Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Interim Recovery Plan No. **388**

Dwellingup Synaphea (*Synaphea stenoloba*)

Interim Recovery Plan

Department of Biodiversity, Conservation and Attractions, Western Australia

December 2018

List of Acronyms

The following acronyms are used in this plan:

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
DBCA	Department of Biodiversity, Conservation and Attractions
DPLH	Department of Planning, Lands and Heritage
DPaW	Department of Parks and Wildlife
DRF	Declared Rare Flora
EN	Endangered
EPBC	Environment Protection and Biodiversity Conservation
IBRA	Interim Biogeographic Regionalisation for Australia
INRMAG	Indigenous Natural Resource Management Advisory Group
IRP	Interim Recovery Plan
IUCN	International Union for the Conservation of Nature
LGA	Local Government Authority
MRWA	Main Roads WA
NRM	Natural Resource Management
PICA	Public Information and Corporate Affairs
PTA	Public Transport Authority
SCP	Species and Communities Program
SRTFCRT	Swan Region Threatened Flora and Communities Recovery Team
TEC	Threatened Ecological Community
TFSC	Threatened Flora Seed Centre
TPFL	Threatened and Priority Flora database
UNEP-WCMC	United Nations Environment Program World Conservation Monitoring Centre
UWA	University of Western Australia
VU	Vulnerable
WA	Western Australia

Foreword

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Biodiversity, Conservation and Attractions (DBCA) Corporate Policy Statement No. 35 (DPaW 2015*a*) and DBCA 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.

DBCA is committed to ensuring that Threatened Flora (also known as Declared Rare Flora (DRF)) are conserved through the preparation and implementation of Recovery Plans (RPs) or Interim Recovery Plans (IRPs), and by ensuring that conservation action commences as soon as possible.

This plan, which replaces IRP No. 62 Dwellingup Synaphea (*Synaphea stenoloba*) (Evans and English 2000), will operate from December 2018 to December 2023 but will remain in force until withdrawn or replaced. It is intended that, if *Synaphea stenoloba* is still listed as Threatened Flora 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 19 December 2018 and was approved by the Executive Director of Biodiversity and Conservation Science on 19 December 2018. The provision of funds identified in this plan is dependent on budgetary and other constraints affecting DBCA, as well as the need to address other priorities.

Information in this plan was accurate at October 2018.

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Summary

Scientific name:	*Synaphea stenoloba* A.S.George	**NRM region:**	South West Catchment Council
Family:	Proteaceae	**IBRA region:**	Swan Coastal Plain
Common name:	Dwellingup Synaphea	**IBRA subregion:**	Perth SWA02
Flowering period:	August–October	**Recovery team:**	Swan Region Threatened Flora and Communities Recovery Team (SRTFCRT)
DBCA region:	Swan		
DBCA district:	Swan Coastal, Perth Hills		
Shires:	Murray, Waroona		

Distribution and habitat: *Synaphea stenoloba* is endemic to the Pinjarra Plain and occurs on sandy or sandy clay soils on winter wet flats, often in swampy loam in depressions that are occasionally inundated.

Habitat important for the survival of the species, and important subpopulations: *Synaphea stenoloba* is listed as Threatened Flora (Critically Endangered) in Western Australia and it is considered that all known habitat for wild subpopulations that is not in degraded condition is important for the survival of the species, and that all wild subpopulations with extant plants or habitat that is not in degraded condition are important subpopulations. Habitat important for the survival of *S. stenoloba* includes the area of occupancy of subpopulations, areas of similar habitat surrounding and linking subpopulations (these providing potential habitat for subpopulation expansion and for pollinators), additional occurrences of similar habitat that may contain undiscovered subpopulations 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: *Synaphea stenoloba* was listed as specially protected under the WA *Wildlife Conservation Act 1950* on 17 December 1999. It was ranked as Critically Endangered (CR) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 Red List criteria B1ab(iii)+2ab(iii) due to its extent of occurrence estimated to be less than 100 km^2, area of occupancy estimated to be less than 10 km^2, severe fragmentation of subpopulations and a continuing decline in the quality of habitat. The species is listed as Endangered (EN) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Government of Australia 1999).

Threats: The main threats to the species are weeds, road, rail and firebreak maintenance activities, infrastructure maintenance, hydrological changes, future mining operations, grazing and habitat disturbance by rabbits, illegal waste dumping, motorbike riders, heavy vehicle movement, altered fire regimes, insect infestation, clearing, insecure land tenure, poor recruitment, limited seed production, recreational activities and dieback disease.

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. Extensive surveys were undertaken for *Synaphea stenoloba* in 1998 (ALCOA), 2004 (Ryonen Butcher), 2015 and 2016 (DBCA and Mandurah Herbarium).
2. ALCOA completed seed set and propagation trials on *Synaphea stenoloba* prior to the species being listed as Threatened.
3. A genetic study was conducted as an Honours project by Jesse Mahony (UWA in conjunction with BGPA) in 1998.
4. DBCA's TFSC collected 54 *Synaphea stenoloba* fruit from Subpopulation 4 in December 1999 and additional fruit from Subpopulation 5 in January 2009.
5. A study into the *in vitro* conservation of *Synaphea stenoloba* was undertaken as part of a Honours research project by Benjamin Stone (UWA in conjunction with BGPA and ALCOA) in 2005.
6. ALCOA conducted weed control at Subpopulations 1a–d in 2005, 2006 and 2007 using herbicides.

7. The discovery of Subpopulations 10, 13 and 14 in 2005 and 2008, and extension of Subpopulation 6c in 2016 contributed to an increase in the species' extent of occurrence.
8. *Synaphea stenoloba* plants generated from tissue culture were propagated at ALCOA's Marrinup Nursery.
9. ALCOA prepared a Translocation Proposal in 2007 to establish a seed orchard of *Synaphea stenoloba* on ALCOA farmlands.
10. ALCOA planted a three-replicate translocation trial for *Synaphea stenoloba* in winter 2007, and replanted in June 2008.
11. Weed control was undertaken in 2008 by DBCA Swan Coastal District staff at Subpopulations 6 and 10 on conservation reserves.
12. An insect control trial was undertaken in November 2009 at Subpopulation 6a by DBCA Swan Coastal District.
13. Fairbridge Farm staff conducted weed control in 2010 and 2011 at Subpopulations 4a, b and 13.
14. Threatened Flora markers have been installed at Subpopulations 1c, 4a, 4b, 4c, 4d, 5 and 12.
15. The taxonomic status of each Priority and Threatened species of *Synaphea* from the Swan Coastal Plain was investigated by Butcher and Thiele (published in 2014) through morphometric analyses.
16. An onsite meeting was conducted on 3 December 2015 between staff from DBCA and Fairbridge Farm to discuss fire and weed management and site rehabilitation at Subpopulations 4a, 4b and 13.
17. A collection of a scale insect observed to be in large numbers on highly stressed and dead individuals was made in 2016 and identified as a poorly known native species of soft scale, *Coccus synapheae*.
18. A meeting between staff from DBCA Swan Coastal District and the Shire of Murray was held to discuss weed control activities at Subpopulation 6e in October 2016.
19. A Translocation Proposal that aims to restock extinct Subpopulation 2b, using material propagated from clones generated by tissue culture sourced from Subpopulation 1a, was approved in 2018.
20. A 'toolbox' meeting was held by DBCA staff addressing approximately 35 people at the Shire of Murray on 3 May 2017 to inform on-ground staff about management and legislation of Threatened Flora within the Shire.
21. BGPA currently have eighteen clones, consisting of small, whole explants, less than 10 cm in height, maintained in nutrient agar tubes in cool storage incubators.
22. The BGPA nursery currently has three living (potted) specimens of *Synaphea stenoloba* that are approximately six years old.

Plan objective: The objective of this plan is to abate identified threats and maintain or enhance extant subpopulations 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 subpopulations has remained within a 5% range or has increased by >5% from 2,882 to 3,026 or more; or
- New subpopulations have been found, increasing the number of known subpopulations from 12 to 13 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:

- Subpopulations have been lost which results in a reduction in the extent of occurrence; or
- The number of mature plants has decreased >5% to 2,738 or less; or
- The area of occupancy has decreased by >10%.

