Department of Parks and Wildlife

Interim Recovery Plan No. **379**

Granite Banksia (*Banksia verticillata*)

Interim Recovery Plan 2017–2022

Department of Parks and Wildlife, Western Australia

April 2017

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
CFF	Conservation of flora and fauna
CITES	Convention on International Trade in Endangered Species
CPC	Conservation and Parks Commission
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
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
IRP	Interim Recovery Plan
IUCN	International Union for Conservation of Nature
NP	National Park
NR	Nature Reserve
NRM	Natural Resource Management
PICA	Public Information and Corporate Affairs
SCB	Species and Communities Branch
SWALSC	South West Aboriginal Land and Sea Council
TFSC	Parks and Wildlife Threatened Flora Seed Centre
TPFL	Threatened and Priority Flora System
UNEP-WCMC	United Nations Environment Program World Conservation Monitoring Centre
VU	Vulnerable
WA	Western Australia
WRTFRT	Warren Region Threatened Flora Recovery Team

Foreword

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Parks and Wildlife Corporate Policy Statement No. 35 (DPaW 2015*a*) and Department of Parks and Wildlife Corporate Guideline No. 35 (DPaW 2015*b*). 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 flora 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, always within one year of endorsement of that rank by the Minister.

This plan will operate from April 2017 to March 2022 but will remain in force until withdrawn or replaced. It is intended that if *Banksia verticillata* is still listed as Threatened in Western Australia following five years of implementation this plan will be reviewed and the need for further recovery actions assessed.

This plan was given regional approval on 23 March 2017 and was approved by the Director of Science and Conservation on 13 April 2017. 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 April 2017.

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Summary

Scientific name:	*Banksia verticillata*	**IBRA regions:**	Esperance Plains, Warren, Jarrah Forest
Common name:	Granite Banksia		
Family:	Proteaceae	**IBRA subregions:**	Fitzgerald ESP 01, Warren WAR01, Southern Jarrah Forest JAF02
Flowering period:	January–April		
DPaW regions:	South Coast, Warren	**Recovery teams:**	Albany District Threatened Flora and Communities Recovery Team; Warren Region Threatened Flora Recovery Team
DPaW districts:	Albany, Frankland		
Shires:	Albany, Manjimup		
NRM regions	South Coast, South West		

Distribution and habitat: *Banksia verticillata* occurs two disjunct population centres along the south coast of Western Australia – one near Walpole and another in the Albany area. It is restricted to exposed granite outcrops, growing in a shallow sandy loam in fissures and deeper soils on the edges of outcrops.

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 all wild populations are important populations. Habitat critical to the survival of *B. verticillata* includes the area of occupancy of populations and areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators). It may also include 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 verticillata* was listed as specially protected under the Western Australian *Wildlife Conservation Act 1950* on 25 September 1987. It is ranked as Critically Endangered (CR) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 criteria A3ce due to a population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations due to changed fire regimes, *Phytophthora cinnamomi* dieback and aerial canker. The species is listed as Vulnerable (VU) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Threats: The major threats to the species are *Phytophthora* dieback, aerial canker, altered fire regimes, recreational activities, senescence and drought.

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. Parks and Wildlife with assistance from the Albany District Threatened Flora and Communities Recovery Team (ADTFCRT) and Warren Region Threatened Flora Recovery Team (WRTFRT) are overseeing the implementation of recovery actions for *Banksia verticillata*.
2. Land managers have been notified of the location and threatened status of *Banksia verticillata*. Notifications detail the current DRF status of the species, the associated legal obligations in regards to its protection, and contact details for management assistance.
3. All suitable habitat for the species (South Coast granite outcrops) has been thoroughly surveyed.
4. Monitoring has been carried out with micro-habitat, plant numbers, recruitment, reproductive status, fire response, size, health and current threats recorded.
5. A project aimed at supplementing natural recruitment was undertaken at Population 15 of *Banksia verticillata* in 2006.
6. Aerial canker impact has been monitored in five populations over three years with temperature and humidity recorded and the fungus sampled at these sites. An investigation into the effectiveness of foliar fungicide application on aerial canker was conducted between October 2012 and April 2013 (Barrett and Lehmann 2013).

7. Disease hygiene measures including boot cleaning and interpretation stations have been set up at Populations 3, 4 and 10 and Subpopulation 6a to reduce the spread/introduction of *Phytophthora*.
8. A sign has been placed at the site of Population 33 to discourage entry by 4WD's.
9. Information on the threat of *Phytophthora* and appropriate hygiene measures was added to the Geocache description for Subpopulation 6a.
10. Approximately 87,000 seeds have been collected from populations of *Banksia verticillata*.
11. The sensitivity to temperature ranges during germination has been assessed (Cochrane and Schreck 2009; Cochrane 2016).
12. Botanic Gardens and Parks Authority (BGPA) have 9.92g of *Banksia verticillata* seed in storage.

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

Recovery criteria

Recovery will be considered successful if one or more of the following take place over the term of the plan.

- There is no reduction in the extent of occurrence and the number of mature plants within known populations has remained within a 10% range or has increased by >10% from 5531 to 6084 or more or
- New populations have been found, increasing the number of known populations from 30 to 31 or more with no net loss of mature plants or
- The area of occupancy has increased by >10% with no net loss of mature plants.

Recovery will be considered unsuccessful if one or more of the following take place over the term of the plan.

- Populations have been lost which result in a reduction in the extent of occurrence or
- The number of mature plants has decreased by >10% from 5531 to 4978 or less or
- The area of occupancy has decreased by >10%, with a net loss of mature plants.

Recovery actions

1. Coordinate recovery actions
2. Monitor populations
3. Apply phosphite to *Phytophthora* dieback infected habitat
4. Undertake fungicide trials for aerial canker control
5. Maintain hygiene measures to protect populations from *Phytophthora* dieback
6. Develop and implement a fire management strategy
7. Restrict access into the habitat of populations
8. Collect and store seed
9. Develop and implement translocations
10. Obtain biological and ecological information
11. Undertake surveys
12. Liaise with land managers and Aboriginal communities
13. Map habitat critical to the survival of *Banksia verticillata*
14. Promote awareness
15. Review this plan and assess the need for further recovery actions

1. Background

History

The first collection of *Banksia verticillata* was made from King George Sound in December 1801 by Robert Brown who described the species in 1811 (Brown 1811). The species is found in two disjunct areas, one near Walpole and the other near Albany.

Banksia verticillata was listed as Threatened Flora in 1987 due to the combined threats of dieback (*Phytophthora cinnamomi*) and aerial canker. At that time, its wide range, relatively high number of populations and fairly inaccessible habitat resulted in it being given the rank of Vulnerable. However, as there has been a 40% decline in plant numbers between 2008 and 2013 and seven populations are now presumed extinct, its ranking was upgraded to Critically Endangered in 2014.

Bushfire has recently had a big impact on the species with Populations 3, 10, 13, 15, 19 and 31 burnt in 2014 and 2015. Prior to this, Populations 3, 10 and 13 were burnt in 1998, and Populations 15 (70%) and 19 were burnt in 2005. *Banksia verticillata* is currently known from 27 extant populations, comprising 5531 mature plants. A further three extant populations together contain 6516 seedlings.

