Department of Parks and Wildlife

Interim Recovery Plan No. **346**

Cactus banksia (*Banksia anatona*)

Interim Recovery Plan
2014–2019

Department of Parks and Wildlife, Western Australia

June 2014

List of Acronyms

The following acronyms are used in this plan:

ADTFCRT	Albany District Threatened Flora and Communities Recovery Team
BGPA	Botanic Gardens and Parks Authority
CALM	Department of Conservation and Land Management
CCWA	Conservation Commission of Western Australia
CITES	Convention on International Trade in Endangered Species
CR	Critically Endangered
DAA	Department of Aboriginal Affairs
DEC	Department of Environment and Conservation
DPaW	Department of Parks and Wildlife (Parks and Wildlife)
DRF	Declared Rare Flora
EN	Endangered
EPBC	Environment Protection and Biodiversity Conservation
IBRA	Interim Biogeographic Regionalisation for Australia
IRP	Interim Recovery Plan
IUCN	International Union for Conservation of Nature
NRM	Natural Resource Management
PEC	Priority Ecological Community
RP	Recovery Plan
SCB	Species and Communities Branch (Parks and Wildlife)
SCD	Science and Conservation Division
SWALSC	South West Aboriginal Land and Sea Council
TEC	Threatened Ecological Community
TECSC	Threatened Ecological Community Scientific Committee
TFSC	Threatened Flora Seed Centre
UNEP-WCMC	United Nations Environment Program World Conservation Monitoring Centre
VU	Vulnerable
WA	Western Australia

Foreword

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Parks and Wildlife Policy Statements Nos. 44 and 50 (CALM 1992; CALM 1994). Note: The Department of Conservation and Land Management (CALM) formally became the Department of Environment and Conservation (DEC) in July 2006 and the Department of Parks and Wildlife in July 2013. Plans 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.

Parks and Wildlife is committed to ensuring that Threatened taxa are conserved through the preparation and implementation of Recovery Plans (RPs) or IRPs, and by ensuring that conservation action commences as soon as possible and, in the case of Critically Endangered (CR) taxa, within one year of endorsement of that rank by the Minister.

This plan, which results from a review of, and replaces plan No. 111 Cactus Banksia (*Dryandra anatona*) (Phillimore and Brown 2001*a*), will operate from June 2014 to May 2019 but will remain in force until withdrawn or replaced. It is intended that, if the taxon is still ranked as CR in WA, this plan will be reviewed after five years and the need for further recovery actions assessed.

This plan was given regional approval on 6 June 2014 and was approved by the Director of Science and Conservation on 13 June 2014. The provision of funds identified in this plan is dependent on budgetary and other constraints affecting Parks and Wildlife, as well as the need to address other priorities.

Information in this plan was accurate at June 2014.

Plan preparation: This plan was prepared by:

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Cover photograph by Sarah Barrett.

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Summary

Scientific name:	***Banksia anatona***	**Common name:**	Cactus Banksia
Family:	Proteaceae	**Flowering period:**	January–June
DPaW region:	South Coast	**DPaW district:**	Albany
Shires:	Gnowangerup, Plantagenet	**NRM region:**	South Coast NRM
IBRA region:	Esperance Plains	**Recovery team:**	ADTFCRT
IBRA subregion:	Fitzgerald ESP01		

Distribution and habitat: *Banksia anatona* is endemic to WA where it is confined to the Stirling Range National Park. The species grows on slopes in sandy soil over shale and sandstone in thick kwongan vegetation (George 1996).

Habitat critical to the survival of the species, and important populations: It is considered that all known habitat for wild populations is critical to the survival of the species and that the wild populations are important populations. Habitat critical to the survival of *B. anatona* includes the area of occupancy of populations, areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators), additional occurrences of similar habitat that may contain undiscovered populations of the species or be suitable for future translocations, and the local catchment for the surface and/or groundwater that maintains the habitat of the species.

Conservation status: *Banksia anatona* is specially protected under the Western Australian *Wildlife Conservation Act 1950* and is ranked as Critically Endangered (CR) in Western Australia under IUCN (1994) criteria B1+2a–e due to its extent of occurrence estimated to be less than 100km^2 and area of occupancy estimated to be less than 10km^2; it being severely fragmented and there being a continuing decline in extent of occurrence, area of occupancy, quality of habitat, number of locations and number of mature individuals. The species is listed as Endangered (EN) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Threats: The main threats to the species are disease, fire and grazing.

Existing recovery actions: The following recovery actions have been, or are currently being, implemented and have been considered in the preparation of this plan:

1. Laboratory testing has shown that *Banksia anatona* is highly susceptible to dieback caused by *Phytophthora cinnamomi*.
2. Aerial spraying of Subpopulations 2a and 4b with phosphite commenced in 1998, and has occurred regularly since. Spraying of Subpopulations 3a, 3c and 3e commenced in 2003.
3. Monitoring plots were established along dieback fronts at Subpopulation 2a in 1998 and 2002, and at Subpopulation 4b in 1999 to establish the impact of dieback and the effectiveness of phosphite application.
4. The species has been extensively surveyed by Parks and Wildlife's Albany District staff with new subpopulations being discovered.
5. Some 5,073 seed and 75 follicles collected from *Banksia anatona* are currently stored in the Threatened Flora Seed Centre (TFSC) at –18°C.
6. The Botanic Gardens and Parks Authority (BGPA) have two plants of *Banksia anatona* in their nursery. The plants were grown from seed collected in April 2009 by the TFSC.
7. Tree guards were placed around juvenile plants at Populations 2 and Subpopulation 3e in 2007 and 2008 to reduce grazing pressure by herbivores with wire fencing erected in 2011 and 2012.
8. Declared rare flora (DRF) markers have been installed along the track at Subpopulation 2a. These alert people working in the vicinity to the presence of DRF and the need to avoid work that may damage the species or its habitat.

