

Consultation on Species Listing Eligibility and Conservation Actions

Lepyrodia valliculae (Kangaroo Island scale-rush)

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

1) the ineligibility of *Lepyrodia valliculae* (Kangaroo Island scale-rush) for inclusion on the EPBC Act threatened species list; 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: species.consultation@awe.gov.au

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 8 July 2022.

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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: https://www.awe.gov.au/sites/default/files/env/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 LEPYRODIA VALLICULAE

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?

SECTION C 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:

□ 1–250 □ 250–1000 □ 1000–2500 □ 2500–10,000 □ >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 1940s to late-1980s (at or soon after the start of the most recent three generation 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:

□ 1-250 □ 250-1000 □ 1000-2500 □ 2500-10,000 □ >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 33–78 years (i.e. three generations 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

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

 \Box 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 – 5000 km² \Box 5000 – 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

 \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

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 10 – 500 km² \Box 500 – 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

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

Threatened Species Scientific Committee

- 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 – 5000 km² \Box 5000 – 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 10 – 500 km² \Box 500 – 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

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 Lepyrodia valliculae (Kangaroo Island scale-rush)

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 *Lepyrodia valliculae* (Kangaroo Island scale-rush). It provides a foundation for conservation action and further planning.



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Conservation status

Lepyrodia valliculae (Kangaroo Island scale-rush) is not proposed to be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act).

The Kangaroo Island scale-rush was assessed by the Threatened Species Scientific Committee to be ineligible for listing under any criteria. 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: Insufficient data
- Criterion 3: Ineligible
- Criterion 4: Ineligible
- Criterion 5: Insufficient data

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 *Lepyrodia valliculae* J.M.Black (Black 1928). Family: Restionaceae.

Description

The Kangaroo Island scale-rush is a small, perennial sedge with simple, erect, stems to 30 cm high, with basal sheaths and sheaths along the stem appressed with short points at intervals along the stem. It has a non-creeping rootstock. Flowers are small and brown in a narrow spike-like panicle that is 1–7 cm long. The capsule is up to 1.5 mm long, and seeds are tiny, brown, ellipsoid in shape to 1.2 mm long and 0.8 mm wide, with a fine smooth and shiny surface. Seed embryo type is broad. Description from DEW (2021) and Plants of SA (2021).

Distribution

The Kangaroo Island scale-rush is endemic to Kangaroo Island (KI) and the adjacent mainland of South Australia near Victor Harbour (ALA 2021). The species is present in reserved areas in Flinders Chase National Park (particularly widespread on the undissected plateau occurring in the north-eastern quarter of the Park) and Ravine Des Casoars Wilderness Protection Area, and also occurs on private property, including under Heritage Agreements, and roadsides (Davies 1986; ALA 2021).

The number of subpopulations of the Kangaroo Island scale-rush is highly uncertain. There are only two records post-1970 on the mainland (in 1975 and 1990; ALA 2021), both in the Back Valley region where most native vegetation was cleared in the mid-20th century (Bickford et al. 2008). Searches since the 1990s on the mainland have failed to find the species, suggesting that it now only survives on KI (D. Murfet 2021 pers. comm. 13 Dec). There are 126 records of the species across the western third of KI, the majority post-1980 (ALA 2021). Based on the lack of

spatial clustering of records (ALA 2021) and the ecology of the species (likely wind-pollinated; Hartley et al. 2008), the species is considered to occur in a single subpopulation covering the western third of KI. There are no estimates of the population size other than the observation that the species is often a dominant component of the understorey vegetation across much of its distribution (Davies 1986).





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 the 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). This is a precautionary approach in line with the purpose of the mapping as indicative. 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

The cultural, customary and spiritual significance of species and the ecological communities they form are diverse and varied for Indigenous Australians and their stewardship of Country. This section describes some examples of this significance but is not intended to be comprehensive or applicable to, or speak for, Indigenous Australians. Such knowledge may be held by Indigenous Australians who are the custodians of this knowledge and have the rights to decide how it is shared and used.

Kangaroo Island has important cultural significance to the Kaurna, Ngarrindjeri, Narungga and Ramindjeri nations, and these groups maintain a spiritual connection to the region (DEH 2006; Ngarrindjeri Nation 2007). The Kaurna, Ngarrindjeri, Narungga and Ramindjeri peoples would like to be involved in the development and implementation of natural resources management in their traditional lands and waters (Ngarrindjeri Nation 2007). Current members of these nations have a strong understanding of Country and feel responsible for lands and waters (Ngarrindjeri Nation 2007; NRKI 2017).

Given the acknowledged importance to Aboriginal peoples of Connection to Country and the widespread importance of Caring for Country (which includes biodiversity, 'place', custom and totemic elements) it is considered likely that the species has or is associated with some cultural and/or community significance.

Relevant biology and ecology

Habitat

On the mainland, the species was reported to occur in and around swamps and wet depressions (Davies 1986).

On KI, Kangaroo Island scale-rush mainly occurs in shallow depressions subject to winter waterlogging on undissected plateaux (Davies 1986). It also occurs near the crests of broad ridges, at the bottom of river valleys, on the banks of semi-permanent lagoons, and on undulating plains and broad, gentle-sloping, ephemeral river flats (Davies 1986). The soil is generally loam to loamy sand (Davies 1986), but the species may occasionally be found on clay soils (ALA 2021). On undissected plateaux, Kangaroo Island scale-rush grows in open-heath with *Eucalyptus baxteri* (brown stringybark) or open forest with brown-stringybark and *E. remota* (Kangaroo Island ash). Associated dominant species in open-heath are *Caustis pentandra* (thick twist-rush), *Leptocarpus tenax* (slender twine rush), *Patersonia fragilis* (short purple-flag), *Darwinia micropetala* (small darwinia), *Melaleuca gibbosa* (slender honey-myrtle), *Allocasuarina* spp. (sheoak), *Leucopogon concurvus, Phyllota pleurandroides* (heathy phyllota), *Spyridium* spp. (spyridium), *Conospermum patens* (slender smoke-bush), *Petrophile multisecta* (cone bush), *Hypolaena fastigiata* (tassel rope-rush) and *Schoenus breviculmis* (matted bog-sedge).

