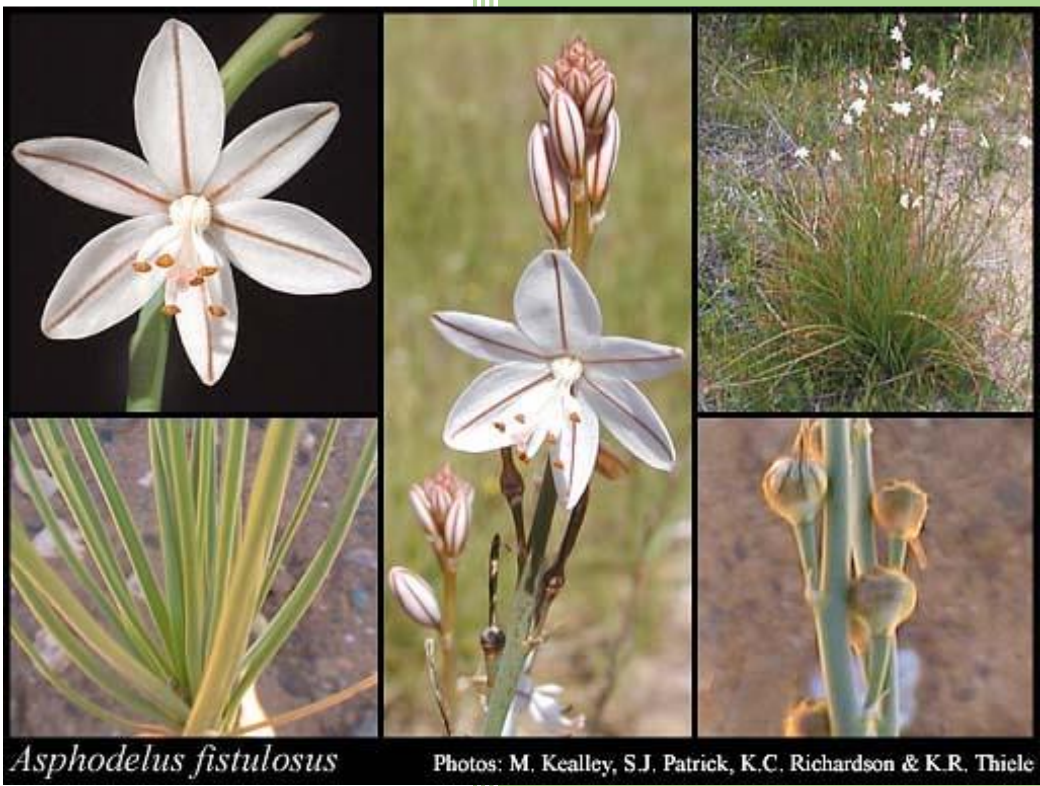
2021

# Literature review of Asphodelus fistulosus (Onion Weed) and its potential biological control options




Produced for the GNRBA
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# Contents

## 1. Introduction

*Asphodelus fistulosus* (Onion weed) was first introduced to Australia as an ornamental plant and was first recorded in South Australia. The plant is distributed extensively throughout south-east Australia and has spread to a lesser degree across WA (Cullen *et. al.* 2012). It has been considered a noxious weed in South Australia since 1897, as a response to growing concerns regarding its spread (Pitt, 2006). It is now widespread in Australia, and present across all states and territories (ALA, 2021).

*A. fistulosus* has also become invasive across the USA, India, Spain and New Zealand (Patterson, 1996). In Australia and America, the species is found in pastures, rangelands and crops, where it outcompetes grasses and other desirable forage species. The plant is unpalatable and avoided by livestock (Boatright 2012).

The plant does not have great value to the agriculture industry however, it has played a minor role to apiarists in building up bee colonies in early spring, through the use of its pollen and nectar, prior to Eucalypts flowering (PIRSA, 2015).

The weed is spread across disturbed areas such as roadsides, train lines and tracks where machinery operate. While native vegetation will pose somewhat of a barrier to its spread, this barrier breaks down on occasions such as drought, or overgrazing by stock or invasive species including rabbits. During these periods the onion weed population thrives, outcompeting native vegetation as well as pasture species (PIRSA, 2015).

There is no selective herbicide treatment that is cost-effective against onion weed. A range of non-selective herbicides have been used to control onion weed on roadside reserves and along tracks, where other weeds are also being actively controlled (PIRSA, 2015). These are all too expensive for broad-acre treatments on land of low value, which precludes their use in the pastoral zone where even a sustained reduction in grazing pressure may be ruled out by economic considerations (PIRSA, 2015).

