Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Interim Recovery Plan No. **390**

Gastrolobium vestitum

Interim Recovery Plan

Department of Biodiversity, Conservation and Attractions, Western Australia

April 2020

List of Acronyms

The following acronyms are used in this plan:

ADTFCRT	Albany District Threatened Flora and Communities Recovery Team
BGPA	Botanic Gardens and Parks Authority
CALM	Department of Conservation and Land Management
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
DPaW	Department of Parks and Wildlife
DPLH	Department of Planning, Lands and Heritage
EM	Ectomycorrhizal
EN	Endangered
EPBC Act	Environment Protection and Biodiversity Conservation Act
IBRA	Interim Biogeographic Regionalisation for Australia
IRP	Interim Recovery Plan
IUCN	International Union for Conservation of Nature
Mt	Mount
NRM	Natural Resource Management
PEC	Priority Ecological Community
PICA	Public Information and Corporate Affairs
SCP	Species and Communities Program
SRNP	Stirling Range National Park
SWALSC	South West Aboriginal Land and Sea Council
TEC	Threatened Ecological Community
TFSC	Threatened Flora Seed Collection
TPFL	Threatened and Priority Flora database
UNEP-WCMC	United Nations Environment Program World Conservation Monitoring Centre
VU	Vulnerable
WA	Western Australia

Foreword

Interim recovery plans (IRPs) are developed under Section 105 of the *Biodiversity Conservation Act 2016* and 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*). In the absence of sufficient scientific information to prepare a recovery plan (RP), an IRP makes provision for the conservation, protection and management of a threatened species or ecological community in order to stop its decline and support its recovery, so that its chances of long-term survival in the wild are maximised. An IRP outlines the recovery actions that are required to address those threatening processes most affecting the ongoing survival of the threatened species or ecological community, and begin the recovery process.

DBCA is committed to ensuring that threatened species and ecological communities are conserved through the preparation and implementation of Recovery Plans (RPs) or Interim Recovery Plans (IRPs), and by ensuring that urgent conservation actions commence as soon as possible. A collaborative approach is taken towards the implementation of RPs and IRPs – DBCA works with government departments, other government bodies, research institutions, companies, individuals and other relevant organisations that are identified in a plan as stakeholders. Under Sections 103 and 113 of the *Biodiversity Conservation Act 2016*, public authorities must have regard to RPs and IRPs when performing functions that relate to matters dealt with in a plan.

This plan will operate from April 2020 and will remain in force until withdrawn or replaced. If *Gastrolobium vestitum* 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.

Notice of this plan was published in the *Western Australian Government Gazette*. The plan was given regional endorsement on 28 January 2020 and was approved by the Executive Director of Biodiversity and Conservation Science on 31 January 2020. Consultation with the Conservation and Parks Commission occurred on 14 February 2020, and the plan was available for public consultation from 19 February to 18 March 2020. The Director General of DBCA approved the plan on 30 April 2020. The attainment of objectives and the provision of funds identified in this plan are subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.

Approved IRPs are subject to amendment where deemed necessary by the Director General. Information in this plan was accurate at January 2020.

Plan preparation. This plan was prepared by:

Robyn Luu	Project Officer, DBCA Species and Communities Program, Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
Sarah Barrett	Flora Conservation Officer, DBCA Albany District, 120 Albany Highway, Albany, Western Australia 6330
Tanya Llorens	Conservation Botanist, DBCA Species and Communities Program, Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

Acknowledgments. The following people provided assistance and advice in the preparation of this plan:

Lyn Cook	Associate Professor, University of Queensland
Andrew Crawford	Research Scientist, WA Seed Centre, DBCA Biodiversity and Conservation Science
Mike Crisp	Emeritus Professor, Australian National University
Libby Sandiford	Consultant Botanist and member of Albany District Threatened Flora and Communities Recovery Team
Amanda Shade	Curator (Nursery), DBCA Botanic Gardens and Parks Authority

Thanks also to the staff of the Western Australian Herbarium for providing access to Herbarium databases and specimen information, and other DBCA staff for assistance in developing this plan.

Cover photograph by Sarah Barrett.

Citation. This plan should be cited as:

Department of Biodiversity, Conservation and Attractions (2020) *Gastrolobium vestitum* Interim Recovery Plan. Interim Recovery Plan No. 390. Department of Biodiversity, Conservation and Attractions, Western Australia.

Summary

Scientific name:	*Gastrolobium vestitum*	**Shire:**	Gnowangerup
Common name:	None	**NRM region:**	South Coast
Family:	Fabaceae	**IBRA region:**	Esperance Plains
Flowering period:	September – October	**IBRA subregion:**	Fitzgerald ESP01
DBCA region:	South Coast	**Recovery team:**	Albany District Threatened Flora and Communities Recovery Team (ADTFCRT)
DBCA district:	Albany		

Distribution and habitat: *Gastrolobium vestitum* is restricted to skeletal sandy clay loam over sandstone and quartzite on summits and mid-slopes in the Stirling Range National Park in shrubland and open scrub communities.

Habitat important for the survival of the species, and important subpopulations: All known habitat for wild subpopulations is considered to be important for the survival of the species, and all subpopulations are considered to be important for the long-term survival of the species. Habitat important for the survival of *G. vestitum* 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 surface hydrology or drainage that maintains the habitat of the species.