The Kangaroo Island scale-rush occurs in the following vegetation associations on river flats:

- i. Small *Darwinia* open-heath, and low shrubland (both with and without slender honeymyrtle as a co-dominant) with a very sparse understorey dominated by Kangaroo Island scale-rush;
- ii. *Eucalyptus cosmophylla* (cup gum) low open-woodland (with and without *E. fasciculosa* (pink gum) as a co-dominant) over a very sparse understorey dominated by Kangaroo Island scale-rush;
- iii. Sheoak tall shrubland with a sparse understorey dominated by *Acacia myrtifolia* (myrtle-leaf wattle), thick twist-rush, *L. concurvus* and Kangaroo Island scale-rush; or,
- iv. *Leptosperumum* spp. open-heath and low shrubland with an understorey dominated by myrtle-leaf wattle, slender honey-myrtle, *L. concurvus, Platylobium obtusangulum* (common flat-pea), cone bush and Kangaroo Island scale-rush.

Vegetation associated with lagoon banks is usually a *Leptospermum* closed-heath and openheath with a mid-dense understorey dominated by *Epacris impressa* (common heath), myrtleleaf wattle, *Hibbertia* sp., *Adenanthos macropodianus* (gland flower) and *L. concurvus*.

Reproductive biology

Little is known about the reproductive ecology of the Kangaroo Island scale-rush, and as a result, this section draws largely on published literature from species in the same genus or family.

The Kangaroo Island scale-rush flowers and fruits primarily from September to February (DEW 2021). Flowers are likely to be wind-pollinated, as is the case in other Restionaceae (Hartley et al. 2008). Seed dispersal is probably limited to the immediate vicinity of adult plants (Hartley et al. 2008), particularly since the seed lacks an elaiosome that would facilitate ant dispersal, although it may occur occasionally via water movement across short distances (e.g. within the same swamp system occupied by adult plants). Longer distance water dispersal is unlikely as the species rarely occurs near running water.

Soil-stored seed may only be short-lived, with seed viability in other species of Restionaceae declining to five percent 12–21 months after storage (Meney & Pate 1999). However, annual fruiting probably maintains soil seed banks in the absence of serious threats (Meney et al. 1994).

The length of the primary juvenile period is 18 months (D. Duval 2021 pers. comm. 6 Dec), although, like other Restionaceae species, individuals may not reach full reproductive capacity until 4–8 years of age (Meney et al. 1994). The Kangaroo Island scale-rush may live for >20 years (Plants of SA 2021). Other estimates of longevity of *Lepyrodia* species include 4 to more than 42 years (four species from data collated in Falster et al. 2021), and estimated generation lengths iunclude 35–90 years (*L. anarthria* (broom scale-rush); DELWP 2021a) and 45–90 years (*L. flexuosa* (twisting scale-rush); DELWP 2021b). These higher estimates may reflect longer lifespans of resprouting species of *Lepyrodia*, but suggest that in the absence of fire, the lifespan of Kangaroo Island scale-rush could be substantially longer than 20 years.

Fire ecology

Kangaroo Island scale-rush is an obligate seeder, with adult plants killed by fire (D. Duval 2021 pers. comm. 6 Dec). The *Lepyrodia* genus contains both obligate seeder and resprouter species (Pate et al. 1991). Fire is probably required for seed germination, as fire-stimulated germination appears to be universal in the Restionaceae (Lamont et al. 2019). No recruitment occurs in the absence of fire for two Western Australian obligate seeder Restionaceae species (Meney et al. 1994). Post-fire germination of *Chordifex abortivus* averaged 300 seedlings per square metre following a summer bushfire, compared to a density of adult plants in unburnt vegetation of five plants per square metre (Hartley et al. 2008). For two obligate seeder Restionaceae in southwest WA (*Lepidobolus chaetocephalus* and *Desmocladus semiplanus*), post-fire seedling densities within one year after fire were more than 10 times higher than parent densities (Meney et al. 1994). Germinable seed banks of Restionaceae have been reported to be totally depleted following fire (Meney et al. 1994).

Threats

The major threats to the Kangaroo Island scale-rush include competition with, and hydrological changes caused by, *Eucalyptus globulus* (southern blue-gum) plantations, which were widely planted on KI in the early 2000s (Davies et al. 2021), and changes to temperature and precipitation patterns driven by anthropogenic climate change. Based on observations of related species, the Kangaroo Island scale-rush is likely to be resistant to disease caused by *Phytophthora cinnamomi* infection (Kennedy & Weste 1986; Hartley et al. 2008), although confirming this is a research priority.

Threat	Status a	Evidence
Invasive species		
Competition with, and hydrological changes caused by, forestry plantations of southern blue-gum	 Timing: current Confidence: observed Likelihood: possible Consequence: major Trend: increasing Extent: across parts of the range 	Forestry plantations of southern blue-gum were widely established on Kangaroo Island in the early 2000s (Davies et al. 2021). Following the 2019/20 bushfire, major incursions of southern blue-gum seedlings have occurred across large tracts of native vegetation on western KI (Davies et al. 2021). Southern blue-gum seedlings from wind-dispersed seed were observed up to 87 m from adjoining plantations, and seedlings from water-dispersed seed (along drainage lines) were observed up to 615 m into native vegetation downstream from the nearest plantation (Davies et al. 2021). Post-fire densities of southern blue-gum seedlings in native vegetation near plantations on western KI averaged 9309 seedlings/ha, with up to 29,500 seedlings/ha in wet heath vegetation and 250,000 seedlings/ha in native vegetation along drainage lines (Davies et al. 2021). At such densities southern blue-gum are likely to outcompete other native species, including Kangaroo Island scale-rush, and affect the hydrology of its habitat by causing drying of swamps and wet heath vegetation (Potts et al. 2004; Benyon et al. 2006; Jury 2006; Davies et al. 2021). In western Europe, fire and other disturbance events known to facilitate invasion of southern blue-gum into native vegetation from adjacent plantations (Silva et al. 2016; 2021). Southern blue- gum has been reported to escape from plantations and naturalise in native vegetation across higher-rainfall districts of South Australia (Jury 2006). Southern blue-gum naturalisation currently threatens most Kangaroo Island scale-rush plants located near plantations (e.g. near the western and northern edges of Flinders Chase National Park). Although the proportion

