

Consultation on Species Listing Eligibility and Conservation Actions

Drosera gibsonii (Gibson's pygmy sundew)

You are invited to provide your views and supporting reasons related to:

1) the eligibility of *Drosera gibsonii* (Gibson's pygmy sundew) for inclusion on the EPBC Act threatened species list in the Endangered category; and

2) the necessary conservation actions for the above species.

The purpose of this consultation document is to elicit additional information to better understand the status of the species and help inform on conservation actions and further planning. As such, the below draft assessment should be considered to be **tentative** as it may change following responses to this consultation process.

Evidence provided by experts, stakeholders and the general public are welcome. Responses can be provided by any interested person.

Anyone may nominate a native species, ecological community or threatening process for listing under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or for a transfer of an item already on the list to a new listing category. The Threatened Species Scientific Committee (the Committee) undertakes the assessment of species to determine eligibility for inclusion in the list of threatened species and provides its recommendation to the Australian Government Minister for the Environment.

Responses are to be provided in writing by email to: <u>species.consultation@environment.gov.au</u>

Please include species scientific name in Subject field.

or by mail to:

The Director Bushfire Affected Species Assessments Section Department of Agriculture, Water and the Environment John Gorton Building, King Edward Terrace GPO Box 858 Canberra ACT 2601

Responses are required to be submitted by 24 March 2022.

Contents of this information package	Page
General background information about listing threatened species	2
Information about this consultation process	3
Consultation questions specific to the assessment	4
Information about the species and its eligibility for listing	12
Conservation actions for the species	27
References cited	29
Listing assessment	34

General background information about listing threatened species

The Australian Government helps protect species at risk of extinction by listing them as threatened under Part 13 of the EPBC Act. Once listed under the EPBC Act, the species becomes a Matter of National Environmental Significance (MNES) and must be protected from significant impacts through the assessment and approval provisions of the EPBC Act. More information about threatened species is available on the department's website at: https://www.awe.gov.au/environment/biodiversity/threatened.

Public nominations to list threatened species under the EPBC Act are received annually by the department. In order to determine if a species is eligible for listing as threatened under the EPBC Act, the Threatened Species Scientific Committee (the Committee) undertakes a rigorous scientific assessment of its status to determine if the species is eligible for listing against a set of criteria. These criteria are available on the Department's website at: http://www.awe.gov.au/system/files/pages/d72dfd1a-f0d8-4699-8d43-5d95bbb02428/files/tssc-guidelines-assessing-species-2021.pdf.

As part of the assessment process, the Committee consults with the public and stakeholders to obtain specific details about the species, as well as advice on what conservation actions might be appropriate. Information provided through the consultation process is considered by the Committee in its assessment. The Committee provides its advice on the assessment (together with comments received) to the Minister regarding the eligibility of the species for listing under a particular category and what conservation actions might be appropriate. The Minister decides to add, or not to add, the species to the list of threatened species under the EPBC Act. More detailed information about the listing process is at: https://www.awe.gov.au/environment/biodiversity/threatened/nominations.

To promote the recovery of listed threatened species and ecological communities, conservation advices and where required, recovery plans are made or adopted in accordance with Part 13 of the EPBC Act. Conservation advices provide guidance at the time of listing on known threats and priority recovery actions that can be undertaken at a local and regional level. Recovery plans describe key threats and identify specific recovery actions that can be undertaken to enable recovery activities to occur within a planned and logical national framework. Information about recovery plans is available on the department's website at: https://www.awe.gov.au/environment/biodiversity/threatened/recovery-plans.

Privacy notice

The Department will collect, use, store and disclose the personal information you provide in a manner consistent with the Department's obligations under the Privacy Act 1988 (Cth) and the Department's Privacy Policy.

Any personal information that you provide within, or in addition to, your comments in the threatened species assessment process may be used by the Department for the purposes of its functions relating to threatened species assessments, including contacting you if we have any questions about your comments in the future.

Further, the Commonwealth, State and Territory governments have agreed to share threatened species assessment documentation (including comments) to ensure that all States and Territories have access to the same documentation when making a decision on the status of a potentially threatened species. This is also known as the <u>'Common Assessment Method' (CAM)</u>. As a result, any personal information that you have provided in connection with your comments may be shared between Commonwealth, State or Territory government entities to assist with their assessment processes.

The Department's Privacy Policy contains details about how respondents may access and make corrections to personal information that the Department holds about the respondent, how respondents may make a complaint about a breach of an Australian Privacy Principle, and how the Department will deal with that complaint. A copy of the Department's Privacy Policy is available at: <u>https://www.awe.gov.au/about/commitment/privacy</u>.

Information about this consultation process

Responses to this consultation can be provided electronically or in hard copy to the contact addresses provided on Page 1. All responses received will be provided in full to the Committee and then to the Australian Government Minister for the Environment.

In providing comments, please provide references to published data where possible. Should the Committee use the information you provide in formulating its advice, the information will be attributed to you and referenced as a 'personal communication' unless you provide references or otherwise attribute this information (please specify if your organisation requires that this information is attributed to your organisation instead of yourself). The final advice by the Committee will be published on the department's website following the listing decision by the Minister.

Information provided through consultation may be subject to freedom of information legislation and court processes. It is also important to note that under the EPBC Act, the deliberations and recommendations of the Committee are confidential until the Minister has made a final decision on the nomination, unless otherwise determined by the Minister.

CONSULTATION QUESTIONS FOR DROSERA GIBSONII

SECTION A - GENERAL

- Is the information used to assess the nationally threatened status of the species/subspecies robust? Have all the underlying assumptions been made explicit? Please provide justification for your response.
- 2. Can you provide additional data or information relevant to this assessment?
- 3. Have you been involved in previous state, territory or national assessments of this species/subspecies? If so, in what capacity?

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

<u>SECTION B</u> DO YOU HAVE ADDITIONAL INFORMATION ON THE ECOLOGY OR BIOLOGY OF THE SPECIES/SUBSPECIES? (If no, skip to section C)

Biological information

- 4. Can you provide any additional or alternative references, information or estimates on longevity, average life span and generation length?
- 5. Do you have any additional information on the ecology or biology of the species/subspecies not in the current advice?

<u>SECTION C</u> ARE YOU AWARE OF THE STATUS OF THE TOTAL NATIONAL POPULATION OF THE SPECIES/SUBSPECIES? (If no, skip to section D)

Population size

- 6. Has the survey effort for this taxon been adequate to determine its national adult population size? If not, please provide justification for your response.
- 7. Do you consider the way the population size has been derived to be appropriate? Are there any assumptions and unquantified biases in the estimates? Did the estimates measure relative or absolute abundance? Do you accept the estimate of the total population size of the species/subspecies? If not, please provide justification for your response.
- 8. If not, can you provide a further estimate of the current population size of mature adults of the species/subspecies (national extent)? Please provide supporting justification or other information.

If, because of uncertainty, you are unable to provide a single number, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the

table below of possible species/subspecies numbers, and also choose the level of confidence you have in this estimate:

Number of mature individuals is estimated to be in the range of:

□ 1–50 □ 51–250 □ 251–1000 □ >1000 □ >10 000

Level of your confidence in this estimate:

 \Box 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

 \Box 31–50% - more than a guess, some level of supporting evidence

□ 51–95% - reasonably certain, information suggests this range

95–100% - high level of certainty, information indicates quantity within this range

99–100% - very high level of certainty, data are accurate within this range

<u>SECTION D</u> ARE YOU AWARE OF TRENDS IN THE OVERALL POPULATION OF THE SPECIES/SUBSPECIES? (If no, skip to section E)

9. Does the current and predicted rate of decline used in the assessment seem reasonable? Do you consider that the way this estimate has been derived is appropriate? If not, please provide justification of your response.

Evidence of total population size change

10. Are you able to provide an estimate of the total population size during the mid-1990s (at or soon after the start of the most recent three generation/10 year period)? Please provide justification for your response.

If, because of uncertainty, you are unable to provide a single number, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of possible species/subspecies numbers, and also choose the level of confidence you have in this estimate.

Number of mature individuals is estimated to be in the range of:

□ 1–50 □ 51–250 □ 251–1000 □ >1000 □ >10 000

Level of your confidence in this estimate:

 \Box 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

 \Box 31–50% - more than a guess, some level of supporting evidence

□ 51–95% - reasonably certain, information suggests this range

95–100% - high level of certainty, information indicates quantity within this range

99–100% - very high level of certainty, data are accurate within this range

11. Are you able to comment on the extent of decline in the species/subspecies' total population size over the last approximately 15 years (i.e. three generations/10 year period)? Please provide justification for your response.

If, because of uncertainty, you are unable to provide an estimate of decline, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of decline, and also choose the level of confidence you have in this estimated range.

Decline estimated to be in the range of:

□ 1–30% □31–50% □51–80% □81–100% □90–100%

Level of your confidence in this estimated decline:

 \Box 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

 \Box 31–50% - more than a guess, some level of supporting evidence

□ 51–95% - reasonably certain, suggests this range of decline

95–100% - high level of certainty, information indicates a decline within this range

- 99–100% very high level of certainty, data are accurate within this range
- 12. Please provide (if known) any additional evidence which shows the population is stable, increasing or declining.

<u>SECTION E</u> ARE YOU AWARE OF INFORMATION ON THE TOTAL RANGE OF THE SPECIES/SUBSPECIES? (If no, skip to section F)

Current Distribution/range/extent of occurrence, area of occupancy

- 13. Does the assessment consider the entire geographic extent and national extent of the species/subspecies? If not, please provide justification for your response.
- 14. Has the survey effort for this species/subspecies been adequate to determine its national distribution? If not, please provide justification for your response.
- 15. Is the distribution described in the assessment accurate? If not, please provide justification for your response and provide alternate information.
- 16. Do you agree that the way the current extent of occurrence and/or area of occupancy have been estimated is appropriate? Please provide justification for your response.
- 17. Can you provide estimates (or if you disagree with the estimates provided, alternative estimates) of the extent of occurrence and/or area of occupancy.

If, because of uncertainty, you are unable to provide an estimate of extent of occurrence, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of extent of occurrence, and also choose the level of confidence you have in this estimated range.

Current extent of occurrence is estimated to be in the range of:

 \Box <100 km² \Box 100 – 5 000 km² \Box 5 001 – 20 000 km² \Box >20 000 km²

Level of your confidence in this estimated extent of occurrence

 \Box 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

 \Box 31–50% - more than a guess, some level of supporting evidence

□ 51–95% - reasonably certain, data suggests this range of decline

95–100% - high level of certainty, data indicates a decline within this range

99–100% - very high level of certainty, data is accurate within this range

If, because of uncertainty, you are unable to provide an estimate of area of occupancy, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of area of occupancy, and also choose the level of confidence you have in this estimated range.