9. Two translocations have been carried out for this species. The initial translocation was undertaken in June 2007 and consisted of a 'conservation introduction' at a seed orchard site on private property with a total of 49 seedlings planted. The second translocation, also a 'conservation introduction', comprised 127 seedlings planted at another 'seed orchard' site in 2008.
10. Aerial canker (*Pestalotiopsis*) was isolated from samples taken from Population 2 in 2008 but did not appear to be a primary pathogen.

Plan objective: The objective of this plan is to abate identified threats and maintain or enhance *in situ* populations to ensure the long-term conservation of the species in the wild.

Recovery criteria

Criteria for recovery success:

- The number of extant natural populations has increased from four to five or more over the term of the plan and/or
- The number of mature individuals has increased by 5% or more over the term of the plan from 4,695 to 4,930 or more.

Criteria for recovery failure:

- The number of extant natural populations has decreased from four to three or less over the term of the plan and/or
- The number of mature individuals has decreased by 5% or more over the term of the plan from 4,695 to 4,460 or less.

Recovery actions

1. Coordinate recovery actions
2. Monitor populations
3. Apply phosphite
4. Determine susceptibility to diseases such as aerial canker
5. Protect plants from herbivory
6. Implement SRNP Fire Management Strategy
7. Continue translocation program
8. Maintain disease hygiene
9. Undertake surveys
10. Collect and store seed
11. Obtain biological and ecological information
12. Liaise with land managers and Aboriginal communities
13. Promote awareness
14. Map habitat critical to the survival of *Banksia anatona*
15. Review this plan and assess the need for further recovery actions

1. Background

An analysis of outputs and effectiveness of Interim Recovery Plan (IRP) 111 (2001-2004) by R. Phillimore and A. Brown follows. This plan replaces IRP 111.

The criteria for success in the previous plan (the number of individuals within populations and/or the number of populations have increased) has been met as the number of subpopulations has increased from five to 13. It is not possible to judge the criteria for success by the number of individuals as, when the previous plan was written in 2001, the number of mature plants was unknown due to a fire. A new population established through translocation is not yet self-sustaining.

Some recovery actions in the previous plan are now fully or partially implemented while others have not yet started. The species' restricted extent of occurrence, continuing decline in quality of habitat, and current critical ranking warrants continuing recovery. *Action 9* "Write a full Recovery Plan" is now redundant as Parks and Wildlife no longer produces full recovery plans for flora. IRPs are reviewed and updated if required.

Table 1: Status of recovery actions included in previous plan

Recovery action	Status	Result
Coordinate recovery actions	Ongoing	Recovery actions have been conducted by the Albany District Flora Conservation Officer with assistance from the ADTFCRT. The team meets biannually.
Apply phosphite	Ongoing	Aerial spraying of Subpopulations 2a and 4b with phosphite commenced in 1998 (24kg/hectare) and has occurred regularly since (reduced to 12kg/hectare). Spraying of Populations 3a, 3c and 3e commenced in 2003. Staff from Parks and Wildlifes Albany District have been monitoring the effectiveness of phosphite application. A monitoring program has been set up in Population 2. The 5x5m quadrats have been monitored annually since 2002.
Monitor populations	Ongoing	Populations have been monitored and data has been collected on population demography, habitat details and status, threat assessments, post fire recruitment and other notable attributes, during the term of this plan. All monitoring data is stored at Parks and Wildlife's Albany District and SCB.
Develop and implement a fire management strategy	Strategy complete, implementation ongoing	The Fire Management Strategy for the SRNP (2010) has taken into consideration the vulnerability of threatened species to frequent fire regimes and all populations are to be excluded from fire for the foreseeable future.
Collect seed and cutting material	Collections made, ongoing	The TFSC currently has 5,073 seed and 75 follicles made from 26 collections from the taxon. BGPA currently have two plants of *Banksia anatona* in their nursery. The plants were from seedlings germinated from seed collected in April 2009 by the TFSC.
Conduct further surveys	Surveys conducted, ongoing	The species has been extensively surveyed for by Parks and Wildlife's Albany District staff in areas of suitable habitat with new subpopulations found. Where possible local volunteers have assisted.
Obtain biological and ecological information	Started, ongoing	Quadrat monitoring has occurred at Populations 2 and 4. Testing for susceptibility to *Phytophthora* dieback caused by *P. cinnamomi* found that out of 190 plants tested with inoculations of the pathogen, 100% died indicating the species is highly susceptible. A further quantified risk assessment undertaken by Barrett *et al.* (2008*b*) found *P. cinnamomi* had a direct impact score on the species of 8.6 out of 10 which in combination with other risk factors including percentage of habitat

		infested and other threatening processes resulted in a 'Very High' extinction risk score of 33.6 out of 36. A study in germination response of a number of threatened *Dryandra* species was published by Cochrane *et al*. in 2002.
Promote awareness	Ongoing	Several articles and presentations have been written about, or included, the species, including a paper presented at Seed Ecology Conference 2004: Seed and seedling ecology of three rare endemics from Western Australia: important factors in the management of threatened species by Barrett and Cochrane; Cochrane *et al*. Kew Bulletin Vol 65 (2010).
Write a full Recovery Plan	No longer a requirement	As Parks and Wildlife no longer produces full recovery plans for flora, this plan will be reviewed and a new plan prepared if necessary.

Ongoing recovery actions included in the previous plan are also included in this revised plan. New recovery actions included in this plan are – determine susceptibility to diseases such as aerial canker, protect plants from herbivory, implement the Stirling Range National Park Fire Management Strategy, continue the translocation program, continue to maintain disease hygiene, liaise with land managers and Aboriginal communities, map habitat critical to the survival of *Banksia anatona*, and review this plan and assess the need for further recovery actions.

History

Banksia anatona was described as a species of *Dryandra* by Alex George in 1996, its specific name derived from the Greek *tonos* which refers to drawing out or stretching, and the prefix *ana* meaning upwards, referring to the tall, spindly habit (George 1996). Following a phylogenetic analysis by Mast and Thiele in 2007 the species was transferred to the genus *Banksia*.

