The Minister's delegate approved this Conservation Advice on 15/07/2016.

# Conservation Advice

# *Pimelea spicata*

spiked rice-flower

## Conservation Status

*Pimelea spicata* (spiked rice-flower) is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act). The species is eligible for listing as prior to the commencement of the EPBC Act, it was listed as Endangered under Schedule 1 of the *Endangered Species Protection Act 1992* (Cwlth).

The spiked rice-flower is listed as Endangered in New South Wales under Schedule 1 of the *Threatened Species Conservation Act 1995* (TSC Act).

The main factors that are the cause of the species being eligible for listing in the Endangered category are that the species has, a very restricted area of occupancy, and a highly fragmented geographic distribution.

## Description

The spiked rice-flower is a shrub to 50 cm tall with an increasingly spreading habit with maturity. The stems are glabrous (smooth, shiny). The leaves are narrow-elliptical to elliptical in shape, to 20 mm long x 8 mm wide, opposite in arrangement and usually held outwards from the stem. The white, pink-tinged flowers are tubular, grow to 7 - 10 mm long, with four spreading petals and sparsely hairy sepals. Flowers may appear at any time of the year, but tend to be more abundant in summer, particularly after periods of higher rainfall. Like most *Pimelea* species, the inflorescences (flower-bearing structures) of the spiked rice-flower start as dense racemes, however, unlike other rice-flower species in the greater Sydney metropolitan area, the inflorescences become fragmented along the elongating stem as the inflorescences age (Harden 2000). Plants vary in size from one or two stems to up to 50 stems (Nash & Matthes unpubl. data cited in DEC 2006). With increasing maturity the stems lose most of the leaves along their length and retain leaves and flowers only at the tips. Older stems are many branched and intertwine with the surrounding grasses and herbs (NSW NPWS 1993 cited in DEC 2006). The fruit is green and approximately 2.5 mm long (Harden 2000).

## Distribution

The spiked rice-flower has a highly fragmented distribution occurring in two disjunct regions of the Sydney Basin IBRA bioregion (DSEWPaC 2012) in NSW: the Cumberland Plain in western Sydney and the coastal region of the Illawarra, south of Sydney. The species is likely to have been relatively abundant across these regions before European settlement. In 2006, there were thirty known extant populations of the spiked rice-flower: twenty-five on the Cumberland Plain ranging from Marayong and Prospect Reservoir south to Narellan Vale and Douglas Park; and five along the coast in the Illawarra from Landsdowne through Shellharbour to northern Kiama (OEH 2016). In both the Illawarra and on the Cumberland Plain, the spiked rice-flower is found on well-structured clay soils (DEC 2006).

On the Cumberland Plain, the spiked rice-flower occurs on an undulating topography of well structured clay soils derived from Wianamatta shale. In this region, the species is restricted to areas supporting, or that previously supported, the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and the Western Sydney Dry Rainforest and Moist Woodland on Shale ecological communities, which are both protected as threatened ecological communities under both the EPBC Act and the TSC Act. The species has also been recorded from highly

degraded areas that no longer support native vegetation: for example, a mown cemetery dominated by exotic grasses.

The diverse understorey is similar in both the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forests. Blackthorn (*Prunus spinosa*) may provide the spiked rice-flower protection from grazing by livestock. It is common to find grasses, such as *Themeda australis* (kangaroo grass), *Microlaena stipoides* var. *stipoides* (weeping meadow grass) and herbs such as *Dichondra repens* (kidney weed), *Brunoniella australis* (blue trumpet) and *Desmodium varians* (slender tick trefoil). The presence of kangaroo grass is indicative of a less intensive grazing history (DEC 2006; OEH 2016).

In the coastal region of the Illawarra, the spiked rice-flower occurs generally in close proximity to the coast on hills or coastal headlands. The geology and soil types where the species occurs in the Illawarra, including siltstone, sandstone and latite, are derived from the Permian Shoalhaven group and are more variable than for those on the Cumberland Plain. The species commonly occurs in *Banksia integrifolia* (coast banksia) open grassy woodland. Coastal headlands and hilltops are the favoured sites. The IIllawarra populations occur in two intergrading vegetation communities: a woodland dominated by forest red gum and thin-leaved stringybark with a groundcover dominated by *Lomandra longifolia* (matrush) and kangaroo grass; and a grassland dominated by kangaroo grass and matrush with *Imperata cylindrica* (blady grass). An emergent shrubby layer, where present, is dominated by coast banksia, *Acacia sophorae* (coastal wattle) and *Westringia fruticosa* (coast rosemary) (DEC 2006; OEH 2016).

