

# Chapter 1

## Understanding fireweed and its impacts

### 'At a glance'

- Fireweed, *Senecio madagascariensis*, is a daisy originating from southern Africa that, in Australia, mostly grows as a cool season annual.
- First detected in Australia in 1918, fireweed is now widely distributed along the coast and hinterland of New South Wales (NSW) and south-eastern Queensland (Qld).
- It is also present in Far North Qld (FNQ), the Australian Capital Territory (ACT) and north-eastern Victoria (Vic).
- Most fireweed germinates in autumn and quickly commences ongoing flowering and seed set.
- Fireweed seed spreads rapidly—locally mainly via wind and regionally as a contaminant or 'hitchhiker'.
- It readily invades pastures and other open, regularly disturbed environments.
- Fireweed is highly toxic to cattle and horses, causing irreversible liver damage. However, it is highly unpalatable, so poisoning is rare.
- Sheep and goats are more tolerant of fireweed toxins and readily graze the plant.

### 1.1 Description of fireweed

#### Key points

- Fireweed originates from southern Africa and is now widespread in eastern NSW and south-eastern Qld. It is also present in ACT, Vic and FNQ.
- Fireweed has narrow, lance-shaped leaves with finely toothed to lobed edges, canary yellow daisy flowers with 13–15 'petals' and white, fluffy seedheads.
- There are various native and exotic weedy *Senecio* species that are similar in appearance and/or name.

#### 1.1.1 Name and taxonomy

*Senecio madagascariensis* Poir is a member of the daisy family, Asteraceae. In Australia it is commonly called 'fireweed'. However, a range of other types of plants in Australia and elsewhere, both natives and weeds, are also called fireweeds.

The species is also more specifically called Madagascan fireweed, Madagascar groundsel or Madagascar ragwort, based on its scientific name. However, its origin is more broadly southern Africa rather than just Madagascar.

#### 1.1.2 Origin and history

*Senecio madagascariensis* is native to South Africa (KwaZulu-Natal, Eastern and Western Cape provinces), Eswatini (formerly Swaziland), Zimbabwe, Mozambique and Madagascar (Wijayabandara et al., 2022). The fireweed in Australia has been demonstrated genetically to have likely originated

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**WoNS**  
WEEDS OF  
NATIONAL  
SIGNIFICANCE

## Fireweed is a Weed of National Significance

Fireweed was one of 12 additional species or groups of species added to the existing list of 20 Weeds of National Significance (WoNS) in 2012 (AWC, 2021). Fireweed was included on the WoNS list based on assessment of its invasiveness, impacts and potential for further national spread. A national fireweed strategic plan was developed, which included actions aimed at preventing and responding to new regional incursions; developing and promoting best practice management for on-property control of fireweed; and further research into biological control.

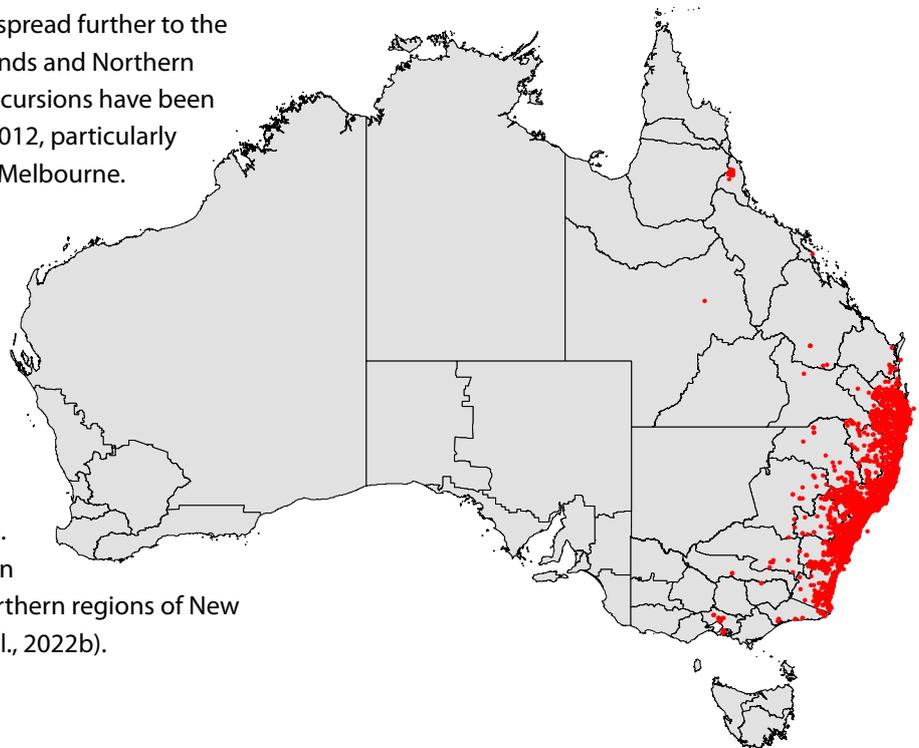
from KwaZulu-Natal (Scott et al., 1998; Radford et al., 2000).