Conservation status: *Gastrolobium vestitum* was originally listed as specially protected under the Western Australian *Wildlife Conservation Act 1950* on 17 August 2010 and ranked as Endangered. This Act has now been superseded by the *Biodiversity Conservation Act 2016*. In January 2018, the species' ranking was reviewed and changed to Critically Endangered (CR) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 Red List criteria B1ab(iii,v)+2ab(iii,v) due to: its extent of occurrence is estimated to be less than 100 km^2; area of occupancy less than 10 km^2; and an observed, inferred or projected continuing decline in the area, extent and/or quality of habitat and the number of mature individuals. *Gastrolobium vestitum* was listed as Critically Endangered (CR) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 11 May 2018.

Threats: The threats to the species are *Phytophthora* dieback, recreational impacts, too-frequent fire, drought and browsing by herbivores.

Existing recovery actions: DBCA has been overseeing the implementation of recovery actions for *Gastrolobium vestitum*. The established Albany District Threatened Flora and Communities Recovery Team (ADTFCRT) assists with the co-ordination of recovery actions. The following recovery actions have been or are currently being implemented, and have been considered in the preparation of this plan:

1. Surveys of six mountain peaks in the Stirling Range National Park were conducted between 1994 and 1996 during the 'Biological Survey of Mountains of Southern Western Australia' project.
2. A study investigating the role of pollinators and ecology in speciation was initiated by Cook *et al*. in 2015.
3. An investigation into the fungal mycorrhizal species associated with increased plant growth was completed by Celeste Linde for *Gastrolobium vestitum* in 2009.
4. Tree guards were placed around *Gastrolobium vestitum* seedlings at Subpopulation 1a to protect the seedlings from trampling.
5. Laying of brush and installation of directional and 'Let it Grow' signs was undertaken at Subpopulation 1a where track braiding has occurred to delineate the correct path for walkers to use.
6. Seed was collected from Subpopulations 1a and 2 in 2003 and 2010 and is currently stored at –20°C in the department's Threatened Flora Seed Collection (TFSC) at the WA Seed Centre.

7. Stirling Range National Park rangers are aware of the threatened status of *Gastrolobium vestitum* and where it occurs in the park.

Plan objectives: The objectives of this plan are to abate identified threats and maintain or enhance extant subpopulations and their habitat to ensure the long-term conservation of the species in the wild.

Performance criteria

Criteria for success
The objectives of this plan will have been achieved 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 individuals within known subpopulations has increased by >10%; or
- New subpopulations have been found, increasing the number of extant subpopulations from two to three or more with no net loss of mature individuals; or
- The area of occupied habitat has increased by >10% with no net loss of mature individuals.

Criteria for failure
The objectives of this plan will not have been achieved if one or more of the following take place over the term of the plan:

- Any subpopulation has been lost; or
- The number of mature individuals has decreased by >10%; or
- The area of occupied habitat has decreased by >10% with a net loss of mature individuals.

Recovery actions

1. Monitor subpopulations
2. Assess the need for phosphite and apply if necessary
3. Maintain disease hygiene
4. Implement actions to reduce recreational impacts
5. Implement fire exclusion for both subpopulations
6. Continue to protect seedlings from trampling and potentially browsing where necessary
7. Collect and store seed
8. Undertake surveys
9. Acquire biological and ecological knowledge
10. Consider the development of a translocation proposal
11. Liaise with Stirling Range National Park staff and Aboriginal communities
12. Promote awareness
13. Map habitat important for the survival of *Gastrolobium vestitum*
14. Review this plan and evaluate its performance

1. Background

History

The earliest known collection of *Gastrolobium vestitum* was made from the 'Stirling Range' in 1881 by J. Forrest. Since then, a number of surveys have occurred within the Stirling Range National Park (SRNP), including during the Biological Survey of Mountains in the South West from 1994 to 1996 (Barrett 1996), but no new subpopulations have been found until 2006, when Subpopulation 1b was located. The species was described by Karel Domin in 1923 as *Nemcia vestita* from specimens collected in the Stirling Range, east of Mt Toolbrunup (Domin 1923). Chandler *et al*. (2002) then published a monograph of *Gastrolobium* in which they synonymised *Nemcia* under *Gastrolobium* and as a result, changed the generic and specific epithets of *Nemcia vestita* to *G. vestitum*.

Gastrolobium vestitum is only known from two subpopulations, currently consisting of approximately 250 mature individuals and 90 juveniles and seedlings (inter-fire recruits) following a bushfire that impacted all populations in late December 2019 (Tables 1 and 2). Populations are threatened by *Phytophthora* dieback, recreational impacts, browsing by herbivores, too frequent fire and drought.

Description

Gastrolobium vestitum is an upright shrub to one to three metres tall, with thick branches and dark grey-green leaves. The leaves are opposite with strongly recurved margins, elliptic to rhombic in shape and 3 to 4.5 cm long and 2.5 to 3.5 cm wide. The underside of the leaf is covered in soft hairs. The inflorescences are axillary and contain four yellow-red flowers (Chandler *et al*. 2002). Flowering occurs in September and October (Western Australian Herbarium 1998).

Gastrolobium vestitum is similar to *G. luteifolium*, *G. leakeanum*, *G. mondurup* and *G. rubrum* but differs from all these species in its fleshy petals, rhombic leaves, recurved leaf margins and is generally more hairy (Chandler *et al*. 2002).

Illustrations and/or further information

Chandler, G.T., Crisp, M.D., Cayzer, L.W. and Bayer, R.J. (2002) Monograph of *Gastrolobium* (Fabaceae: Mirbelieae). *Australian Systematic Botany* 15: 619–739.