In 2006, the total population of spiked rice-flowers across 30 known populations was estimated to be as low as 4300. Populations varied from only a few individuals to more than 500 individual plants, although the majority of populations consisted of a low number of plants. In addition, the majority of populations had a small area of occupancy with 80 percent of populations occupying an area of less than 0.5 ha. Only three populations occupied an area of greater than 1 ha (DEC 2006). Since 2006, some populations have been reduced or translocated as a result of development approvals. However, other populations are known to have considerably increased in abundance and area of occupancy due to recovery actions. For example, the population at Narellan, which encompasses the Australian Botanic Gardens at Mount Annan, William Howe Regional Park, Camden Golf Course, Crown and Council lands and private property, has expanded following extensive African Olive (*Olea europea* subsp. *cuspidate*) control and numbers approximately 6,000 plants. A population at Menangle in the Wollondilly local government area (LGA) has increased as a result of installation of fencing to exclude European rabbits (*Oryctolagus cuniculus*). The population in Prospect Nature Reserve numbers approximately 3,000 plants. There are a number of newly discovered populations each numbering between 10 and 100 plants, for example, in the Penrith LGA and near Edmondson Park in the Liverpool LGA. Other newly discovered populations number more than 100, some of which occur in the Fairfield and Wollondilly LGAs (Ridgeway & Lee pers. comm. 2016).

Given that the spiked rice-flower is listed as Endangered, any habitat where populations are known to occur is considered habitat critical to the survival of the species. Similarly, all populations are considered to be important populations that are necessary for the species' survival and recovery.

### Relevant Biology/Ecology

The spiked rice-flower is known to flower sporadically throughout the year and the peak flowering time may vary from year to year. It is likely that the species flowers opportunistically with flowering likely to depend upon climatic conditions, particularly rainfall (DEC 2006). The species continues to produce flowers as fruits mature. Native bees have been observed visiting flowers of the spiked rice-flower (Hogbin pers. obs. cited in DEC 2006), and it has been suggested that moths may contribute to pollination (Willis pers. comm. cited in DEC 2006). The species may be capable of self-pollination as seed set has been observed in glass-house plants that were highly likely to have been isolated from pollinators (Willis pers. comm. cited in DEC

2006). The morphology of the species' flower is also indicative that self-pollination could occur (DEC 2006).

Disturbance, particularly from fire, appear to stimulate the production of stems, flowers and fruits due to the creation of gaps in overlying vegetation allowing more light to be received at ground level (Matthes et al., 1996 and NSW NPWS 1997 cited in DEC 2006). Older spiked rice-flowers that have not experienced much disturbance have significantly fewer stems (Nash & Matthes 1995 cited in DEC 2006). The species has been noted to grow actively during winter (Hogbin pers. obs. cited in DEC 2006) and can exhibit rapid growth when conditions are favourable. The species is capable of flowering, fruiting and producing seed from re-sprouting stems within two months of a fire under favourable conditions(NSW NPWS 1997 cited in DEC 2006).

Fruit production is extremely variable within and between populations, and also between years, and is likely to be associated with environmental conditions such as rainfall and disturbance history (NSW NPWS 1997 cited in DEC 2006). Seed viability has been found to be relatively high, ranging from 83 percent to 86 percent (Nash & Matthes 1995 and Willis et al., 2003 cited in DEC 2006). The species has no obvious adaptations to aid seed dispersal (Willis et al., 2003 cited in DEC 2006) and the majority of seedlings observed emerged within 30 cm of adult plants following fire suggesting seed dispersal is likely to be very low (Hogbin pers. obs. cited in DEC 2006).

Seed production has been observed in plants 1.5 - 2 years after germination (NSW NPWS 1997 cited in DEC 2006). The spiked rice-flower maintains a long-lived, persistent, soil-stored seed bank. Long undisturbed sites, or sites that are subject to high levels of weed infestation, may exhibit very few mature plants, but the presence of a large soil-stored seed bank may result in considerable recruitment following disturbance. Soil-stored seed banks appear to be about as extensive underneath infestations of invasive weeds as they are in relatively weed free areas (Willis et al., 2003 cited in DEC 2006) suggesting that extant individuals have been displaced from weed infested habitats leaving only the soil seed bank as evidence of their previous occurrence (DEC 2006).