Table 1 Threats impacting the Kangaroo Island scale-rush

Threat	Status ^a	Evidence
		of Kangaroo Island scale-rush habitat currently threatened by southern blue-gum is relatively small, as Kangaroo Island scale- rush is widespread away from plantations. However, with time and if incursions are not eliminated, southern blue-gum is likely to continue to spread and degrade increasingly large areas of habitat.
Soil disturbance and herbivory from feral pigs	 Timing: current Confidence: suspected Likelihood: possible Consequence: moderate Trend: unknown Extent: across parts of the range 	Feral pigs are found in all states and territories of Australia and are listed as a Key Threatening Process (KTP) under the EPBC Act (DoEE 2017). Feral pigs are widespread across the western side of KI, including in the Western River Wilderness Protection Area (DEH 2006, 2009; NRKI 2017). Feral pigs can destroy native vegetation by trampling plants, causing soil disturbance and facilitating weed invasion (DoEE 2017). Feral pigs primarily impact wet or waterlogged areas, and therefore pose a threat to Kangaroo Island scale-rush. However, the extent to which feral pigs are impacting the species is not well understood. A feral pig control program is currently underway on KI (PIRSA 2021).
Weed invasion	 Timing: current Confidence: suspected Likelihood: possible Consequence: moderate Trend: unknown Extent: across parts of the range 	Eight Weeds of National Significance (WoNS) and 27 Declared Weeds of SA are found on KI, including notable fire-adapted and fast-growing 'pioneer' weeds: bluebell creeper (<i>Sollya</i> <i>heterophylla</i>), gorse (<i>Ulex europaeus</i>), Montpellier broom (<i>Genista monspessulana</i>), bridal creeper (<i>Asparagus</i> <i>asparagoides</i>), variegated thistle (<i>Silybum marianum</i>), African boxthorn (<i>Lycium ferocissimum</i>), blackberry (<i>Rubus fructicosus</i>) and one-leaf cape tulip (<i>Moraea flaccida</i>) (Thorp & Lynch 2000; Landscape South Australia 2020a,b; NRKI 2020). The vast majority of weeds occur on the eastern extent of the island (DEW 2020a). However, weed invasion has also been identified as a threat to biodiversity in the Cape Forbin area, which includes the Western River Wilderness Protection Area (DEH 2009). Weeds capable of growing in seasonally inundated areas, such as blackberry, are the most likely to threaten Kangaroo Island scale-rush. Blackberry threatens understorey plants by outcompeting them for light and nutrients (Scott et al. 2014).
Climate change		
Changes to temperature and precipitation patterns	 Timing: current Confidence: inferred Likelihood: likely Consequence: major Trend: increasing Extent: across the entire range 	The CSIRO & Bureau of Meteorology (2020) and DEW (2020b) project that KI is projected to experience increased mean temperatures and decreased annual rainfall. By 2050, annual rainfall is projected to decline by 7.5–8.9% under intermediate and high emissions pathways, respectively (CSIRO & Bureau of Meteorology 2020). Droughts and long-term reductions in annual rainfall are likely to have a substantial negative impact on the hydrology of vegetation in which the species grows, and thereby the population of Kangaroo Island scale-rush. If water availability decreases substantially, species reliant on high soil moisture can be negatively affected, through mortality or increased competition from species adapted to drier soil conditions (Alba et al. 2019). As Kangaroo Island scale-rush is dependent on winter waterlogged soils, it may be threatened by reduced soil moisture and hydrological changes as a result of reduced precipitation caused by climate change. Kangaroo Island scale-rush may also be threatened by changes to rainfall patterns and warming which can act synergistically with inappropriate fire regimes, herbivory or other threats.

Threat	Status ^a	Evidence
Habitat loss, disturba	nce and modifications impac	rts
Fire regimes that cause declines in biodiversity ¹	 Timing: current Confidence: inferred Likelihood: possible 	Kangaroo Island scale-rush is an obligate seeder with adult plants killed by fire (D. Duval 2021 pers. comm 6 Dec). The majority of specimen records in The Australasian Virtual Herbarium (82%) and approximately 66% of the modelled current range of the Kangaroo Island scale-rush burnt in the 2020 bushfires on KI (Gallagher 2020).
	 Consequence: moderate Trend: increasing Extent: across the entire range 	There are a number of mechanisms by which a fire regime can impact an obligate seeder species (Keith 1996; DAWE 2021a). 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 (herbivory, disease, etc.). The Kangaroo Island scale-rush may be sensitive to out-of-season fires and interactions between fire and other threats.
		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 2021a). 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 obligate seeders from the temperate zone (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.
		Kangaroo Island scale-rush is likely adapted to seasonal fire regimes consisting of fire during the dry dormant summer periods followed by moist conditions during the growing and reproductive period. If fires occur during the growing season, standing plants may be killed before seed is produced, inhibiting the population from being replenished.
		Nothing is known about the impacts of out-of-season fire (mid autumn – mid spring) Kangaroo Island scale-rush. Out-of- season prescribed burning is likely to negatively impact post- fire recruitment of obligate seeder Restionaceae (Meney et al. 1994).
		The interaction between fire and other threats
		There are a range of mechanisms by which fire interacts with other threats and increases the impacs on species recovery potential following fire relative to the impact of isolated threats (DAWE 2021a). Interactions between fire and other threats may be more serious than the threat of inappropriate fire regimes alone, particularly if co-occurring threats cause the depletion of annual fruiting that could reduce the size of soil seed banks (Meney et al. 1994).
		Grazing of the Kangaroo Island scale-rush by macropods has been observed (D. Duval 2021 pers. comm. 16 Dec) and the interaction between grazing and inappropriate fire regimes is a plausible threat to the speceis. Grazing may interact with fire, drought or other threats if it reduces the size of soil seed banks, compounding the effects of these threats by reducing the seed bank available for recruitment post-fire (Meney et al. 1994). However, given that the species is often locally dominant (Davies 1986), and post-fire recruitment of Kangaroo Island