Profitability of pastureland is reduced when Onion Weed outcompetes pasture grasses. Farmer's organisations claim that carrying capacity across South Australian grazing lands was reduced by up to 75% where onion weed infestations have outcompeted grasses and other plants that are palatable to stock (Grice, 2004). The plant can survive in very hot and dry conditions giving it an advantage throughout drought years, and this is when it has the potential to overtake (PIRSA, 2015).

There is a growing demand for control options that are cost effective and suitable for the vast rangeland areas. This has led to interest in identifying suitable biological control agents and pursuing the possibility of their release in Australia. The ecological approach to the control of onion weed was identified as a superior approach when compared to control with herbicide (Carter 1950, as cited by Pitt, Virtue, and Feuerherdt, 2006)

The purpose of this paper is to collect the available information in regard to biological control options for Onion Weed that would be suitable for arid rangelands in WA, to provide to the Goldfields-Nullarbor Rangelands Biosecurity Group, in Western Australia, so to create an informed approach to future management of this invasive species.

## 1.1 Description

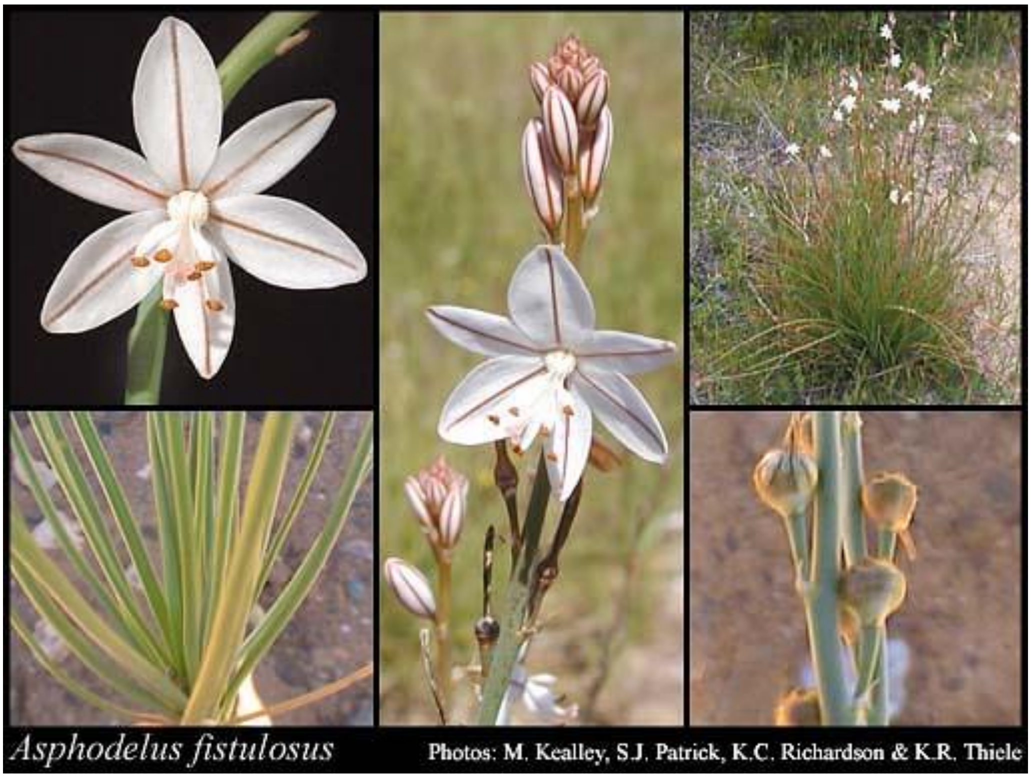


**Plate 1: *Asphdelus fistulosus* (Onion Weed) – FloraBase**

Onion weed is categorised as an annual or perennial forb or herb growing 0.2-0.4 m high. It is known by many common names, also known as Asphodelus, Wild Onion and Hollow-stemmed Asphodel. It's synonym is *A. tenuifolius*. There is also a similar species, *Trachyandra divaricate*, also exotic, and similar in appearance, however it occurs primarily on sand dunes (Florabase, 2019).

