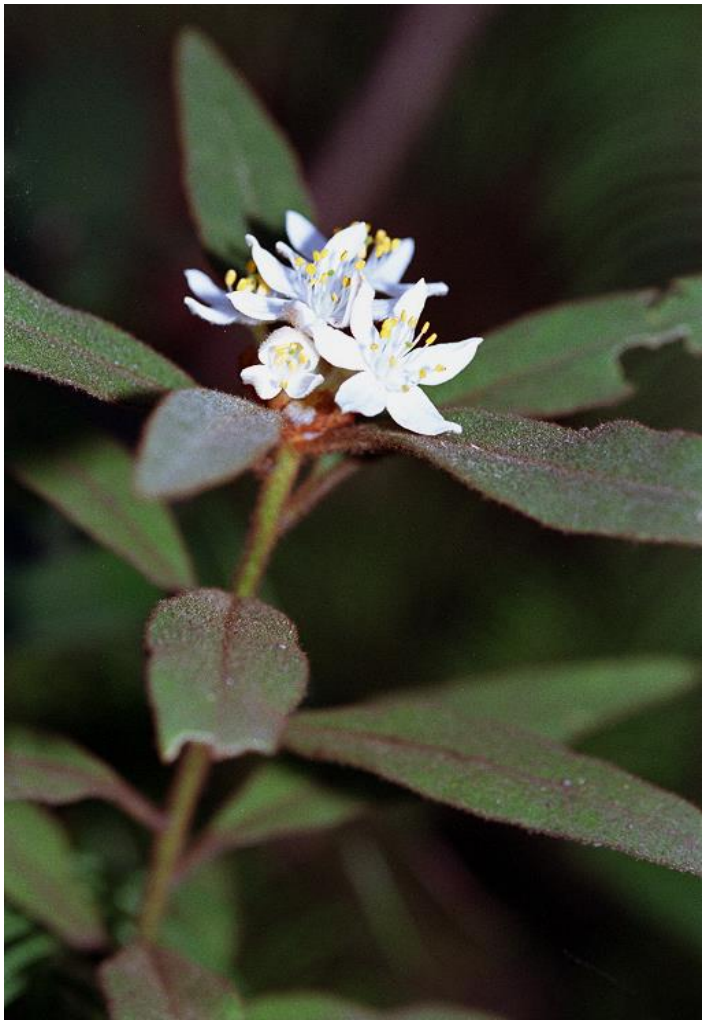
Australian Government
Department of Agriculture, Water and the Environment

Conservation Advice for *Asterolasia elegans*

In effect under the *Environment Protection and Biodiversity Conservation Act 1999* from 29 September 2021.

This document provides a foundation for conservation action and further planning.



Asterolasia elegans. Photography by Andrew Orme. Image used with the permission of the Botanical Information Service, National Herbarium of New South Wales. Permission granted 19 January 2021.

Conservation status

Asterolasia elegans is listed in the Endangered category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwth) (EPBC Act) effective from 16 July 2000. The species is eligible for listing because prior to the EPBC Act, it was listed as Endangered under the *Endangered Species Protection Act 1992* (Cwlth).

A. elegans is listed as Endangered due to its restricted geographic distribution and small population size.

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 Species Profile and Threats Database.

Species information

Taxonomy

Conventionally accepted as *Asterolasia elegans* L. McDougall & MF Porteners (1990).

Description

Asterolasia elegans (*A. elegans*) (family Rutaceae) is a tall, slender, and erect shrub that grows up to three metres high (McDougall & Porteners 1990; Scott 1994). The leaves are lance shaped, 4–13 cm long, with rusty star-shaped hairs on both surfaces (DEC 2005, as cited in OEH 2011). *Asterolasia elegans* flowers in spring, producing large white flowers with long dense star-shaped hairs on the outer surface (DEC 2005, as cited in OEH 2011). Fruiting occurs in November, and seeds are released in December. The fruits are covered in white and rusty hairs containing oblong shiny grey seeds (McDougall & Porteners 1990).

Distribution

Asterolasia elegans is currently known from seven populations, in a disjunct distribution separated by roads and ridges north of Maroota in the Central Coast botanical subdivision of New South Wales (NSW) (Map 1). The species occurs in the local government areas of Hawkesbury, Baulkham Hills, and Hornsby. All populations exist within the Hawkesbury/Nepean Catchment Management Authority boundary (OEH 2020a). The seven populations are Laughtondale Gully Road, Marramarra National Park, Old Northern Road, Marramarra Creek, Maron's Rock Reserve, Putty Road, Parr State Conservation Area (SCA) (OEH 2011; Table 1). The Laughtondale Gully Road population consists of three subpopulations and the Old Northern Road population consists of two subpopulations. A population was once thought to be extant in Jerusalem Bay (Ku-ring-gai National Park), though this was confirmed as species misidentification (DEE 2021).