Current area of occupancy is estimated to be in the range of:

 \Box <10 km² \Box 11 – 500 km² \Box 501 – 2000 km² \Box >2000 km²

Level of your confidence in this estimated extent of occurrence:

- \Box 0–30% low level of certainty/ a bit of a guess/ not much data to go on
- \Box 31–50% more than a guess, some level of supporting evidence
- □ 51–95% reasonably certain, data suggests this range of decline
- \Box 95–100% high level of certainty, data indicates a decline within this range
- 99–100% very high level of certainty, data is accurate within this range

<u>SECTION F</u> ARE YOU AWARE OF TRENDS IN THE TOTAL RANGE OF THE SPECIES/SUBSPECIES? (If no, skip to section G)

Past Distribution/range/extent of occurrence, area of occupancy

- 18. Do you consider that the way the historic distribution has been estimated is appropriate? Please provide justification for your response.
- 19. Can you provide estimates (or if you disagree with the estimates provided, alternative estimates) of the former extent of occurrence and/or area of occupancy.

If, because of uncertainty, you are unable to provide an estimate of past extent of occurrence, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of past extent of occurrence, and also choose the level of confidence you have in this estimated range.

Past extent of occurrence is estimated to be in the range of:

 \Box <100 km² \Box 100 - 5 000 km² \Box 5 001 - 20 000 km² \Box >20 000 km²

Level of your confidence in this estimated extent of occurrence

 \Box 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

 \Box 31–50% - more than a guess, some level of supporting evidence

- □ 51–95% reasonably certain, data suggests this range of decline
- 95–100% high level of certainty, data indicates a decline within this range

99–100% - very high level of certainty, data is accurate within this range

If, because of uncertainty, you are unable to provide an estimate of past area of occupancy, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of past area of occupancy, and also choose the level of confidence you have in this estimated range:

Past area of occupancy is estimated to be in the range of:

 \Box <10 km² \Box 11 – 500 km² \Box 501 – 2000 km² \Box >2000 km²

Level of your confidence in this estimated extent of occurrence:

 \Box 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

 \Box 31–50% - more than a guess, some level of supporting evidence

□ 51–95% - reasonably certain, data suggests this range of decline

 \Box 95–100% -high level of certainty, data indicates a decline within this range

99–100% - very high level of certainty, data is accurate within this range

PART 2 – INFORMATION FOR CONSERVATION ADVICE ON THREATS AND CONSERVATION ACTIONS

<u>SECTION G</u> DO YOU HAVE INFORMATION ON THREATS TO THE SURVIVAL OF THE SPECIES/SUBSPECIES? (If no, skip to section H)

- 20. Do you consider that all major threats have been identified and described adequately?
- 21. To what degree are the identified threats likely to impact on the species/subspecies in the future?
- 22. Are the threats impacting on different populations equally, or do the threats vary across different populations?
- 23. Can you provide additional or alternative information on past, current or potential threats that may adversely affect the species/subspecies at any stage of its life cycle?

24. Can you provide supporting data/justification or other information for your responses to these questions about threats?

<u>SECTION H</u> DO YOU HAVE INFORMATION ON CURRENT OR FUTURE MANAGEMENT FOR THE RECOVERY OF THE SPECIES/SUBSPECIES? (If no, skip to section I)

- 25. What planning, management and recovery actions are currently in place supporting protection and recovery of the species/subspecies? To what extent have they been effective?
- 26. Can you recommend any additional or alternative specific threat abatement or conservation actions that would aid the protection and recovery of the species/subspecies?
- 27. Would you recommend translocation (outside of the species' historic range) as a viable option as a conservation actions for this species/subspecies?

<u>SECTION I</u> DO YOU HAVE INFORMATION ON STAKEHOLDERS IN THE RECOVERY OF THE SPECIES/SUBSPECIES?

- 28. Are you aware of other knowledge (e.g. traditional ecological knowledge) or individuals/groups with knowledge that may help better understand population trends/fluctuations, or critical areas of habitat?
- 29. Are you aware of any cultural or social importance or use that the species/subspecies has?
- 30. What individuals or organisations are currently, or potentially could be, involved in management and recovery of the species/subspecies?
- 31. How aware of this species/subspecies are land managers where the species/subspecies is found?
- 32. What level of awareness is there with individuals or organisations around the issues affecting the species/subspecies?
 - a. Where there is awareness, what are these interests of these individuals/organisations?
 - b. Are there populations or areas of habitat that are particularly important to the community?

PART 3 – ANY OTHER INFORMATION

33. Do you have comments on any other matters relevant to the assessment of this species/subspecies?

Conservation Advice for Drosera gibsonii (Gibson's pygmy sundew)

This draft document is being released for consultation on the species listing eligibility and conservation actions

The purpose of this consultation document is to elicit additional information to better understand the status of the species and help inform conservation actions, further planning and a potential recovery plan. The draft assessment below should therefore be considered **tentative** at this stage, as it may change as a result of responses to this consultation process.

<u>Note</u>: Specific consultation questions relating to the below draft assessment and preliminary determination have been included in the consultation cover paper for your consideration.

This document combines the approved conservation advice and listing assessment for the subspecies. It provides a foundation for conservation action and further planning.



Photos of *Drosera gibsonii* @ Copyright Boaz (from Fierce Flora) (top left and bottom) and @ Copyright John Fleming (from Atlas of Living Australia) (top right).

Conservation status

Drosera gibsonii (Gibson's pygmy sundew) *is proposed* to be listed in the Critically Endangered category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999.*

The Committee's assessment is at Attachment A. The Committee's assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: Insufficient data
- Criterion 2: B1ab(iii,v): Critically Endangered
- Criterion 3: Ineligible
- Criterion 4: Ineligible
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Critically Endangered category are a restricted range, low number of locations, and continuing decline in the quality of habitat and number of mature individuals and subpopulations.

Species can also be listed as threatened under state and territory legislation. For information on the current listing status of this species under relevant state or territory legislation, see the <u>Species Profile and Threat Database</u>.

Species information

Taxonomy

Conventionally accepted as Drosera gibsonii P.Mann (2007).

Description

The following description for Gibson's pygmy sundew has been adapted from Mann (2007) and Lowrie (2013). Gibson's pygmy sundew is a small, carnivorous, fibrous rooted perennial herb from the family Droseraceae. The stem grows to 4 cm and is covered by the withered remains of the previous season's growth. The species has semi-erect rosetted leaves; the rosette is 1.25 cm in diameter and consists of 6–12 leaves. The leaf blade is narrowly elliptical (3 mm long by 1.5 mm wide) and has a leaf tip (apex) that is 0.5 mm wide. The lamina has an adaxial surface with insect-catching glands positioned around margins and smaller glands within. The leafstalk (petiole) is 5 mm long by 0.75 mm wide at the base. Ovoid-shaped stipule buds are found at the base of the leafstalk, which are 7 mm long by 5 mm wide, and have bristles (setae). Three lobed stipules are also found at the base of the leafstalk, 6.5 mm long and 3 mm wide with the central lobe divided into four segments. The species is anchored by long stilted roots that bring up moisture from deep in the soil (International Carnivorous Plant Society 2020a).

The single flowering shoot (scape) grows at the tip (inflorescence racemose), so the base of the stalk has the oldest flowers. The scape is up to 3 cm long, is covered with minute short-stalked glands and has between 7–12 flowers. The flower stalk (pedicel) is 1.5 mm long and is covered in minute short-stalked glands that contain fruit. Flower sepals are ovate shaped and joined at the base (calyx lobes). Lobes are 2.5 mm long, 1.5 mm wide and covered with minute short-

stalked glands. Flower petals are pink to mauve, ovate-shaped and 8 mm long by 5 mm wide with a slightly tapered apex. The ovary is globular and 1 mm long by 1 mm wide. There are three mauve styles (3.5 mm in length) and a translucent white stigma that is club-shaped (claviform). Five pink-mauve stamens, 5 mm long, are also present that have yellow pollen. The plant reproduces asexually by gemmae (1.5mm long, 1.2 mm wide and 0.75 mm thick) during the wet periods in autumn and winter.

Distribution

Gibson's pygmy sundew is endemic to a small area of the Esperance Plains region, northeast of Albany, in south-west Western Australia (WA). Recent surveys suggest that there are eight subpopulations spread across 35 km of Stirling Range National Park (SRNP) and occur at elevations of 300 m and 500 m (Table 1, T Krueger pers comm 2021, 3 November). All subpopulations are found on the lower/middle slopes in the central and eastern peaks of SRNP (T Krueger pers comm 2021, 3 November).

The total population size is estimated to be >10,000 mature individuals, with each subpopulation ranging in size from a minimum of five hundred plants and up to a maximum of ten thousand plants (T Krueger pers comm 2021, 3 November).

Prior to 2016, only two subpopulations were known, one at the base of Bluff Knoll and one in a valley approximately 13 km to the east, and the species was estimated to have between 500 to 1000 individuals (Cross 2020). This information was used to support the IUCN assessment (Cross 2020).

Table I Distribution of disson's pyging sundew (Rideger dispusifica)	Table 1 [Distribution (of Gibson's p	bygmy sundew	(Krueger un	published)
--	-----------	----------------	---------------	--------------	-------------	------------

Subpopulation number and location	Dates visited	# mature individuals^	2019–20 fire affected	Regeneration post 2019 fires	Fire history (1984– 2018)	Notes
1 North of Stirling Range Drive	2021	Not surveyed	No	Not surveyed	1997	Abundance noted as 'occasional'. Collection made in 2008 (PERTH 08675325).
2 North of Stirling Range Drive	2021	Not surveyed	No	Not surveyed	1997	Noted as locally abundant. Collection made in 2017 (PERTH 09087265).
3 Stirling Range Drive	Oct 2021	500-2500	Yes - part	500–2500 seedlings (October 2021)	1996 & 2009 (south of the road), 1997, 2010 (north of the road)	Noted as locally abundant. Collection made in 2008 (PERTH 08675333).
4 Stirling Range Drive	Feb, 2020, Oct 2021	0 (Feb 2020) 20–100 (Oct 2021)	Yes - all	500–1000 seedlings (October 2021)	1996	Collection made in 2016 (PERTH 08962421).
5 Stirling Range Drive	2014, 2020, 2021	500-1000*	Yes, but only a small part	Mostly not affected by fire. Number of seedlings not surveyed.	1996	Only very small part impacted by 2019 fire. Collection made in 1991 (PERTH 05863368).
6 Base of Bluff Knoll	2021	Not surveyed	Yes – likely all	Not surveyed	1991, 2001	Noted as locally abundant. Collection made in 2017 (PERTH 09087273).
7 Bluff Knoll Road	Oct 2014, Nov 2019, Feb 2020	5000- 10,000*	Yes - part	Not surveyed	1991, 2001	Type location for this species. Plants form a very dense population along the road verge and around the car park. Several hundred plants growing close to the road survived 2019 fires. Collection made in 2006 (PERTH 07220731 and PERTH 08692408).
8 Bluff Knoll Road	Sept 2014, Nov 2019	500-1000*	Yes – likely all	Not surveyed	1991, 2001	Collection made in 1994 (PERTH 04595378).

