. E of Busselton	Shire Road Reserve	1995 *200+ [100+ dead] 1997 200+ 2000 150+ [10 dead] 2003 289	Moderate	Dieback, weeds, drain maintenance, road maintenance
2B. E of Busselton	Rail Reserve	1995 *200+ [100+ dead] 1997 *200+ 2003 8	Moderate	Dieback, weeds
3A. E of Busselton	Shire Road Reserve	1997 *50+ 2003 *60+	Healthy	Road maintenance, grazing, dieback, weeds
3B. E of Busselton	Rail Reserve	1997 *50+ 2003 *60+	Healthy	Firebreak maintenance, dieback, weeds
3C. E of Busselton	Nature Reserve	1998 100+ 2003 *60+	Moderate/ Poor	Dieback, weeds
3D. E of Busselton	Private Property (Iluka)	1998 100+ 2003 *60+	Healthy	Dieback, mining
4A. ESE of Busselton	State Forest	2003 1	Moderate	Mining, dieback
4B. ESE of Busselton	State Forest	2002 40 [2 dead] 2003 49 [2 dead]	Healthy	Mining, dieback
5. E of Busselton	Shire Road Reserve	1994 1 1995 1 2003 0	Poor	Dieback, road maintenance, weeds
6. SW of Busselton	Nature Reserve	1997 100+ 2001 284 [52 dead] 2003 665 (1) [19 dead]	Moderate	Dieback, weeds, grazing, rabbits, rubbish dumping
7A. SW of Busselton	Shire Road Reserve	2003 20 [3 dead]	Moderate	Dieback, road maintenance, rabbits
7B. SW of Busselton	State Forest	1997 50+ [20+ dead]	Moderate	Dieback, weeds, rabbits, rubbish dumping

[3] Kim Williams, Program Leader Nature Conservation, CALM's South West Region

		2003 393 (5+) [41 dead]		
8A. SW of Busselton	State Forest	1997 100+ 2003 537+ (21+) [68+ dead]	Healthy/ Disturbed	Dieback, gravel extraction, rabbits, rubbish dumping, road and track maintenance
8B. SW of Busselton	Private Property	2003 186 [10 dead]	Poor	Dieback, rubbish dumping, rabbits, gravel extraction, grazing
10. E of Busselton	Shire Gravel Reserve	1997 3 (20+) 2003 63 (500+) [3 dead]	Healthy	Mining, dieback
14. E of Busselton	Main Roads WA Gravel Reserve	2000 150+ (50+) [2 dead] 2003 875 (79) [22 dead]	Moderate	Dieback, track maintenance, gravel extraction
15. ESE of Busselton	Shire Road Reserve	1998 14 2003 14	Poor	Weeds, dieback, track maintenance, mining

Numbers in brackets = number of seedlings.
*= total for subpopulations combined.
Populations 9 and 12 were redetermined to be a common species of *Dryandra*.
Populations 11 and 13 were combined with Population 1.

Guide for decision-makers

Section 1 provides details of current and possible future threats. Developments in the immediate vicinity of the populations or within the defined critical habitat of *Dryandra squarrosa* subsp. *argillacea* require assessment. No developments should be approved unless the proponents can demonstrate that they will have no significant impact on the taxon, its habitat or potential habitat, or the local surface or ground water hydrology.

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 taxon 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 period of the plan's adoption under the EPBC Act.
Criteria for failure: The number of individuals within populations and/or the number of populations have decreased by ten percent or more over the period of the plan's adoption under the EPBC Act.

3. RECOVERY ACTIONS

Existing recovery actions

Land managers have been notified of the location and threatened status of the taxon. The notification details the Declared Rare status of *Dryandra squarrosa* subsp. *argillacea* and the legal responsibility to protect it. The mining company with a tenement over the area containing Population 4 of *Dryandra squarrosa* subsp. *argillacea* was notified in June 1999 of the presence of the species and a number of other Declared Rare and Priority species that occur there.

