NSW GOVERNMENT

Blue heliotrope

A best practice manual for managing blue heliotrope (*Heliotropium amplexicaule*) in NSW

2023

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing [June 2023]. However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of Regional NSW or the user's independent adviser.

Published by the Department of Primary Industries

Title: A best practice manual for managing blue heliotrope (*Heliotropium amplexicaule*) in NSW

First published: July 2023

Web version: ISBN 978-1-76058-719-2

The publication should be cited as:

Potter, S., Sheehan, M.R. and Virtue, J.G. (2023). A best practice manual for managing blue heliotrope (*Heliotropium amplexicaule*) in NSW. New South Wales Department of Primary Industries, Orange, NSW.

Support: This project was funded by the New South Wales Department of Primary Industries, New South Wales Local Land Services, the Centre for Invasive Species Solutions and MACH Energy Australia (through the Box Gum Grassy Woodland Weed project).

Design and typesetting: R.G. and F.J. Richardson, Melbourne, Victoria.

Front cover image: Blue heliotrope infestation (Photo: New South Wales Department of Primary Industries).

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Blue heliotrope workshops and land manager surveys

Land managers and agronomists contributed to the development of the manual through their participation in an online survey and a series of workshops held throughout New South Wales. These events resulted in contributions from over 220 dedicated blue heliotrope managers who provided valuable information on current management and control practices, much of which forms the basis of this manual. Many thanks to all who contributed.

Foreword

I first became aware of blue heliotrope as a teenager driving around our neighbour's farm. Within two years it had 'jumped the fence' and was spreading throughout our pasture paddocks and remnant bushland.

As an agronomist and grazier in Coonabarabran, I have been battling blue heliotrope all my professional career. It can grow on most soil types, and its drought hardiness and toxicity has made it a formidable competitor against native and introduced species in both natural and agricultural environments. Blue heliotrope has the potential to grow in many environments and regions, and it persists in temperate and sub-tropical climates. It occupies a significant number of hectares in New South Wales and has the potential to invade so many more.

But, in the time I have been working with blue heliotrope, I have learned that the weed can be managed. I have benefited from the experience, knowledge and research of innovative weed officers, agronomists, landholders and scientists who have all made a significant contribution to the management and control of this weed.

Much of the existing research has been conducted using what we would now call a co-innovation approach, with land managers identifying the problem posed by blue heliotrope and then working with weed professionals, government bodies and researchers to try and solve the problem together. I am pleased to say this approach has been used by the authors of this manual to create a resource that should be the first point of call for anyone dealing with blue heliotrope.

This manual is the culmination of the available knowledge on blue heliotrope, from ecological and research studies and from on-the-ground experience of weed control professionals and land managers. It provides a great deal of information about the weed, for example, about its impact, life cycle and how it spreads. The manual also presents various control options as well as case studies of land managers who, through a planned and integrated approach (and a lot of hard work), have been able to manage the impact of blue heliotrope.

I thank everyone who has contributed their ideas and time to this manual. This knowledge will enable you, the reader, to assess your own property and situation and develop a property weed management plan that includes an integrated approach to blue heliotrope management.

Callen Thompson
Grazier and consultant, Coonabarabran

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Using this manual

Who should use this manual?

This manual has been written to assist anyone with an interest in managing blue heliotrope (*Heliotropium amplexicaule*). The manual's content is intended to help people make decisions about blue heliotrope management by providing a guide based on current knowledge and understanding of best practice.

The manual focuses primarily on property scale management of blue heliotrope, but the information is also relevant for district scale control programs.

Where does the information come from?

The manual draws from published material, scientific studies, reviews by technical experts and the experiences of individuals and organisations currently managing blue heliotrope.

The manual incorporates findings from a 2021 online survey, through which land managers and agronomists shared their experience and knowledge of blue heliotrope, including its impacts and effective control methods. Additionally, between March and April 2022, workshops and field trips were held with land managers, professional weed managers, community volunteers and researchers. Held in Bathurst, Coonabarabran, Dubbo, Muswellbrook and Tamworth, the workshops sought local knowledge on blue heliotrope biology, impacts and management approaches.

The manual provides source information for developing future extension materials, such as factsheets, newsletter articles and website information.

How to use this manual

This manual has been designed to allow easy access to all available information on managing blue heliotrope. Arranged in five stand-alone yet complementary chapters, the manual presents a guide to the biology and impacts of blue heliotrope (Chapter 1), how to develop a property weed management plan (Chapter 2), how it can be prevented and controlled (Chapter 3), and case study examples of how blue heliotrope is being managed (Chapter 4). Chapter 5 provides sources of further information.

The manual has a substantial focus on preventing and managing blue heliotrope through establishing and maintaining dense pastures. Best practice weed control is not just killing weeds, but also how to limit their establishment in the first place.

It is important that the information provided in this manual is adapted by individuals according to their own environmental, financial and social circumstances. Always seek local advice in planning weed control on your property.

Summary of the five chapters

1. **Understanding blue heliotrope and its impacts**
   - Identification
   - Where it grows
   - Life cycle
   - Impacts

2. **Planning**
   - Property weed management planning
   - Local and regional control programs

3. **Controlling blue heliotrope**
   - Integrated weed management (IWM)
   - Choosing a control method
   - Preventing weed entry and spread
   - Pasture management
   - Using herbicides
   - Biological control
   - Other control measures

4. **Case studies**
   - What are other land managers doing?
   - Applying IWM
   - Overcoming challenges
   - Practical tips and learnings

5. **Further information**
   - Property planning resources
   - Pasture management resources
   - Legal obligations to control
   - Weed control contacts
   - References

Abbreviations

AHA	Animal Health Australia
ALA	Atlas of Living Australia
APVMA	Australian Pesticides and Veterinary Medicines Authority
GPS	global positioning system
Ha	Hectares
IWM	integrated weed management
LLS	Local Land Services (NSW)
MLA	Meat and Livestock Australia
NRM	Natural Resources Management
NSW	New South Wales
NSW DPI	NSW Department of Primary Industries
PAs	pyrrolizidine alkaloids
PHA	Plant Health Australia
PPE	personal protective equipment
pHCa	pH measured in calcium chloride
Qld	Queensland
SA	South Australia
Vic	Victoria
WA	Western Australia

Glossary

Calyx	The sepals of a flower, typically forming a whorl that encloses the petals and forms a protective layer around a flower in bud
Defoliation	Loss of leaves from a plant
Delimitation	The act of determining the full extent of a weed invasion
Fallow	Area of agricultural land that is not sown for a period of time
Herbaceous	Plants that do not have woody stems
Naturalised	A introduced (non-native) plant that is capable of reproducing, spreading and establishing in an area
Perennial	A plant that lives for several years, re-growing from root reserves
Prostrate	A plant with branches spreading along the ground or lying flat on the ground
Temperate Pasture	Cool season plants that use the C3 pathway in photosynthesis
Tropical Pasture	Warm season plants that use the C4 pathway in photosynthesis
Vegetative	Plant parts such as stems, leaves, roots

Chapter 1

Understanding blue heliotrope and its impacts

At a glance

- Blue heliotrope, a perennial ground cover, is widely distributed as a weed throughout New South Wales (NSW).
- Plants grow and flower throughout the warmer seasons of the year, spreading by both seeds and root fragments.
- Blue heliotrope is considered a major agricultural weed in NSW. Dense infestations compete strongly with pastures, field crops and native plants.
- Blue heliotrope is highly toxic to cattle and horses, causing irreversible liver damage. However, it is unpalatable, so poisoning is uncommon.
- Sheep and goats are more tolerant of blue heliotrope toxins, but are not immune to the toxins.

What is blue heliotrope?

Key points

- Blue heliotrope is native to South America.
- It is a low-growing, perennial plant with a deep and spreading root system.
- Distinguishing features include hairy, aromatic stems and leaves, and small purplish flowers at the coiled tips of flowering stems held above the plant.
- Historically a garden ornamental, it has been naturalised in Australia for over 125 years.
- It is now widespread in NSW and Queensland (Qld) with localised occurrences elsewhere in Australia.

Name and taxonomy

The scientific name of blue heliotrope is *Heliotropium amplexicaule* Vahl. It is a member of the Boraginaceae family, which includes a range of ornamental plants such as forget-me-nots (*Myosotis* spp.), comfrey (*Symphytum officinale*) and borage (*Borago officinalis*). This family of plants also includes several other species that are weeds in Australia: Paterson's curse (*Echium plantagineum*), common heliotrope (*Heliotropium europaeum*) and yellow burrweed (*Amsinckia* spp.). Other common names for blue heliotrope include clasping heliotrope, summer heliotrope and creeping heliotrope.

Origin

Blue heliotrope is native to central-eastern South America: Argentina, Bolivia, Uruguay and Brazil (Plants of the World Online [POWO], 2023). It is now found naturalised across various parts of the United States of America, South Africa, the western Mediterranean and Australia (Global Biodiversity Information Facility Secretariat, 2023; POWO, 2023).

Identification

Blue heliotrope is a low-growing, hairy, perennial herb, 30–200 cm in diameter. It is highly aromatic when crushed. Young plants start off as rosettes and develop many prostrate, branched stems, 15–30 cm high. Over time, plants grow a deep, woody taproot and an extensive system of lateral roots.

Blue heliotrope has dull green leaves with sunken veins and wavy margins, that clasp the stem. Small, purplish flowers grow in dense clusters at the tips of erect, coiled stalks. Small, rounded fruits dry to split into two nutlets, each containing 1–2 seeds.

Identifying features of blue heliotrope

Key information sources for this section: Dellow et al., 2008; Environmental Weeds of Australia [EWA], 2016; Wilson et al., 1995.

Seedlings

- two opposite, fleshy, egg-shaped seedling leaves (cotyledons), 6 mm long × 3 mm wide
- first true leaves dark green, oval or egg-shaped, with sparse hairs, short stalks and indented veins
- new seedlings growing from lateral roots are similar in appearance, but with a traceable root to the parent plant
- seedlings initially form rosettes, similar in appearance to Paterson's curse.

NSW DPI

Seedling with cotyledons and first true leaves.

Matt Sheehan

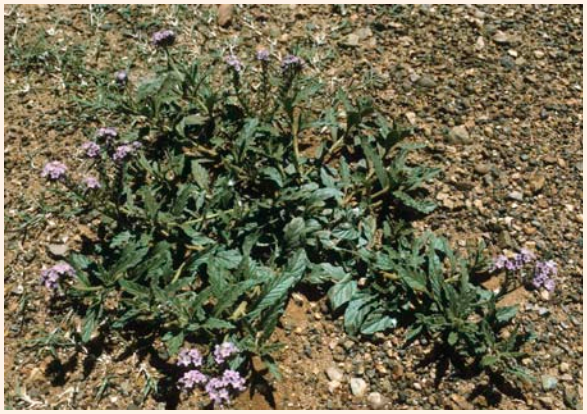
Plants can stay in rosette form for long periods, especially under harsh conditions such as drought.

Matt Sheehan

Seedling and developing root system.

Stems

- cylindrical, woody, hairy, branching
- prostrate stems radiate outwards from the central woody rootstock
- crushed stems may smell like passionfruit.



NSW DPI

Stems growing out from the taproot.

Matt Sheehan

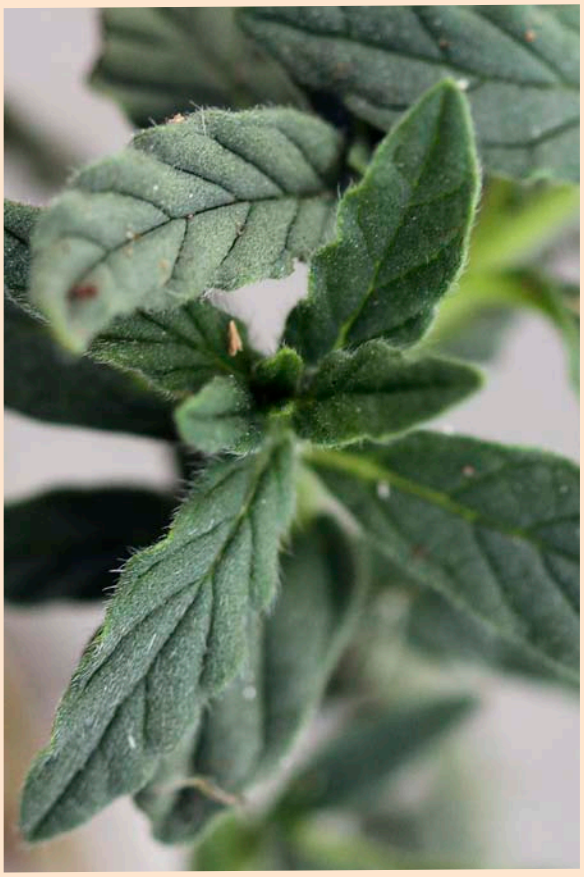
Stems are covered in fine hairs.

Leaves

- soft, hairy, dull to dark green, prominent indented veins, wavy leaf edges
- 'stretched oval' shape (elliptic to lanceolate) with pointed or rounded ends, 20–90 mm in length and 4–25 mm in width; leaves at stem tips smaller, thinner, almost linear
- arranged alternately along and clasping the stem.

Matt Sheehan

Leaves have a wavy edge and clasp the stem.



Matt Sheehan

Leaves are hairy.

Flowers

- one to several flowering stems form at the end of branches
- 3 mm wide flowers arranged in dense, terminal clusters, in 2 rows along one side of the flowering stem
- flowering stems rolled back from the tip, straightening as fruits form
- five fused purple, lilac, blue or pinkish petals surround a central, yellow tube
- base of each flower is a green, hairy calyx (green, outer base of flower).

NSW DPI

Flowering stem uncurls as fruit forms.

Matt Sheehan

Flowers enclosed by green, hairy calyx.

NSW DPI

Purple flowers have a yellow centre.

Fruits and seeds

- fruit held within calyx
- green rounded fruit matures to become dark brown to black, wrinkled and warty
- fruit separates into two small segments (nutlets) when ripe
- nutlets 2–3 mm long, each containing 1–2 seeds.

Matt Sheehan

Fruits contain a pair of nutlets.

Matt Sheehan

Nutlet separated from calyx.

Roots

- strong, slim, woody taproot grows 1–3 m deep
- complex system of horizontal lateral roots arising from the taproot.

Matt Sheehan

Blue heliotrope has a woody taproot.

Similar species

Blue heliotrope is similar in appearance to some other weeds, ornamentals and native plants.

All *Heliotropium* and *Amsinckia* species have characteristic terminal-flowering stems that are coiled at the tip. Various weed species in the Verbenaceae family have somewhat similar purple flowers, but the terminal flowerheads are not coiled.

Australia has over 90 native *Heliotropium* species, most of which have white flowers, though some can also be yellow (Atlas of Living Australia [ALA], 2023a; Craven, 1996). Only introduced *Heliotropium* spp. naturalised in Australia have flowers that are pink, purple or blue.

Chapter 5 provides more information on species that may be confused with blue heliotrope.

Where does blue heliotrope grow?

Key points

- **Likely introduced to Australia in the 1800s as an ornamental plant.**
- **First recorded as naturalised in Australia in 1893. First recorded in NSW at Singleton in 1908.**
- **Now widely distributed in NSW and Qld. Also present in Victoria (Vic), South Australia (SA), Northern Territory (NT) and Western Australia (WA).**
- **Grows in a wide range of habitats and in many soil types.**
- **Grows in temperate and subtropical climates, with potential for further southerly and high-altitude spread in Australia under climate change.**

History of spread

Blue heliotrope is likely to have been introduced to Australia as an ornamental garden plant (Craven, 1996). First records of naturalisation include Adelaide in 1893, Brisbane in 1902, Singleton (Hunter Valley, NSW) in 1908 and Sydney in 1913 (ALA, 2023b). Throughout the first half of the 20th century blue heliotrope was progressively found in areas of western

NSW (e.g. Coonamble 1927, Bathurst 1936), northern NSW (e.g. Tenterfield 1939) and south-west Qld (e.g. Roma 1935). In the latter half of the 20th century, its recorded range extended to include southern and north-west NSW (ALA 2023b).

Current distribution in Australia

Blue heliotrope has been recorded in all states and territories except Tasmania (Figure 1.1).

While infestations in southern NSW are locally restricted, widespread infestations occur over thousands of hectares in northern and central NSW. Significant infestations also occur in southern and central Qld, and blue heliotrope grows as far north as Cairns.

Scattered infestations of blue heliotrope are found in parts of SA around Port Augusta, Adelaide and along the River Murray. In Vic, a small number of scattered infestations are recorded around Melbourne and in the north-east of the state. Isolated occurrences in the NT and WA have also been recorded — around Alice Springs and Perth, respectively.

Distribution in New South Wales

Blue heliotrope's distribution varies among regions of NSW (Figure 1.2). It is generally absent from western NSW, except for scattered infestations around Cobar and the Broken Hill area. Likewise, in southern NSW, limited infestations are scattered through the Wagga Wagga, Griffith, Murrumbidgee and Hay Shire council areas (ALA, 2023b). Further north, infestations become more common, with widespread distribution in the Central Tablelands, Central West, North West and Hunter Local Land Services regions. Infestations also occur along the coast around Sydney and Newcastle.

There are no current estimates of the area occupied by blue heliotrope in NSW. Estimates from the 1980s indicated that approximately 110,000 ha were impacted at the time (Mitchell, 1988). However, with many further records made across the state since then, the area of occupation is likely to have increased considerably.

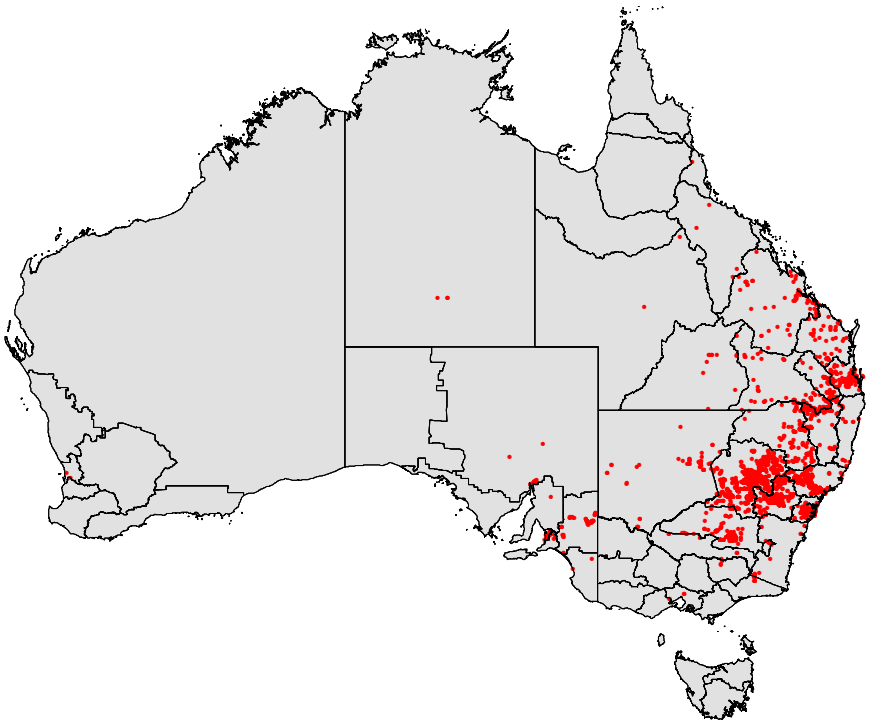


Figure 1.1 Current distribution of blue heliotrope in Australia, by Dr Farzin Shabani from Macquarie University. Data from ALA (2022) and NSW DPI.

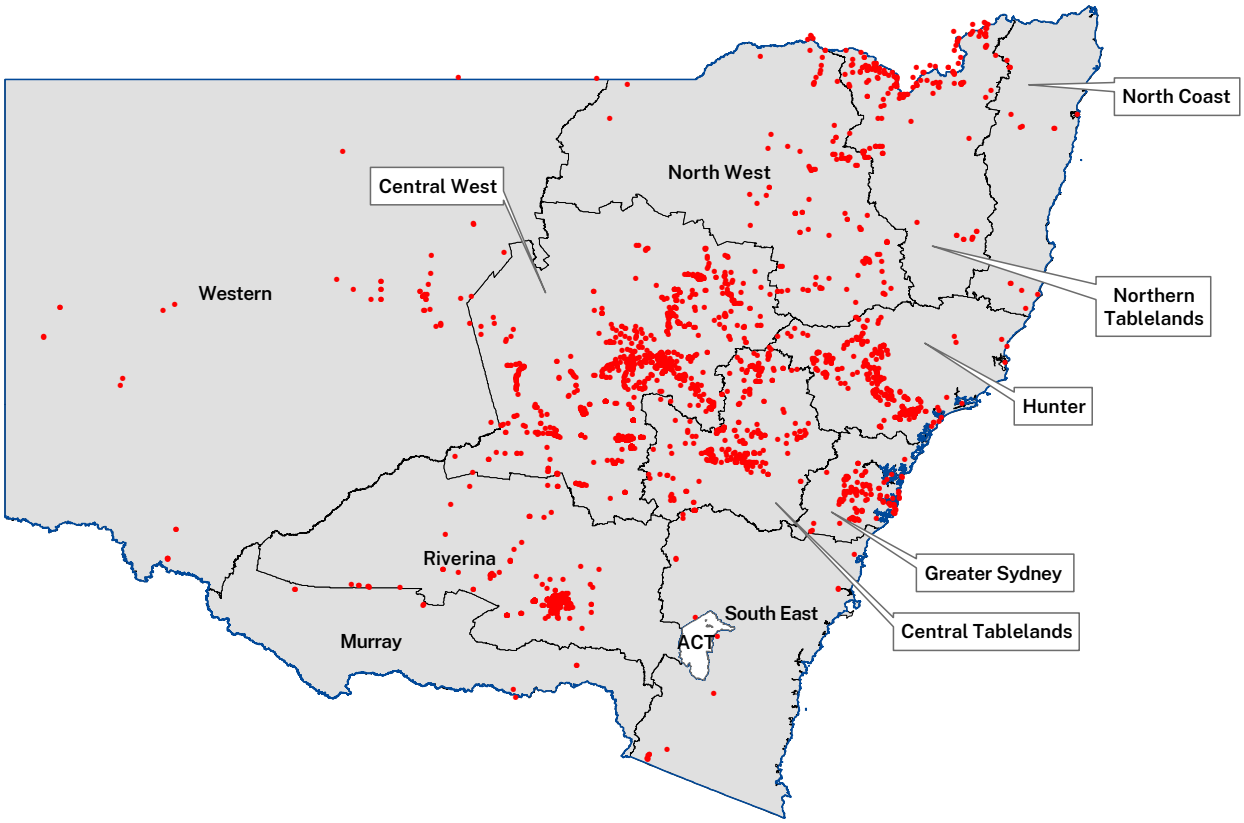


Figure 1.2 Current distribution of blue heliotrope in NSW. Map by Dr Farzin Shabani from Macquarie University with data from ALA (2022) and NSW DPI.

Preferred habitats

Blue heliotrope has adapted to a wide range of habitats and soil types (EWA, 2016; Milne, 1996), including:

- native/introduced pastures
- non-arable areas and rocky outcrops
- cultivated fallows
- roadsides and other disturbed areas
- waterways and drainage/flood-out areas
- native vegetation (open woodland and grasslands)
- lawns, and parks and gardens.

Shauna Potter

Blue heliotrope growing in a patch of bare ground west of Coonabarabran, NSW.

Shauna Potter

Blue heliotrope growing under a fence line near Tamworth, NSW.

Matt Sheehan

Blue heliotrope growing among roadside vegetation near the Warrumbungle National Park.

Jodie Lawler

Blue heliotrope can be found growing in parks and gardens.

Blue heliotrope is a coloniser of disturbed areas (Zapater et al., 2004) and thus favours overgrazed pastures and land that has been cultivated, cleared, graded, slashed or burnt. It can tolerate shading but not waterlogging. Blue heliotrope grows on a wide range of soils varying in texture, fertility and pH. These include sandy loams, heavy brown clay loams, black cracking clays, calcareous red earths and volcanic red soils (Cunningham et al., 1992; da Silva, 1991; Parsons and Cuthbertson, 2001). It is well adapted to infertile soils and can grow in highly acidic soils (da Silva, 1991).

Bill Davidson

A lack of competitive pasture species result in dense blue heliotrope infestations.

Blue heliotrope grows in both temperate and subtropical climates. Although historically reported to grow in areas with more than 500 mm annual rainfall (da Silva, 1991), plants will grow in lower-rainfall areas and through successive years of drought. Seedlings are frost sensitive, but can survive if protected by other plants, including pasture (da Silva, 1991).

Potential distribution in Australia

The potential distribution of blue heliotrope has been modelled based on its current distribution in Australia. Under current climate conditions, there is potential for further southerly spread of blue heliotrope into northern Victoria (Figure 1.3a). The central-southern coast of WA is also at risk.

Under a climate change scenario for 2050 (Riahi et al., 2017), higher-altitude tableland areas in NSW will become more suitable for blue heliotrope (Figure 1.3b). In addition, much of Vic, southern SA, south and south-west WA, and the coastal hinterland of northern Qld are susceptible to invasion. Potential distribution modelling by Steel et al. (2008) also revealed increased vulnerability for western Victoria and eastern SA under climate change.

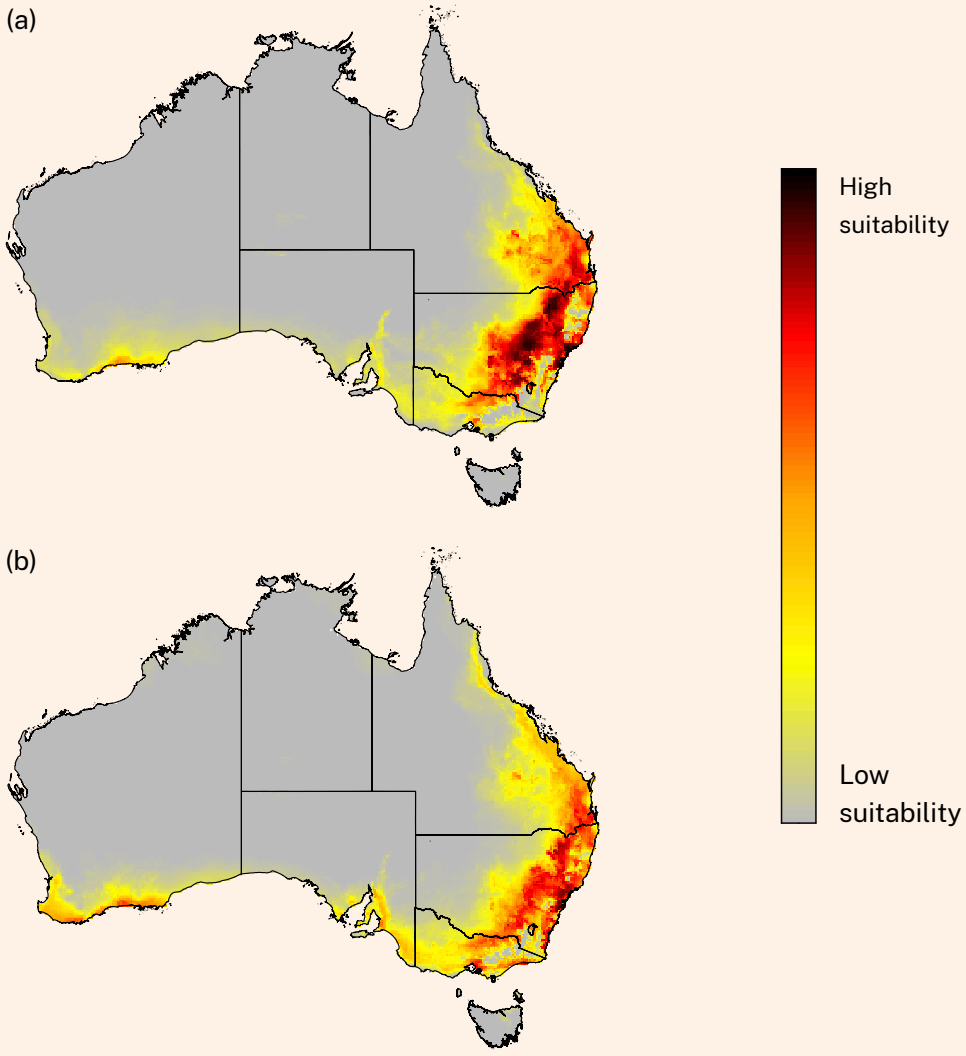


Figure 1.3 Areas of suitability for blue heliotrope under (a) current climate conditions and (b) predicted conditions in 2050 under the SSP2-4.5 climate scenario, by Dr Farzin Shabani from Macquarie University. SSP2-4.5 is an intermediate greenhouse gas emissions scenario where global carbon dioxide emissions continue around current levels until 2050 and then decrease but do not reach net zero by 2100 (Riahi et al., 2017).