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

Distribution and habitat

Gastrolobium vestitum is endemic to Western Australia where it is restricted to skeletal sand clay loam over sandstone and quartzite on summits and mid-slopes in the SRNP (Tables 1 and 2). Habitat consists of shrubland and open scrub/herbland communities consisting of *Calothamnus montanus, Hakea florida, Banksia formosa, Kunzea montana, Lasiopetalum dielsii* (Priority 2), *Acacia veronica* (Priority 3)

Platysace sp. Stirling (J.M. Fox 88/262) (Priority 4), *Velleia foliosa*, *Stypandra glauca*, *Xerochrysum macranthum*, *Billardiera drummondii* and *Actinotus rhomboideus* (Priority 4). The extent of occurrence for extant subpopulations is 8 km^2 and the area of occupancy is estimated to be 8 km^2 using the IUCN 2 x 2 km grid method.

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

TPFL subpopulation number & location	DBCA district	Shire	Vesting	Purpose	Manager
1a. Mt Toolbrunup	Albany	Gnowangerup	Conservation and Parks Commission (CPC)	National park	DBCA
1b. Mt Toolbrunup	Albany	Gnowangerup	CPC	National park	DBCA
2. Mt Hassell	Albany	Gnowangerup	CPC	National park	DBCA

Biology and ecology

Gastrolobium vestitum has a juvenile period of approximately four to five years and is likely to be bird-pollinated. Plants of *G. vestitum* have significantly lower seed set : ovule ratios compared to other *Gastrolobium* species, which may result from fewer pollinator visits or the delivery of incompatible pollen (Lyn Cook[1], pers. comm).

Plants are killed by fire and regenerate from soil-stored seed. The longevity of soil-stored seeds, and the dynamics of the seed bank, are unknown. Inter-fire recruitment has been observed on the summit of Mt Toolbrunup as old mature plants have died, and a range of plant ages were present at this site compared to more even-aged stands on the slopes. Until the December 2019 bushfire, both subpopulations had last been burnt in 1996 with pockets of the species escaping in rocky summit areas. Inter-fire seedling establishment at 23 years post fire had been observed to be relatively poor. Plant densities had declined with time since fire as plants increased in volume. The maximum age of *G. vestitum* plants is unknown; however, a small number of individuals in rocky summit areas in both subpopulations escaped the 1996 fires and may potentially have been up to 39 years old in 2019.

On 28 December 2019, a bushfire burned a section of the SRNP and has significantly impacted both subpopulations of *G. vestitum*. Satellite imagery and ground surveys indicate that most if not all mature plants in Subpopulations 1b and 2 were killed by the fire, but some 250 mature plants and 90 juveniles and seedlings in Subpopulation 1a escaped fire on the summit of Mt Toolbrunup. Due to the long inter-fire interval following the 1996 fire, it is likely that in 2019 there existed a soil-stored seed bank of sufficient magnitude to potentially enable post-fire regeneration of the subpopulations, provided that other conditions are favourable.

Gastrolobium vestitum contains a suite of mycorrhizal associations with at least 11 ectomycorrhizal (EM) associations detected from only 10 individuals on Mt Toolbrunup and Mt Hassell (Linde 2009). As EM diversity plays an important role in plant diversity and performance, it appears that mycorrhizal associations do not pose a limiting factor for the growth of the species (Linde 2009).

Gastrolobium vestitum occurs on skeletal soils on summits and ridges with deeper soils present in gullies. Plants of shallow-soil endemics often possess a specialised root system that allows them to explore a rocky area and locate cracks in the underlying rock (Poot and Lambers 2008).

[1] Associate Professor, University of Queensland

Gastrolobium vestitum is susceptible to *Phytophthora* dieback (*Phytophthora cinnamomi*) and all habitat is considered to have been long infested with few dieback-susceptible plant species persisting. A quantified risk assessment undertaken by Barrett *et al*. (2008) found *P. cinnamomi* had a direct impact score of 7.1 out of 10 on *G. vestitum* based on shade house inoculation experiments. This, in combination with percentage of habitat infested and other threatening processes, resulted in a 'High' extinction risk score of 26.1 out of 36. Root samples taken from a recently-dead individual in Subpopulation 2 on Mt Hassell in 2007 tested positive for *P. cinnamomi*. Ongoing scattered deaths have been observed on the Toolbrunup summit area since 2011, but sampling is required to verify whether disease is the cause of the deaths, as drought and/or age may also be a factor.

Conservation status

Gastrolobium vestitum was originally listed as specially protected under the Western Australian *Wildlife Conservation Act 1950* on 17 August 2010 and ranked as Endangered. This Act has now been superseded by the *Biodiversity Conservation Act 2016*. In January 2018, the species' ranking was reviewed and changed to Critically Endangered (CR) in Western Australia under International Union for Conservation of Nature (IUCN) 2001 Red List criteria B1ab(iii,v)+2ab(iii,v) due to: its extent of occurrence is estimated to be less than 100 km^2; area of occupancy less than 10 km^2; and an observed, inferred or projected continuing decline in the area, extent and/or quality of habitat and the number of mature individuals. *Gastrolobium vestitum* was listed as Critically Endangered (CR) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 11 May 2018.