Research indicates that seedling emergence is benefited by disturbance as mass germinations of soil-stored seed banks have been observed following fire, slashing/mowing, grazing and soil disturbance (Hogbin pers. obs., NSW NPWS 1997, and Willis et al., 2003 cited in DEC 2006). Occasional seedlings have been observed in areas that had not recently been disturbed. Monitoring of seedlings following a fire revealed 80 percent survival in the first year after fire (NSW NPWS 1997 cited in DEC 2006). Ex situ germination trials found that smoke application significantly increased seed germination (Tozer & Robertson 1998, and Willis et al., 2003 cited in DEC 2006). However, Willis and colleagues (2003) (cited in DEC 2006) found that, despite any treatments to promote germination under optimal conditions, the proportion of seeds germinating in any trial was consistently between 20 and 30 percent.

The spiked rice-flower possesses a carrot-like tap-root up to 18 cm long by 24 mm in diameter (Nash & Matthes 1995 cited in DEC 2006). It is likely that the reallocation of energy reserves stored in the tap-root enables the species to re-sprout after defoliation caused by fire, drought or physical damage (NSW NPWS 1997, and Matarczyk et al., 2002 cited in DEC 2006). The species can survive periods of drought stress by dying back to the underground tap-root and re-sprouting when favourable conditions return (NSW NPWS 1997 cited in DEC 2006). It is unknown at what age the tap-root has to be of a sufficient size to facilitate re-sprouting. NSW National Parks and Wildlife Service (NSW NPWS) (1997) (cited in DEC 2006) estimate this to be greater than three years while Matarczyk et al., (2002) (cited in DEC 2006) found that plants less than six months old were not capable of re-sprouting. Mature individuals can also spread over short distances through underground rhizomes, which can assist them to recover from disturbances (OEH 2016). Individual of the species are likely to be long-lived. Matarczyk (1999) (cited in DEC 2006) suggests that the longevity of the species could be 30 years or more.

It is expected that some mortality of mature individuals occurs after major disturbances such as fire, however it is unknown what proportion of populations typically survive such disturbance events (DEC 2006). The critical fire or physical disturbance frequencies for survival have not yet been determined. In the absence of this information, a precautionary approach should be taken and prescribed disturbance regimes should not be actively implemented at less than 10 year intervals (DEC 2006).

**Threats**

Table 1 – Threats impacting the spiked rice-flower in approximate order of severity of risk, based on available evidence.

| Threat factor | Threat type and status | Evidence base |
|---|---|---|
| Habitat loss and degradation | | |
| Land clearing or land-use change | known current | Land clearing for infrastructural, industrial and residential development on the Cumberland Plain and in the coastal Illawarra has occurred over many years (DEC 2006) and continues to have an adverse impact on the spiked rice-flower given that the majority of populations occur on private and public lands that are not zoned for conservation. The once widespread Cumberland Plain Woodland ecological community has been reduced to only 8.5 % of its pre-European settlement extent (NSW NPWS 2002 cited in DEC 2006). By 2006, two populations of the spiked rice-flower (in Landsdowne and at Freeman's Reach) and two subpopulations (in Smithfield and Camden) were known to have become extinct as a result of land clearing for residential or industrial development. The construction of the M7 motorway in western Sydney resulted in the loss of some individuals and habitat for three extant populations of the species (DEC 2006).<br><br>Land clearing or land-use changes, such as road construction or upgrades, or other infrastructural, industrial or residential developments, can also result in changes in the hydrology of the landscape, soil erosion and/or sedimentation, nutrient or chemical pollution, weed invasion and/or significant changes in the overlying vegetation composition and structure, which are likely significantly alter the natural fire regimes of native vegetation. Such may adversely affect a population or result in a partial destruction or modification of its habitat (DEC 2006). |
| Illegal dumping of rubbish and garden waste | known current | Repeated and occasional dumping of rubbish and garden waste is a known threat to the survival of the spiked rice-flower as individuals have been smothered by waste. A population in western Sydney is known to have been threatened with extinction because of the dumping of grass clippings at the base of trees (DEC 2006). |
| Invasive species | | |
| Weed invasion and competition | known current | Given the low-growing habit of the species, certain invasive weed species that form dense thickets or ground-covers are known to outcompete and displace spiked rice-flower populations. Weed invasion and competition is likely to reduce the reproductive capacity of adult plants, reduce the ability of adult plants to re-sprout following disturbance, and inhibit seedling recruitment |