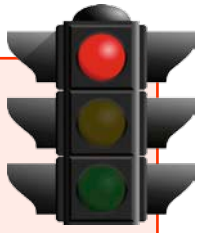
Blue heliotrope life cycle

Key points

- **Seed germination, shoot growth and flowering are all favoured by warm and wet conditions.**
- **In cool temperate climates, blue heliotrope dies back in winter, regrowing from the perennial root system in spring. In warm temperate and subtropical climates, it can stay green year-round.**
- **Continuous flushes of flowering enable high seed production.**
- **Seeds are long lived in the soil.**
- **Reproduction occurs via seed and root fragments, which are spread by water, people, vehicles and machinery, and animals.**

Blue heliotrope is a long-lived herbaceous groundcover. Seasonal shoot growth and flowering occurs in flushes throughout the warmer months from a deep, extensive, perennial root system.

Seed germination



Knowledge on blue heliotrope seed viability, longevity and seedbank dynamics is limited – further research is needed.

Blue heliotrope initially establishes in a new area from seed. Mature plants then spread locally from further seeds produced and from vegetative growth emerging from lateral roots. The latter are similar in appearance to, but are not, true seedlings.

Factors influencing blue heliotrope germination and seedling survival have not been extensively studied. One trial concluded that seed germination can occur throughout the year, given sufficient soil moisture and optimal temperature (da Silva, 1991). Temperature is a key constraint, with more germination in the warmer months and limited seedling recruitment in winter (da Silva, 1991). In laboratory trials, germination was greatest at 25°C, but still substantial at both 20°C and 30°C. The importance of sufficient levels of moisture availability for seed germination (i.e. following a significant rainfall event) has been shown for *H. europaeum* (Hunt et al., 2009) and *H. indicum* (Chauhan and Johnson, 2008).

The effects of drought

Blue heliotrope's ability to produce large amounts of long-lived seed creates persistent seedbanks. When droughts break, mass germination can occur, resulting in large infestations that are difficult to manage.

The jury's out on germination

Information is lacking on germination triggers in blue heliotrope. One report suggested most blue heliotrope seedlings were recruited from buried seeds but did not provide data to support this (da Silva, 1991).

Laboratory studies involving other *Heliotropium* spp. have found maximum seed germination or emergence at the surface or from shallow depths. For example, *H. europaeum* germination was noted at depths of 0–2 cm (Benvenuti, 2022; Humphries et al., 2018), while *H. indicum* seeds germinated at 0–0.2 cm (Chauhan and Johnson, 2008) and those of *H. curassavicum* could emerge from a depth of 1 cm (Hegazy et al., 1994). Overall, seed germination or emergence rapidly declined at greater depths. This inhibition of germination has been linked to the small seeds of *Heliotropium* spp., providing limited energy resources to grow to the soil surface from depth.

In the above studies, germination of *H. curassavicum* and *H. europaeum* did not require light. However, light exposure significantly increased germination for *H. indicum*. Blue heliotrope germination can be stimulated by soil cultivation (Briese et al., 2005). The implication of this and other *Heliotropium* study findings is that germination may be enhanced by cultivation, which brings buried blue heliotrope seeds to the surface.

Seedling establishment

Levels of blue heliotrope germination are high after rainfall in summer, but seedling establishment and survival is low if hot and dry conditions follow. Seedlings recruited in mild conditions in late summer-early autumn, or in wet summers, have greater success (da Silva, 1991).

Shauna Potter

Blue heliotrope seedlings germinate in a recently sown pasture in early autumn.

Early spring or late autumn seedlings may be killed by successive frosts but can survive where protected by other plants (da Silva, 1991) and where the perennial root system has established.

Young seedlings develop a deep taproot, aiding their persistence and enabling vigorous regrowth the following spring (da Silva, 1991).

Fire and blue heliotrope

Land managers in NSW have observed blue heliotrope establishing following fires. It is unclear if the seeds are directly stimulated to germinate by fire (e.g. from chemicals in ash or smoke) or if they are responding to the removal of competing plants. Another possibility is that a flush of pseudo 'seedlings' are triggered from buds on the lateral root.

More research may provide an understanding of the role of fire in blue heliotrope establishment.

Vegetative growth

Annual vegetative growth of blue heliotrope begins in late winter to early spring and continues through the warmer months into the following autumn. New shoots can grow quickly in response to warm, wet weather, aided by reserves stored in the root system. Several long, horizontal (prostrate) stems are produced from the central, woody root crown. Shoots also emerge from buds along lateral roots. During the warm season, roots grow and store reserves for overwintering and reshooting the following spring (Zapater et al., 2004).

Flushes of new vegetative growth (and flowering) can occur throughout the growing season in response to rainfall events. Above-ground growth can also die back because of drought.

In milder climates, growth stops in late autumn as the plant enters winter dormancy. Above-ground growth dies back because of cold temperatures and frosts (Zapater et al., 2004). In warmer climates, plants can remain 'evergreen' even if growth slows down.

Recorded density of adult blue heliotrope plants in established infestations ranges from 14 to 27 plants/m^2 (Briese and Zapater, 2001; Schulze and Unwin, 2006). The typical age of an individual blue heliotrope plant in Australia is not known.

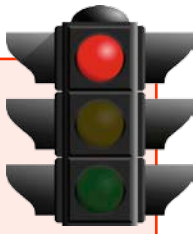
Flowering

Flowering generally occurs from spring until autumn. Flowering starts two months after shoot emergence, with seeds produced one month later (da Silva, 1991). Timing varies with location and seasonal conditions. In cool temperate areas, flowering can cease in late autumn, at the commencement of frosts, resuming in mid- to late-spring. In warmer, frost-free coastal and subtropical regions, flowering can occur year-round. The number of flowering flushes per season can be reduced by drought and can increase during wet summers (da Silva, 1991).

Seed production

Plants can produce large amounts of seed. Field trials in central NSW estimated 18,600 seeds/m^2 in soils of blue heliotrope-infested sites. Seed production is highest in early spring and drops off over summer (Briese and Zapater, 2001). Fresh seeds have a period of dormancy that can last between one month and one year (da Silva, 1991), during which seeds will not germinate.

Buried seeds can also remain viable for more than a decade (Briese and Zapater, 2001). When blue heliotrope is not controlled, this results in vast soil seedbanks: approximately 50,000 seeds/m^2 after eight years (Briese and Zapater, 2001). It may take many years for the seedbank to decline, even when plants are controlled to prevent flowering and further seed production. A field trial in NSW found that it took approximately 10 years for the seedbank to decline from around 50,000 to 1,500 seeds/m^2 (Briese and Zapater, 2001).



Blue heliotrope plants like warm and wet conditions, responding quickly to rainfall events. The seed can germinate, and the plants can actively grow and flower throughout the year if moisture and temperatures are suitable.

Figure 1.4 summarises typical timings of the life cycle stages for blue heliotrope in cool temperate and warm temperate/subtropical climates. This is based on published information (da Silva, 1991), updated with information from regional blue heliotrope workshops conducted in 2022. Note that this will vary with local climate, seasonal weather, finer scale site conditions and management.

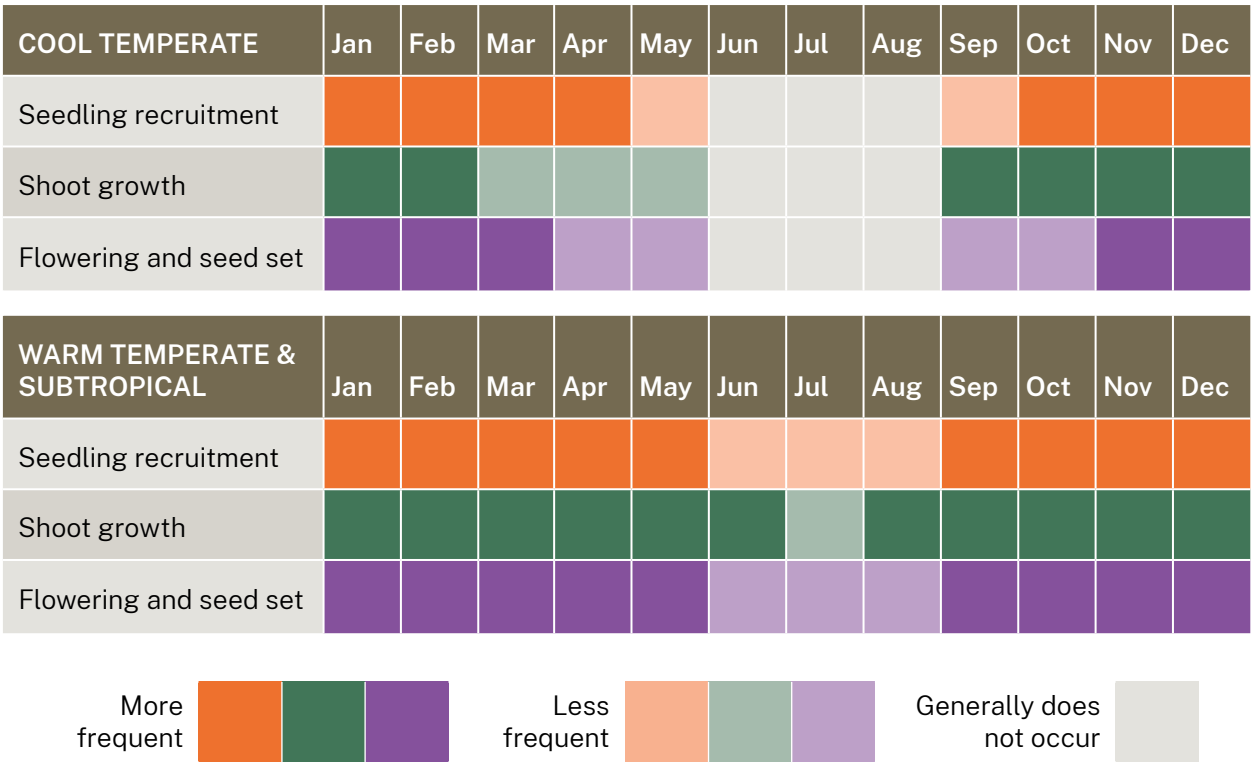


Figure 1.4 Seasonal growth pattern of blue heliotrope in cool temperate (e.g. Central Tablelands, Central West regions) and warm temperate/subtropical climates (e.g. North West, Hunter regions).

How does it spread?

The small, rounded, seed-containing nutlets produced by blue heliotrope can be spread by:

- livestock, native and feral animals — stuck in wool and fur, lodged in hooves and remaining viable after passing through the digestive tract
- vehicles and machinery — attached in mud, caught in crevices, distributed during slashing
- people — on clothing and boots
- produce — contaminating hay, grains, firewood
- water — washed along the soil surface and into waterways.

(Parsons and Cuthbertson, 2001).

Baling of hay and other fodder presents a high-risk spread pathway for blue heliotrope.

Blue heliotrope also reproduces vegetatively, with shoots growing from buds on the lateral roots. This enables plants to spread out locally from the central taproot. Vegetative dispersal can also occur over greater distances when roots are broken up, transported and inadvertently buried elsewhere. Root fragments may be spread by:

- soil cultivation — by cutting and dragging/carrying fragments across a paddock and beyond
- earth moving — such as grading during road maintenance
- flood events — eroded soil exposing and carrying roots.

What are the impacts of blue heliotrope?

Key points

- **Blue heliotrope contains plant toxins called pyrrolizidine alkaloids (PAs).**
- **Blue heliotrope is highly toxic to cattle and horses; however, it is also highly unpalatable to them, reducing risk of poisoning to situations where they cannot avoid eating it.**
- **Sheep and goats are much more tolerant of these toxins but can suffer poisoning if too much blue heliotrope is ingested.**
- **Blue heliotrope has various advantages that enable it to form dense infestations. It can compete with pastures and field crops.**
- **Blue heliotrope also invades native woodlands and grasslands.**
- **Its persistence makes it an emotionally challenging weed to control.**
- **Economic impacts include cost of control and reduced farm productivity and profitability.**

Agricultural impacts

Toxicity to livestock

All above-ground parts of blue heliotrope, including flowers and seeds, contain toxic chemicals called pyrrolizidine alkaloids (PAs) that affect grazing livestock (Everist, 1974). These can cause acute disease which manifests as sudden death or can accumulate over time giving a chronic presentation of illthrift, due to irreversible liver damage (McKenzie, 2012).

Box 1.1 lists the possible symptoms that may be seen in animals affected by PA poisoning. Symptoms are often seen after stock have been removed from areas containing blue heliotrope. Chronically affected sheep accumulate copper in the liver and if stress is applied, such as movement or cold weather, they can die suddenly due to the sudden release of liver copper.

There are at least nine types of PAs in blue heliotrope, the most common being indicine. They have been measured to total around 2% of the dry weight of shoots (Carpinelli de Jesus et al., 2019). This is similar to the total PA levels of 1–3% present in common heliotrope (O'Dowd and Edgar, 2006; Shimshoni et al., 2015).

Mick Willott

Cow in poor condition grazing on blue heliotrope.

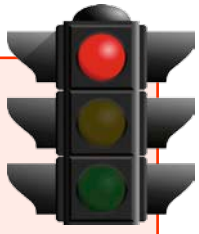
Different livestock species have differing susceptibility to PA poisoning. Generally, pigs and chickens are most susceptible. Horses and cattle are more susceptible than sheep and goats. Donkeys and alpacas are also highly susceptible (McKenzie, 2012; Vaughan, 2018). Cases of cattle death have been documented in Qld (Ketterer et al., 1987). In these cases, poisoning appeared to be a cumulative effect in adult animals and more immediate in young cattle after a short period of exposure. Compared with cattle, sheep and goats are much more tolerant to PAs. This is thought to be because PAs are deactivated by microorganisms in their rumens, and by liver enzymes (Giaretta et al., 2014).

NSW DPI has not recorded any definitive clinical cases of blue heliotrope poisoning in sheep or goats (H. Schaefer, personal communication, 23 March 2023). While few cases of blue heliotrope poisoning in sheep or goats are formally documented (e.g. da Silva, 1991; Everist, 1974), PA poisoning in sheep is a well-known risk associated with the more widespread common heliotrope (Al-Snafi, 2018; Peterson et al., 1992; Salmon, 2012).

Box 1.1 Symptoms of PA poisoning in livestock (Ketterer et al., 1987; McKenzie, 2012)

Note that this is general information and only a vet can give a formal diagnosis:

- reduced growth rates and milk yields
- loss of condition/weight loss ('ill thrift')
- loss of appetite
- weakness
- abdominal straining and chronic scouring (diarrhoea)
- skin sensitisation to sunlight (reddening and peeling)
- blindness
- jaundice (including from chronic copper poisoning in sheep)
- muscle tremors
- confusion, aimless wandering, unusual aggression
- poor coordination, staggering
- acute lung damage
- sudden death.



Risk factors for livestock poisoning:

- overgrazing of palatable pasture species leaves animals forced to eat blue heliotrope as a food source
- heavy infestations make it difficult to avoid
- drought years where feed production is low and becomes more limiting over time as it gets eaten out
- blue heliotrope cut in hay or silage
- stock are young, hungry or new and not previously exposed to blue heliotrope
- grazing of mown paddocks containing blue heliotrope before pasture regrows
- grazing of blue heliotrope-infested paddocks recently treated with 2,4-D herbicide for broadleaf weed control
- grazing of blue heliotrope along with other plants containing PAs, such as Paterson's curse
- diet high in copper (for sheep).

Bill Davidson

Cattle are highly susceptible to PA poisoning through grazing.

In 2021, 138 land managers from across NSW provided feedback on their experiences with blue heliotrope via an online survey. Land managers commented on blue heliotrope's ability to reduce production; the time and expense associated with its control; loss of pasture availability; and interference with planned crops or pastures because of control requirements.

The following responses were received in relation to the listed blue heliotrope impacts:

Impact	Response*
Competes with pasture (native/improved)	82%
Stock health reduced	14%
Stock performance reduced (e.g. reduced growth rates, reduced weight gain, reduced wool cuts)	12%
Stock deaths	6%
None	13%

When asked about specific economic impacts, land managers reported experiencing the following:

Impact	Response*
Decreased stocking rates	43%
Decreased reproduction rates (weaning rates)	11%
Livestock mortality	4%
Decreases in weaning/turnoff weight	9%
Reduced wool yield	1%
Land devaluation because of heavy weed infestation	35%
None	39%

A number of human welfare issues were also raised, such as worry, distress, restricted farm improvements, allergies and the inability to 'switch off' from thinking about blue heliotrope management when spending time on the property. The following key feedback was received in relation to social impacts:

Impact	Response*
Financial distress (from cost of control/reduced productivity)	48%
Psychological distress (from worry)	39%
Missed opportunities (e.g. family/social activities) because of time needed to manage blue heliotrope	31%
Disputes with neighbours over action/lack of action	18%
None	27%

* Land managers could select multiple impacts during the survey.

Pasture competition

There are no published studies on the competitiveness of blue heliotrope and its effect on pasture yields and carrying capacity. Blue heliotrope has various growth advantages in pastures (da Silva, 1991):

- It can grow rapidly to take advantage of warm, wet conditions, such as after summer rainfall events. Similarly, it can recover quickly after drought.
- It draws on its deep root system to supply moisture and stored nutrients for shoot growth, including for new shoots emerging from lateral root buds.
- Its regeneration in early spring enables shoot growth prior to germinating summer pastures.
- Paddocks that are dominated by cool season, annual pastures offer limited competition over summer.
- Its low palatability means competing pasture plants are preferentially grazed, aiding its access to sunlight, soil moisture and nutrients.
- Blue heliotrope's prostrate, lateral shoot growth enables it to cover a large ground area for accessing sunlight.
- Mass seed germination over a prolonged period aids its chances of successful establishment and increasing plant density.

There are counterarguments to blue heliotrope being a competitive weed. Among these is that it becomes most prolific in degraded and bare paddocks when there is little other competition. Tall, warm season, perennial grass pastures provide good competition (see Chapter 3). In its native range in Argentina, blue heliotrope is a coloniser of recently disturbed areas and does not persist, or stays at low densities, because it is outcompeted by later successional vegetation. This may be aided by its natural enemies (Zapater et al., 2004).

NSW DPI

Blue heliotrope invading a pasture.

In the 2021 survey, 62% of respondents said maintaining good pasture competition was a critical management approach for blue heliotrope. The use of pasture improvement strategies was reported by 27% of people to be a highly or very highly effective strategy.

Blue heliotrope does not commonly invade dense and well-managed pastures. In circumstances where it does establish dense infestations it can become a very persistent and dominating weed that can be very difficult to manage. Without re-establishment of fodder species, such as pasture grasses and legumes, paddocks will have lower livestock-carrying capacity. Case studies (Chapter 4) describe how blue heliotrope has impacted on productivity and profitability for various farming properties.

Shauna Potter

Blue heliotrope growing among perennial pasture grasses.

Loss of potential hay and silage

Pastures and fodder crops containing blue heliotrope should not be used to make hay or silage because of the risk of toxic contamination. There is also the risk of blue heliotrope seed spread.

Cost of control in pastures

Because of the risks of poisoning and the reduced carrying capacity arising from blue heliotrope's unpalatability and dominance, it needs to be controlled in pastures. An integrated weed management approach is needed, including building competitive pastures, grazing management, herbicides and/or other control methods (as detailed in Chapter 3). This represents a substantial annual cost over many years for properties that graze cattle, horses and other susceptible livestock.

Impacts on cropping

Blue heliotrope can be a weed of sugarcane and cotton systems (Johnson and Hazlewood, 2002; Parsons and Cuthbertson, 2001). It can also be prevalent in fallows, taking moisture and nutrients from subsequently planted crops (Weir, 2016).

Environmental impacts

Blue heliotrope can be an environmental weed. It invades the herbaceous layer of open types of native vegetation, particularly woodlands and grasslands. Invasion of native vegetation by blue heliotrope reduces plant diversity and available wildlife habitat (Newell, 1997).

Blue heliotrope has become dominant in grassy woodland areas of the Warrumbungle National Park, perhaps because of heavy grazing pressure from kangaroos (EWA, 2016). It outcompetes native ground species in endangered Cumberland Plains woodland in western Sydney and threatens the endangered native herb granite zieria (*Zieria obcordata* A.Cunn.) in central-western NSW (EWA, 2016). It is recorded as an invader of mulga (*Acacia aneura*) and bimble box (*Eucalyptus populnea*) communities in western NSW (Cunningham et al., 1992).

Matt Sheehan

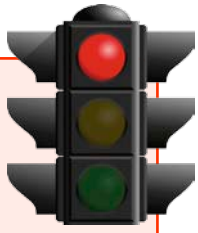
Blue heliotrope (in foreground) growing in the Warrumbungle National Park.

Impacts on people

Blue heliotrope can take an emotional toll on property managers because of concerns over livestock health, difficulties in achieving satisfactory levels of control and the need for constant vigilance to detect and respond to new outbreaks. Progress can seem to be very slow in managing such a persistent weed. Realistic expectations need to be set regarding the need for long-term management and what can be achieved given available resources. Peer support and expert advice should be sought at an early stage.

Health concerns are commonly raised about PAs being passed on to humans from grazing animals via meat, milk or eggs. There is no definitive evidence that significant human health risks are posed by blue heliotrope or other PA-containing weeds from grazing animals passing on very low concentrations of PAs in the food chain (Australia New Zealand Food Authority [ANZFA], 2001; World Health Organization [WHO] and Food and Agriculture Organisation [FAO], 2020).

Honey contaminated with PAs is perceived to present a higher risk for people. Bees do seek out nectar from blue heliotrope and PAs matching blue heliotrope's profile have been detected in honey (Carpinelli de Jesus et al., 2019). Australian industry practices of blending honeys from multiple sources reduce the risk of PAs to acceptably low levels (ANZFA, 2001). However, consuming honey known to be primarily sourced from blue heliotrope infestations should be minimised (Carpinelli de Jesus et al., 2019), similar to recommendations for Paterson's curse honey (Food Standards Australian and New Zealand [FSANZ], 2022). The broader issue of PAs and food safety continues to be examined by the Australia/New Zealand and international food standards organisations (FSANZ, 2022; WHO and FAO, 2020).



If blue heliotrope management is getting the better of you:

STOP. REASSESS. REACH OUT. ACCESS SUPPORT.

Beyond Blue: www.beyondblue.org.au
1300 224 636

Lifeline Australia: www.lifeline.org.au
13 11 14

National Centre for Farmer Health:
www.farmerhealth.org.au

The comprehensive *National Centre for Farmer Health* website provides resources such as tools, blogs, webinars and links. Visit the site for information on:

- emotional and social wellbeing
- farm business support services
- rural support organisations
- emergency information for bushfires and climate.

Chapter 2

Planning

At a glance

- **Planning helps you prioritise what actions are needed to protect and develop your property.**
- **A property weed management plan determines priority actions to prevent new weeds and manage the spread and impacts of existing weeds.**
- **This chapter describes a simple way to develop a property weed management plan.**
- **The chapter also provides guidance on planning community-led and large (landscape-scale) weed management programs.**

Introduction

Planning is one of the most important steps in weed management. Although it is tempting to jump straight to weed control, taking a planned approach to weed management will help ensure what you do is effective, efficient and achievable. A planned approach keeps one eye on the big picture (your property goals) and the other on the detail (priority actions and timing). It helps you judge whether you are on track to reduce the impacts and spread of blue heliotrope or whether you might need to change tactics.

Having a plan means your day-to-day activity is focused on achieving long-term outcomes.

Property planning can occur at various scales (Figure 2.1).

Figure 2.1 Three examples of property plans.

A **property management plan,** or a farm business plan, takes a holistic view of the economic, environmental and social aspects of running a property. It entails a self-review of the property's resources (natural, financial, people, infrastructure, livestock), limitations to these resources, external influences, and opportunities and options for improvement. Property management plans are important for both commercial and lifestyle properties.

A **property biosecurity plan** focuses on minimising the threat posed to livestock, cropping and natural resources by new and established weeds, pests and diseases.

A subset of biosecurity planning is a **property weed management plan,** which is the main focus of this chapter.

Preventing or controlling blue heliotrope and other weeds requires a long-term commitment. Having a property weed management plan allows you to:

- prioritise the use of limited resources
- identify the best control methods and their timing, thereby increasing your chances of success
- coordinate activities with your neighbours
- meet your legal obligations (where applicable)
- incorporate weed management tasks into broader property planning
- undertake monitoring to gauge success, thereby allowing you to revise the plan as needed.

Refer to Chapter 5 for weblinks to property, biosecurity and weed management planning information and tools.

NSW DPI

Planning helps you focus on your priorities.

Developing a plan

While this manual is about blue heliotrope, it is good practice to consider all weeds and how to align their management in the one property weed management plan. Focusing solely on blue heliotrope risks missing actions required for other weeds of equivalent or even greater impact. This may include state and regional priority weeds listed in Regional Strategic Weed Management Plans.

Hence, the following information is about weeds in general, with some specific examples given for blue heliotrope.

A **property weed management plan** (hereafter 'weed plan') outlines priority actions needed to prevent new weeds and control the further spread and impacts of weeds that are established on the property. A weed plan includes:

- stocktake of weeds present on the property and possible future weed incursions
- map of weed locations, spread pathways and assets at risk on the property
- analysis of options to manage key weeds
- consideration of property goals and weed management constraints and opportunities
- plan of priority weed management actions to be performed throughout the year
- monitoring of control methods for cost and effectiveness
- annual review and revision of the plan.

Planning principles

A good plan is one that provides a clear path to your management goals, allowing for flexibility and refinement along the way. It does not need to be lengthy or elaborate; rather, it should include what you can realistically achieve each year. Effective control of weed infestations can take many years, so the plan should be long term.

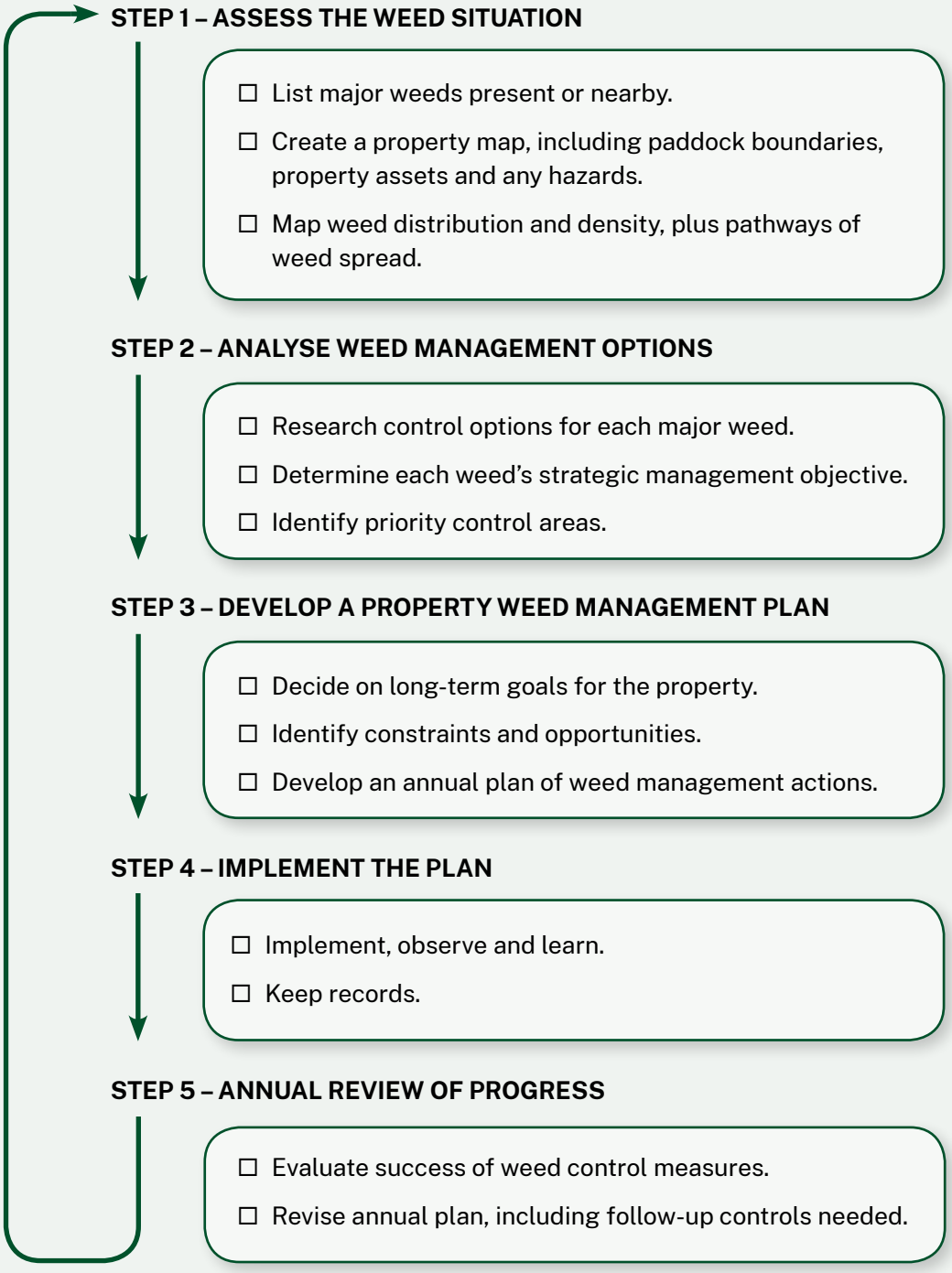
Thought should also be given to why you are developing a plan. Be clear on:

- your general Biosecurity Duty (refer to Weedwise or relevant Regional Strategic Weed Management Plans for information on priority weeds)
- why you want to manage blue heliotrope
- how a plan can assist in reaching your management goals
- what success will look like
- how to integrate management activities into day-to-day operations
- who should be involved.