Threat	Status ^a	Evidence
		scale-rush appears extensive following the 2020 bushfire (D. Duval 2021 pers. comm. 16 Dec) the threat of grazing is probably moderate.
		susceptible to grazing (Meney & Dixon 1988), while disease outbreaks of fungal smuts have also been observed following fire (Websdane et al. 1994).
		Fire can also catalyse naturalisation of southern blue-gum in the species' habitat, which exposes the species to direct competition and possible alterations to the hydrology of its habitat if the naturalising incursions are not removed (Davies et al. 2021).
		Too frequent fires
		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, DAWE 2021a). If a fire occurs within the primary juvenile period, there could be a reduction the Kangaroo Island scale- rush population, particularly as its seed bank is likely to be severely depleted or exhausted following the previous fire (Meney et al. 1994). However, Kangaroo Island scale-rush has a short primary juvenile period of 18 months (D. Duval 2021 pers. comm. 16 Dec). This suggests that the likelihood of sufficient fuel accumulation to support fires in consecutive years that could burn across significant portions of the species range (particularly in wet habitats) is low.
Land clearing and fragmentation	 Timing: historical Confidence: inferred Likelihood: unlikely Consequence: moderate Trend: static Extent: across parts of the range 	Kangaroo Island scale-rush appears extinct on the mainland (D. Murfet 2021 pers. comm. 13 Dec), where almost all of its habitat has been cleared. While land clearing has slowed since the introduction of the <i>Native Vegetation Act 1991</i> in South Australia, intensive clearing occurred from the 1950s to 1980s (Robinson & Armstrong 1999). Approximately 2300 km ² of land on KI has been cleared and is used for agriculture (Dohle 2007), mostly on the east and centre of the island. However, Kangaroo Island scale-rush is now largely protected in conservation reserves in the western half of KI. Nevertheless, the risks posed by smaller road and infrastructure development are likely to continue to threaten some areas of habitat for the species, particularly on roads and private land, but also in conservation reserves if developed for tourism.
Overabundant native	species	
Browsing/grazing by overabundant native herbivores	 Timing: current Confidence: observed Likelihood: likely Consequence: moderate Trend: unknown Extent: across 	On KI, land clearance and increased water availability due to provision of artificial water points have favoured high population densities of <i>Notamacropus eugenii eugenii</i> (Tammar wallaby) and <i>Macropus fulignosus</i> (western grey kangaroo) (DEH 2001; Pisanu et al. 2014; NRKI 2017). Overabundant native browsers and grazers can prevent plant regeneration and reduce plant recruitment (NRKI 2017) and can have detrimental impacts on native vegetation on KI (Pisanu et al. 2014). Grazing of the Kangaroo Island scale-rush by macropods has
	parts of the range	been observed (D. Duval 2021 pers. comm. 16 Dec). Although unlikely to threaten the species by itself, this threat could interact with inappropriate fire regimes (see discussion under that threat above).
Disease		
Infection by smut fungi	 Timing: unknown Confidence: unknown 	Smuts (e.g. <i>Restiosporium, Tolyposporium</i>) are native fungal pathogens that attack the fruiting parts (capsules) of plants in the Restionaceae family. <i>Restiosporium lepyrodiae</i> has been recorded on <i>Lepyrodia scariosa</i> in New South Wales (Vánky

Threat	Status ^a	Evidence
	 Likelihood: unknown Consequence: moderate Trend: unknown Extent: across the entire range 	2006), while other species of <i>Restiosporium</i> and <i>Tolysporium</i> attack other Restionaceae species (Meney & Dixon 1988; Vánky & Shivas 2006). Incidence of smut disease appears to increase in response to disturbance, and 20–50% of populations can be affected following frequent fire, mining or roadworks (Websdane et al. 1994) and can cause severe reduction in reproductive output in infected plants (Meney & Dixon 1988). There have not been any observations of fungal smutting on Kangaroo Island scale-rush, including during seed collections and following fire (D. Duval 2021 pers. comm. 16 Dec). However, the disease can be difficult to observe unless a close examination of fruiting material is undertaken, and it is possible that undetected smut fungi occur.

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; Likelihood—identifies the likelihood of the threat impacting on the whole population or extent of 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;

¹Fire regimes that cause biodiversity decline include the full range of fire-related ecological processes that directly or indirectly cause persistent declines in the distribution, abundance, genetic diversity or function of a species or ecological community. 'Fire regime' refers to the frequency, intensity or severity, season, and types (aerial/subterranean) of successive fire events at a point in the landscape.

Each threat has been described in Table 1 in terms of the extent that it is operating on the species. The risk matrix (Table 2) 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					
Likely			Browsing/grazing by overabundant native herbivores	Changes to temperature and precipitation patterns	
Possible			Fire regimes that cause declines in biodiversity Soil disturbance and herbivory from feral pigs Weed invasion	Competition with, and hydrological changes caused by, forestry plantations of southern blue- gum	
Unlikely			Land clearing and fragmentation		
Unknown			Infection by smut fungi		

Risk Matrix legend/Risk rating:

	Low Risk Moderate Risk High Risk Very High Risk
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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

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

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 monitoring.

Conservation and recovery actions

Primary conservation objective

By 2030, the population of Kangaroo Island scale-rush will have increased in abundance and viable subpopulations are sustained in habitats where threats are managed effectively.

Conservation and management priorities

Habitat loss, disturbance and modifications impacts

- Avoid all further loss and fragmentation of habitat by prohibiting development likely to damage the species or conditions required to support the persistence of the species.
- Purchase habitat currently on private land and incorporate into the conservation reserve system.

Fire, climate change and extreme weather impacts

- Ensure that the locations of all subpopulations are recorded on relevant state databases, including those used by land management and fire response agencies.
- Exclude planned fire (and unplanned fire where possible) from all habitat for at least five years post-fire. If fire impacts subpopulations, managers must ensure that subsequent fires do not occur within the critical regeneration period to allow the species to rebuild its soil seed bank to sustain the population through the next fire event.
- Investigate options for maintaining in situ persistence as the climate changes, for example by minimising other population pressures, enhancing resilience and promoting recruitment or supplementing existing subpopulations.