Recovery actions

1. Coordinate recovery actions
2. Monitor subpopulations
3. Liaise with land managers and Aboriginal communities
4. Undertake weed control
5. Collect and store seed
6. Increase biological and ecological knowledge
7. Install, replace and reposition Threatened Flora markers
8. Install fencing
9. Implement rabbit control
10. Undertake surveys
11. Remove rubbish
12. Install signage
13. Develop and implement a fire management strategy
14. Undertake regeneration trials
15. Maintain disease hygiene
16. Seek protection for subpopulations
17. Develop and implement a Translocation Proposal
18. Continue to promote awareness
19. Map habitat important for the survival of *Synaphea stenoloba*
20. Review this plan and assess the need for further recovery actions

1. Background

Review of Dwellingup Synaphea (*Synaphea stenoloba*) Interim Recovery Plan 2000–2003 (Evans and English 2000)

Following 18 years of implementation, the criterion for success "the number of individuals within subpopulations and/or the number of subpopulations have increased" in the previous Interim Recovery Plan (IRP) has been met. The number of subpopulations has increased from four to 12 subpopulations[3]. The number of mature plants has also increased from 332 to a current 2,882 due to the location of additional subpopulations and extension of a known subpopulation through survey of suitable habitat. However, many subpopulations occur on road and rail reserves where habitat important for the species is highly threatened, in poor condition and not primarily managed for conservation. Plant numbers are declining in these areas. The main recovery actions from the previous plan and their outcomes are listed in Table 1.

Most of the recovery actions included in the previous IRP have been partially implemented (Table 1). *Action 14* 'Develop full Recovery Plan' is redundant as DBCA does not generally produce full Recovery Plans for flora and current Interim Recovery Plans have been extended to five-year terms. Although *Action 6* 'Confirm species status through genetic studies' has commenced, further action is required and it has been incorporated into the action 'Increase biological and ecological knowledge' in the current plan. All ongoing recovery actions included in the previous plan are included in this revised plan. New recovery actions included in this plan are: install fencing; implement rabbit control; remove rubbish; install signage; undertake regeneration trials; maintain disease hygiene; seek protection for subpopulations; map habitat important for survival; and review the plan.

Table 1: Status of the implementation of recovery actions from the previous Interim Recovery Plan

Recovery action	Status	Result
Coordinate recovery actions	Started and ongoing	Recovery actions conducted by the Swan Coastal and Perth Hills Districts' Flora Conservation Officers are coordinated through the relevant DBCA District, with assistance from the Swan Region Threatened Flora and Communities Recovery Team.
Collect seed and cutting material	Started and ongoing	467 plants were generated from tissue culture by Alcoa's Marrinup Nursery and were transported to BGPA in 2013 following the closure of the nursery. Currently less than 100 plants remain and they are all in poor condition. DBCA's TFSC collected 54 *Synaphea stenoloba* fruit from Subpopulation 4 in December 1999 and additional fruit from Subpopulation 5 in January 2009. Although not yet processed, the low numbers of fruit collected suggests that the number of seeds is also likely to be extremely low, if any. The propagules of *Synaphea* species are usually collected as fruits, and it is common for most of those fruits to be empty.
Install DRF markers	Started	Threatened Flora markers are present at Subpopulations 1c, 4a, 4b, 4c, 4d, 5 and 12.
Liaise with relevant land managers	Completed and ongoing	All managers of land where new occurrences were discovered during the term of the plan have been sent official notification letters.

[3] Butcher and Thiele (2014) morphometric analyses confirmed that individuals from Subpopulation 9 were *Synaphea* sp. Pinjarra Plain, and individuals from Subpopulation 11 were most likely *S.* sp. Fairbridge Farm. Consequently, subpopulation numbering ranges from 1 to 14, but there are only 12 known subpopulations.

		A meeting was held between DBCA and the Shire of Murray in 2016 to discuss weed control activities at Subpopulation 6e. An onsite meeting was held between DBCA and Fairbridge Farm staff on 3 December 2015 to discuss weed and fire management and proposed rehabilitation. Fairbridge Farm staff assisted with surveys completed in 2011 for Subpopulations 4a, 4b and 13.
Undertake weed control	Started and ongoing	Some weed control has been undertaken by ALCOA and DBCA. DBCA undertook control of *Vulpia bromoides* (Squirrel Tail Fescue), *Eragrostis curvula* (African Lovegrass) and *Watsonia meriana* var. *bulbillifera* (Bugle Lily) at Subpopulations 6 and 10 in 2008. Fairbridge Farm staff also completed some weed control at Subpopulations 4a, 4b and 13.
Confirm species status through genetic studies	Started and ongoing	Samples were collected and genetic studies commenced. The taxonomic status of each Priority and Threatened species of *Synaphea* from the Swan Coastal Plain was investigated by Butcher and Thiele (2014) using morphometric analyses. These analyses were unable to resolve *Synaphea stenoloba* and *S. odocoileops* into discrete groups, despite them being recognisably different in the field, and some specimens allied to *S. stenoloba* could also not be adequately classified. Further investigation using genetic tools is required.
Monitor subpopulations	Started and ongoing	DBCA's Swan Coastal and Perth Hills District Flora Conservation Officers monitor the subpopulations. All information collected during monitoring is stored at the relevant DBCA district offices and with Species and Communities Program. Monitoring of all subpopulations within the Swan Coastal and Perth Hills Districts was undertaken in 2010 by Swan Coastal District staff. Monitoring was undertaken at Subpopulations 6, 10 and 14 by DBCA Swan Coastal District and volunteers from the Mandurah Herbarium in 2015 and 2016. Monitoring of DBCA Perth Hills District subpopulations was completed in 2013/14.
Conduct further surveys	Ongoing	An extensive survey of *Synaphea* occurring on the Pinjarra Plain was undertaken in 2004, resulting in the discovery of further new subpopulations of *S. stenoloba* (Butcher 2004) additional to the population discovered by Davis (1998). Surveys were undertaken at Subpopulations 6, 10 and 14 by DBCA Swan Coastal District and volunteers from the Mandurah Herbarium in 2015 and 2016. An extension of Subpopulation 6c was recorded in 2016.
Develop and implement a fire management strategy	Not commenced	Although an official fire strategy has not been developed, results from a disturbance trial utilising fire as one of the disturbance mechanisms has provided some useful information on appropriate fire management of *Synaphea stenoloba* and is used for managing fire at these sites.
Promote awareness	Started and ongoing	A toolbox meeting was held by DBCA staff addressing approximately 35 people from the Shire of Murray on 3 May 2017. A PowerPoint presentation was given that included information on Threatened Flora marker identification, weed control activities, Threatened Flora issues on roadsides and within shire reserves, responsibility of the person undertaking the task, where information can be obtained, Permits to Take, and dieback issues etc.
Obtain biological and ecological information	Started and ongoing	A short-term trial for controlling an insect infestation (at the time identified as a mealy bug) at Subpopulation 6a was undertaken by DBCA's Swan Coastal District in 2009. An environmentally-friendly oil-based spray that suffocates the insect was used. The results were inconclusive and further longer-term trials are recommended. A further collection of a soft, white insect (it is unclear whether it is the same species collected in 2009) was made in 2016 and identified as the soft scale, *Coccus synapheae* (not mealy bug) which is a rarely-collected native invertebrate. It was observed to only infest Threatened *Synaphea* species. The reason for this is unknown. Control measures for the insect(s) have been suspended until further investigation is undertaken.

Develop Translocation Proposal	Complete	A Translocation Proposal was developed by ALCOA in 2007 to establish a seed orchard of *Synaphea stenoloba* in ALCOA farmlands. A total of 105 plants were planted on 14 July 2007. Heavy grazing by kangaroos, drought, unsuitable soils and competition from grassy weeds are thought to have contributed to the loss of all plants by winter 2008 (Monks *et al.* 2017). A subsequent Translocation Proposal that aims to restock extinct Subpopulation 2b (Monks *et al.* 2017) was approved in 2018.
Implement and monitor translocation	Started and ongoing	ALCOA planted a large three-replicate translocation trial for *Synaphea stenoloba* in winter 2007. All the plants died or were grazed heavily by kangaroos in the first seven months. Replanting occurred in June 2008 but all plants died.
Develop full Recovery Plan	No longer relevant	DBCA does not generally produce full Recovery Plans for flora. The previous IRP has been reviewed as part of the preparation of this replacement IRP.

History

Synaphea stenoloba was first described by A.S. George in 1995 in a revision of the genus (George 1995). The taxon had previously been included (along with many other taxa recognised as new by A.S. George) in a broad concept of *S. petiolaris*. This revision also recognised the new species *S. odocoileops* A.S.George, which has recently been separated into *S. odocoileops sensu stricto*, and *S.* sp. Serpentine (G.R. Brand 103), each of which is morphologically similar to *S. stenoloba*. The genus is currently undergoing further revision and four new Threatened species (*S.* sp. Fairbridge Farm (D. Papenfus 696), *S.* sp. Pinjarra (R. Davis 6578), *S.* sp. Pinjarra Plain (A.S. George 17182) and *S.* sp. Serpentine (G.R. Brand 103)) from the same geographic area as *S. stenoloba* are now recognised; *S. odocoileops* is listed as Priority One.

Diana Papenfus completed a survey for *Synaphea stenoloba* in 1997, confirming several of the known subpopulations. In 1998 Rob Davis completed a survey for ALCOA that clarified several of the anomalies with respect to historical locations and similar species once regarded as forms of *S. stenoloba* (Davis 1998). One new subpopulation was located during this survey.