There are no silver bullets in the blue heliotrope manager's toolkit. Ensure your plan considers important concepts such as multiple treatments, adaptive management, integrated weed management and monitoring for regrowth or reinvasion. That way you will be on the path towards success.

Box 2.1 summarises the steps involved in developing and implementing a weed plan and provides a checklist for each step. Initial assessment of the weed situation (Step 1) and management options (Step 2) inform priority actions to include in the plan (Step 3). While implementing the plan (Step 4), make observations and keep records to inform an annual review of the plan (Step 5).

Box 2.1 Checklist to assist in the development of an annual property weed management plan.



STEP 1. Assess the weed situation

The first step is to understand the scale of the weed problem on your property. Conduct a survey of weed distribution and density in paddocks and around infrastructure (e.g. farm tracks, sheds, stockyards, stock watering points, fence lines). Weeds present in areas surrounding the property should also be noted.

List the major weeds present on property and surrounds

Compile a list of which major weeds are present. In addition to blue heliotrope, there are likely to be other weeds on the property that are currently causing, or have the potential to cause, serious economic, environmental or social impacts. Also list other major weeds present in the local area but not yet on your property. Talking to your local biosecurity officer, neighbours, agronomist, Landcare officer or other sources of advice will help build your understanding of local and regional weed threats. Also consider weeds that may be brought to your property from long distances, through pathways such as purchased fodder, livestock or machinery.

Various online resources list and identify major weeds, including NSW DPI (e.g. NSW WeedWise weeds.dpi.nsw.gov.au/) and Local Land Service regions (e.g https://www.lls.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/weed-control/weed-identification-and-management).

Map weed infestations, key assets and spread pathways

A map of weed distribution on your property should aim to show:

- location, extent and density of weed infestations
- property and paddock boundaries
- location and types of assets
- weed spread pathways, such as water courses, roads and stock camps
- safety hazards.

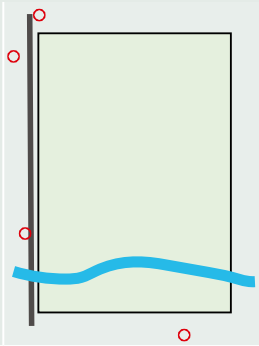
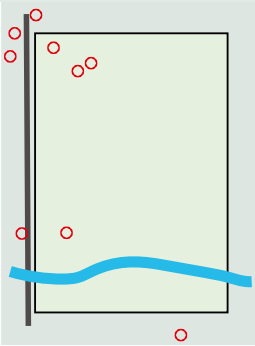
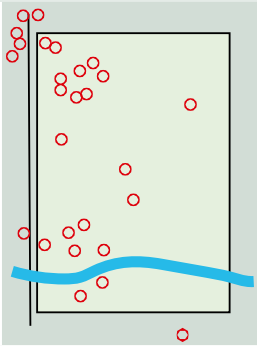
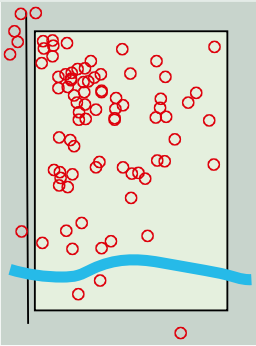
Obtain a map of your property, either as a hard copy or in a digital format that you can add GPS locations to using a smartphone. A map does not need to be complex; the goal is for people, now or in the future, to find their way around the property and follow a logical and strategic approach to weed management. A hand sketch can work for small properties, while a simple, computer-generated map may be better for larger properties.

Walk or drive over your property and determine the presence of weeds in each paddock (or part thereof). Draw a mud map for each paddock and record locations of weeds, transferring this information to your property map later. Alternatively, take GPS readings to record the boundaries of patches of weeds or point locations of individual weeds.

Which weeds to record will be guided by your weed list; but also add any new weeds detected. Since different weeds are more obvious at different times of year, you should repeat this process seasonally. For example, blue heliotrope is easiest to detect when it is flowering.

Record the locations of infestations of **weeds** as areas on the property map. Also record their density so you can judge in future years whether your efforts have been successful. Typical categories for recording weed density are described in Table 2.1 and further detail is given in McNaught et al. (2008).

Table 2.1 Strategic management objectives and actions required for different stages of weed invasion.

				
STAGE OF INVASION	**Absent**	**Early stages of invasion**	**Scattered to frequent**	**Widespread and dense**
	▪ Absent: not known to be present on the property (but may be present in the local area)	▪ Rare (< 1%): isolated individual plants ▪ Low risk of reinfestation from neighbouring areas	▪ Light (1–10%): scattered patches and isolated plant Or ▪ Medium (11–50%): frequent patches with isolated plants commonly interspersed	▪ Heavy (> 50%): large, dense infestations ▪ Weed can be found across most of the property
MANAGEMENT OBJECTIVE	**PREVENT**	**ERADICATE**	**CONTAIN AND REDUCE**	**MANAGE IMPACTS**
	▪ Limit arrival onto the property to prevent it from becoming established	▪ Eliminate all plants, including propagules (seeds and vegetative)	▪ Prevent further spread on the property by eliminating outlying infestations and reducing density of the core infestation/s	▪ Reduce weed density to limit impacts on high-value assets
MANAGEMENT ACTIONS REQUIRED	**Property biosecurity** ▪ Prevent new weeds arriving **'Seek and destroy'** ▪ Ensure ongoing property surveillance for, and response to, new weed incursions ▪ Conduct a coordinated control program across infested properties, where a high impact weed is new to the district	**Delimitation** ▪ Ensure frequent surveillance to map all known infestations **'Seek and destroy'** ▪ Search for and remove all plants prior to reproduction **Property biosecurity** ▪ Implement hygiene practices to prevent spread across the property	**Spread prevention** ▪ Implement hygiene practices to prevent spread across the property **Control** ▪ Conduct an ongoing integrated control program to reduce weed density in areas where firmly established **'Seek and destroy'** ▪ Search for and remove all plants prior to reproduction for outlying infestations	**Spread prevention** ▪ Implement hygiene protocols and other measures to prevent spread off-property **Control** ▪ Conduct an ongoing integrated control program to reduce density to keep impacts at an acceptable level ▪ Protect high-value assets at risk from weed impact

Map property **assets** to help define management goals and areas that will benefit the most from weed prevention and control. Such assets may also require extra care when undertaking weed control to limit any off-target damage. Examples of higher value assets include the most productive paddocks, significant biodiversity areas, property infrastructure, and historical and cultural sites.

Identify and map **pathways** for weed spread on the property, for example:

- roads, tracks and other linear easements, such as stock routes and powerlines
- water courses
- livestock yards and feeding areas
- likely movements of wild animals
- prevailing winds and topography where wind-dispersed weeds are likely to be deposited.

When undertaking mapping and weed control, it is important to identify any **safety risks** to prevent potential injuries, for example, areas that are steep or have hidden ground hazards rendering them unsuitable for driving across with a boom sprayer.

Figure 2.2 provides an example property weed map, which in turn is used to inform examples for other steps.

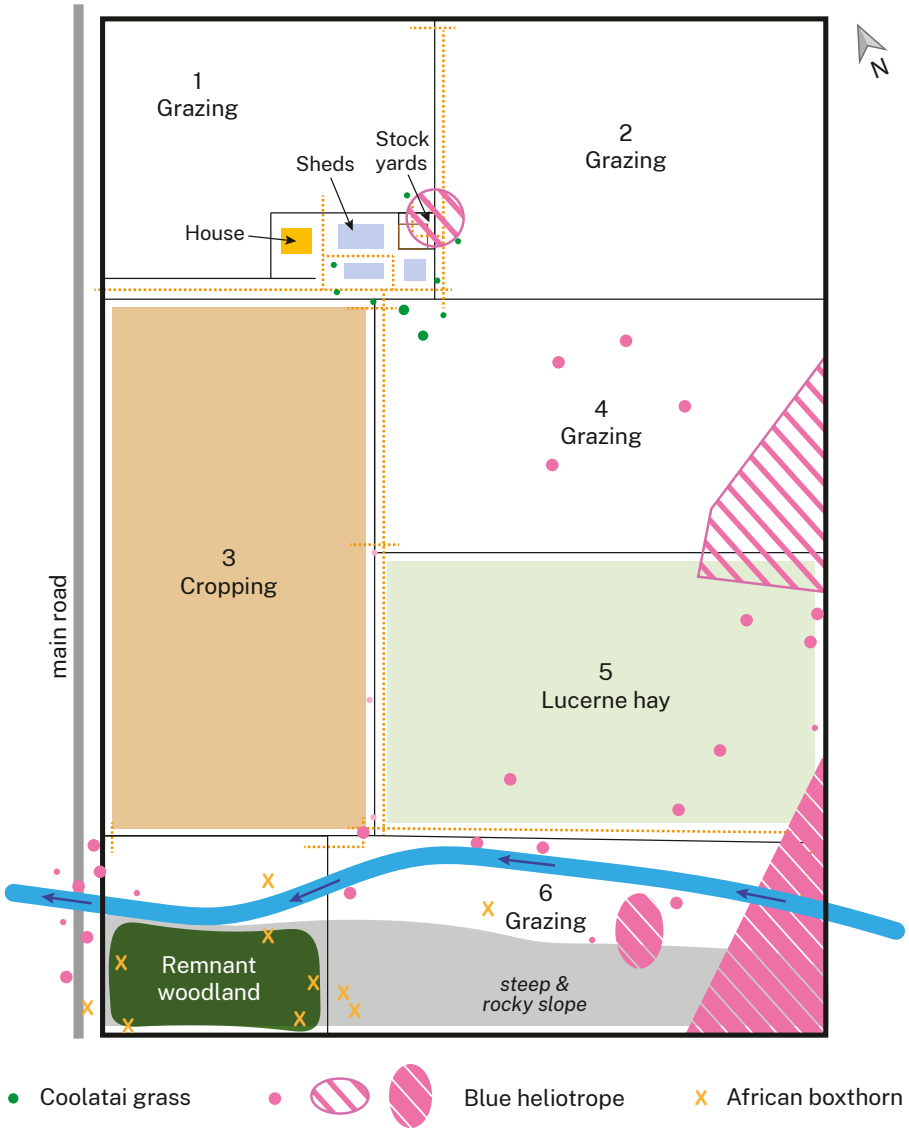
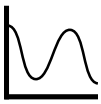


Figure 2.2 An example property weed map showing infestations of blue heliotrope, Coolatai grass and African boxthorn.



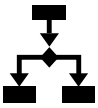
Establishing a baseline of current weed status

Information collected on weed distribution and density can be used to establish a baseline, record change and assess the effectiveness of management outcomes over time. Each time you produce an updated map and record weed density, you can compare it against your original baseline map.

You can also establish fixed photo points, where images are taken at the same spot and time each year. This ensures a long-term photographic record of change in weed distribution and density over time.

STEP 2. Analyse weed management options

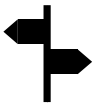
This step requires you to consider the weed control options and strategies available for different parts of your property, based on the weeds identified in Step 1.



Control options for weeds

Conduct some online research on the biology, impacts and management options for the major weeds identified in Step 1, referring to this manual for details on blue heliotrope. A range of information is available from government (state, territory, local), NRM and farming websites. You should also seek advice from Local Land Services (https://www.lls.nsw.gov.au/). Describe the weeds' overall distribution on the property, likely impacts if not controlled and pathways of spread, as well as potential ways to prevent and control them.

It helps to 'think outside the box' in terms of what control options you could adopt. For example, long-term suppression of blue heliotrope can be achieved by establishing sub-tropical perennial grass pasture. You should also be aware of the limitations of control options. These may include off-target effects on desirable plants, restricting livestock access to treated paddocks, suitability for non-arable areas, time required to achieve effective control, and expense. Table 3.1 in Chapter 3 compares the pros and cons of different prevention and control measures for blue heliotrope.



Identify strategic management objectives

Strategic weed management objectives relate to the level of weed invasion and comprise the following: **prevent**, **eradicate**, **contain and reduce** and **manage impacts**. These objectives and the general actions needed to achieve them are described in Table 2.1.

To decide on a feasible management strategy for each weed, consider:

- the distribution of major weeds on the property (from the mapping)
- how they can be cost-effectively prevented or controlled
- the potential impacts of the weed on property assets.

Eradication – is it feasible?

Note that eradication is a term often used but rarely achieved in practice for weeds. Successful eradication requires the elimination of every individual plant and propagules (both seeds and vegetative plant parts) in a defined area, plus no further reintroduction from outside the area. This is extremely difficult to achieve. Generally, eradication is only possible where the weed is new to an area or property.

Factors required for successful weed eradication on a property:

- Weed distribution and density is rare across the property.
- All infested areas are known.
- The chance of reinvasion from surrounding areas is unlikely.
- Newly emerged plants are easily detected before they set seed (or vegetative propagules, for some types of weeds).
- Individual plants are easy to kill, including those that regenerate vegetatively.

- The weed has only been there a short while and, therefore, has not formed a large soil seedbank.
- Seeds do not persist in the soil for many years.
- Sufficient 'people power' is available for regular searching (e.g. fortnightly to monthly) to find and remove all plants before flowering.
- This 'seek and destroy' effort can be maintained each year for many years until there is no more emergence from the soil seedbank.

Priority control areas

The number and extent of weeds on your property is often too much to tackle all at once. It is important not to take on too much from the start, particularly if you lack experience in weed control or in managing a particular weed. Choose a small area that can be regularly observed to gauge whether your control technique is working well; consider ways to achieve an even better result and build confidence for taking on larger infestations.

Generally for weeds, 'prevention is better than cure' and it is best to prioritise new, small or outlying infestations, then areas with high risk of spread, then protection of high-value assets (Table 2.2). However, you also need to weigh up addressing dense weed infestations currently impacting on productivity and profitability versus preventing light infestations from become dense. For a property with widely established blue heliotrope, Hunter LLS (2020) recommends tackling arable paddocks first, then lower productivity areas of a property.

Table 2.2 General order of priority for where to control weeds.

PRIORITY 1	**New, small or outlying weed infestations** These should be intensively controlled (and eradicated where feasible) to prevent them from becoming large infestations with persistent seedbanks.
PRIORITY 2	**Areas with high risk of weed spread** Areas such as farm tracks, parking and visitor areas, stockyards, dams, troughs, gateways and watercourses should be targeted for weed control to reduce the risk of weed spread causing new infestations on the property. Also consider weeds within paddocks that present a high risk of further spread on the property by such means as livestock, machinery or conserved fodder.
PRIORITY 3	**High-value assets** Where weeds are widely established, focus on reducing current and future impacts on important assets. For example, look after the most productive paddocks and the best patches of bush. Maintain access to and functioning of property infrastructure such as fences and dams.

Table 2.3 provides an example of how the information and analysis from Steps 1 and 2 can be combined to decide on the management approach to be adopted for each priority weed.

Table 2.3 Example approach to analysing weed management options on a property.

		BLUE HELIOTROPE (*Heliotropium amplexicaule*)	COOLATAI GRASS (*Hyparrhenia hirta*)	AFRICAN BOXTHORN (*Lycium ferocissimum*)
	CURRENT STATUS	*Medium density in Paddock 6. Light at eastern end spotting elsewhere in Paddocks 4 and 5. Present in and around stockyards. Spotting around tracks and creek. On roadside near front gate.*	*Rare – spotting around sheds and nearby in paddocks. Probably came in on a vehicle.*	*Light – scattered along creek and creeping into remnant woodland.*
	RISK OF IMPACT	*If it becomes dense then risk of cattle poisoning and less pasture productivity. Risk of contaminating hay (seed and toxicity).*	*Low palatability. Can become dominant in pasture. Could invade remnant woodland.*	*Reduced access, amenity and biodiversity. Competes with pastures along creek.*
	ASSETS AT RISK	*Spreading in best grazing paddocks (4 and 5). In Paddock 6 (more marginal grazing). Could spread in woodland.*	*Grazing paddocks in general. Hay paddock.*	*Creek line, woodland and steep grazing paddock.*
	PATHWAY RISKS	*Livestock, vehicles, machinery, drainage lines and creek.*	*Vehicles, machinery, livestock.*	*Birds, floods, foxes.*
PREVENTION AND CONTROL OPTIONS	Spread prevention	*Vehicle and machinery hygiene. Control around sheds, stockyards and tracks.*	*Vehicle and machinery hygiene.*	*Difficult to stop seed spread.*
	Competition	*Establish competitive tropical grass and legume pastures. Note, it takes several years.*	*Establish and maintain competitive pasture.*	*Establish and maintain competitive pasture and riparian native plants.*
	Grazing	*Don't overgraze pasture.*	*Don't overgraze pasture.*	*Not an option – poisonous to livestock.*
	Herbicide	*Boom or spot spray during spring. Search for and spot spray recovering or missed plants in late summer/early autumn after rain events.*	*Spot spray (though risks missing small plants compared with boom spray). Withholding period if using flupropanate.*	*Spot spray or cut stump treatment using a woody weed herbicide.*
	Manual removal	*Only for small infestations.*	*Chip out and bag.*	*Too steep for safe machinery access to pull out big plants.*
	Cultivation	*Possible when renovating pasture, but risks spreading root fragments.*	*Taken out by frequent cultivation – won't persist in cropped paddocks.*	*Not applicable.*
	Biological control	*Leaf beetle not established in region.*	*None available.*	*Rust available but doesn't kill plants.*

Table 2.3 continued/...	BLUE HELIOTROPE (*Heliotropium amplexicaule*)	COOLATAI GRASS (*Hyparrhenia hirta*)	AFRICAN BOXTHORN (*Lycium ferocissimum*)
MANAGEMENT OBJECTIVE	CONTAIN AND REDUCE ▪ *contain further spread* ▪ *seek and destroy new plants* ▪ *control*	ERADICATE ▪ *delimitation* ▪ *seek and destroy new plants* ▪ *property biosecurity*	CONTAIN AND REDUCE ▪ *contain further spread* ▪ *seek and destroy new plants* ▪ *control*
CONTROL AREAS	*Intensive control in Paddocks 4 and 5. Spot spray to eradicate around stockyards and tracks. Spray outliers and adjacent to creek in Paddock 6 to stop further spread. Ask council about control on roadside.*	*All known infestations. Monitor around sheds, farm tracks, fence lines, all paddocks and roadside, and remove any plants found.*	*Paddocks 6 and 7 (hillside, creek line, remnant woodland). Look out for seedlings under trees elsewhere on property.*
MANAGEMENT APPROACH	*Light overall on property but in many paddocks. Dense on neighbouring property to east, so constant risk of reinvasion. Keep density at a light level through competitive pasture, grazing management and use of herbicides. Need high intensity control in Paddocks 4 and 5. Seek to eradicate isolated plants in new areas. Trial tropical pasture in Paddock 2 to see if increases productivity and resists blue heliotrope invasion.*	*Rare on property. Must remove plants prior to flowering. Spot spray and chipping. Regular searching of other paddocks.*	*Light on property. Spot spray seedlings and small bushes. Cut stump herbicide method for large bushes.*

STEP 3. Develop a property weed management plan

This step brings together the priority actions for the weed plan and aligns them with your long-term property goals and available resources. Table 2.4 provides an example of a simple annual property weed management plan.

Property goals

What are the long-term goals for your property? For a commercial farm, the focus is often on ensuring productivity, sustainable use of natural resources and market access for products. For a lifestyle property, the focus may be more on the amenity of living in a rural landscape, the ability to run a few grazing animals, and valuing and restoring the local environment.

Setting long-term goals highlights what you value most about your property. In turn, this influences your weed management priorities – whether those are economic, environmental or social impacts that you wish to prevent and manage.

Constraints

What constraints will limit or direct what you can do to prevent and manage weeds on your property? Consider finances, people, infrastructure, equipment, natural resources and business. Examples of possible constraints include:

- funds to spend on weed control
- cost of individual control options
- time available when weed control needs to occur
- skills and knowledge
- availability of equipment or labour
- accessibility of areas of your property
- work health and safety considerations
- physical ability to use certain control methods
- preferences regarding herbicide use
- legal requirements to control weeds
- avoiding unintended damage (e.g. risks of herbicide drift, contamination of waterways, soil erosion)
- community expectations to control certain weeds
- lack of feasible control measures
- natural dispersal of weeds onto the property.

Opportunities

Are there ways you can make weed prevention and control more efficient or effective? It may be possible to share equipment with a neighbour or split the cost of hiring a spray contractor. There may be multiple weeds that can be controlled by the same method. Opportunities may exist to apply for grant funding to undertake an initial ('primary') control of a weed infestation, thereby helping to protect regional biodiversity or productivity. Joining a local Landcare group may help you share the load and gain access to expertise and equipment. Other forms of assistance may be available through your Local Land Services or local council.

Annual plan of action

Reviewed annually, the weed plan provides a way to record what you need to do to tackle your highest priority weeds. At its simplest, a weed plan can be a calendar of actions required at certain times of the year. It also indicates where on the property these actions are needed.

Consider your long-term goals for the property, analysis of the weed situation and management options, the constraints you are working under and the opportunities to address these. Draft a calendar of actions you can feasibly undertake to address your priority weeds in specified areas of the property.

Think about the timing of these actions in relation to each other and other property activities. Do conflicts exist? Can further efficiencies be implemented to save costs or time? The plan does not need to be perfect; it can be refined until you achieve something workable for the year.

Seek advice and input from weed management experts (e.g. local biosecurity officer, farm advisor, Landcare officer) and neighbours to ensure that your management approach is sound and will align, if needed, with others' weed control activities.

While this is an annual plan, it is important to think ahead to what you will need to do in the following years to progress further in reducing your weeds. Weed management is a long-term investment and cannot be achieved in one year only.

A plan is a guide, and you still need to be flexible with your timing to adapt to unforeseen circumstances such as drought, floods or other extreme weather events. You may also need to alter the timing of weed management activities, based on other factors such as varying seasonal conditions or other urgent property management needs that could arise.

Table 2.4 Example annual property weed management plan.*

PROPERTY GOAL/S	*To have a profitable cattle and cropping enterprise.* *To keep the property in good condition as an asset.*			
Implications for weed priorities	*Focus on protecting pastures for cattle production. Avoid new weeds becoming established. Manage established weeds so they don't become dominant. Work with neighbours on shared weed issues. Look after the remnant woodland and creek habitat.*			
CONSTRAINTS	▪ *Labour: family farm with small workforce so need to be mindful of time and costs.* ▪ *Some steep, rocky areas where pasture grows poorly and access is difficult for spraying, so more vulnerable to weeds.* ▪ *Withholding periods after weed spraying for cattle.* ▪ *Risk of weeds blowing or washing in from neighbouring paddock/property.* ▪ *Need to be careful with herbicides around the remnant bush.* ▪ *Can get very wet in lower paddocks after rain periods, making vehicle access difficult.*			
OPPORTUNITIES	▪ *Agist cattle next door (on non-weedy pastures) during any withholding period.* ▪ *Potential grant funding to fence off creek, control weeds and revegetate so less weedy in long term.*			
Month	**Weed/s**	**Action/s**	**Priority control areas**	**Notes**
Aug	*Pasture weeds*	*Fertilise pastures to increase competitive growth in spring.*	*Soil test to see which paddocks need fertilisation.*	
Oct	*Blue heliotrope*	*Spray with Starane when having spring flush of growth, provided plants not drought stressed.*	*Boom spray patches in Paddock 4. Spot spray in lucerne paddock (Paddock 5) and isolated plants in Paddocks 4 and 6. Intense spot spraying around stockyards. Release biocontrol agent along creek in paddock 6.*	*Delay spraying until immediately after rain events if it is a dry spring.* *Boom spray if not too many desirable legumes present.*
Dec	*Blue heliotrope*	*Follow-up spot spray of regrowth and missed plants.*	*Intensive search in lucerne paddock prior to hay cutting. Other areas as above, as time permits.*	*Only immediately after rainfall events.*
Oct–Dec	*Pasture weeds / blue heliotrope*	*Spray out with glyphosate.*	*Paddock 2 to do a trial sowing of premier digit grass.*	*Need to reduce summer weed seeding for three seasons before sowing tropical grasses. Be wary of blue heliotrope invasion during this time.*
Jan–Feb	*Blue heliotrope*	*Rest from grazing to build competitiveness of pasture.*	*Paddock 4*	*Want to build groundcover to reduce blue heliotrope germination.*
		Summer fallow	*Paddock 2*	
Mar–April	*Blue heliotrope*	*Follow-up spray of regrowth and missed plants with Grazon® Extra + metsulfuron methyl.*	*Paddock 4, 5, 6, 7 and around yards.*	
		Sow winter annual crop.	*Paddock 2*	
Year round	*New weeds*	*Property biosecurity plan – prevention, hygiene, spot and destroy new weeds.*	*Vehicle and machinery entry. Around sheds, tracks, hay feeding areas etc.*	*Constant vigilance!*
Next year	*Check on whether lucerne has been knocked around by herbicides for control of blue heliotrope – may need resowing at east end of paddock.*			

* To save space, this example focuses largely on blue heliotrope and includes only those months that require actions.

STEP 4. Implement the plan

Refer to your plan regularly as you implement your weed management program. You could program actions into an electronic diary (e.g. on your smartphone) to enable pop-up reminders. Use your plan to keep on track, stay motivated and as a reminder of why you are managing weeds. Remember that the plan is a high-level summary of what you are aiming to do and that each action will likely need further division into tasks.

Learning from doing

Use the implementation of your weed plan as an opportunity to observe the cost-effectiveness of your actions, so that you can make future improvements to your plan and methods of weed management. Treat it as a continuous learning exercise and challenge yourself regarding how it could be done better. For particular weed control actions consider:

- Did it cost more or take more time than expected?
- Did you achieve a satisfactory level of weed kill? (See Box 2.2)
- Did you experience scheduling clashes between weed management and other important property activities and needs?
- Make diary notes throughout the year on what you have observed and learned. Failures are just as important to record as successes.

Box 2.2 A simple way of measuring weed kill.

1. Go to the parts of a paddock where the weed has been dense.
2. Looking in from the edge of the treated area, choose a point in the distance that you will walk towards in a straight line transect.
3. Every five steps (or more if the weed is sparse) examine the weed closest to your leading foot.
4. Score the individual weed for level of kill (e.g. dead = 5, stunted/yellowing/burnt off = 3, healthy = 1).
5. Do this for 10 weeds along the transect.
6. Repeat with 4 more transects, at least 10 m apart.
7. Average the 50 weed scores.

John Virtue

Assessing herbicide kill for a grass weed.

Time this exercise according to how long you expect the weed control method would normally take to kill the target weed at that time of year. If the level of kill is less than expected, then repeat your assessment in a fortnight to determine whether the result was due simply to a delay in the treatment working. This approach can also be used to examine off-target damage in desirable plants (e.g. pasture plants).

Establishing fixed photo monitoring points at selected locations throughout the treated area can assist in visually recording changes over time and the impact of your weed control efforts. Photo points tend to be more useful for larger, perennial weeds that are more obvious in photographs than smaller or annual weeds. Various factsheets are available on how to set up photo point monitoring (e.g. NRM South (https://nrmsouth.org.au/wp-content/uploads/2014/08/Photo-Monitoring-Fact-Sheet-NRM-South.pdf, Eyre Peninsula Landscape Board (https://cdn.environment.sa.gov.au/landscape/docs/ep/eplb_photopoint_monitoring_factsheet.pdf)).

Record keeping

In line with the 'learning from doing' approach, log your activities as you undertake them. Keep records of:

- all costs
- time taken
- weed locations
- control methods
- areas treated and their size
- equipment and supplies used (e.g. herbicide volume)
- weather conditions at time of control
- level of weed control achieved.

STEP 5. Annual review of progress

An annual review of the weed plan is recommended to inform what changes are needed for the following year. For each weed targeted in your plan, ask yourself broad questions such as those outlined in Table 2.5. Draw on the monitoring undertaken in Step 1 to measure these questions against a baseline.

Given most weeds require multiple years of follow-up control, you may not be making major changes to your plan initially (unless a control method is clearly not working). When substantial gains have been made against target weeds, usually after at least several years, you can shift your focus to other weeds of lower priority.