Description

Banksia verticillata develops into a dense, spreading shrub (rarely a small tree) when mature, usually up to 3m high but occasionally up to 5m high in more sheltered habitats. It may also be prostrate in coastal sites exposed to strong winds. Its trunk is short and stout and has grey, fissured bark. The narrow leaves, which are blunt-ended, narrow, 3–9cm long and 7–12mm wide, are arranged in whorls and have downward curving margins with no incisions or teeth. They are green and hairless above, with white matted hairs beneath. The inflorescences are pale golden, up to 20cm long, and the ends of branches are surrounded by a whorl of branchlets (Brown *et al*. 1998).

Banksia verticillata is distinguished from other *Banksia* species by its smooth-edged, whorled leaves that are green above and conspicuously matted with white hairs below. It is related to *B. littoralis* but that species has a tree habit, longer serrate leaves and a floral whorl that is hairier inside. *Banksia verticillata* also begins flowering one to two months earlier than *B. littoralis* (Brown *et al*. 1998; George 1981).

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. (1981) The genus *Banksia* L.f. (Proteaceae). *Nuytsia* 3(3): 239–474; Western Australian Herbarium (1998–) *FloraBase—the Western Australian Flora*. Department of Parks and Wildlife. https://florabase.dpaw.wa.gov.au/.

Distribution and habitat

Banksia verticillata is found on the south coast of Western Australia with two disjunct population areas – one near Walpole and the other in the Albany area. In the Albany area it is found at Cheyne Beach/Mount Manypeaks, Gull Rock and Torndirrup. In the Walpole area it is found at Nuyts Wilderness, Poison Hill and the Woolbales. The coastal vegetation corridor that links populations is intact (Barrett and Liddelow 2014).

Banksia verticillata is believed to be the only *Banksia* species restricted to exposed granite outcrops (George 1981). It grows in a shallow sandy loam in fissures on rocks and in deeper soils on the edges of rocks. All but two populations are within two kilometres of the coast. The annual rainfall in its distribution area is estimated to be 800 to 1000mm (Barrett and Liddelow 2014).

In the Walpole area, associated species include *Andersonia sprengelioides*, *Chamelaucium* sp. Walpole (P.G. Wilson 6318), *Eutaxia myrtifolia*, *Gastrolobium bilobum*, *Stypandra glauca*, *Taxandria marginata*, and *Verticordia plumosa* var. *plumosa*. *Banksia seminuda* can also occur near or with *B. verticillata* on deeper soils around outcrops (Barrett and Liddelow 2014).

In the Albany area associated species include *Andersonia sprengelioides*, *Anthocercis viscosa*, *Banksia formosa*, *Borya nitida*, *Chamaescilla corymbosa*, *Dodonaea ceratocarpa*, *Eutaxia myrtifolia*, *Hakea elliptica*, *Lepidosperma angustatum*, *Platysace compressa*, *Stypandra glauca* and *Taxandria marginata* (Barrett and Liddelow 2014).

Table 1. Summary of population land vesting, purpose and manager

TPFL population number & location	DPaW district	Shire	Vesting	Purpose	Manager
1. Mt Manypeaks	Albany	Albany	Not vested	Water	Parks and Wildlife
2. Mt Manypeaks	Albany	Albany	Not vested	Water	Parks and Wildlife
3a. Stony Hill	Albany	Albany	CPC	National park	Parks and Wildlife
3b. Stony Hill	Albany	Albany	CPC	National park	Parks and Wildlife
3c. Stony Hill	Albany	Albany	CPC	National park	Parks and Wildlife
4a. Bald Head	Albany	Albany	CPC	National park	Parks and Wildlife
4b. Bald Head	Albany	Albany	CPC	National park	Parks and Wildlife
4c. Bald Head	Albany	Albany	CPC	National park	Parks and Wildlife
5a. Two Peoples Bay	Albany	Albany	CPC	CFF	Parks and Wildlife
5b. Two Peoples Bay	Albany	Albany	CPC	CFF	Parks and Wildlife
5c. Two Peoples Bay	Albany	Albany	CPC	CFF	Parks and Wildlife
5d. Two Peoples Bay	Albany	Albany	CPC	CFF	Parks and Wildlife
6a. Mt Hopkins	Frankland	Manjimup	CPC	National park	Parks and Wildlife
6b. E Mt Hopkins	Frankland	Manjimup	CPC	National park	Parks and Wildlife
6c. E Mt Hopkins	Frankland	Manjimup	CPC	National park	Parks and Wildlife
6d. E Mt Hopkins	Frankland	Manjimup	CPC	National park	Parks and Wildlife
7. NNW Mermaid Point	Albany	Albany	CPC	National park	Parks and Wildlife
8. NNE Mermaid Point	Albany	Albany	CPC	National park	Parks and Wildlife
9a. NE The Gap	Albany	Albany	CPC	National park	Parks and Wildlife
9b. NE The Gap	Albany	Albany	CPC	National park	Parks and Wildlife
10. Peak Head	Albany	Albany	CPC	National park	Parks and Wildlife
11. NE Normans Beach	Albany	Albany	Not vested	Water	Parks and Wildlife
12. Isthmus Hill	Albany	Albany	CPC	National park	Parks and Wildlife
13a. NE Stony Hill	Albany	Albany	CPC	National park	Parks and Wildlife
13b. NNE Stony Hill	Albany	Albany	CPC	National park	Parks and Wildlife
15. ENE Woolbales Hill	Frankland	Manjimup	CPC	National park	Parks and Wildlife
16. Mt Manypeaks	Albany	Albany	Not vested	Water	Parks and Wildlife
17. Mt Manypeaks	Albany	Albany	Not vested	Water	Parks and Wildlife
18. N Mermaid Point	Albany	Albany	CPC	National park	Parks and Wildlife

19. NW Jimmy Newells Harbour	Albany	Albany	CPC	National park	Parks and Wildlife
23.Waychinicup NP	Albany	Albany	CPC	National park	Parks and Wildlife
24. Torndirrup NP	Albany	Albany	CPC	National park	Parks and Wildlife
25a. Torndirrup NP	Albany	Albany	CPC	National park	Parks and Wildlife
25b. Torndirrup NP	Albany	Albany	CPC	National park	Parks and Wildlife
25c. Torndirrup NP	Albany	Albany	CPC	National park	Parks and Wildlife
25d. Torndirrup NP	Albany	Albany	CPC	National park	Parks and Wildlife
26. Poison Hill, Walpole-Nornalup NP	Frankland	Manjimup	CPC	National park	Parks and Wildlife
27. Herald Point	Albany	Albany	CPC	National park	Parks and Wildlife
29. NW of Channel Point	Albany	Albany	CPC	National Park	Parks and Wildlife
30. Waychinicup NP	Albany	Albany	CPC	National park	Parks and Wildlife
31. Mermaid Point	Albany	Albany	CPC	National park	Parks and Wildlife
32. Ben Dearg Point	Albany	Albany	CPC	National park	Parks and Wildlife
33. Ben Dearg Point	Albany	Albany	CPC	National park	Parks and Wildlife
34. D'Entrecasteaux NP	Frankland	Manjimup	CPC	National park	Parks and Wildlife
35. Point Nuyts, D'Entrecasteaux NP	Frankland	Manjimup	CPC	National park	Parks and Wildlife
36. Two Peoples Bay	Albany	Albany	Private property		Landowners