Threats

The following threats to the survival of *Gastrolobium vestitum* have been identified:

- ***Phytophthora* dieback** (*Phytophthora cinnamomi*). Since 2007, ongoing scattered deaths of *Gastrolobium vestitum* have been observed at Subpopulation 1a. From 2011 onwards, a higher mortality rate was recorded of approximately 2%. Deaths have been most apparent in the summit area of Mt Toolbrunup and further sampling is required to verify that *P. cinnamomi* is causing this mortality. Scattered deaths have also been observed in Subpopulation 2 with *P. cinnamomi* confirmed through samples taken in 2007. The reduced abundance of this species and other susceptible species from the summits, northern ridges and slopes of Mt Toolbrunup and Mt Hassell, where it is assumed that *G. vestitum* would have previously occurred, is likely associated with the higher impact of *P. cinnamomi* in more exposed habitat with higher soil temperatures. The species appears to be persisting in shaded gullies and southern slopes that are less conducive to the pathogen. Habitat composition changes may also impact on the species and its habitat over the long term.
- **Recreational users.** Increased visitation to Mt Toolbrunup has seen a number of new tracks being created within habitat in the summit area, resulting in the compaction and erosion of soil. Observations by Libby Sandiford (Albany District Threatened Flora and Communities Recovery Team, (ADTFCRT)) have also determined that *G. vestitum* germinants have been dislodged or trodden on and tree guards which have been installed for seedling protection have been knocked over. Brushing, signage and directional markers have also been dislodged or removed. Visitors continue to leave the designated path, particularly when descending.
- **Fire.** Fire that occurs too frequently may cause a decline in numbers of individuals, as multiple fires that occur in short succession can kill plants and deplete the soil seed bank. Continued climatic warming and drying is likely to increase fire frequency which, synergistically, increase the risk of

recruitment failure due to repeated fire events and extreme drought stress. On 28 December 2019, a bushfire burned a section of the SRNP and has had a significant impact on all subpopulations of *G. vestitum*. Although the soil may contain a sizable seed bank, successful post-fire regeneration of the subpopulations will depend upon adequate germination, favourable climatic conditions to enable plant survival and recruitment, and protection of plants from recreational users, herbivore browsing and the impacts of *Phytophthora*. If any subpopulation is subjected to further fire within the presumed juvenile period of four to five years, its future viability is likely to be severely compromised by inadequate seed bank size. Given the likely negative impact of a drying climate on the survival, growth and reproductive rates of individuals, a fire-free interval of at least 10 years will probably be necessary to enable adequate seedbank replenishment. Although unlikely to be of concern in the future, very long intervals between fires may also be detrimental to subpopulations, evidenced by observations of poor inter-fire seedling establishment at 23 years post fire. Plant densities at all subpopulations had declined with time following the 1996 fire.

- **Drought.** Continuing drought is a future threat to the species and may cause plant stress and death, particularly where individuals are growing on shallow soil. Drought is also likely to hinder seedling growth and survival.
- **Browsing by herbivores.** Browsing of foliage has not been observed despite previous signs of browsing of other plant species by Quokka (*Setonix brachyurus*) and browsing of a related species (*G. leakeanum*) on Bluff Knoll. Close monitoring of potential browsing and possible protective measures are required for seedlings that germinate post-fire or inter-fire. Observations have also been made of invertebrates (a weevil) grazing leaves of *G. vestitum* seedlings.

The intent of this plan is to provide actions that will mitigate immediate threats to *Gastrolobium vestitum*. 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 2. Summary of subpopulation information and threats

TPFL subpopulation number & location	Land status	Year / no. of individuals	Current condition of:		Recent fire history	Threats
			Plants	Habitat		
1a. Mt Toolbrunup	National park	1999 ~1,000 (2,000) 2003 ~5,000 2007 ~5,000 2009 ~5,600 2011 ~5,600 [2% dead] 2015 ~2,320 2019 2,000 (30) 2020 ~ 250 (60/30)	Moderate to healthy	Moderate	1996 (BF) 28/12/2019 (BF)	Recreational users, disease, fire, drought, herbivory
1b. Mt Toolbrunup	National park	2006 ~4,000 (100) [10 dead] 2020 0	Healthy	Moderate	1996 (BF) 28/12/2019 (BF)	Recreational users, disease, fire, drought, herbivory
2. Mt Hassell	National park	2000 10 (500) 2005 ~5,000 2007 ~5,000 2008 ~5,000 2010 ~5,000 2011 ~5,000 [2% dead] 2016 ~1,000 2019 850 2020 0	Moderate to healthy	Moderate	1996 (BF) 28/12/2019 (BF)	Disease, herbivory, fire, drought

Note: () = number of juveniles/seedlings. Fire history refers to bushfire (BF) events where details are known or suspected.

Guide for decision-makers

Section 1 provides details of current and possible future threats. Actions that result in any of the following may potentially produce 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;
- Spread or amplification of dieback disease.

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

All subpopulations and all known habitat for the subpopulations are considered to be important for the survival of the species. Habitat important for the survival of *G. vestitum* 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 surface hydrology or drainage 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 *Gastrolobium vestitum* will also protect and improve the habitat of four threatened flora and 11 priority flora species listed in Table 3.