If weed control has been poor, then you need to determine why. Seek professional advice on what changes are needed to your control techniques and your broad management approach. Weed management is a long-term undertaking, and you need to be confident that the time and money invested will give you effective results.

Table 2.5 Example annual review questions.

Review questions	Monitoring techniques that can address questions
Has the extent (area) of the weed infestation increased or decreased?	Update the property map to record any changes in weed distribution or any new weeds.
Has the density of the weed increased or decreased?	Check against categories in Table 2.1.
Are desirable plants recovering?	Key pasture species can also be assessed using the categories in Table 2.1.
Which control methods have been most successful?	Measure and compare weed kill according to the method in Box 2.2.
How much is control costing?	Calculate costs/ha from your record keeping, including cost for your time.

Follow-up

Since blue heliotrope grows from both a large soil seed bank and its perennial root system, it will take multiple years of treatment to reduce an infestation to a low density. This applies to weeds in general.

For large woody weeds, the first year of 'primary' control is usually the most intense. Seedlings or regrowth in successive years will still require follow-up control, but this could employ different methods, and less time might

be required. This should be factored into the next and subsequent years' weed plans.

Repeating the annual planning cycle

Updating your plan should become quicker each year. Reviewing progress (Step 5) from the previous year informs any updates needed to describe the weed situation (Step 1). Any new information on weed control techniques, plus observations on how well the methods worked in the previous year, will inform analysis of weed management options (Step 2). The previous year's plan will provide a template for drafting the revised plan (Step 3).

Every three to five years, it is valuable to spend more time assessing the current state of weed prevention and management on your property. Ask yourself whether you are truly on track and making substantial progress. Involve others in the process to act as peers and provide new insights and observations.

If the planning process is working well for you, then inform and encourage others to do the same and make broader district gains on weed management. The next section provides tips on how to achieve a coordinated approach to weed management across neighbouring properties.

Working together on weeds

Weeds do not respect property boundaries, and a coordinated approach with neighbours will result in effective control programs. Approaches can be implemented at different scales (local, landscape) and informally or formally.

Local – informal

This can be a grass roots approach in which a rural neighbourhood chooses to work together on a common weed problem. Such cooperation can be quite informal, for example:

- welcoming new landholder arrivals and providing them with information on local weed problems
- organising paddock walks to discuss control methods
- sharing weed control equipment
- agreeing to let each other know if you observe a weed outbreak on your neighbour's property
- having an in-principle agreement that neighbours may hand pull the occasional weed appearing just over the fence.

Local – formal

A more formal approach is to form a weed-focused community group. Recommendations on how to achieve this are detailed below by the Australian Centre for Culture, Environment, Society and Space (ACCESS), University of Wollongong. Key points are:

- establishing an agreed, common goal for the weed in the local area
- defining the boundaries within which the weed will be tackled
- creating an achievable workplan
- sharing the organisational and weed management load
- documenting and promoting what has been achieved.

Regional

The next level of collaboration is a district coordinated control program run by a biosecurity officer to tackle a regional priority weed. Understanding and developing social relationships is vital for planning and implementing such a program. Guidance to help establish the social context is provided by ACCESS and is presented below.

Key points are to:

- tap into existing networks to reach land managers
- understand community diversity, capacity and views concerning weed management
- build community support for viewing the weed's control as a priority
- document where the weed is and where it could spread to – who is affected now and who is at risk?
- establish what has been successful regarding timing and methods of control
- draft a regional weed management plan that includes both social and technical considerations
- establish a steering committee to oversee the plan's implementation.

Better together: building networks and shared objectives to achieve landscape control

Coordinated control of blue heliotrope provides many benefits to land managers, from building neighbourly relationships and support networks, though to reducing the spread and impact of the weed itself. Making connections with others may provide motivation, knowledge and friendships and help ease the burden of weed control. Working together in times of drought can be especially beneficial in breaking the back of established blue heliotrope infestations.

This section provides tips for property managers and weed management professionals to leverage and coordinate communities to achieve landscape control.

Tips for property managers

There are many examples across Australia of property managers successfully working together across properties to reduce their shared weed burden. These tips come from observing community groups working with a diverse range of weeds.

ACCESS
Australian Centre for Culture, Environment, Society & Space

UNIVERSITY OF WOLLONGONG AUSTRALIA

1. **Identify a group of people** concerned about the target weed and passionate about working together. Locate them through a community meeting, social barbeque, Facebook group etc.
2. **Develop a common goal** e.g. prevent the weed from going to seed, reduce local spread, local eradication.
3. **Define a clearly bounded area to work** together on weed control, e.g. a river corridor, small valley, several adjoining properties, or a rural residential estate. Define an area consistent with the amount of time and resources you have to invest in weed management; too large an area can mean results take too long to see, and motivation can wane.

4. **Develop a plan to prioritise your efforts** within the clearly bounded area. This may involve focusing on the lightest infestations and the outliers, and then working in towards the densest infestation. Include:
   - the activities the group will use to address the weed, e.g. working bees, individuals looking after specific sections, employing a contractor to reach difficult-to-access areas or to manage particularly dense infestations
   - the frequency (e.g. weekly, monthly) and timing (e.g. Tuesdays) of any group work
   - whether there are any native animals or plants currently benefiting from the weed – this ensures your management activities are undertaken sensitively.

   Ensure you have all landowner's permission (and involvement) before commencing planning and work.

5. **Ensure a social component to activities** – keep motivation going through social activities, e.g. sharing afternoon tea at the end of a working bee. This enables groups to reflect on what they have achieved together, beyond what they could have achieved alone; determine their plan's effectiveness; and whether the clearly bounded area is too big or small.

6. **Share the load** – organising working bees, contractors and other weed control activities can become an administrative burden that undermines the group's longevity. Assign group roles based on experience, expertise and interest in key areas such as:
   - communications – for sharing information about group activities on social media or via email
   - recruitment – for inviting and welcoming new people to the group
   - grant writing – to apply for funding to support group activities
   - plant identification – to teach members to identify the target weed(s) and other plants.

   Also share the weed control load. Groups of neighbours might rotate work on each other's properties, finishing each rotation with a barbecue or other social activity.

7. **Document your journey** e.g. photos or brief written accounts of weed management impacts, to showcase your successes; develop a collective sense of achievement; and attract new recruits. Recording lessons learned may also be useful for other groups.

8. **Connect with others** – make connections with groups addressing the same, or similar, weeds in neighbouring areas or further afield. Share your knowledge and resources and the activities and decisions that have (and haven't) worked. Link with local, state government and non-government organisations for potential funding and grants, resources and support.

Tips for weed professionals

The following points guide professional weed control and project officers in understanding and working with their local communities to develop coordinated weed management programs for priority regional weeds.

1. **Know who – identify, understand and encourage social relationships**

   Identify existing land manager networks.

   Networks, including those that are not weed specific, may be leveraged for communicating weed-related messages and events, e.g.
   - Farming networks – producer groups, sustainable farming, restorative agriculture

- Volunteer networks – Landcare groups, community associations, Rural Fire Services
- Agronomist and other advisor networks
- Local government
- Regional NRM bodies (e.g. Local Land Services), regional managers of reserves (e.g. conservation, water) and existing cross-agency bodies (e.g. roadside environment committees).

Understand the local community.

Understanding the composition, capacities and perspectives of the community will help to determine weed control priorities, preferred control methods, underlying issues related to weeds and weed control, and where tensions are likely to emerge. Consider:

- the proportion of land managers that are Indigenous land managers, production farmers, hobby farmers/life-stylers, government or corporate (e.g. forestry)
- how these proportions have changed over time
- which land managers and weed management experts people currently turn to for advice
- who may be most interested in building their capacity to manage weeds.

Build trust.

Encourage formation of positive relationships among land managers and other stakeholders. Consider:

- bringing together land managers who may not know one another early on
- prioritising weed management along private and public boundaries to demonstrate commitment to being a good neighbour
- developing relationships with other relevant stakeholders with land management aspirations – e.g. Indigenous organisations and community groups – to broaden the weed management knowledge base and practice.

2. **Know what and know why – prioritise your target weed relative to other weeds and land management issues**

Establish the community's priority weeds.

Where does your target weed fit in relation to the list of weeds that are a priority for control? What are the other key weeds of community concern? These may be different from formal priorities. Are some segments of the community more concerned about your target weed than others? Regional Strategic Weed Management Plans will help with this task, as these were developed in consultation with the community.

Establish your target weed's community impacts.

What are the motivating factors that drive people in the community to control the weed? Are they to do with protecting livestock? Being a good neighbour? Caring for nature? Having a tidy-looking property?

Identify the benefits of controlling your target weed.

This includes not only reduced weed density and spread but also environmental, economic and social benefits resulting from working together on weeds.

3. **Know where – where is your target weed located and most likely to spread?**

Map the weed extent.

Establish where the core and outlying infestations are. The weed may be widespread in some areas, but emerging in others. Knowing its extent and density will be important to develop a plan for where to prioritise on-ground works; how to allocate resources; and to identify stakeholders in adjoining areas who could benefit from joining the initiative.

Consider any boundaries the weed crosses.

Any land tenure boundaries the target weed crosses will have management implications that will need to be considered.

- Does the target weed spread across private land or public land?
- Does it spread along corridors, such as rivers, roadsides, travelling stock routes or irrigation channels?
- Do opportunities exist to coordinate the timing of management along corridors or across boundaries for more effective management?
- Are there stakeholders whose jurisdiction spans similar boundaries to the weed who could facilitate coordinated responses?

4. **Know how – what approaches have been used to control your target weed locally?** Identifying and examining stories of previous target weed control success, failure and experimentation provides for collective learning and insights into the time and approaches needed to achieve success. Were there any weaknesses inherent in unsuccessful past efforts where land managers had given up? And how long did any successful effort take to achieve?
5. **Know when – identify the most effective time to control your target weed.** Timing is critical to successful weed control. Consider how the optimum weed control time fits with other community commitments such as sowing, harvesting, summer holidays. Will land managers have the capacity to control the target weed at certain times of year or during periods of seasonal difficulty such as floods and drought?
6. **Bringing it all together – develop a weed management plan.** Develop a landscape-scale weed management plan that brings together your understanding of both the weed and the local community. This is fundamental to leading an effective weed management program. Consider establishing a steering committee to help develop the plan, engage with diverse stakeholders, and oversee its implementation. Follow the five steps at the beginning of this chapter.

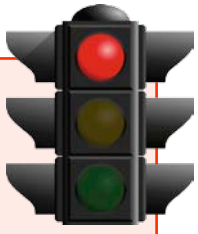
Acknowledgements: This section was prepared by the Australian Centre for Culture, Environment, Society & Space (University of Wollongong) with contributions by Associate Professor Nicholas Gill, Associate Professor Jenny Atchison, Associate Professor Sonia Graham, Dr Gina Hawkes, Dr Kaitlyn Height, Dr Rebecca Campbell, Crystal Arnold, Diana Dawson, Jennifer Smart, Janine Bailey, and Laura Butler.

Chapter 3

Controlling blue heliotrope

At a glance

- **Limiting the spread, establishment and seed production of blue heliotrope is critical for its effective control.**
- **There are various ways to prevent and control blue heliotrope, and combining these achieves better results.**
- **Establishing and maintaining competitive pastures, including sustainable grazing management, is critical in preventing blue heliotrope establishment.**
- **A range of herbicides are available to suit different situations.**
- **Biological control can have localised impacts when leaf-beetle numbers are high.**
- **Cultivation may assist in some situations but can also stimulate further germination and spread.**



Legal requirements to control blue heliotrope

In New South Wales (NSW), everybody has a general obligation (General Biosecurity Duty) to be aware of their surroundings and take action to prevent the introduction and spread of pests, diseases, weeds and contaminants.

In certain parts of NSW, you may be legally required to take measures to prevent the spread of blue heliotrope. You may also be required to control blue heliotrope infestations on your property.

Refer to Chapter 5 for the current declaration status of blue heliotrope throughout NSW (as of June 2023). Contact your local biosecurity officer for further information.

Some content in this chapter was adapted from the national best practice management manual for fireweed (Virtue and Sheehan, 2022), which is available for download from https://wildmatters.com.au/resources/

Integrated weed management

Blue heliotrope is a challenging weed to control, but there are ways to manage it and, better still, to prevent its establishment. The key is increasing resilience to blue heliotrope invasion by building and maintaining ground cover such as competitive perennial pastures, supplemented by biosecurity measures to prevent its establishment and limit its spread. This requires a multipronged approach, namely, integrated weed management (IWM), which combines various control options in a strategic manner. IWM for blue heliotrope includes:

- hygiene measures
- early detection and control of new outbreaks
- promotion and maintenance of pastures or other competitive ground covers
- carefully planned and monitored grazing
- strategic use of herbicides
- biological control.

To develop an IWM approach for your property, consider the advantages, disadvantages and timing of different management options. These options are described in this chapter and summarised in Table 3.1. Examples of IWM approaches are presented in the property case studies in Chapter 4.

Principles for integrated management of blue heliotrope

Develop a weed management plan and implement it

- Identify weed control options and ways to integrate them.
- Incorporate blue heliotrope management into daily property activities.
- Regularly monitor, follow up and review treatments.

Prevent/reduce weed seed spread

- Use prevention strategies, including vehicle, machinery and equipment hygiene, and livestock quarantine.
- Regularly monitor areas at high risk of invasion, such as fence lines and areas surrounding previous infestations.
- Quickly eradicate new, small or outlying infestations.

Actively increase ground cover and competition

- Ensure there is always competition for blue heliotrope seedlings.
- Prevent initial establishment of blue heliotrope populations. A good vigorous pasture is less likely to be infested by blue heliotrope.
- Depleting blue heliotrope seed banks can take a long time.

Seed bank management

- Prevent seed set in adult plants.
- Manage seed bank germination using integrated management methods.

Target young blue heliotrope seedlings

- Seedlings are small, vulnerable to competition and easier to control.
- Reduce seedling survival by minimising bare ground cover, increasing the level of desirable vegetation and/or spraying with selective herbicides.

Critical factors for success

- Prevent the spread of blue heliotrope through good hygiene measures.
- Detect new infestations early.
- Begin control when infestations are small and manageable. Letting it 'get away' will increase the time and expense of getting blue heliotrope back under control.
- Rotationally graze and manage vegetation levels accordingly. Overgrazing and set stocking can leave bare patches of ground and provide room for blue heliotrope to re-emerge.
- Make a long-term commitment. Follow-up control or adequate pre-control (if sowing pasture) is essential.

A control strategy that focuses only on treating existing blue heliotrope infestations and does not invest in prevention strategies and pasture management may result in the continual need to manage blue heliotrope reinvasion.

(Adapted from Osmond and Verbeek, 2008)

NSW DPI

Dense infestation of flowering blue heliotrope.

The management challenges of blue heliotrope

Blue heliotrope can be a challenging weed to control given the following traits.

No special growing requirements

- Blue heliotrope can grow in a range of soils, situations and climates.
- It can germinate year-round under the right conditions.
- It is highly drought hardy.

Fast growing and competitive

- Blue heliotrope seedlings grow and establish quickly, developing a root system more rapidly than many pasture plants.
- Plants can start flowering 2–3 months after seedling emergence.
- Plants take advantage of drought or overgrazed pastures.

Prolific seed producer

- Blue heliotrope produces many sticky seeds.
- The seeds are produced almost year-round, under the right conditions.
- They are long lived.

Spreads easily

- Blue heliotrope plants regrow from seeds and root fragments.

Difficult to control

- Blue heliotrope is hard to control, and regrowth is common.
- It is costly to control, especially when established.

(Based on da Silva, 1991)

Matt Sheehan

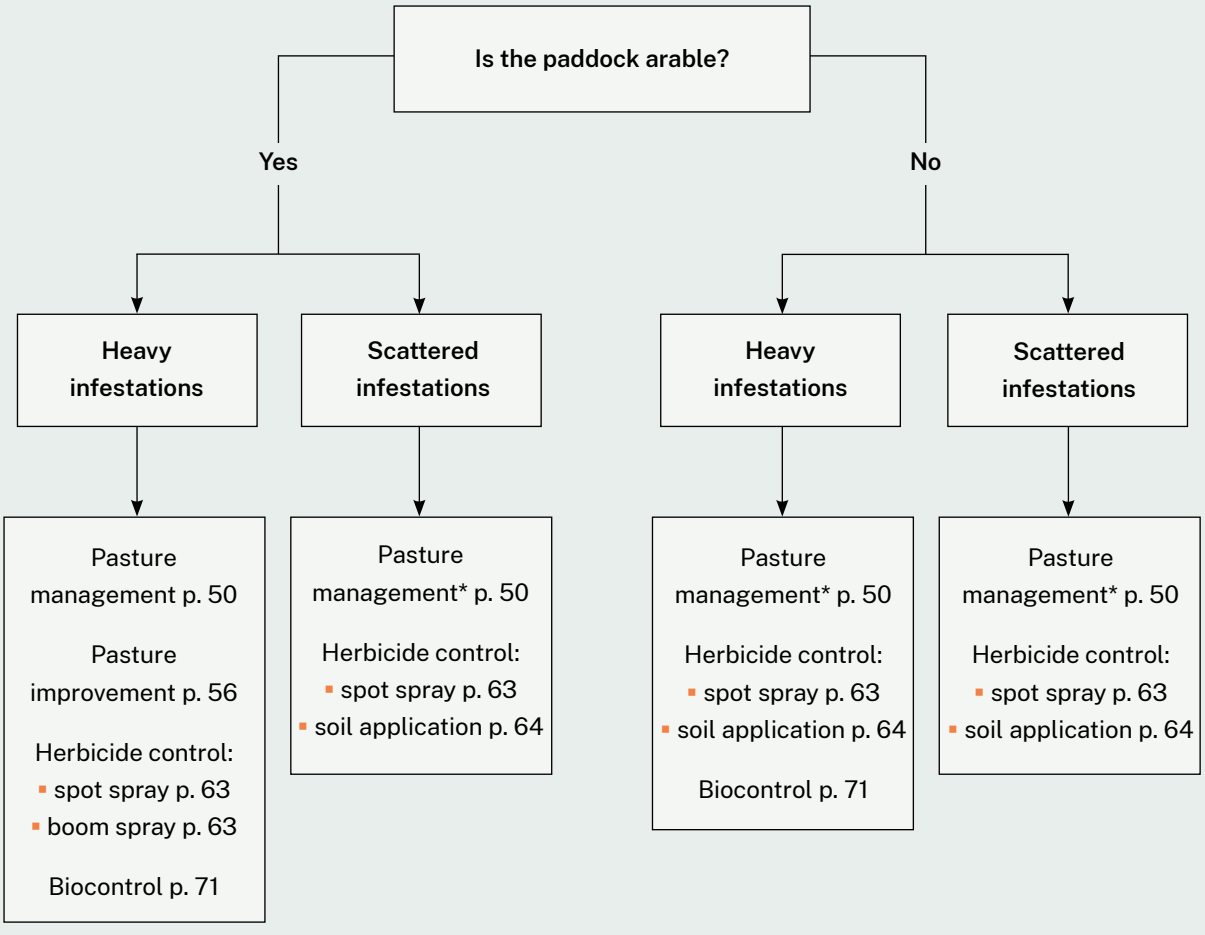
Blue heliotrope takes advantage of drought or overgrazed pastures.

Choosing a control method

Effective control of blue heliotrope requires an integrated approach that is tailored to your situation. The most suitable option will depend on your property, your enterprise and the level of blue heliotrope infestation. Factors identified in your property plan such as goals, management constraints and opportunities will also influence the options available to you. Figure 3.1 provides a quick reference guide to choosing a control method. These methods are summarised in Table 3.1 and expanded on in the following pages.

What is best practice management?

Best practice management is the use of control methods that, through experience and research, have been found to be the most effective and practical means of achieving a management objective (such as reducing the impact of blue heliotrope). It is important to note that the methods described here are only as good as our current knowledge. Documenting and sharing the methods and outcomes of your control programs will contribute to the available knowledge base and highlight areas that need further research.



* Note pasture improvement may not be suitable for these situations. Refer to the planning checklist on page 62 for more information.

Figure 3.1 Decision support tool for choosing appropriate control methods for arable and non-arable areas.

Table 3.1 Summary of blue heliotrope prevention and control options.

	Advantages	Disadvantages	Caution!	Timing	Integrate with
On-farm biosecurity	▪ Prevents weed entry and spread ▪ Avoids future costs and impacts ▪ Low ongoing cost	▪ Set-up costs for washdown areas ▪ Ongoing time commitment to manage spread pathways ▪ Ongoing effort needed to obtain everyone's compliance	▪ Difficult to limit natural pathways of spread	▪ Year-round	▪ All on-property activities ▪ All other control measures
Surveillance	▪ Early detection and intervention reduces impacts and costs	▪ Searching is time consuming and ongoing	▪ Difficult to detect blue heliotrope until it is flowering, by which time it may have set seed	▪ Easiest when flowering; primarily spring to autumn ▪ May be required year-round, depending on seasons	▪ All other control measures
Pasture management	▪ Limits germination and establishment of blue heliotrope ▪ Can increase livestock grazing capacity and farm profits ▪ Suppresses other weeds and protects soil from erosion	▪ Need for ongoing pasture management, including grazing ▪ High upfront establishment costs for pasture improvement and changes to grazing management e.g. fencing ▪ Blue heliotrope plants may still grow, albeit at a low density	▪ Seek professional advice on establishing locally adapted pasture species and a sustainable grazing system ▪ Need to manage blue heliotrope at pasture establishment phase	▪ Year-round ▪ Focus on having dense cover leading into summer	▪ Biosecurity ▪ Surveillance ▪ Herbicides ▪ Hand removal ▪ Biological control
Herbicide control	▪ Can enable targeted control of blue heliotrope ▪ Quick to apply to multiple plants ▪ Range of herbicides to suit different situations	▪ Risk of off-target effects on desirable plants ▪ Risk of spray drift and environmental contamination	▪ There is a legal requirement to follow all label instructions ▪ Follow safety directions ▪ Follow directions on managing drift and residue risks	▪ Boom spray seedlings in spring to summer ▪ Spot spray at other times of year ▪ Soil application year-round	▪ Biosecurity ▪ Surveillance ▪ Pasture management ▪ Cultivation ▪ Hand removal ▪ Biological control

Table 3.1 continued on next page/...

	Advantages	Disadvantages	Caution!	Timing	Integrate with
Biological control	▪ Can defoliate plants, reducing growth, competitiveness and seed production ▪ Can be self-sustaining	▪ Unlikely to give sufficient control on its own ▪ Prefers mild summers and higher rainfall areas ▪ Release sites may require watering in drier seasons to sustain populations	▪ Requires sufficient soil moisture to persist, e.g. riparian areas ▪ Biocontrol agents need blue heliotrope plants to survive and persist	▪ Release agents in spring when sufficient soil moisture is present	▪ All other control measures
Cultivation	▪ Non-chemical means of controlling seedlings ▪ Suitable for gardens/parks ▪ May be used in pasture establishment	▪ Promotes germination, requiring further control ▪ Risk of blue heliotrope regrowth in moist soils ▪ Opens area to invasion by other weeds ▪ Cost of machinery	▪ Can spread blue heliotrope via root fragments ▪ Frequent cultivations can damage soil structure and risks erosion	▪ Spring–summer for blue heliotrope seedlings	▪ Biosecurity ▪ Surveillance ▪ Pasture management ▪ Herbicides
Hand removal	▪ Low cost ▪ Suitable for small infestations ▪ No chemicals or equipment required ▪ Good for follow-up after other controls	▪ Time consuming and labour intensive ▪ Not practical for large infestations ▪ Will not work in hard or compacted soils, such as dry clay	▪ Care needed to remove taproot ▪ Dispose of all plant parts appropriately to prevent spread ▪ Wear gloves	▪ Year-round	▪ Biosecurity ▪ Surveillance ▪ Pasture management ▪ Herbicides ▪ Biological control

On-farm biosecurity

Key points

- **Blue heliotrope and other weeds may be brought to, and spread within, a property in many ways.**
- **Ensure vehicles, machinery and equipment arrive and depart clean.**
- **Establish a dedicated clean-down area.**
- **Quarantine livestock on arrival.**

Biosecurity at the property level involves measures to prevent the entry, spread and establishment of new weeds, pests and diseases. It also applies to not 'exporting' weeds, pests and diseases from your property to other properties (e.g. through contaminated produce or machinery). Developing and routinely implementing a property biosecurity plan is a valuable, low-cost investment to prevent and lessen incursions of a wide range of weeds and other pests and diseases. Guidance on property biosecurity planning is available on the **Farm Biosecurity website** (www.farmbiosecurity.com.au) and from other government and industry sources (see Chapter 5).

For blue heliotrope, various biosecurity practices can be implemented to prevent the movement of blue heliotrope to and across a property. Managing the following potential sources of blue heliotrope seed and/or root fragments will help prevent its spread.

Vehicles, machinery and equipment

Limit where vehicles that come onto your property can go. Clean vehicles, machinery, equipment and tools with a high-pressure blower and/or washer at a designated site on exiting a known infestation area and before entering clean properties. Inspect the clean-down site regularly for weeds. Slash or mow from the least to most weed-infested areas. Avoid times when weeds are flowering and seeding if possible.

Vehicle and machinery clean-down procedures are available at:

- https://www.lls.nsw.gov.au/__data/assets/pdf_file/0003/804387/A4-facts-Sheet-weed-hygiene-FINAL.pdf (LLS)
- www.daf.qld.gov.au/__data/assets/pdf_file/0011/58178/cleandown-procedures.pdf (Biosecurity Queensland, 2019).

People

Use signage at entry points to raise awareness of the biosecurity requirements of your property. Clean footwear and clothing of mud and plant material before entering weed-free areas.

Livestock

Inspect stock for weed seeds before transporting animals to and from your property. Quarantine stock on arrival to allow time for weed seeds to pass through. Monitor paddocks where new stock has been introduced and control outbreaks of blue heliotrope. Maintain fencing between properties to prevent stock movement.

Fodder

Purchase only weed-free hay and other livestock feed such as grains. Where possible, determine where fodder has come from and ask for a vendor declaration. Feed out fodder to livestock in set areas where you can check regularly for new weeds. Ensure pasture and crop seed has been cleaned and certified free of weed seeds. Do not make hay or silage in paddocks infested with blue heliotrope.

Natural spread

Spread by water and wild animals is more difficult to manage but should still be considered in seeking to prevent new weeds arriving and spreading on your property. Monitor areas that feral and native animals frequent because they may introduce weeds. Bear in mind that watercourses may be an occasional spread pathway for blue heliotrope.

Surveillance: Finding new infestations

Key points

- **Regular searching is needed to detect and remove blue heliotrope plants before seeding.**
- **Focus on areas that are a high risk for blue heliotrope incursions.**
- **Record locations where blue heliotrope is found in order to check again in future searches.**

In addition to hygiene measures, another component of a property biosecurity plan is regular surveillance to detect new incursions of pests, weeds and diseases. To detect new outbreaks of blue heliotrope, monitor high risk sites and control plants before they set seed.

Areas to check during regular farm activities include:

- fence lines
- property boundaries
- roads and tracks
- rocky outcrops
- infrastructure (e.g. sheds, yards, tanks)
- livestock camps and feeding areas

- cultivated paddocks
- flood out areas and waterways
- areas surrounding previous infestations.

Areas of bare or disturbed ground are more likely to have blue heliotrope growing. Locations of treated or removed plants should be recorded and mapped so that it is easy to return to the same location to search for new plants.

Matt Sheehan

Farm tracks can provide bare, disturbed ground suitable for blue heliotrope introduction and establishment.

Matt Sheehan

Seedlings emerge in cultivated areas.

The importance of ground cover

Establishing and maintaining dense, competitive ground cover is one of the best ways to limit the germination and establishment of blue heliotrope. Blue heliotrope germinates in response to bare and disturbed ground and reduced vegetative cover. Maintenance of competitive ground cover is particularly critical during summer when blue heliotrope germination typically occurs.

Achieving good competition will depend on your situation and management purpose:

- For properties with livestock – aim to establish and maintain dense, vigorous pastures.
- For amenity areas – maintain dense lawns (e.g. raised mower height) and groundcover.
- On roadsides – maintain or establish competitive, low-growing native vegetation, or otherwise maintain grass swards.
- In areas of degraded and disturbed native vegetation – regenerate and restore with indigenous plantings of quick-growing ground covers, dense shrubs and shading trees.

Note that dense ground cover does not completely prevent blue heliotrope establishing. For example, occasional plants can emerge through well established and dense tropical pasture. However, the number of blue heliotrope plants that need to be controlled by other means will be much lower.