Taxonmy

*Asphodelus fistulosus* (Onion weed) belongs to the family Asphodelaceae (or Xanthorrhoeaceae). It was previously grouped in the family Lilliaceae until it was discovered that the genus Asphodelus belongs within the family that is now known as Asphodelaceae in 2003 (Klopper, 2013). While this change occurred in 2003, the change was not widely accepted until 2009. Klopper, Smith, and Van Wyk (2013) proposed to conserve the family name Asphodelaceae rather than to use Xanthorrhoeaceae, which was a more likely candidate for the role but little known outside of its native habitat within Australia. There are several Australian native species in this family, however there are no Australian native species in the genus A*sphodelus* (Morin, 2013). There are other related invasive species including *Asphodelus aestivus*.

Biology

The climate preferences for *A. fistulosus* are in warm temperate, semi-arid to subhumid regions with annual rainfall of 250-500mm (Agriculture Victoria 2020, and QG, 2020). It is found to inhabit areas that receive winter rainfall (Florabase, 2019). The plant is frost and drought hardy once established (Florabase, 2019).

Seasonal growth patterns start with young plants establishing themselves in late summer through autumn, while established plants generally grow most of their leaves in winter, with flowering and seed setting occurring over spring (QG, 2020).

Seeds can survive in the soil for several years (FloraBase, 2019), are most likely to remain dormant for 4-5 months, with a preferred depth of 2 - 3 cm's (Sahai and Bahn 1991). A 1991 study by Sahai *et al.* showed germination temperature preferences for *A. fistulosus* were between 10°C and 35°C in laboratory experiments, with maximin germination at 15°C (50.7%) and most rapid germination at 20°C. The plants flower prolifically and are pollinated by insects.

<u>Habitat</u>

Alkaline sandy or gravelly well drained soils are preferred. The species is frequent in sites with low nutrient levels and may depend on its mycorrhizal associates for nutrients and growth. (FloraBase, 2019)

<u>Distribution method</u>

Known vectors of distribution for the subject species include water and wind, as well as through machinery, native animals and livestock, with agricultural produce also found to be contaminated with the weed at times (Herbguide, 2014). This species thrives in disturbed habitats such as overgrazed pasture areas, roadways, rail corridors, and other areas where machinery operate (FloraBase, 2019 and AV, 2020). In drought years, where overgrazing of rangelands is likely to occur, this weed can invade pastures and become dominate (AV, 2020).

## 1.2 Distribution

This species is already widely spread In Australia, as shown by the Atlas of Living Australia's distribution map (**Figure 1**).

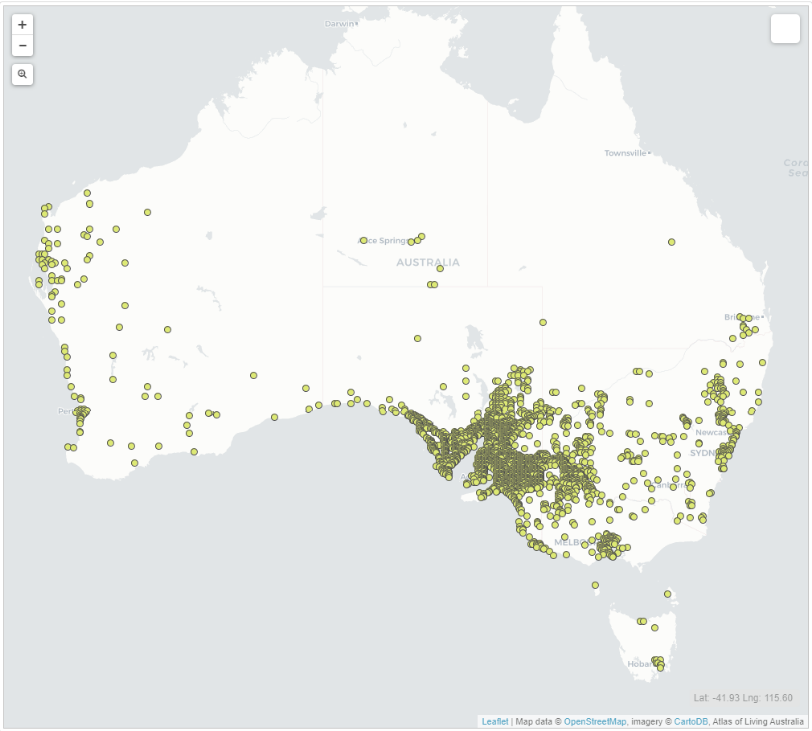


**Figure 1: Atlas of Living Austrlia known distribution of *Asphodelus fistulosus***

Modelling completed by Agriculture Victoria (2020) of *A. fistulosus* at a state scale suggest that there was a much larger range of suitable habitat the weed would likely invade, than its current distribution across Victoria. This modelling was based on land use data and climatic variables.