Invasive species impacts

- Remove all southern blue-gum (Eucalyptus globulus) individuals from potential habitat for Kangaroo Island scale-rush in western KI. Removal is easiest and most effective when undertaken in the first three to five years following fire (Davies et al. 2021). Removal should be undertaken at regular intervals and particularly following fire events. Methods of removal should avoid and minimise non-target impacts to native vegetation. Cutting of southern blue-gum stems below the developing lignotuber was the most effective method of removing southern blue-gum with no off-target impact in Davies et al. (2021).
- Introduce minimum buffer zones (areas with no plantation species separating plantations and native vegetation) for all current and future plantations to avoid naturalisation of plantation species into potential habitat for Kangaroo Island scale-rush. Following observations after the 2020 bushfires, buffers for southern blue-gum must be a minimum width of 87 m, except along drainage lines where plantations must be a minimum of 615 m from downstream Kangaroo Island scale-rush habitat.
- Implement site-based weed control using appropriate methods in consultation with land managers and community groups to ensure that there is no impact on Kangaroo Island scale-rush.
- Continue feral pig population control measures in consultation with land managers and community groups in and near subpopulations of Kangaroo Island scale-rush.

Overabundant native species impacts

• Control populations of overabundant native species to sustainable levels in the vicinity of Kangaroo Island scale-rush.

Ex situ recovery actions

- To manage the risk of losing genetic diversity, undertake appropriate seed collection and storage, and monitor the viability of stored seed. For species where few seed are produced, seed quality is low, or seeds are difficult to store long-term, undertake alternative ex situ storage such as tissue culture and cryopreservation, vegetative propagation or cultivation of living collections. Seed/tissue collection and storage should be conducted in accordance with best practice guidelines and procedures (refer to Martyn Yenson et al. 2021 or Commander 2021).
- If appropriate, investigate the feasibility of establishing translocated subpopulations that will improve the conservation outlook of the species. Translocations should be conducted in accordance with best practice guidelines and procedures (refer to Commander et al. 2018), including monitoring translocated subpopulations through to recruitment to ensure they are viable.

Stakeholder engagement/community engagement

- Engage and involve Traditional Owners in conservation actions, including surveying for new populations and management actions.
- Liaise with relevant land managers to ensure that plants are not accidentally damaged or destroyed. The approval and assistance of land managers should also be sought to implement recovery actions, and recent population data should inform management.
- Engage community groups by encouraging participation in surveys or monitoring for the species.
- Promote public awareness of biodiversity conservation and protection through dissemination of information through print and digital media.

Survey and monitoring priorities

- Undertake surveys for Kangaroo Island scale-rush across its range.
- Estimate the population size of Kangaroo Island scale-rush.
- Establish and maintain a monitoring program to:
 - monitor species recruitment and plant health after fire events;
 - determine trends in population size;
 - document the post-fire recovery and causes of recruitment failure;
 - determine threats and their impacts (particularly herbivory from overabundant native species and the presence of smut fungi); and,
 - monitor the effectiveness of management actions and the need to adapt them if necessary.

Information and research priorities

- Understand the degree of population fluctuation that occurs following fire events, and the extent of seedbank exhaustion following fire.
- Increase knowledge surrounding the ecology of Kangaroo Island scale-rush. This includes improving understanding of habitat requirements, recruitment and soil-seed bank dynamics (especially seed bank longevity and germination cues), appropriate fire regimes, pollination biology, seed and plant longevity, genetic structure, and minimum viable population size.
- Understand the susceptibility of Kangaroo Island scale-rush to disease caused by *Phytophthora* spp.
- Ascertain the cultural significance of Kangaroo Island scale-rush.
- Understand the germination requirements of Kangaroo Island scale-rush.
- Determine habitat critical to the survival of Kangaroo Island scale-rush.
- Undertake vulnerability assessments of the species' sensitivity and adaptive capacity to changing climatic conditions which draw on genetic, physiological or ecological evidence.
- If vulnerability assessments indicate the species has a high likelihood of extinction due to climate change, undertake research to identify climate refuges that may be suitable for translocations, including both modelling and experimental approaches (e.g. trial translocations). Consideration should be given to the benefits to the species in mitigating climate change related threats, as well as the risks to the recipient site (e.g. introduction of diseases, pests and/or pathogens, and invasiveness of the species).

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.

Links to relevant implementation documents

This Conservation Advice is developed to be able to subsequently inform other planning instruments such as a Bioregional Plan or a multi-entity Conservation Plan.

Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (2017)

<u>Draft listing assessment for Key Threatening Process 'fire regimes that cause biodiversity loss'</u> (2021)

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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 *Lepyrodia valliculae*

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	unknown	unknown	unknown	There are no formal population estimates for Kangaroo Island scale- rush. The species often forms a dominant part of the understorey where it occurs (Davies 1986), suggesting a large population. In addition, there are 126 records across the western third of KI, the majority recorded post-1980 in extant native vegetation (ALA 2021), which also suggests a large population.
Trend	Stable (historical decline)			Kangaroo Island scale-rush appears to have undergone a historical decline, particularly on the mainland where there are nine records, the most recent of which is from 1990 (ALA 2021). More recent survey effort has failed to locate the species on the mainland and it is likely locally extinct (D. Murfet 2021 pers. comm. 13 Dec). The species probably also experienced some historical decline on KI due to clearing of native vegetation from the 1950s to 1980s (Robinson & Armstrong 1999). However, clearing on KI has almost ceased (Dohle 2007), and nearly all records since 1980 appear to be in areas of extant native vegetation (ALA 2021). There is no evidence of a recent decline of Kangaroo Island scale-rush. The species was observed recruiting