An extensive survey of rare and priority species of *Synaphea* occurring on the Pinjarra Plain was undertaken in 2004, resulting in the discovery of further new subpopulations of *S. stenoloba* and a taxonomic review by R. Butcher. The survey also identified three subpopulations considered to be closely affiliated with *S. stenoloba* but that showed similarity to other species (e.g. *S. odocoileops*, *S. gracillima* and *S. petiolaris*; Butcher 2004). One subpopulation has since been confirmed to be *S. stenoloba* (Subpopulation 12) and another as *S.* sp. Pinjarra Plain (previously known as Subpopulations 9a and 9b of *S. stenoloba*); the remaining *S.* aff. *stenoloba* subpopulation could not be adequately resolved through morphometric analyses (Butcher and Thiele 2014). Some *Synaphea* specimens from ALCOA-held lands (Subpopulations 1 and 2) appear intermediate between *S. stenoloba* and *S. petiolaris* and require further taxonomic resolution. Butcher and Thiele (2014) used morphometric analyses to investigate taxonomic boundaries among morphologically similar *Synaphea* taxa on the Swan Coastal Plain, but this was inconclusive in some instances.

Currently, there are 48 collections of *Synaphea stenoloba* held in the WA Herbarium. In addition, there are two specimens identified as *Synaphea* aff. *stenoloba* and one (poor specimen) as *Synaphea* ?*stenoloba*; the subpopulations from which these specimens were taken require further investigation and clarification.

Description

Synaphea stenoloba is a compact, tufted shrub to 50 cm high. Leaves are 10 to 45 cm long and tripinnatipartite. Yellow inflorescences are borne above the leaves to a height of 35 cm. Flowers can be seen in August but occur mainly from September to October (George 1995).

Synaphea stenoloba has elongated, pinkish stems with long internodes, such that the leaves arise at discrete points along the stem. Inflorescences are terminal with spikes arising at the apices of the branches. The leaf lamina is either folded along the midline or has distinctly multiplanar ultimate lobes, the petioles are long and glabrous, and the margins of the sheathing bases of the petioles are usually pink to red. The inflorescences are long and somewhat undulate through the flowering region with slightly pendulous apices, and the sheaths surrounding the base of the spikes are few in number and are usually pink to red. The flowers are usually glabrous, moderately to widely opening, and have a broad, convex stigma which has short apical lobes (Butcher 2004; Butcher and Thiele 2014).

Many sympatrically-occurring *Synaphea* species are morphologically very similar to each other but variable within species. These species include *S. gracillima*, *S. petiolaris*, *S. odocoileops*, *S.* sp. Fairbridge Farm, *S.* sp. Serpentine and a putative hybrid between *S. gracillima* and *S. petiolaris.* Species occurring in mixed subpopulations with *S. stenoloba* include *S. gracillima*, *S. petiolaris* and *S.* sp. Fairbridge Farm. *Synaphea* sp. Serpentine (previously included in *S. odocoileops*) was previously thought to be the same as *S. stenoloba* (Davis 1998) but was confirmed as a distinct taxon in 2005 through a taxonomic review by R. Butcher.

Distinguishing between species in the field can be difficult. *Synaphea stenoloba* is recognised as being part of a complex requiring further systematic investigation to determine the boundaries between *S. stenoloba* and other closely related taxa, in particular *S. odocoileops* (Butcher and Thiele 2014). In Butcher's (2004) survey of rare *Synaphea* species on the Swan Coastal Plain, three subpopulations were found to be closely affiliated with *S. stenoloba* but also showed similarity to other *Synaphea* species; one has since been confirmed as *S. stenoloba*, one has been determined to be *S.* sp. Pinjarra Plain, and the third requires further investigation.

Using morphometric analyses based on characters of leaves, inflorescences, flowers and fruits, Butcher and Thiele (2014) investigated the taxonomic boundaries among morphologically similar taxa of *Synaphea* occurring on the Swan Coastal Plain. These analyses were unable to resolve *S. stenoloba* and *S. odocoileops* into discrete groups, despite them being recognisably different in the field and as herbarium specimens, and some specimens allied to *S. stenoloba* could also not be adequately classified. This may indicate either that *S. stenoloba* constitutes a single variable species, with phenotypic variation between subpopulations reflected by habitat differences, or its observable variation was not adequately captured in the selection and scoring of characters for the numerical analysis. Further investigation of species boundaries using molecular markers is required (Butcher and Thiele 2014).

Morphological variation is evident among subpopulations of *S. stenoloba*. Individuals in Subpopulation 3 have been observed to display shorter, more folded leaves than plants in other subpopulations, as well as hairs on the outside of the flowers. Many plants also displayed a flowering abnormality whereby bracts were present but flowers were absent or retarded at an early bud stage. These differences may be associated with differences in the habitat, as this site is drier and has a slightly different soil type and associated vegetation (Butcher 2004).

Illustrations and/or further information

Butcher, R. (2004) *A Survey of Gazetted and Proposed Declared Rare species of Synaphea (Proteaceae) occurring on the Pinjarra Plain*. Unpublished report prepared for the Western Australian Threatened Species and Communities Unit, Department of Conservation and Land Management.

Butcher, R. and Thiele, K.R. (2014) An investigation of taxon boundaries in rare and range-restricted *Synaphea* (Proteaceae: Conosperminae) species from south-west Western Australia. *Australian Systematic Botany* 27(2): 119–144.

Davis, R. (1998) Survey of the Priority 1 Flora *Synaphea stenoloba* (Proteaceae). Report for J. Koch, ALCOA of Australia Limited; George, A.S. (1995) *Synaphea*. *Flora of Australia* 16: 271–316.

Western Australian Herbarium (1998–) *FloraBase*— the Western Australian Flora. Department of Biodiversity, Conservation and Attractions. https://florabase.dpaw.wa.gov.au/

Distribution and habitat

Synaphea stenoloba is known from 12 subpopulations and is endemic to the Pinjarra Plain south of Perth. The species generally occurs within the Pinjarra area, with one subpopulation located north of Yarloop, some 40 km to the south.

The species most commonly occurs in swampy loam or sandy clay soils in depressions that are occasionally inundated, and winter wet flats. *Synaphea stenoloba* is normally associated with low wetland heath to one metre high with emergent *Nuytsia*. Associated habitat consists of *Pericalymma ellipticum*, *Regelia ciliata* and *Corymbia calophylla*. However, the woodland habitat and drier soils of Subpopulation 3 are quite different to the habitat associated with the other subpopulations. The extent of occurrence is 89 km^2 and the area of occupancy is estimated to be 52 km^2 using the IUCN 2 km x 2 km grid method.

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

TPFL subpopulation number & location	DBCA district	Shire	Vesting	Purpose	Manager
1a. E of Pinjarra	Perth Hills	Murray	Main Roads WA (MRWA)	Road reserve	MRWA
1b. E of Pinjarra	Perth Hills	Murray	Private property		ALCOA
1c. E of Pinjarra	Perth Hills	Murray	Private property		ALCOA
1d. E of Pinjarra	Perth Hills	Murray	Private property		ALCOA
2a. ENE of Pinjarra	Perth Hills	Murray	Private property		Landowners
2b. ENE of Pinjarra	Perth Hills	Murray	Private property		Landowners
2c. NE of Pinjarra	Perth Hills	Murray	Private property		Landowners
3a. SE of Pinjarra	Perth Hills	Murray	Public Transport Authority (PTA)	Rail reserve	Arc Infrastructure
3b. SE of Pinjarra	Perth Hills	Murray	PTA	Rail reserve	Arc Infrastructure
3c. SE of Pinjarra	Perth Hills	Murray	PTA	Rail reserve	Arc Infrastructure
3d. SE of Pinjarra	Perth Hills	Murray	PTA	Rail reserve	Arc Infrastructure
4a. NE of Pinjarra	Perth Hills	Murray	Local Government Authority (LGA)	Road reserve	Shire of Murray
4b. NE of Pinjarra	Perth Hills	Murray	LGA	Road reserve	Shire of Murray
4c. NE of Pinjarra	Swan Coastal	Murray	MRWA	Road reserve	MRWA
4d. NE of Pinjarra	Perth Hills	Murray	MRWA	Road reserve	MRWA
5. N of Yarloop	Swan Coastal	Waroona	PTA	Rail reserve	Arc Infrastructure

6a. W of Pinjarra	Swan Coastal	Murray	Private property		Landowners
6b. W of Pinjarra	Swan Coastal	Murray	LGA	Recreation	Shire of Murray
6c. W of Pinjarra	Swan Coastal	Murray	LGA	Recreation	Shire of Murray
6d. W of Pinjarra	Swan Coastal	Murray	Private property		Landowners
6e. W of Pinjarra	Swan Coastal	Murray	LGA	Drainage	Shire of Murray
7. SE of Pinjarra	Perth Hills	Murray	PTA	Rail reserve	Arc Infrastructure
8. E of Pinjarra	Perth Hills	Murray	Private property		ALCOA
10. SW of Pinjarra	Swan Coastal	Murray	Conservation and Parks Commission (CPC)	Conservation of Flora and Fauna (CFF)	DBCA
12. NE of Pinjarra	Swan Coastal	Murray	PTA	Rail reserve	Arc Infrastructure
13. ENE of Pinjarra	Perth Hills	Murray	Private property		Landowners/ALCOA
14. W of Pinjarra	Swan Coastal	Murray	CPC	CFF	DBCA

Biology and ecology

Synaphea stenoloba plants are self-compatible (Ye *et al.* 2012), and pollination is likely to be mediated by insect vectors (e.g. species of the native solitary bee *Leioproctus* (Colletidae); Houston 2000). The species has numerous scentless flowers clustered in dense inflorescences and deploys a ballistic pollen ejection system, characteristic of all *Synaphea* species. A research study found that this system enabled pollen to disperse to neighbouring plants and could enhance inter-plant pollination in pollinator-excluded environments, suggesting an adaptation to pollinator scarcity from habitat disturbance or competition for pollinators (Ye *et al.* 2012).