*includes juvenile and mature plants which fluctuate between years within the range, ND = no
 data, ^ = estimated subpopulation range at each date visited



Map 1 Modelled distribution of Gibson's pygmy sundew

Source: Base map Geoscience Australia; species distribution data <u>Species of National Environmental Significance</u> database. **Caveat:** The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.

Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the specific habitat type or geographic feature that represents to recent observed locations of the species (known to occur) or preferred habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

This section describes some published examples of this significance but is not intended to be comprehensive, applicable to, or speak for, all Indigenous people. Such knowledge may be only held by Indigenous groups and individuals who are the custodians of this knowledge.

The cultural significance of Gibson's pygmy sundew is not known. However, Indigenous Australians have had a long and continuous association with country within the Stirling Ranges which is located within the region of the Minang people of the Noongar Nation, according to the Map of Indigenous Australia (AIATSIS 1996). The Stirling Ranges contains many areas of significant cultural importance including camping grounds and sacred freshwater holes (gnamma) (Mia 2008). Bula Meela (Bluff Knoll), is of particular cultural importance as it is where the spirits of Minang Noongar people go after death (Mia 2008). The species has no known food, medicinal or material values.

The genus is of significant interest to carnivorous plant collectors and enthusiasts within Australia and worldwide (International Carnivorous Plant Society 2020; May & Pludra 2021). Gibson's pygmy sundew is available for sale (gemmae) on international markets (Carnivorous and Exotic Plants 2020) indicating that illegal collections of the species have already occurred, given it is endemic to WA. One internet site that specialises in the sale of carnivorous plants has had ~900 000 people visit the site between 2002-2021 (Carnivorous and Exotic Plants 2020).

The species has a Priority 2 conservation status in Western Australia, meaning that it is a poorly known species requiring urgent research to protect the population from threatening processes.

Relevant biology and ecology

Ecology

Drosera spp. (sundews) are carnivorous perennial plants that catch prey using sticky mucilage secreted from glands on the tips of modified trichomes found on their leaves, and research suggests that they are generalist arthropod predators (Verbeek & Boasson 1993). The leaves bear sticky, multicellular hairs (tentacles) that produce mucilage and respond to touch, causing the tentacles to bend toward the prey and ensure close contact with sticky glands for digestion (Groom & Lamont 2015). Prey are thought to be attracted by the colour of the leaves or the glistening mucilage produced by the tentacles (Gibson & Walker 2009). The mucilage contains proteolytic and other hydrolysing enzymes that break down proteins and compounds in the prey, and chitinous exozymes (chitinases, produced by bacteria) that break down the prey's exoskeleton (Groom & Lamont 2015). Absorption of digested products accounts for 50 (Schulze et al. 1991) to 80 (Dixon et al. 1980) percent of nitrogen uptake in *Drosera* in south-west Australia. After a few days, undigested remains fall away and the tentacles resume their original position (Groom & Lamont 2015). The number of prey captured during peak growing periods (winter and spring) can be high. For example, *D. erythrorhiza* (red ink sundew) can capture an average of 80 arthropods per cm², per day in spring (Dixon et al. 1980).

Reproduction

Gibson's pygmy sundew reproduces both sexually, through seed production and asexually, through the production of gemmae, where unexpanded leaves become hardened and 'seed-like', and break off (e.g., by a raindrop) and sprout under suitable moisture conditions to produce a new plant often located close to the parent plant (Cross 2020). The species flowers and produces seed from late September to December (T Krueger pers comm 2021, 3 November). Seed production rates are low for the species (Cross 2020; T Krueger and A Fleischmann pers comm 2021, 18 November). Despite up to ten capsules produced per season, only one or two of them are fertile, due to the species potential self-incompatibility (Lowrie 2014; T Krueger and A Fleischmann pers comm 2021, 18 November). Each fertile capsule contains one to five seeds (Fleischmann pers comm 2021), so each Gibson's pygmy sundew plant is estimated to produce between four-40 seeds in its lifetime. Low seed production rates have also been observed in closely related species. For example, *D. dichrosepala* (rusty sundew) and *D. scorpioides* (shaggy sundew) usually produce one fertile seed capsule containing five seeds or less with an estimated 4–20 number of capsules over one growing season (T Krueger and A Fleischmann pers comm 2021, 18 November). Time to reproductive maturity is estimated to be at least three years based on the prevalence of seedlings and juvenile plants in subpopulations which had all mature plants killed in the 2019–20 fires (subpopulation 4, Table 1) (T Krueger pers comm 2021, 3 November). Cultivation experiments support the three year period to reach reproductive maturity for the species (T Krueger and A Fleischmann pers comm 2021, 18 November).

The longevity of Gibson's pygmy sundew is estimated to be between five to seven years (T Krueger pers comm 2021, 16 November). This is based on field observations of counts of new stem segments with carnivorous leaves that regrow from the over-summering dormant bud and therefore a 'growth bulge' indicates a year of growth (Figure 1). A similar longevity has been observed in cultivated Gibson's pygmy sundew (T Krueger and A Fleischmann pers comm 2021, 18 November). Other perennial sundews have also been shown to live for a similar period (five years, *D. rotundifolia* (round-leaved sundew); Crowder et al. 1992).

Asexual reproduction is dependent on sufficient rainfall in autumn and winter because during this time, the species produces large amounts of gemmae that require moist conditions to establish into new individuals (T Krueger pers comm 2021, 8 November). Gemmae can dry out easily once produced, according to cultivators. For example, a window of only one month in which to plant gemmae is suggested for pygmy *Drosera* (International Carnivorous Plant Society 2020a). This has resulted in the number of juvenile plants being highly variable between growing seasons (T Krueger pers comm 2021, 8 November). The prevalence of asexual reproduction was observed in subpopulation 5, which was unaffected by fire and had sufficient juvenile plants in October 2021 (Table 1, T Krueger pers comm 2021, 8 November).

Sundews are known to invest nutrients obtained from prey into reproductive structures (Krafft & Handel 1993; Hanslin & Karlsson 1996). Therefore, any competitors which reduce arthropod abundance have been shown to reduce the number of flower stalks, flowers, seeds and leaves (Jennings 2011).

Figure 2 Growth of Gibson's pygmy sundew (courtesy of T Krueger 2021). The numbers represent growth layers in years.



Fire ecology

Very little is known about the fire ecology of Gibson's pygmy sundew. Fire kills plants and potentially smoke from a fire enables seeds to germinate. Other *Drosera* species have been known to decline rapidly following disturbance to natural fire and hydrological processes, and population recovery has been low and slow in some subpopulations of the species following fire (Cross et al. 2020). Despite this, the 2019–20 fires resulted in the production of a high number of seedlings in burnt subpopulations (Table 1). Therefore, population recovery post fire, is likely to be related to the availability of soil stored seed, which is dependent on the fire history. Successful germination and establishment of new seedlings following fire, is also likely to be dependent on sufficient rainfall (T Krueger pers comm 2021, 8 November).

Habitat critical to the survival

Gibson's pygmy sundew occurs in heathland and open *Eucalyptus* woodland on low slopes and in sandy clay loam soils (Cross 2020) on laterite or sandstone in the SRNP. It is found at elevations between 300 m and 500 m (T Krueger pers comm 2021, 3 November).

No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat.

Important populations

In this section, the word population is used to refer to subpopulation, in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

Considering the limited range for this species, there is sufficient evidence through the species eligibility for listing to declare all subpopulations as important populations of this taxon under particular pressure of survival and which therefore require protection to support the recovery of the species.

Threats

The main threats to Gibson's pygmy sundew are a change to the fire regime and fire interactions due to climate change, and habitat transformation due to *Phytophthora cinnamomi* (Table 2). The species has a very restricted range, placing subpopulations at risk of localised extirpation from a single threatening event, despite its reservation within a national park. Threats in Table 2 are noted in approximate order of highest to lowest impact, based on available evidence.

Threat	Status ^a	Evidence				
Habitat loss, distur	Habitat loss, disturbance and modification					
Fire regime that causes a decline in biodiversity	 Timing: current/future Confidence: observed/projected Consequence: major Trend: increasing Extent: across the entire range 	Gibson's pygmy sundew is fire-sensitive because fire kills standing plants but facilitates regeneration by breaking dormancy of soil-stored seed (Groom & Lamont 2015). Stirling Range National Park has been exposed to repeated fires over the last forty years (Allan & Herford 1999; Barret & Yates 2015). These fires include prescribed burns, escapes from prescribed burns and wildfires (OBRM 2018; DAWE 2020). Fires within the SRNP are often large-scale (T Krueger pers comm 2021, 3 November), however they can also be patchy. The 2019-20 fires burnt the majority of subpopulations of Gibson's pygmy sundew (Table 1) and facilitated the growth of an estimated 3750–9000 seedlings in three subpopulations following the fire (Table 1, 5). There are a number of mechanisms by which the fire regime impacts a species with obligate seeding traits (Keith 1996; DAWE 2021). These include the frequency of fire (high vs low); the severity of fires (high vs low); the season of fire; and the interactions between fire and climate change and other threats (weeds, disease, etc.). Gibson's pygmy sundew is sensitive to high fire frequency, low severity fires; out of season fires; and interactions between fire and climate change, fire and reduced rainfall, and potentially fire and weeds.				
		Too frequent fires				