Banksia anatona was first collected from the Stirling Range National Park in 1979. During surveys by department staff in 1996, 1997, 1999 and 2000 four additional populations were found. All natural populations are located within the park. By 1997, Population 1 was believed extinct and a fire in spring 2000 resulted in the loss of many mature plants from Populations 2, 3 and 4. Population 5 has not been relocated since the fire.

Banksia anatona occurs with several other Declared Rare Flora (DRF) species and the Priority 1 ecological community - 'Montane mallee thicket community of the Stirling Range' (assessed as EN). Habitat in which *Banksia anatona* occurs is highly susceptible to infestation by *Phytophthora* dieback and laboratory testing confirms *B. anatona* is also highly susceptible to the disease.

Banksia anatona is known from five natural populations and two translocated populations comprising 4,695 mature plants. However, one population and six subpopulations no longer have extant plants due to *Phytophthora* dieback and changed fire regimes.

Description

Banksia anatona grows to 5m tall and has a single main stem with numerous short lateral branches covered with felty hairs. Leaves are 30 to 70mm long by 12 to 22mm wide when flattened and have 10 to 12 teeth on each side. Leaves are hairy above when young but become glabrous over time. The underside of the leaf has a white felty covering. The inflorescence is either terminal or on short lateral branchlets and comprises over 100 flowers (Brown *et al*. 1998).

Banksia anatona resembles *B. falcata* but is hairier, has long (15 to 17mm) floral bracts and has a different shaped fruit. Juvenile leaves are obovate to cuneate and shortly serrate (George 1996).

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* R. Br. (Proteaceae: Grevilleoideae). *Nuytsia* 10(3): 313–408; Robinson, C.J. and Coates, D.J. (1995) *Declared Rare and Poorly Known Flora in the Albany District*. Department of Conservation and Land Management, Western Australia; Western Australian Herbarium (1998–) *FloraBase-The Western Australian Flora*. Department of Parks and Wildlife. http://florabase.dpaw.wa.gov.au/.

Distribution and habitat

Banksia anatona is endemic to Western Australia where it is confined to the Stirling Range National Park. The species grows on slopes in sandy soil over shale and sandstone in thick kwongan vegetation (George 1996).

Associated species include *Daviesia glossosema* (DRF), *Allocasuarina humilis*, *Anarthria prolifera*, *Andersonia echinocephala* (Priority 3), *Banksia oreophila*, *B. coccinea*, *B. plumosa*, *B. sphaerocarpa, B. mucronulata, Beaufortia decussata*, *Conospermum coerulescens*, *Eucalyptus marginata*, *E. staeri*, *Hakea baxteri*, *Isopogon latifolius* (Priority 3), Kingia *australis*, *Lambertia ericifolia*, *L. uniflora*, *Nuytsia floribunda*,

Table 2. Summary of population land vesting, purpose and manager

Population number & location	Parks and Wildlife district	Shire	Vesting	Purpose	Manager
1. Talyuberlup Peak	Albany	Plantagenet	CCWA	National Park	Parks and Wildlife
2a. E South Bluff	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
2b. E South Bluff	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
3a. Mount Success	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
3b. Mount Success	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
3c. Mount Success	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
3d. Mount Success	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
3e. Mount Success	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
3f. Mount Success	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
3g. Mount Success	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
4a. SE Ellen Peak	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
4b. SE Ellen Peak	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
4c. SE Ellen Peak	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
4d. SE Ellen Peak	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
5. N Ellen Track	Albany	Gnowangerup	CCWA	National Park	Parks and Wildlife
6T. E of Mt Barker	Albany	Plantagenet	Private property		Landowners
7T. NE of Albany	Albany	City of Albany	Private property		Landowners

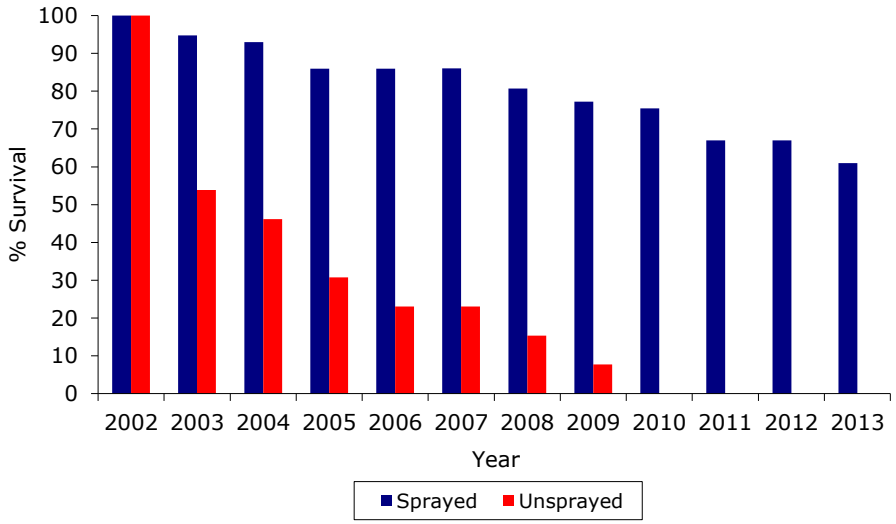
Note: Populations 6 and 7are translocated populations.

Biology and ecology

Banksia anatona is highly susceptible to *Phytophthora cinnamomi* which is present at all sites where the species occurs. All 190 potted plants inoculated with the pathogen died. A further quantified risk assessment undertaken by Barrett *et al*. (2008*b*) found *P. cinnamomi* had a direct impact score on the species of 8.6 out of 10 which, in combination with other risk factors including percentage of habitat infested and other threatening processes, resulted in a 'Very High' extinction risk score of 33.6 out of 36. The species may also be affected by the indirect impact of the pathogen on the community structure. *Banksia anatona* also appears to be affected by aerial canker with observations of limb death and whole plant death at Population 2 possibly a result of the pathogen. The aerial canker causing fungi *Pestalotiopsis* was isolated from samples from Population 2 in 2008. However, as there were no obvious stem lesions, it was concluded that it was not a primary pathogen and was only contributing to its decline.