Pasture management

Key points

- **Dense ground cover will suppress blue heliotrope germination and growth.**
- **Grow locally adapted, competitive, perennial pasture species to suppress blue heliotrope and other weeds.**
- **Manage soil health to increase pasture competitiveness.**
- **Practise rotational grazing to optimise pasture growth and competitiveness.**
- **Sowing improved pasture may help to manage dense infestations of blue heliotrope.**

Vigorous, nutritious, sustainable pastures are the fundamental basis of productive, grass-fed livestock enterprises. Maintaining the density and growth of such pastures brings yield benefits for meat, milk and fibre production as well as sustained feed supply for companion animals (e.g. horses). It also provides competitiveness to suppress blue heliotrope establishment and growth. Well-adapted and managed pasture species are key.

The key elements of growing and maintaining healthy pastures are:

- selecting pasture species and varieties suited to local climatic and soil conditions
- ensuring diversity of pasture species for growth in different seasons
- providing nutrition (including fertilisers, planting legumes and liming)
- conducting rotational grazing
- performing weed and other pest control, especially at establishment.

To access more information on pasture management, including online tools and training, refer to Chapter 5.

Dense pastures can be challenging to achieve. Constraints include:

- seasonal conditions such as drought
- less productive soils
- non-arable country
- low (or nil) economic returns per hectare
- high stocking densities
- small properties lacking economies of scale
- lack of time, expertise or equipment.

Nevertheless, the focus should still be on the bigger picture of achieving more productive pastures, rather than solely on controlling blue heliotrope.

A summer-growing perennial pasture will be most effective at competing with blue heliotrope (Dellow et al., 2008), primarily by limiting the establishment of blue heliotrope seedlings within the pasture. It does this by robbing blue heliotrope seedlings of space to germinate, light needed for photosynthesis, and water and nutrients in the root zone. These pastures should thrive if external factors that inhibit their growth are managed (Sindel, 2000).

Shauna Potter

A dense, well-maintained pasture limits blue heliotrope establishment.

Soil health

Pastures should be free from constraints such as nutrient deficiencies, soil structural problems or pH imbalance. For instance, blue heliotrope can grow in acidic soils with poor nutrition. Improving nutrition or correcting pH through applying lime increases the competitiveness of the pasture species against blue heliotrope infestations.

Soil pH has significant effects on pasture plant performance. It can affect the availability of soil nutrients and the health of beneficial microorganisms. Test paddock soils (pH and nutrient status) to determine whether liming is required to reduce acidity and what fertiliser will be needed for strong pasture growth. Key nutrients that may be deficient include nitrogen (N), phosphorus (P), sulphur (S), potassium (K) and molybdenum (Mo). Pasture legumes will fix soil N but still require other nutrients to grow well, particularly P, S and Mo (Leech et al., 2009).

Matching the timing of fertiliser application to the start of active pasture growth periods is crucial, such as spring application for warm season grasses and winter top-dressing with N for ryegrass pastures.

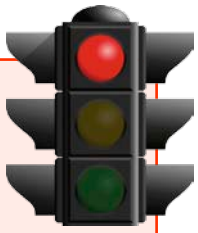
Understanding your soils is key to selecting the right pasture species and managing existing pastures.

Callen Thompson

Monitoring soil fertility and pH is important to maintain pasture productivity.

Weed control

Herbicides can be used to manipulate the balance between pasture weeds and desirable pasture species. Selective herbicides can be used to target particular types of weeds while limiting impacts on pasture species (e.g. a broadleaf herbicide sprayed over a grass pasture). Spot spraying or the use of soil-applied herbicides (e.g. pellets) can be used to avoid off-target damage to pasture species.



Use various pasture management information sources and seek local, professional advice to determine your property's carrying capacity and optimal rotational grazing system.

Managing blue heliotrope through drought

Blue heliotrope is drought tolerant owing to its long taproot and complex system of lateral roots that occur throughout the soil profile (see photo below right). Blue heliotrope will often respond after small rainfall events and can set seed with minimal moisture. Blue heliotrope stores energy in its roots and is often the first plant to respond after opening summer rain.

Managing blue heliotrope using pasture competition can be difficult in drought situations because it is often more tolerant than desirable pasture species. Ensure the following to give pastures the best chance to compete:

- Maintain ground cover, particularly in summer – this will make it harder for blue heliotrope to establish and will increase water infiltration, so when it does rain, desirable pasture species will also respond.
- Do not overgraze pastures; instead, use strategies such as confinement feeding or sacrifice paddocks. Remember blue heliotrope is toxic to livestock and in drought situations may be the only green feed available.
- If sowing pasture, select summer-growing, drought-tolerant species suited to your environment. For example, digit grass cv. Premier has been shown to be highly drought tolerant in the Central and North West areas of NSW and is also responsive to rainfall events.
- Use chemical control options, such as spot spraying, before blue heliotrope plants become moisture stressed.

For more information on pasture management visit the following links:

https://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/establishment-mgmt/drought,-fires-and-floods/pasture-sustainability-management-drought

https://www.dpi.nsw.gov.au/animals-and-livestock/beef-cattle/feed/confinement-feeding-cattle-drought

Grazing management

Key points

- **Graze strategically to maintain ground cover.**
- **Pastures should provide strong competition in summer when blue heliotrope seedlings are establishing.**
- **Overgrazing can lead to bare ground, which will favour blue heliotrope growth.**
- **Blue heliotrope is toxic to livestock. Consumption can lead to ill health and possibly death.**

Grazing pressure is a major driver of pasture productivity, competitiveness and composition. An appropriate grazing strategy should optimise the use of pasture throughout the year, maintain ground cover and give desirable plants time to recover and regrow after periods of grazing. Stocking rates are critical.

Long-term overstocking risks bare paddocks prone to soil erosion, death of valuable pasture species and proliferation of weedy, non-palatable species – including blue heliotrope, which increases the risk of livestock poisoning. Overgrazing is a major cause of blue heliotrope infestations (Dellow et al., 2008).

Pasture availability should be regularly monitored to detect any long-term changes in carrying capacity and to determine when livestock should be moved to another paddock. To ensure year-round feed, and to avoid overgrazing and the development of bare ground, consider conserving fodder through the production of hay and silage for later supplementary feeding.

The use of rotational grazing to regulate grazing pressure is important in maintaining pasture health, productivity and competition against blue heliotrope. There are many ways to practise rotational grazing. These vary in the length, frequency and intensity of pasture rotation and in the length of the rest period.

Grazing rotations should also consider blue heliotrope germination and growth times. Maintaining ground cover from spring through to autumn will reduce the establishment of blue heliotrope. Aim for at least 70% ground cover on flat to slightly sloping paddocks (Figure 3.2).

Grazing management will change depending on species composition, environment, location, pasture health and livestock requirements. It is important that you discuss grazing management techniques with a local expert such as your agronomist or Local Land Services advisor.

Callen Thompson

30% Ground cover

- pasture is not competitive
- weeds will establish in bare areas
- high water run-off
- poor soil and pasture health.

70% Ground cover

- pasture will compete with weeds
- some weeds may establish in bare areas
- reduced water run-off
- good soil and pasture health.

90% Ground cover

- pasture will compete with weeds
- weed establishment is greatly reduced
- minimal water run-off
- great soil and pasture health.

Figure 3.2 Ground cover of at least 70%, but ideally 90%, will support healthy soils and competitive pastures.

Grazing blue heliotrope with sheep and goats

Blue heliotrope contains toxins called pyrrolizidine alkaloids (PAs). When consumed PAs can build up over time, causing chronic organ damage, especially to the liver. Once illness becomes evident, the damage is already severe and irreversible, and there is no treatment. Affected animals may experience prolonged illness, resulting in reduced productivity, or die. Sudden death can occur during times of stress such as mustering (Baskind, 2018).

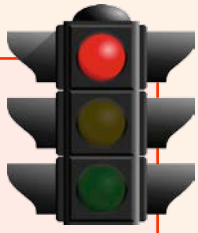
Blue heliotrope is not highly palatable and tends to be avoided by grazing livestock (Dellow et al., 2008). The experience of northern NSW producers during the 2017–2020 drought was that livestock ate it only when it was the sole food source available (C. Thompson, personal communication, 15 June 2022).

Sheep and goats have a higher tolerance of PA toxins than cattle and horses (Dellow et al. 2008) and have been used to manage large infestations of blue heliotrope, including in fallow situations; however, sheep and goats are not immune to blue heliotrope poisoning, and continual ingestion of large amounts of blue heliotrope (either fresh or dried), or their seeds as contaminants in stock feed, can cause irreversible liver damage and reduced productivity (Dellow et al., 2008).

Additional care should be taken where alpacas or donkeys are used as guard animals because they are more susceptible to poisoning than are sheep or goats.

Livestock that have been exposed to other plants containing PAs, such as Paterson's curse (*Echium plantagineum*), common heliotrope (*Heliotropium europaeum*) or fireweed (*Senecio madagascariensis*), may be at higher risk.

In addition to the livestock welfare risks, grazing paddocks infested with blue heliotrope may exacerbate blue heliotrope infestations. For example, grazing at low intensities over long periods may lead to removing beneficial pasture species, reducing competition, and potentially creating a more advantageous situation for blue heliotrope.



Take care not to expose sheep or goats to blue heliotrope, whether over a short period with limited other feed available or over a prolonged period in pastures with a high density of blue heliotrope.

Seek advice from your local vet.

Callen Thompson

Blue heliotrope in a sacrifice paddock following a false break in the 2017–2020 drought. Palatable species have been grazed out.

Tropical pastures

A summer-growing perennial pasture of healthy, introduced tropical grasses competes effectively with blue heliotrope by maintaining ground cover throughout the year and robbing seedlings of light, moisture, nutrients and space (Dellow et al., 2008).

Tropical grasses must compete with blue heliotrope plants as soon as the season breaks in spring so they can grow strongly throughout summer and into autumn, when blue heliotrope seedlings are most likely to establish. This may mean delaying grazing to ensure the grasses grow tall enough to compete with existing blue heliotrope plants for light and establish their roots sufficiently to compete for water and nutrients (Figure 3.3).

Grazing intensively in early summer is possible if the pasture has sufficient moisture and nutrients to recover from grazing. Allowing the pasture to grow tall again will shade any germinating blue heliotrope plants in late summer and autumn. The dry standing grass can be grazed in winter to reduce the chance of blue heliotrope seedlings being sheltered from frost (da Silva, 1991).

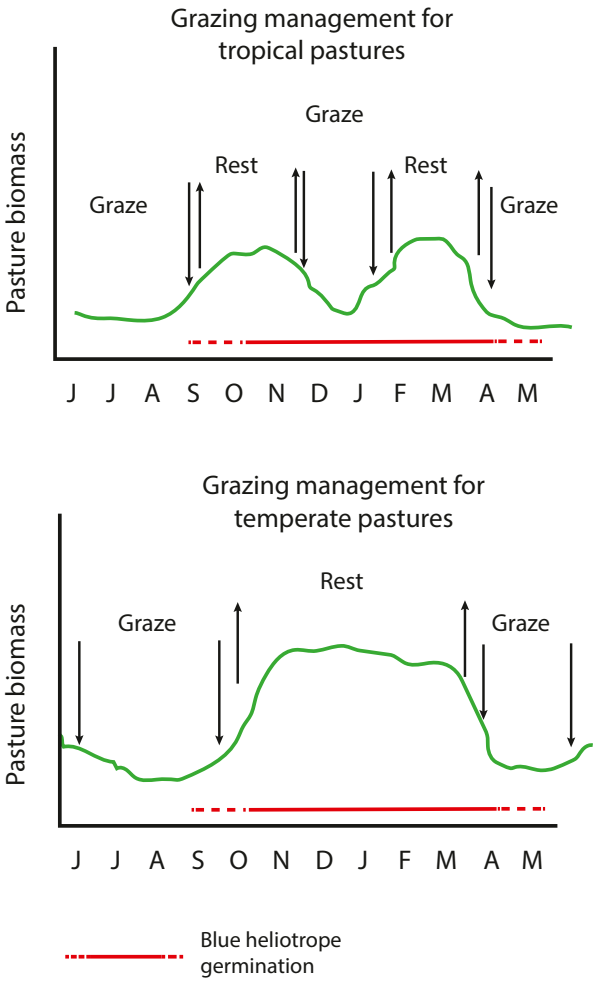


Figure 3.3 Simplified grazing management techniques to manage blue heliotrope in tropical and temperate pastures. Note the intent is to provide good pasture cover (biomass) during the period blue heliotrope seedlings are germinating and establishing.

Temperate and native pastures

Temperate and native grasses are not as competitive with blue heliotrope during summer and autumn and require a different management approach from tropical pastures (Figure 3.3). Reduced grazing in spring will allow temperate pastures to create a dense canopy, thereby increasing the likelihood of the cover remaining over summer and into autumn. As with tropical pastures, dry standing grass can be grazed in winter. This will reduce the chance of blue heliotrope seedlings being sheltered from frost and allow pastures to re-tiller and grow. Compared with tropical pastures, these pasture systems are more likely to produce winter growth and can be grazed in the cooler months.

Callen Thompson

Overgrazed paddocks with a low population of perennial grasses are at high risk of blue heliotrope colonisation because there is space, light and moisture for germinating seedlings.

Sowing improved pasture

Key points

- **Sowing improved pasture can control dense infestations of blue heliotrope.**
- **Pastures take time to establish and effectively compete with blue heliotrope.**
- **Start preparing for pasture establishment at least three years before sowing.**
- **Seek local, professional advice on pasture establishment tailored to your property.**

In some situations, sowing an improved pasture may be a viable control option for dense infestations of blue heliotrope. The combination of reducing blue heliotrope seed in the seed bank and increasing competition over the summer months has worked well for producers in the north of NSW. It is critical to establish pasture correctly to create a dense and competitive pasture.

Sowing improved pastures can be costly, and preparation is therefore critical. It is essential to assess whether it is an economical, practical or legal option for you on your farm. Table 3.2 outlines keys points for establishing pasture. If you require further assistance, contact your local agronomist or a Local Land Services advisor.

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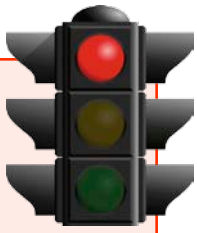
No-till sowing minimises soil disturbance, which can reduce germination of weed seeds, among other benefits.

Table 3.2 Key considerations for improving pastures.

Plan	Identify why pasture improvement is needed. Prioritise which paddocks to improve.
Check for soil constraints	Conduct soil tests and use starter fertiliser if required.
Species selection	Select a species that is suited to your soil, environment and enterprise.
Seed quality	Test seed for purity, viability, germination and weed contamination. Purchase certified seed where possible.
Adequate moisture	Sow with good fallow moisture and at the recommended time for your area. Adequate moisture may vary for tropical and temperate perennial species.
Sowing depth	Ensure shallow sowing depth. For temperate perennials: seed should be covered with no more than 1–2 cm of soil, (<1 cm for very small seed). For tropical perennials: sow less than 1.5 cm deep.
Sowing method	Ensure you are achieving good seed to soil contact.
Follow-up	Monitor for insect pests, weed establishment and disease. Control weeds early.
Grazing management	Ensure grasses are well anchored before grazing, there is good soil moisture and plants are not stressed. Allow pasture to set seed in the first year.

(Source: NSW DPI, 2016; NSW DPI, n.d.)



Before modifying existing pasture, contact Local Land Services to ensure you are undertaking an allowable activity under the *Local Land Services Act 2013* regarding native vegetation. https://www.lls.nsw.gov.au/help-and-advice/land-management-in-nsw

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Established digit grass (Digitaria eriantha *ssp.* eriantha*) and Consol lovegrass (*Eragrostis curvula *type* Conferta*) pasture on the left of the fence line and native/annual summer grass pasture on the right. Note the blue heliotrope on the right-hand side.*

Pasture species selection

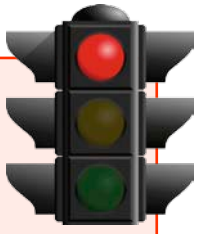
The three types of pasture species suitable for selection are tropical pastures, temperate or native pastures and other crops such as legumes.

A well-managed paddock of **tropical grasses** will compete with blue heliotrope and reduce seedling establishment for the following reasons:

- There are a range of cultivars that are well suited to NSW conditions.
- The cultivars actively grow in spring, summer and autumn when blue heliotrope seedlings are most likely to establish.
- They maintain ground cover throughout the year, thereby limiting weed seedling emergence by robbing seedlings of light, moisture, nutrients and space.
- They persist on a range of soil types.

A range of cultivars are well suited to NSW conditions and have good grazing tolerance. Species such as digit grass cv. Premier (*Digitaria eriantha* ssp. *eriantha*) have been shown to work well on light to medium clay soils in the Central West, North West and Hunter regions of NSW. Bambatsi panic (*Panicum coloratum* var. *makarikariense*) is more suited to heavier clay soils and can handle more waterlogging than digit grass.

In some situations, tropical perennial grasses may be a better option than temperate perennial grasses to compete against blue heliotrope, but they may not be suited to your farm. It is important that you speak to your local agronomist or Local Land Services advisor before sowing tropical grasses.



Are tropical grasses the right option for your farming enterprise?

Tropical grasses (tropicals) produce large amounts of feed in summer and can limit the growth of winter feed.

Tropical grasses can have lower feed quality than temperate species at the same growth stage and may not be suited to all classes of stock, particularly as they become reproductive.

For more information visit: https://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/establishment-mgmt/tpg/northern-inland

Temperate grasses have higher growth rates in spring and early summer but are not as competitive in late summer when blue heliotrope is establishing. There may be benefits to sowing a temperate instead of a tropical pasture owing to regional environmental conditions, pasture quality requirements or the need to fill feed gaps, so temperate species should not be overlooked.

If sowing temperate species to compete with blue heliotrope, it is important to manage pastures to maximise ground cover in late summer. Species options could include perennial ryegrass, cocksfoot, phalaris and fescue. It is important that you choose a species that is suited to your enterprise, soil type and climate.

Lucerne is a temperate **legume** that is very competitive, but is known for having bare patches between plants. Blue heliotrope can establish and persist in these patches, requiring its ongoing control. The lack of a selective herbicide to control blue heliotrope means there may be significant impact on the surrounding lucerne. For best results, lucerne should be sown as a mix with a perennial grass that will fill gaps and provide less opportunity for blue heliotrope to establish.

Incorporating a legume such as clover, medic or serradella is recommended for any grass pasture mix. Legumes provide nitrogen, increase feed quality and quantity and can increase grass growth and competitiveness.

Land managers should select species that are suitable for their area, soil type and situation. Table 3.3 provides guidance on suitable species and should be used in conjunction with local knowledge and advice from your local advisor/ agronomist.

Table 3.3 Competitive pasture species for consideration in pasture improvement.

Pasture species	Perennial	Summer growing	Maintains ground cover	Tolerant of acid soils (pHCa <5.0–6.0)	Tolerant of alkaline soils (pHCa 6.0–8.0)	Tolerant of low fertility soils
Digit grass	✓	✓	✓	✓	✗	✓
Panic (e.g. Gatton panic)	✓	✓	✓	✓	✓	✓
Bambatsi panic (Makarikari panic)	✓	✓	✓	✗	✓	✓
Phalaris	✓	✓	✓	✗	✓	✗
Cocksfoot	✓	✓	✓	✓	✓	✓
Lucerne	✓	✓	✗	✗	✓	✗

✓ Suitable.
✓ Suitable in some situations.
✗ Not suitable.

Comparison between tropical and temperate pastures

Figure 3.4 compares the growth rate of tropical and temperate pasture grasses throughout the year. Many temperate pasture compositions, such as phalaris with subterranean clover, and wallaby grass (*Austrodanthonia* spp.) with subterranean clover typically reach maximum production in spring and taper off in summer. Conversely, tropical grasses actively grow from spring until autumn, when blue heliotrope seedlings are typically germinating.

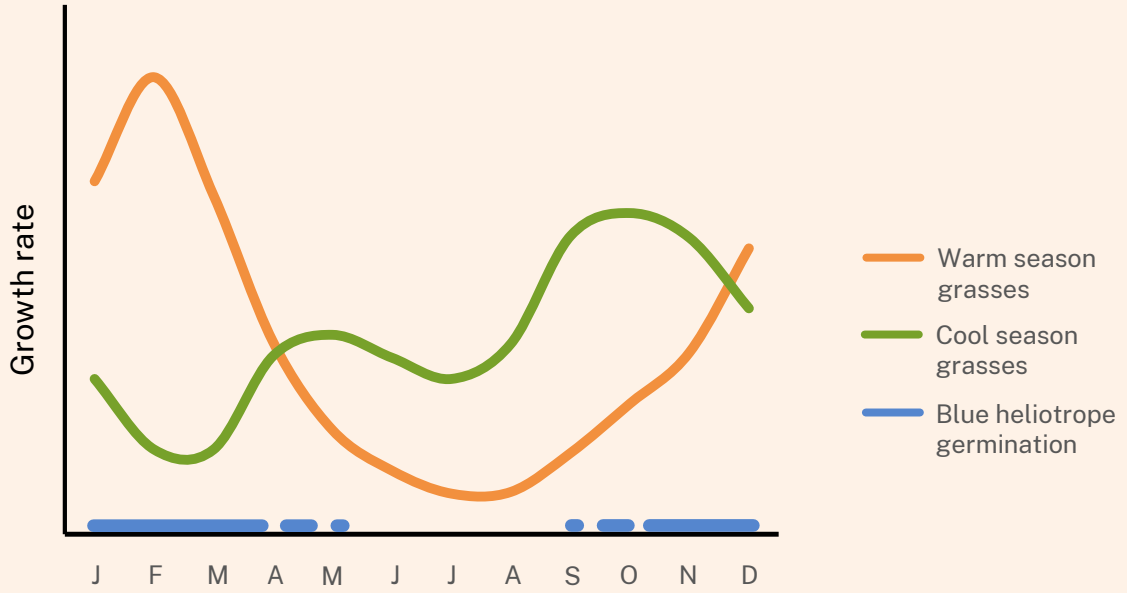


Figure 3.4 Generalised growth pattern of warm season and cool season perennial grasses during the year, overlaid with timing of blue heliotrope germination.

Aerial sowing – a viable option?

While aerial sowing or broadcasting seed is occasionally used to establish pastures in high rainfall zones and in non-arable country, it is not recommended for establishing perennial pastures because of its limited success. When pasture seed is dropped onto the soil surface, weed competition, excessive plant residue, ant theft and slug damage are all factors that can reduce pasture establishment (Ayres et al., 2016). It is important that you speak to your local agronomist or Local Land Services advisor to discuss whether this is a viable option in your environment or situation.

Paddock preparation

Weed competition is a leading cause of establishment failure of new pastures. Undesirable perennial species such as blue heliotrope, bent grass (*Agrostis capillaris*), Yorkshire fog (*Holcus lanatus*) and couch (*Cynodon dactylon*) will prevent the establishment of sown species if they are not controlled prior to sowing. Annual species like liverseed grass (*Urochloa panicoides*) and barnyard grass (*Echinochloa* spp.) in summer, and annual ryegrass (*Lolium rigidum*) and vulpia (*Vulpia* spp.) in winter, compete strongly against desirable pasture species. They germinate and establish faster than newly sown perennial grass, taking up available space, light and soil moisture. Sown perennial grasses are slow to

establish and less competitive than undesirable species at this early stage because they put their energy into root and leaf development.

A three-to-four-year preparatory phase (Figure 3.5) is recommended to reduce the seedbank of undesirable species such as blue heliotrope. Once established, the desirable pasture species will compete with blue heliotrope seedlings. Good grazing management and an IWM approach (including on-farm biosecurity practices) support management of the seedbank and seeds entering the paddock through stock and machinery movement.

The following steps help with pasture establishment.

Step 1 — Reduce weed seed banks

To reduce the soil seed bank of competitive weed species, do not allow plants to set seed for at least three years prior to sowing. Generally, this can be achieved by growing winter cereals for three years and maintaining effective fallows through summer. This process can be modified to suit your own system. For instance, some land managers may sow hard-seeded annual pasture legumes during winter and use a selective herbicide to spray out annual grasses or grow a summer crop with a winter fallow. The priority is not allowing weeds to set seed (Thompson, 2021).

Step 2 — Summer fallow

The fallow over summer is critical for depleting the seedbank by controlling seedlings. A summer fallow has the added benefit of controlling large adult plants that would not be easily controlled by selective herbicide in a pasture situation.

Controlling blue heliotrope in fallow can be difficult because its hairy leaves limit herbicide uptake, which can be aggravated by dust held on the leaves. Often, herbicides will only kill the top of the plant, leaving it to re-shoot from the root system. Broadleaf selective chemicals such as 2,4-D can exacerbate this. Land managers in northern NSW have successfully used glyphosate at high label rates recommended for fallow situations, if the plant is fresh and actively growing and there is no 2,4-D used in the mix (Thompson, 2020). Achieving good coverage is essential, so using higher water rates (100 L/ha) is recommended. Refer to the 'Herbicide control' section of this chapter for more information.

Shauna Potter

Blue heliotrope seedlings emerging after pasture renovation.

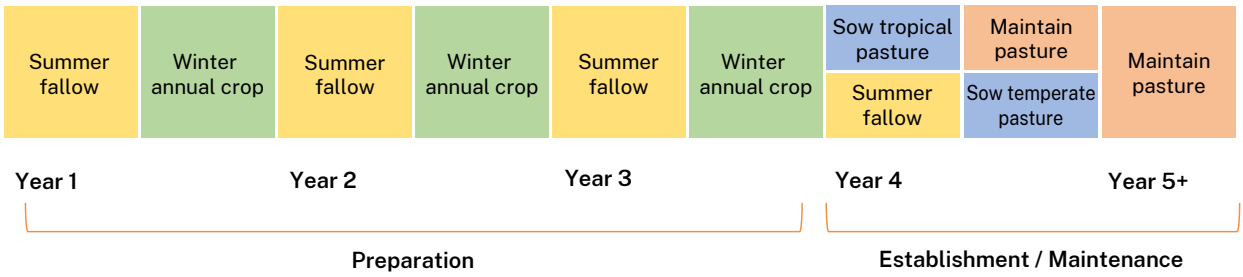


Figure 3.5 Timeline of paddock preparation and pasture establishment.

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A clean fallow free from weeds over summer will reduce weed seed and increase the chance of successful pasture establishment.

A fallowed paddock is a paddock that is not sown for a period. Using a chemical fallow over summer is a good way to control adult blue heliotrope plants and reduce the seedbank.

Step 3 — Cultivation

Cultivation can be used to control blue heliotrope in fallow, but it can also potentially spread the weed, which can regrow from root fragments. To reduce the spread and subsequent establishment of new plants from root fragments, cultivation is best performed after applying a systemic herbicide. Follow-up seedling control is essential (Dellow et al., 2008).

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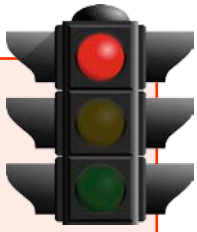
Cultivation of adult plants can lead to establishment of new plants from root fragments. It is important to control adult plants with a systemic herbicide prior to cultivation.



It is important to limit the spread of blue heliotrope root fragments on sowing or cultivation machinery. All machinery should be cleaned down before leaving the paddock.

Post-sowing weed control

Weed control continues to be important post pasture establishment. Even with good pasture management, blue heliotrope can persist on your property or re-enter it. Ensure you plan for and manage seed spread from wildlife, stock, machinery and vehicles and from areas where pasture may not have been sown, such as fence lines, waterways, rockpiles and contour banks. These areas may harbour blue heliotrope; they should be monitored through the growing season and new plants controlled before they set seed.

Read more about paddock preparation in case study 1 in Chapter 4.

Planning checklist for sowing improved pasture

Before sowing improved pasture, it is important to assess whether this is the appropriate management tool for your situation. The following checklist will help determine this. If you answer no to any of these questions, sowing an improved pasture may not be the best way to control blue heliotrope on your property. If this is the case, refer to Figure 3.1 for alternative control options.

Planning checklist

☑ Is improved pasture suitable to your land use?

Improved pasture often has production benefits for grazing enterprises but would not be viewed as an advantage for horticulture or cropping enterprises. Improved pasture may not be a viable option for land managers focused on managing natural environments, riparian zones or those in peri-urban environments.

☑ Is your land arable?

To establish an improved pasture, the country must be suitable for sowing with either a disc or tyne sowing implement. It must be trafficable and relatively free of rock and stone. Under the NSW Land and Soil Capability Assessment Scheme, improving pasture through sowing on land classed 6 and above (OEH, 2012) is not recommended. It is advisable to use zero till and maintain ground cover on any land that is being pasture improved. Improving pasture on land that is moderately or heavily timbered may not be physically possible or economically viable.

☑ Are blue heliotrope infestations widespread and dense across the paddock?

Land managers should assess the weed population to determine whether it is economically viable to spot spray weeds that are at low density or in patches rather than distributed across a paddock. It may be an option to spot spray and improve other aspects of pasture management depending on the pasture composition. If weeds are dense and widespread, sowing improved pasture may be a good option. Refer to Chapter 2 (Table 2.1) for more information on weed invasion stages.

☑ Is existing pasture in poor condition and lacking competitive perennial species?