Table 2 Threats impacting Gibson's pygmy sundew

Threat	Status ^a	Evidence
		Obligate seeders require a minimum time between successive fires to allow time for the species to accumulate sufficient soil-stored seed to ensure population persistence (Keith 1996, 2012). This is termed the minimum fire interval. Gibson's pygmy sundews take at least three years to reach reproductive maturity and can live for approximately five to seven years (T Krueger and A Fleischmann pers comm 2021, 18 November). The species is slow to produce seed and is estimated to produce between four to 40 seeds in its lifetime (see reproduction section). Although the species can also reproduce asexually under suitable moist conditions, irregularity of environmental conditions preclude relying on this method to ensure population persistence. Therefore, the minimum fire interval for the species is estimated to be six to seven years (Gill & Nicholls 1989; Gosper et al. 2013). If the fire frequency is less than the minimum fire interval, the species is unlikely to have replenished its population to pre- fire numbers and population declines are projected.
		<i>Low severity fires</i> Temperature-sensitive obligate seeders require soil
		temperatures to be sufficient to break seed dormancy (either physically or physiologically) and initiate germination (Auld & O'Connel 1991; Auld & Ooi 2009). Failure to do this can result in a low rate of recruitment and subsequent population decline (Regan et al. 2003). Low severity fires can occur when fuel loads are low, e.g., because previous fire has reduced vegetation load. An increased frequency of fire, as projected under future climate change, can therefore increase the risk of low severity fires. Although it is unknown if Gibson's pygmy sundew has temperature-sensitive dormancy, low severity fires are a risk to the species, until further research suggests otherwise.
		Out of season fires
		When fire occurs out of season there are a number of mechanisms that lead to recruitment failure and reduce the recovery potential of species following fire (DAWE 2021). These include:
		1) seedling mortality due to desiccation as a consequence of the interaction between out of season fires and fire- hydrological interactions, particularly by temperate region obligate seeders (Miller et al. 2019),
		2) low rate of seed production due to sub-optimal flowering cues (Morgan 1995) and/or dormancy cues (Ooi et al. 2007), particularly by species that rely on seasonal pollinators or specific flowering conditions, and
		3) disruption to processes that facilitate post-fire recovery and limit dispersal (Jasinge et al. 2018; Keith et al. 2020), particularly by species with seasonal growing conditions.
		The Gibson's pygmy sundew is adapted to seasonal fire regimes consisting of fire during the dry dormant summer periods followed by moist conditions during the growing and reproductive period in winter. If fires occur during the growing season, standing plants will be killed before seed is produced, inhibiting the population from being replenished. Fire that occurs in spring could result in high seedling mortality due to desiccation during the summer dry period. Out of season fires could also reduce germination due to sub- optimal flowering cues. For example, out of season fires may have been the cause of poor recruitment observed in 1994

Threat	Status ^a	Evidence		
		(exact numbers not known; Cross 2020). Lastly, out of season fires may impact the diversity and availability of invertebrate prey upon which carnivorous plants, like Gibson's pygmy sundew may have a partial dependence upon (Cross et al. 2020).		
		Fire interactions		
		There are a range of mechanisms by which fire interacts with other threats and impacts the species recovery potential following fire (DAWE 2021).		
		For the Gibson's pygmy sundew, the interaction between climate change and the fire regime could lead to significant impacts on the population. Climate change can increase the frequency of fire through changes in the landscape moisture levels increasing the risk of localised extinctions (Gallagher et al. 2021). For example, climate change is predicted to increase the number of days of elevated temperatures (0.5– 1.5°C by 2030 and by 1–4°C by 2070), and increase the Forest Fire Danger Index (FFDI; DIICCSRTE 2013; CSIRO & BOM 2015; Dowdy et al. 2019) in south-west Australia. This indicates a potential subsequent reduction in the fire-free interval for the species (Enright et al. 2014; Gallagher 2020; Gallagher et al. 2021).		
		Climate associated warming and drying can also reduce the species resilience by interacting with natural hydrological cycles (see climate change section). This is particularly important for a species that depends on specific conditions for reproduction and germination. However, it is also possible that climate related drying could help to minimise the impact of habitat modification driven by <i>P. cinnamomi</i> (see below).		
		The two climate associated threat pathways can also act in concert through processes such as the 'interval squeeze', whereby climate drives increased pressure via higher fire frequency, while also reducing resilience via slower rates of maturation and lower fecundity (Enright et al. 2015; Henzler et al. 2018).		
		Prescribed burning can also increase the frequency of wildfires. For example, a widespread fire in 2018 was the result of an escaped prescribed burn and was followed a year later by a wildfire in 2019 (OBRM 2018). Although mature individuals were not impacted by the 2018 burn (Table 1, not all subpopulations surveyed), prescribed burns are a risk and can change the fire regime and reduce the fire-free interval. Other potential fire-related threats include potential fire-		
		weed interactions (see section on weeds).		
Disturbance by recreational activities	 Timing: current/future Confidence: suspected Consequence: moderate Trend: increasing Extent: across part of its range 	The Stirling Range has a long history of recreational use dating back to the 1920's when the Stirling Range Tourist Association made the area accessible to tourists by creating roads (DBCA 2017). Today the SRNP is highly valued by tourists for bushwalking, nature observation and rock- climbing (DBCA 2017). Most known subpopulations of Gibson's pygmy sundew are located close to roads (e.g., subpopulations 3, 4, 5, 7 and 8) and therefore could be susceptible to direct damage by trampling or modification of habitat (erosion). Subpopulations adjacent to road verges could also be more susceptible to competition with weeds and local mortality from accidental fires.		
Habitat modification	Timing: current/futureConfidence: suspected	The SRNP has a long history of infection by the soil-borne pathogenic fungus, <i>P. cinnamomi</i> and up to 80% of SRNP is now infected with the fungus (DBCA 2021). Although the		

Threat	Status ^a	Evidence		
driven by Phytophthora cinnamomi	 Consequence: moderate Trend: increasing Extent: across part of its range 	Gibson's pygmy sundew is not known to be susceptible to <i>P. cinnamomi</i> , the pathogen has dramatically impacted the landscape of SRNP and transformed the heathlands and mallee proteaceous rich shrublands into restionaceous sedgelands (Wills 1992). Dramatic landscape transformations of this magnitude are likely to impact upon the species' ability to occupy new areas and may have already fragmented the species habitat. The effect may also have consequential impacts upon the species reproductive ecology, such as the availability of prey upon which the species may be partially dependent.		
Climate Change				
Reductions in precipitation due to climate change	 Timing: current/future Confidence: observed/estimated Consequence: major Trend: increasing Extent: across the entire species range 	Mean annual rainfall in south-west Australia has declined since 1970, with reductions in rainfall becoming larger and more widespread since 2000 (DIICCSRTE 2013). The largest reductions have been observed in autumn and winter, when most rainfall occurs (DIICCSRTE 2013). Persistent reductions in rainfall can lead to drought conditions. Future climate change predictions for southwest Australia include precipitation decreases of 5–20% by 2030 and 10-40% by 2070 (Ford et al. 2013). It is unknown how Gibson's pygmy sundew will be impacted by reduced precipitation and drought. Reduced rainfall during autumn and winter, prior to the growing and reproductive season, could limit growth and reduce asexual reproduction potential by gemmae because the species requires moist conditions to produce gemmae for establishment of the gemmae into plants and for soil-stored seed to germinate. Reduced soil moisture could expose plants to hydraulic stress and decrease habitat for the species, as shown in other montane species (Enright et al. 2014). Reduced precipitation will likely increase fire risk during dry periods. For example, leaf litter in mallee-heath must have a moisture content less than 8% before fires can be sustained and spread (Allan & Herford 1999). Pre-fire dry conditions could also limit population persistence by reducing the health		
Limited long- term adaptive ability due to allee effects and low genetic diversity	 Timing: future Confidence: inferred Consequence: unknown Trend: increasing Extent: across the entire range 	A predominance of asexual reproduction could limit the long- term adaptive ability of the taxon and may also limit translocation success, as identified for other asexually reproducing species (Chen et al. 2019). Therefore, despite species with restricted distributions and specific habitat requirements persisting for long periods, their ability to adapt to rapid changes in climate conditions, may be limited by low genetic exchange. Asexual reproduction is also dependent on moist conditions in autumn and winter, and therefore in poor seasons this method may not be sufficient to support the build-up of the soil seed bank. Therefore, the restricted subpopulations of Gibson's pygmy sundew could be at risk of the negative consequences associated with low genetic diversity in a future changing climate.		
Invasive species				
Weeds	 Timing: future Confidence: suspected Consequence: unknown Trend: unknown Extent: across part of its range 	Weeds are not currently considered a threat to the species, despite 93 species of weeds having been recorded in SRNP (Allan & Herford 1999). However, weeds could be a threat in the future, if climate change pushes weed species to higher elevations. For example, species distribution modelling in NSW predicts an upward movement of weeds of up to 500 m under all climate change scenarios (Petitpierre et al. 2016),		

Threat	Status ^a	Evidence
		which is the maximum elevation observed for the species. Recreational use could also facilitate the prevalence of weeds in the future (Allan & Herford 1999).
Breeding and seed	collection	
Illegal plant or seed collection	 Timing: current/future Confidence: inferred Consequence: moderate Trend: unknown Extent: across part of its range 	Illegal collections of carnivorous plants are a threat to the Gibson's pygmy sundew. Western Australian sundews are of interest to specialist plant collectors and the species is already in cultivation worldwide (International Carnivorous Plant Society 2020b) and offered for sale to overseas markets indicating that illegal collection of the species has already occurred. Ongoing illegal collection is likely to lead to depletion of individuals in the wild which could be significant for species with highly restricted habitats, such as Gibson's pygmy sundew. Although the species is located entirely within a National Park, where collection of specimens requires a permit, illegal collection of the species is a risk to Gibson's pygmy sundew, which has also been observed for other members of the <i>Drosera</i> genus (DAWE 2010).

Timing—identify the temporal nature of the threat;

Confidence—identify the extent to which we have confidence about the impact of the threat on the species; Consequence—identify the severity of the threat;

Trend—identify the extent to which it will continue to operate on the species;

Extent—identify its spatial content in terms of the range of the species.

Each threat has been described in Table 2 in terms of the extent that it is operating on the species. The risk matrix (Table 3) provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, they are: the life stage they affect; the duration of the impact; and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed in consultation with experts and using available literature.

Likelihood	Consequences						
	Not significant	Minor	Moderate	Major	Catastrophic		
Almost certain	Low risk	Moderate risk	Very high risk	Very high risk Reductions in precipitation due to climate change Fire regime that causes a decline in biodiversity	Very high risk		
Likely	Low risk	Moderate risk	High risk Habitat modification driven by <i>P.</i> <i>cinnamomi</i> Illegal plant or seed collection	Very high risk	Very high risk		
Possible	Low risk	Moderate risk	High risk Disturbance by recreational activities	Very high risk	Very high risk		
Unlikely	Low risk	Low risk	Moderate risk	High risk	Very high risk		
Unknown	Low risk	Low risk	Moderate risk Limited long- term adaptive ability due to allee effects and low genetic diversity Weeds	High risk	Very high risk		

Table 3 Gibson's pygmy sundew Risk Matrix

Categories for likelihood are defined as follows:

Almost certain – expected to occur every year

Likely – expected to occur at least once every five years

Possible – might occur at some time

Unlikely - such events are known to have occurred on a worldwide bases but only a few ties

Unknown – currently unknown how often the incident will occur

Categories for consequences are defined as follows:

Not significant – no long-term effect on individuals or populations

Minor - individuals are adversely affected but no effect at population level

Moderate - population recovery stalls or reduces

Major – population decreases

 ${\it Catastrophic-population\ extirpation/extinction}$

Priority actions have then been developed to manage the threat particularly where the risk was deemed to be 'very high' (red shading) or 'high' (yellow shading). For those threats with an

unknown or low risk outcome (green and blue shading) it may be more appropriate to identify further research or maintain a watching brief.