Table 3 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
				from seed following the 2020 bushfire (D. Duval 2021 pers. comm. 16 Dec). Therefore, the KI subpopulation is probably stable.
Generation time (years)	11-26	~10	~40	The generation length of Kangaroo Island scale-rush is not documented. The primary juvenile period for the species is 18 months and its lifespan is >20 years (Plants of SA 2021; D. Duval 2021 pers. comm. 16 Dec). Other <i>Lepyrodia</i> species are capable of living for many decades, with <i>L.</i> <i>muelleri</i> (common scale-rush) recorded as having a lifespan of <100 years (Falster et al. 2021). DELWP (2021 a, b) estimated generation lengths of 35–90 years for <i>L. anarthria</i> (broom scale-rush) and 45–90 years for <i>L. flexuosa</i> (twisting scale-rush), although these species are capable of resprouting following fire so are likely to have a longer generation length than the obligate seeding Kangaroo Island scale-rush. A suggested estimated longevity for Kangaroo Island scale- rush is approximately 20–50 years. Therefore, a plausible generation length for Kangaroo Island scale- rush may be approximately 11–26 years (see Criterion 1).
Extent of occurrence	1078 km ²	~1000 km ²	~3000 km ²	The extent of occurrence (EOO) is based on the mapping of available point records from 1991 to 2021. This timeframe was used as records prior to this period may not be extant due to widespread clearing of native vegetation in South Australia up until the 1980s (Robinson & Armstrong 1999). In addition, the most recent mainland record of the species was collected in 1990 (ALA 2021), however this population is apparently no longer extant, and the species is likely to be extinct on the mainland (D. Murfet 2021 pers. comm. 13 Dec). The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines (IUCN 2019). If the species is still extant on the mainland, EOO could increase to ~3000 km ² . Additional records from KI would result in a small increase in the estimated EOO.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	assessment value value Stable (historical decline)			Kangaroo Island scale-rush appears to have undergone a historical decline, particularly on the mainland where it is likely locally extinct. However, clearing of native vegetation on KI has almost ceased (Dohle 2007). There is no evidence of a recent decline of Kangaroo Island scale-rush. The species was observed recruiting from seed following the 2020 bushfire (D. Duval 2021 pers. comm. 16 Dec). Therefore, the EOO is probably stable.
Area of Occupancy	92 km ²	~72 km ²	~300 km ²	The AOO is estimated is based on the mapping of available point records from 1991 to 2021. This timeframe was used as records prior to 1990 may not be extant due to widespread clearing of native vegetation in South Australia up until the 1980s (Robinson & Armstrong 1999). The AOO is calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). The maximum plausible value represents the plausible AOO if unknown subpopulations exist (considered likely as the species has not been subject to intensive, dedicated survey effort and is locally dominant in some localities; Davies 1986). The minimum plausible value represents the plausible AOO if records older than 20 years are excluded.
Trend	Stable (historical decline)			Kangaroo Island scale-rush appears to have undergone a historical decline, particularly on the mainland where it is likely locally extinct. However, clearing of native vegetation on KI has almost ceased (Dohle 2007). There is no evidence of a recent decline of Kangaroo Island scale-rush. The species was observed recruiting from seed following the 2020 bushfire (D. Duval 2021 pers. comm. 16 Dec). Therefore, the AOO is probably stable.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of subpopulations	1	1	~5	Kangaroo Island scale-rush is likely to be wind-pollinated as is the case in other Restionaceae (Hartley et al. 2008). Considering that Kangaroo Island scale-rush is often locally dominant where it occurs, there is likely to be gene flow across large distances (Steven & Waller 2007). Based on the lack of spatial clustering of records, high likelihood of additional undocumented occurrences on KI, and ecology of the subspecies (wind-pollinated), Kangaroo Island scale-rush is likely to have a single large subpopulation covering much of the western third of KI (ALA 2021). If a smaller distance is used to define separate subpopulations, the number of subpopulations could be higher (perhaps around five based on the spatial arrangement of records on ALA 2021). If the species was rediscovered on the mainland, the number of subpopulations would likely be two. However, this is unlikely as dedicated searches have failed to locate the species on the mainland (D. Murfet 2021 pers. comm. 13 Dec).
Trend	Stable (historical	decline)		Kangaroo Island scale-rush appears to have undergone a historic decline, particularly on the mainland where it is likely extinct. However, clearing of native vegetation on KI has almost ceased (Dohle 2007). There is no evidence of a recent decline of Kangaroo Island scale-rush. The species was observed recruiting from seed following the 2020 bushfire (D. Duval 2021 pers. comm. 16 Dec). Therefore, the number of subpopulations on KI is probably stable.
Basis of assessment of subpopulation number	See justification f	or Number of subp	oopulations.	

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
No. locations	undefined	undefined	undefined	The main threats facing the species are changes to temperature and precipitation patterns, competition with and hydrological changes caused by southern blue-gum plantations and southern blue-gum establishment outside plantations, browsing/grazing by overabundant native herbivores, inappropriate fire regimes, weed invasion, grazing by feral pigs and interactions between threats (Table 3). However, the Kangaroo Island scale- rush has a short primary juvenile period, is currently locally dominant across much of its range, and has a generation length of (11–26 years). All threats are either spatially- restricted, operate on time scales longer than the species generation length, or are unlikely to cause the elimination of the species when they do occur (see additional justification under Criterion 2 below). Therefore, there do not appear to be any threats capable of causing the rapid elimination of the Kangaroo Island scale-rush population, and the number of locations is undefined.
Trend	Not applicable			The number of locations is undefined.
Basis of assessment of location number	See justification f	for number of locat	cions.	
Fragmentation	Kangaroo Island scale-rush is considered to occur as a single subpopulation covering much of the western third of KI. The species often forms a dominant part of the understorey where it occurs (Davies 1986) suggesting a population larger than rudimentary estimates of minimum viable population size (MVPS) (e.g. MVPS of <1000 individuals as per Frankham et al. 2014). Therefore, the population is very unlikely to be severely fragmented, as defined by IUCN (2016).			
Fluctuations	No evidence of ex mature individua	treme fluctuations	s in EOO, AOO, nun	ber of subpopulations, locations or

Criterion 1 Population size reduction

Red	Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4					
		Critically Endangered Very severe reduction	Endangered Severe reduction		Vulnerable Substantial reduction	
A1		≥ 90%	≥ 70%		≥ 50%	
A2, A	13, A4	≥ 80%	≥ 50%		≥ 30%	
A1 A2 A3	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 be understood OR may not be reversibl Population reduction, projected or susp to a maximum of 100 years) [(<i>a</i>) cannot	red, inferred or suspected in e clearly reversible AND red, inferred or suspected in may not have ceased OR ma e. vected to be met in the futur t be used for A3]	the the y not e (up Based on any of the following	(a) (b) (c) (d) (e)	direct observation [except A3] an index of abundance appropriate to the taxon a decline in area of occupancy, extent of occurrence and/or quality of habitat actual or potential levels of exploitation the effects of introduced	
A4	An observed, estimated, inferred, project reduction where the time period must in future (up to a max. of 100 years in futur reduction may not have ceased OR may be reversible.	cted or suspected populatio nclude both the past and th ıre), and where the causes o not be understood OR may	n e f not		taxa, hybridization, pathogens, pollutants, competitors or parasites	