Testing of susceptibility to *Phytophthora cinnamomi* has shown that *S. stenoloba* has a high level of tolerance to the disease. Of 26 plants inoculated with *P. cinnamomi*, two died after 309 days, and their deaths were not attributed to the disease (C. Crane *pers. comm.* March 2015; cited in Monks *et al.* 2017).

Synaphea stenoloba and other Threatened *Synaphea* species appear to suffer from infestations of a 'soft, white insect' scale, primarily later in a species' life cycle. Individuals may recruit (either naturally or through disturbance) and grow to maturity without scale problems, but the scale infestation appears and increases as the plants age or become stressed due to hydrological or habitat changes. The plants then succumb to the combined stressors (A. Harris *pers. comm.*).

Research into the *in vitro* conservation of *Synaphea stenoloba* concluded that *S. stenoloba* is a recalcitrant species and therefore plant propagation via seed stock is difficult. *In vitro* methods in association with habitat preservation, genetic sampling and cryostorage of seed and somatic tissues provided the most efficient method of preservation (Stone 2005).

Conservation status

Synaphea stenoloba was listed as specially protected (rare flora) under the WA *Wildlife Conservation Act 1950* on 17 December 1999. It was ranked as Critically Endangered (CR) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 Red List criteria B1ab(iii)+2ab(iii) due to its extent of occurrence estimated to be less than 100 km^2, its area of occupancy estimated to be less than 10 km^2, severe fragmentation of subpopulations and a continuing decline in the quality of habitat. The species is listed as Endangered (EN) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Government of Australia 1999). Note: The species' area of occupancy is now

greater than 10 km^2 using the 2 km x 2 km grid method and therefore it no longer meets IUCN Red List criteria B2, so its listing criteria will be reviewed.

Threats

- **Weeds** are having a major impact on all subpopulations. The main weed threats are introduced grasses, in particular *Eragrostis curvula* (African Lovegrass), and *Watsonia meriana* var. *bulbillifera* (Bugle Lily). Weeds suppress early plant growth by competing for soil moisture, nutrients and light. They also increase the fire hazard due to the high fuel loads that are produced annually by many grass weed species.
- **Road, rail, track and firebreak maintenance activities** impact on many subpopulations and their habitat. Threats include actions such as grading road reserves, spraying of chemicals, construction and maintenance of drainage channels and mowing of roadside vegetation to improve visibility. These disturbance events also often encourage weed invasion into adjacent habitat as well as causing damage to actual plants. Relevant authorities have been informed of the location of subpopulations so that appropriate protective measures can be implemented. Adjacent landowners should also be informed of the location of subpopulations to prevent possible damage due to fence-line or firebreak maintenance, grazing, cropping or other activities.
- **Infrastructure maintenance** including maintenance to powerlines and pipelines at Subpopulations 1b, 1d, 3a and 5, and maintenance to buildings at Subpopulation 8, has the potential to impact *Synaphea stenoloba*. Disturbance during maintenance may encourage weed invasion and also directly damage plants. The relevant authorities have been notified of the subpopulations.
- **Hydrological changes** are likely to impact several subpopulations, as the condition of *S. stenoloba* plants has been observed to deteriorate following flooding. Hydrological changes can arise from increased inundation and waterlogging following changes to drainage associated with road building. Long-term changes in the flooding regime are likely to impact on the viability of subpopulations.
- **Future mining operations** have the potential to impact Subpopulation 3 due to clearing of habitat.
- **Rabbits** (*Oryctolagus cuniculus*) are having an impact at the majority of the subpopulations. Grazing of plants by rabbits is likely to reduce recruitment at these sites. In addition, rabbit activity encourages weed invasion through digging, erosion, the addition of nutrients and introduction of weed seeds.
- **Illegal waste dumping** and associated damage by vehicles has occurred in the past at Subpopulations 1a, 1c, 1d, 4b and 6b. A number of these sites are located adjacent to industrial areas and are used for dumping industrial as well as domestic waste such as car bodies, machinery parts, building materials, garden waste, diesel fuel containers and household rubbish. Waste may impact on the site through the leaching of toxic chemicals into the soil, encouraging weeds, and providing habitat for rabbits. The appearance of waste usually contributes to additional rubbish being dumped at the site.
- **Motorbike riders and off-road vehicles** impact Subpopulations 6b and 14 of *S. stenoloba*. The habitat at Subpopulation 6b has been highly dissected with erosion of vegetation edges occurring where tracks have been created. These activities increase the risks of damaging plants through trampling and increasing the spread of diseases.
- **Heavy vehicle movement** can impact Subpopulation 5, which is located along a rail reserve. A large area of vegetation was recently disturbed by heavy vehicles entering the site and using the rail reserve to turn around. The recent installation or maintenance of utilities further along the railway line may have been the cause of this incursion. It is not known whether this was a 'one off'

occurrence or something that will happen regularly. Signs denoting the importance of the area may be required if this disturbance is repeated.

- **Altered fire regimes** have the potential to impact all subpopulations of *S. stenoloba*. There is limited information on fire response for this species, but it is likely that occasional fires are needed for regeneration. Routine monitoring of Subpopulations 1 and 3 have indicated that individual plants can regenerate and new juveniles recruit well post-fire from soil-stored seeds. Fire also facilitates weed invasion and should be followed up with appropriate weed control.
- **Insect infestations** were observed in 2006 occurring in high numbers on individuals at Subpopulations 6a and 6b of *Synaphea stenoloba*. These were identified at the time by Bryan Shearer (DBCA) as a 'mealy bug'. A small control trial was undertaken in 2009 but the results were inconclusive due to the small number of replicate and control quadrats used. In 2015, a 'soft, white insect' was also collected from individuals at Subpopulation 6c and identified as *Coccus synapheae*, a poorly collected, native soft scale. It is not known whether the mealy bug identified initially and *Coccus synapheae* are the same or separate species, and further investigation is required.
- **Clearing** for industrial development may have an impact on subpopulations located on private property. In particular, clearing approval was granted in 2008 for three quarters of the lot containing Subpopulation 6a, resulting in approximately one third of the *S. stenoloba* plants being destroyed for the construction of buildings associated with industrial development.
- **Insecure land tenure.** With the exception of two subpopulations that occur on conservation reserves, all subpopulations are found on land tenure that is not consistent with conservation and is of poor and deteriorating quality. The primary uses of these areas are not conducive to the long-term conservation of flora.
- **Poor recruitment** is observable in most *S. stenoloba* subpopulations due to the absence of factors such as fire in the species' habitat which may positively influence reproduction. Utilisation of fire as a tool for management should be investigated, but only with a high level of resources available for on-going weed control and rehabilitation of degraded areas within subpopulation sites.
- **Limited seed production.** The fruits of all *Synaphea* species are single-seeded and high levels of seed abortion and predation have been observed across the genus, making seed collection for storage and propagation difficult. In addition, few fruits are initiated in inflorescences relative to the large number of flowers produced.
- **Recreational activities** may impact Subpopulation 13. The species occurs adjacent to a café and sports oval, and the subpopulation is dissected by a pedestrian access track. A boardwalk has been constructed to prevent people trampling the plants.
- **Dieback disease** (*Phytophthora cinnamomi*) is a pathogen that causes root rot resulting in susceptible plants dying of drought stress. Although *S. stenoloba* is not susceptible to *P. cinnamomi*, a decline in condition and degradation of the vegetation and habitat in which it occurs may impact on the species in the long term if the pathogen is introduced into the area.