Monitoring plots were established at Population 2 to investigate the effectiveness of phosphite application following fires in 1991 and 2000. Between 1998 and 2012, percentage survival was compared for plants sprayed with 6 to 12kg/hectare of phosphite, and plants not sprayed (control) (see figure 1). The rate of decline for the phosphite sprayed plots was considerably lower than that of the unsprayed plots.

Figure 1. Survivorship of *Banksia anatona* Population 2, 2000 cohort, with and without phosphite application (6 to 12kg per hectare) 2002 to 2013



Banksia anatona is an obligate re-seeder, killed by fire and relies on canopy-stored seed (serotinous) for its persistence. Follicles are retained on the plant but after two years start to open and release seed. The soil seed bank is not persistent with 0% viable four months after burial experiments (Barrett *et al*. 2008*a*; Cochrane *et al*. 2010).

The juvenile period for *Banksia anatona* is relatively long ranging from six to seven years (Cochrane *et al*. 2010), with first flowering of 50% of individuals observed at Population 2 occurring 5.5 years after the 1991 fire. Longer juvenile periods were observed after the 2000 fire and this may be related to grazing impacts. A longer juvenile period was also observed in upland populations and is related to slower growth rates. The fruit to flower ratio is low (Barrett *et al*. 2008*a*).

Fires in 1991 and 2000 killed most plants at all populations. Moderate recruitment was recorded post-fire at Population 2 with a seedling to adult ratio of 0.9. Recruitment was very low in Subpopulation 4b with a seedling to adult ratio of 0.02. *Banksia anatona* is vulnerable to short fire intervals and a nine year interval was insufficient for upland populations to regenerate to pre-fire densities (Barrett *et al*. 2008*a*).

A study in germination response of a number of threatened *Dryandra* (now *Banksia*) species found that there was no significant difference in the germination of *Banksia anatona* (referred to as *Dryandra anatona* in the study) seed after storage for one year at -20ºC and at 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).

Plantings of *Banksia anatona* has proven to be a successful method of increasing the survival prospects of the species. New habitat has been provided and the number of known reproductive plants increased while time has been bought for advances to be made on *Phytophthora* management (Cochrane *et al*. 2010).

Data (unpublished) has been collected on growth, flowering, fruit to flower ratio, canopy seed banks, longevity of canopy seed bank and soil seed bank, seedling to adult ratios after fire, seedlings densities, seed characteristics and germination.

Conservation status

Banksia anatona is specially protected under the Western Australian *Wildlife Conservation Act 1950* and is ranked as Critically Endangered (CR) in Western Australia under International Union for Conservation of Nature (IUCN) 1994 criteria B1+2a−e due to its extent of occurrence estimated to be less than 100km^2 and area of occupancy estimated to be less than 10km^2; it being severely fragmented and their being a continuing decline in extent of occurrence, area of occupancy, quality of habitat, number of locations and number of mature individuals. The species is listed as Endangered (EN) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Threats

- **Disease** caused by *Phytophthora cinnamomi*, a pathogen that causes root rot resulting in susceptible plants dying of drought stress, is a threat to all populations. Testing has revealed the species is highly susceptible to the disease. Canker-like symptoms have also been observed in populations and the fungus *Pestaliotopsis* isolated from Population 2. This may be relatively benign or a facultative parasite.
- **Altered fire regimes** Fires that occurred in 1991 and 2000 killed many adult plants. If fires occur before plants are able to produce sufficient seed there is a significant risk of population extinctions.
- **Grazing** Rabbits (*Oryctolagus cuniculus*) and quokkas (*Setonix brachyurus*) appear to be the primary herbivores. Tree guards and wire fences installed around juvenile plants at Population 2 and Subpopulation 3e have been effective in reducing grazing pressure.

The intent of this plan is to provide actions that will mitigate immediate threats to *Banksia anatona*. Although climate change and drought may have a long-term effect on the species, actions taken directly to prevent their impact are beyond the scope of this plan.

Table 3. Summary of population information and threats

Population number & location	Land status	Year	Number of plants			Condition	Threats
			Mature	Seedlings/ juveniles	Dead		
1. Talyuberlup Peak	National Park	1993 1997	15 0	0 0	0 0	Presumed extinct	Disease, fire (burnt 1991, 2000)
2a. E South Bluff	National Park	1997 2000 2002	2000+ 2000+ 1000+	0 0 1000+	0 1000+ 30+	Moderate/ habitat good	Disease, fire (burnt 1991, 2000), grazing
2b. E South Bluff	National Park	1997 2000	50 0	0 0	0 0	Not seen since 2000 fire	Disease, fire (burnt 1991, 2000)
3a. Mount Success	National Park	1999 2005 2010 2012	1000+ 42 75 350+	0 350+ 150 <10	25–50% 136+ 100 -	Moderate plants/ habitat degraded	Disease, fire (burnt 1991, 2000), grazing
3b. Mount Success	National Park	2002 2003	0 0	4 4	0 0	Poor	Disease, fire (burnt 1991, 2000), grazing
3c. Mount Success	National Park	2003 2006 2007	5 1 1	300+ 10+ 0	30+ 40+ 11+	Poor	Disease, fire (burnt 1991, 2000), grazing
3d. Mount Success	National Park	2002 2003	0 0	60+ 60+	0 0	Poor	Disease, fire (burnt 1991, 2000), grazing
3e. Mount Success	National Park	2003 2007 2012	0 30+ 250	500+ 270+ 50	100+ 5% <10	Moderate plants/ habitat good	Disease, fire (burnt 1991, 2000), grazing
3f. Mount Success	National Park	2002 2003	0 0	20+ 20+	0 0	Poor	Disease, fire (burnt 1991, 2000), grazing
3g. Mount Success	National Park	2002 2006	0 0	15+ 0	0 10+	Extinct?	Disease, fire (burnt 1991, 2000), grazing
4a. SE Ellen Peak	National Park	1997 2000 2011	300+ 0 0	0 0 0	0 500+ 1	Healthy/ habitat good	Disease, fire (burnt 1991, 2000), grazing
4b. SE Ellen Peak	National Park	1999 2007 2012	300 39 68	700 39 67	10% 7+ 1	Healthy plants/ habitat good	Disease, fire (burnt 1991, 2000), grazing
4c. SE Ellen Peak	National Park	2000 2002	0 0	0 30+	500+ 0	Poor	Disease, fire (burnt 1991, 2000), grazing
4d. SE Ellen Peak	National Park	2007	20	17	13	Poor	Disease, fire (burnt 1991, 2000), grazing
5. N Ellen Track	National Park	2000	7	0	6	Poor	Disease, fire (burnt 1991, 2000), grazing
6T. E of Mt Barker	Private property	2007 2009 2012	0 0 0	49 251 202	0 0 49		
7T. NE Albany	Private property	2008 2012	0 0	127 128	0 6		