Table 3. Conservation-listed flora species occurring in the vicinity of *Gastrolobium vestitum*

Species name	Conservation status (WA)	Conservation status (EPBC Act)
Hibbertia barrettiae	Threatened (CR)	CR
Leucopogon gnaphalioides (likely locally extinct)	Threatened (CR)	EN
Sphenotoma drummondii	Threatened (EN)	EN
Deyeuxia drummondii	Threatened (VU)	EN
Gastrolobium crenulatum	Priority 2	-
Gonocarpus rudis	Priority 2	-
Lasiopetalum dielsii	Priority 2	-
Schoenus sp. Stirling (G.J. Keighery 3427)	Priority 2	-
Spyridium montanum	Priority 2	-
Stylidium oreophilum	Priority 2	-
Thomasia brachystachys	Priority 2	-
Acacia veronica	Priority 3	-
Actinotus rhomboideus	Priority 4	-
Platysace sp. Stirling (J.M. Fox 88/262)	Priority 4	-
Stylidium rosulatum	Priority 4	-

For a description of conservation codes for Western Australian flora and fauna see https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Conservation%20code%20definitions.pdf

This IRP will be implemented in conjunction with the IRP for *Leucopogon gnaphalioides*. Management of the species has been incorporated into the Stirling Range and Porongurup National Parks Management Plan (CALM 1999).

Gastrolobium vestitum occurs within the 'Montane Mallee Thicket of the Stirling Range' ecological community, which is listed as Priority 1 in Western Australia[2].

Two threatened fauna species, the Quokka (*Setonix brachyurus*) and the Toolbrunup Assassin Spider (*Zephyrarchaea melindae*) (both listed as VU in WA), and the priority-listed Glauert's Land Snail (*Bothriembryon glauerti*) (priority 2), may also benefit from the management of *Gastrolobium vestitum*.

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. *Gastrolobium vestitum* 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.

Stakeholder consultation

In the course of preparing this plan, the authors consulted with the following stakeholders:

- Conservation and Parks Commission

Aboriginal engagement

Involvement of the Aboriginal community will be sought through the working group for the Wagyl Kaip and Southern Noongar Regional Corporation of the South West Native Title Settlement, to assist in the identification of cultural values for land occupied by *Gastrolobium vestitum*, to identify any groups with a cultural connection to land that is important for the species' conservation, and to determine whether there are any community issues or interests identified in the IRP. Continued liaison between DBCA and the Aboriginal community will identify areas in which collaboration will assist implementation of recovery actions. The opportunity for involvement of the Aboriginal community in the implementation of the plan is included as a recovery action.

A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Sites Register did not reveal any sites of Aboriginal significance adjacent to subpopulations of *G. vestitum*. The species occurs within the SRNP which is known to be culturally significant to Aboriginal people. 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.

[2] For definitions and categories of Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) see: https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf

Social and economic impacts

All subpopulations of *Gastrolobium vestitum* occur on land that is managed by DBCA. The implementation of this IRP may have some economic impact through the cost of implementing recovery actions such as controlling recreational impacts and *Phytophthora* dieback.

Affected interests

All subpopulations occur within a national park for which DBCA has primary management responsibility.

Evaluation of the plan's performance

DBCA, with the assistance of the ADTFCRT, will evaluate the performance of this plan. The plan will be reviewed following five years of implementation.

2. Recovery objectives and criteria

Plan objectives

The objectives of this plan are to abate identified threats and maintain or enhance extant subpopulations and their habitat, to ensure the long-term conservation of *Gastrolobium vestitum* in the wild.

Performance criteria

Criteria for success
The objectives of this plan will have been achieved 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 individuals within known subpopulations has increased by >10%; or
- New subpopulations have been found, increasing the number of extant subpopulations from two to three or more with no net loss of mature individuals; or
- The area of occupied habitat has increased by >10% with no net loss of mature individuals.

Criteria for failure
The objectives of this plan will not have been achieved if one or more of the following take place over the term of the plan:

- Any subpopulation has been lost; or
- The number of mature individuals has decreased by >10%; or
- The area of occupied habitat has decreased by >10% with a net loss of mature individuals.

3. Recovery actions

Existing recovery actions

DBCA is overseeing the implementation of recovery actions for *Gastrolobium vestitum*. The established ADTFCRT assists with the co-ordination of recovery actions.

During the 'Biological Survey of Mountains of Southern Western Australia' between 1994 and 1996, surveys of six mountain peaks were conducted in the SRNP but no subpopulations of *Gastrolobium vestitum* were found (Barrett 1996). Extensive surveys have been conducted in the SRNP since 1996. A trial drone survey was conducted on remote slopes from Mt Hassell in spring 2019, but no new subpopulations were located.

A pollination study on the species was initiated by Cook *et al*. in 2015. The study aimed to test the following hypotheses:

- Red colouration evolves before other bird-pollination syndrome traits as turning red immediately repels bees causing pollinator-mediated selection to be focused on birds.
- Pollinator selection genetically structures populations prior to speciation as most species of *Gastrolobium* have yellow, bee-pollinated flowers.

Field collections of leaves and pods of *Gastrolobium rubrum*, *G. crenulatum*, *G. leakeanum*, *G. luteifolium*, *G. mondurup* and *G. vestitum* were made in December 2015, and October and December 2016. The number of seeds per pod and the number of funicles were scored and seed predation was recorded. DArTseq data was obtained for all the species to investigate past geneflow across the landscape, but analysis has not yet been completed (*pers comm*. Lyn Cook).

An investigation of the fungal mycorrhizal species associated with increased plant growth in *Gastrolobium vestitum* was completed by Celeste Linde (Australian National University) in 2009.