Eight NSW Saving Our Species (SoS) population monitoring plots were established in 2017–18 across Laughtondale Gully Rd (five plots) and Coopers Creek (Marramarra National Park population, three plots) (Table 1). Monitoring has been undertaken every three years. Surveys in 2020–21 revealed that the 247 individuals in plots recorded at Laughtondale Gully road in 2017–18 had declined to 201 individuals, and the 125 plotted individuals at Coopers Creek in 2017–18 had declined to 102 individuals. However, these declines are suspected to be as a result of natural variation in the population. Plant condition and health measures did not change between monitoring years, there was a higher proportion of juveniles in 2020-21 compared to 2017-18, and no major new threats were identified in 2020-21. Monitoring of these populations is ongoing (DEE 2021).

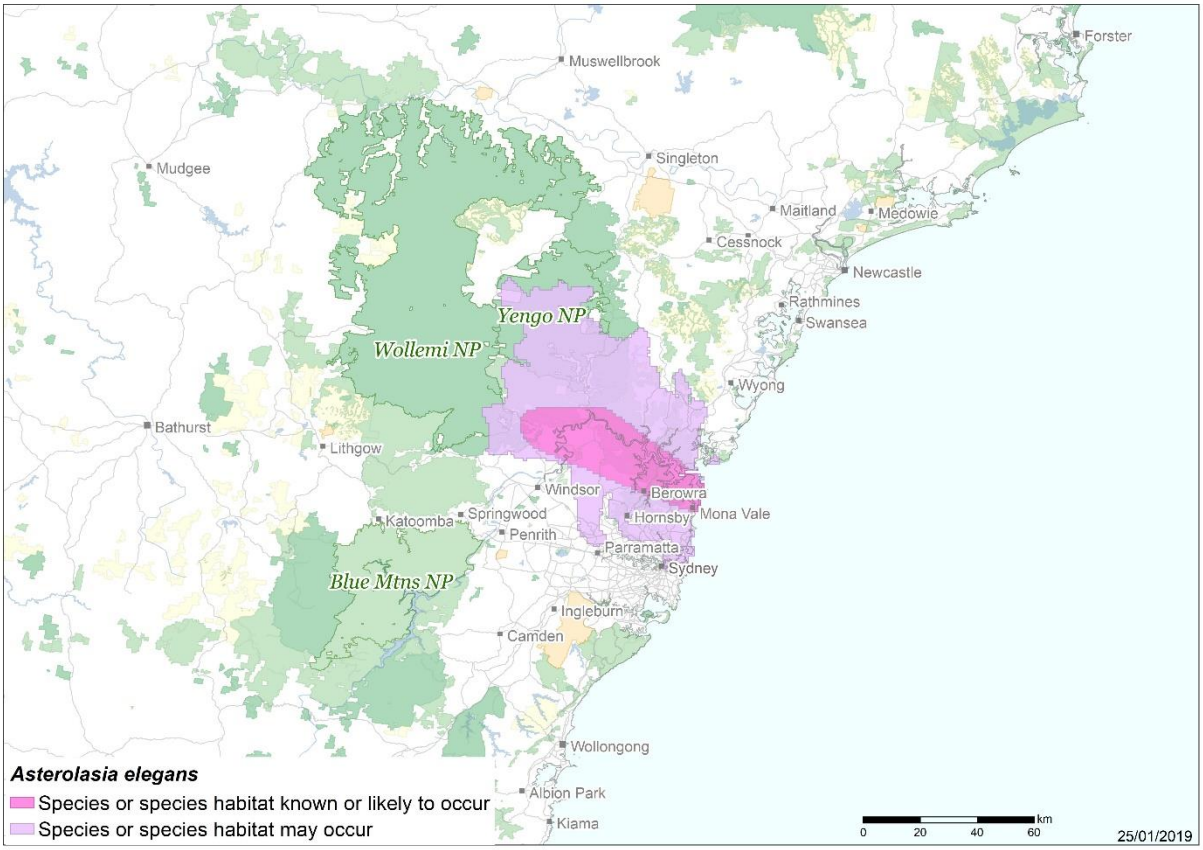
Table 1. Populations and abundances of *A. elegans*, including accuracy and date of last survey (OEH 2011; DEE 2021).