Note: Populations in **bold text** are considered to be important populations;* = total for subpopulations combined; Populations 6 and 7 are translocated populations.

Guide for decision-makers

Section 1 provides details of current and possible future threats. Actions for development and/or land clearing in the immediate vicinity of *Banksia anatona* may require assessment.

Actions that could result in any of the following may potentially result in a significant impact on the species:

- Damage or destruction of occupied or potential habitat
- Alteration of the local surface hydrology or drainage
- Reduction in population size
- Spread or amplification of *Phytophthora* dieback
- An increase in disturbance in the vicinity of populations.

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

Banksia anatona is ranked as CR in Western Australia and it is considered that all known habitat for wild populations is critical to the survival of the species and that the wild populations are important populations. Habitat critical to the survival of *B. anatona* includes the area of occupancy of populations, areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators), additional occurrences of similar habitat that may contain undiscovered populations of the species or be suitable for future translocations, and the local catchment for the surface and/or groundwater that maintains the habitat of the species.

Benefits to other species or ecological communities

Recovery actions implemented to improve the quality or security of the habitat of *Banksia anatona* will also improve the status of associated native vegetation. Eight declared rare and 19 priority flora taxa occur within 500m of the species (see table 4).

Table 4. Conservation-listed flora species occurring within 500m of *Banksia anatona*

Species name	Conservation status (WA)	Conservation status (EPBC Act)
Banksia brownii	DRF (CR)	EN
Darwinia squarrosa	DRF (VU)	VU
Darwinia wittwerorum (extinct population only)	DRF (EN)	EN
Daviesia glossosema	DRF (CR)	CR
Daviesia obovata	DRF (EN)	EN
Lambertia fairallii	DRF (CR)	EN
Latrobea colophona	DRF (CR)	-
Persoonia micranthera	DRF (CR)	EN
Banksia plumosa subsp. *denticulata*	Priority 2	-
Daviesia mesophylla	Priority 2	-
Dielsiodoxa tamariscina	Priority 2	-
Gastrolobium leakeanum	Priority 2	-
Gastrolobium pulchellum	Priority 2	-
Latrobea pinnacula	Priority 2	-
Leucopogon lasiophyllus	Priority 2	-
Leucopogon psilopus	Priority 2	-
Andersonia echinocephala	Priority 3	-
Andersonia grandiflora (extinct population only)	Priority 3	-
Banksia hirta	Priority 3	-
Hypocalymma phillipsii (extinct population only)	Priority 3	-

Isopogon latifolius	Priority 3	-
Petrophile longifolia	Priority 3	-
Banksia concinna	Priority 4	-
Banksia solandri	Priority 4	-
Darwinia leiostyla	Priority 4	-
Eucalyptus marginata x pachyloma	Priority 4	-
Muiriantha hassellii	Priority 4	-

For a description of conservation codes for Western Australian flora see http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Conservation_code_definitions_18092013.pdf

Two priority fauna species that occur near populations will also benefit from the management of *Banksia anatona*. These include land snail (*Bothriembryon brazieri*) Priority 2 and Western Whipbird (*Psophodes nigrogularis* subsp. *oberon*) Priority 4.

Banksia anatona occurs within the 'Montane mallee thicket community of the Stirling Range (Mallee-heath and mallee-thicket community on mid to upper slopes of Stirling Range mountains and hills)' Priority Ecological Community (PEC). This PEC is currently listed as Priority 1. It is known from 25 occurrences consisting of 1,391 hectares. For a description of Threatened Ecological community (TEC) categories see DEC (2010*c*).

This plan will be implemented in conjunction with the plan for 'Montane Mallee Thicket of the Stirling Range' IRP (Barrett 2005), and the plans for *Banksia brownii* (Gilfillan and Barrett 2005), *Darwinia wittwerorum* (Hartley *et al*. 2005), *Daviesia glossosema* (Phillimore and Brown 2001*b*), *Daviesia obovata* (DEC 2010*a*), *Lambertia fairallii* (Hartley and Barrett 2005), *Latrobea colophona* (DEC 2010*b*) and *Persoonia micranthera* (Stack and Brown 2003).

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 species is not listed under Appendix II in the United Nations Environment Program World Conservation Monitoring Centre Convention on International Trade in Endangered Species and this plan does not affect Australia's obligations under any other international agreements.