Conservation and recovery actions

Primary conservation objective

By 2030, Gibson's pygmy sundew has increased in abundance, viable populations are sustained in habitats where high-risk manageable threats are managed effectively, and a viable ex-situ collection of the species is maintained to allow for conservation translocation in the event of future threatening events.

Conservation and management priorities

Habitat loss, disturbance and modifications

- Avoid or minimise loss and fragmentation of habitat.
- Minimise the impacts associated with the transformation of landscapes because of *P. cinnamomi* infestation by implementing mitigation measures in the area adjacent to, and surrounding, subpopulations where *P. cinnamomi* presents a threat. Consider the localised use of a biodegradable, systemic fungicide such as phosphite or other alternatives, that minimise potential off-target impacts that may result from the build-up of phosphorus in low-nutrient soils (Lambers et al. 2013; Hopper et al. 2021).

Climate Change and Fire

- Develop and implement a fire management strategy that optimises the survival of Gibson's pygmy sundew.
 - Avoid planned burns in all habitat until the fire-response and the minimal fire-interval period of Gibson's pygmy sundew are better understood,
 - Take the likelihood of increasingly frequent bushfires into account when developing prescribed burning programs, to avoid excessive, frequent burning of any localities.
 - Ensure that when a prescribed burn has been implemented that wildfires are managed to protect subpopulations and reduce the risk of subsequent burn until the elapse of a full-term recovery of the species ,
 - Provide maps of known occurrences to local and State Rural Fire Services and consult with them when planning for prescribed burns is being undertaken.
- Identify current and future habitat likely to remain or become suitable habitat due to climate change and ensure impacts of other threats to this habitat are minimised.
- Spread the risk to the species associated with climate change and fire by establishing multiple translocated populations in suitable habitat.

Invasive species

• If weeds become a threat to subpopulations in the future, implement weed management actions in consultation with land managers and community groups, using appropriate techniques to minimise the effect of herbicide on native vegetation, according to the Australian Weeds Strategy 2017-2027 (IPAC 2016). Consider the possible disturbance/overspray threats associated with the control method.

Ex-situ recovery action

- To manage the risk of losing genetic diversity, collect and store sufficient quantities of seed from all known subpopulations in long-term storage to preserve genetic material, in accordance with the Plant Germplasm Conservation Guidelines (Martyn Yenson et al. 2021). Determine the viability of stored seed.
- Establish plants in cultivation in appropriate institutions such as Botanic Gardens. Obtaining plants may be a particularly important ex situ resource given the species produces abundant and highly fecund gemmae.

Stakeholder engagement/community engagement

- Engage with Indigenous Australians to identify Indigenous management responsibilities and cultural connections to Gibson's pygmy sundew. Identify and encourage collaboration opportunities and awareness of this taxon.
- Support interested community groups to carry out conservation activities for the taxon, including weed control and citizen science activities, noting that the location of the subpopulations are to be kept confidential in the broader community.
- Engage with researchers prior to conducting surveys and developing the monitoring program, to obtain the most up-to-date advice on the taxon.

Survey and monitoring priorities

- Establish and maintain a monitoring program to:
 - locate new subpopulations in similar habitat within SRNP,
 - determine population size and trends, particularly seedling survival,
 - determine habitat conditions, particularly the health of individuals in unburnt habitat,
 - assess threats and their impacts (weeds, recreational damage, etc.), including the effect
 of fire on the life-cycle on the species,
 - document recruitment, pollination activity and seed production, and
 - monitor the effectiveness of management actions and the need to adapt them, if necessary.

Information and research priorities

- Undertake genetic research to:
 - create a resource for understanding the genetic ability for adaptive change, and
 - understand the taxon's genetic diversity and minimum viable population size.
- Undertake research into the taxon's fire ecology, including seedling recruitment and survival post-fire, , and the interval required to allow plants to reach reproductive maturity and produce soil stored seed.
- Investigate potential threats to the species, including but not limited to, weeds, recreational use, and habitat transformation and fragmentation from *P. cinnamomi* infestation.
- Undertake research into the taxon's reproductive ecology, including reproductive strategies, seedling recruitment, pollinators and their fidelity to the species fecundity, and seed germination requirements (e.g., moisture conditions required for germination). Improve

understanding of the impacts of climate change on population viability, including the impacts of increased bushfire frequency and reduction in rainfall.

- Identify priority sites for monitoring and for future translocations.
- Investigate new methods for the effective control of *P. cinnamomi* and treatment of the disease it causes, in order to reduce potential off-target impacts caused by the application of phosphite.
- Undertake research on the most appropriate method for seed collection and determine conditions for seed storage that maximises viability of the seed.

Recovery plan decision

A decision about whether there should be a Recovery Plan for this species has not yet been determined. The purpose of this consultation document is to elicit additional information to help inform this decision.

Conservation Advice and Listing Assessment references

- AIATSIS (Australian Institute of Aboriginal and Torres Strait Islander Studies) (1996) *The AIATSIS Map of Indigenous Australia*. Viewed: 8 October 2021. Available at: <u>https://aiatsis.gov.au/explore/map-indigenous-australia</u>.
- Alan J & Herford I (1999) *Management Plan: Stirling Range National Park And Porongurup National Park, 1999-2009.* Department of Conservation and Land Management, Perth, WA.
- Auld, T. D., & O'Connel, M. A. (1991). Predicting patterns of post-fire germination in 35 eastern Australian Fabaceae. Australian Journal of Ecology, 16, 53–70.
- Auld, T. D., & Ooi, M. K. J. (2009). Heat increases germination of water-permeable seeds of obligate-seeding Darwinia species (Myrtaceae). Plant Ecology, 200, 117–127.
- Barrett S & Yates CJ (2015) Risks to a mountain summit ecosystem with endemic biota in southwestern Australia. *Austral Ecology* 40, 423–432.
- Carnivorous and Exotic Plants (2020) Gemmae. Viewed: 10 December 2021. Available at: https://www.czplants.com/category/seeds-_amp_-gemmae/gemmae/74.
- Chen SH, Guja LK & Schmidt-Lebuhn AN (2019) Conservation implications of widespread polyploidy and apomixis: a case study in the genus *Pomaderris* (Rhamnaceae). *Conservation Genetics* 20, 917–926.
- Commander LE, Coates D, Broadhurst L, Offord CA, Makinson RO & Matther M (2018) *Guidelines for the Translocation of Threatened Plants in Australia.* Australian Network for Plant Conservation, Canberra.
- Cross A (2020) *Drosera gibsonii*. The IUCN Red List of Threatened Species 2020: e.T63891123A63891140. Viewed: 2 November 2021. Available at: <u>https://dx.doi.org/10.2305/IUCN.UK.2020-1.RLTS.T63891123A63891140.en</u>

- Cross A. Kruegar TA, Gonella PM, Robinson AS & Fleischmann AS (2020) Conservation of carnivorous plants in the age of extinction. *Global Ecology and Conservation* 24, e01272.
- Crowder AA, Pearson MC, Grubb PJ & Langlois PH (1990) Biological flora of the British Isles. *Journal of Ecology* 78, 233–267.
- CSIRO and Bureau of Meteorology (2015) *Climate Change in Australia Information for Australia's Natural Resource Management Regions*: Technical Report. CSIRO and Bureau of Meteorology, Australia.
- DAWE (Department of Agriculture Water and the Environment) (2010) *Drosera prolifera* (a sundew) Listing Advice: Advice from the Threatened Species Scientific Committee (the Committee) on the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Department of Agriculture Water and the Environment, Canberra.
- DAWE (Department of Agriculture, Water and the Environment) (2020) National indicative aggregated fire extent datasets. Viewed: 12 October 2021 Available at: <u>http://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B</u> <u>9ACDCB09-0364-4FE8-9459-2A56C792C743%7D</u>
- DAWE (2021) *Fire regimes that cause biodiversity decline as a key threatening process (draft)*. Department of Agriculture, Water and the Environment, Canberra, February.
- DBCA (Department of Biodiversity, Conservation and Attractions) (2017) *Stirling Range National Park.* Viewed: 11 October 2021. Available at: <u>https://parks.dpaw.wa.gov.au/park/stirling-range</u>
- DBCA (Department of Biodiversity, Conservation and Attractions) (2021) *Phytophthora dieback*. Viewed: 11 October 2021. Available at: <u>https://www.dpaw.wa.gov.au/management/pests-diseases/phytophthora-dieback</u>
- DIICCSRTE (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education) (2013) *The Critical Decade 2013: Climate change, science, risks and responses*. Commonwealth of Australia.
- Dixon KW, Pate S & BaileyWJ (1980) Nitrogen nutrition of the tuberous sundew *Drosera erythrorhiza* Lindl. with special reference to catch of arthropod fauna by its glandular leaves. *Australian Journal of Botany*, 28, 283–297.
- Dowdy AJ, Ye H, Pepler A, Thatcher M, Osbrough SL, Evans JP, Di Virgilio, G & McCarthy N (2019) Future changes in extreme weather and pyroconvection risk factors for Australian wildfires. *Scientific Reports* 9, 10073.
- Enright NJ, Fontaine JB, Lamont BB, Miller BP & Westcott VC (2014) Resistance and resilience to changing climate and fire regime depend on plant functional traits. *Journal of Ecology* 102, 1572–1581.
- Enright NT, Fontaine JB, Bowman DMJS, Bradstock RA & Williams RJ (2015) Interval squeeze: altered fire regimes and demographic responses interact to threaten woody species persistence as climate changes. Frontiers in Ecology and the Environment 13, 265–272.