If the pasture comprises predominantly annuals species, improving the pasture with a perennial summer grass may be beneficial.

In cases where summer-growing perennial pasture species are already present, but may not be performing well, changes to grazing management, soil fertility and pests or disease will increase their ability to compete with weeds. Addressing these limiting factors may increase pasture competition, eliminating the need to sow improved pasture.

☑ Is improving your pasture legal?

Before you remove or change your perennial native grass-based pastures, it is important to consider that native ground cover is subject to the NSW Land Management Framework and other NSW and federal biodiversity conservation laws and regulations, unless otherwise authorised. Contact your Local Land Services office for advice on your specific circumstances.

☑ Do you have the resources?

Improving pasture is expensive, takes time and requires specialised farming equipment. Do you own the required equipment or is there a contractor in your area who can assist?

☑ Do you have the livestock to capitalise on the improved pasture?

Improved pastures often have greater quantity and/or quality of available feed than natural pastures. To capitalise on the investment of improved pasture, ensure you have the right class and number of livestock to utilise the new pasture. Speak to your Local Land Services advisor to discuss potential changes in feedbase quantity, quality and timing and how this might affect your enterprise.

Herbicide control

Key points

- **A range of herbicides are available for use on blue heliotrope.**
- **These differ in their recommended timing, off-target risks and methods of application.**
- **It is a legal requirement to follow the instructions on a herbicide label.**
- **Blue heliotrope seedlings are more susceptible to herbicides than are adult plants.**
- **Multiple annual herbicide applications are needed for effective control.**

Herbicides are a fundamental tool in the control of blue heliotrope. This section provides critical information to enable you to tailor a herbicide control program for your situation based on available application methods. Remember, herbicides are most effective when combined with other control measures (see Table 3.1). Multiple treatments per year may be required to control blue heliotrope, which may have both time and cost implications.

This section outlines critical information on:

- how to apply herbicides to blue heliotrope – page 63
- when to apply herbicides for the best result – page 64
- herbicides available for use on blue heliotrope – page 66
- how to use herbicides legally, safely and effectively – page 68.

Application methods

Application methods used for blue heliotrope include spot spraying, boom (broadacre) spraying and soil application. Read on to find out more about these methods.

Spot spraying

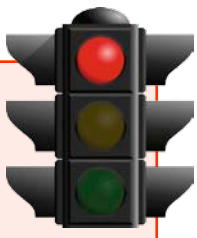
Spot spraying, using a backpack spray unit, controls individual plants or infestations that are small or isolated. Tanks can also be mounted on tractors, vehicles or all-terrain vehicles (for use in areas that are difficult to access).

Spot spraying can be convenient because the same tank mix of herbicides may be used for other weeds growing on the property, thereby reducing the need for different tank mixes. However, some land managers have reported that spot spraying must be repeated three to four times on the same plant to be effective on blue heliotrope.

Boom spraying

Blanket spraying using a boom spray mounted on a vehicle treats large and/or dense areas of blue heliotrope (NSW DPI, 2018). Boom spraying may be used to manage blue heliotrope plants in pasture (using selective herbicides), to prepare heavily infested paddocks for pasture improvement and to maintain fallow.

Spot spraying may be used after boom spraying to control plants that have been missed or regrown.



Before commencing any weed control ensure you:

- **read the factsheet *Using herbicides legally, safely and effectively* (page 68)**
- **are aware of legislation regarding herbicide use**
- **refer to weed control contacts (Chapter 5) for advice and assistance.**

Tips for getting the right spray quality

Blue heliotrope's hairy leaves can limit herbicide uptake. Using adjuvants, such as penetrants, surfactants and wetting agents, can assist. Use only those adjuvants that are compatible with the herbicide and are listed on the label.

Note that adjuvants containing higher amounts of wetter or penetrants, such as an organosilicone penetrant, will result in a finer spray quality (droplet size) than the nozzle type suggests.

Choosing the appropriate spray quality will also improve herbicide uptake. Coarse spray quality works best for blue heliotrope, but always follow the label's direction. Always match application volume to the target spray quality; that is, as the droplet size becomes coarser, the minimum application volume must increase to ensure high levels of spray coverage.

Soil application

Some herbicides registered for use of blue heliotrope, such as tebuthiuron, are applied as pellets directly to the soil. A dispensing device or scales can be used to measure the correct dose, which is then spread via hand over the area.

Soil-based application of herbicides can occur year-round; however, care should be taken when using pellets on hard or dry ground (e.g. during drought). Pellets may be washed away during heavy breaking rains or summer storms, causing off-target damage.

Timing and frequency

It is recommended to spray for blue heliotrope in early spring and early to mid-autumn, assuming plants are actively growing. This limits the potential for plants to dominate pastures and reduces seed set. Learning to recognise blue heliotrope seedlings for spraying is important (see Chapter 1).

Since blue heliotrope can germinate in flushes from spring to autumn, a single annual herbicide application will likely not control all plants that year. Autumn spot spraying of individual plants can also be performed to 'mop up' areas previously treated in spring. This is important, as plants germinating in late summer to autumn can establish deep roots systems, which results in fast regrowth the following spring.

Tips for spraying at the right time

- Spray plants when actively growing. This may occur year-round under the right seasonal conditions.
- Spray within two days following rain.
- Be mindful of seasonal conditions and do not spray if too dry.
- Spray early in the day, when temperatures are 25°C or below.
- Spray before flowering to prevent seed set.
- Aim to spray seedlings (ideally at the four-leaf stage or before) or young plants – controlling mature plants is difficult and they can regrow.

Figure 3.6 provides a calendar of herbicide use timing, based on the typical flush of spring and late summer blue heliotrope germination. Note that timing should be adjusted when flushes occur at other times of the year.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growth stage	May become stressed in intense hot and dry		Growth stage, flowering		Tops die off with frosts in cold areas. May continue to grow and flower in July in warmer areas				Growth stage, flowering			
Action	Can be sprayed with herbicide if not stressed		Best time for herbicide control with active growth		Over-sow with winter crops or winter-active pasture				Best time for herbicide control with active growth			

Figure 3.6 Calendar of herbicide timing for control of blue heliotrope (Hunter Regional Weeds, n.d.).

Herbicides should be integrated with other control measures, particularly those fostering competitive pastures and managing grazing pressure.

Herbicides are also used in pasture renovation and re-establishment. See the section on 'Sowing improved pasture' in this chapter for more information.

What experience tells us

Experienced land managers* offer the following advice for herbicide control of blue heliotrope:

- Results can be variable – tailor control activities to your situation and manage expectations of what can be achieved.
- Timing is critical – spraying stressed plants is a waste of time and money.
- Spot-treat weeds if detected early to prevent establishment and spread.
- A one-off spray will be insufficient – follow-up is crucial. You may also need to spray multiple times in one season, as well as over many years.
- Established plants can re-shoot post control.
- Good coverage of plants is needed – removing pasture bulk, using adjuvants and plenty of water (100 L/ha for boom spraying) will assist.
- Use appropriate nozzle size for adequate herbicide coverage and uptake.
- Selective herbicides applied via boom sprays are only moderately effective in pastures and will take out legumes such as lucerne.
- Consider timing of residual herbicides – if applied in spring they are inactive by winter.
- Integrate herbicide control with competitive pastures.
- Dense infestations may be best tackled through pasture renovation or re-establishment.
- Herbicide and contractor availability may limit planned control activities.
- Manage on-farm biosecurity by spraying boundaries, tracks and infrastructure to keep clean.

* Advice collated from a series of workshops held throughout NSW in 2022.

In 2021, 138 land managers from across NSW provided feedback on their experiences with blue heliotrope via an online survey. Nearly 90% of people responding to the survey used herbicides to control blue heliotrope. Most sprayed more than twice a year (44%), followed by once a year (34%) and twice a year (22%). Over 50% of people using herbicides reported them to be highly to very highly effective at controlling blue heliotrope.

Those that reported high to very high effectiveness with chemical control were more likely to spray more than twice per year. Grazon* was the herbicide most associated with high to very high effectiveness.

Additionally, people reported the following regarding timing and application method:

When do you spray?#	
Spring	60%
Summer	57%
Autumn	19%
What application method do you use?#	
Spot spray	88%
Boom spray	37%
Soil application (pellets)	12%

* Respondents did not specify whether they used Grazon or Grazon® Extra.

Respondents could select multiple options to answer these questions during the survey.

Herbicides for blue heliotrope

A range of herbicides are registered for use on blue heliotrope. Each has strengths and weaknesses, including recommended timing and risks of off-target damage to desirable plants. Table 3.4 lists the herbicides registered for use on blue heliotrope.

NOTE: Not all registered herbicides are commercially available. Often, companies will improve herbicide formulations and only market the new formulation. For example, many herbicides are now being marketed in higher concentrations than they were previously. This reduces transport, storage costs and container disposal costs. Check the company website for a current label.

Combining herbicides

Sometimes herbicides are combined in the same tank mix. For example, a common tank mix for blue heliotrope is picloram + triclopyr + aminopyralid and metsulfuron methyl. Tank mix partners must be physically compatible and registered for the intended situation. Some tank mixes can reduce control efficacy, so seek advice from a reputable agronomist.

Livestock health and herbicides

Blue heliotrope can become more palatable to stock following spraying. Group 4 herbicides such as fluroxypyr and dicamba are particularly problematic because they increase the sugar content of the plants. Livestock should be kept away from sprayed plants until the plants have died down.

Table 3.4 Herbicides registered for use on blue heliotrope.

Application method	Active ingredient	Commercial product examples[1]	State or territory[2]	Rate	Situation in which the herbicide is registered	Comments
Foliar spray	Picloram + 2,4-D (75 + 300 g/L)	Tordon® 75-D	NSW & Qld	1 L/100 L water High volume handgun	Pastures, rights-of-way, commercial and industrial areas	Grass pastures only. Apply to young actively growing plants. Do not graze or cut crops (except sugar cane 8 weeks) or pastures for stock food for 7 days after application.
	Aminopyralid + picloram + triclopyr (8 + 100 + 300 g/L)	Grazon® Extra	All	500 mL/100 L	Agricultural non-crop areas, pastures, rights-of-way, commercial and industrial areas	Treat at flowering. Apply in a minimum spray volume of 1250 L/ha. Corteva Agriscience recommends the use of knapsacks or 12 volt sprayers for use on low-growing herbaceous weeds and woody weeds that are not regrowth and are less than 60 cm high or 60 cm diameter.
	Picloram + triclopyr (100 + 300 g/L)	Adama Fightback®	NSW & Qld	500 mL/100 L High volume handgun	Agricultural non-crop areas, pastures, rights-of-way, commercial and industrial areas	Apply at flowering in a minimum spray volume of 1250 L/ha.
	Fluroxypyr[3] (333 g/L)	Starane® Advanced	All	600 mL/100 L water High volume handgun	Agricultural non-crop areas, pastures, rights-of-way, commercial and industrial areas, forests (including softwood plantations)	Flowering Legumes present at the time of spraying will be severely damaged.
	Dicamba[3] (750 g/L)	Nufarm Kamba® 750	All	400 mL/100 L water + surfactant 1500 L/ha spray volume High volume handgun	Non-crop	Spray prior to flowering.
				87 mL/15 L knapsack	Non-crop	Spray prior to flowering.
				5.9 L/ha + surfactant Boom spray		
Soil application[3]	Tebuthiuron[4] (200 g/kg)	Graslan®	NSW only	0.5 g/m^2	Woody weeds on grazing land	Hand application only. **DO NOT** use within 30 m of trees. **DO NOT** apply to single continuous area greater than 0.5 hectares in size.

[1] Commercial products listed here are examples only, and many other products containing these active ingredients are registered for use on blue heliotrope visit www.apvma.gov.au.

[2] Products may be registered for use on blue heliotrope in all states and territories (shown as 'All') or only in the specific states and territories listed.

[3] Use of soil-applied herbicides must be in accordance with state and/or local native vegetation legislation. Do not use soil-applied herbicides within a distance of two to three times the mature height of wanted trees. Do not apply tebuthiuron within 100 m of a recognised watercourse or on land with a slope greater than 20% (11 degrees).

[4] These products contain different concentrations of the active ingredients. For example, registered products containing the active fluroxypyr are available at 200, 333 and 400 g/L concentrations. Check the label for rates.

FACTSHEET: Using herbicides legally, safely and effectively

Herbicide labels and legislation

The Australian Pesticides and Veterinary Medicines Authority (APVMA) regulates the availability of all pesticides, including herbicides. Herbicides are registered with the APVMA for specific applications as stated on the label, and state or territory governments regulate the use of herbicides after sale (see Chapter 5). A herbicide label is a legal document that defines where, when and how a herbicide may be used, on which weed species and at what rate. This is referred to as 'on label' use.

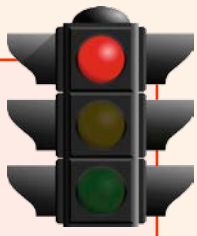
By law, you must read the label (or have it read to you) before using any herbicide product.

Off-label use

Off-label use is the use of a registered chemical to address a specific issue that is not covered by an APVMA approved label or permit, such as to control a different weed, to protect a different host (such as a crop) or to apply at a different rate or frequency. In the case of blue heliotrope, this may include the use of glyphosate in fallow situations.

Refer to the table below for current provisions for off-label use in NSW.

Herbicides allowed Yes (Y) / No (N)		NSW
Rates of application	Lower rate than on label	**Y**
	Higher rate than on label	**N**
	Lower frequency than on label	**Y**
	Higher frequency or rate than on label	**N**
Weed	Different weed than on label	**Y**
Situations and crops	Different crop or situation than on label	**N**
Application equipment	Different application equipment than on label	**N**
Preparation	Tank mixes	**Y**



Warning!

Off-label practices DO NOT exclude or override product maximum residue limits, work health and safety or environmental safety.

If intending to use the product off-label, the user must consider the rate of pesticide, the time and frequency of application, the likelihood of residues and the potential for worker exposure.

'Off-label use' DOES NOT override Directions for Use 'DO NOT' statements on labels and permits, such as 'DO NOT apply to crops or pastures with clover, lucerne or medics'.

The pesticide manufacturer is not liable for off-label use of its product.

Minor use and emergency use permits

The APVMA may issue minor use and emergency use permits for herbicide applications that are not otherwise registered for that particular use. Minor use permits can also be referred to as 'off-label' permits. Minor use and emergency permits are valid ('in force') for a limited time. See the APVMA website to find current permits.

If you are unsure which herbicides may legally be used on a particular weed in NSW, contact the AVPMA or your local weed authority for advice and further information. For priority weeds, herbicide options are listed on NSW Weedwise.

Chemical use training and certification

Chemical use training is required for people using herbicides as part of their job or business. Training is also recommended for community groups and may be required if working on public land. Several training providers exist in NSW, including Tocal College, ChemCert and TAFE. Other training courses may be available through local councils or non-government organisations.

Commercial weed control operators must be licensed in NSW. It should also be noted that shared responsibility now exists between land managers and their contractors for any breaches of laws and regulations such as herbicide drift.

Safe use of herbicides

Take care to minimise off-target herbicide damage to desired plants and animals, the environment, yourself and other workers.

Operator safety

Herbicide labels will indicate the personal protective equipment (PPE) required for operator safety. This may include:

- impervious gloves
- eye protection
- respirator (with a filter appropriate to the level of herbicide toxicity)
- clothes, hat and boots that cover the whole body.

For herbicides with a higher risk to operator safety, additional PPE and precautions may apply, including wearing a full-face respirator and chemical-resistant overalls.

Always follow the herbicide label requirements and consult the Safety Data Sheet on the health risks of exposure and PPE recommendations.

Withholding periods

Certain herbicides have withholding periods, during which livestock must be excluded from grazing treated areas, and cutting pastures for hay or silage should be avoided. Do not introduce stock within the withholding period stipulated by the product label.

Peter Casey

PPE may include gloves, eye protection, mask, covered clothes and waterproof boots. Always follow the label and Safety Data Sheet recommendations for PPE.

Environmental protection

Herbicide labels provide the mandatory measures an operator should adopt to protect the environment and non-target plants during the product's use. This may include instructions for preventing spray drift.

Herbicide users have a legal obligation to avoid spray drift damage and to ensure that the applied chemical stays within the target area. This is to avoid 'off-target' impacts to crops, native vegetation and other plants, and 'chemical trespass' onto neighbouring properties.

Measures to reduce the risk of spray drift include:

- spraying when the wind is 3–15 km per hour, or when no surface temperature inversion conditions exist
- using a coarse to very coarse spray quality nozzle type
- avoiding the use of high pump/sprayer pressures that create small droplets that float in the air
- having buffer zones.

Follow label directions regarding any risk of soil-applied herbicides spreading via run-off following rainfall or irrigation.

Using herbicides near water

Riparian zones are sensitive habitats and therefore a licence may be required to conduct weed control works within these zones. Use only herbicides that are registered or permitted for use in and around aquatic areas; some are formulated to be lower risk when used near water, for example, Roundup® Biactive. Never:

- spray herbicides over waterbodies or plants standing in water
- add adjuvants to herbicides to be used near water.

Effective use of herbicides

Successful herbicide control is dependent on:

- selecting the right herbicide for the target species
- the growth stage of the target species
- the weather conditions during and after spraying
- how thoroughly the herbicide is applied
- the herbicide mix and application rate.

For spraying, wind speeds should be low (<15 km/h but above 3 km/h), and no rain should be expected in the following six hours.

Do not apply herbicide to plants that are under any sort of stress because it will not be absorbed and translocated effectively, resulting in a reduced level of control. Plants may be stressed owing to:

- dry soil
- low humidity
- air temperatures above 30°C
- frost.

Herbicide effectiveness can be maximised by:

- mixing it with dye to help minimise missed areas and prevent over-spraying (double spraying). Similarly, a foam marker or GPS can be used to indicate the edges of boom spraying
- using an adjuvant – an additive that improves herbicide uptake
- ensuring spray equipment is correctly calibrated and maintained, including by thoroughly cleaning it between uses.

If an adjuvant is used, always read the product label to ensure it is compatible with the herbicide and there are no restrictions on its use, e.g. adjuvants should not be used near waterways.

Where to get help

Refer to Chapter 5 for contact details and more information on the safe use of herbicides and chemical use training and certification.

Biological control

Key points

- **One biological control agent, the leaf-beetle, has been released in Australia.**
- **The leaf-beetle is widespread in higher rainfall areas of NSW.**
- **Localised impacts, including defoliation of blue heliotrope plants, occur when leaf-beetle numbers are high.**
- **The leaf-beetle can be field collected or reared in cages and redistributed directly into suitable blue heliotrope infestations.**
- **Water-stressed plants may not support as many leaf-beetles as healthy plants can.**
- **Research into a second agent, the root-feeding flea-beetle, is occurring, but the flea-beetle has not been approved for release in Australia.**
- **Biological control should form part of an integrated control program.**

Blue heliotrope was approved as a target for biological control, or biocontrol, in 1997 (Briese, 2012). Shortly thereafter, researchers introduced two species of insect from South America into Australian quarantine to test their potential as biocontrol agents for this target weed. One of these, the blue heliotrope leaf-beetle (*Deuterocampta quadrijuga*) was approved for release in 2001 (Briese and Zapater, 2001) and has subsequently established in the field (Briese, 2012). The second species, the blue heliotrope flea-beetle (*Longitarsus* sp.), is not yet approved for release in Australia. It is currently undergoing further testing in its native range (Argentina) before a decision is made regarding whether to submit a revised application to the Australian Government for its release.

The following biocontrol best practice information is a modified excerpt from *Biological control of weeds: a practitioner's guide for south-east Australia* (Harvey et al., 2021). Approval to use this information is gratefully acknowledged.

Blue heliotrope leaf-beetle (*Deuterocampta quadrijuga*)

First released in 2001 and later redistributed from 2003 to 2010, the blue heliotrope leaf-beetle is now widespread throughout the cooler regions of NSW (e.g. Tablelands and North West Slopes), where rainfall is high. The potential benefits of this biocontrol agent are reducing blue heliotrope above-ground biomass (thereby reducing the potential to poison stock and limit photosynthesis), competitiveness, seed production and seed bank (leading to eventual population decline and reduction in spread into new areas) (Briese, 2012).

Establishment of the blue heliotrope leaf-beetle remains poor in arid areas and in places with high summer temperatures because beetles do not breed well on moisture-stressed plants. In areas with high densities of beetle, complete defoliation of above-ground plant material by adults and larvae occurs, and localised control is achieved. Repeated defoliation assists to deplete the plant's underground reserves, leading to plant death.

Identification

This large, shiny, black beetle (up to 10 mm long) is readily identified by its orange to red stripes along the length of its elytra (hardened forewings). Larvae are cream to light pink with seven orange bands across their back. Depending on stage of development, larvae can range from approximately 2 to 15 mm in length. Both larvae and adults feed on the leaves and stems and can completely defoliate the above-ground biomass, particularly early in the growing season. Egg clusters can be found under the leaves, and they transition from orange to brown as they develop.

Andrea Fletcher-Dawson

Blue heliotrope leaf-beetle. NSW DPI.

Matt Sheehan

Blue heliotrope leaf-beetle larvae.

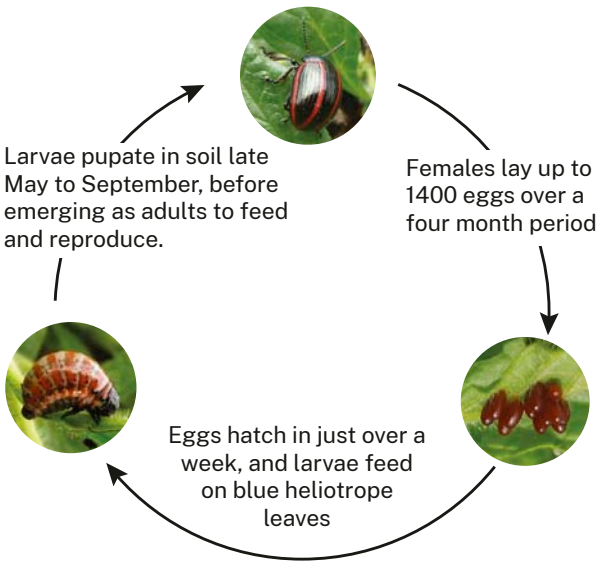


Figure 3.7 Life cycle of the leaf-beetle.

Life cycle

Blue heliotrope leaf-beetles can undergo several overlapping generations per year (Figure 3.7). Females are highly fecund and may lay up to 1400 eggs over a four-month period. Eggs hatch in a little over a week, and the emerged larvae feed on leaves before leaving the plant and pupating in the adjacent soil. Pupation takes place over the winter period from late May to September, before adults emerge to feed and reproduce over the warmer months (Briese, 2012).

Agent distribution

The blue heliotrope leaf-beetle has been released at a variety of sites in NSW, covering a range of climatic and ecological situations, but with variable results. Beetles prefer healthy, actively growing plants, but this has still not proved a guarantee of establishment.

Directions for rearing and releasing

Field collection

Adult beetles and larvae can be collected for redistribution from spring to summer. Either collect them by hand or by beating the plants' foliage. Collect at least 500 beetles for each planned release site. Prior to redistribution, beetles can be stored temporarily (at cool

Mick Willott

Field-collected adults and larvae in tub.

Andrea Fletcher-Dawson

Weed professionals collecting the blue heliotrope leaf-beetle in Bathurst, NSW.

temperatures) in sealed containers with small air holes for ventilation (i.e. for a few days at around 15°C).

Rearing insects away from the field

Beetles are easy to rear in insect-proof cages containing potted blue heliotrope. On average, 10 large plants can fit in a 1.2 × 0.6 m cage, which will support the offspring of five to seven egg-laying females. Assuming 50% of beetles are female, add 10 to 14 adult beetles to each cage. Because larvae are voracious feeders, they can defoliate plants within a few days, so it is important to monitor regularly and replace their food source. Keep plants well-watered because water-stressed plants can potentially stop the beetles breeding. Collect pea-sized and larger larvae for redistribution, leaving adults to continue to reproduce to their full potential. Larvae are best collected by hand using soft touch forceps, which are available from entomological equipment suppliers. Like field-collected larvae, cage-reared larvae may be stored temporarily prior to release.

Releasing insects into the field

Release collected beetles (adults and larvae) directly onto healthy plants as soon as possible. To assist with establishment, consider making multiple releases at a single site over a season. Since populations of beetles are less likely to build up on water-stressed plants, be sure to water the plants regularly at your release or nursery site. Field cages (distinct from cages used to rear beetles) can also assist establishment by eliminating predators and containing beetles to restrict dispersal prior to mating and egg production.

Ensure you check regularly that there is sufficient food supply. Simply move the field cages around locally on a regular basis to achieve this. Adults can be released whenever they are present over the warmer months. Cages are best used if you are attempting to build populations in the late summer or early autumn so that the population is contained as the pupae overwinter. Cages should be removed the following spring once there is evidence of egg and larval production. Record release information as per the weed biocontrol release form (refer to Chapter 5) and submit a copy to your local biosecurity officer.

When releasing the blue heliotrope leaf-beetle, it is important that you:

- release individuals in spring and on healthy plants where your site has sustained soil moisture (e.g. riparian or higher rainfall regions)
- recognise that blue heliotrope is best managed when utilising biocontrol as one component of a broader, integrated management strategy.

NSW DPI

Leaf-beetle feeding damage on blue heliotrope leaves.

Monitoring establishment and dispersal

Inspect for leaf-beetle presence (adults and larvae) and feeding damage (chewed leaf edges) at the nursery site within one year of release. Examine the underside of leaves for egg clusters and/or larvae. Record their presence or absence as per monitoring guidelines (Harvey et al., 2021, Appendix 3), and if present, begin monitoring agent dispersal at incremental distances away from each nursery site as per your guidelines. Monitor annually.

Biocontrol Hub

Information sharing is vital to the success of biological control of weeds. Recording what weed species you are controlling and the locations of agent release sites can assist others to obtain access to the right agents for their infestation.

The Atlas of Living Australia (ALA) is a national online biodiversity database that supports information sharing. The Australian Biocontrol Hub is a portal within the ALA that acts as a one-stop shop for data and information sharing on weed biological control.

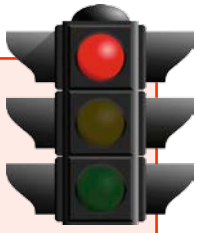
The Biocontrol Hub can:

- facilitate recording of biological control agent release and establishment data
- capture observations of biological control agent spread
- ensure biological control agent distribution data are readily accessible
- provide access to biological control extension material.

For further information on how to contribute to or utilise information on the Australian Biocontrol Hub, visit the website: https://biocollect.ala.org.au/biocontrolhub

Cultivation

Cultivation can be used as a control technique for blue heliotrope in cropping systems and home gardens, but it has limited use in other situations, such as pasture paddocks. The disturbance caused by soil cultivation may stimulate a flush of blue heliotrope germination. Seedlings can then be controlled by subsequent cultivations or herbicides. Summer cultivation may help reduce seed set from established plants and prevent regeneration of root propagules (da Silva, 1991).



Cultivation can spread blue heliotrope both within paddocks and to areas outside infested paddocks. Employ hygiene techniques, such as working in clean paddocks first and washing down machinery and vehicles to prevent movement of root fragments.

Frequent cultivation can also damage soil structure and risks erosion.

Hand removal

Hand pulling seedlings or young plants is possible; however, care must be taken to remove the entire root system or the plant may regrow. This method is generally only suitable for individual plants or small infestations because it is time consuming. Plants are easiest to remove when soil is moist. For best results, follow this process:

- Hold the plant stem as close as possible to the base of the plant.
- Gently tug the plant and rock from side to side. This will loosen the soil and allow the roots to come free.
- If the stems are breaking off from the taproot, use a knife or trowel to help free the roots as they are being pulled out. The entire root system must be removed.
- Remove the plant, shaking off any soil, bag and dispose of plants (including roots) properly (OEH, 2013).

Chapter 4

Case studies

Case study 1 Herbicides and pasture management at Binnaway

Jim Larkin and Bill Davidson

Key points

- **Well managed perennial grass pastures are integral for managing blue heliotrope while providing production for the farm business.**
- **It is vital to boom or spot spray actively growing plants within two days after significant rain (20–25 mm) to achieve best results when controlling blue heliotrope.**
- **Due to a large seedbank built up over time, eradication at Binnaway is unlikely. However it is possible to keep impacts of blue heliotrope to a minimum with a well-managed pasture system.**

The property

'Clarefield' is situated east of Binnaway in central-west NSW. It is 1300 ha in size, with the use of an additional lease block.

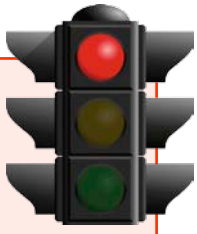
The main enterprise on 'Clarefield' is a self-replacing Angus breeding herd that consists of 400 cows in a normal season. During the most recent drought, numbers were reduced to 200 cows. There has been a gradual build-up of numbers since the season has improved in the last two to three years. The best of the female offspring is returned to the herd for future breeders, while cull females and steers are sold as feeder cattle or into the supermarket trade.