Criterion 1 evidence

Insufficient data to determine eligibility

Generation time

The primary juvenile period of Kangaroo Island scale-rush is 18 months (D. Duval 2021 pers. comm. 16 Dec). Longevity of the species is >20 years (Plants of SA 2021). Other *Lepyrodia* species are capable of living for many decades, with *L. muelleri* (common scale-rush) recorded as having a lifespan of <100 years (Falster et al. 2021). A suggested estimated longevity for Kangaroo Island scale-rush is therefore approximately 20–50 years. Therefore, a plausible generation time may be:

Generation time = age of first reproduction + [0.5 * (length of reproductive period)]

Minimum (using longevity of 20 years): Generation time = 1.5 + [0.5 * (20 - 1.5)] = 11 years

Maximum (using longevity of 50 years): Generation time = 1.5 + [0.5 * (50 - 1.5)] = 26 years

DELWP (2021a,b) estimated generation lengths at 35–90 years for *L. anarthria* (broom scalerush) and 45–90 years for *L. flexuosa* (twisting scale-rush), although these species are capable of resprouting following fire so are likely to have a longer generation length than the obligate seeding Kangaroo Island scale-rush. Using the above generation time of 11–26 years gives an estimated three-generation period of approximately 33–78 years.

Population trend

Kangaroo Island scale-rush appears to have undergone a historic decline, particularly on the mainland where there are nine records, the most recent of which is from 1990 (ALA 2021). More recent survey effort has failed to locate the species on the mainland and it is likely extinct (D. Murfet 2021 pers. comm. 13 Dec). The decline of the species on the mainland is captured within the three-generation period if using the maximum generation time estimate, as most clearing of native vegetation in the area occurred in the mid-20th century (Bickford et al. 2008). The species probably also experienced some historical decline on KI due to clearing of native vegetation from the 1950s to 1980s (Robinson & Armstrong 1999), although there are very few records (possibly two or less) from this time that are now located in cleared areas (ALA 2021). Substantial population declines from land clearing are unlikely to be captured within the three generation length period if using the minimum generation length estimate. Clearing on KI has almost ceased (Dohle 2007), and nearly all records since 1980 appear to be in areas of extant native vegetation (ALA 2021). There is no evidence of a recent decline of Kangaroo Island scale-rush. The species was observed recruiting from seed following the 2020 bushfire (D. Duval 2021 pers. comm. 16 Dec).

Estimating the decline caused by historical land clearing is difficult, as no historical records include count data or notes on the species' abundance (ALA 2021). The current estimated EOO of Kangaroo Island scale-rush on KI is approximately 1078 km², while the EOO of the mainland records is approximately 39 km² (Table 3; GeoCat 2021). Although the EOO of the species on the mainland is likely artificially low due to limited survey effort prior to widespread vegetation clearing, and may not accurately reflect the extent of habitat for this species, it does suggest the Kangaroo Island scale-rush had a limited distribution in the Back Valley area, and the loss of the mainland subpopulation may be unlikely to have caused a >30 percent reduction of the species' total population size over the last three-generation period.

Therefore, due to a lack of data on population trends and uncertainty around whether the species' three-generation period includes or excludes likely historical population declines caused by land clearing, there are insufficient data to list Kangaroo Island scale-rush under any category under this criterion.

Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OF
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)	(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)	(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

Insufficient data to determine eligibility

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

The EOO of Kangaroo Island scale-rush is 1078 km² and the AOO is 92 km² (Table 3). Therefore, the species' EOO and AOO meet the threshold for Endangered under B1 and B2.

Severely fragmented

Kangaroo Island scale-rush is considered to occur as a single subpopulation covering much of the western third of KI (Table 3). The species often forms a dominant part of the understorey where it occurs (Davies 1986), and there are 126 records across the western third of KI, the majority recorded post-1980 in extant native vegetation (ALA 2021), suggesting a large population that is very unlikely to be smaller than a rudimentary estimate of minimum viable population size (e.g. <1000 individuals as per Frankham et al. 2014). Therefore, the species is very unlikely to meet the severe fragmentation requirement for listing under this sub-criterion.

Number of locations

The most significant threats to the Kangaroo Island scale-rush are changes to temperature and precipitation patterns, competition with and hydrological changes caused by southern blue-gum plantations and southern blue-gum establishment outside plantations, browsing/grazing by overabundant native herbivores, inappropriate fire regimes, weed invasion, and grazing by feral pigs (Table 2).

Kangaroo Island is projected to experience increased mean temperatures and decreased median rainfall due to climate change (Table 1; CSIRO & Bureau of Meteorology 2020). As Kangaroo

Island scale-rush is dependent on winter waterlogged soils, it may be threatened by changes in soil moisture and hydrology as a result of reduced precipitation or establishment of southern blue-gum. If the hydrology of currently winter-wet habitat in western KI changes, the species is likely to be negatively affected, through mortality or increased competition from species adapted to drier soil conditions (Alba et al. 2019). It is plausible that these impacts could occur within one generation length if the upper estimate is used (26 years). However, the species is often a dominant component of the understorey vegetation across much of its distribution, and occupies habitat across a range of hydrological conditions (e.g. from winter-wet swamps to drier plains and ridges). This suggests that hydrological changes caused by climate change may be unlikely to result in the elimination of the species' population within one generation.

Competition with, or hydrological changes caused by, naturalised southern blue-gum is a serious threat to Kangaroo Island scale-rush near plantations. Although such hydrological changes are yet to be documented on KI, it is plausible that if not controlled, naturalised populations of southern blue-gum could dry the winter-waterlogged habitat and make it unsuitable for Kangaroo Island scale-rush (Potts et al. 2004; Benyon et al. 2006; Jury 2006; Davies et al. 2021). However, the spatial extent of this threat is currently limited to areas surrounding plantations. As Kangaroo Island scale-rush is widespread away from plantations, it appears unlikely that southern blue-gum invasion could rapidly eliminate the population of Kangaroo Island scale-rush within one generation (11–26 years). Although it is likely that southern blue-gum naturalisation will spread beyond areas adjacent to plantations if not controlled, the spread of the species is likely tied to fires, as demonstrated in research from areas with a similar climate in western Europe (Silva et al. 2016; 2021). This is likely to limit the rate of spread of southern blue-gum in otherwise intact native vegetation.