The intent of this plan is to identify actions that will mitigate immediate threats to *Synaphea stenoloba*. Although climate change and drought may have a long-term effect on the species, direct actions to prevent the impact of climate change and drought are beyond the scope of this plan.

Table 3. Summary of subpopulation information and threats

TPFL subpopulation number & location	Land status	Year / no. of plants		Condition		Threats
				Plants	Habitat	
1a. E of Pinjarra	MRWA road reserve	1993 1998 2003 2006 2010	135* 142** 322 (152) [6]* 100*** 453 [6]*	Moderate		Weeds, road maintenance, grazing, waste dumping, hydrological changes, altered fire regimes
1b. E of Pinjarra	Private property	1993 1998 2003 2006 2010 2014	As in 1a* As in 1a** As in 1a* As in 1a*** As in 1a* 134	Moderate	Very good	Weeds, road maintenance, pipeline maintenance, hydrological changes, grazing, altered fire regimes
1c. E of Pinjarra	Private property	1993 1998 2002 2003 2006 2010	6 As in 1a** 0 (area burnt) 4 As in 1a*** 0	Moderate	Good	Track maintenance, weeds, grazing, vehicle damage, hydrological changes, waste dumping, altered fire regimes
1d. E of Pinjarra	Private property	1997 1998 2002 2003 2006 2010 2014	25 As in 1a** 28 2 As in 1a*** 3 5	Healthy	Good	Weeds, grazing, gas pipeline maintenance, hydrological changes, waste dumping, altered fire regimes
2a. ENE of Pinjarra	Private property	1993 1998 2002 2003 2010	6 As in 1a** 4 9 0	Poor		Weeds, grazing, hydrological changes, altered fire regimes
2b. ENE of Pinjarra	Private property	1993 1998 2003 2010 2016	6 As in 1a** 32 (2) 0 0	Poor		Grazing, hydrological changes, altered fire regimes
2c. NE of Pinjarra	Private property	2002 2003 2010	2 3 0	Poor		Weeds, grazing, hydrological changes, altered fire regimes
3a. SE of Pinjarra	Rail reserve	1997 1998 2002 2003 2010 2014	15 50 100 65 (2) [1] 437 (18) [8] 248 (6)	Moderate	Good	Weeds, rail maintenance, powerline maintenance, mining activities, altered fire regimes
3b. SE of Pinjarra	Rail reserve	1998 2002 2003 2010 2014	40 As in 3a 154 (31) 666 [2] 330	Moderate	Good	Grazing, weeds, hydrological changes, rail maintenance, mining activities, disease, altered fire regimes
3c. SE of Pinjarra	Rail reserve	2003 2010 2014	11 (5) 28 (3) 20	Moderate	Good	Grazing, weeds, hydrological changes, rail maintenance, mining activities, disease, altered fire regimes
3d. SE of Pinjarra	Rail reserve	2003 2010 2014	116 (11) 216 [1] 180	Moderate	Good	Grazing, weeds, hydrological changes, rail maintenance, mining activities, disease,

						altered fire regimes
4a. NE of Pinjarra	Shire road reserve	1998 2002 2003 2009 2011 2013	50-100 64 [1] 4 12 26 23 (2)	Moderate	Degraded	Weeds, road maintenance, grazing, altered fire regimes
4b. NE of Pinjarra	Shire road reserve	2003 2009 2011 2013	94 [3] 10 7 (4) 15 (16)	Moderate	Good	Weeds, road and track maintenance, grazing, altered fire regimes
4c. NE of Pinjarra	MRWA road reserve	2003 2007 2010 2011 2013	1 1 0 1 5	Moderate	Degraded	Weeds, road maintenance, altered fire regimes
4d. NE of Pinjarra	MRWA road reserve	2003 2010	1 0		Degraded	Road, fence-line and drainage channel maintenance, weeds, grazing, altered fire regimes
5. N of Yarloop	Rail reserve	2001 2003 2010	14 (1) 55 (15) 33	Moderate		Weeds, road and rail maintenance, gas pipeline maintenance, vehicle movement, hydrological changes, altered fire regimes
6a. W of Pinjarra	Private property	2003 2007 2008 2010 2015	7 100+ 346 143 [7] 1	Poor/ senescing	Degraded	Clearing, senescence, weeds, insect infestation, altered fire regimes
6b. W of Pinjarra	Shire recreation reserve	2003 2010 2015	218 38 [4] 13 (1) [2]	Healthy	Very good	Insect infestation, motorbike riders, waste dumping, weeds, grazing, altered fire regimes
6c. W of Pinjarra	Shire recreation reserve	2003 2008 2010 2016	110 (46) [2] 15 150 [20] 1,523 [62]	Moderate	Excellent	Hydrological changes, weeds, disease, grazing, altered fire regimes, insect infestation
6d. W of Pinjarra	Private Property	2010 2015	As for 6a 4 [75% dead]	Poor	Good	Clearing, senescence, weeds, insect infestation, altered fire regimes
6e. W of Pinjarra	Drainage reserve	2015 2016	1 1	Poor	Completely degraded	Weeds, weed spraying, senescence, insect infestation
7. SE of Pinjarra	Rail reserve	2003 2007 2010	9 0 0	Poor Disturbed	Degraded	Weeds, grazing, rail maintenance, fence-line maintenance, altered fire regimes
8. E of Pinjarra	Private property	2005 2007 2010 2014	60 103 0 0	Disturbed	Good	Weeds, hydrological changes, rabbits, infrastructure maintenance
10. SW of Pinjarra	Nature reserve	2005 2007 2010 2015	Unknown 15 7 4	Healthy	Excellent	Grazing, weeds, disease, altered fire regimes
12. NE of Pinjarra	Rail reserve	2003 2007 2010	1 1 0	Moderate		Rail maintenance, weeds, disease, altered fire regimes
13. ENE of Pinjarra	Private property	2008 2009 2011 2013	100+ 48 [4] 30 (1) [1] 4	Moderate	Degraded	Recreational activities (trampling), weeds

14. W of Pinjarra	Nature Reserve	2008 2010 2011 2015	4 53 25 20	Healthy	Very good	Weeds, off-road vehicles, fire

Note: Subpopulations in **bold text** are considered to be important subpopulations;
*total estimated count for Subpopulations 1a and 1b; **total estimated count for Subpopulations 1a to d and 2a to b; ***total estimated count for Subpopulations 1a to 1d; () = number of seedlings; [ ] = number of dead plants.
Subpopulations 9a and 9b were re-determined as *S.* sp. Pinjarra Plain (plants are intermixed with *S. odocoileops* in this area). Although there is no voucher specimen for Subpopulation 11, there are *S.* aff. sp. Fairbridge Farm specimens from this locality; these were found to group with *S.* sp. Fairbridge Farm specimens in morphometric analyses (Butcher and Thiele 2014). No *S. stenoloba* plants were observed at this site during survey by Butcher (2004).

Guide for decision-makers

Section 1 provides details of current and possible future threats. Actions that result in any of the following may potentially have a significant impact on the species:

- damage or destruction of occupied or potential habitat
- alteration of the local surface hydrology or drainage
- reduction in subpopulation size
- a major increase in disturbance in the vicinity of a subpopulation.

Habitat important for the survival of the species, and important subpopulations

Synaphea stenoloba is listed as Threatened Flora (Critically Endangered) in Western Australia and it is considered that all known habitat for wild subpopulations that is not in degraded condition is important for the survival of the species, and that all wild subpopulations with extant plants or habitat that is not in degraded condition are important subpopulations. Habitat important for the survival of *S. stenoloba* includes the area of occupancy of subpopulations, areas of similar habitat surrounding and linking subpopulations (these providing potential habitat for subpopulation expansion and for pollinators), additional occurrences of similar habitat that may contain undiscovered subpopulations 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 *Synaphea stenoloba* will also improve the status of associated native vegetation. Seven Threatened Flora species and 12 Priority flora taxa also occur in association with *S. stenoloba* (Table 4).

Table 4. Conservation-listed flora species occurring in the habitat of *Synaphea stenoloba*

Species name	Conservation status (WA)	Conservation status (EPBC Act)
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	Threatened (CR)	CR
Synaphea sp. Pinjarra (R. Davis 6578)	Threatened (CR)	CR
Synaphea sp. Serpentine (G.R. Brand 103)	Threatened (CR)	CR
Diuris purdiei	Threatened (EN)	EN

Synaphea sp. Pinjarra Plain (A.S. George 17182)	Threatened (EN)	EN
Diuris drummondii	Threatened (VU)	VU
Tetraria australiensis	Threatened (VU)	VU
Grevillea bipinnatifida subsp. *pagna*	Priority 1	-
Synaphea odocoileops	Priority 1	-
Acacia benthamii	Priority 2	-
Gastrolobium sp. Harvey (G.J. Keigheryi 16821)	Priority 2	-
Schoenus benthamii	Priority 3	-
Schoenus pennisetis	Priority 3	-
Stylidium aceratum	Priority 3	-
Centrolepis caespitosa	Priority 4	-
Drosera occidentalis subsp. *occidentalis*	Priority 4	-
Microtis quadrata	Priority 4	-
Ornduffia submersa	Priority 4	-
Tripterococcus sp. Brachylobus (A.S. George 14234)	Priority 4	-

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

Synaphea stenoloba also occurs in association with three Threatened Ecological Communities (TECs) (Table 5).