This suggests that the same is true at a national scale, and therefore onion weed has great potential to continue it's spread to areas where it is either not yet present, or present in low abundance

### 1.2.1 *Asphodelus fistulosus* control across the globe

There has been little interest in control of Onion Weed overseas, however recently South Africa have listed the species as an eradication target.

An assessment into the risk of invasion and potential for eradication in South Africa, was undertaken in a 2019 study by Jubase, *et al*. The first records of *A. fistulosus* were recorded in South Africa in the early 1990s. Two populations were later recorded in 2012, and by 2016 five additional populations were found. With a total of seven populations, it has been proposed the species becomes: 'listed as a *National Environmental Management: Biodiversity Act* 10 of 2004 1a invasive species.' Proposed control methods are through mechanical and chemical removal as the populations are still relatively small.

In America, Paterson (1996) predicted that *A. fistulosus* would remain within its then current range within the south-west of the USA, due to climatic conditions only being suitable within the region already occupied.

# 2. Control Options

## 2.1 Hand Pulling and Chemical Control

Hand-pull small infestations and apply metsulfuron-methyl at 0.1 g /10 L + 100 ml spray oil when flowering.

**Table 1: Management Calendar (FloraBase, 2019)**

| Calendar Type | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Active Growth | | | | | Y | Y | Y | Y | Y | Y | | |
| Germination | O | O | O | O | U | U | U | U | O | O | O | O |
| Flowering | | | | | | | Y | Y | Y | Y | | |
| Fruiting | | | | | | | | | Y | Y | Y | |
| Manual Removal | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Herbicide Treatment | | | | | | | Y | Y | Y | Y | | |

**Legend:** Y = Yes, regularly, O = Occasionally, U = Uncertain, referred by others but not confirmed.

## 2.2 Improving pastures

Improving pastures is identified as an indirect method of control for onion weed (AV, 2020) and is likely to be more suitable across crop lands, rather than rangeland grazing areas and non-cultivated areas (Pitt, 2006).

PIRSA (2015) suggest four actions that will improve pastures and as a result, control onion weed including: rabbit control, application of fertilisers, improved management and pasture seeding (SA gov, 2015). Field trials have shown that as pastures improve, onion weed density decreases as it becomes outcompeted by crops such as lucerne or Wimmera ryegrass. The difficulty with this method is that it requires a high capital outlay, usually beyond the value of the land (PIRSA, 2015).

Onion weed is not found to invade native mallee vegetation across Victoria, due to competition from the root systems of established trees and shrubs (PIRSA, 2015). It is found to dominate in abandoned farm land, but will decline where native vegetation overtakes and is found to disappear after around 5 years (PIRSA, 2015). It was noted that low soil nitrogen is a critical factor that would prevent other plants from growing in areas that are dominated by Onion Weed and overcropping or overgrazing could allow it to dominate by lessening soil fertility, and degrading natural pastures (PIRSA, 2015).

Control on roadsides and in remnant vegetation is best achieved by management aimed at restoring the native species. (PIRSA, 2015).

## 2.3 Biological Control Options

The ecological approach to the control of onion weed was identified as a superior approach when compared to control with herbicide (Carter 1950, as cited by Pitt, 2006). However, there is little known in regard to natural enemies of Onion Weed, and there appears to have been no extensive surveys completed to date (Morin, 2013).

### 2.3.1 Arthropods

(Morin, 2013 ) No arthropods that merited further work identified during surveys.

### 2.3.2 Fungus

A rust species, *Puccinia barbari* appears to be the most promising biological control option identified to date, while root rot has been known to kill some areas of Onion Weed.

#### *2.3.2.1 Fusarium*

Fusarium, a root rotting fungus has been known to occasionally kill areas of onion weed, however the weed re-establishes the following year (Herbiguide, 2014).