Other threats, including grazing by feral pigs and overabundant native herbivores, weed invasion and clearing and fragmentation are all likely to contribute to a decline in habitat quality, and potentially impact some sites. Feral pigs are widespread across western KI (DEH 2006, 2009; NRKI 2017) and can severely degrade native vegetation (DoEE 2017). Feral pigs primarily impact wet or waterlogged areas, and therefore pose a threat to Kangaroo Island scale-rush. Overabundant native herbivores (primarily macropods) are also present and impacts have been observed on Kangaroo Island scale-rush (D. Duval 2021 pers. comm. 16 Dec). Competition with invasive weeds is also likely in some areas, and localised native vegetation clearing (e.g. along roads or on private property) is possible. However, Kangaroo Island scalerush is widespread and often a dominant component of the understorey vegetation across western KI (Davies 1986). Therefore, these threats are unlikely to cause the rapid extinction of the entire Kangaroo Island scale-rush subpopulation due to their spatially-restricted nature. In addition, active management actions are underway for some threats (e.g. a feral pig control program is currently in action; PIRSA 2021), and legal protections restrict the threat of land clearing across the majority of the species' population, although these actions need to be sustained to reduce the impacts of these threats in the long-term.

Inappropriate fire regimes are a potential threat to Kangaroo Island scale-rush. The species is an obligate seeder (D. Duval 2021 pers. comm. 16 Dec) and soil seed banks may be exhausted by a single fire (Meney et al. 1994). Although the primary juvenile period of Kangaroo Island scale-rush is 18 months (D. Duval 2021 pers. comm. 16 Dec), suggesting that the likelihood of sufficient fuel accumulation to support fires in consecutive years that could burn across significant portions of the species range (particularly in wet habitats) is low. Therefore, inappropriate fire regimes alone are unlikely to result in the rapid elimination of the species' population.

Interactions between threats, particularly among inappropriate fire regimes, climate change, weed invasion and herbivory, also threaten the Kangaroo Island scale-rush. For example, climate change may drive increased pressure via higher fire frequency, while also reducing resilience via slower rates of maturation, lower fecundity or higher post-fire seedling mortality through postfire drought (Enright et al. 2015; Henzler et al. 2018). This interaction could be further exaggerated by high post-fire grazing by overabundant native herbivores, as post-fire seedling recruits of Restionaceae are likely to be more susceptible to grazing (Meney et al. 1994) and substantial post-fire grazing was observed in some areas following the 2019/20 bushfires (D. Duval 2021 pers. comm. 16 Dec). If such interacting threats cause the depletion of annual fruiting that reduces the size of soil seed banks, the species may become vulnerable to future fire events (Meney et al. 1994). However, Kangaroo Island scale-rush has a short primary juvenile period and is currently locally dominant across much of its range, suggesting these interactions are unlikely to result in the rapid elimination of the species. The likelihood of high frequency fires or fires earlier in spring that could interrupt annual fruiting of Kangaroo Island scale-rush could be magnified by southern blue-gum naturalisation, which may increase fuel loads and lower soil moisture if left uncontrolled (Davies et al. 2021). However, the Kangaroo Island scalerush is widespread away from plantations, and therefore, it is unlikely that southern blue-gum naturalisation could affect fuel loads across the majority of the Kangaroo Island scale-rush habitat within one generation (11–26 years).

Therefore, there do not appear to be any threats capable of causing the rapid elimination of the Kangaroo Island scale-rush population, and the species appears to not meet the requirement for listing under sub-criterion (a).

Continuing decline

There are no known estimates of population numbers and there is no evidence of a recent decline of Kangaroo Island scale-rush (Table 3). The species was observed recruiting from seed abundantly following the 2020 bushfire (D. Duval 2021 pers. comm. 16 Dec) and there is currently very little clearing of native vegetation on KI (Dohle 2007). Therefore, there is no evidence of continuing decline in EOO, AOO, the number of locations or subpopulations, or number of mature individuals.

However, there are numerous threats that are likely to cause continuing decline in habitat quality. Naturalisation of southern blue-gum into Kangaroo Island scale-rush habitat from adjacent plantations was observed following the 2020 bushfires. If not controlled, southern blue-gum is likely to degrade habitat by causing drying of waterlogged soils (Potts et al. 2004; Benyon et al. 2006; Jury 2006; Davies et al. 2021). Feral pigs are present in western KI (DEH 2006, 2009; NRKI 2017) and are likely to degrade some areas of habitat, although they are currently the focus of a control program (PIRSA 2021). Overabundant native herbivores are also

present and impacts have been observed on Kangaroo Island scale-rush following the 2020 bushfire (D. Duval 2021 pers. comm. 16 Dec). Competition with invasive weeds is also likely in some areas, and small-scale native vegetation clearing (e.g. along roads or on private property) is also possible.

Therefore, the species appears to be undergoing continuing decline in the quality of habitat. Accordingly, the species appears to meet the continuing decline requirement for listing under sub-criterion (b).

Extreme fluctuations

There are no known extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals. Therefore, Kangaroo Island scale-rush does not meet the threshold for listing under sub-criterion (c).

Conclusion

The data presented above appear to demonstrate that there are insufficient data to list Kangaroo Island scale-rush under any category under criterion 2, as only one of the three sub-criteria is met.

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

Insufficient data to determine eligibility

The total number of mature individuals is unknown (Table 3). However, the species often forms a dominant part of the understorey where it occurs (Davies 1986), and there are 126 records across the western third of KI, the majority recorded post-1980 in extant native vegetation (ALA 2021), suggesting a large population (probably >10,000 individuals). The species is also likely to be substantially under-surveyed. Therefore, insufficient information to determine the eligibility of the species for listing in any category under this criterion.

Criterion 4 Number of mature individuals

	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 km² or number of locations ≤ 5

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

As per the evidence presented above for Criterion 3, the number of mature individuals is unknown (but highly likely >1000). Therefore, Kangaroo Island scale-rush appears to be ineligible for listing under this criterion.

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 has not been undertaken. Therefore, there is insufficient information to determine the eligibility of the species for listing in any category 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 species has not yet been determined. The purpose of this consultation document is to elicit additional information to help inform this decision.

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This publication is available at the SPRAT profile for Lepyrodia valliculae (Lepyrodia valliculae).

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