Population no.	Population (subpopulation)	Abundance	Year of population survey
1	Laughtondale Gully Road (a)	3540 (± 520) 245 in 5 plots 209 in 5 plots	Recorded in October 1993, prior to January 1994 bushfire when all known plants were burnt. 2017–2018 2020–2021
1	Laughtondale Gully Road (b)	840 (± 80)	Recorded in October 1993, prior to January 1994 bushfire when all known plants were burnt.
1	Laughtondale Gully Road (c)	>230	Estimated at >230 in March 2006. Previously estimated as 2940 (±700) in October 1993, prior to January 1994 bushfire when all known plants were burnt.
2	Marramarra National Park	12220 (± 1980) 125 in 3 plots 109 in 3 plots	Recorded in November 1993, prior to January 1994 bushfire when 99% of plants were burnt. 2017–2018 2020–2021
3	Old Northern Road (a)	Unknown	Not recorded.
3	Old Northern Road (b)	20 8	Recorded in September 1995. Recorded in 2019 as part of the NSW SoS program.
4	Marramarra Creek	250 350	Recorded in September 1998. Recorded in 2017 as part of the NSW SoS program.
5	Maron's Rock Reserve	30	Recorded in July 1996.
6	Putty Road	15	Recorded in January 1996
7	Parr State Conservation Area (a,b,c)	300–500, 204 counted in distributional search Unknown, 161 in plots	Recorded in 2017–18 as part of the NSW SoS program. Recorded in 2018–19 as part of the NSW SoS program.

Tenure

Four of the seven known populations of *A. elegans* occur on conservation reserves. Three of these are in the Marramarra National Park and one is in Parr SCA. The Laughtondale Gully Road population exists on three tenures (Marramarra National Park, a Crown road reserve and on rural private property). Three sites are currently receiving conservation actions as part of the NSW SOS program: Parr State Conservation Area, Maroota/Laughtondale, and Turnbull's Arm OEH (2020b).

Map 1 Modelled distribution of *Asterolasia elegans*



Source: Species distribution data Species of National Environmental Significance database, Base map Geoscience Australia.
Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.
Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the specific habitat type or geographic feature that represents to recent observed locations of the species (known to occur) or preferred habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

Two populations of *A. elegans* are on land under Aboriginal land claims and native title claims. The Traditional Owner groups affected by conservation planning of *A. elegans* include the Deerubbin and Metropolitan Local Aboriginal Land Councils. The species is also in the area of

interest to the Darug Tribal Aboriginal Corporation and Darug Custodian Aboriginal Corporation. This information is sourced from OEH (2011).

Relevant biology and ecology

Habitat

Asterolasia elegans grows on Hawkesbury sandstone, commonly amongst rocky outcrops and boulders on the Hawkesbury and Gymea erosional soil landscapes (PlantNET 1991; OEH 2020a). It is found in wet, sheltered sclerophyll forest on the moist mid to lower slopes and valleys of gullies, often above creek lines (Scott 1994; OEH 2011). The species has also been found inhabiting Sydney coastal dry sclerophyll forests, Sydney hinterland dry sclerophyll forests, rainforests and wet sclerophyll forests (DEC 2005, as cited in OEH 2011). Canopy vegetation at known sites include *Syncarpia glomulfera* subsp. *glomulifera* (Turpentine), *Angophora costata* (Smooth-barked Apple), *Eucalyptus piperita* (Sydney Peppermint), *Allocasuarina torulosa* (Forest Oak) and *Ceratopetalum gummiferum* (Christmas Bush) (OEH 2020a). *Asterolasia elegans* can also be found growing with the Vulnerable species *Zieria involucrata* (Scott 1994).

Reproductive biology and ecology

There is limited information on the reproductive ecology of *A. elegans*. *Asterolasia* flowers are typically insect pollinated, and visitors to species in the genus are mostly beetles, though flies and bees also occasionally visit (Armstrong 1979). However, the specific pollinators of *A. elegans* are not known. The impact of the introduced European honey bee (*Apis mellifera*) on pollination and subsequent seed production of the genus is also unknown, though the honeybee is considered to be a potential threat (Auld 2001).

The species produces white star-shaped flowers from August to October, and fruit in November (McDougall and Porters 1990). Mature fruits burst open in December, releasing both dormant and non-dormant seeds. A high proportion of seed is viable (88–98 percent), though the proportion of dormant seeds is variable at seed release (49–100% percent) (Scott 1994; Auld et al. 2000). While the non-dormant seeds undergo rapid decay, dormant seeds show no significant decay over a two-year period, suggesting that relatively long-lived persistent soil seedbanks may be established. Auld et al. (2000) estimated the half-life of the dormant, viable seed fraction ranges from two to three years, indicating that the species could last five–ten years as seed in the soil after adults have died. However, the seedbank must receive a constant influx of new seeds to survive and maintain viability for an extended period.

Seed dispersal in *Asterolasia* species is initially by forcible ejection from the fruit. The presence of an ant-attracting food body (elaiosome) within the seed indicates that secondary dispersal by ants is also likely to occur (J. Howell, as cited in Benson and McDougall 2001). At present, there is little knowledge of the nature of ant interactions with *A. elegans*. Even with this mechanism, seed dispersal distance is likely to be short, from one to three metres (Auld 2001).