Table 5. Threatened Ecological Communities with which *Synaphea stenoloba* occurs in association

TEC name	Conservation status (WA)	Conservation status (EPBC Act)
Corymbia calophylla-Kingia australis woodlands on heavy soils, Swan Coastal Plain (type SCP3a)	CR	EN
Dense shrublands on dry clay flats (type SCP09) (a component of the Claypans of the Swan Coastal Plain EPBC listed TEC)	VU	CR
Banksia attenuata or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain (SCP 20b)	EN	-

For a description of the TEC categories see https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf.

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. *Synaphea stenoloba* 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

Involvement of the Aboriginal community is being sought through the Indigenous Natural Resource Management Advisory Group (INRMAG) of the Swan Catchment Council to: assist in the identification of cultural values for land occupied by *Synaphea stenoloba*; identify any groups with a cultural connection to land that is important for the species' conservation and determine whether there are any issues or interests identified in the plan. A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System has identified that *S. stenoloba* subpopulations co-occur with two culturally significant sites (Site IDs 4327, 3786). General advice will be sought from the INRMAG

regarding management, conservation and recognition of the shared values at these sites. The INRMAG recognises that DBCA, through the recovery plan process, seeks to conserve and protect areas of natural remnant vegetation. The INRMAG recognises that together we share similar goals of seeking to manage these areas for conservation and seek to include and support Aboriginal interest and involvement in the management and planning processes. Continued liaison between DBCA and the Aboriginal community will identify areas in which collaboration will assist implementation of recovery actions.

Social and economic impacts

The implementation of this plan may cause some adverse social and economic impact. For subpopulations occurring on private property (Subpopulations 1b–1d, 2a–c, 6a, 6d, 8 and 13) social and economic impacts may occur through a reduction in land available for development and mining, as well as the cost of implementing recovery actions (maintaining fencing, undertaking weed and rabbit control). For land under the management of the Shire of Murray (Subpopulations 4a, 4b, 6b, 6c and 6e), Arc Infrastructure (Subpopulations 3a–d, 5, 7 and 12) and MRWA (Subpopulations 1a, 4c and 4d), social and economic impacts may also be through the implementation of recovery actions (controlling weeds) and restrictions imposed on the management of the land, including maintenance of the road infrastructure.

Affected interests

The implementation of this plan has some implications for land managers, such as private landholders, ALCOA, Shire of Murray, MRWA and Arc Infrastructure, where subpopulations occur on lands not specifically managed for conservation.

Evaluation of the plan's performance

DBCA, with assistance from the Swan Region Threatened Flora and Communities Recovery Team (SRTFCRT), 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 extant subpopulations 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 subpopulations has remained within a 5% range or has increased by >5% from 2,882 to 3,026 or more; or
- New subpopulations have been found, increasing the number of known subpopulations from 12 to 13; 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:

- Subpopulations have been lost which results in a reduction in the extent of occurrence; or
- The number of mature plants has decreased >5% to 2,738 or less; or
- The area of occupancy has decreased by >10%.

3. Recovery actions

Existing recovery actions

DBCA, with assistance from the SRTFCRT, is overseeing the implementation of recovery actions for *Synaphea stenoloba*. The following recovery actions have been or are being implemented.

Survey

- R. Davis conducted an extensive survey for *S. stenoloba* for ALCOA in 1998. One additional subpopulation (Subpopulation 8) was located.
- An extensive survey of rare and priority species of *Synaphea* occurring on the Pinjarra Plain was undertaken in 2004 by Ryonen Butcher, resulting in the discovery of further new subpopulations of *S. stenoloba* (Butcher 2004).
- Collections made from nature reserves in 2005 (PERTH 07289642) (Subpopulation 10) and 2008 (PERTH 08057133) (Subpopulation 14), and from private property in 2008 (PERTH 07894686) (Subpopulation 13) contributed to an increase in the species' extent of occurrence.
- Surveys were undertaken at Subpopulations 6, 10 and 14 by DBCA Swan Coastal District and volunteers from the Mandurah Herbarium in 2015 and 2016. An extension of Subpopulation 6c was recorded in 2016.

Research

- ALCOA completed seed set and propagation trials on *S. stenoloba*. This research indicated that the species is not easy to propagate, that seed set is low and there is minimal or no viable seed produced by the subpopulations on ALCOA land.
- A study into the *in vitro* conservation of *S. stenoloba* was undertaken in 2005 by Benjamin Stone (UWA) as part of a Honours research project in conjunction with BGPA and ALCOA (Stone 2005). The primary aims of the research were to provide guidelines for the *in vitro* preservation and cultivation of the species and obtain knowledge of subpopulation dynamics.
- A genetic study was conducted as an Honours project by Jesse Mahony from UWA in conjunction with BGPA (Mahoney 1998). Each subpopulation of *S. stenoloba* was found to be genetically distinct. This study has also confirmed the separation of *S.* sp. Fairbridge Farm as a distinct species. During this project, material was collected and the first stages of micro-propagation and cryostorage completed.
- The taxonomic status of each Priority and Threatened species of *Synaphea* from the Swan Coastal Plain was investigated by Butcher and Thiele through morphometric analyses. Plants from all confirmed and unconfirmed subpopulations of *S. stenoloba* were included in the analyses and leaf material was collected for genetic work (Butcher and Thiele 2014).
- A trial to control an insect, identified at the time as a 'mealy bug', was undertaken in November 2009 at Subpopulation 6a by DBCA Swan Coastal District. An environmentally friendly oil based spray that suffocates the insect was applied to a subset of plants. The results were inconclusive and further longer-term trials are recommended.
- A collection of scale insect observed to be in large numbers on highly stressed and dead plants was made in 2016 and identified as a poorly known, rarely collected native invertebrate species, *Coccus synapheae*. It was observed to be invasive only on Threatened *Synaphea* species, for reasons unknown. Control measures for the scale have been suspended until further investigation is undertaken.

Translocation

- ALCOA prepared a Translocation Proposal in 2007 to establish a seed orchard of *S. stenoloba* in ALCOA farmlands, southeast of Pinjarra. The plants were propagated from tissue culture sourced from Subpopulation 1 in 2005. The key goal for the translocation was to develop methods to successfully establish nursery grown plants in agricultural sites. The medium term aim was to use the trial as a pollination biology and seed orchard research site. A total of 105 plants were planted at the translocation site on 14 July 2007. However, a combination of heavy grazing by kangaroos, drought, unsuitable soils and competition from grassy weeds are thought to have contributed to the loss of all plants by winter 2008 (Monks *et al*. 2017).
- ALCOA implemented a large, three-replicate translocation trial for *S. stenoloba* in winter 2007. All of the plants died or were grazed heavily by kangaroos in the first seven months. Fencing and weed control followed. In June 2008 all three plots were replanted with larger plants that had tougher leaves (thought to be less palatable to kangaroos). These were all protected with anti-kangaroo grazing guards. The plants were still alive in September 2008 but with little new above ground growth, and all later died.
- A Translocation Proposal (Monks *et al*. 2017) that aims to restock extinct Subpopulation 2b, using material propagated from clones generated by tissue culture sourced from Subpopulation 1a, was approved in 2018. Planting took place in winter 2018.

Onground actions

- ALCOA conducted weed control at Subpopulations 1a to 1d in 2005, 2006 and 2007 with herbicides.
- Staff from Fairbridge Farm conducted weed control at Subpopulations 4a, 4b and 13 in 2010 and 2011.
- Following an intense wildfire in summer 2007, weed control was undertaken in 2008 by DBCA Swan Coastal District staff at Subpopulations 6 and 10. The main weed species targeted were *Vulpia bromoides* (Squirrel Tail Fescue), *Eragrostis curvula* (African Lovegrass) and *Watsonia meriana* var. *bulbillifera* (Bugle Lily).
- Threatened Flora markers have been installed at Subpopulations 1c, 4a, 4b, 4c, 4d, 5 and 12 to alert people working in the vicinity to the presence of Threatened Flora.