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|---|---|---|
| | | (Matarczyk 1999, NSW NPWS 1997, and Willis pers. comm. cited in DEC 2006).<br><br>Bitou bush (*Chrysanthemioides monilifera* subsp. *rotundata*) is the primary weed species that threatens the spiked rice-flower in the Illawarra. On the Cumberland Plain, common weed species that are a particular threat to the spiked rice-flower are the African olive, lantana (*Lantana camara*), African lovegrass (*Eragrostis curvula*), Rhodes grass (*Chloris gayana*) (Ridgeway & Lee pers. comm. 2016), Kikuyu grass (*Pennisetum clandestinum*) and bridal creeper (*Asparagus asparagoides*) (Matarczyk 1999, NSW NPWS 1997, and Willis pers. comm. cited in DEC 2006). DEC (2006) lists other weed species that have been known to pose an increasing threat to the species.<br><br>Given that weed infested sites may exhibit very few mature spiked rice-flowers, estimates of above ground abundance of the species should be viewed with caution and may be a poor indicator of the potential abundance of the species at a site (DEC 2006). |
| Browsing by European rabbits | known current | Browsing by rabbits is known to have adversely affected some populations of the species on the Cumberland Plain (Ridgeway & Lee pers. comm. 2016). |
| High-frequency land-use/management activities | | |
| Slashing and mowing | known current | Although slashing and mowing has ceased in the immediate vicinity of occurrences of the spiked rice-flower within many local government-managed reserves, they are common practices at many other locations supporting the species, particularly in local government reserves and along road reserves and fire trials. Slashing or mowing is likely to destroy young spiked rice-flowers that do not possess a well developed tap-root, destroy the above ground parts of mature individuals and prevent seed production. Repeated slashing/mowing in short succession is likely to exhaust the energy reserves stored within of a mature individual and decrease its ability to re-sprout following subsequent disturbances (Matarczyk et al., 2002, Nash & Matthes 1995, and NSW NPWS 1997 cited in DEC 2006). It is also likely to decrease the rate of recruitment in populations if the disturbance occurs at intervals too short to enable seedlings to mature to a stage where they are capable of producing seed and/or capable of re-sprouting. Therefore, frequent slashing/mowing may lead to local extinctions of the species in the long term (DEC 2006). |
| Broad-scale mechanical weed-control operations and herbicide spraying | known current | Very little is known about methods to control non-woody weeds, other than spraying herbicide, without having an impact on the spiked rice-flower. Given that the spiked rice-flower is cryptic, individuals may be inadvertently damaged or destroyed during mechanical weed control or herbicide spraying operations (DEC 2006). Matarczyk et al., (2002) (cited in DEC 2006) observed a significant reduction in tap-root size for individuals re-sprouting after herbicide spraying. Broad-scale mechanical weed-control operations and herbicide spraying are likely to have the same long-term effects on the species as other land-uses or management activities, as described for slashing/mowing (Matarczyk et al., 2002, |

| | | |
|---|---|---|
| | | Nash & Matthes 1995, and NSW NPWS 1997 cited in DEC 2006) in this table. |
| Intensive livestock grazing | known current | Intensive livestock grazing, predominantly by cattle (*Bos taurus*), but also by sheep (*Ovis aries*) and goats (*Hircus capra*), is a known threat to the species in the Illawarra. It is still a threat to the species on the Cumberland Plain (Ridgeway & Lee pers. comm. 2016), although, this land-use and its threat is diminishing due to urbanisation.<br><br>Intensive livestock grazing is likely to have the same long-term effect on the species as other land-uses or management activities, as described for slashing/mowing (Matarczyk et al., 2002, Nash & Matthes 1995, and NSW NPWS 1997 cited in DEC 2006) in this table. Soil compaction is a common impact of cattle grazing, particularly on the medium to fine-textured, moist soils of the Cumberland Plain. Soil compaction leads to reduced water infiltration, which in turn affects plant germination and growth (DEC 2005). Livestock grazing can also contribute to the spread of weed seeds (DEC 2006). |
| Fire | | |
| High frequency of disturbance from fire | known current | The spiked rice-flower is threatened by frequent fires. Due to its urban setting, arson is a significant risk in the bushland remnants of western Sydney, increasing the frequency of fire (DEC 2006). Fire is likely to have the same long-term effect on the species as other land-uses or management activities, as described for slashing/mowing (Matarczyk et al., 2002, Nash & Matthes 1995, and NSW NPWS 1997 cited in DEC 2006) in this table. In the absence of scientific research and taking a precautionary approach, DEC (2006) assumed that fire frequencies less than 10 years are detrimental for the species. |
| Low frequency of disturbance from fire | potential current | Many of the smaller remnant spiked rice-flower populations on the Cumberland Plain have been excluded from fire for long periods. Given that the species' growth, flowering, seed production, seed germination, and seedling survival all appear to be enhanced by disturbances, particularly wildfires, and the creation of gaps in the overlying vegetation in the habitat of a population, a long-term absence of such disturbances could be detrimental to the persistence a population (NSW NPWS 1997 and Matarczyk 1999 cited in DEC 2006). Increased shading decreases seedling root and growth increases mortality in the species (Matarczyk 1999 cited in DEC 2006). |