Biology and ecology

Banksia verticillata flowers between January and April (George 1981; Kelly and Coates 1995). The flowers often open in an irregular order or with opening commencing at the base of the inflorescence (Rees and Collins 1994). The major bird pollinator of *B. verticillata* was reported by Rees and Collins (1994) to be the New Holland Honeyeater (*Phylidonyris novaehollandiae*) with White Cheeked Honeyeater (*Phylidonyris nigra*), Western Spinebill (*Acanthorhyncus superciliosus*) and Honey Bee (*Apis mellifera*) being less frequent visitors. The pollinators rely on associated plant species, such as *Adenanthos sericeus* for food and shelter and changes to habitat composition and structure may reduce pollinator numbers and diversity (Kelly and Coates 1995). Honeyeaters have been observed moving up to 15m between inflorescences on different plants but most movements occurred between inflorescences on the same plant. New Holland Honeyeaters are considered to be transients, suggesting long distance pollen dispersal between neighboring populations is possible. Although small mammals were found to carry *B. verticillata* pollen, they are not believed to be significant pollinators (Kelly and Coates 1995; Rees and Collins 1994).

Numbers of flowers and fruit were found to be correlated with plant size with high levels of fruiting success (38 to 43% of inflorescences forming infructescences) recorded at sites containing larger plants (Rees and Collins 1994). Between eight and 11% of flowers developed into follicles, higher than for many related *Banksia* species. Follicles are concentrated in the middle third of the inflorescence (Kelly and Coates 1995). Each follicle produces two seeds, with one seed always aborted. Few plants set seed in their first year of flowering (Monks 1994).

Seed viability varies between 4% and 22%, and may be determined by local habitat conditions, disease, population size, levels of inbreeding and pollinator numbers and behaviour (Monks 1994). As plants age, their ability to produce viable seed decreases, as shown in older populations which produce lower percentages of viable seed (Monks 1994). Rees and Collins (1994) recorded a comparable seed viability of 20%. Of the 80% of non-viable seed produced, 17% was damaged by insects, 2% was diseased/decayed, 58% aborted, and 2% firm but non-viable. A high abortion rate (30 to 40%) was also recorded at five out of six populations by Monks (1994).

Population recruitment in *Banksia verticillata* is usually episodic, most likely corresponding to last fire, but interfire recruitment may occur as a result of drought and cone aging, where seeds may be released in the absence of fire (Monks 1994). Recruitment has also been observed at Gull Rock (Population 33) after seed has been released following mass plant death due to aerial canker (S. Barrett pers. comm.). The juvenile period is generally 13 to 17 years and is longer than most other *Banksia* species (Monks 1994). However, primary juvenile periods of eight to 10 years have been observed at Population 3 after a fire in 1998 (S. Barrett pers. comm.).

The natural life span of *Banksia verticillata* is unknown but the species is likely to be long lived given its extended juvenile period. The mean age of live and dead plants within a population did not differ significantly suggesting that premature death is common (Monks 1994). Natural deaths may occur following the blowing over and uprooting of plants in its exposed habitat (Monks 1994).

Banksia verticillata is a non-resprouter with plants killed by fire and regenerating from seed. With such a long juvenile period, it can take more than 20 years for plants to become mature enough to build adequate seed banks for population replacement. The granite outcrops provide some protection against fire with plants that occur on rock margins 2.7 times more likely to be completely burnt by fire than plants that occur on the rock itself. The location within granite outcrops may also contribute to seedling survival following fire. Granite fissures providing a significant amount of substrate retains extra moisture enabling survival over dry summers (Liddelow 2010).

Although not essential to seedling recruitment, Monks (1994) observed that burnt cones released twice as many seeds as unburnt cones, and burnt plants were ten times more likely to have seedlings grow under their crown than unburnt plants. An average of 25.2 seedlings may generate per burnt parent plant (Monks 1994). Percentage of closed follicles was found to be low on all individuals regardless of plant health.

Native stem cankers *Luteocirrhus shearii* (formerly *Zythiostroma* sp.) and *Neofusicoccum australe* (Crane and Burgess 2013; Crane *et al*. 2012) are prevalent within *Banksia verticillata* communities. *Luteocirrhus shearii* is particularly pathogenic to both juvenile and adult plants of *B*. *verticillata* with lesion growth rates, which indicate relative susceptibility of the host to the disease, being significantly higher compared to other species of *Banksia* (Crane and Burgess 2013). All populations of *B*. *verticillata* are affected to varying degrees by aerial canker with symptoms ranging from partial canopy/limb decline to plant death. Monitoring of plants at Subpopulation 3a between 2010 and 2014 showed 100% mortality as a result of canker infection. At Gull Rock there was 87% mortality of juveniles between 2010 and 2015 that had recruited after the mass collapse of Population 33 due to aerial canker (S Barrett unpublished data).

Fungicides (Switch and Rubigan) have been shown to have a potential role in limiting aerial canker impacts in a population of *Banksia verticillata*. In field trials conducted at Subpopulation 3a between 2012 and 2013, 100% mortality occurred in the control plants (no fungicide applied), compared to a 0% mortality in 30 plants sprayed with Switch/Rubigan monthly from October to March 2013. Note, however, three sprayed plants died shortly after the trial and a more extensive study with greater replication is required to validate these results and allow for habitat differences (Barrett and Lehmann 2013).

Based on test inoculation with the pathogen, *Banksia verticillata* has been shown to be highly susceptible to *Phytophthora cinnamomi* (Shearer *et al*. 2013). Under laboratory conditions 227 out of 244 plants (93%) died as a result of infection. This has been further confirmed in the field by observations

of mass deaths in Population 24 in recent years (S. Barrett pers. comm; Parks and Wildlife Health and Vegetation Services records). Population 32 was presumed to be extinct due to *P. cinnamomi* with no plants seen since 2007. However, six juveniles were found in 2013. All populations are at risk of infestation.

Conservation status

Banksia verticillata was listed as specially protected under the Western Australian *Wildlife Conservation Act 1950* on 25 September 1987. It is ranked as Critically Endangered (CR) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 criteria A3ce due to a population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations due to changed fire regimes, *Phytophthora cinnamomi* dieback and aerial canker. The species is listed as Vulnerable (VU) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Threats

Major threats to the species include:

- **Phytophthora dieback** (*Phytophthora cinnamomi*). *Banksia verticillata* and its associated habitat are highly susceptible with all populations at risk.
- **Canker** (*Luteocirrhus shearii* and *Neofusicoccum australe*). Aerial canker is having a significant impact on most populations.
- **Recreational activities.** Four Wheel Drive vehicles (Populations 18, 32, 33) and walkers (3, 4, 6a, 10, 12, 15) are a threat to populations due to direct habitat damage and the potential introduction and spread of *Phytophthora* dieback. A sign placed at the site of Population 33 to discourage entry has been removed and a 4WD has traversed the population causing considerable damage to adjacent vegetation. The habitat of Subpopulation 6a contains a walk trail. Population 15 is directly opposite a section of the Bibbulmun track and occurs on a granite hill that would attract people to climb.
- **Altered fire regimes**. Infrequent fires may be required to stimulate seed release from cones. However, given the long juvenile period of the species, seedlings may not be sufficiently mature to release seed following fires that occur in quick succession.
- **Senescence.** Populations 1, 17, 29 and 35 are long unburnt and comprise very old plants. In these areas little to no inter-fire regeneration has occurred.
- **Drought.** Most plants are on skeletal soils and drought is likely to affect plant establishment and survival.