Trail assessment and management works have been undertaken on Mt Toolbrunup and include:

- Installation of tree guards to protect *Gastrolobium vestitum* germinants and seedlings from trampling and potential grazing;
- Brushing and installation of directional and 'Let it Grow' signs where track braiding has occurred to delineate the correct path for walkers to use. However, visitors continue to leave the track and have difficulty finding the correct track down from the summit.

Susceptibility to *P. cinnamomi* was assessed in a shade house inoculation experiment and a risk of extinction determined (Barrett *et al*. 2008).

Seed was collected from Subpopulations 1 and 2 in 2003 and 2010 and is stored in the Threatened Flora Seed Collection (TFSC) at the WA Seed Centre, DBCA at –20°C (see Table 4).

Table 4. WA Seed Centre collection details for *Gastrolobium vestitum*

Accession	Date collected	TPFL subpopulation	Individuals in storage[1]	Seeds in storage	Estimated germinable seeds
01148-1	3/01/2003	1	B/250	2,241	2,127
03387-1	17/12/2010	2	B/100	1,032	not yet tested

[1] 'B' = a bulk collection/number of individual plants that seeds were collected from

SRNP rangers are aware of the location and Threatened status of *Gastrolobium vestitum* and have been involved in visitor and track management within its habitat.

Future recovery actions

DBCA will continue to oversee the implementation of recovery actions for *Gastrolobium vestitum*. The ADTFCRT helps to coordinate recovery activities for many species and ecological communities, including *G. vestitum*.

The following recovery actions are listed approximately 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. If recovery actions are to be implemented on lands other than those managed by DBCA, permission will be sought from the appropriate land managers prior to actions being undertaken.

1. Monitor subpopulations

Monitoring of subpopulations and associated habitat should be undertaken regularly to further refine subpopulation estimates and identify trends or potential management requirements. At least one subpopulation should be monitored annually. Following the December 2019 bushfire, all subpopulations will require monitoring to determine fire impacts and assess post-fire regeneration. Subpopulation monitoring should record the health and expansion or decline in subpopulations, and other observations such as pollinator activity or seed production. Site monitoring should include observations of vertebrate browsing, habitat degradation including presence of *Phytophthora* dieback, weed invasion, and hydrological status (drought). Specific monitoring of hydrology and activities relating to research into the biology and ecology of *Gastrolobium vestitum* are included in other recovery actions detailed below.

Action: Monitor subpopulations
Responsibility: DBCA (Albany District)
Cost: $10,000 per year

2. Assess need for aerial phosphite application and apply if required

As the habitat in which *Gastrolobium vestitum* occurs is infested with *Phytophthora* dieback, DBCA will further assess whether observed plant deaths are due to the disease and apply phosphite to both subpopulations as required. Application of phosphite to the habitat of *G. vestitum* will also protect other threatened flora species.

Action: Assess need for aerial phosphite application and apply if required
Responsibility: DBCA (Albany District)

Cost: $5,000 per year ($667 per hectare for 7.3 hectares)

3. Maintain disease hygiene

Disease hygiene as outlined in DPaW (2015*d*) will be followed where subpopulations remote from dieback infested walk trails are being surveyed with access restricted to dry conditions where possible and additional hygiene measures undertaken during moist soil conditions.

Action: Maintain disease hygiene
Responsibility: DBCA (Albany District)
Cost: $3,000 per year

4. Implement actions to reduce recreational impacts

Several management actions have been undertaken to reduce the impact of trail users on Mt Toolbrunup, with limited results. These have included installation of signage, directional markers, brushing of vegetation and erosion control. Some of these will need to be replaced following the 2019 bushfire. Further action will be investigated and implemented to encourage visitors to stay on the main trail path to minimise trampling of seedlings and damage to mature plants. Proposed future actions will include improved track marking and an interpretative panel explaining the significant flora values of the summit area and the need to stay on the path.

Action: Implement actions to reduce recreational impacts
Responsibility: DBCA (Albany District)
Cost: $4,000 per year

5. Implement fire exclusion for both subpopulations

Fire is known to kill mature plants of *Gastrolobium vestitum* and may be detrimental to the species' long-term survival if it occurs before plants reach maturity and replenish the soil seed store. For the life of this plan fire will, if possible, be prevented from occurring in the vicinity of both *G. vestitum* subpopulations, unless it is determined to be required for ecological regeneration.

Action: Implement fire exclusion for both subpopulations
Responsibility: DBCA (Albany District)
Cost: $1,000 per year

6. Continue caging/fencing individuals where necessary

Seedlings that germinate should be closely monitored for signs of trampling and /or herbivory and fencing or caging of individuals or groups of plants should be undertaken in high priority areas as soon as possible. The source of herbivory, if determined to be present, should be determined using infra-red cameras.

Action: Continue caging individuals where necessary
Responsibility: DBCA (Albany District)
Cost: $10,000 in year 1; $8,000 per years 2–5

7. Collect and store seed

To guard against the possible future extinction of known natural subpopulations it is recommended that additional seed be collected and stored at the TFSC at the WA Seed Centre once plants mature. Collections should aim to sample and preserve the maximum range of genetic diversity possible.

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

8. Undertake surveys

Opportunistic surveys for potential new occurrences or extensions to known subpopulations should be undertaken in areas of potential habitat. If possible, surveys should be conducted in September or October when plants are flowering and more visible in the landscape. All surveyed areas should be recorded and the presence or absence of *Gastrolobium vestitum* documented to improve survey efficiency and prevent duplication of effort. Due to the remote, rocky, steep terrain and the instability of scree slopes, the use of drones will be investigated as a potentially effective and safer method of survey.