***Ex situ* collections**

- The BGPA nursery currently has three living (potted) specimens of *Synaphea stenoloba* that are approximately six years old. The tissue cultured plants were collected from Subpopulation 1 in June 1999.
- BGPA currently have eighteen clones, consisting of small, whole explants, less than 10 cm in height, maintained in nutrient agar tubes in cool storage incubators. Shoot-tip meristems (< 2 mm in size) from the clones are slowly being added to liquid nitrogen (dewars) for more secure, long-term storage. For display purposes and as proof of concept, a small number of potted specimens are also in the Science growing areas. These are whole plants, growing to full maturity, flowering and seeding.
- *Synaphea stenoloba* plants generated from tissue culture were propagated at ALCOA nursery in Marrinup. Following the closure of the nursery in April 2013, 467 plants were transported to the BGPA nursery and re-potted. Despite further re-potting into larger containers and regular maintenance, the number of plants has steadily declined. Currently there are less than 100 plants, in poor condition.
- DBCA's Threatened Flora Seed Centre (TFSC) collected 54 *S. stenoloba* fruits from Subpopulation 4 in December 1999. No germination tests were conducted due to the small number of fruits collected, and therefore no estimation has been made of the number of seeds in the collection. Another fruit collection was made from Subpopulation 5 in January 2009 from eight individuals. Although not processed yet, fruit numbers are low, so seed numbers are likely to also be extremely low. The propagules of Synaphea species are usually collected as fruit and it is common for most of those fruit to be empty as a result of seed abortion or predation.

Promote awareness/liaison

- A meeting between staff from DBCA Swan Coastal District and the Shire of Murray was held to discuss weed control activities at Subpopulation 6e in October 2016.
- An onsite meeting was conducted on 3 December 2015 with staff from Fairbridge Farm to discuss weed and fire management, and proposed rehabilitation at Subpopulations 4a, 4b and 13.
- A 'toolbox' meeting was held by DBCA staff addressing approximately 35 people at the Shire of Murray on 3 May 2017. A PowerPoint presentation was given that included information on Threatened Flora marker identification, weed control activities, Threatened Flora issues on roadsides and within shire reserves, responsibility of the person undertaking the task, where information can be obtained, Permits to Take, and dieback issues etc.

Future recovery actions

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

1. Coordinate recovery actions

DBCA, with assistance from the SRTFCRT, will continue to oversee the implementation of recovery actions for *Synaphea stenoloba* and will include information on progress in annual reports.

Action: Coordinate recovery actions
Responsibility: DBCA (Swan Region), with assistance from the SRTFCRT
Cost: $8,000 per year

2. Monitor subpopulations

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

Pre/post burn monitoring is recommended following prescribed burns, and may include plots/transects, method of regeneration, and time to first flowering.

Action: Monitor subpopulations
Responsibility: DBCA (Swan Coastal and Perth Hills Districts), with assistance from the SRTFCRT
Cost: $10,000 per year

3. Liaise with land managers and Aboriginal communities

Staff from DBCA Swan Coastal and Perth Hills Districts will liaise with appropriate land owners/managers to ensure subpopulations are not accidentaly damaged or destroyed, and the habitat is maintained in a suitable condition for the conservation of *S. stenoloba*. Consultation with Aboriginal communities will take place to determine if they have any issues or interests in areas that provide habitat for the species, and opportunities will be provided for Aboriginal people in implementing this plan.

Action: Liaise with land managers and Aboriginal communities
Responsibility: DBCA (Swan Coastal and Perth Hills Districts)
Cost: $4,000 per year

4. Undertake weed control

Weeds are impacting most subpopulations. The following actions will be implemented for subpopulations, with priority given to subpopulations containing extant individuals:

1. Determine which weeds are present and map them.
2. Select appropriate technique for weed control.
3. Control invasive weeds as they first emerge.
4. Monitor the success of the treatment on weed death, and the tolerance of *Synaphea stenoloba* and associated native plant species to the treatment methods.
5. Report on the method and success of the treatment.
6. Revegetate with site-specific species (in autumn) to suppress weeds if required.

Action: Undertake weed control
Responsibility: DBCA (Swan Coastal and Perth Hills Districts) and land managers
Cost: $10,000 per year, as required

5. Collect and store seed

To guard against the extinction of known natural subpopulations of *Synaphea stenoloba*, it is recommended that seed be collected and stored at the TFSC. Collections should aim to sample the maximum range of genetic diversity possible by collecting from the widest range of reproductive plants. If it is not feasible to collect seed, living collections from cuttings or storage of tissue culture material should be undertaken.

Action: Collect and store seed
Responsibility: DBCA (Swan Coastal and Perth Hills Districts, TFSC)
Cost: $10,000 per year

6. Increase biological and ecological knowledge

Increased knowledge of the biology and ecology of *Synaphea stenoloba* requires the following investigations:

1. Clarification of the taxonomic boundary between *S. stenoloba* and *S. odocoileops* using molecular data and explore the use of three dimensional geometric morphometrics for differences in floral morphology;
2. Clarification of the interaction between *Coccus synapheae* and *S. stenoloba*, and need for control;
3. Soil seed bank dynamics and the role of various factors including disturbance, competition, drought, inundation and grazing in recruitment and seedling survival;
4. Reproductive strategies, phenology and seasonal growth;
5. Reproductive success and pollination biology;
6. Longevity of plants, time taken to reach maturity, and minimum viable subpopulation size;
7. The impact of *Phytophthora* dieback on the habitat of *Synaphea stenoloba* and the effectiveness of control techniques; and
8. The impact of changes in hydrology in the habitat.

Action: Increase biological and ecological knowledge

Responsibility: DBCA (Biodiversity and Conservation Science, Swan Coastal and Perth Hills Districts)
Cost: $50,000 in years 1–3

7. Install, replace and reposition Threatened Flora markers

Threatened Flora markers are required to be installed at Subpopulations 1d, 6c, 6e and 7 and replaced at Subpopulations 3a, 3b and 3d. If not already present, markers will also need to be installed along tracks where infrastructure (powerline and pipeline) maintenance is undertaken.

Action: Install, replace and reposition Threatened Flora markers
Responsibility: DBCA (Swan Coastal and Perth Hills Districts), Shire of Murray, Arc Infrastructure, MRWA and landowners
Cost: $4,000 in year 1

8. Install fencing

Barriers such as bollards or fencing may be needed to control access and protect vegetation at Subpopulations 1b, 4a, 4b, 6e, 13 and 14. Although Subpopulation 5 is already fenced, motorbike riders often cut the fence and these holes need to be repaired to prevent access.

Action: Install fencing
Responsibility: DBCA (Swan Coastal and Perth Hills Districts), Shire of Murray, Arc Infrastructure and landowners
Cost: $10,000 in year 1; $3,000 in years 2–5

9. Implement rabbit control

The level of threat posed by rabbits may vary from year to year with environmental conditions and rabbit numbers. When monitoring ascertains that the threat is high, methods of control, such as baiting using 1080 oats, should be investigated.

Action: Implement rabbit control
Responsibility: DBCA (Swan Coastal and Perth Hills Districts), land managers/owners
Cost: $4,000 in years 1, 3 and 5

10. Undertake surveys

Surveys should be undertaken from August through October with all surveyed areas recorded and the presence or absence of *Synaphea stenoloba* documented to improve survey efficiency and prevent duplication of effort. Where feasible, volunteers will be encouraged to participate. Because *Synaphea* species are subtly different, voucher specimens must be taken from all new subpopulations to confirm the presence of *S. stenoloba*, as well as identify whether *S. stenoloba* is in a mixed subpopulation with similar taxa, to ensure that the correct species is being surveyed.

Action: Undertake surveys
Responsibility: DBCA (Swan Coastal and Perth Hills Districts), with assistance from the SRTFCRT

Cost: $10,000 per year

11. Remove rubbish

Rubbish dumped within the habitat of *S. stenoloba*, including car bodies, machinery parts, building materials, garden waste, diesel fuel containers and household waste, will need to be removed.

Action: Remove rubbish
Responsibility: DBCA (Swan Coastal and Perth Hills Districts), Shire of Murray, MRWA and ALCOA
Cost: $15,000 in year 1

12. Install signage

Signs advising people to keep to the designated pathways and boardwalk will be installed at Subpopulation 13 if deemed necessary, to prevent trampling of the plants. Signs indicating the significance of the area may also need to be introduced to Subpopulations 5 and 6b to protect vegetation.

Action: Install signage
Responsibility: DBCA (Perth Hills and Swan Coastal Districts), Shire of Murray, Arc Infrastructure and landowners
Cost: $3,000 per year

13. Develop and implement a fire management strategy

A fire management strategy will be developed in consultation with land owners/managers, the Shire of Murray and Arc Infrastructure, that recommends fire frequency, intensity and seasonality, precautions to prevent bushfire and strategies for reacting to bushfire, and the need for, method of construction and maintenance of firebreaks. The risk of fire occurring in the habitat of subpopulations should be minimised, except where it is being used to assist recovery. 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: DBCA (Swan Coastal and Perth Hills Districts), land owners/managers, Shire of Murray, Arc Infrastructure
Cost: $10,000 in year 1, and $6,000 in years 2–5

14. Undertake regeneration trials

Observational evidence suggests that appropriate natural disturbance events (physical or fire) may be the most effective means of germinating *Synaphea stenoloba* in the wild. Different disturbance techniques should be investigated (i.e. soil disturbance and fire), to determine the most successful and appropriate method. Records will need to be maintained for future research. Any disturbance trials will need to be undertaken in conjunction with weed control.