Fireweed was first officially recorded in Australia in 1918 at Raymond Terrace in the lower Hunter Valley of NSW, purported to have arrived in shipping ballast via Newcastle or Sydney, or in hay associated with horses imported from South Africa (Dormontt et al., 2014). It is now present to varying extents in NSW, Qld, ACT and Vic (Figure 1.1).

Fireweed was first detected at Lismore on the Far North Coast of NSW in 1940, suspected to have been introduced in contaminated crop seed. It was first reported in Qld in 1950, at Numinbah Valley in the Gold Coast hinterland. By the 1980s, fireweed had spread north and south from the Hunter and Far North Coast along coastal and hinterland NSW, and southern Qld (Hannan-Jones, 2017; Sindel and Coleman, 2012).

Since the 1980s, fireweed has spread further to the South Coast, Southern Tablelands and Northern Tablelands of NSW. Multiple incursions have been recorded in Vic since around 2012, particularly in East Gippsland and around Melbourne. Fireweed was first detected in FNQ in 2007 at Milla Milla in the Atherton Tablelands. Incursions into the ACT were first detected in 2011.

Fireweed has also invaded Hawaii, Japan and various countries in South America, including Brazil and Argentina. In addition, it has recently been confirmed to be present in northern regions of New Zealand (Schmidt-Lebuhn et al., 2022b).



**Figure 1.1** Current distribution of fireweed in Australia, by Dr Farzin Shabani from Macquarie University. Data from ALA (2022), NSW Department of Primary Industries (NSW DPI) and Tablelands Regional Council.

### 1.1.3 Identification

*Key information sources for this section:*  
NSW DPI (2019); QDAF (2022); Sindel and Coleman (2012); Southern Rivers CMA (2009).

Fireweed is a branching, erect, annual to short-lived perennial herb. It typically grows to 30–40 cm high but can grow up to 60 cm. Leaves are narrow and

bright to dark green, with finely toothed edges and tapered, stem-clasping bases. The prominent flower heads are canary yellow and daisy like, typically with 13–15 curved ray florets ('petals'). Each seed is attached to a parachute-like pappus of fine hairs.

Further details on identifying features are provided below.

#### Identifying features of fireweed

##### Seedlings

- two opposite narrow seedling leaves (cotyledons)
- cotyledons and first true leaves often red underneath
- seedling stem also often red in colour

J.J. Dellow, NSW DPI © State of New South Wales



Seedling showing cotyledons.

John Virtue



Cotyledons and first true leaves.



Seedling showing red stem colouration.

John Virtue

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## Leaves

- lance-shaped leaves slightly fleshy, thin, narrow, bright to dark green and 2–7 cm long
- leaves clasp the stems at their bases
- leaves tightly packed and alternate along the stems and branches
- leaf margins slightly curved, with occasional fine toothing (small points)
- stem and major branch leaves commonly undivided, but sometimes serrated or slightly to deeply lobed
- central, pale leaf vein extending to a pointed leaf tip



John Virtue

*Leaves with slightly lobed margins.*



John Virtue

*Leaves with serrated margins.*



John Virtue

*Leaves with lobed margins.*



John Virtue

*Leaves with toothed margins.*

### Stem and branches

- generally grows as an erect plant, with a woody lower stem supporting extensive branching
- lower stem can 'rest' on the ground and take root



John Virtue

*Stem and branch of adult plant.*

### Roots

- fibrous roots branch from a central tap root
- roots 10–20 cm deep; plant easily pulled by hand
- additional roots grow from stem in moist conditions