Action: Undertake surveys
Responsibility: DBCA (Albany District)
Cost: $7,000 per year

9. Acquire biological and ecological knowledge

It is recommended that research on the biology and ecology of *Gastrolobium vestitum* include:

1. Identification of pollinators and their habitat requirements;
2. Soil seed bank dynamics and seed viability;
3. The effect of fire interval, season, climatic conditions and vertebrate browsing on recruitment and survival;
4. Longevity of individuals, time taken to reach maturity, and minimum viable population size; and
5. The impact of *Phytophthora* dieback and the effectiveness of control techniques.

Action: Acquire biological and ecological knowledge
Responsibility: DBCA (Biodiversity and Conservation Science, Albany District)
Cost: $50,000 in years 1–3

10. Consider the development of a translocation proposal

Translocations may be required for the long-term conservation of *Gastrolobium vestitum*, with the priority being establishment of new subpopulation/s in suitable habitat in an area removed from recreational disturbance and *P. cinnamomi* infestation.

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 that 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 translocation target (Commander *et al*. 2018), but 1,000 or more individuals may be required to maintain evolutionary potential (Frankham *et al*. 2014). Suitable translocation sites may include where the species 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 species (Commander *et al*. 2018). However, if translocation to a *Phytophthora* dieback-free site is considered to be a pre-requisite, then novel habitat outside of the Stirling Range may need to be considered also, due to the extent of this disease within the Park. 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 species, and potential negative consequences to existing biodiversity and cultural values at the site (Commander *et al*. 2018).

All translocation proposals require the approval of DBCA's Executive Director of Biodiversity and Conservation Science. Monitoring of translocations and reporting against success criteria are essential components of a translocation and will be included in the timetable developed for the translocation proposal.

Action: Consider the development of a translocation proposal
Responsibility: DBCA (Biodiversity and Conservation Science, Albany District)
Cost: $42,000 in years 1 and 2; and $26,500 in years 3–5 as required

11. Liaise with Stirling Range National Park staff and Aboriginal communities

Staff from DBCA Albany District will liaise with Stirling Range National Park staff to ensure that subpopulations of *Gastrolobium vestitum* are not accidentally damaged or destroyed and the habitat is maintained in a suitable condition for the conservation of the species. The protection of the species will also be considered when developing and implementing a trail works program for Mt Toolbrunup. Consultation with the Aboriginal community will take place to determine if they have any issues or interests in areas that provide habitat for the species.

Action: Liaise with Stirling Range National Park staff and Aboriginal communities
Responsibility: DBCA (Albany District)
Cost: $4,000 per year

12. Promote awareness

The importance of biodiversity conservation and the protection of *Gastrolobium vestitum* will be promoted through direct contact with relevant departmental staff, and more broadly through the print and electronic media and by setting up poster displays. Formal links with naturalist groups and interested individuals will also be encouraged.

Action: Promote awareness
Responsibility: DBCA (Albany District, Species and Communities Program (SCP) and Public Information and Corporate Affairs (PICA))
Cost: $7,000 in years 1 and 2; $5,000 in years 3–5

13. Map habitat important for the survival of *Gastrolobium vestitum*

Although spatial data relating to habitat that is important for the survival of *Gastrolobium vestitum* has been identified in Section 1, 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 *Gastrolobium vestitum*
Responsibility: DBCA (SCP, Albany District)
Cost: $6,000 in year 2

14. Review this plan and evaluate its performance

DBCA, in conjunction with the ADTFCRT, will evaluate the performance of this Interim Recovery Plan. If *Gastrolobium vestitum* is still listed as threatened in Western Australia following five years of implementation of this plan, the plan will be reviewed and an assessment made of the need for a new or revised plan.

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

Table 5. Summary of recovery actions

Recovery action	Priority	Responsibility	Completion date
Monitor subpopulations	High	DBCA (Albany District)	Ongoing
Assess the need for and apply phosphite as required	High	DBCA (Albany District)	Ongoing
Maintain disease hygiene	High	DBCA (Albany District)	Ongoing
Implement actions to reduce recreational impacts	High	DBCA (Albany District)	Ongoing
Implement fire exclusion for both subpopulations	High	DBCA (Albany District)	Ongoing
Continue caging individuals where necessary	High	DBCA (Albany District)	Ongoing
Collect and store seed	High	DBCA (Albany District, TFSC)	2024
Undertake surveys	High	DBCA (Albany District)	Ongoing
Acquire biological and ecological knowledge	High	DBCA (Biodiversity and Conservation Science, Albany District)	2022
Consider the development of a translocation proposal	High	DBCA (Biodiversity and Conservation Science, Albany District)	2024
Liaise with Stirling Range National Park staff and Aboriginal communities	Medium	DBCA (Albany District)	Ongoing
Promote awareness	Medium	DBCA (Albany District, SCP and PICA)	Ongoing
Map habitat important for the survival of *Gastrolobium vestitum*	Medium	DBCA (Albany District)	2021
Review this plan and assess the need for further recovery actions	Medium	DBCA (SCP, Albany District)	2024

4. Term of plan

This plan will operate from April 2020 and will remain in force until withdrawn or replaced. If *Gastrolobium vestitum* is still listed as threatened following five years of implementation, the plan will be reviewed and the need for further recovery actions assessed.

5. References

Barrett, S. (1996) *Biological Survey of Mountains of Southern Western Australia*. Department of Conservation and Land Management, Albany.