Minor threats to the species include:

- ***Armillaria luteobubulina***. This fungal pathogen has caused plant death in Population 10 and all populations are at risk of infestation. However, it is considered a relatively minor threat at present.
- **Grazing.** Herbivore grazing appears to be a minor threat to plants.

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

Table 2. Summary of population information and threats

TPFL population number & location	Land status	Year/no. mature plants	Condition		Threats
			Plants	Habitat	
1. Mt Manypeaks	Water reserve	1979 1 1989 1 2013 1	Moderate		Disease (canker), fire, senescence
2. Mt Manypeaks	Water reserve	1985 5 1989 1 2007 0			Presumed extinct
3a. Stony Hill	National park	1985 300 1988 30 1992 50 2012 500 (100) [50] 2014 350 (20) [100]	Poor	Very good	Disease (canker), fire (burnt 15/11/2015), recreational activities
3b. Stony Hill	National park	1985 75 1998 60 [240] 2002 138 (107) [173] 2007 145 (151)	Moderate		Disease (canker), fire (burnt 15/11/2015)
3c. Stony Hill	National park	1998 60 [240] 2002 68 (435) [235] 2007 316 (423)	Moderate		Disease (canker), fire (burnt 15/11/2015)
4a. Bald Head	National park	1985 75 1989 20 1993 40 2000 60 (5) 2009 9	Poor	Good	Disease (canker), fire, recreational activities
4b. Bald Head	National park	1993 20 2000 10 (5) 2009 11 (1)	Moderate	Good	Disease (canker), fire, recreational activities
4c. Bald Head	National park	2009 50	Moderate	Good	Disease (canker), fire, recreational activities
5a. Two Peoples Bay	Nature reserve	1988 4 1993 0 1996 0			Presumed extinct
5b. Two Peoples Bay	Nature reserve	1988 4 1996 1 2008 0			Presumed extinct
5c. Two Peoples Bay	Nature reserve	1988 1 1993 0 1996 0			Presumed extinct
5d. Two Peoples Bay	Nature reserve	1985 0 1994 0			Presumed extinct
6a. Mt Hopkins	National park	1984 300 2003 (10,000+) 2007 30 (10,000) 2015 100+	Healthy	Excellent	Disease (Pc), fire (burnt 2001), recreational activities
6b. E Mt Hopkins	National Park	2010 40 (150)	Moderate	Very good	Disease (Pc, canker), fire
6c. E Mt Hopkins	National park	2002 20 (100) [20] 2005 20 (34) [48] 2010 53 (34) [25]	Moderate	Very good	Disease (canker type?, Pc), fire
6d. E Mt Hopkins	National park	2011 74 (16)	Healthy	Excellent	Disease (canker, Pc), fire
7. NNW Mermaid Point	National park	1985 5 1993 15 2006 44 (1)	Moderate	Very good	Disease (canker), fire
8. NNE Mermaid Point	National park	1985 150 1993 15 1999 20 [1]	Moderate		Disease (canker), fire
9a. NE The Gap	National park	1986 30 2007 0			Presumed extinct
9b. NE The Gap	National park	1985 5 2007 0			Presumed extinct

10. Peak Head	National park	1985 150 1986 75 2005 200 [10] 2009 151 [15] 2015 70 (3)	Moderate	Very good	Disease (canker), fire (burnt 15/11/2015), recreational activities
11. NE Normans Beach	Water reserve	1984 5 1994 0			Presumed extinct
12. Isthmus Hill	National park	1985 30 1992 20 2000 70 [5] 2009 130 2010 180	Moderate	Excellent	Disease (canker), fire, recreational activities
13a. NE Stony Hill	National park	1987 200 1998 160 [240] 2007 370 (885) 2016 120 (30)	Moderate		Disease (canker), fire
13b. NNE Stony Hill	National park	1998 8 2000 5 (1,000) [800] 2007 332 (230) 2009 204 2016 90 (10)	Poor		Disease (canker), fire (burnt 16/11/2015)
15. ENE Woolbales Hill	National park	1989 200 (200) [200] 2005 150 [112] 2013 74 (48) [163] 2014 91 (76) 2015 44 (23) [~100]	Poor	Excellent	Disease, fire (burnt 2005, 2015), recreational activities
16. Mt Manypeaks	Water reserve	1979 [7] 1998 2 2007 0 [1]	Poor		Presumed extinct (burnt 2005)
17. Mt Manypeaks	Water reserve	1979 1 [11] 2013 3	Poor		Disease (canker), fire, senescence
18. N Mermaid Point	National park	1985 150 1992 2,000 2013 1,500 (20) 2014 1,000 2015 700	Poor	Excellent	Disease (canker), fire, recreational users (4WD)
19. NW Jimmy Newells Harbour	National park	1987 25 1992 128 (2) [10] 2000 130 [5] 2005 120 [60] 2013 90 (60) [75] 2015 45 (15)	Poor		Disease (canker), fire (burnt 17/11/2015, partly burnt 2005)
23.Waychinicup NP	National park	1991 50 (50) 1995 10 [50] 2007 4 [50] 2008 4	Moderate		Disease (canker), fire (burnt 2007)
24. Torndirrup NP	National park	1987 100 1997 165 2006 500 (13) [40] 2011 140 [2] 2012 80 (7) [140]	Moderate	Excellent	Disease (Pc, canker), fire (burnt 2010)
25a. Torndirrup NP	National park	1987 6 1997 70 2007 61 (122) 2014 116 (39)	Moderate		Disease (canker), fire (burnt 1997)
25b. Torndirrup NP	National park	1987 6 1997 480 [320] 2002 99 (919) [678] 2007 632 (1,222) 2011 181 [10] 2012 177 [1] 2014 2,000 (750)	Moderate		Disease (canker), fire (burnt 1998)
25c. Torndirrup NP	National park	1997 250 2000 250 (1,000) 2006 350 (17) 2007 532 (648) 2014 560	Moderate		Disease (canker), fire