- Ford B, Cook B, & Rogers D (2013) Climate change impacts and adaptation in the Southern & Southwestern Flatlands cluster: review of existing knowledge. Report No CENRM133, Centre of Excellence in Natural Resource Management, University of Western Australia, Albany.
- Gallagher RV (2020) National prioritisation of Australian plants affected by the 2019-2020 bushfire season – Report to the Commonwealth Department of Agriculture, Water and Environment. Australian Government Department of Agriculture, Water and the Environment, Canberra. Viewed 8 October 2021. Available at: http://www.environment.gov.au/biodiversity/bushfire-recovery/priority-plants
- Gallagher RV, Allen A, Mackenzie BDE, Yates CJ, Gosper CR, Keith DA, Merow C, White MD, Wenk E, Maitner BS, He K, Adams VM & Auld TD (2021) High fire frequency and the impact of the 2019–2020 megafires on Australian plant diversity. *Biodiversity Research* 27, 1166–1179.
- Gibson TC & Waller DM (2009) Evolving Darwin's 'most wonderful' plant: ecological steps to a snap-trap. *New Phytologist*, 183, 575–587.
- Gill AM & Nicholls AO (1989) Monitoring fire-prone flora in reserves for nature conservation. In: Burrows N, L McCaw, G Friend (eds) *Fire management on nature conservation lands*. Department of Conservation and Land Management (WA), Western Australia. pp 137– 151. Available at: <u>http://hdl.handle.net/102.100.100/262058?index=1</u>
- Gosper CR, Prober SM & Yates CJ (2013) Estimating fire interval bounds using vital attributes: implications of uncertainty and among population variability. *Ecological Applications* 23, 924–35.
- Groom P & Lamont B (2015) Plant life of southwestern Australia: adaptation for survival. De Gruyter Open Poland, Poland. 268 p.
- Hanslin HM & Karlsso PS (1996) Nitrogen uptake from prey and substrate as affected by prey capture level and plant reproductive status in four carnivorous plant species. *Oecologia* 106, 370–375.
- Henzler J, Weise H, Enright NJ, Zander S & Tietjen B (2018) A squeeze in the suitable fire interval: Simulating the persistence of fire killed plants in a Mediterranean-type ecosystem under drier conditions. *Ecological Modelling* 389, 41–49.
- Hopper SD, Lambers H, Silveira FAO & Fiedler PL (2021) OCBIL theory examined: reassessing evolution, ecology and conservation in the world's ancient, climatically buffered and infertile landscapes. *Biological Journal of the Linnean Society* 133, 266–296.
- International Carnivorous Plant Society (2020a) Growing pygmy Drosera. Viewed: 10 December 2021. Available at: https://www.carnivorousplants.org/grow/guides/PygmyDrosera.
- International Carnivorous Plant Society (2020b) Guide to pygmy Drosera. Viewed: 10 December 2021. Available at: https://www.carnivorousplants.org/cp/taxonomy/pygmyDrosera/pg2
- IPAC (Invasive Plants and Animals Committee) (2016) *Australian weeds strategy 2017-2027*. Department of Agriculture, Water and the Environment (Commonwealth), Canberra.

- IUCN (2019) *Guidelines for using the IUCN red list categories and criteria. Version 14.* Prepared by the IUCN Standards and Petitions Committee.
- Jasinge NU, Huynh T, & Lawrie AC (2018) Changes in orchid populations and endophytic fungi with rainfall and prescribed burning in *Pterostylis revoluta* in Victoria, Australia. *Annals* of Botany 121, 321–334.
- Jennings D (2011) *The Conservation and Ecology of Carnivorous Plants*. A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy. University of South Florida, USA.
- Krafft CC & Handel SN (1993) The role of carnivory in the growth and reproduction of *Drosera filiformis* and *D. rotundifolia*. *Bulletin of the Torrey Botanical Club* 118, 12–19.
- Keith D (1996) Fire-driven extinction of plant populations: a synthesis of theory and review of evidence from Australian vegetation. *Proceedings of the Linnean Society of New South Wales* 116, 37–78.
- Keith DA (2012). Functional traits: their roles in understanding and predicting biotic responses to fire regimes from individuals to landscapes. In R. J. Williams, R. A. Bradstock, & A. M. Gill (Eds.) *Flammable Australia: Fire regimes, biodiversity and ecosystems in a changing world* (pp. 97–125). CSIRO Publishing.
- Lambers H, Ahmedi I, Berkowitz O, Dunne C, Finnegan PM, Hardy GESJ, Jost R, Laliberté E, Pearse SJ & Teste FP (2013) Phosphorus nutrition of phosphorus-sensitive Australian native plants: threats to plant communities in a global biodiversity hotspot. *Conservation Physiology* 1, cot010.
- Lowrie A (2013) Carnivorous Plants of Australia, Magnum Opus 2, 465.
- Lowrie A (2014) Carnivorous Plants of Australia. Redfern Natural History Productions, Poole.
- Mann P (2007) *Drosera gibsonii* (Droseraceae), a new Pygmy Drosera from south-west Western Australia. *Nuytsia* 16, 321–323.
- Martyn Yenson AJ, Offord CA, Meagher PF, Auld T, Bush D, Coates DJ, Commander LE, Guja LK, Norton SL, Makinson RO, Stanley R, Walsh N, Wrigley D & Broadhurst L (2021) *Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising ex situ collection. Third edition.* Australian Network for Plant Conservation, Canberra.
- May A & Pludra L (2021) Growing Pygmy Sundews. Viewed: 10 December 2021. Available at: https://www.growsundews.com/sundews/Pygmy_sundews_Drosera.
- Mia T (2008) *Kepwaamwinberkup (Nightwell)*. Cultural Survival Quarterly Magazine, September 2008. Viewed: 8 October 2021. Available at: <u>https://www.culturalsurvival.org/publications/cultural-survival-quarterly/kepwaamwinberkup-nightwell</u>
- Miller G, Tangney R, Enright NJ, Fontaine JB, Merritt DJ, Ooi MKJ, Ruthrof KX & Miller BP (2019) Mechanisms of fire seasonality effects on plant populations. *Trends in Ecology and Evolution* 34, 1104–1117.

- Morgan JW (1995). Ecological studies of the endangered *Rutidosis leptorrhynchoides. I.* Seed production, soil seed bank dynamics, population density and their effects on recruitment. *Australian Journal of Botany* 43, 1–11.
- OBRM (Office of Bushfire Risk Management) (2018) Report of the circumstances that led to the escapes of planned burns in the south west and great southern regions of Western Australia on 24 and 25 may 2018. Office of Bushfire Risk Management (WA), Perth.
- Ooi, M J, Auld TD & Whelan R J (2007) Distinguishing between persistence and dormancy in soil seed banks of three shrub species from fire-prone southeastern Australia. *Journal of Vegetation Science* 18, 405.
- Petitpierre B, McDougall K, Seipel T, Broennimann O, Guisan A & Kueffer C (2016) Will climate change increase the risk of plant invasions into mountains? *Ecological Applications* 26, 530–544.
- Regan, HM, Auld TD, Keith DA & Burgman MA (2003) The effects of fire and predators on the long-term persistence of an endangered shrub, *Grevillea caleyi*. *Biological Conservation* 109, 73–83.
- Schulze ED, Gebauer G, Schulze W & Pate JS (1991) The utilization of nitrogen from insect capture by different growth forms of *Drosera* from southwest Australia. *Oecologia*, 87, 240–246.
- Wills RT (1992) The ecological impact of *Phytophthora cinnamomi* in the Stirling Range National Park, Westerna Australia. *Australian Journal of Ecology* 17, 145–159.
- Verbeek NAM & Boasson R (1993) Relationship between types of prey captured and growth form in *Drosera* in southwestern Australia. *Australian Journal of Ecology* 18, 203–207.

Other Sources

- Krueger T (2021) Personal communication by email, 3 November 2021, Curtin University.
- Krueger T (2021) Personal communication by email, 8 November 2021, Curtin University.
- Krueger T (2021) Personal communication by email, 16 November 2021, Curtin University.
- Krueger T and Fleischmann A (2021) Personal communication by email, 18 November 2021, Curtin University and Botanische Staatssammlung Munchen (Germany), respectively.

THREATENED SPECIES SCIENTIFIC COMMITTEE

Established under the Environment Protection and Biodiversity Conservation Act 1999

The Threatened Species Scientific Committee finalised this assessment on DD Month Year.

Attachment A: Listing Assessment for Drosera gibsonii

Reason for assessment

This assessment follows prioritisation of a nomination from the TSSC.

Assessment of eligibility for listing

This assessment uses the criteria set out in the <u>EPBC Regulations</u>. The thresholds used correspond with those in the <u>IUCN Red List criteria</u> except where noted in criterion 4, subcriterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

Key assessment parameters

Table 3 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	>10,000	3420	10,400- 19,400	Gibson's pygmy sundew undergoes natural fluctuations in the number of mature individuals, because mature individuals are killed by fire and persistent drying conditions, and the species requires moist conditions to reproduce asexually (Cross 2020; T Krueger pers comm 2021, 8 November). The minimum plausible value is based on post- fire surveys in 2021 and on existing pre-fire surveys (Table 5, see evidence under Criterion 1). The maximum plausible value is also based on post-fire surveys in 2021 and on existing pre- fire surveys (Table 5, see evidence under Criterion 1). However, an additional 2,000 mature individuals are added to the maximum range because data from three subpopulations are unavailable, and two of these subpopulations have not been affected by the 2019–20 fires (November). Also, 9,000 seedlings are estimated to have germinated post- fire, therefore the maximum number of mature individuals could be usell over 10,000
Trend	Unknown	<u> </u>	1	The population trajectory is unknown due to the lack of consistent pre-fire and post-fire surveys and a limited understanding of post- fire recovery.