Liaison with the stakeholders at Population 4 is ongoing as the area is still under a Mineral Lease. Approval to mine Location 4102 adjacent to Population 4 was granted, with conditions to protect the TEC and threatened species in this area, in 2002. Discussions between the proponent, the Department and relevant government bodies is ongoing. Potential impacts include major modification of the hydrology of the area. The proponent has installed an artificial recharge system to maintain the water levels at the site and several piezometers for monitoring purposes, and has also provided some funds for designing and implementing programmes for monitoring vegetation health and for general maintenance of the TEC and component threatened flora.

Declared Rare Flora (DRF) markers have been installed at Population 15. These serve to alert people working in the vicinity to the presence of DRF, and the need to avoid work that may damage plants or their habitat. Dashboard stickers and posters describing the significance of DRF markers have been produced and distributed.

Aerial spraying of phosphite has been undertaken in the Busselton ironstone community (see table below). A proposed aerial spraying program is also to be undertaken to March 2005, at a number of populations of the taxon, with most sites being sprayed every second years. Monitoring of deaths that are likely to be due to dieback at a number of the sites during April and May each year indicated that there was 22% mortality in 1999 in Population 1; 11% mortality in 1999, and 17% in 2000 for Population 6; and 18% mortality at Population 3 in 2001 (Smith *et al*. 2002; Smith *et al*. 2001; Smith *et al*. 2000).

Population	Area sprayed (hectares)	Dates sprayed
1	11	17/4/98, 13/3/01, 11/4/01, 2/4/03, 14/5/03
2A, 2B, 3A, 3B	7	3/5/00, 29/5/00, 21/3/02, 26/4/02
3C	7	3/5/00, 29/5/00, 21/3/02, 26/4/02
3D	18	3/5/00, 29/5/00, 21/3/02, 26/4/02
4	4.2	1997, 17/4/98, 29/5/00, 13/3/01 (part), 21/3/02, 26/4/02, 2/4/03, 14/5/03
6	6.4	17/4/98, 13/3/01, 11/4/01, 2/4/03, 14/5/03
5	5	21/3/02, 26/4/02

Disease hygiene measures are implemented at all locations, including limiting vehicle access to tracks. Bollards were installed across the main access track into Population 4 in 1999, to prevent vehicle access.

Approximately 26 hectares of private property containing Subpopulation 3c of *Dryandra squarrosa* subsp. *argillacea* was purchased with funding assistance from the Natural Heritage Trust National Reserve System Program in 1998/99 and is managed by CALM on behalf of the Conservation Commission.

The ironstone area containing Population 3d has been fenced by the land owners to protect the habitat.

A fire response strategy for areas that contain *Dryandra squarrosa* subsp. *argillacea* has been prepared and incorporated into the Blackwood District's Fire Control Working Plan.

Implementation of the recovery actions outlined in the IRP for the community 'Shrublands on southern Swan Coastal Plain Ironstones' (English 1999) has commenced, and recovery actions that benefit the TEC habitat will also benefit *Dryandra squarrosa* subsp. *argillacea,* where they co-occur.

A brochure about the values of Abba Plains vegetation that includes the TEC habitat of *Dryandra squarrosa* subsp. *argillacea* has been produced by local catchment group Geocatch with Departmental assistance, in support of landholders protecting their remnant vegetation. This brochure includes details of the 'Shrublands on southern Swan Coastal Plain Ironstones' community and photos of *Dryandra squarrosa* subsp. *argillacea* and other key species. It is hoped that this may result in the discovery of new populations.

There have been several collections of *Dryandra squarrosa* subsp. *argillacea* seed. Approximately 859 seeds were collected from Population 2 and 458 seeds from Population 1 in July 1997; 210 seeds from Population 2 in 1994; and 2914 seeds were collected from Subpopulation 3D in January 1998. All were initially stored in CALM's TFSC at –18°C. The TFSC test the viability of the seed initially, after one year in storage and then after five years in storage. The initial germination rate of *D. squarrosa* subsp. *argillacea* seed ranged from 73 to 96%, after one year in storage from 80 to 100%, and after five years in storage ranged from 84 to 92%

germination (unpublished data, A. Cochrane). Five hundred seeds were transferred to the Botanic Gardens and Parks Authority (BGPA) in 1998 for storage.