25d. Torndirrup NP	National park	2011	35 (6)	Moderate		Disease (canker), fire (burnt 1998)
26. Poison Hill, Walpole-Nornalup NP	National park	1987 1997 2007 2009 2012	50 2,000 (500) 400 (500) [100] 200 (690) [257] 500 (550) [168]	Moderate	Excellent	Disease (Pc, canker), fire (burnt 2005)
27. Herald Point	National park	1992 1993 1995	3 [3] 4 [4] 0 [4]			Presumed extinct
29. NW of Channel Point	National park	1992 1993 1994 2006 2015	75 [9] 75 [9] 108 [6] 65 [2] 50	Moderate		Disease (canker), fire, senescence
30. Waychinicup NP	National park	1993 2006 2008 2013 2015	187 130 [10] 200 (2) 200 100	Poor	Excellent	Disease (canker), fire (burnt 1998)
31. Mermaid Point	National park	1993 2000 2012 2014 2015	133 130 [5] 115 (5) [1] 6 (1) [115] (6,500)	Moderate	Excellent	Disease (canker), fire (burnt 11/2014)
32. Ben Dearg Point	National park	1995 1999 2006 2007 2013	8 [5] 7 [1] 2 [5] 0 (6)	Moderate		Recreational users (4WD), disease (Pc), fire (burnt 1989)
33. Ben Dearg Point	National park	1995 2003 2005 2013 2015	300 75 [25] 58 (32) [150] 0 (25) [10] (10)	Poor	Good	Recreational users (4WD), disease (canker), fire
34. D'Entrecasteaux NP	National park	1996 2007 2016	1 2 2	Healthy		Disease, fire (burnt 2005)
35. Point Nuyts, D'Entrecasteaux NP	National park	1997 2005 2013	1,200 [150] 20 [2] 150 (1)	Moderate	Pristine	Disease (canker), fire, senescence
36. Two Peoples Bay	Private property	2008	0			Presumed extinct

Note: Extant populations with 20 or more plants are considered to be important populations. ( ) = number of seedlings. [ ] = number dead. Populations 14, 20 and 21 are no longer listed as they are now thought to represent another species of *Banksia*. Population 22 was combined with Population 17. Population 28 is no longer listed as it is now considered to represent another population. Population 37 was re-determined as Subpopulations 6c and 6d.

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 verticillata* may require assessment.

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

- Damage or destruction of occupied or potential habitat
- Changed fire regimes
- Reduction of pollinator habitat
- Alteration of the local surface hydrology or drainage

- Reduction in population size
- A major increase in disturbance in the vicinity of a population and
- Spread or amplification of disease.

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

Banksia verticillata is listed as Threatened in Western Australia and it is considered that all known habitat for wild populations is critical to the survival of the species, and all wild populations are important populations. Habitat critical to the survival of *B. verticillata* includes the area of occupancy of populations and areas of similar habitat surrounding and linking populations (these providing potential habitat for population expansion and for pollinators). It may also include 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 verticillata* will also benefit the Threatened and Priority flora listed in the table below.

Table 3. Conservation-listed flora species occurring within 500m of *Banksia verticillata*

Species name	Conservation status (WA)	Conservation status (EPBC Act 1999)
Asplenium obtusatum subsp. *northlandicum*	DRF (VU)	-
Daviesia ovata	DRF (CR)	-
Isopogon uncinatus	DRF (CR)	EN
Kennedia glabrata	DRF (VU)	VU
Myriophyllum trifidum	DRF (VU)	-
Reedia spathacea	DRF (EN)	CR
Sphenotoma drummondii	DRF (EN)	EN
Agrostocrinum scabrum subsp. *littorale*	Priority 2	-
Chamaexeros longicaulis	Priority 2	-
Chamelaucium sp. Nornalup (N.G. Marchant 76/125)	Priority 2	-
Leucopogon cymbiformis	Priority 2	-
Scaevola xanthina	Priority 2	-
Stylidium articulatum	Priority 2	-
Stylidium corymbosum var. *proliferum*	Priority 2	-
Stylidium keigheryi	Priority 2	-
Stylidium oreophilum	Priority 2	-
Andersonia setifolia	Priority 3	-
Calectasia obtusa	Priority 3	-
Chamelaucium sp. Walpole (P.G. Wilson 6318)	Priority 3	-
Leucopogon altissimus	Priority 3	-
Pultenaea pinifolia	Priority 3	-
Sphenotoma sp. Stirling Range (P.G. Wilson 4235)	Priority 3	-
Synaphea preissii	Priority 3	-
Adenanthos x *cunninghamii*	Priority 4	-
Banksia serra	Priority 4	-
Eucalyptus x *missilis*	Priority 4	-
Gahnia sclerioides	Priority 4	-

Laxmannia jamesii	Priority 4	-
Marianthus granulatus	Priority 4	-
Muiriantha hassellii	Priority 4	-
Pleurophascum occidentale	Priority 4	-
Pomaderris grandis	Priority 4	-
Spyridium spadiceum	Priority 4	-
Thomasia solanacea	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

Banksia verticillata occurs within the boundary and/or buffer area of the three Priority Ecological Communities (PECs) listed in the table below.

Table 4. PECs containing populations of *Banksia verticillata* within 1km of their boundary.

PEC title	*Banksia verticillata* population	Conservation status (WA)	Conservation status (EPBC Act)
Melaleuca striata/Banksia spp. Coastal Heath	27, 32, 33	Priority 1	-
Reedia spathacea - Empodisma gracillimum - Schoenus multiglumis dominated peat paluslopes and sandy mud floodplains of the Warren Biogeographical Region.	15	Priority 1	-
Banksia coccinea Shrubland/*Eucalyptus staeri*/Sheoak Open Woodland (Community 14a - Sandiford & Barrett 2010)	11	Priority 1	-

For a description of PEC categories see DEC (2010).

Banksia verticillata benefits from the conservation of habitat for five threatened bird species; Noisy Scrub-bird, Western Bristlebird, Western Whipbird, Carnaby's Cockatoo and Baudin's Cockatoo and three threatened mammal species; Western Ringtail Possum, Quokka and Dibbler.

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 (UNEP-WCMC) Convention on International Trade in Endangered Species (CITES), 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 no registered Aboriginal sites adjacent to populations of *Banksia verticillata* and input and involvement has been sought through the South West Aboriginal Land and Sea Council (SWALSC) and DAA to determine if there are any issues or interests with respect to management for this species. Indigenous opportunity for future involvement of Aboriginal people 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 this species occurs.

Social and economic impacts

Although the majority of populations of *Banksia verticillata* are on land managed by 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 aerial canker or *Phytophthora* dieback).

Affected interests

The implementation of this plan has implications for Parks and Wildlife which has primary management responsibility for most populations.

Evaluation of the plan's performance

Parks and Wildlife, with assistance from the Albany District Threatened Flora and Communities Recovery Team (ADTFCRT) and Warren Region Threatened Flora Recovery Team (WRTFRT), 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 important extant populations to ensure the long-term conservation of the species in the wild.

Recovery criteria

Recovery will be considered successful if one or more of the following take place over the term of the plan.

- There is no reduction in the extent of occurrence and the number of mature plants within known populations has remained within a 10% range or has increased by >10% from 5531 to 6084 or more or
- New populations have been found, increasing the number of known populations from 30 to 31 or more with no net loss of mature plants or
- The area of occupancy has increased by >10% with no net loss of mature plants.

Recovery will be considered unsuccessful if one or more of the following take place over the term of the plan.

- Populations have been lost which result in a reduction in the extent of occurrence or
- The number of mature plants has decreased by >10% from 5531 to 4978 or less or
- The area of occupancy has decreased by >10%, with a net loss of mature plants.

3. Recovery actions

Existing recovery actions

Parks and Wildlife with assistance from the ADTFCRT and WRTFRT are overseeing the implementation of recovery actions for *Banksia verticillata*.

Land managers have been made aware of *Banksia verticillata* and its locations. Notifications detail the current threatened status of the species, the associated legal obligations in regards to its protection and contact details for management assistance.