Table 4 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Generation time (years)	4.5	4	5	The calculation for generation length for Gibson's pygmy sundew is explained in the evidence under Criterion 1. The minimum plausible value represents the lowest generation period for the species, and the maximum value represents the maximum generation period based on IUCN guidelines. The estimate used in the assessment is based on a midpoint between the minimum and maximum plausible value.
Extent of occurrence	61 km ²	49 km ²	61 km ²	The maximum plausible value has been calculated using record data from 2008-2021 for extant subpopulations and applying the smallest polygon boundary around points which can be drawn to encompass these records, as outlined in the Guidelines for Using the IUCN Red List Categories and Criteria (IUCN 2019). The minimum plausible value is based on the EOO reported in IUCN assessment (Cross 2020)
				The maximum plausible value was used in this assessment, which contains the most up- to-date information on the species occurrence because additional information has been obtained since the 2016 IUCN assessment (T Krueger pers comm 2021, 3 November).
				All values are within the range of the Critically Endangered category of Criterion 2.
Trend	Stable			The population trajectory of the species' EOO is likely to be stable because all subpopulations are expected to be extant; subpopulations 1 and 2 were not affected by the 2019–20 fires and there is no information to suggest that subpopulation 6 has become locally extinct
Area of Occupancy	32 km ²	24 km ²	32 km ²	The maximum plausible value is an estimate based on the mapping of cleaned point records from 2008–2021, obtained from state governments, herbarium collections, and other sources. The AOO was then calculated using a 2x2 km grid cell method over these points, based on the IUCN Red List Guidelines (IUCN 2019).
				The minimum plausible value is based on the AOO reported in the IUCN assessment for the species (Cross 2020).
				The estimate used in the assessment is based on the maximum plausible value which contains the most up-to-date information on the species occurrence because additional information has been obtained since the 2016 IUCN assessment (T Krueger pers comm 2021, 3 November).
				All values are within the range of the Endangered category of Criterion 2.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification	
Trend	Stable			The population trajectory of the species' AOO is likely to be stable because all subpopulations are expected to be extant; subpopulations 1 and 2 were not affected by the 2019–20 fires and there is no information to suggest that subpopulation 6 has become locally extinct.	
Number of subpopulations	8	8	>8	There was originally thought to be three subpopulations occupying two main regions prior to 2008 (subpopulations 5, 7 and 8, Table 1). However, new subpopulations have been identified since 2008 (T Krueger pers comm 2021, 3 November). Therefore, the minimum number of subpopulations is based on all known subpopulations (T Krueger pers comm 2021, 3 November). The maximum number of subpopulations is based on the possibility of additional undiscovered subpopulations. Undiscovered subpopulations are possible because comprehensive surveys across the whole of the species potential habitat range have not been undertaken. For example, two new subpopulations have been identified in the last five years due to increased survey effort. The estimate used in the assessment is based on all known extant subpopulations.	
Trend	Stable			The population is considered stable, as post- fire surveys and pre-fire herbarium records appear to occupy the same location. The identification of new subpopulations is likely related to increased survey effort, rather than new subpopulations becoming established.	
Basis of assessment of subpopulation number	new subpopulations becoming established. There are eight known subpopulations of Gibson's pygmy sundew based on post-fire and pre- fire surveys. Although some subpopulations are located in close proximity to each other (i.e., less than 2 km apart between subpopulations 1 and 2, 4 and 5, and 7 and 8), there is a lack of information on the species connectivity to indicate that cross-pollination occurs. Further, considering that the species mainly relies on asexual reproduction (T Krueger pers comm 2021, 8 November), it is likely that each subpopulation represents a unique subpopulation				

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
No. locations	1	1	4	Gibson's pygmy sundew is found in a very restricted habitat along the lower/mid-slopes of the central and eastern section of Stirling Range National Park (SRNP). The most plausible threats to the taxon are from an increased risk of frequent bushfires and an increased risk of reduced moisture conditions due to a reduction in rainfall as a consequence of climate change. A single bushfire event could impact the entire population which occupies less than 61 km ² . Similarly, a prolonged dry period during the growing season could impact the whole population as moist conditions are required for successful germination and for the production and development of gemmae. While the taxon has seed that can survive and germinate after fire, multiple fires in rapid succession, not allowing time for germinated plants to reach reproductive maturity, could cause the population to decline (TSS 2016). Future projections for the Stirling Range
				region include an increased frequency of high fire danger weather (DIICCSRTE 2013; Dowdy et al. 2019; CSIRO & Bureau of Meteorology 2015) and a decrease in precipitation of 5– 20% by 2030 and 10-40% by 2070 in southwest WA (Ford et al. 2013). Therefore, one location represents the most plausible minimum value.
				The maximum plausible value considers subpopulations that are in close proximity to each other and have a similar fire history (i.e., exposed to the same fire events previously, Table 1) to represent one location because not all fire events affected every subpopulation. This means that subpopulations can be grouped in four locations: subpopulations 1 and 2; 3 only; 4 and 5; and 6, 7 and 8).
				A location of one was used in the assessment which represents the most likely estimate because it is feasible for a single threatening event within one generation to affect the species' entire distribution. This is because fire and reduced rainfall present a particular risk to this taxon due to the long-time required to reach reproductive maturity (at least 3 years, T Krueger pers comm 2021, 3 November), short life-span (5–7 years) and low seed production rates (Cross 2020; T Krueger and A Fleischmann pers comm 2021, 18 November). Other threats including fire interactions with weeds, could also contribute to the taxon being considered to have a single location.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	Stable			One location has been used for this assessment. Although, future climate change predictions for this region (elevated risk of fire and reduced rainfall) could result in population decline, it is unlikely to reduce the number of locations to zero (and result in extinction of the taxon).
Basis of assessment of location number	Gibson's pygmy sundew occurs in a very restricted location within SRNP and occupies less than 61km ² . Climate change predictions include an increased risk of frequent and intense bushfires, and reduced rainfall. A single bushfire and/or reduced rainfall during the growing season could impact the entire population. Repeated fires in close succession followed by reduced rainfall can prevent the plant from reaching maturity and producing seeds, and inhibit the population from reproducing asexually, resulting in a population decline.			
Fragmentation	The population is not considered severely fragmented due to all subpopulations occurring with a national park that allows for natural connection.			
Fluctuations	There are no known extreme fluctuations in EOO, AOO, and number of subpopulations or locations.			

Criterion 1 Population size reduction

Redu	uction in total numbers (measured over t	he longer of 10 years or 3 g	enerat	ions) based on	any	of A1 to A4
		Critically Endangered Very severe reduction	Enda Sevei	ngered re reduction		Vulnerable Substantial reduction
A1		≥ 90%	≥ 70%	6		≥ 50%
A2, A	.3, A4	≥ 80%	≥ 50%	6		≥ 30%
A1 A2	Population reduction observed, estimat past and the causes of the reduction are understood AND ceased. Population reduction observed, estimat past where the causes of the reduction	ed, inferred or suspected in e clearly reversible AND ed, inferred or suspected in may not have ceased OR ma	the the y not		(a) (b) (c)	direct observation [except A3] an index of abundance appropriate to the taxon a decline in area of occupancy, extent of
A3 A4	be understood OR may not be reversibl Population reduction, projected or susp to a maximum of 100 years) [(<i>a</i>) cannot An observed, estimated, inferred, proje- reduction where the time period must i future (up to a max. of 100 years in futu	e. bected to be met in the futur <i>t be used for A3</i>] cted or suspected populatio nclude both the past and th ure), and where the causes o	e (up n e of	Based on any of the following	(d) (e)	actual or potential levels of exploitation the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites
	reduction may not have ceased OR may be reversible.	not be understood OR may	not			

Criterion 1 evidence

Insufficient data to determine eligibility

Generation length

The time to reproductive maturity for the species is at least three years (T Krueger pers comm 2021, 8 November) and the longevity for the species is estimated at 5–7 years (T Krueger and A

Fleischmann pers comm 2021, 18 November). Following the IUCN guidelines for calculating generation length, the generation time is in the range of:

Generation time = age of first reproduction + [0.5 * (length of reproductive period)]Generation time = 3 + [0.5 * (5 - 3)] = 4 years

OR

Generation time = 3 + [0.5 * (7 - 3)] = 5 years

This gives an estimated three-generation period of approximately 12–15 years.

Population size reduction

Targeted post-fire surveys were carried out in October 2021 at three subpopulations (subpopulation 3, 4 and 5; Tables 1 & 5). Two of the subpopulations were either partially burnt (subpopulation 3) or fully burnt (subpopulation 4) and the remaining subpopulation (subpopulation 5) was not affected by fire (Table 1). The estimate for subpopulation 5 includes seedlings, juveniles and mature individuals, while the estimate for subpopulation 3 and 4 includes mature individuals only. For the purpose of the assessment, half of subpopulation 5 was considered to be mature individuals (Table 5).

Table 5 Estimated population of Gibson's pygmy sundew post 2019–20 fires (adapted from	n
Krueger unpublished, Table 1)	

Subpopulation number	# mature individuals minimum	# mature individuals' maximum	# juveniles minimum	# juveniles' maximum
1	unknown	unknown	unknown	Unknown
2	unknown	unknown	unknown	unknown
3	500	2500	500	2500
4	20	100	500	1000
5	250 (estimated)	500 (estimated)	250 (estimated)	500 (estimated)
6	unknown	unknown	unknown	unknown
7	2500 (estimated)	5000 (estimated)	2500 (estimated)	5000 (estimated)
8	150 (estimated)	300 (estimated)	unknown	unknown
TOTAL	3420	8400	3750	9000

Pre-fire subpopulation estimates for juvenile and mature individuals were also available for subpopulations 7 and 8 (Table 1). Both of these subpopulations were either partially burnt (subpopulation 7) or suspected to be totally burnt (subpopulation 8) by the 2019–20 fires (Table 1; T Krueger pers comm 2021, 3 November). Therefore, it is unclear how many mature individuals remain in these two subpopulations after the 2019–20 fires. For the purpose of the assessment, half of subpopulation 7 (fifty percent) and thirty percent of subpopulation 8 is estimated to remain after the 2019-20 fires (Table 5). However, these values should be considered cautiously because it is unknown how many (if any) mature individuals remain in these two subpopulations.

It is also important to note that the maximum number of mature plants in the total population (Table 5) would be an underestimate because three subpopulations are lacking data. These subpopulations are still considered extant because subpopulations 1 and 2 were not affected by the 2019–20 fires and there is no information to suggest that subpopulation 6 has become locally extinct.

Despite estimates of the number of mature individuals, population size reduction cannot be measured because of the wide range of population estimates recorded through time and a lack of temporal replication within subpopulations. The wide range of population estimates are a reflection of the natural fluctuations in the number of mature individuals of the species, because mature individuals are killed by fire and the species requires moist conditions to germinate and reproduce asexually (Cross 2020; T Krueger pers comm 2021, 8 November).

Conclusion

Although pre-fire and post-fire estimates are available for some subpopulations, there is no consistent temporal replication of subpopulations with specific data to indicate population trends through time. Therefore, there are insufficient data to demonstrate if the taxon is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the varieties status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy

		Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited	
B1.	Extent of occurrence (EOO)	< 100 km ²	< 5,000 km ²	< 20,000 km ²	
B2.	Area of occupancy (AOO)	< 10 km ²	< 500 km ²	< 2,000 km ²	
AND	AND at least 2 of the following 3 conditions:				
(a)	Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10	
(b)	 Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals 				
(c)	:) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals				

Criterion 2 evidence

Eligible under Criterion 2 B1ab(iii, v) for listing as Critically Endangered

Extent of occurrence (EOO) and area of occupancy (AOO)

The most plausible area of occupancy (AOO) and extent of occurrence (EOO) of Gibson's pygmy sundew are estimated at 32km² (range is 24 km²–32 km²) and 61 km² (range is 49 km²–61 km²), respectively. These figures are based on mapping point records from 2008–2021, obtained from herbarium collections, and other sources. AOO was calculated using a 2 x 2 km grid cell method over each spatial data point and the EOO was calculated using a minimum convex hull (IUCN 2019).