Action: Undertake regeneration trials

Responsibility: DBCA (Biodiversity and Conservation Science, Swan Coastal and Perth Hills Districts)
Cost: $10,000 in years 1 and 3, $4,000 in years 2, 4 and 5

15. Maintain disease hygiene

Although *Synaphea stenoloba* is not susceptible to *Phytophthora cinnamomi*, a decline and degradation of the habitat in which it occurs may impact on the species in the long term if dieback disease is introduced into the area. Disease hygiene measures are required for all subpopulations. Dieback hygiene (outlined in DPaW 2014) will be followed during installation and maintenance of firebreaks and when walking into subpopulations 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: DBCA (Swan Coastal and Perth Hills Districts)
Cost: $4,000 per year

16. Seek protection for subpopulations

Improved security of private property locations containing subpopulations of *S. stenoloba* and their associated habitat will be investigated and may include land acquisition for conservation reservation, conservation covenants and/or registering with the Land for Wildlife program.

Action: Seek protection for subpopulations
Responsibility: DBCA (Swan Region, SCP Nature Conservation Covenant Program and Land Unit)
Cost: $4,000 in years 1–3

17. Develop and implement a Translocation Proposal

Translocations may be required for the long-term conservation of *Synaphea stenoloba*, with the first priority being augmentation of any secure subpopulations.

Information on the translocation of Threatened plants and animals in the wild is provided in DBCA Corporate Policy Statement No. 35 (DPaW 2015*a*), DBCA Corporate Guideline No. 36 (DPaW 2015*c*) and the Australian Network for Plant Conservation (ANPC) Translocation Guidelines (Commander *et al*. 2018). A translocation may decrease the risk of extinction when a species is represented by few subpopulations and the creation of additional self-sustaining, secure subpopulations may decrease its susceptibility to catastrophic events and environmental stochasticity (Commander *et al*. 2018). For small subpopulations which may be declining in size or subject to high levels of inbreeding, successful subpopulation enhancement may increase subpopulation stability and hence long-term viability (Commander *et al*. 2018).

Depending on the characteristics of the species, a minimum viable subpopulation size of 200 to 250 mature individuals is a useful initial target (Commander *et al*. 2018), but 1,000 or more plants may be required to maintain evolutionary potential (Frankham *et al*. 2014). Suitable translocation sites may include where the taxon currently occurs, where it was known to have occurred historically, and other areas that contain similar habitat (soil, associated vegetation type and structure, aspect, mutualisms *etc*.), preferably within the known range of the taxon (Commander *et al*. 2018). Other factors that should

be considered when selecting recipient sites include the security of land tenure for conservation, the ability to effectively mitigate threats to the taxon, and potential negative consequences to existing biodiversity and cultural values at the site (Commander *et al*. 2018).

All Translocation Proposals require approval by the department's Executive Director of Biodiversity and Conservation Science. Monitoring of translocations is essential and will be included in the timetable developed for the Translocation Proposal.

Action: Develop and implement a Translocation Proposal
Responsibility: DBCA (Biodiversity and Conservation Science, Swan Coastal and Perth Hills Districts), BGPA
Cost: $42,000 in years 1–2; and $26,500 in years 3–5 as required

18. Continue to promote awareness

The importance of biodiversity conservation and the protection of *Synaphea stenoloba* will be promoted to the public through direct contact with affected land owners/managers, and more broadly through the print and electronic media, and by setting up poster displays. An information sheet that includes photographs and a description of the plant, its habitat type, threats and management actions, will be produced. Formal links with local naturalist groups and interested individuals will also be encouraged.

Action: Continue to promote awareness
Responsibility: DBCA (Swan Region, Species and Communities Program (SCP), Public Information and Corporate Affairs (PICA)), with assistance from the SRTFCRT
Cost: $7,000 in years 1–2; $5,000 in years 3–5

19. Map habitat important for the survival of *Synaphea stenoloba*

Although habitat that is important to the survival of *S. stenoloba* has previously been identified, it has not been mapped. If additional subpopulations are located, habitat important for their survival will also be determined and mapped.

Action: Map habitat important for the survival of *Synaphea stenoloba*
Responsibility: DBCA (SCP, Swan Region)
Cost: $6,000 in year 2

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

If *Synaphea stenoloba* is still listed as Threatened in Western Australia 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: DBCA (SCP, Swan Region)
Cost: $6,000 in year 5

Table 6. Summary of recovery actions

Recovery action	Priority	Responsibility	Completion date
Coordinate recovery actions	High	DBCA (Swan Region), with assistance from the SRTFCRT	Ongoing
Monitor subpopulations	High	DBCA (Swan Coastal and Perth Hills Districts), with assistance from the SRTFCRT	Ongoing
Liaise with land managers and Aboriginal communities	High	DBCA (Swan Coastal and Perth Hills Districts)	Ongoing
Undertake weed control	High	DBCA (Swan Coastal and Perth Hills Districts) and land managers	Ongoing
Collect and store seed	High	DBCA (Swan Coastal and Perth Hills Districts, TFSC)	2023
Increase biological and ecological knowledge	High	DBCA (Biodiversity and Conservation Science, Swan Coastal and Perth Hills Districts)	2021
Install, replace and reposition Threatened Flora markers	High	DBCA (Swan Coastal and Perth Hills Districts), Shire of Murray, Arc Infrastructure and landowners	2019
Install fencing	High	DBCA (Swan Coastal and Perth Hills Districts), Shire of Murray, Arc Infrastructure and landowners	2023
Implement rabbit control	High	DBCA (Swan Coastal and Perth Hills Districts), land managers/owners	Ongoing
Undertake surveys	High	DBCA (Swan Coastal and Perth Hills Districts), with assistance from the SRTFCRT	2023
Remove rubbish	High	DBCA (Swan Coastal and Perth Hills Districts), Shire of Murray, MRWA and ALCOA	2019
Install signage	High	DBCA (Perth Hills and Swan Coastal Districts), Shire of Murray, Arc Infrastructure and landowners	2019
Develop and implement a fire management strategy	High	DBCA (Swan Coastal and Perth Hills Districts), land managers/owners, Shire of Murray and Arc Infrastructure	Strategy developed initially and implementation ongoing
Undertake regeneration trials	High	DBCA (Biodiversity and Conservation Science, Swan Coastal and Perth Hills Districts)	2023
Maintain disease hygiene	High	DBCA (Swan Coastal and Perth Hills Districts)	Ongoing
Seek protection for subpopulations	High	DBCA (Swan Region, SCP Nature Conservation Covenant Program and Land Unit)	2021
Develop and implement a Translocation Proposal	High	DBCA (Biodiversity and Conservation Science, Swan Coastal and Perth Hills Districts), BGPA	2023
Continue to promote awareness	Medium	DBCA (Swan Region, SCP, Public Information and Corporate Affairs (PICA)), with assistance from the SRTFCRT	Ongoing
Map habitat important for the survival of *Synaphea stenoloba*	Medium	DBCA (SCP, Swan Region)	2020
Review this plan and assess the need for further recovery actions	Medium	DBCA (SCP, Swan Region)	2023

4. Term of plan

This plan will operate from December 2018 to December 2023 but will remain in force until withdrawn or replaced. If the species 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

Synaphea stenoloba
George, A.S. (1995) *Synaphea*. *Flora of Australia* 16: 271–316.

Stems many, to 3 cm long, pubescent. Leaves tripinnatipartite, multiplanar; each primary lobe twice tripartite; petiole 5–27 cm long, glabrous except pubescent sheath; lamina 5–18 cm long, 2.5–9 cm wide; ultimate lobes erect, linear, 1–2 mm wide, acute, concave, shallowly reticulate, glabrous (not seen young). Inflorescence much exceeding foliage; spikes 10–15 cm long; flowers crowded; peduncle simple or sparsely branched, glabrous but puberulous towards base, 10–18 cm long; rachis very sparsely puberulous; bracts ovate, obtuse, spreading, 1–1.5 mm long, glabrous except ciliate margins. Perianth opening ±widely, glabrous; adaxial tepal 4.5–5 mm long, 2 mm wide; abaxial tepal 3.5 mm long. Stigma ovate, lobed to less than a third, 1 mm long, 1–1.2 mm wide, ±convex; ovary pubescent. Fruit obovoid, 6 mm long, shortly pilose.

Known from several small subpopulations at a single locality near Pinjarra, WA. Grows on winter-damp sandy flats with low heath sedgeland. Flowers August to October.