## Conservation Actions

### Conservation and Management priorities

Habitat loss and degradation

- In accordance with the EPBC Act and the TSC Act, assess all activities that may have a direct and indirect adverse impact on the species and implement measures to avoid them. Examples of such actions include, but are not limited to, those resulting in the

loss or degradation of habitat for the species, including from soil erosion, transport or movement, nutrient or chemical contamination or changes to the hydrology of the landscape; reductions in populations or seed banks; and weed invasion of habitats.

- Ensure that adequate targeted surveys for the spiked rice-flower, including thorough seed bank searches, and habitat assessments are conducted prior to assessing development or rezoning applications that affect known or potential occurrences or habitats of the species.
- Ensure that all relevant infrastructure construction and maintenance contractors are aware of the species' occurrence and implement measures to avoid damaging populations during works.
- Continue to collect and store seed from known populations to maintain adequate representation of the remaining genetic diversity from known populations of the species for the future restorations of populations and potential translocations.

Weed invasion

- Incorporate weed management/habitat restoration plans in site-specific management plans developed for all known spiked rice-flower populations, including surrounding buffer zones.
- Site-specific weed management plans should describe the most appropriate weed suppression methods for eliminating/suppressing relevant weed species at those sites while minimising the risk of incidental impacts on the spiked rice-flower.
- Post-fire monitoring for weeds should be included in site-specific weed management plans for the species.
- Weed management plans should include measures to avoid the incidental spraying of populations of the species with herbicides and, where necessary and feasible, precautionary measures for the application of herbicides to control environmental weeds within or near the occurrences and habitats of the species. For example, applying herbicide during calm, near windless weather conditions in order to minimise the potential for harmful sprays to be wind-dispersed.
- Implement relevant weed control measures according to site-specific weed management plans.
- Record the timing, climatic conditions and weed control methods applied to control specific weed species at specific sites.

High-frequency land-use/management activities

- Continue to develop and implement site-specific management plans, including threat abatement measures, for spiked rice-flower populations occurring on all tenures in cooperation with landholders and other relevant stakeholders.
- Continue to exclude slashing and mowing from relevant areas and, where slashing/mowing has not been excluded, ensure that all relevant site managers/ machine operators responsible for areas adjacent to species' habitats are made aware of the occurrence of the species and avoid entering surrounding buffer zones.
- Ensure that measures to exclude or manage all activities that have a potential to adversely affect populations of the species including, but limited to, slashing and

mowing, are incorporated in site-specific management plans for the species and continue to implement these measures accordingly.

- Continue to prevent accidental destruction of populations of the species, where necessary, by installing and maintaining adequate buffer zones, exclusion fencing and/or signage indicating the species' presence and the importance of avoiding impacts on the population and its habitat.
- Continue to design, install and maintain rabbit exclusion fencing, where necessary, in order to protect relevant populations.
- Where necessary, continue to manage infrequent livestock grazing in areas where the species occurs, or install and maintain adequate exclusion fencing in order to protect relevant populations from relevant livestock species.