John Virtue

*Root growth from stem of adult plant.*

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## Flowers

- up to several hundred flower heads (capitula) produced
- flowers displayed in clusters of 2–10 at the ends of branches
- small, canary yellow, daisy-like flower heads 1–2 cm in diameter
- 13–15 slightly curved ray florets ('petals'), 8–14 mm in length with rounded tips
- each flower head emerges from a green 'cup', 3–5 mm wide
- this 'cup' is made up of a single row of 20–21 green, long, narrow, vertical bracts (modified leaves called 'involucral bracts') with darkened tips
- the involucral bracts are of the same length and slightly overlap



John Virtue



John Virtue

*Daisy-like flower heads with curved ray florets.*



John Virtue



John Virtue

*Involucral bracts showing dark tips (left); 'cup' (right).*



Queensland Government

*Flowering plant.*

## Seeds

- small, cylindrical seeds ('achenes') are 1.5–2.2 mm long and 0.5 mm in diameter
- mostly light brown in colour, but some green and some dark brown
- up to 120 seeds produced per flower head
- each seed attached to a parachute-like pappus of fine, white hairs 3.5–6.5 mm long



John Virtue

*Seedhead showing each seed attached to a pappus.*



Brian Sindel

*Differing seed colours.*

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Seek expert advice to confirm the identity of fireweed in a new area before undertaking any control—you may be looking at a native *Senecio*. Some differences are highlighted below but use of a botanical key is recommended for formal identification. If in Qld you can use the Queensland Herbarium's **Have I got fireweed (*Senecio madagascariensis*)?** factsheet (available at [www.qld.gov.au/environment/plants-animals/plants/herbarium/weeds/weed-resources](http://www.qld.gov.au/environment/plants-animals/plants/herbarium/weeds/weed-resources)) to rule in/out fireweed (Holland 2016).

## 1.1.4 Not to be confused with

*Senecio* is one of the largest genera of flowering plants, with over 1000 species worldwide and over 150 native species or sub-species in Australia alone.

Many native *Senecio* are broadly similar in appearance to fireweed, including *S. brigalowensis*, *S. daltonii* and *S. spanomerus*. The *Senecio pinnatifolius* 'complex' (variable groundsel, native fireweed), also similar in appearance to fireweed, is found across Australia and genetic analysis indicates it is likely to be a mix of species that requires further taxonomic investigation (Schmidt-Lebuhn et al., 2022a). *Senecio brigalowensis* is native to central Qld where it is reported to cause similar poisoning in cattle to fireweed. The native *S. linearifolius* has a quite different appearance but is also called fireweed or fireweed groundsel, and is often found in disturbed areas on farms in south-eastern Australia.

Exotic, weedy *Senecio* that are also established in Australia include *S. jacobaea* (ragwort), *S. pterophorus* (African daisy, winged groundsel) and *S. vulgaris* (common groundsel). Three weedy *Senecio* not known to be in Australia are *S. inaequidens* (South African ragwort) and *S. skirrhodon*, which are very closely related to fireweed, and *S. brasiliensis* (flower of souls). These species can have livestock toxicity impacts similar to those of fireweed.

## Look-a-like/similar named native *Senecio*

Key information sources for this section: RBG (2022); Thompson (2015). All maps provided in the section below have been sourced from [www.ala.org.au](http://www.ala.org.au)

### *Senecio brigalowensis*

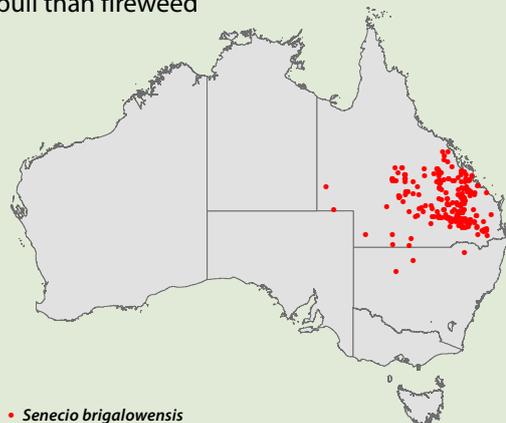
#### brigalow fireweed, brigalow yellowtop

- annual to 0.5 m high
- found in central and western Qld, and north-western NSW



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- increasingly abundant and weedy in central Qld; toxic to cattle
- differs from fireweed by generally having narrow, divided leaves and larger seeds (achenes 2.5–3 mm long)
- has a deep taproot making it harder to hand pull than fireweed