The South West Region Threatened Flora and Communities Recovery Team (SWTFCRT) is overseeing the implementation of this IRP and will include information on progress in their annual report to CALM's Corporate Executive and funding bodies.

Staff from CALM's Blackwood District monitor populations of this taxon.

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 South West Region Threatened Flora and Communities Recovery Team (SWRTFCRT) will continue to coordinate recovery actions for *Dryandra squarrosa* subsp. *argillacea* and other Declared Rare Flora and threatened ecological communities in their region. They will include information on progress in their annual report to CALM's Corporate Executive and funding bodies.

Action: Coordinate recovery actions
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $2,100 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 done 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 (Blackwood District, WATSCU) through the SWRTFCRT
Cost: $2,000 in the first year

3. Install Declared Rare Flora markers

Declared Rare Flora (DRF) markers are required for all road reserve, track and firebreak populations (1a, 2a, 3a, 7a, 8a, 14). Their purpose is to alert people operating in the area to the presence of DRF and to help prevent habitat disturbance.

Action: Install DRF markers
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $900 in first year

4. Formally notify land managers

The owners of land adjacent to Subpopulation 7a and Population 15 need to be formally notified of the presence of *Dryandra squarrosa* subsp. *argillacea* to help ensure plants are not damaged accidentally. Both of these populations are located on road reserves.

Action: Formally notify land managers
Responsibility: CALM (Wildlife Branch)
Cost: $100 in first year

5. Conduct further surveys

Although the community type in which *Dryandra squarrosa* subsp. *argillacea* occurs has been extensively surveyed over the last decade it is possible that additional populations of this or other threatened ironstone species may be discovered on private land. Further surveys will be conducted for this taxon during its flowering period (June to November). Volunteers from the local community, Wildflower Societies and Naturalist Clubs will be encouraged to be involved in surveys supervised by CALM staff. Areas considered suitable for translocation will also be noted.

Action: Conduct further surveys
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $2,300 per year

6. Maintain disease hygiene

The ironstone habitat in which *Dryandra squarrosa* subsp. *argillacea* typically occurs is inundated over the winter months, and this favours the establishment and spread of *Phytophthora* species. Many plant species in the ironstone community are presumed to be susceptible to this disease, including *D. squarrosa* subsp. *argillacea*. Dieback hygiene (outlined in Department of Conservation and Land Management 2003) will therefore be adhered to for activities such as installation and maintenance of firebreaks and walking into the populations in wet soil conditions.

Action: Maintain disease hygiene
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $400 per year

7. Continue to apply phosphite

Dryandra squarrosa subsp. *argillacea* has been shown to be susceptible to *Phytophthora cinnamomi*. Research conducted from 1992 to 1997 indicates that phosphite application is a very effective tool in controlling the pathogen (Murray 1997). CALM will continue to apply phosphite to those areas affected by dieback, either by hand spraying or by aerial spraying. This action will have the added benefit of protecting a number of other threatened plant species in the threatened ecological community in which the taxon typically occurs.

Action: Continue to apply phosphite
Responsibility: CALM (Blackwood District, Dieback Disease Coordinator) through the SWRTFCRT
Cost: $14,300 in first, third and fifth years; $7,500 in second and fourth years

8. Fence Subpopulations 1b and 8b

Agreement will be sought to fence Subpopulations 1b and 8b on private land, including a buffer of surrounding habitat, to protect *Dryandra squarrosa* subsp. *argillacea* from rubbish dumping or destruction caused by gravel extraction. Funding assistance may be sought from various sources, for example as part of a covenanting process.

Action: Fence Subpopulations 1b and 8b
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $7,300 in first year

9. Restrict access

Access to the State Forest Subpopulation 1a of *Dryandra squarrosa* subsp. *argillacea* will be restricted using gates or bollards to prevent illegal firewood cutting and the spread of disease. Agreement will also be sought from the Local Authority to restrict access and rehabilitate the reserve that contains Population 15.