Fire

- Fires must be managed to ensure that prevailing fire regimes do not disrupt the life cycle of the spiked rice-flower [or component flora of the species' habitat], that they support rather than degrade the habitat necessary to the species, that they do not promote weed invasion and growth, and that they do not increase impacts of browsing by rabbits.
- Develop and implement a fire management strategy for conservation of the based on research of the species' fire ecology and in consultation with the NSW Rural Fire Service and other relevant stakeholders with regards to fire control measures.
- The species is a woody re-sprouting perennial shrub, avoid successive fire intervals that are shorter than the period required to maintain the recovery capacity of re-sprouting individuals.
- Given that the species produces and relies on dormant soil seed banks for rejuvenation and long-term persistence of populations, avoid use of prescribed fire between mid autumn and late spring.
- Where invasive grasses or forbs are a local threat to a population, minimise the use of prescribed fire and follow up with appropriate weed control.
- Where invasive shrub species are a local threat to a population, use prescribed fire or other appropriate means to manage changes in the density or abundance of the invasive species that may reduce the suitability of habitat for the species.
- Use physical or chemical control methods as an alternative to prescribed fire, where appropriate, noting that many invasive species germinate in response to physical disturbance of soils.
- Physical damage to the habitat and individuals of the threatened species must be avoided during and after fire operations. Ensure that personnel planning and undertaking hazard reduction burns are able to identify the species and are aware of natural and modified vegetation types in which it may occur.
- Continue to update the Threatened Species Hazard Reduction List (Part 1 – Plants) for the Bush Fire Environmental Assessment Code (RFS 2013) to reflect the relevant recommendations stated in this advice for the spiked rice-flower.
- Landholders and managers should be provided the above information in order to manage fire for the benefit of the species.

Stakeholder Engagement

- Ensure that relevant NSW State Government authorities, local government and private landholders, land managers and contractors are informed about local occurrences of the species and the types of actions that could adversely affect the species or its habitat, and are advised how to avoid or mitigate impacts on the species.
- Advise landholders of the opportunities and advantages of entering into voluntary, cooperative conservation agreements or covenants to conserve spiked rice-flower populations on their properties and negotiate such agreements.
- Assist landholders to develop and implement site management plans for sites where the species occurs on their properties.
- Maintain cooperation between the NSW State Government, local councils and conservation groups to coordinate, implement and monitor relevant conservation actions, as outlined in this advice, for the species.
- Continue to regularly update distribution mapping databases and profiles of the species and distribute information about the species' conservation requirements and the progress of conservation actions to raise community awareness.
- The NSW Rural Fire Service and land managers should use suitable maps and install field markers to avoid damage to the species and its habitat.
- Identify opportunities for, and promote and support the involvement of community groups and volunteers in surveys, the monitoring of populations of the species and the implementation of conservation actions at known sites. For example, devise and implement a community education campaign about the impact of dumping rubbish and garden waste and promote the minimisation of dumping activity and its impact by encouraging community participation in organised regular events to remove waste from the species' habitat.

**Survey and monitoring priorities**

- Continue to facilitate a long-term monitoring program for all known populations of the spiked rice-flower, including the four sites supporting potentially extinct populations/subpopulations, and their habitats. Monitoring of populations should be conducted annually and coincide with expected peak flowering times during the year. However, where the annual monitoring of all populations is not achievable in the short term, the selection of population for monitoring should be prioritised based on the levels of threat acting on each population.
- Monitoring should include an assessment of the general condition of the population and any changes to the vegetation. Tag and record individuals that have suffered dieback of aboveground parts and record any whether any tagged individuals have re-sprouted (noting their age). Note seedling survival and count/estimate the number of new seedlings.
- Continue to survey potential habitat on all tenures, where possible, to locate any new or unconfirmed populations of the species.
- Measure the effectiveness of management actions and the need to adapt them if necessary.

**Information and research priorities**

- Research key biological attributes and functions of the species, including the pollination biology; the environmental stimuli for successful seed germination; the longevity of viable

seed and the current statuses of seed banks; the rate of the species' growth under variable environmental conditions (particularly rainfall and light availability/intensity); the minimum size and age range at which the species' tap-root is capable of enabling re-sprouting and survival of the plant; and the species' longevity.

- Improve understanding of the mechanisms of response to different fire regimes and identify appropriate fire regimes for conservation of the species by undertaking appropriately designed experiments in the field and/or laboratory.
- Analyse population trends and responses against recovery actions. Collate and analyse census data, compare with management histories and conduct population viability analyses.
- Investigate options for linking, enhancing or establishing additional populations.

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