Banksia verticillata has been thoroughly surveyed for in areas of granite on the south coast. Known populations (with the exception of Mt Manypeaks) are visited on a rotation basis of approximately one to five years dependant on known threats and specific monitoring projects.

Monitoring has been carried out both systematically and opportunistically, with micro-habitat, plant numbers, recruitment, reproductive status, size, health and current threats recorded. Global Positioning System (GPS) locations of plants within the population have been recorded in Geographic Information System databases at Albany and Frankland Districts, and at Species and Communities Branch (SCB). More systematic monitoring has been undertaken of populations on Torndirrup National Park after fires in 1998 and 2015 recording plant locations, size, reproductive status, seed banks and habitat; several of these surveys have been undertaken in conjunction with UWA students as part of their studies. The impact of aerial canker was monitored in Populations 3, 15, 18, 24 and 31 over three years as part of a research project undertaken in conjunction with Parks and Wildlife Science and Conservation Division.

Pre-burn monitoring was undertaken at Subpopulation 6b in 2011 to determine the reproductive status of *Banksia verticillata* following a wildfire in 2001. Two groups were compared, these consisting of plants that survived the 2001 fire and plants that germinated post wildfire. The pre-fire plants were found to be in moderate health with many affected by aerial canker and branch death. Post-fire plants were healthier and more abundant. However, almost half of these had not reached flowering stage and only 28% had fruit. It would be expected to be at least another three to four years before significant cone production occurs. It was therefore considered that a further burn would be detrimental to this subpopulation and that it should be excluded from a proposed control burn (Liddelow 2011).

A seeding project aimed at supplementing natural regeneration was undertaken at Population 15 in 2006. Some 732 seed sourced from individuals within the population were broadcast prior to burning. Monitoring showed low germination rates and poor survival with only 26 seedlings seen in the plot areas in 2007 and five seedlings in 2009. The focus of the study changed from natural post fire regeneration to identifying successful recruiting areas and determining defining factors of success. Age composition, general health, seedling survival over summer and percentage of closed follicles on adult plants were measured. Surviving seedlings were limited to four specific areas indicating location has the potential to provide quantifiable factors of where seedlings are unlikely to survive. Furthermore, the low percentage of germination and survival of manually seeded sites correlated to site selection. Percentage of closed follicles was found to be low on all individuals, regardless of plant health. Fire in this population after one to two years of negligible flowering would potentially result in minimal amount of available seed for regeneration (Liddelow 2010).

Aerial canker impact (percentage of plant canopy affected by canker) has been monitored in five populations over three years with temperature and humidity recorded and the fungi sampled at these sites. A trial to investigate the effectiveness of foliar fungicide application on the control of aerial canker (*Luteocirrhus shearii* and *Neofusicoccum australe*) was conducted between October 2012 and April 2013 (Barrett and Lehmann 2013). Thirty individuals were randomly selected across Population 3. Canker symptoms were assessed pre and post fungicide (Switch and Rubigan) application. Control plants deteriorated with a mean decrease in canopy cover affected by aerial canker of 20%. Three plants died while five had approximately 95% of their canopy affected. Sprayed plants showed no deterioration in mean canopy health. However, the health of three individuals had declined considerably scoring 95% canopy cover affected by canker. A repeat trial with greater replication across habitat types was recommended (Barrett and Lehmann 2013).

Disease hygiene measures have been implemented including a boot cleaning and interpretation station being set up at Populations 3, 4 and 10 to reduce the spread/introduction of *Phytophthora* dieback into the area from walkers.

Geocaching Australia was recently contacted by staff from Parks and Wildlife Frankland District to ensure information on the threat of *Phytophthora* dieback and appropriate hygiene instructions was added to the Geocache description for the site containing Subpopulation 6a. Boot cleaning stations, as well as a sign has also been installed at the site to further emphasise the need for hygiene.

Approximately 87,000 seed collected from populations of *Banksia verticillata* is currently stored at the Threatened Flora Seed Centre (TFSC) at –20°C (see table 5). The effect of temperature on germination has been researched and the results suggest that *B. verticillata* has a relatively wide temperature window for germination (Cochrane and Schreck 2009; Cochrane 2016).

Table 5. TFSC seed collection details for *Banksia verticillata*

Accession number	Date collected	TPFL population number	Number of plants collected (B: Bulk, I:Individual)	Quantity in storage (seed)	Estimated germinable seed
00022 Base 1	30/6/1987	26	I/9	397	380
00023 Base 1	10/05/1986	3	I/13	445	415
00032 Base 1	12/12/1992	3	I/10	6,840	
00032 Base 2	12/12/1992	3	B/10	300	192
00044 Base 1	19/08/1992	19	B/6	542	
00055 Base 1	4/04/1993	29	I/25	4,904	
00055 Base 2	4/04/1993	29	B/25	918	845
00056 Base 1	6/04/1993	3a	I/15	2,877	
00056 Base 2	6/04/1993	3a	B/15	60	22
00057 Base 1	7/04/1993	15	I/25	2,320	
00057 Base 2	7/04/1993	15	B/25	508	366
00078 Base 1	23/08/1993	8	I/8	3,532	
00078 Base 2	23/08/1993	8	B/8	200	200
00079 Base 1	23/08/1993	30	I/16	3,579	
00079 Base 2	23/08/1993	30	B/16	800	750
00120 Base 1	9/01/1994	31	I/13	3,244	
00120 Base 2	9/01/1994	31	B/13	200	196
00138 Base 1	20/04/1994	3a	I/13	3,547	
00138 Base 2	20/04/1994	3a	B/13	447	429
00161 Base 1	30/06/1987	6	I/19	730	438
00169 Base 1	28/08/1994	12	I/13	3,406	
00169 Base 2	28/08/1994	12	B/13	225	222
00231 Base 1	26/04/1995	23	B/6	120	110

00231 Base 2	26/04/1995	23	I/6	2,291	2,211
00233 Base 1	28/04/1995	33	I/12	4,127	
00233 Base 2	28/04/1995	33	B/12	150	150
00731 Base 1	31/12/2000	4	I/21	4,259	3,173
00807 Base 1	19/03/2001	6	B/15	1,625	1,188
01569 Base 1	29/11/2004	15	I/34	4,142	1,254
01941 Base 1	27/01/2006	33	I/28	7,732	
01942 Base 1	27/01/2006	32	I/5	674	
01955 Base 1	1/02/2006	30	I/28	not yet processed	
01966 Base 1	10/02/2006	8	I/50	10,564	
01967 Base 1	13/02/2006	24	I/37	3,180	2,970
02414 Base 1	11/09/2007	1	I/1	206	139
02415 Base 1	10/09/2007	32	B/3	346	340
02417 Base 1	10/09/2007	33	B/50	4,183	4,153
02995 Base 1	30/05/2008	24	B/50	2,890	
03191 Base 1	8/05/2009	6	I/6	242	
03360 Base 1		5	I/1	443	
03391 Base 1	27/09/1994	17	I/6	413	
05856 Base 1	11/12/2015	10	I/48	not yet processed	

Botanic Gardens and Parks Authority (BGPA) have 9.92g of *Banksia verticillata* seed in storage (accession 20140701, 19780179, 19870154). Germination testing of accession 19870154 was undertaken which resulted in 60% and 90% success.