Barrett, S., Shearer, B.L., Crane, C.E. and Cochrane, A. (2008) An extinction-risk assessment tool for flora threatened by *Phytophthora cinnamomi*. *Australian Journal of Botany* 56: 477–486.

Chandler, G.T., Crisp, M.D., Cayzer, L.W. and Bayer, R.J. (2002) Monograph of *Gastrolobium* (Fabaceae: Mirbelieae). *Australian Systematic Botany* 15: 619–739.

Commander, L.E., Coates, D.J., Broadhurst, L., Offord, C.A., Makinson, R.O. and Matthes, M. (2018) Guidelines for the Translocation of Threatened Plants in Australia. Third Edition. *The Australian Network for Plant Conservation*. Canberra, Australia.

Cook, L., Toon, A., Ortiz-Barrientos, D. and Crisp, M. (2015) Going red with altitude: how do pollinators structure pea populations across an ecological gradient? The University of Queensland; Australian National University.

Department of Conservation and Land Management (1999) *Stirling Range and Porongurup National Parks Management Plan*. Department of Conservation and Land Management, Western Australia.

Department of Environment and Conservation (2011) Leucopogon gnaphalioides *Interim Recovery Plan No. 334, 2011–2016*. Department of Environment and Conservation, Western Australia.

Department of Parks and Wildlife (2015*a*) Corporate Policy Statement No. 35 *Conserving Threatened Species and Ecological Communities*. Perth, Western Australia.

Department of Parks and Wildlife (2015*b*) Corporate Guideline No. 35 *Listing and Recovery of Threatened Species and Ecological Communities*. Perth, Western Australia.

Department of Parks and Wildlife (2015*c*) Corporate Guideline No. 36 *Recovery of Threatened Species through Translocation and Captive Breeding or Propagation*. Perth, Western Australia.

Department of Parks and Wildlife (2015*d*) Corporate Policy Statement No. 3 *Management of* Phytophthora *disease*. Department of Parks and Wildlife, Western Australia.

Domin, K. (1923) *Nemcia*, a new genus of the Leguminosae. *Preslia* 2: 27–28.

Frankham, R., Bradshaw, C.J.A. and Brook, B.W. (2014) Genetics in conservation management: Revised recommendations for the 50/500 rules, Red List criteria and population viability analyses. *Biological Conservation* 170: 56 – 63.

Linde, C. (2009) Mycorrhizal associations of *Gastrolobium vestitum*. Final Report to the Australian Flora Foundation.

Poot, P. and Lambers, H. (2008) Shallow-Soil Endemics: Adaptive Advantages and Constraints of a Specialized Root-System Morphology. *The New Phytologist* 178(2): 371–381.

Western Australian Herbarium (1998–) *FloraBase– the Western Australian Flora*. Department of Parks and Wildlife. http://florabase.dpaw.wa.gov.au/.

World Conservation Union (2001) *IUCN Red List Categories: Version 3.1*. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

6. Taxonomic description

Description by Gregory Chandler, Michael Crisp, Lindy Cayzer and Randall Bayer from *Australian Systematic Botany* 15: 619–739 (2002).

Erect, arborescent *shrubs*, 1–3 m high. *Branchlets* ascending, compressed, angular, ridged, densely villous. *Petioles* terete, continuous and decurrent with the branchlet, up to 10 mm long. *Leaves* spreading, opposite, elliptic to ± rhombic, 30–45 x 25–35 mm, upper surface with prominent venation, lower surface moderately to densely villous, especially along the veins; apex truncate to retuse; margins strongly recurved; base rounded. *Stipules* erect, *c.* 15 mm long, mostly villous. *Inflorescences* axillary umbels, 4-flowered; *peduncle* compressed, ridged, 10–18 mm long; *rachis* nil; *subtending bracts* somewhat persistent to caducous, scale-like, semi-globose, shallowly trifid, up to 18 mm long including 8–13-mm midrib decurrent extension, densely tomentose. *Flowers*: not resupinate, erect; *pedicels* terete, 4–5 mm long, densely pubescent. *Calyx* 12–13 mm long including the *c.* 1.5-mm receptacle, densely pubescent, unicoloured, with either golden brown or white villous hairs only present, or bicoloured, with both golden brown and white hairs present, upper 2 lobes recurved, lower 3 lobes straight; upper 2 lobes united higher than the lower 3, ±obtuse, *c.* 6 mm long; lower 3 lobes triangular, subacute, *c.* 5.5 mm long. *Corolla*: *standard* transversely elliptic, fleshy, not fully reflexed, giving a hooded appearance, 16–18 x 17–18 mm including the 6.5-mm claw, margins orange, deep red at base with yellow markings, apex emarginate, base cordate, slightly auriculate; *wings* broadly obovate, 16–17 x 6 mm including the 5.5–6-mm claws, deep red, apex rounded, incurved and touching, ± enclosing the keel, base truncate,

not or very scarcely auriculate on the upper margin only, saccate; *keel* half broadly elliptic, incurved longitudinally, 16−17 x 6 mm including the 6-mm claws, deep red, margins not incurved, apex broadly rounded, base auriculate, saccate. *Style* very long, strongly incurved, lower-third pubescent; *ovary* shortly stipitate, densely pubescent; *ovules* 4 or more. *Pod* sessile, ovoid, 10−12 x 6−7 mm, moderately to densely villous. *Seed* not seen.