#### *2.3.2.2 Puccinia barbari*

*Puccinia barbeyi* has been identified as a potentially useful biological control for onion weed, with high host specificity even among other plants of the genus *Ashpodelus* (Hassan, 1991). This fungus is of Mediterranean origin (Cullen, 2012). One species of the same genus, *P.chondrillina* was introduced in 1971, and had a significant impact in the control of Skeleton weed (*Chondrilla juncea*) (Rosskopf, 1999), and this prompted further research into a suitable rust species for Onion Weed. Many other plant rusts are currently in use across Australia, from the same genus (*Puccinia* spp.) for the control of weed species, and these are: listed in **Table 2** below.

Table 2: Puccinia spp. currently is use throughout Australia as biocontrol agents for invasive weeds

| Rust | Host | Source |
|---|---|---|
| *Puccinia myrsiphylla* | *Asparagus asparagoides* (Bridal creeper) | Biosecurtiy SA, 2011 |
| *Puccinia cardui-pycnocephali* | *Carduus pycnocephalus* (Slender Thistle) and *C. tenuiflorus* (Slender Thistle) | Biosecurtiy SA, 2011 |
| *Puccinia abrupta* | *Parthenium hysterophorus* L. (parthenium) | Rosskopf, 1999 |
| *Puccinia expansa* | *Senecio jacobaea* L. (tansy ragwort) | Rosskopf, 1999 |
| *Puccinia xanthii* | *Xanthium* spp. (cocklebur) | Rosskopf, 1999 |

Preliminary studies of the rust indicate that the rust fungus could be having enough impact to reduce its competitiveness with other plants, however this impact will differ across different areas with varying climatic conditions (Morin, 2013).

When initial studies were conducted in South Australia on potential agents for biological control of *A. fistulosus*, demand was high for a biological control agent (Cullen, 2012), however pastoralists were unable to demonstrate that *A. fistulosus* was having a significant impact on biodiversity or production (Pitt, 2006). However, a lack of impact data will no longer preclude Onion Weed from being nominated as a target weed for biocontrol, as there has been a shift in attitude in the national committee endorsing these nominations (EIC), (Sandy Loyd, 2020). Currently, if there is funding and interest in the release of a biological control agent, it can be pursued (Louise Morin, 2021).

### 2.3.3 Other potential agents

There are no other known potential agents, although comprehensive surveys have not been performed (Morin, 2013)

## 3. Discussion

This paper outlines the difficulties with controlling onion weed across the rangelands, and the need for finding a time and cost-effective alternative to manual removal or chemical control of the weed in disturbed areas. There is one known potential biocontrol agent suitable for the control of onion weed. There is a risk in investing in this process, as the rust will need to pass initial host specificity tests, along with relevant approvals from regulatory bodies.

The following information was obtained from Dr Louise Morin (CSIRO, May 2021):

CSIRO have created a staged approach for releasing bio-control. The main barrier ahead, or point where this process could be put to a stop, is after host specificity test have been conducted. If it is found that *P. barbari* could negatively affect any Australian native plant species, the process would come to a halt. However, if these tests show that there is no impact on 'non-target' species, and the host specificity tests are successful, then the process could move ahead as per the flowchart in **Appendix 1.** This flowchart clearly communicates the process, along with the various roles and responsibilities of each group involved. This includes relevant Australian Government regulatory bodies and the approvals required from them, along with the role of the research body, and community groups.

Sandy Loyd (DAFWA) suggested the process could take 2-3 years and cost about $250-300K in order to:

- Recollect the candidate agent in the field and establish a culture.
- Devise the test list and source/propagate non-target plants for testing
- Perform host-specificity tests
- Nominate the target weed for biocontrol.
- Pending the candidate agent is demonstrated to be safe for introduction, prepare and submit an application to release in Australia.

# 4. Conclusion and Recommendation

## 4.1 Opportunities:

1. Make contact with other groups to exchange advice on management options for onion weed:
    - South Africa have planned to eradicate this weed.
    - The contact is: Nolwethu Jubase; Email: n.jubasetshali@sanbi.org.za, Website: http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0006-82412019000100020
2. Collaborate with other groups within Australia who have investigated control options for Onion Weed, such as Meat and Livestock Australia
3. Contact CSIRO Dr Louise Morin, for further information or to begin the process to release the rust *Puccinina barabri* into Australia for biological control of Onion Weed:

# 5. References and Sources

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## 5.2 Researchers and industry representatives who provided input and advice