The soil types on this farm vary from light sandy soils to black self-mulching clays and alluvial soils along the creek flats. Country is mostly arable except for the timbered ridges. Rainfall is 600 mm per annum and is spread evenly across the year.

The pasture base consists of native C3 and C4 grasses in some areas and sub-tropical grass pastures mixed with introduced legumes (arrowleaf clover). Forage oat crops are grown to provide good quality feed over winter, along with lucerne paddocks to provide hay and standing feed.

The problem

Previous owners suggest that blue heliotrope was first introduced in the 1930s via a railway that ran through the middle of the property. In those times, livestock were commonly moved on trains and stock would often be unloaded on 'Clarefield' for a rest or delivery within the district. Blue heliotrope with its 'sticky' seed heads would have easily attached itself to stock and been deposited wherever animals were unloaded or travelled through the property.



Consol lovegrass maybe invasive in certain parts of NSW and landowners need to be aware of their General Biosecurity Duty. For more information visit: www.dpi.nsw.gov.au/biosecurity/managing-biosecurity/the-general-biosecurity-duty

Jim Larkin

Dense infestations of blue heliotrope have resulted in a large and persistent seed bank at 'Clarefield'.

First attempts to control the weed involved the use of a plough. However this only aided in moving the weed around the property. Glyphosate was used with varying levels of success, with effectiveness dependent upon application timing and size of the individual plant. Before the introduction of tropical grasses, a lot of pastures on 'Clarefield' were subclover dominant. These pastures produced high quality feed through winter and spring in a decent season, but once the subclover had burnt off in late spring, blue heliotrope would dominate these pastures until late autumn/early winter the following year. These paddocks were very unproductive over the warmer months because once the blue heliotrope started growing and dominating, there was little palatable feed left. As a result, they could only be grazed for a short time until the small amount of good pasture was eaten off and the stock were moved on.

The approach

Herbicides

Spot and boom spraying are the primary methods used to control blue heliotrope on the property. A mix of metsulfuron and picloram + triclopyr + aminopyralid is used when spot spraying. Picloram + triclopyr + aminopyralid is sometimes used through the boom spray in grass pasture paddocks, depending upon how much desirable legume is present. Glyphosate is effective in the fallow paddocks, provided application occurs on actively growing plants that are not moisture stressed and within two to three days following rain.

Boom spraying with glyphosate is used in the cropping country to control blue heliotrope and other fallow weeds, before growing dual purpose oats or sowing tropical pasture. It is critical to spray actively growing plants within two days significant rainfall (20–25 mm), as this seems to enhance the results. Check soil moisture and plant health before you spray to ensure optimal spray conditions.

Pasture improvement

Once a paddock becomes heavily infested with blue heliotrope, it will be sprayed out with glyphosate in the spring, fallowed over summer and have oats sown the following autumn. This cycle is repeated for the next two years to make sure blue heliotrope and summer grass weeds are cleaned up, before sowing the new tropical grass pasture. Once this pasture is well established it is normally competitive enough to keep blue heliotrope at bay. A dense, healthy, well managed tropical grass pasture out competes blue heliotrope and Jim finds that very few plants grow in such pastures.

Jim Larkin

Heavy infestation of blue heliotrope before pasture improvement.

Jim Larkin

The same paddock as above, with a dense cover of competitive pasture.

The result

At 'Clarefield', the key to controlling blue heliotrope is the use of warm season perennial grasses such as 'Premier' digit, Bambatsi panic and Consol lovegrass to provide competition. If these types of pastures are well established and maintained, blue heliotrope numbers can be kept to minimum or negligible levels. At 'Clarefield' this means that instead of blue heliotrope dominated pastures over the warmer months, these competitive perennial grass pastures provide high levels of production while keeping the weed burden to a very low level. This leads to a more profitable business and a reduction of blue heliotrope seed in the soil seed bank. These pastures have the potential to persist for a long time, if well managed (through adequate resting from grazing and supplemental nutrition). Having competitive pastures that outcompete blue heliotrope means significantly less herbicide use and time spent spraying, which leaves more time for other important tasks within the business. It is important to remain vigilant though, and swiftly treat any new incursions before they become a big problem.

Jim Larkin

Competitive pastures have successfully reduced blue heliotrope infestations, resulting in a more profitable enterprise.

The future

To date, Jim has been able to keep blue heliotrope at bay by using competitive, warm season, perennial grass pastures. He will continue with this approach as it seems to be working well and provides good production for the cattle enterprise. Patches in other areas will be managed through constant vigilance and spot spraying. Ensuring longevity of these pastures in the future, through grazing rotation and nutrition, is key to providing a cost efficient and productive way of managing blue heliotrope so that it doesn't adversely affect the business. A common concern among producers is herbicide resistance. The prospect of an additional biological control agent is encouraging (see Chapter 3), as it will provide another tool to help manage blue heliotrope.

Key learnings

- Competitive, warm-season growing pastures are key to managing blue heliotrope.
- Perennial grass pastures such as 'Premier' digit, Bambatsi and Consol lovegrass are very competitive and productive grasses that — if well established and appropriately managed — will out compete blue heliotrope.
- It is important when selecting pasture species that you talk to an agronomist or pasture specialist to ensure they are not invasive in your area.
- For best results from boom spraying with glyphosate, it is preferable for plants to be sprayed within two days after significant rain.

This case study documents the decisions and experiences of the land manager. It is important to select a control option that is suited to your specific situation and enterprise. Refer to Chapter 3 for more information and seek professional advice from your local biosecurity officer or agronomist.

Case study 2 Integrating biocontrol with other control options near Bathurst

Mick Willott and Andrew McConnachie

Key points

- **A long history of overgrazing had led to a lack of summer feed, and over 60% of the property being infested with blue heliotrope.**
- **Chemical control (metsulfuron and picloram + triclopyr + aminopyralid) was adopted as the first management approach, but topography limited its application.**
- **In the wet spring and summer seasons of 2020/21, the resident population of the blue heliotrope leaf-beetle exploded, significantly impacting blue heliotrope on parts of the property.**
- **The leaf-beetle has also been found 20 km north and 10 km south of the property.**
- **The current strategy is to treat areas with good populations of the leaf-beetle with Seasol™ and exclude herbicide control.**

The property

'Stoney Creek' is a 500-ha property situated north of Bathurst, in the Central Tablelands region of NSW. Soil types vary from slate derived soils to acidic soils and less fertile soils (kurosols and rudosols). Rainfall is approximately 620 mm per annum and spread evenly throughout the year.

The main production system on 'Stoney Creek' centres around 80 Angus breeders, with the best of the heifers retained in the herd and the remaining offspring sold off at varying ages depending on the season and markets. Also, run are 200 head of Merino sheep.

'Stoney Creek' has 30 ha of arable country and 270 ha of non-arable mountain country. The pasture base consists of native C3 and C4 grasses (*Austrostipa* spp., Red grass, Kangaroo grass, some old stands of Phalaris, Cocksfoot, and clover). Rye grass, Tall fescue, Cocksfoot and clovers were all recently introduced, with Consol lovegrass, 'Premier' digit grass and

Shauna Potter

Much of Mick's property is non-arable, presenting challenges for weed control activities.

native grasses all present, and Serradella and clovers as the legume base.

The problem

When Mick Willott took over 'Stoney Creek' 15 years ago, blue heliotrope was already present. The history of the weed's introduction and establishment on the property is unknown. However, potential overgrazing of cattle may have contributed to the heavy infestation of blue heliotrope, which became established across 60% of the farm. This resulted in a lack of summer feed in areas dominated by blue heliotrope.

The approach

Pasture improvement

Mick initially invested in boom spraying (with metsulfuron and picloram + triclopyr + aminopyralid) of accessible areas infested with blue heliotrope. Thereafter, he reseeded these sites with a locally-sourced 'Tablelands' mix and treated with Seasol™ and/or superphosphate. Applied across approximately 30 ha of accessible area, this approach costs approximately $6,000 in product and a minimum of 160 hours of labour annually. Results showed this approach to be very effective for providing summer feed that competes well with blue heliotrope. Mick continues to implement this method as well as subscribing to regenerative practices of improving soil, pasture and stock health.

Despite his success, Mick is concerned about resources spent in trying to control blue heliotrope on his property.

> *"Ongoing costs will increase (before decreasing) as soon we will be working on land that is more difficult to access, in turn driving the cost up. In future we will need to bring in a helicopter to spray and seed. Recently, after the drought, we have lost cattle, we suspect from blue heliotrope poisoning, costing more than $20,000."*

Biological control

Mick was aware that the blue heliotrope leaf-beetle (*Deuterocampta quadrijuga*) was present on the property when he acquired it, but noted that the leaf-beetle population (and impact) were sporadic. Then, during the wetter years of 2020 and 2021, Mick noticed an explosion of leaf-beetle numbers while out mustering cattle. He found leaf-beetles in vast numbers and at all life stages. Extreme damage was noted on the leaves and flowers of blue heliotrope:

> *"Whilst out moving cattle I noticed many black beetles. I stopped to investigate and realised it was the blue heliotrope leaf-beetle. I was thrilled to see it in such large populations!"*

Shauna Potter

Mick has been pleased with the impact of the leaf-beetle at Stoney Creek.

Research on the blue heliotrope leaf-beetle has revealed that for populations to thrive and persist on the weed, soil moisture must remain at a high level (Harvey et al., 2021). Not only does this keep the plants in good condition for the insect, but part of the leaf-beetle's life cycle is directly dependant on good soil moisture.

Matt Sheehan

Blue heliotrope leaf-beetle larva.

With La Niña events having led to above-average rainfall for northern and eastern Australia over spring and summer of 2022 and 2023, conditions were very favourable for blue heliotrope leaf-beetle populations. Therefore, Mick chose not to spray the areas where the leaf-beetle was thriving. Instead, he treated these areas with Seasol™ with the hope that native grass species would become more competitive, and that the blue heliotrope would become more nutritious for the biocontrol agent. Conditions will be less favourable for the leaf-beetle in El Niño periods.

Refer to Chapter 3 for more information on the blue heliotrope leaf-beetle.

The result

Mick found his approach of boom spraying blue heliotrope followed by reseeding and then fertilising to be very effective. With regard to his approach with his biocontrol management sites (delimitation and treating with Seasol™), Mick says "*I am awaiting the results of this action, and I am eagerly anticipating the return of the leaf-beetles again.*" According to Mick, the impact of the biocontrol agent in 2020/21 was spectacular, especially on flowers and leaves. He hopes that with favourable conditions this will be repeated in future years.

Shauna Potter

Arable areas provide an opportunity for pasture improvement at Stony Creek, providing summer feed in areas previously dominated by blue heliotrope.

The future

Mick hopes to contain and reduce the blue heliotrope infestation at 'Stoney Creek' over time. Keeping pastures competitive via treatment regimes and conservative stocking densities is an important part of his approach. Chemical control, while effective, is cost-prohibitive and is not an option for inaccessible parts of his property. Instead, Mick hopes that the blue heliotrope beetle and any other additional agents in the biocontrol pipeline will play an important role as part of his integrated weed management toolkit.

Key learnings

- When releasing field-collected blue heliotrope leaf-beetles it is important that you release them in spring on healthy plants at sites that have sustained soil moisture (e.g., riparian or higher rainfall regions). This will ensure the collection of a good quantity/quality of leaf-beetles for redistribution.
- Ensure that your weed management techniques do not overlap. Reserve separate areas for chemical and biocontrol techniques, as the former may negatively impact the efficacy of the latter.
- Record beetle release information annually and share this information with your local biosecurity officer (see biocontrol section for further information).

This case study documents the decisions and experiences of the land manager. It is important to select a control option that is suited to your specific situation and enterprise. Refer to Chapter 3 for more information and seek professional advice from your local biosecurity officer or agronomist.

Case study 3 Chemical control of blue heliotrope at Dungowan

Cameron and Caroline Tongue and Bill Davidson

Key points

- **Spraying blue heliotrope in the spring, when plants are small, is the most effective way to keep on top of its management.**
- **The removal of dry grass in the winter is key in making sure that the maximum amount of herbicide contacts the leaf surface of blue heliotrope, especially when boom spraying.**
- **Use the recommended herbicide rate, and do not reduce rates for cost saving purposes, as this may lead to inferior results.**
- **Frequent monitoring of paddocks is critical to detect new incursions.**
- **The containment of blue heliotrope has allowed the Tongues to maintain production levels on their farm.**

Bill Davidson

'Clermont' has a native grass and subclover/clover pasture base.

The property

'Clermont' is a 1836-ha property in Dungowan, near Tamworth in the North West region of NSW. The property has basalt derived soils with country ranging from small, undulating to steep timbered hills. Approximately 2% is arable. Rainfall is 650–700 mm, spring summer dominant.

'Clermont' runs 200 beef breeding cows and calves plus 200 trade cattle, with cattle grown out for the supermarket trade. Cattle are raised using native C3 and C4 grass and clover-based pasture, with a small amount of forage oats and supplementary feeding with grain to assist in getting cattle to market specifications. The Tongues also run approximately 500 Merino wethers for 18–20 micron wool.

The problem

Blue heliotrope spread to the Tongue's property around 15 years ago in the airstrip paddock, most likely via animals (possibly kangaroos) transporting seed. This weed has the potential to take over a lot of country, especially the steeper non-arable parts. If this were to occur, production would severely decline as livestock do not thrive on blue heliotrope-infested pastures. Cattle are highly susceptible to the toxins contained in blue heliotrope plants, with impacts ranging from poor health through to sudden death.

Some landholders in the district have given up on controlling blue heliotrope, especially in the non-arable steeper parts of their properties. Control in these areas is more difficult and expensive because of accessibility issues,

requiring the use of a 4WD-mounted 'Quik Spray' unit. With contractors charging $80–90 per hour (plus herbicide), it becomes a very expensive exercise. Blue heliotrope continues to spread in the district and the concern is that this will result in large areas becoming unproductive.

Bill Davidson

Although blue heliotrope is more easily managed on the flats, the Tongue's are concerned it will spread to the less accessible areas of the property.

The approach

The Tongue's first attempts to control blue heliotrope involved use of a boom spray to apply the herbicide Hotshot® in a paddock where a dense population of seedlings had emerged. It was sprayed at the top label rate, which resulted in very effective control. Good leaf coverage by the herbicide was achieved as there was limited grass growing at the time.

Cameron believes the key to controlling blue heliotrope is applying herbicide in the spring, when the plants have fresh new growth. It is very important that the bulk of carryover grass or pasture is removed through either grazing, slashing or burning. This leaves very little material to get in the way of herbicide droplets hitting the leaves of the blue heliotrope plants.

The Tongues use a two-pronged control approach of:

- boom spraying on the arable areas, and
- spot spraying with a 'Quik Spray' unit in the non-arable areas, where boom spraying is not practical.

The most productive paddocks are a priority when it comes to spraying, and paddocks are constantly monitored for new incursions. After the first application in the spring, Cameron checks the areas he has sprayed to see if plants have died and if any follow-up treatments is required.

Bill Davidson

Without a vigilant control program, livestock health could be impacted, along with productivity.

Herbicides

The Tongues' preferred boom spray mix is fluroxypyr tank mixed with metsulfuron methyl and 'Consume' penetrant (to increase herbicide uptake by the weed). The worst of the paddocks are sprayed every year if the budget allows. Following boom spraying, a spot spray is used for any remaining plants that were missed. Although his selected mix is expensive, Cameron believes the investment is worth it, with the alternative being inferior results with cheaper herbicide options.

This mix has been used for the past 10–12 years and has produced very effective results at 'Clermont'. The key is to make sure blue heliotrope plants are small and fresh when sprayed, and that the bulk of carryover grass is removed so as much chemical as possible hits the leaf of the weed.

Shauna Potter

Arable paddocks are boom sprayed to control blue heliotrope. Follow-up spot spraying is required for any missed or regrowing plants.

The result

The main goal of blue heliotrope control at 'Clermont' is to maintain production on the better paddocks and prevent further spread in the hilly, non-arable and hard to access country. The approach is to:

- spray when plants are small (spring)
- monitor for and treat surviving plants or regrowth
- employ surveillance and treatment of new patches.

These actions appear to be preventing weed spread across the property, and Cameron believes they have maintained production levels by containing of blue heliotrope. Carrying capacity has not yet been adversely impacted because of the constant attention to surveillance and control work.

> *"It feels like we are keeping blue heliotrope under control for the moment; however, we are wary that if we don't constantly monitor for the weed that it has the potential to get away and undo our previous control work."*
> Cameron Tongue

The future

Cameron's vigilance means he has been able to halt the spread of blue heliotrope and he hopes to prevent further spread into the future to reduce its impact on the family's business. Cameron thinks eradication of blue heliotrope is not possible. He is hoping that an effective biological control agent can be found for blue heliotrope to help reduce herbicide and labour costs to the business. He believes biological control will be especially important if blue heliotrope gets away in steep, hard to access country.

Key learnings

- Spray when blue heliotrope is small and newly emerging in spring.
- Remove bulk of grass before spraying to allow maximum leaf coverage by the herbicide.
- Don't skimp on chemical rates or use cheaper alternatives.
- Production levels can be maintained if blue heliotrope is kept under control.

This case study documents the decisions and experiences of the land manager. It is important to select a control option that is suited to your specific situation and enterprise. Refer to Chapter 3 for more information and seek professional advice from your local biosecurity officer or agronomist.

Case study 4 Containing blue heliotrope in the hills of Barraba

Dennis Forrest and Bill Davidson

Key points

- **The threat of blue heliotrope spreading into the hill country is motivation for the surveillance and control of this weed.**
- **The promotion of warm season grasses — both native and improved — is essential as competition against blue heliotrope.**
- **Blue heliotrope is being contained on this property, but eradication is most likely not possible.**
- **Use different herbicides when practical, to reduce the risk of herbicide resistance.**
- **Production levels have been maintained because of the weed control program, but these efforts must be carried out annually to prevent weed spread.**

The property

'Trevallyn' is a 4858-ha property situated west of Barraba, in the North West region of NSW. The property comprises creek flats rising to steep hills. Rainfall is 750 mm per annum and soils consist of basalt and traprock derivatives.

'Trevallyn' runs 1200 beef breeding cows and calves, with a percentage of heifers retained in the herd and the remaining offspring finished as yearlings on forage oat crops. In the sheep enterprise, 1400 Merino ewes are joined to terminal rams to produce either lambs sold as stores or supermarket trade lambs. An area of 445 ha is set aside each year to grow forage crops for finishing weaners and yearling cattle.

Bill Davidson

'Trevallyn' contains a mix of creek flats rising to steep hills.

The problem

Dennis has been controlling blue heliotrope since he took over management of the property some 40 years ago. The weed first appeared on 'Trevallyn' around that time and was likely transported onto the property by feral or native animals. It is believed that blue heliotrope originally came into the farming district as an escaped garden plant from town. It is now scattered over a significant portion of the property at a light density, with some thicker patches in parts.

Considerable time is spent containing blue heliotrope through its growing season, with up to three staff members out on ATVs searching for new incursions and treating existing ones. This time could be spent on other more productive tasks on the property; therefore the opportunity cost of time and labour controlling blue heliotrope is quite a concern.

If livestock were to be grazed on country heavily infested with blue heliotrope, significant reductions in weight gain and general health of animals would occur, along with the risk of livestock being susceptible to poisoning. Dennis believes there would also be a severe reduction in the property's carrying capacity if blue heliotrope was to get away in the hill country.

Bill Davidson

Constant surveillance and treatment of new infestations help manage the risk of blue heliotrope spreading to hill country.

The approach

Surveillance

Dennis believes the key to controlling blue heliotrope is constant surveillance and monitoring of where blue heliotrope is occurring, and treatment with effective herbicides. All paddocks are constantly monitored for any new incursions.

Herbicides

Dennis and his staff mostly use spot spraying for controlling blue heliotrope. He has spot spraying units mounted on the back of ATVs, and from October to April, up to three staff are out in paddocks monitoring and spraying existing and new incursions.

After the first application in the spring, Dennis and staff check the areas that have been sprayed to see if plants have died and if any follow-up treatment is required. This process continues throughout the warmer months with the most productive paddocks being a priority when it comes to spraying. Once these paddocks have been treated, control moves on to the less productive areas.

Several herbicides have been trialled over the years – some with very limited success. First attempts were with glyphosate, which wasn't very successful. Plants would initially appear as though they had died, only to grow back. Dennis then tried Tordon, which although more effective than glyphosate, resulted in regrowth in a significant number of plants. Trial and error have informed the herbicides he now uses in his blue heliotrope control program.

Three tank mixes are used to effectively spot spray blue heliotrope on this property:

- Metsulfuron, Velpar® and a wetter
- Grazon® Extra, Velpar® and a wetter
- Grazon® Extra, metsulfuron and a wetter.

These herbicide mixes are used at different times to prolong the onset of resistance, and seem to be the most effective after trying other herbicides combinations.

Grazing management

Strategic grazing, including adequate rest periods, promotes competitive warm season grasses and is an important part of the control program. Good grazing management ensures that groundcover is maintained, and grasses are thriving which in turn provides good competition against blue heliotrope.

Bill Davidson

The property has a mix of native and introduced summer active perennial grasses.

The result

The main objective at 'Trevallyn' is to stop further spread of blue heliotrope, especially in the hilly, non-arable and hard to access country. The practice of constant vigilance over the warmer months and treating patches using spot sprayer mounted ATVs is successfully containing weed spread. Dennis is wary that if they don't constantly monitor the weed it has the potential to get away and undo previous efforts.

Thanks to constant surveillance and control efforts production levels have been maintained via containment of blue heliotrope, with no adverse impacts on carrying capacity.

The future

Although annual spraying efforts are preventing further weed spread, infestations are not reducing in size and Dennis doesn't think he will ever eradicate blue heliotrope from the property. With blue heliotrope present on neighbouring properties, the threat of spread by animals is ongoing and a consistent effort is required each year to keep areas clean. The best-case scenario is to contain weed spread, with the aim of reducing impacts on the business.

The prospect of an additional biological control agent provides hope for future management.

Key learnings

- Constant surveillance for blue heliotrope is crucial. Check for new incursions and monitor sprayed plants in case follow-up treatment is needed.
- Rotate herbicides when practical, to delay the onset of resistance.
- Look after warm season grasses to provide competition against blue heliotrope.

This case study documents the decisions and experiences of the land manager. It is important to select a control option that is suited to your specific situation and enterprise. Refer to Chapter 3 for more information and seek professional advice from your local biosecurity officer or agronomist.

Case study 5 Integrated management of blue heliotrope at the foot of the Warrumbungles

Anthony and Patty Webb and Bill Davidson

Key points

- **Managing blue heliotrope on 'Topwalga' is time consuming and costly.**
- **Competitive perennial grasses suited to the environment are a vital management tool.**
- **Graslan™ pellets are a convenient way to control small patches of blue heliotrope, especially in difficult terrain.**
- **It is vital to boom spray within two days after significant rain to achieve best results.**
- **Blue heliotrope is being held in check on 'Topwalga' but eradication is most likely not possible.**

The property

'Topwalga' is a 2226-ha property situated west of Coonabarabran in the Central West region of NSW. Soil types varies from sandstone derived to heavy basalt and alluvial on the creek flats. Rainfall is approximately 620 mm per annum and spread evenly throughout the year. Topwalga has 1416 ha of arable country and 810 ha of non-arable mountain country. The pasture base consists of Consol lovegrass, 'Premier' digit grass and native grasses with Serradella and clovers as the legume base.

The main production system on 'Topwalga' centres around 400 angus breeders, with the best of the heifers retained in the herd and the remaining offspring sold off at varying ages depending on the season and markets.

The problem

When Anthony and Patty Webb took over 'Topwalga' 30 years ago, blue heliotrope was already there. Their property borders onto the Warrumbungles National Park, which has also had blue heliotrope infestations for many decades, even before it was a national park.

The Webbs have worked hard to prevent the spread of blue heliotrope on their property. The largest infestations are generally restricted to a few arable paddocks, and they have managed to stop large patches from establishing in their hilly areas. Their greatest concern is new plants arriving and establishing in these hilly areas, as this limits control efforts to foot-based work.

Of concern to Anthony and Patty is the spread of blue heliotrope throughout the district and onto their property. With infestations in the National Park and on surrounding properties, blue heliotrope could be easily spread by native and feral animals onto 'Topwalga'. This would increase the resources required to control blue heliotrope on their property, as they say:

> *"One of the major costs of blue heliotrope control for our operation is labour and time. We spend on average two days per week over the blue heliotrope growing season to control this weed. This is a substantial opportunity cost to the business, especially when there are other jobs that need doing on the farm."*

The Webbs believe it would only take one wet summer without blue heliotrope control to potentially set back the weed control program four to five years. In native pastures, where access is difficult and control is largely done by hand, missing two to three control seasons could mean infestations would become so

dense that the Webbs would be left without viable control options. If blue heliotrope was left unchecked, significant production losses would be experienced, along with potential poisoning of stock.

The approach

Herbicides

The first efforts to control blue heliotrope involved the use of secateurs to cut plants off at ground level. However, plants grew back when conditions were favourable. Initial herbicides used for spot spraying were 2,4-D mixes designed for spraying burrs, which burnt off the top of the blue heliotrope plants, but was soon followed by regrowth.

The main method currently used for controlling blue heliotrope in existing pastures on 'Topwalga' is Graslan™ (tebuthiuron) pellets. The pellets are always carried in vehicles and quad bikes during the growing season and if a blue heliotrope plant or patch is spotted, it is treated immediately by sprinkling pellets around the drip zone of the plant. This kills existing plants and prevents emergence of new seedlings. For larger patches of plants a handheld fertiliser spreader is used to apply the pellets evenly over the infested area. There is the potential for bare patches to occur when using Graslan™ pellets. However, over time grasses and clovers will start to grow back and fill in the area. When used at low rates Graslan™ pellets will not kill grasses.

Boom spraying of glyphosate is used in the cropping country to control blue heliotrope and other fallow weeds, before growing dual-purpose oats or sowing of tropical pasture. According to Anthony and Patty:

> *"It is critical to spray blue heliotrope within two days of significant rainfall, as from ours and other observations, it just seems to get a lot better result if sprayed within this time frame after rain."*

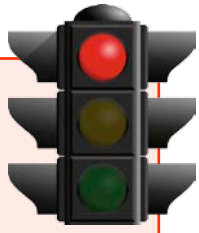
Graslan™ pellets are used with some caution at 'Topwalga', and they are not used on creek lines or around trees to avoid damaging or killing trees.

Matt Sheehan

Graslan pellets are used to treat scattered infestations in native pastures.

Pasture management

One of the Webbs important management tools is use of competitive perennial pasture against weeds like blue heliotrope. They have found Consol lovegrass to be quite persistent in their area. It grows for long periods throughout the year, is incredibly resilient to grazing and can provide good cattle feed at varying times throughout the year when other species have stopped producing. There is a significant problem at 'Topwalga' with kangaroos eating pastures and crops, and Consol lovegrass seems to be able to survive heavy grazing pressure from livestock and kangaroos. Keeping their grass pastures competitive through adequate nutrition and recovery from grazing is also an important part of the Webbs' management approach.



Some exotic perennial grasses may be invasive in certain parts of NSW and landowners need to be aware of their General Biosecurity Duty. For more information visit: www.dpi.nsw.gov.au/biosecurity/managing-biosecurity/the-general-biosecurity-duty

Matt Sheehan

Perennial grasses provide a resilient and competitive pasture at 'Topwalga'.

The result

The combination of competitive perennial pastures and use of Graslan™ pellets on both existing and new patches of blue heliotrope seems to have kept the weed in check at 'Topwalga'. Constant surveillance and rapid treatment of new incursions have helped contain blue heliotrope. The Webbs say:

> *"We know that eventually herbicide effectiveness will decline and that we will need other tools to manage this weed. Future biological control agents will be crucial to help manage blue heliotrope going forward".*

Shauna Potter

Occasional blue heliotrope plants do emerge in the perennial pasture.

The future

Anthony and Patty have been able to reduce the impacts of blue heliotrope on their business by controlling new incursions and small patches of blue heliotrope, in turn reducing further spread. They are concerned that herbicides will eventually lose their effectiveness and are hoping that effective biological control agents will be available to help with management of blue heliotrope in the future.

Matt Sheehan

Constant vigilance is required to stop blue heliotrope spreading into non-arable country.

This case study documents the decisions and experiences of the land manager. It is important to select a control option that is suited to your specific situation and enterprise. Refer to Chapter 3 for more information and seek professional advice from your local biosecurity officer or agronomist.

Key learnings

- Graslan™ pellets provide a simple method of controlling small incursions of blue heliotrope.
- For best boom spray results on fallow paddocks, apply glyphosate within two days after significant rain.
- Maintaining healthy pastures through strategic grazing and nutrition provides excellent competition against blue heliotrope.