Future recovery actions

The following recovery actions are listed in approximate 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. Where these 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.

1. Coordinate recovery actions

Parks and Wildlife with assistance from the ADTFCRT and WRTFRT will oversee the implementation of recovery actions for *Banksia verticillata* and will include information on progress in annual reports.

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

2. Monitor populations

Monitoring of populations and habitat should be undertaken to identify trends or potential management requirements. Population monitoring should record the health and expansion or decline in the population, and other observations such as pollinator activity or seed production. Site monitoring should include observations of disease, grazing, habitat degradation including weed invasion, and hydrological status (drought). Specific monitoring of hydrology and activities relating to research into the biology and ecology of *B. verticillata* are included in other recovery actions detailed below.

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

3. Apply phosphite to *Phytophthora* dieback infected habitat

Where funding permits, Parks and Wildlife will apply phosphite to the *Phytophthora* dieback infected habitat of *Banksia verticillata* populations 6, 24, 26 and 32.

Action:	Apply phosphite to *Phytophthora* dieback infected habitat
Responsibility:	Parks and Wildlife (Albany and Frankland Districts)
Cost:	To be determined

4. Undertake fungicide trials for aerial canker control

Trials undertaken in 2012 and 2013 have shown fungicide application (Switch and Rubigan) may limit aerial canker impacts on *Banksia verticillata* (Barrett and Lehmann 2013). More extensive trials are required to validate these results.

Action:	Undertake further fungicide trials for aerial canker control
Responsibility:	Parks and Wildlife (Science and Conservation Division; Albany District)
Cost:	$10,000 per year

5. Maintain hygiene measures to protect populations from *Phytophthora* dieback

To protect populations of *Banksia verticillata* from dieback disease, hygiene measures (as outlined in Department of Parks and Wildlife 2014) will be followed during installation and maintenance of firebreaks and when walking into populations in wet soil conditions. Boot cleaning stations and purpose-built signs advising of the dieback risk and high conservation values of the sites will be installed if required.

Action:	Maintain hygiene measures to protect populations from *Phytophthora* dieback
Responsibility:	Parks and Wildlife (Albany and Frankland Districts)
Cost:	$4,000 per year

6. Develop and implement a fire management strategy

A fire management strategy which includes recommendations on fire frequency, intensity and seasonality, precautions to prevent bushfire and strategies for responding to bushfire, and the need, method of construction and maintenance of firebreaks will be developed in consultation with land managers and implemented if necessary. Fire management will take into account the fire sensitivity of the species and its long juvenile period. Bush fires will be prevented from occurring in the habitat of *B. verticillata*, in particular regenerating populations, where possible.

All data relating to fire response of the species will be entered into the Threatened Priority Flora (TPFL) fire response database.

Action:	Develop and implement a fire management strategy
Responsibility:	Parks and Wildlife (Albany and Frankland Districts)
Cost:	$10,000 in year 1, and $6,000 in years 2–5

7. Restrict access into the habitat of populations

The destruction of habitat by 4WD vehicles and walkers and the potential spread of *Phytophthora* dieback are a threat to Populations 3, 4, 10, 12, 15, 18, 32 and 33 and Subpopulation 6a. Access to the these areas may need to be restricted through track closures, brushing of vegetation across closed tracks, the installation of signs and barriers such as bollards.

Action:	Restrict access into the habitat of populations
Responsibility:	Parks and Wildlife (Albany and Frankland Districts)
Cost:	$5,000 per year

8. Collect and store seed

To guard against the extinction of natural populations of *Banksia verticillata* it is recommended that seed be collected and stored at the Parks and Wildlife TFSC. Collections should aim to sample and preserve the maximum range of genetic diversity possible by collecting from the widest range of reproductive plants.

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

9. Develop and implement translocations

Translocations may be required for the long term conservation of *Banksia verticillata* if natural populations continue to decline.

Information on the translocation of threatened plants and animals in the wild is provided in Parks and Wildlife Corporate Policy Statement No. 35 (DPaW 2015*a*), Parks and Wildlife Corporate Guideline No. 36 (DPaW 2015*c*) and the Australian Network for Plant Conservation translocation guidelines (Vallee *et al*. 2004). The 2004 guidelines state that a translocation may be needed when a species is represented

by few populations and the creation of additional self-sustaining, secure populations may decrease its susceptibility to catastrophic events and environmental stochasticity. For small populations which may be declining in size or subject to high levels of inbreeding, successful population enhancement may increase population stability and hence long-term viability.

Depending on the characteristics of the species, Vallee *et al*. (2004) suggest a minimum viable population size estimated between 50 and 2,500 individuals will be required. Suitable translocation sites may include where the taxon occurs, where it was known to have occurred historically and other areas that have similar habitat (soil, associated vegetation type and structure, aspect etc.), within the known range of the taxon (Vallee *et al*. 2004). The potential for a seed orchard on private land may also be investigated.

All translocation proposals require endorsement by the department's Director of Science and Conservation. Monitoring of translocations is essential and will be included in the timetable developed for the Translocation Proposal.

Action:	Develop and implement translocations
Responsibility:	Parks and Wildlife (Science and Conservation Division, Albany and Frankland Districts), BGPA
Cost:	$42,000 in years 1 and 2; and $26,500 in subsequent years as required

10. Obtain biological and ecological information

Research on the biology and ecology of *Banksia verticillata* will include:

1. The effect of microhabitat (aspect, soil moisture and temperature) on seedling recruitment and survival.
2. Response of species to disease, fire-interval, competition, drought and grazing.
3. Longevity of plants, time taken to reach maturity and minimum viable population size.

Action:	Obtain biological and ecological information
Responsibility:	Parks and Wildlife (Science and Conservation Division, Albany and Frankland Districts)
Cost:	$50,000 in years 1–3

11. Undertake surveys

Surveys, restricted to dry soil conditions when the risk of potential spread of disease is lower, should be undertaken for *Banksia verticillata* in areas of potentially suitable habitat that have not been searched before and also in the habitat of populations that are presumed extinct (plants may have recruited from seed). Surveys should be conducted by Parks and Wildlife staff with, where feasible, volunteers from landcare groups, wildflower societies and naturalist clubs. All surveyed areas will be recorded and the presence or absence of the species documented to increase survey efficiency and prevent duplication of effort.

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

12. Liaise with land managers and Aboriginal communities

Parks and Wildlife will liaise with land managers to ensure that populations of *Banksia verticillata* are not accidentaly damaged or destroyed, and habitat is maintained in a suitable condition for the conservation of the species. Consultation with the Aboriginal community will take place to determine if there are any issues or interests in areas that are habitat for the species and opportunities will be provided for Aboriginal people to be involved in implimenting this plan.

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

13. Map habitat critical to the survival of *Banksia verticillata*

Although spatial data relating to habitat critical to the survival of *Banksia verticillata* has been identified in Section 1, it has not been mapped. If additional populations are located, habitat critical to their survival will also be determined and mapped.

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

14. Promote awareness

The importance of biodiversity conservation and the protection of *Banksia verticillata* will be promoted through the print and electronic media and by setting up poster displays. Formal links with local naturalist groups and interested individuals will also be encouraged

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

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

If *Banksia verticillata* is still listed as Threatened at the end of the five-year term of this plan, the plan will be reviewed and the need for further recovery actions assessed.