Action: Restrict access

Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $2,000 in first year

10. Rehabilitate habitat

Habitat rehabilitation at Subpopulations 1b, 8a, 8b and Populations 14 and 15 will include the planting of species native to that site with particular emphasis on species that provide habitat for pollinators. Site rehabilitation will extend beyond the current boundary of the populations to help inhibit further weed invasion.

Action: Rehabilitate habitat
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $16,100 in first year, $4,000 in second and third years, and $2,700 in subsequent years

11. **Develop and implement a fire management strategy**

It appears that fire kills most adult plants of the species and regeneration is largely from seed. A fire management strategy will be developed that recommends fire frequency, intensity, season, and control measures. A fire response plan has been developed and incorporated into the Blackwood District's Fire Control Working Plan. This plan will be incorporated into the fire management strategy. Other fire fighting agencies will be informed of appropriate responses to fire threatening areas that contain *Dryandra squarrosa* subsp. *argillacea*. Firebreaks will continue to be maintained.

Action: Develop and implement a fire management strategy
Responsibility: The Department (Blackwood District) through the SWRTFCRT
Cost: $2,500 in first year and $1,000 in subsequent years.

12. Develop and implement a drainage management strategy

A drainage control and rehabilitation strategy will be developed for the habitat of Subpopulation 2a and implemented in liaison with relevant stakeholders including the Water Corporation and local Shire. Such a strategy may include the establishment of a drain maintenance track north of the drainage channel between the channel and private property fence to allow the existing track to revegetate. This would increase the width of potential habitat for *Dryandra squarrosa* subsp. *argillacea* and reduce the risk of disturbance and weed invasion during future drain maintenance activities.

Action: Develop and implement a drainage management strategy at Subpopulation 2a
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: To be determined

13. Develop a kangaroo management strategy

A management strategy will be developed in areas where kangaroos are having an impact on populations (in particular Population 6) of *Dryandra squarrosa* subsp. *argillacea* by trampling and breaking foliage when moving through the area. The strategy will include a survey to determine animal density, monitoring of impacts on the taxon, and recommendations to reduce the impact.

Action: Develop a kangaroo management strategy
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $2,000 in first year (cost of monitoring included under action 16)

14. Undertake weed control

Weed control will be undertaken in consultation with the land managers. Appropriate methods of weed control are found in Brown and Brooks (2002) and may include hand weeding or localised application of herbicide. 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 *Dryandra squarrosa* subsp. *argillacea* and associated native plant species. It is anticipated that native species in the habitat will regenerate after weed competition is removed.

Action: Undertake weed control
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $1,100 per year

15. Control rabbits

Most populations are affected by rabbits. Although there is no evidence of grazing on the plants themselves, young shoots are extremely vulnerable to grazing. In addition, the soil is being disturbed, and this combined with the increased nutrient levels and the presence of weed seed in their droppings is introducing weeds into the habitat. Baiting or trapping will be undertaken in and around the habitat of *Dryandra squarrosa* subsp. *argillacea* as required.

Action: Control rabbits
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $800 per year

16. Remove rubbish

Rubbish containing plant material and soil dumped in areas containing *Dryandra squarrosa* subsp. *argillacea* populations will be removed and disposed of correctly.

Action: Remove rubbish
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $300 per year

17. Monitor populations

Annual monitoring of factors such as habitat degradation (including weed invasion), population stability (expansion or decline), pollinator activity, seed production, recruitment, longevity and predation is essential. All populations will be inspected annually with special attention given to any impacts from altered hydrology. In areas that are possibly under threat from salinisation or water logging, soil salinity and pH readings will be taken annually during winter.

The presence and advancement of *Phytophthora cinnamomi* will be monitored and the need for further dieback control will be assessed periodically. Monitoring will also examine the affect of phosphite application, both for its control of *P. cinnamomi* and its impact on native species.