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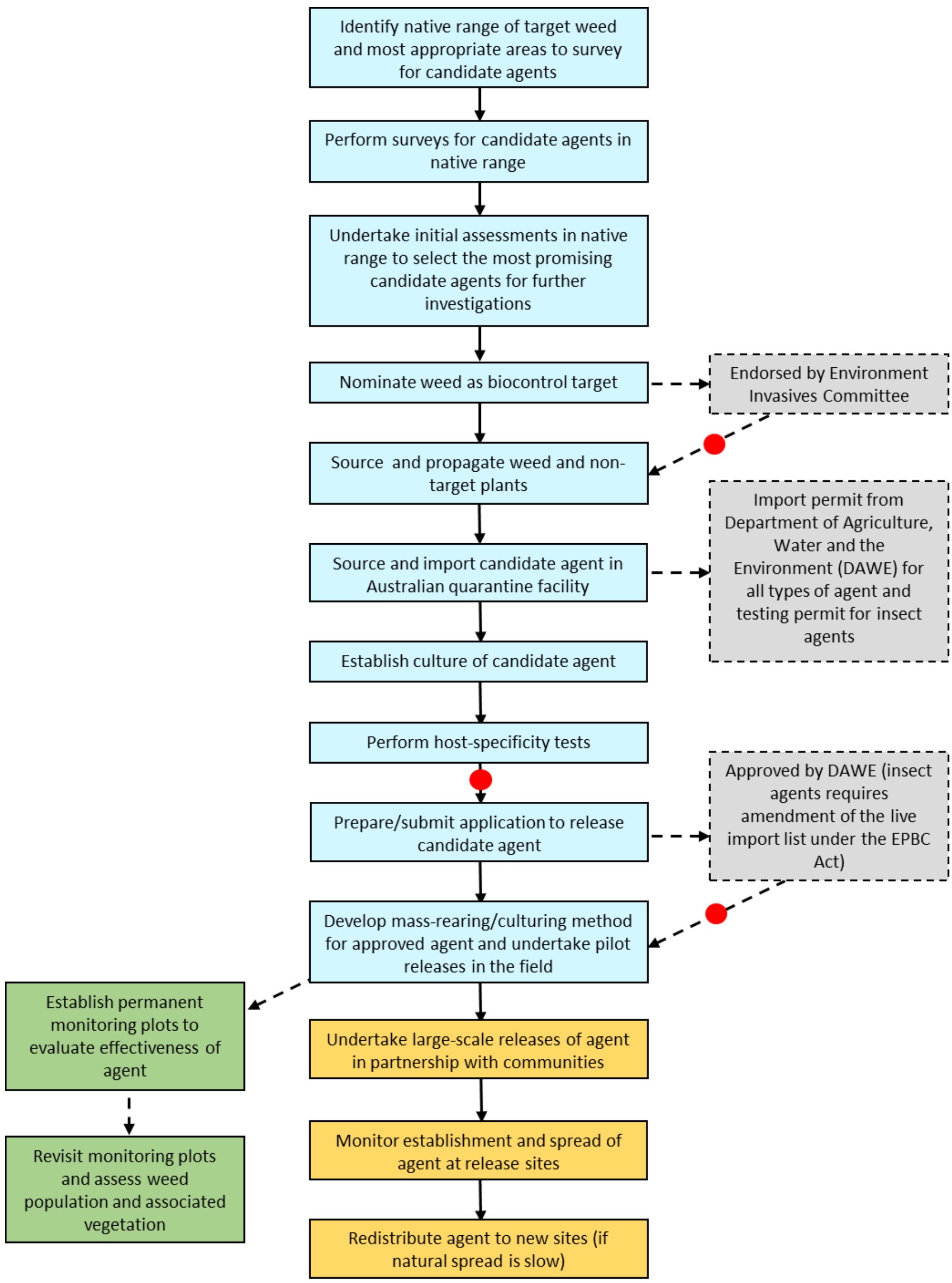
# Appendix 1

**Schematic of all the steps involved in a typical biocontrol program.** Host-specificity tests are sometimes performed in the native range, but it can be a challenge for another country to import Australian native plants to another country. Blue boxes = activities that are the responsibility of the research provider; Yellow boxes = activities that involve engagement from communities members; Green boxes = activities to quantitatively evaluate the impact of the biocontrol agent, typically involving the research provider who was responsible for the release of the agent; Grey boxes = the different approvals required from Australian regulators. The red dots represent possible 'stop points' where further work could be deemed unnecessary based on outcomes of the previous step.



**Two-tier approach to undertake research on a promising candidate biocontrol agent for a weed. Go (green) and stop (red) points are included to make best use of resources provided.**