Disturbance ecology

Asterolasia elegans is an obligate seeder (can only regenerate from seed after fire). Mature plants are usually killed by fire and population recovery is dependent on viable seeds stored in the soil, which require disturbance to break dormancy and germinate. Seed dormancy can be broken by heat and smoke, though temperatures between 77°C and 110°C are required for promotion of

germination (Scott 1994). Such temperatures are often only reached in the top four cm of soil (Bradstock and Auld 1995). Moderate to high severity fires, or low severity fires that move slowly and fully combust fuels, will promote recruitment of *A. elegans* (Scott 1994). Fires that do not break seed dormancy will lead to population decline, as fire kills mature plants and subsequent recruitment not promoted.

The non-dormant seeds stored in the soil provide a source of germination between fire events. It is likely that "natural" disturbances (resulting from storm damage, animal scratchings) provide recruitment opportunities for the species in a healthy ecosystem (OEH 2011). Seedlings can emerge on a regular basis from the seed bank as seeds decay in the soil, but the survival of these seedlings is likely low if fire has not recently occurred (Scott 1994). A greater understanding of the species seedling recruitment and seedling survivorship between fires is required to assess the likely rate of decline and plan effective conservation actions.

Habitat critical to the survival

Due to the species eligibility for listing (highly restricted range and small population size), all habitat is considered critical to the survival of the species.

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

Important populations

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

There is sufficient evidence through the species eligibility for listing, to declare all populations/the national population of this species under particular pressure of survival and which therefore require protection to support the recovery of the species.

Threats

Asterolasia elegans is threatened by high frequency fire related to climate change, and fire promoted weed invasion. The species is also threatened by habitat loss and fragmentation, water pollution, road maintenance, bush rock removal and invasive species. *Phytophthora cinnamomi* dieback may also eventually spread to the distribution of the species, potentially having severe effects on population health. Introduced bees may also threaten the species, though more information is required on this subject and hence it has not been included in Table 2.

Table 2 Threats impacting *Asterolasia elegans*.

Threat	Status and severity [a]	Evidence
Climate change		
Increased frequency and severity of bushfires	• Timing: current • Confidence: known • Consequence: catastrophic • Trend: increasing • Extent: across the entire range	The CSIRO & Bureau of Meteorology (2015) predict that climate change will continue to reduce rainfall and increase temperatures on the east coast of Australia, leading to increased fire frequency and severity where *A. elegans* occurs (DPI 2020). A regime of high-frequency fire leading to short intervals between fires is likely to

Threat	Status and severity [a]	Evidence
		severely impact all *A. elegans* populations, as the species requires adequate time between fires for seedlings to mature and set seed to replenish soil stored seed banks (OEH 2020a). The minimum fire-free interval required for the species to persist is approximately seven years (Scott 1994; RFS 2004, as cited in OEH 2011). Too-frequent fire may lead to population declines, if adult plants are killed by fire and the resprouted seedlings are killed by a consecutive fire before a seed bank can be built (OEH 2011). Sustained high frequency fires may also cause changes in vegetation structure and therefore microclimate, leading to a decline in moist sheltered habitats preferred by *A. elegans*, as well as promoting weed invasion (OEH 2020a). In 2019–20, following years of drought (DPI 2020), catastrophic bushfire conditions resulted in fires over an unusually large area of eastern Australia. The NSW Department of Planning, Industry and Environment (2020) estimated that 38.4 percent of known *A. elegans* records were within spatial extent of the 2019–20 bushfires, whilst Gallagher (2020) estimated 18 percent of the range may have been burnt. Approximately 38 percent of the species records occur in unburnt areas within the protected area network (DPIE 2020). Post-fire field surveys indicated that most subpopulations were not burnt in the 2019-2020 fire season, and only one SoS management site was fire impacted (Parr SCA population). A rapid post-fire assessment conducted in July 2020 confirmed all three known subpopulations in Parr SCA were burnt in the 2019–20 bushfires at medium to high severity. Adult survivorship varied across monitoring plots and approximately half of all plants were killed, with no seedlings located in these early post-fire surveys. As of Autumn 2021, post-fire monitoring is continuing to document post-fire recruitment at this management site. The substantial loss (c. 50 percent) of mature individuals at Parr SCA may increase the species' extinction risk, particularly given that climate change will likely increase the risk of fires across the species range (CSIRO & Bureau of Meteorology 2015; DEE 2021).