Action:	Review this plan and assess the need for further recovery actions
Responsibility:	Parks and Wildlife (SCB, Albany and Frankland Districts)
Cost:	$6,000 at the end of year 5

Table 6. Summary of recovery actions

Recovery action	Priority	Responsibility	Completion date
Coordinate recovery actions	High	Parks and Wildlife (Albany and Frankland Districts), with assistance from the ADTFCRT and WRTFRT	Ongoing
Monitor populations	High	Parks and Wildlife (Albany and Frankland Districts), with assistance from the ADTFCRT and WRTFRT	Ongoing
Apply phosphite to *Phytophthora* dieback infected habitat	High	Parks and Wildlife (Albany and Frankland Districts)	Ongoing
Undertake fungicide trials trials for aerial canker control	High	Parks and Wildlife (Science and Conservation Division, Albany District)	2022
Maintain hygiene measures to protect populations from *Phytophthora* dieback	High	Parks and Wildlife (Albany and Frankland Districts)	Ongoing
Develop and implement a fire management strategy	High	Parks and Wildlife (Albany and Frankland Districts)	Developed by 2018, implementation ongoing
Restrict access into the habitat of populations	High	Parks and Wildlife (Albany and Frankland Districts)	2022
Collect and store seed	High	Parks and Wildlife (Albany and Frankland Districts, TFSC)	2022
Develop and implement translocations	High	Parks and Wildlife (Science and Conservation Division, Albany and Frankland Districts), BGPA	2022
Obtain biological and ecological information	High	Parks and Wildlife (Science and Conservation Division, Albany and Frankland Districts)	2020
Undertake surveys	High	Parks and Wildlife (Albany and Frankland Districts), with assistance from the ADTFCRT, WRTFRT and volunteers	Ongoing
Liaise with land managers and Aboriginal communities	High	Parks and Wildlife (Albany and Frankland Districts)	Ongoing
Map habitat critical to the survival of *Banksia verticillata*	Medium	Parks and Wildlife (SCB, Albany and Frankland Districts)	2019
Promote awareness	Medium	Parks and Wildlife (Albany and Frankland Districts, SCB, PICA), with assistance from the ADTFCRT and WRTFRT	2022
Review this plan and assess the need for further recovery actions	Medium	Parks and Wildlife (SCB, Albany and Frankland Districts)	2022

4. Term of plan

This plan will operate from April 2017 to March 2022 but will remain in force until withdrawn or replaced. If *Banksia verticillata* is still listed as Threatened after five years, a review of this plan will be completed, the need for further recovery actions determined and a revised plan prepared if necessary.

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6. Taxonomic description

***Banksia verticillata* R.Br.**

George, A.S. (1981) The genus *Banksia* L.f. (Proteaceae). *Nuytsia* 3(3): 239–474.

Mature plant a shrub (rarely tree) to 5 m with a thick trunk, much-branched above. *Bark* ± 1 cm thick, hard, roughly fissured, grey. *Branchlets* irregularly ribbed when dry, closely pubescent when young with short curled hairs and sparsely hirsute with long hairs, becoming glabrous; a few subulate-terete tomentose brown bracts on lower part, deciduous. *Leaves* whorled, sometimes scattered, the internodes 1–2 cm long; leaves narrowly elliptic to oblong, obtuse, 3–9 cm long, 7–12 mm wide, narrowed to a petiole 5–11 mm long; margins entire, recurved; upper surface when young loosely hirsute becoming glabrous but finely granular, midrib slightly impressed, lateral nerves evident when dry; lower surface densely tomentose with matted, crisped, white hairs, midrib hirsute with long ferruginous hairs becoming glabrous; leaves drying yellow-green. *Inflorescence* terminal to a usually 1 year old branchlet, with several lateral branches immediately below. *Involucral bracts* subulate from broad bases, up to 15 mm long, densely ferruginous-hirsute, persistent. *Axis* 8–20 cm long, 4–5 mm wide, 11–13 mm wide with common bracts; no flowers for 9–17 mm from base and at extreme apex. *Common bracts* narrowly cuneate, 3–4 mm long, densely ferruginous-hirsute; exserted apex thickened to 2.5–3 mm wide, shortly tomentose with curled hairs, apex upturned and somewhat raised. *Floral bracts* similar but smaller. *Flowers* golden yellow throughout; styles pale yellow. *Perianth* 25–30 mm long including limb of 3.5–4 mm, straight but with limb upturned before anthesis; claws 0.5 mm wide above base, tapering upwards, closely pubescent outside, glabrous inside above base but pubescent along upper margins which are involute after anthesis; limb narrowly ovate to oblong, obtuse, thick, densely pubescent with pale-ferruginous straight hairs. *Anthers* elliptic, 1 mm long; filaments short and thick; connective broad, shortly and obtusely produced. *Hypogynous scales* broadly oblong, obtuse or bilobed, sometimes cohering. *Pistil* 30–35 mm long, ± straight but curved through 60–90° below apex; thick, tapering upwards, slightly constricted and ribbed below pollen-presenter, glabrous except sometimes a row of short hairs extending a few mm above ovary; pollen-presenter ovoid, obtuse, 0.4–0.5 mm long; stigmatic groove small, terminal; ovary ± 1 mm long, the apex pubescent with straight ferruginous hairs. *Infructescence* ± oblong, perianths somewhat persistent but finally deciduous; axis 4.5–5 cm diam. including bracts. *Follicles* in plain view narrowly elliptic, 11–15 mm long, 2–3 mm high, 3–4 mm wide; valves semi-circular, ± smooth, tomentose with short, spreading hairs; ridge ± acute; suture fine; opening without fire after several years, the valves recurving; lips ± 2 mm wide, dark brown. *Seed* obovate-cuneate, 18–20 mm long; seed body narrowly cuneate, 10–11 mm long, acute to obtuse at

base, upper margin oblique; outer surface smooth, grey-brown, inner slightly rugose; wing 8–10 mm wide, apex rounded, slightly oblique, dark brown. *Separator* similar to seed in shape and size, dark brown tending to almost black at apex. *Cotyledons* obovate, widely spreading, ± 12 mm long, 7 mm wide, flat, deep green, 3-nerved and faintly reticulate; auricles ± horizontal, obtuse, 1.5 mm long. *Hypocotyl* moderately stout, glabrous, dull red. *Seedling leaves* in opposite pairs, the higher ones verticillate; first two ± 5 mm above cotyledons, oblong, obtuse, sessile, shortly and obtusely dentate in distil half, margins ± flat; next pairs 10–15 mm part, oblong, obtuse, 20–35 mm long, 5–10 mm wide, margins flat, obtusely dentate in distal half, the teeth ± 1 mm long; in all leaves the upper surface hirsute becoming glabrous; lower surface closely white-woolly; nerves obscure. *Seedling stem* sparsely hirsute at base, more densely so above. Leaves of older seedlings similar but often narrowly elliptic, rounded or truncate, up to 7 cm long, 18 mm wide, shortly petiolate; stem closely pubescent with curled hairs and loosely hirsute with straight hairs; entire leaves developing after 2–3 years.