Aboriginal consultation

A search of the Department of Aboriginal Affairs (DAA) Aboriginal Heritage Sites Register revealed one site (#5145;Kojaneerup; artefacts) of Aboriginal significance adjacent to a population of *Banksia anatona*. The species also occurs within the Stirling Range National Park and this is known to be a culturally significant site to Aboriginal people. Input and involvement has been sought through the South West Aboriginal Land and Sea Council and DAA to determine if there are any issues or interests with respect to the management of *Banksia anatona* in the vicinity of these significant sites. Aboriginal opportunity for future involvement in the implementation of the plan is included as an action in the plan. Aboriginal involvement in management of land covered by an agreement under the *Conservation and Land Management Act 1984* is also provided for under the joint management arrangements in that Act, and will apply if an agreement is established over any reserved lands on which *Banksia anatona* occurs.

Social and economic impacts

As all natural populations of *Banksia anatona* are on land under the management responsibility of the Department of Parks and Wildlife, the implementation of this recovery plan may cause some economic impact through restrictions imposed on the management of the land and through the cost of implementing recovery actions (controlling *Phytophthora* dieback and grazing). For private property locations containing translocated populations, impacts to landholders may occur through the loss of land available for development as well as the cost of implementing recovery actions (maintaining fencing) and restrictions imposed on the management of these lands. These implications were agreed prior to the establishment of the translocated populations.

Affected interests

All natural populations occur in a national park for which Parks and Wildlife has primary management responsibility.

Evaluation of the plan's performance

Parks and Wildlife, with assistance from the Albany District Threatened Flora and Communities Recovery Team (ADTFCRT), will evaluate the performance of this plan. In addition to annual reporting on progress and evaluation against the criteria for success and failure, the plan will be reviewed following five years of implementation.

2. Recovery objective and criteria

Plan objective

The objective of this plan is to abate identified threats and maintain or enhance *in situ* populations to ensure the long-term conservation of the species in the wild.

Recovery criteria

Criteria for recovery success:

- The number of extant populations has increased from four to five or more over the term of the plan and/or
- The number of mature individuals has increased by 5% or more over the term of the plan from 4,695 to 4,930 or more.

Criteria for recovery failure:

- The number of extant populations has decreased from four to three or less over the term of the plan and/or
- The number of mature individuals has decreased by 5% or more over the term of the plan from 4,695 to 4,460 or less.

3. Recovery actions

Existing recovery actions

Laboratory testing confirms that *Banksia anatona* is highly susceptible to dieback caused by *Phytophthora cinnamomi*. All 190 plants that were inoculated with the pathogen died.

Aerial spraying with phosphite commenced on Subpopulations 2a and 4b in 1998 (24kg/hectare) and has occurred regularly since (reduced to 12kg/hectare). Spraying of Subpopulations 3a, 3c and 3e commenced in 2003 (note: spraying of Subpopulation 3c ceased in 2008). The following table outlines dates during which populations were sprayed at 12kg per hectare, except where otherwise stated.

Table 5. *Banksia anatona* populations sprayed with phosphite

Population number	Location	Area sprayed (hectares)	Dates sprayed (sprayed twice except where otherwise stated)
2a	Ellen Track	25	1998, 1999, 2000, 2001–2007 (6kg/ha x 2 sprays), 2006 (6kg/ha), 2008–2012
3a, 3c, 3e	Mount Success	5	2003/2004 (6kg/ha x 2 sprays), 2005 (6kg/ha), 2006–2007 (6kg/ha x 2 sprays), 2008 (3c spraying ceased), 2009, 2010, 2011, 2012
4b	SE Ellen Peak	3.5	1998 (6kg/ha), 1999, 2000, 2002–2006 (6kg/ha x 2 sprays), 2008–2012

In order to establish the impact of *Phytophthora* dieback on *Banksia anatona* and the effectiveness of phosphite applications, monitoring plots were established along or near dieback fronts at Subpopulation 2a in 1998 and 2002, and Subpopulation 4b in 1999. Data collected from quadrats included counts of the number of adults, juveniles, seedlings and the number of dead individuals.

The species has been surveyed for by Parks and Wildlife's Albany District with new subpopulations discovered.

Some 5,073 seeds and 75 follicles collected from *Banksia anatona* are stored in the Threatened Flora Seed Centre (TFSC) at –18°C (see table 6). Some seed has been processed with the germination rate ranging from 80 to 100%.

Table 6. TFSC collection details for *Banksia anatona*

Accession number	Date collected	Population number	Collection type	Seeds/follicles in storage	Germination rate (%)
00070	18/08/1993	1	B/15	85	100
00170	1/09/1994	1	B/6	75 follicles	83
00333	21/04/1996	2	B/12	47	100
00436	4/02/1997	2	B/8, B/500	1614	100
00437	4/02/1997	2	B/12	132	-
01215	19/06/2003	3	B/22	57	85
01311	10/12/2003	3	B/5	26	-
01312	3/12/2003	3	B/25, B/20	167	80

01712	18/02/2005	4	I/5	145	85
01964	8/02/2006	2	I/81	735	not yet conducted
01974	15/02/2006	3	I/1	not yet processed	
01984	23/02/2006	4	I/4	76	88
02361	31/03/2006	3	I/1?	not yet processed	
02367	28/03/2007	3	B/20	341	87
02381	10/05/2007	4	I/6	23	91
02382	9/05/2007	3	I/2	13	-
02834	7/04/2008	3	I/30	not yet processed	
02839	9/04/2008	2	I/100	1130	not yet conducted
03026	11/02/2009	3	B/10	not yet processed	
03263	24/02/2010	3	I/19	107	not yet conducted
03264	24/02/2010	3	I/48	95	-
03377	15/10/2010	2	I/28	125	not yet conducted
03470	1/04/2011	3	I/25	155	not yet conducted
03681	17/01/2012	6	I/1	not yet processed	
03696	1/02/2012	3	I/20	not yet processed	
03707	18/02/2012	3	I/20	not yet processed	

Note: 'I' = a collection of individuals and the number of plants collected; 'B' = a bulked collection and the number of plants sampled

The Botanic Gardens and Parks Authority (BGPA) have two plants of *Banksia anatona* in their nursery germinated from seed collected in April 2009 by the TFSC. Other seedlings germinated from seed collected in 1993, 1996 and 1997 have since died. No propagation records are available.