The species' EOO appears to meet the requirements for listing as Critically Endangered under B1 (<100 km²). The species' AOO appears to meet the requirements for listing as Endangered under B2 (<500 km²).

Number of locations

Gibson's pygmy sundew is considered to be a single location, within a restricted habitat of the lower/mid-slopes of central and eastern SRNP (Cross 2020; T Krueger pers comm 2021, 3 November).

The most plausible threats to the taxon are inappropriate fire regimes and reduced rainfall events, and the interaction between fire and reduced precipitation. Catastrophic bushfires in 2019–20 affected six of the eight subpopulations (Table 1). The only localities not impacted by the recent fires were the subpopulations located furthest to the west of the species range. Reduced rainfall during the growing season after a fire event, can exacerbate the effect of fire by slowing population recovery because moist conditions are required for seeds to germinate and for the production and development of gemmae into plants (T Krueger pers comm 2021, 3 November). Further, the species is self-incompatible and has low seed production rates, similar to closely related species (Cross 2020; T Krueger and A Fleischmann pers comm 2021, 18 November). Therefore, several growing seasons are likely to be necessary to build up sufficient soil stored seed to ensure the persistence of subpopulations. Despite the impacts of fire, surveys 22 months after the 2019–20 fire revealed that there was sufficient remaining seed in the soil at subpopulations 3 and 4 for the germination of an estimated 1000 to 3500 seedlings. However, the subpopulations had a fire-free period of at least 10 years before the 2019–20 fires (T Krueger pers comm 2021, 8 November).

Climate change predictions for the region include an increased risk of more frequent fires (DIICCSRTE 2013; Dowdy et al. 2019) and a decrease in precipitation of five–20 percent by 2030 and 10-40 percent by 2070 in south-west WA (Ford et al. 2013). Therefore, if another fire was to occur in the range of the species within the next six years (i.e., within the recommended fire-free interval, see Table 2), then individuals would be at risk of death or poor recovery, and there may not be sufficient seed to replenish the population. Further, if fires are proceeded by reduced moisture conditions (i.e., reduced rainfall), then seedlings can be prevented from germinating. Reduced moisture conditions will also put the species in a vegetative state where it will not reproduce asexually, and prolonged reduced rainfall could cause the species to decline in number (Cross et al. 2020). Other threats that interact with fire may also affect seedling recruitment and survival, such as the potential interaction with weeds as climate change conditions unfold (Petitpierre et al. 2016). Therefore, an intense bushfire and reduced rainfall could be capable of impacting the entire population.

Consequently, only a single threatening event (e.g., fire) would be required within the next six years for all individuals to be rapidly affected.

The number of locations used in this assessment is one. The species' number of locations appears to meet the requirement for listing under sub-criterion (a).

Severe fragmentation

The population is not considered severely fragmented because all individuals occur within a 35 km section of a national park. Despite a road separating east and west subpopulations, natural processes that allow for connection between subpopulations are facilitated within this protected and managed area. However, *P.cinnamomi* infestation could be impacting the surrounding landscape and causing fragmentation of the species' habitat. Further research is required to understand if and how, populations are being impacted by this threat.

Therefore, the species does not appear to meet the severe fragmentation requirement for listing under this criterion.

Continuing decline (quality of habitat and number of mature individuals)

Continuing decline is projected in the quality of Gibson's pygmy sundew habitat. Fire kills plants but also facilitates the germination of seedlings. Too frequent fires however, within a period of less than six years, can remove any soil-stored seed and prevent the population from recovering. Asexual reproduction will also no longer be possible if all mature plants are killed by fire. Reduced moisture conditions due to a reduction in rainfall during the growing season is capable of inhibiting asexual reproduction and the germination of seedlings following fire. Severe and more frequent fires and reduced rainfall are predicted in southwest Australia, within the species range (DIICCSRTE 2013; Ford et al. 2013; CSIRO & BOM 2015; Dowdy et al. 2019).

Continuing decline is projected in the number of mature individuals. It takes a minimum of three years for the species to reach maturity, the generation length is 4.5 years and seed production is likely to be low (as evident in closely related sundew species). As a result, the species requires 3–4 years to build up sufficient soil stored seed to ensure population persistence following fire. Therefore, if fire frequency is shorter than six, it is likely that the number of mature individuals will reduce. For example, the 2019–20 fires killed all mature individuals in subpopulation 4 and resulted in between 500–1000 seedlings germinating post fire (Table 1). If this subpopulation was to be impacted by another fire event within six years, the number of mature individuals would be considerably reduced. The majority of subpopulations 6 and 8 were also estimated to be burnt (T Krueger pers comm 2021, 3 November) and therefore would be highly susceptible to impact by another fire event within the next six years. Post fire surveys have not been carried out in these two subpopulations but all three of these subpopulations may be vulnerable to a loss in the number of mature individuals from the impacts of frequent fire.

The species appears to meet the requirement for listing under sub-criterion (b).

Extreme fluctuations

Extreme fluctuations represent changes in the total population (rather than a flux of individuals between different life stages), which exceed one order of magnitude (IUCN 2019). Extreme fluctuations can be diagnosed by interpreting population trajectories which show a recurring pattern of increases and decreases; or by using life history characteristics (IUCN 2019).

The population numbers naturally fluctuate because mature individuals are killed by fire and reproduce asexually under suitable moist conditions (Cross 2020; T Krueger pers comm 2021, 8 November). Fluctuation projections are unknown because of a lack of temporal data on the same subpopulation. However, fluctuations are not considered to be extreme and operate under non-natural events. There are no known extreme fluctuations in EOO, AOO, and number of subpopulations, locations or mature individuals. Therefore, the species does not appear to meet the threshold for listing under sub-criterion (c).

Conclusion

The Committee considers that the species AOO is restricted, and the EOO and number of locations are very restricted; and continuing decline is projected in the area, and quality of habitat and number of subpopulations and mature individuals due to threats posed by inappropriate fire regimes and decreasing precipitation caused by climate change.

The data presented above appear to demonstrate that the species is eligible for listing as Critically Endangered under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the varieties status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3 Population size and decline

	Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals	< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true			
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	Very high rate 25% in 3 years or 1 generation (whichever is longer)	High rate 20% in 5 years or 2 generation (whichever is longer)	Substantial rate 10% in 10 years or 3 generations (whichever is longer)
C2. An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(ii) % of mature individuals in one subpopulation =	90 - 100%	95 - 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

Criterion 3 evidence

Ineligible

Number of mature individuals

The number of mature individuals is estimated to be greater than 10,000 (see the evidence under Criterion 1). This value is based on pre-fire and post-fire surveys. Therefore, the number of mature individuals does not appear to meet the requirement for listing under this criterion.

Population decline

As discussed in Criterion 2, the taxon is projected to decline in the number of mature individuals. This is because of the threats due to climate change (increased fire and reduced rainfall), and the interactions between climate related threats (fire-reduced rainfall), and the potential interaction of fire with weeds. However, the percent decline cannot be estimated as there is insufficient

replication of temporal data to estimate population trajectories in the future. Therefore, there is insufficient information to determine the requirements for listing under this criterion

Number of mature individuals in each subpopulation

As shown in Table 5, the number of mature individuals within each subpopulation ranges from 20 to 5,000 (for which data are available). Therefore, the number of mature individuals in each subpopulation does not appear to meet the requirement for listing under this criterion.

Percent of individuals in one subpopulation

As shown in Table 5, the number of individuals within each subpopulation is spread over eight subpopulations (for which data is available). The percentage of mature individuals in one subpopulation is considered to be less than 100 percent, so the species does not appear to meet this requirement for listing under this criterion.

Conclusion

The data presented above appear to demonstrate that the species is not eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
D. Number of mature individuals	< 50	< 250	< 1,000
D2. ¹ Only applies to the Vulnerable category Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km ² or number of locations ≤ 5

Criterion 4 Number of mature individuals

¹ The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments may include information relevant to D2. This information will not be considered by the Committee in making its recommendation of the species' eligibility for listing under the EPBC Act, but may assist other jurisdictions to adopt the assessment outcome under the <u>common</u> <u>assessment method</u>.

Criterion 4 evidence

Ineligible

Number of mature individuals

The number of mature individuals is estimated to be greater than 10,000 (see the evidence under Criterion 1). This value is based on pre-fire and post-fire surveys. The species does not appear to meet the requirement for listing under this criterion.

Conclusion

The data presented above appear to demonstrate that the species is not eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 5 Quantitative analysis

	Critically Endangered Immediate future	Endangered Near future	Vulnerable Medium-term future
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Criterion 5 evidence

Insufficient data to determine eligibility

Population Viability Analysis

Population viability analysis has not been undertaken for this taxon.

Conclusion

There is insufficient information to determine the eligibility of the taxon for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Adequacy of survey

The survey effort has been considered adequate and there is sufficient scientific evidence to support the assessment.

Listing and Recovery Plan Recommendations

A decision about whether there should be a Recovery Plan for this taxon has not yet been determined. The purpose of this consultation document is to elicit additional information to help inform this decision.

© Commonwealth of Australia 2021



Ownership of intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights) in this publication is owned by the Commonwealth of Australia (referred to as the Commonwealth).

Creative Commons licence

All material in this publication is licensed under a <u>Creative Commons Attribution 4.0 International Licence</u> except content supplied by third parties, logos and the Commonwealth Coat of Arms.

Inquiries about the licence and any use of this document should be emailed to <u>copyright@awe.gov.au</u>.

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the

 $(\mathbf{\hat{H}})$

Environment 2021, Conservation Advice for Drosera gibsonii, Canberra.

This publication is available at the SPRAT profile for Drosera gibsonii.

Department of Agriculture, Water and the Environment GPO Box 858, Canberra ACT 2601 Telephone 1800 900 090 Web <u>awe.gov.au</u>

The Australian Government acting through the Department of Agriculture, Water and the Environment has exercised due care and skill in preparing and compiling the information and data in this publication. Notwithstanding, the Department of Agriculture, Water and the Environment, its employees and advisers disclaim all liability, including liability for negligence and for any loss, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying on any of the information or data in this publication to the maximum extent permitted by law.

Acknowledgements

Thilo Krueger is kindly acknowledged for his assistance with providing information, data and advice to support the assessment. Dr Adam Cross is kindly acknowledged for referring the department to Thilo.

Version history table

Document type	Title	Date [dd mm yyyy]
-	-	_
-	-	-