Threat	Status and severity [a]	Evidence
Habitat disturbance and fragmentation		
Land clearing and fragmentation	• Timing: current • Confidence: known • Consequence: major • Trend: increasing • Extent: across parts of the range	The extant populations of *A. elegans* are scattered and isolated by roads and ridges. The species was listed under the NSW Threatened Species Conservation act due to its small and fragmented range (OEH 2011) and is currently listed under the NSW Biodiversity Conservation Act 2016. Fragmentation and direct loss of habitat may occur through native vegetation clearing for semi-rural and urban expansion, as well as agricultural development (OEH 2020a). The populations that are not in conservation reserves are most threatened by land clearing, especially as metropolitan Sydney continues to expand. The loss of individuals or populations through land clearing will further reduce the distribution and available habitat for the species. Populations of *A. elegans* are already disjunct, and the loss of populations will fragment the species further (OEH 2011).
Inappropriate fire regime and planned burns	• Timing: current • Confidence: known • Consequence: major • Trend: unknown • Extent: across the entire range	Too infrequent fires can threaten *A. elegans* by allowing adult plants to mature and die without new seedlings emergence, meaning they exist only as a soil stored seed bank with a finite life span (OEH 2011). Fires that fail to break seed dormancy (too cool) or kill stored seed (too hot) may also lead to population decline. The species may also be threatened by planned fire regimes, especially if they are too-infrequent or too-frequent for the required inter-fire period of *A. elegans*. Planned burn management strategies proposed in the habitat of *A. elegans* should take the ecology of the species and previous fire history into account.
Road maintenance	• Timing: current • Confidence: inferred • Consequence: moderate • Trend: unknown • Extent: across parts of the range	Most of the known extant populations of *A. elegans* are on road verges in steep gullies. Indeed, some populations are found so close to the roadside that vehicle parts have fallen into gullies supporting the species (Scott 1994). Due to this proximity, mechanical and chemical methods for roadside vegetation management and bushfire hazard reduction pose a threat to roadside populations. Such vegetation management also poses a threat to any individuals nearby utilities such as powerlines and other assets (OEH 2020a).

Threat	Status and severity [a]	Evidence
Bushrock removal	• Timing: current • Confidence: suspected • Consequence: minor • Trend: unknown • Extent: across parts of the range	Bushrock removal is a Key Threatening Process listed under the NSW BC Act 2016 (DPIE 2019). Theft of bush rock is an issue in Marramarra National Park. The removal of bushrock in *A. elegans* habitat may destroy plants and degrade the habitat of the species. Access to *A. elegans* populations via roads allows for easy disturbance and removal of biotic and abiotic material from the National Park (OEH 2011).
Water pollution and runoff	• Timing: current • Confidence: known • Consequence: moderate • Trend: unknown • Extent: across parts of the range	*Asterolasia elegans* occurs in moist gullies close to creek lines, making the species vulnerable to water pollution and runoff. The 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' is listed as a Key Threatening Process under the BC Act (DPIE 2019). The Putty Road population occurs adjacent to a creek affected by sewage pond outflow. The high level of nutrients that are being expelled from the outlet is likely to promote the growth of weeds (Leishman et al. 2004). Runoff from developed areas may also wash weeds and nutrients downstream into *A. elegans* populations (OEH 2011).
Rubbish dumping	• Timing: current • Confidence: known • Consequence: minor • Trend: static • Extent: across parts of the range	There have been instances of rubbish being dumped from the roadside into the habitat of *A. elegans* (OEH 2020a). Incidental rubbish dumping continues along Laughtondale Gully Road, and monitoring and removal is completed annually as part of the NSW SoS project, in conjunction with Hornsby Shire Council (DEE 2021).
Invasive species		
Weed invasion	• Timing: current • Confidence: inferred • Consequence: moderate • Trend: static • Extent: across parts of the range	Crofton Weed (*Ageratina adenophora)* and Common Sowthistle (*Sonchus oleraceus*) occur along Laughtondale Gully Road in Marramarra National Park. The Marramarra National Park Plan of Management identifies these weeds as a threat to *A. elegans* and weed populations are being monitored (OEH 2011). Infestations of Crofton Weed (*Ageratina adenophora*) and other key weed species, predominantly invasive grasses including Weeping Lovegrass (*Eragrostis curvula*) and some woody weeds are present along Marramarra National Park tributaries (up- and down- stream of the Coopers Creek subpopulation), and along Laughtondale Gully Road. Infestations are monitored and maintained at low levels through annual weed control (DEE 2021). Frequent fires may exacerbate the risk posed by weed invasion, as