Case study 6 Trialling integrated weed management at 'Garrallan'

Marion Mitchell

Key points

- **Limiting blue heliotrope seed set and germination are key to reducing infestation size and spread.**
- **Competition in the form of healthy native pastures and mulching of blue heliotrope are important control strategies.**
- **Trialling new control methods, including the integration of different options, can provide choice and flexibility as your enterprise or circumstances change.**
- **Persistence has allowed the reintroduction of grazing in paddocks previously keep out of grazing rotation.**

The property

Marion Mitchell, a fifth-generation farmer, owns 'Garrallan', a 663-ha property located near Cowra, in the Central Tablelands region of NSW. The undulating property features clay loams and alluvial soils, with native pastures on the hills and improved pastures on the alluvial flats. The average annual rainfall for the area is around 635 mm. The property has been in Marion's family since 1826, with Marion taking over management in 2014.

The farming enterprise has changed over time because of family circumstances, with 'Garrallan' until recently having run lambs. Marion now runs cattle and agists sheep. The property also has patches of remnant vegetation that Marion is committed to conserving.

Marion Mitchell

'Garrallan' has a history of grazing lambs.

The problem

Blue heliotrope has been present on the property for many years. Although unsure what it was, Marion's mum remembers seeing odd patches in the 1950s in the house paddock and areas that were not used regularly. Marion's mum started spot spraying plants in the early 1990s, which may have helped contain the small infestations. However, by the early 2000s blue heliotrope was quite noticeable across the property.

Scattered infestations cover approximately 150–180 ha of the property, with a dense infestation completely covering a 21 ha hill side. The size of this infestation grew significantly following a 2012 grass fire. With a new property manager, and attention focused on fence repairs and other fire recovery activities, infestations quickly took hold. By 2014, when Marion took over the farm, the scale of the problem was hard to ignore.

Infestations have restricted farm operations, and until recently some paddocks were excluded from summer rotations because of blue heliotrope's toxicity to livestock. The reduced number of paddocks has put pressure on the native pasture base and bushland areas across the property. The densest infestation of blue heliotrope occurs amongst native bush, and conserving the natural values of 'Garrallan' is significantly hampered by the aggressive and competitive nature of the weed.

The approach

A change in direction

Marion introduced regenerative agriculture and rotational grazing to the property in 2015, at the same time employing an agronomist and contractor to advise on and implement a management program for blue heliotrope. Early herbicide mixes included picloram + triclopyr + aminopyralid, fluroxypyr and metsulfuron methyl at various rates, which were boom sprayed across paddocks for three years. Control continued through the 2018/19 drought, with early morning spot spraying of blue heliotrope plants.

Native grasses did return following spraying, providing adequate feed, but concerns over blue heliotrope toxicity meant affected paddocks were left ungrazed from October to June each year. Marion realised the sheep were spreading blue heliotrope, even though the paddocks were only grazed during winter (when plants are not generally producing seed). The sticky seed and large seed bank were both thought to be contributing to the persistence and spread of blue heliotrope.

The next step was to boom spray four additional paddocks, starting in the cleanest areas and working back towards the densest patches. In 2019/20, the break of drought resulted in mass recruitment of native pasture species, which has limited the use of non-selective herbicides to control blue heliotrope. Marion's approach here has been to mulch paddock boundaries to create a weed-free buffer and stop seed spreading downhill into clean areas.

Other paddocks are mostly spot sprayed, including via the use of a quad-mounted spray unit. Fluroxypyr and metsulfuron methyl are used at a rate of 1.25 L and 3 g respectively per 50 L tank mix. This herbicide mix works well if applied early enough and repeated after each rainfall event. Because of blue heliotrope's highly competitive nature, in some years Marion is still spraying late into the season; for example in 2022 (a bad year for blue heliotrope) spraying occurred into late May.

Control trials

Marion is continually trialling new approaches, integrating methods including herbicides (organic and conventional), burning, mulching and hand removal of seeds. This is born out of a desire to limit herbicide use, especially in sensitive bushland areas. These approaches are outlined below.

1. Spraying glyphosate and pine oil in summer

Motivated by the potential for pine oil to kill blue heliotrope seeds, Marion is trialling this herbicide combination with a quad mounted spot spray unit. Spraying occurs over several months as Marion works her way over the farm. Trials so far indicate this treatment is only sometimes effective at killing plants and Marion has not yet been able to identify a reason for these intermittent results. Marion has noticed the pine oil spray appears to sterilise some seeds, but best results are achieved when combined with burning.

Marion Mitchell

Pine oil applied to blue heliotrope plants in the foreground (note red die used to mark where spraying occurs). Seeds have been collected and bagged for disposal.

Marion Mitchell

Pine oil and glyphosate applied to blue heliotrope plants in February or March. Note red die is used to mark where spraying occurs. Plants are either burnt or deseeded post spraying.

2. Spraying, then burning

This approach was initially trialed in two paddocks, with a combined area of 35 ha. Large patches of blue heliotrope are sprayed and dead plants then burnt using a $40 butane fuelled-flame wand. This process occurs over several months, as Marion and her helpers work their way across the property, burning piles of dead weeds to kill any seed. Early indications suggest this approach is very successful in reducing both the number of mature blue heliotrope plants and level of germination, with much smaller patches of the weed a result.

Marion Mitchell

Patches of blue heliotrope are sprayed then burnt with a flame weeder. Over time Marion is treating fewer plants and smaller areas.

Marion Mitchell

Blue heliotrope patch after burning.

3. Mulching blue heliotrope

Machine mulching of plants was also trialed in the densest blue heliotrope infestations in April 2022. Marion uses a flail mower, also known as a tractor mulcher. These machines cut material much like a slasher and evenly spread the cut material, rather than creating windrows. Mulching occurred in Autumn, after native grasses had set seed.

Observations so far indicate there has been a reduction in blue heliotrope patches, with plants appearing spindlier and with fewer seeds because blue heliotrope is smothered by the mulched material. As a result, follow-up control has been easier to undertake. Further monitoring will better indicate the success of this trial. These results align with Marion's key goal of reducing blue heliotrope seed and she is pleased to have achieved this in an area she has not had the capacity to intensively manage with other control methods.

4. Hand removal of seeds

In areas of lighter infestations, Marion and farm helpers deseed plants after spraying. Seeds are removed from plants with hedging shears, bagged and disposed of in a 'dead hole', to be burnt in the cool season. This is an activity that can be undertaken during the fire season, when control options, such as burning, are limited. Deseeding is a time-consuming task, that may not be possible on a larger property, or for those without help from family and friends.

Marion targets erect, old plants as they pose the greatest risk in terms of seed attaching onto sheep and spreading across the property.

5. Biological control

In 2022 Marion sought out the leaf-beetle to release at her property, bringing home a bucket of them. It wasn't until she went to release them that she realised the leaf-beetles had already made their way to 'Garrallan' of their own accord. They defoliated plants to an extent, but seeding still occurred and Marion returned to spray isolated plants. Marion suspects the leaf-beetle did a good job at weakening the plants, given that they died and did not resprout. The limiting factor is having enough leaf-beetles to be effective at a large scale.

Marion has also installed sprinklers in parts of the 21 ha paddock where the densest infestation occurs. Whilst it is too early to judge her success, the aim is to provide a more hospitable nursery site for the leaf-beetles, as Cowra can get very hot over summer. These paddocks will also be mulched again to smother any blue heliotrope seed, as it appeared to do the previous year.

Current approach

Marion has drawn on the success of broad scale herbicide control to trial new, integrated control methods. She now applies the following strategies across her property.

Timing	Control action
Early November – December	**Herbicide control** Applies to early emerging plants. Spot sprays Starane® and Ally® at a rate of 1.25 L and 3 g respectively per 50 L tank.
January – March (depending on season)	**Herbicide control** Applies to late-emerging plants and plants starting to seed. Spot sprays Roundup® and pine oil at a rate of 500 mL and 5 L respectively per 50 L tank.
Summer (fire season)	**Manual control** In areas with lighter infestations, returns to sprayed plants and manually removes seed heads with hedging shears. Seed disposed of and burnt later.
Summer	**Biological control** Waters areas where leaf-beetles have established, using wobble tee sprinklers.
Autumn (mid-April onwards)	**Fire control** Flame wand sprayed plants to kill seeds.
Autumn (April/May onwards, depending on season)	**Mechanical control** Mulches blue heliotrope plants using a flail mower. This occurs in areas of dense infestations, where time constraints preclude any other control actions.
Year-round	**Manual control** Hand-pulls isolated plants seen during routine farm activities. Maps location and returns to monitor for regrowth. Plants are disposed of and burnt.

The result

Over the last three years Marion has seen a significant reduction in plant numbers across the property – aided, she believes, by her focus on reducing seed set and germination. Importantly, Marion has been able to find practical solutions that she can apply to different situations and to suit her enterprise. By starting with the most lightly infested areas and working towards the densest infestations, Marion has seen a major reduction in infestation size and the number of seeds individual plants are producing. Marion has been able to reintroduce sheep into two paddocks that were previously not in rotation because of the presence of blue heliotrope.

Whilst she can't predict what will happen in future years, she is hopeful that she is breaking the back of the problem and is buoyed by her ability to clean up some of the lighter

infestations that had spread across the property via sheep. She has also been able to prevent the spread of blue heliotrope from her property onto neighboring farms.

The future

Marion's goals are to find management approaches that can be used across the whole property to reduce the size of infestations and stop the spread of blue heliotrope. Having access to a range of options that can be integrated with each other might be the best way to manage blue heliotrope at 'Garrallan'.

Marion is committed to finding an approach that meets her needs and accepts that this might involve some trial and error. She is hopeful that an integrated approach that prevents or reduces seed set will lead to long-term reductions in infestation size and spread. Marion acknowledges the approaches she is trialling may not be for everyone – particularly for large scale properties, given their labor-intensive nature. Hope remains that effective biological control options will prove a viable part of the integrated management of blue heliotrope.

Key learnings

- Managing blue heliotrope seeds, either through deseeding or suppressing germination, will give you a better chance of managing infestations.
- Don't be afraid to try new approaches, particularly if your situation doesn't support conventional broadacre herbicide control.
- Consider how blue heliotrope may be spreading across (or onto) your property and manage these pathways to prevent large infestations from establishing.

This case study documents the decisions and experiences of the land manager. It is important to select a control option that is suited to your specific situation and enterprise. Refer to Chapter 3 for more information and seek professional advice from your local biosecurity officer or agronomist.

Chapter 5

Further information

Similar species

Below are profiles of native and weed species that may be confused with blue heliotrope.

Heliotropium europaeum
common heliotrope, potato weed, heliotrope

- upright, summer-growing, annual herb reaching 10–50 cm tall
- grey-green, hairy leaves with pale undersides
- small, white flowers
- dry brown fruit splits into 4 segments.

H. supinum, creeping heliotrope, is another weed that is similar in appearance to *H. europaeum*, but with a prostrate growth habit.

John Virtue

Asad Shabbir

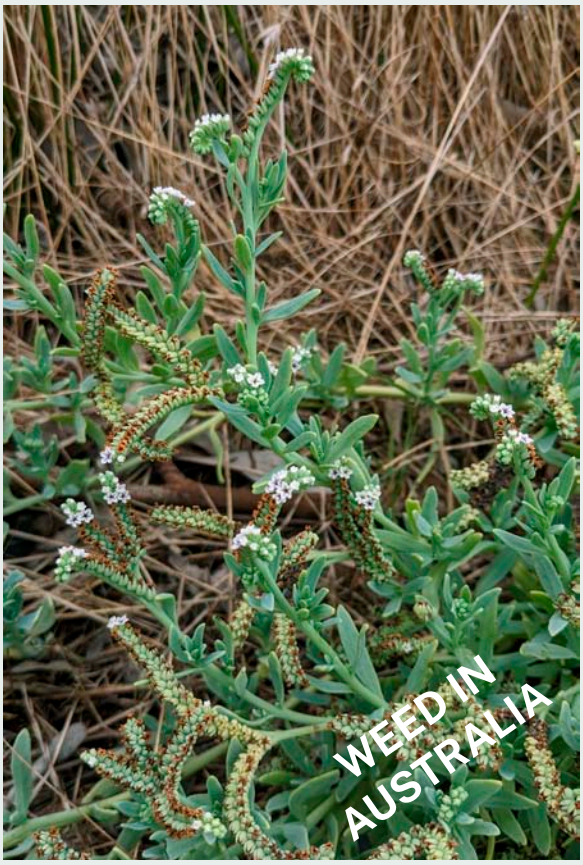
H. supinum *(left) and* H. europaeum *(right) growing together*

Heliotropium indicum
Indian heliotrope, Indian turnsole

- upright, tropical, annual herb reaching 10–60 cm tall
- hairy branches and large, heavily wrinkled, hairy leaves 35–230 mm long
- small, pale mauve to white flowers
- dry brown fruit splits into 4 segments.

Heliotropium curassavicum
smooth heliotrope, salt heliotrope

- fleshy, hairless, creeping, annual to short-lived perennial herb usually up to 15 cm tall
- thick, blueish, oval or spade-shaped leaves
- small, white to pale mauve flowers
- dry brown fruit splits into 4 segments
- grows in saline soils.



Heliotropium asperrimum
rough heliotrope

- upright, perennial, native herb, 30–60 cm tall
- densely haired leaves with wavy margins, similar to those of blue heliotrope
- small, white flowers
- dry brown fruit splits into 3–4 segments.

***Amsinckia* species**
fiddlenecks, yellow burrweed

- annual, upright herbs with bristly hairs, 20–100 cm tall
- yellow to orange flowers
- four species naturalised in Australia
- superficially similar to Paterson's curse (except for the latter's larger, purple flowers).

Glandularia aristigera
Mayne's pest

- perennial, trailing, exotic herb, 10–80 cm tall
- prostrate stems may root at nodes
- leaves finely divided
- pink to purple flowers on terminal flowering stems that are not coiled
- different plant family from blue heliotrope—Verbenaceae.

Lantana montevidensis
creeping lantana, trailing lantana

- prostate, perennial, exotic shrub up to 30 cm tall
- woody stems are square in cross-section
- leaves opposite, bright green, oval-shaped with pointed tips and serrated edges
- pink to purple flowers on terminal flowering stems that are not coiled
- green berries ripen to reddish-purple.

***Verbena* species**
verbena, purple top, vervain

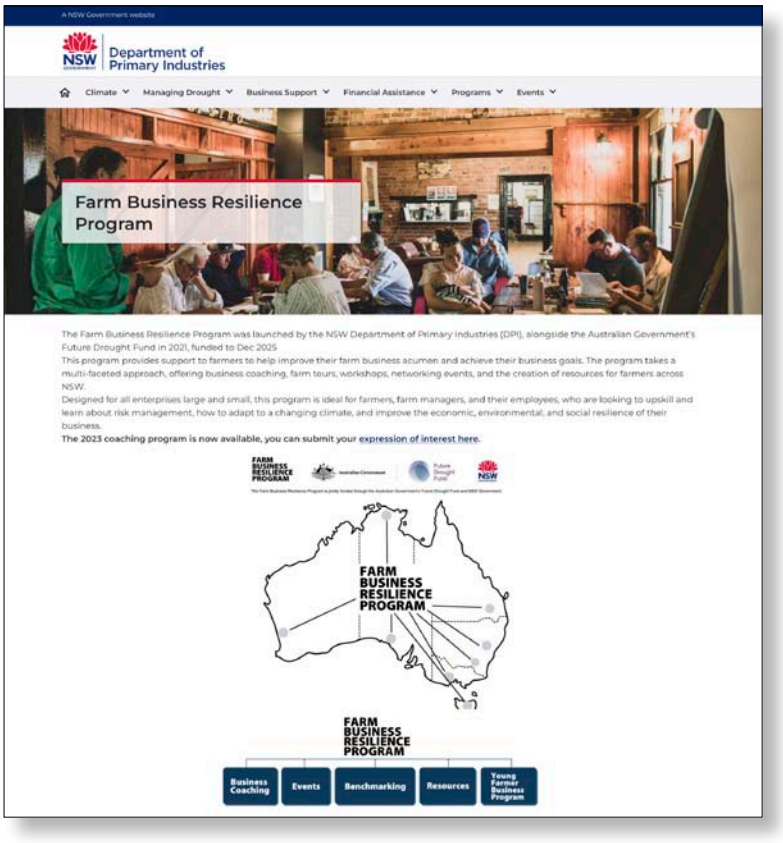
- annual or perennial herbs, prostrate or erect
- stems usually square in cross-section
- leaves opposite, often toothed or highly divided
- blue to purple flowers on terminal flowering stems that are not coiled
- different plant family from blue heliotrope – Verbenaceae
- 19 native or naturalised species in Australia.

Property planning resources

The following tables provide sources of online guidance for property-level planning regarding overall property management, biosecurity management and weed management. The tables are not exhaustive, and new resources and initiatives may become available.

Sources of online information on property management planning

Source	Description	Weblink
NSW Department of Primary Industries Farm business resilience program	The program helps farmers improve their farm business acumen through coaching, farm tours, training and networking events.	www.droughthub.nsw.gov.au/programs/farm-business-resilience-program
Local Land Services NSW Farm planning – setting your vision for your land	This webpage outlines how to undertake a basic property planning.	www.lls.nsw.gov.au/what-we-do/our-major-projects/every-bit-counts/resources/rural-property-ownership/property-management/farm-planning-setting-your-vision-for-your-land
Business Government Farm business resilience plan	This webpage provides templates and checklists to help write a new plan	www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/disaster/drought/assistance/business-resilience-plan

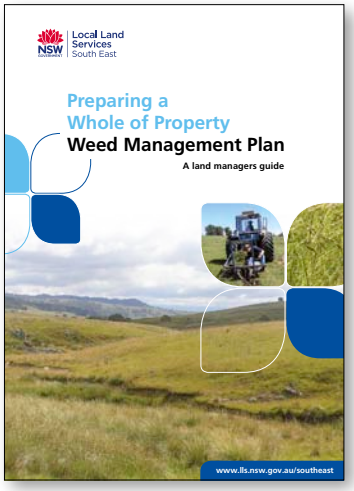


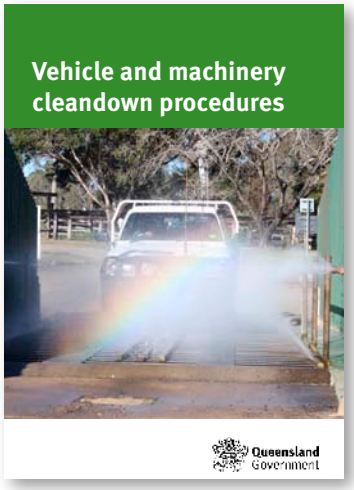
Sources of online information on property biosecurity planning

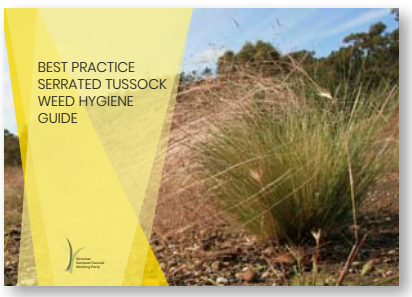
Source	Description	Weblink
Animal Health Australia (AHA) and Plant Health Australia (PHA) Farm Biosecurity Program (joint initiative)	This website is a national hub of farm biosecurity information. It includes information to help producers understand disease, pest and weed risks, what they can do to reduce those risks, and how to go about it. It provides information, tools and templates, including an app, to help producers implement biosecurity measures on their property.	www.farmbiosecurity.com.au
Integrity Systems Livestock production assurance (LPA)	The LPA program is the Australian red meat industry's on-farm assurance program, providing evidence of livestock history and on-farm practices when transferring animals through the value chain. It includes a requirement to have a farm biosecurity plan and provides a template (similar to that provided by AHA).	www.integritysystems.com.au/on-farm-assurance/Biosecurity/
NSW Government Building biosecurity for small farms	This guide provides advice to small farm and lifestyle property owners on how to establish or join a livestock-based small farms network in your community.	www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/1155931/Building-biosecurity-for-small-farms.pdf
Western Australian Department of Primary Industries and Regional Development Biosecurity plans for small landholders	The website is broadly applicable across Australia.	www.agric.wa.gov.au/small-landholders-western-australia/biosecurity-plans-small-landholders

Sources of online information on property weed management planning

Source	Description	Weblink
South East Local Land Services NSW Preparing a whole of property weed management plan	The guide provides a guide and template for preparing a property weed management plan.	www.lls.nsw.gov.au/__data/assets/pdf_file/0011/685460/integrated-weed-management-plan-guide.pdf
NRM North (Tasmania) Guide for developing a weed management plan	The guide provides general guidance on how to develop a best practice plan for weed management.	https://api.nrmnorth.org.au/serve-resource/Guidance_for_developing_a_WMP_TG/
Meat & Livestock Australia (MLA) Weed control hub	The hub details six principles that provide the basis for an effective pasture weed control plan.	www.mla.com.au/extension-training-and-tools/feedbase-hub/weed-control/
University of New England Weed detection and control on small farms	The guide describes pathways of weed spread to farms, where to look for weeds and how to control them.	www.une.edu.au/__data/assets/pdf_file/0004/23575/2010-Weed-Detection-and-Control-on-Small-Farms-A-Guide-for-Owners.pdf
Queensland Government Vehicle and machinery clean-down procedures	The site gives detailed guidance on how to prevent weed movement by such means.	www.daf.qld.gov.au/__data/assets/pdf_file/0011/58178/cleandown-procedures.pdf
Victorian Serrated Tussock Working Party Best practice serrated tussock weed hygiene guide	The guide is broadly applicable to preventing and stopping the spread of pasture weeds.	http://serratedtussock.com/wp-content/uploads/files/WeedHygiene-2020-09-22-web.pdf







Pasture management resources

The following tables provide web links to sources of further information, decision tools and training for pasture management.

Sources of online information on pasture establishment and management

Source	Description	Weblink
NSW Department of Primary Industries – Pasture establishment and management	This includes: ▪ checklist of 'Eight steps for achieving successful perennial pasture establishment', which are also broadly applicable to renovating existing pastures ▪ Temperate perennial pasture establishment guide – Steps to ensure success ▪ Tropical perennial grasses for Northern Inland NSW — second edition ▪ Successful establishment of tropical perennial grasses in North West NSW	www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/establishment-mgmt
NSW Local Land Services – Pastures	This website includes information on pasture health and management and where to go for further information and advice.	www.lls.nsw.gov.au/help-and-advice/growing,-grazing-and-land/pastures
Meat & Livestock Australia (MLA)	This website provide information to red meat producers. There are a number of resource hubs that provide detailed information on various topics.	www.mla.com.au/
	MLA's persistent pastures hub provides information on a wide range of pasture types found across southern Australia.	www.mla.com.au/extension-training-and-tools/feedbase-hub/persistent-pastures/
	MLA's grazing land management hub provides information on stocking rates, monitoring of pasture health, and feedbase and pasture improvement options.	www.mla.com.au/extension-training-and-tools/grazing-land-management-hub/

Online tools to assist with pasture management decision-making

Australian Wool Innovation – Feed on offer	www.wool.com/land/pastures/feed-on-offer
Meat & Livestock Australia (MLA) – Tools and calculators	https://etools.mla.com.au/hub/
MLA online manual – More beef from pastures	https://mbfp.mla.com.au/
Pastures Australia – Pasture selection tool	keys.lucidcentral.org/keys/v3/pastures/

Example sources of training in pasture management

ACS Distance Education – Pasture management	www.acs.edu.au/courses/pasture-management-180.aspx
Meat & Livestock Australia (MLA) – EDGEnetwork	www.mla.com.au/extension-training-and-tools/edgenetwork
MLA – Establishing a new pasture	https://elearning.mla.com.au/courses/how-do-i-successfully-establish-a-new-pasture/
NSW Department of Primary Industries – PROGRAZE	www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/establishment-mgmt/grazing-management2/prograze-profitable,-sustainable-grazing
RCS – Grazing for profit	www.rcsaustralia.com.au/farming-grazing-for-profit-programs/
Tocal College – Introduction to pastures	www.tocal.nsw.edu.au/courses/short-courses/weeds/introduction-to-pastures

Legal requirements to control blue heliotrope

The table below provides an overview of management requirements throughout NSW. Visit https://weeds.dpi.nsw.gov.au/Weeds/BlueHeliotrope#biosecurity for current information.

Area	Regional requirement
All of NSW	Anyone dealing with blue heliotrope has a duty to prevent, eliminate or minimise any associated biosecurity risks.
Central Tablelands LLS and **Hunter LLS**	Land managers should: ▪ Mitigate the risk of the plant being introduced to their land. ▪ Mitigate the spread of the plant from their land. ▪ Reduce the impact of the plant on assets of high economic, environmental and/or social value. A person should not buy, sell, move, carry or release the plant into the environment.
North Coast LLS **Exclusion (eradication) zone:** Bellingen Shire LGA, Coffs Harbour City LGA, Kempsey Shire LGA, Lord Howe Island, Nambucca Valley LGA Port Macquarie-Hastings LGA. **Core infestation (containment) zone:** Ballina Shire LGA, Byron Shire LGA, Clarence Valley LGA, Kyogle Shire LGA, Lismore City LGA, Richmond Valley LGA, Tweed Shire LGA.	**Whole of region:** Land managers should mitigate the risk of the plant being introduced to their land. A person should not buy, sell, move, carry or release the plant into the environment. **Exclusion zone:** Notify local control authority if found. Land managers should eradicate the plant from the land and keep the land free of the plant. **Core infestation:** Land managers should: ▪ Mitigate spread of the plant from their land. ▪ Reduce the impact of the plant on assets of high economic, environmental and/or social value.

Weed control contacts

General weed control information

Organisation	Phone	Email	Website
Local council weeds officer	Search for individual councils using the weblink.		www.lgnsw.org.au/Public/Public/NSW-Councils/NSW-Council-Links.aspx
Department of Primary Industries	1800 680 244	weeds@dpi.nsw.gov.au	www.dpi.nsw.gov.au/biosecurity/weeds weeds.dpi.nsw.gov.au/
Local Land Services (LLS)	See below for individual LLS regional details.		www.lls.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases
Central Tablelands LLS	1300 795 299	admin.ct@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/central-tablelands
Central West LLS	1300 795 299	admin.centralwest@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/central-west
Greater Sydney LLS	1300 795 299	gs.service@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/greater-sydney
Hunter LLS	1300 795 299	admin.hunter@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/hunter
Murray LLS	1300 795 299	admin.murray@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/murray
North Coast LLS	1300 795 299	admin.northcoast@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/north-coast
North West LLS	1300 795 299	admin.northwest@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/north-west
Northern Tablelands LLS	1300 795 299	admin.northerntablelands@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/northern-tablelands
Riverina LLS	1300 795 299	admin.riverina@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/riverina
South East LLS	1300 795 299	enquiry.southeast@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/south-east
Western LLS	1300 795 299	admin.western@lls.nsw.gov.au	www.lls.nsw.gov.au/regions/western

Information on herbicide use, training and certification

Topic	Website
Herbicide regulation	https://apvma.gov.au/
Herbicide use in NSW	www.epa.nsw.gov.au/your-environment/pesticides/pesticides-nsw-overview
Training in herbicide use	www.epa.nsw.gov.au/your-environment/pesticides/compulsory-training-pesticides/pesticide-trainers-courses
Licences for occupational herbicide use	www.epa.nsw.gov.au/your-environment/pesticides/licences-and-advice-for-occupational-pesticide-users
Safe use of herbicides near water	https://archive.dpi.nsw.gov.au/__data/assets/pdf_file/0011/319448/riparian-habitat-management-guide.pdf (A national resource generally applicable to NSW.)

Weed biocontrol release form

Example only: Release form for Weed Biological Control Agents

Please fill in this form each time you release an agent and forward it to your weed or biosecurity officer.

This is the kind of information you would fill in to release your agents. You may need to modify this form to suit the context of your release. You can submit this information directly to the Australian Biocontrol Hub (https://biocollect.ala.org.au/biocontrolhub).

Name the weed and agent including the number required

Weed name	
Agent name	
How many units? (eggs, larvae, adults, infected cladodes, cuttings, etc.)	

Releaser

Name		Organisation	
Email		Phone	

Release site (mark the release site with either flagging tape or a marker peg for future monitoring and a fixed-point photograph associated with marker peg)

Site location	Latitude: Longitude:		
No. & Street / Road			
Area / Village / Town		Post code	
Creek / River System		Region	

Landowner (if different from releaser)

Name		Phone	

Weed infestation

Weed density [tick box]	Light: scattered patches and clumps (1–10%) ☐	Moderate: some spaces between plants (11–50%) ☐	Dense: completely covering in thick layer (>50%) ☐
Area of weed infestation (approximate size m^2 or ha^2):			

Release details

Date of release:		Time:		Temp (°C):	
Weather (please circle):	sunny	overcast	windy	light rain	heavy rain
Draw/insert map here			General comments		

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