Action: Monitor populations
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $1,000 per year

18. Liaise with land managers

Staff from CALM's Blackwood District will continue to liaise with land managers and landowners, including mining and quarrying companies that are active in the area, to ensure that populations are not accidentally damaged or destroyed. In particular, CALM will liaise with owners of land adjacent to Population 6 to ensure that cattle are not moved through the reserve. Input and involvement will also be sought from any indigenous groups that have an active interest in areas that are habitat for *Dryandra squarrosa* susbp. *argillacea*.

Action: Liaise with land managers
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $350 per year

19. Seek improved security for populations

Ways and means of improving the security of populations and their habitat will be investigated. For populations that occur on private property, this may include conservation covenants with a range of agencies, the Land for Wildlife scheme, or possibly acquisition. For populations that occur in gravel pits, liaison will be continued with the Local Authority and land owners to ensure that gravel is no longer extracted.

Action: Seek improved security for populations
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $350 per year

20. 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 will be produced that includes a description of the plant, its habitat, threats, recovery actions and photos.

Action: Promote awareness
Responsibility: CALM (Blackwood District) through the SWRTFCRT
Cost: $1,300 in first year and $600 in remaining years

21. Obtain biological and ecological information

Improved knowledge of the biology and ecology of *Dryandra squarrosa* subsp. *argillacea* will provide a better scientific basis for management of the wild populations. An understanding of the following is particularly necessary for effective management:

1. Soil seed bank dynamics and the role of various disturbances (including fire and grazing by kangaroos or other animals), competition, and rainfall, in germination and recruitment.
2. The pollination biology of the taxon, and the requirements of pollinators.
3. The reproductive strategies, phenology and seasonal growth of the taxon.
4. The population genetic structure, levels of genetic diversity and minimum viable population size.
5. The impact of increased water logging and salinity on *Dryandra squarrosa* subsp. *argillacea* and its habitat.
6. Investigation of the impacts of dieback disease and control techniques on *Dryandra squarrosa* subsp. *argillacea* and its habitat.

Action: Obtain biological and ecological information
Responsibility: CALM (Science Division, Blackwood District) through the SWRTFCRT
Cost: $21,000 per year for the first three years

22. Review the need for a full Recovery Plan

At the end of the fourth year of the five-year term of this Interim Recovery Plan, the need for further recovery will be assessed. If the taxon is still listed as threatened at that time the need for further recovery actions, a full Recovery Plan or to update this IRP will be assessed.

Action: Review the need for a full Recovery Plan
Responsibility: CALM (WATSCU, Blackwood District) through the SWRTFCRT
Cost: $23,700 in the fifth year (if required)

4. TERM OF PLAN

This Interim Recovery Plan will operate from July 2004 to June 2009 but will remain in force until withdrawn or replaced. After five years, the need to review this IRP or to replace it with a full Recovery Plan will be determined.

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6. TAXONOMIC DESCRIPTION

George, A.S. (1996) New taxa and a new infrageneric classification in *Dryandra*. *Nuytsia* 10(3), 336.

Dryandra squarrosa (R.Br.) subsp. *argillacea* A.S. George has *leaves* 5-9mm wide; teeth 3-6 each side. *Perianth* 18-19mm long; limb 2mm long, glabrous. *Pistil* 22-24mm long; pollen presenter 0.8-1mm long.

Australian Government

Department of the Environment and Heritage

ADDENDUM

Whicher Range Dryandra (*Dryandra squarrosa* subsp. *argillacea*) Interim Recovery Plan 2004-2009

In adopting this plan under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Minister for the Environment and Heritage has approved the addition of the following information.

Critical Habitat

The plan identifies critical habitat as including areas located a set distance around known populations which contain habitat similar to that in which the species occurs, as well as areas that do not currently contain the species but may have done so in the past. These areas identified in the plan do not represent areas of critical habitat as defined under section 207A of the EPBC Act, nor do they represent habitats that are critical to the survival of the species identified pursuant to Section 270(2)(d) of the EPBC Act. Habitats identified in Section 270(2)(d) are limited to the area of occupancy of known populations.