Threat	Status and severity [a]	Evidence
		fires can create gaps in vegetation allowing superior competitors to invade.
Grazing and trampling by feral Goats (*Capra hircus*)	• Timing: current • Confidence: inferred • Consequence: minor • Trend: unknown • Extent: across parts of the range	A small number of Unmanaged goats exist in Marramarra National Park (NPWS 1998), and Unmanaged goats have been identified as a possible threat to the Laughtondale Gully Road and Marramarra National Park populations. Unmanaged goats are found in all states and territories of Australia and have been listed as a Key Threatening Process under the EPBC Act (DEWHA 2008). They can destroy and degrade native vegetation by trampling and grazing plants, ring-barking young trees, preventing plant regeneration, altering ecological communities, promoting weed invasion and spreading *P. cinnamomi* (DEWHA 2008; DoEE 2018).
Disease		
Dieback caused by *Phytophthora cinnamomi*	• Timing: future • Confidence: suspected • Consequence: moderate • Trend: unknown • Extent: across parts of the range	*Phytophthora cinnamomi* is an introduced soil-borne pathogen which infects a large range of plant species and may contribute to plant death. Mortality is especially likely when other stressors are present, such as waterlogging, drought and bushfire (DoEE 2018). *Phytophthora cinnamomi* can disperse in water flowing from roots of infected plants and in soil clinging to vehicles, animals, and people (DoEE 2018). Infection results in plant death in susceptible species through the destruction of root systems. Dieback caused by *P. cinnamomi* is listed as a Key Threatening Process under the EPBC Act (DoEE 2018). There is no published evidence regarding the susceptibility of *A. elegans* to the pathogen. However, other members of the Rutaceae family are susceptible (Auld 2001). *Phytophthora cinnamomi* is present in a in the Sydney region (OEH 2017), so may be a threat to *A. elegans* due to the growing potential for spread of the pathogen through human activities.

Status—identify the temporal nature of the threat;
Confidence—identify the extent to which we have confidence about the impact of the threat on the species;
Consequence—identify the severity of the threat;
Trend—identify the extent to which it will continue to operate on the species;
Extent—identify its spatial content in terms of the range of the species.

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

Table 3 *Asterolasia elegans* risk matrix.

Likelihood	**Consequences**				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low risk	Moderate risk **Rubbish dumping**	Very high risk	Very high risk	Very high risk **Increased frequency and severity of bushfires**
Likely	Low risk	Moderate risk **Grazing and trampling by feral Goats (*Capra hircus*)**	High risk **Water pollution and runoff** **Road maintenance** **Weed invasion**	Very high risk **Land clearing and fragmentation** **Inappropriate fire regime and planned burns**	Very high risk
Possible	Low risk	Moderate risk **Bush rock removal**	High risk	Very high risk	Very high risk
Unlikely	Low risk	Low risk	Moderate risk **Dieback caused by *Phytophthora cinnamomi***	High risk	Very high risk
Unknown	Low risk	Low risk	Moderate risk	High risk	Very high risk

Priority actions have then been developed to manage the threat particularly where the risk was deemed to be 'very high' or 'high'. For those threats with an unknown or low risk outcome it may be more appropriate to identify further research or maintain a watching brief.

Conservation and recovery actions

Primary conservation objective

By 2030, the population will have increased in abundance and viable populations are sustained in habitats which are managed for ongoing threats.

Conservation and management priorities

Climate change and fire

- Develop and implement a long-term fire management strategy that optimises the survival of the species and incorporates its fire regime requirements into prescribed management burns (OEH 2020b).

- Provide maps of known occurrences to local and state Rural Fire Services and seek inclusion of mitigation measures in bushfire risk management plans, risk registers and operation maps.
- Avoid physical damage to the habitat and individuals of the species during and after fire management operations.
- Undertake active weed control after bushfires and fire management operations along urban roadsides.
- Manage unburnt areas within or adjacent to recently burnt areas to reduce risks from future bushfires.

Habitat loss disturbance and modifications

- Protect and maintain habitat at known sites, including by: restricting vehicular and pedestrian access, constructing fencing to exclude livestock and/or feral animals, and undertaking targeted bush regeneration and weed control works where required (OEH 2011).
- Ensure land managers are aware of the species' occurrence and their obligations to minimise clearing and fragmentation.
- Liaise with operational managers and land holders to limit the effects of pollution and run-off on the *A. elegans* site near the Hawkesbury Council Sanitation Depot (OEH 2011).
- Install signage and implement legislative measures to reduce damage from road management, pollution, and rubbish dumping at all sites, especially the Laughtondale Gully Road population (OEH 2020b).
- Protect known habitat from the impacts of road construction. Close unused or little-used roads and tracks and revegetate these areas.
- Install signage to deter potential theft of bush rock and biotic material.

Invasive species (including threats from grazing, trampling, predation)

- Implement site-based weed control at all sites where weeds are extant. This includes the use of physical removal and herbicide application. Ensure that there is minimal impact of herbicides on *A. elegans.*
- Implement suitable weed hygiene protocols when undertaking survey, monitoring and management activities. Refer to the *Arrive Clean, Leave Clean Guidelines to help prevent the spread of invasive plant diseases and weeds threatening our native plants, animals, and ecosystems* (DoE 2015).
- Monitor and control damage to riparian areas by feral Goats. This may require collaboration with land holders and local government authorities to control numbers and fence sites.