Tree guards were placed around juvenile plants at Population 2 and Subpopulation 3e in 2007 and 2008 to reduce grazing pressure by herbivores. Wire fencing was erected at Population 2 in 2011 and 2012.

DRF markers have been installed along the track at Subpopulation 2a.

Two translocations have been carried out for *Banksia anatona*. The first translocation, undertaken in June 2007 with a total of 49 seedlings planted, was a 'conservation introduction' at a seed orchard site on private property. The second translocation comprising 127 seedlings, also a 'conservation introduction', was undertaken at a second 'seed orchard' site in 2008.

The aerial canker causing fungi *Pestalotiopsis* was isolated from samples from Population 2 in 2008. However it did not appear to be a primary pathogen.

Future recovery actions

Parks and Wildlife is overseeing the implementation of this plan and with the assistance of the ADTFCRT will include information on progress in annual reports to Parks and Wildlife's Corporate Executive and funding bodies. Where recovery actions are implemented on lands other than those managed by Parks and Wildlife, permission has been or will be sought from the appropriate land managers prior to actions being undertaken. The following recovery actions are roughly in order of descending priority, influenced by their timing over the term of the plan. However this should not constrain addressing any recovery action if funding is available and other opportunities arise.

1. Coordinate recovery actions

Parks and Wildlife with assistance from the ADTFCRT will coordinate recovery actions for *Banksia anatona* and will include information on progress in annual reports to Parks and Wildlife's Corporate Executive and funding bodies.

Action:	Coordinate recovery actions
Responsibility:	Parks and Wildlife (Albany District) with assistance from the ADTFCRT
Cost:	$8,000 per year

2. Monitor populations

Monitoring will include accurate counts, locational information, habitat degradation, disease impact (*Phytophthora* sp. and aerial canker), population stability (expansion or decline), pollinator activity, seed production, recruitment and longevity. Regular monitoring of quadrats to evaluate the effectiveness of phosphite application at Populations 2 and 4 will continue.

Action:	Monitor populations
Responsibility:	Parks and Wildlife (Albany District), with assistance from the ADTFCRT
Cost:	$8,000 per year

3. Apply phosphite

Banksia anatona, and the habitat in which it occurs, is highly susceptible to *Phytophthora* dieback. Parks and Wildlife will continue to apply phosphite as required to Populations 2 and 4, and Subpopulations 3a and 3e, and other populations as appropriate. Application of phosphite to the habitat of *B. anatona* will also protect other threatened plant species and a threatened ecological community.

Action:	Apply phosphite
Responsibility:	Parks and Wildlife (Albany District)
Cost:	$23,000 per year ($667 per hectare for 33.5 hectares)

4. Determine susceptibility to diseases such as aerial canker

Testing is required to determine the susceptibility of the species to aerial canker (e.g. *Botryosphaeria* and *Pestalotiopsis* spp.) and possibly also other diseases such as *Armillaria luteobubalina*.

Action:	Determine susceptibility to diseases such as aerial canker
Responsibility:	Parks and Wildlife (Albany District, Science and Conservation Division(SCD)
Cost:	$3,000 in year 1

5. Protect plants from herbivory

Protective caging will be placed around individual plants and groups of plants to protect them from rabbits. The level of threat posed by grazing may vary from year to year and when monitoring ascertains the threat is high, rabbit control (such as using 1080 oats) may be undertaken.

Action:	Protect plants from herbivory
Responsibility:	Parks and Wildlife (Albany District)
Cost:	$15,000 in years 1, 3 and 5

6. Implement SRNP fire management strategy

Fire is known to kill mature *Banksia anatona* plants and is likely to be detrimental to the species' long-term survival if it occurs at high frequencies. Fire should, if possible, be prevented from occurring in the area of the populations, except where it is being used as a recovery tool.

As indicated in the Stirling Range National Park (SRNP) Fire Management Strategy (2010) all populations are to be excluded from prescribed fire for the foreseeable future (Barrett *et al*. 2010).

Action:	Implement SRNP fire management strategy
Responsibility:	Parks and Wildlife (Albany District)
Cost:	$6,000 per year

7. Continue translocation program

Translocation may be required for the long term conservation of this species, particularly as *Phytophthora* dieback threatens the majority of natural populations which are fragmented and in decline. If required, additional translocation proposals will be developed and disease-free sites selected. Information on the translocation of threatened plants and animals in the wild is provided in Parks and Wildlife's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna* (CALM 1995), and the Australian Network for Plant Conservation translocation guidelines (Vallee *et al*. 2004). All translocation proposals require endorsement by Parks and Wildlife's Director of Science and Conservation. Monitoring of translocations is essential and will be included in the timetable developed for the Translocation Proposal.

Action:	Continue translocation program
Responsibility:	Parks and Wildlife (SCD, Albany District), BGPA
Cost:	$42,000 in years 1–2; and $26,500 in years 3–5 as required

8. Maintain disease hygiene

Phytophthora cinnamomi is present at all natural populations and is a threat to *Banksia anatona* and its habitat. Dieback hygiene (outlined in CALM 2003) will be followed during installation and maintenance of firebreaks and when walking into populations in wet soil conditions. Purpose built signs advising of the dieback risk and high conservation values of the sites will be installed if required.

Action:	Maintain disease hygiene
Responsibility:	Parks and Wildlife (Albany District)
Cost:	$4,000 per year

9. Undertake surveys

It is recommended that areas of potential suitable habitat be surveyed for *Banksia anatona* during its flowering period. However, to avoid the spread of disease, areas should not be visited during the wetter months. All surveyed areas will be recorded and the presence or absence of the species documented to increase survey efficiency and reduce unnecessary duplicate surveys.