Disease

- Implement a *P. cinnamomi* management plan to ensure the pathogen is not introduced into the range of *A. elegans* and to mitigate the spread from any nearby infected areas (DoEE 2018).

- Ensure that appropriate hygiene protocols are adhered to when entering and exiting areas where *A. elegans* occurs, such as those identified in DEWHA (2009).

Breeding, seed collection, propagation, and other ex situ recovery action

- Re-evaluate the applicability of ex situ conservation strategies for the species. As of 2011, ex situ measures were not considered necessary for the conservation needs of the species (OEH 2011).
- Any translocation, either for ex situ populations or reintroductions, should be conducted in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018).

Stakeholder engagement/community engagement

- Liaise with Traditional Owner groups when planning and applying management actions.
- Engage with and involve Traditional Owners in conservation actions, including the implementation of Indigenous fire management and other survey, monitoring and management actions.
- Where *A. elegans* is located on private and public lands outside the protected area network, encourage landholders to prepare Site Management Statements for those sites, and maintain regular contact with landholders (OEH 2011).
- Liaise with relevant stakeholders and landholders to discuss weed control and reduction of pollution.
- Liaise with operators and landholders of nearby industrial areas (e.g., sewage treatment plants) to ensure water runoff is not affecting the species (OEH 2020b).
- Develop and implement procedures to protect the species during road or trail maintenance, for use by landowners/managers and public utilities and their contractors.

Survey and monitoring priorities

- Conduct targeted post-fire monitoring and surveying of the species to assess its status and the impacts of the 2019–20 bushfires. Continue monitoring every six months for three years following the fires (OEH 2020b). Publish monitoring data and metadata in an open access archive to allow sharing of knowledge gained about the species trajectory.
- Monitor abundance, age class, recruitment, population stability, pollinator activity, growth, reproduction, recruitment, and longevity and reproduction every two–three years (OEH 2020b).
- Assess the impacts of roadworks and spread of *P. cinnamomi* every two to three years (OEH 2020b).
- Coordinate targeted surveys of potential habitat for *A. elegans* to identify new populations.

Information and research priorities

- Conduct research to further understand the species' ecological requirements (OEH 2011). This includes:
  - Time to first flowering

  - Quantity and timing of seed production
  - Primary pollinators and their threats, if any
  - Dispersal distance and vectors for dispersal.
- Conduct research to further understand the species' fire ecology, including:
  - Appropriate fire intervals
  - Seedling recruitment and survival between fires.
- Research potential or emerging threats, including from:
  - The introduced honeybee
  - Water-borne pollution
  - *Phytophthora cinnamomi*
- Investigate the impacts of climate change on the long-term survival prospects of the species.
- Determine if ex situ seed orchards and translocations are a viable method of population recovery.
- Investigate options for establishing additional populations; or if new populations are discovered, investigate options for enhancing or increasing connectivity with these populations.

Links to relevant implementation documents

Help Save *Asterolasia elegans* (NSW Saving Our Species Profile)

NSW (2011) Recovery Plan for *Asterolasia elegans*

Threat Abatement Plan for competition and land degradation by unmanaged goats (2008)

Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* (2018)

Conservation Advice references

Armstrong JA (1979). Biotic pollination mechanisms in the Australia flora – a review. *New Zealand Journal of Botany* 17, 467–508.

Auld TD (2011). The ecology of the Rutaceae in the Sydney region of south-eastern Australia: poorly known ecology of a neglected family. *Cunningamia* 7, 213–239.

Auld TD, Mackenzie B, Le Breton T, Keith D, Ooi M, Allen S, Gallagher R (2020). *A preliminary assessment of the impact of the 2019/2020 fires on NSW plants of national significance*. Department of Planning, Industry and Environment (NSW).

Auld TD, Keith DA & Bradstock RA (2000). Patterns in longevity of soil seedbanks in fire-prone communities of south-eastern Australia. *Australian Journal of Botany* 48, 539–548.

Benson D & McDougall L (2001). Ecology of Sydney Plant Species, Part 8 Dicotyledon families Rutaceae to Zygophyllaceae. *Cunninghamia* 7, 241–462.

Bradstock RA & Auld TD (1995). Soil temperature during experimental bushfires in relation to fire intensity: consequences for legume germination and fire management in southeastern Australia. *Journal of Applied Ecology* 32, 76–84.

Commander LE, Coates D, Broadhurst L, Offord CA, Makinson RO, Matther M (2018). *Guidelines for the Translocation of Threatened Plants in Australia.* Australian Network for Plant Conservation, Canberra.

CSIRO & Bureau of Meteorology (2015). *Climate change in Australia information for Australia's natural resource management regions: technical report*. CSIRO and Bureau of Meteorology, Australia.

DEE (NSW Department of Environment and Energy) (2021). Consultation from the Common Assessment Method Working Group, 22 April 2021.

DEWHA (Department of Environment, Water, Heritage and the Arts (2009). Background for the Threat Abatement Plan. Disease in Natural Ecosystems caused by *Phytophthora cinnamomi*.

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008). *Threat Abatement Plan for competition and land degradation by unmanaged goats*. Viewed: 22 December 2020. Available on the internet at: https://www.environment.gov.au/system/files/resources/2109c235-4e01-49f6-90d0-26e6cb58ff0b/files/tap-goat-report.pdf

DoE (Department of the Environment) (2015). *Arrive Clean, Leave Clean Guidelines to help prevent the spread of invasive plant diseases and weeds threatening our native plants, animals, and ecosystems.* Department of the Environment, Canberra.

DoEE (2018). *Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi*. Department of Energy and Environment, Canberra.

DPI (Department of Primary Industries) (2020). *Drought in NSW*. Viewed 22 December 2020. Available on the internet at: https://www.dpi.nsw.gov.au/climate-and-emergencies/droughthub/drought-in-nsw

DPIE (Department of Planning Industry and the Environment) (2019). *Bush rock removal – key threatening process listing*. Date Viewed: 22 December 2020. Available on the internet at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/1996-1999/bushrock-removal-key-threatening-process-listing

DPIE (Department of Planning, Industry and Environment) (2020). *Wildlife and Conservation Bushfire Recovery*. Viewed 23 December 2020. Available on the internet at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Fire/wildlife-and-conservation-bushfire-recovery-immediate-response-january-2020-200027.pdf

Gallagher RV (2020). *Final National prioritisation of Australian plants affected by the 2019-2020 bushfire season*. Report to Department of Agriculture, Water and Environment, Canberra.

Viewed: 30 November 2020. Available on the internet at: http://www.environment.gov.au/biodiversity/bushfire-recovery/priority-plants

Leishman MR, Hughes MT & Gore DB (2004). Soil phosphorus enhancement below stormwater outlets in urban bushland: spatial and temporal changes and the relationship with invasive plants. *Soil Research 42*, 197–202.

McDougall L & Porteners MF (1990). *Asterolasia elegans* (Rutaceae), a new species from the Sydney region. *Telopea* 4, 139–140.

NPWS (NSW National Parks and Wildlife Service 1998). *Marramarra National Park Muogamarra Nature Reserves and Maroota Historical Site Plan of Management*. Department of Environment and Conservation. Date Viewed: 22 December 2020. Available on the internet at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Fire-management-strategies/marramarra-muogamarra-maroota-wisemans-ferry-fire-management-strategy-060384.pdf

OEH (2011). *Recovery plan for* Asterolasia elegans. Office of Environment and Heritage (NSW), Sydney.

OEH (Office of Environment and Heritage) (2017). *Infection of native plants by Phytophthora cinnamomi - Sydney Basin: Distribution and vegetation associations.* Viewed: 4 November 2020. Available on the internet at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profileData.aspx?id=20026&cmaName=Sydney+Basin

OEH (Office of Environment and Heritage) (2020a). Asterolasia elegans – *profile*. Date Retrieved: 22 December 2020. Available on the internet at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10072

OEH (Office of Environment and Heritage) (2020b). *Help Save* Asterolasia elegans. Date Retrieved: 22 December 2020. Available on the internet at: https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=342&ReportProfileID=10072

PlantNET (1991). Asterolasia elegans *L. McDougall & MF Porteners*. Date Retrieved: 22 December 2020. Available on the internet at: https://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Asterolasia%7Eelegans

RFS (New South Wales Rural Fire Service) (2004). *Threatened Species Hazard Reduction List - Part 1- Plants*. Date Viewed: 22 December 2020. Available on the internet at: http://bushfire.nsw.gov.au/file_system/attachments/State/Attachment_20050304_5C7BDF1C.pdf

Scott J (1994). *Recovery plan for* Asterolasia elegans. Australian Nature Conservation Agency, Sydney.

SERA (Society for Ecological Restoration Australia (2017). *National standards for the practice of ecological restoration in Australia. Standards reference group, Society for Ecological Restoration Australia*. Viewed 4 November 2020. Available on the internet at: http://www.seraustralasia.com/standards/National%20Restoration%20Standards%202nd%20Edition.pdf

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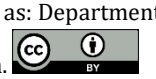
This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the Environment 2021, *Conservation advice for Asterolasia elegans*, Canberra. 

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