Action:	Undertake surveys
Responsibility:	Parks and Wildlife (Albany District), with assistance from the ADTFCRT and volunteers
Cost:	$10,000 per year

10. Collect and store seed

Preservation of genetic material is essential to guard against extinction of the species if wild populations are lost.

Action:	Collect and store seed
Responsibility:	Parks and Wildlife (Albany District, TFSC), BGPA
Cost:	$10,000 per year

11. Obtain biological and ecological information

Improved knowledge of the biology and ecology of the species will provide a scientific basis for management of *Banksia anatona* in the wild and will ideally include:

1. Reproductive success and pollination biology;
2. Canopy-seed bank dynamics and the role of various factors including disturbance, competition, drought, inundation and grazing in recruitment and seedling survival;
3. Minimum viable population size; and
4. The impact of *Phytophthora* dieback and the effectiveness and impact of phosphite application techniques on *Banksia anatona* and its habitat.

Action:	Obtain biological and ecological information
Responsibility:	Parks and Wildlife (SCD, Albany District)
Cost:	$50,000 in years 1–3

12. Liaise with land managers and Aboriginal communities

Conservation staff from Parks and Wildlife's Albany District will liaise with parks staff to ensure that populations of *Banksia anatona* are not accidentaly damaged or destroyed and the habitat is maintained in a suitable condition for the conservation of the species. Aboriginal consultation will take place to determine if there are any issues or interests in areas that are habitat for the species.

Action:	Liaise with land managers and Aboriginal communities
Responsibility:	Parks and Wildlife (Albany District)
Cost:	$4,000 per year

13. Promote awareness

The importance of biodiversity conservation and the protection of *Banksia anatona* will be promoted to the public. An information sheet, which includes a description of the plant, its habitat type, threats, management actions and photos will be produced and distributed. Formal links with local naturalist groups and interested individuals will also be encouraged.

Action:	Promote awareness
Responsibility:	Parks and Wildlife (Albany District, SCB, Public Information and Corporate Affairs (PICA)), with assistance from the ADTFCRT
Cost:	$7,000 in years 1–2; $5,000 in years 3–5

14. Map habitat critical to the survival of *Banksia anatona*

Although habitat critical to the survival of *Banksia anatona* is alluded to in Section 1 it has not been mapped and this will be addressed under this action. If additional populations are located, habitat critical to their survival will be determined and mapped also.

Action:	Map habitat critical to the survival of *Banksia anatona*
Responsibility:	Parks and Wildlife (SCB, Albany District)
Cost:	$6,000 in year 2

15. Review this plan and assess the need for further recovery actions

If *Banksia anatona* is still ranked as CR at the end of the five-year term of this plan, the need for further recovery actions, or a review of this plan will be assessed and a revised plan prepared if necessary.

Action:	Review this plan and assess the need for further recovery actions
Responsibility:	Parks and Wildlife (SCB, Albany District)
Cost:	$6,000 in year 5

Table 7. Summary of recovery actions

Recovery action	Priority	Responsibility	Completion date
Coordinate recovery actions	High	Parks and Wildlife (Albany District), with assistance from the ADTFCRT	Ongoing
Monitor populations	High	Parks and Wildlife (Albany District), with assistance from the ADTFCRT	Ongoing
Apply phosphite	High	Parks and Wildlife (Albany District)	Ongoing
Determine susceptibility to diseases such as aerial canker	High	Parks and Wildlife (Albany District, SCD)	2014
Protect plants from herbivory	High	Parks and Wildlife (Albany District)	Ongoing
Implement SRNP fire management strategy	High	Parks and Wildlife (Albany District)	Ongoing
Continue the existing translocation program	High	Parks and Wildlife (SCD, Albany District), BGPA	2018
Maintain disease hygiene	High	Parks and Wildlife (Albany District)	Ongoing
Undertake surveys	High	Parks and Wildlife (Albany District), with assistance from the ADTFCRT and volunteers	Ongoing
Collect and store seed	High	Parks and Wildlife (Albany District, TFSC), BGPA	2018
Obtain biological and ecological information	High	Parks and Wildlife (SCD, Albany District)	2016
Liaise with land managers and Aboriginal communities	Medium	Parks and Wildlife (Albany District)	Ongoing
Promote awareness	Medium	Parks and Wildlife (Albany District, SCB, PICA), with assistance from the ADTFCRT	2018
Map habitat critical to the survival of *Banksia anatona*	Medium	Parks and Wildlife (SCB, Albany District)	2015
Review this plan and assess the need for further recovery actions	Medium	Parks and Wildlife (SCB, Albany District)	2018

4. Term of plan

This plan will operate from June 2014 to May 2019 but will remain in force until withdrawn or replaced. If the species is still ranked CR after five years, the need for further recovery actions will be determined.

5. References

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6. Taxonomic description

Banksia* (as *Dryandra*) *anatona

George, A.S. (1996) New taxa and a new infrageneric classification in *Dryandra* R. Br. (Proteaceae: Grevilleoideae). *Nuytsia* 10(3): 313–408.

Shrub to 5m with 1 main stem and short laterals, without lignotuber. *Stems* tomentose and hirsute. *Leaves* cuneate, obtuse to acute, irregularly serrate, mucronate, undulate; lamina 3–7cm long, 12–22mm wide, hirsute and glabrescent above, white-tomentose below; margins recurved; teeth 10–12 each side; petiole 3–7mm long, hirsute. *Inflorescence* terminal or on short lateral branchlet; receptacle T-shaped; involucral bracts linear-lanceolate, acute to acuminate, the outer ones squarrose, pubescent with hirsute margins, the innermost 20–25mm long; flowers *c*. 170 per head. *Perianth* 39–40mm long, hirsute above base, then pubescent; limb 5.5–6mm long, acute, hirsute, the apical hairs coarser. *Pistil* 49–50mm long, glabrous; ovary long-hirsute; pollen presenter narrow above slender neck, ribbed, 2–3mm long. *Follicles* obovoid, pubescent, 23–24mm long, hirsute.