• *Senecio brigalowensis*

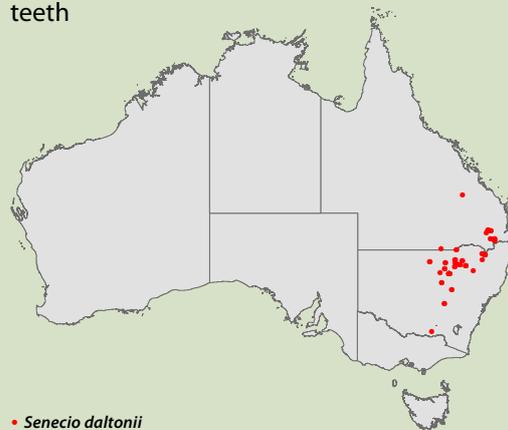
### *Senecio daltonii*

#### Dalton weed

- perennial to 0.5 m high
- found on heavy soils west of the Great Dividing Range in south-eastern Qld and northern NSW
- weed of cultivated areas



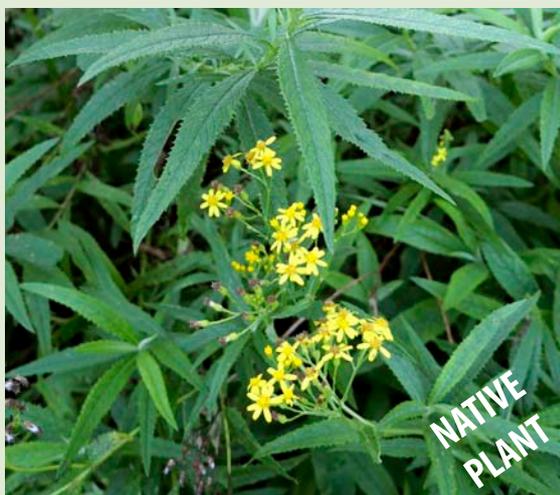
- extensive, rhizomatous root system
- 1–3 flower heads per flowering stem
- flower heads bell shaped and large (10–15 mm diameter)
- seeds 3–5 mm long
- leaves similar to fireweed: undivided with smooth margins or with a few, widely spaced teeth



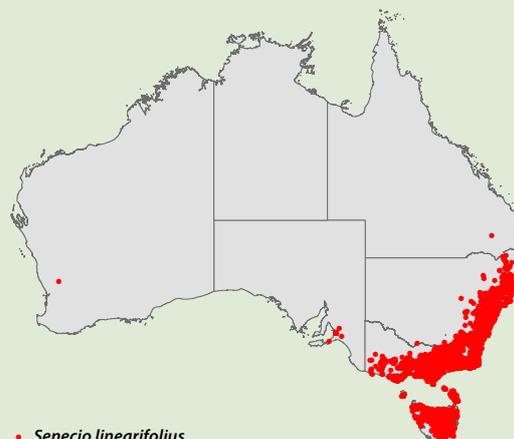
### *Senecio linearifolius*

#### fireweed groundsel; also called fireweed

- perennial to >1 m high
- found in moist habitats in cooler parts of south-eastern Australia, particularly NSW, Vic and Tas



- upright, shrubby growth form
- 8 or fewer ray florets ('petals')
- larger leaves with conspicuous veins on upper surface, finely toothed margins that are slightly rolled under, and pale leaf undersides
- favours disturbance and often found on farms



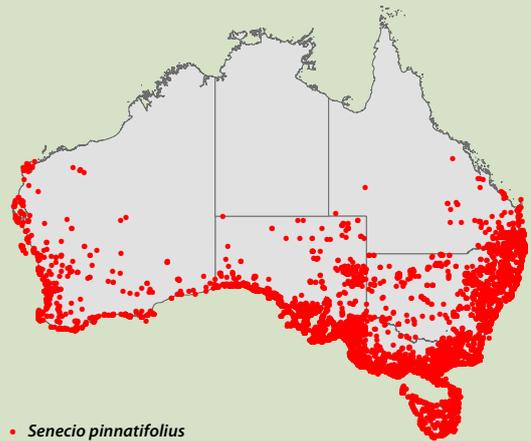
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## *Senecio pinnatifolius* complex variable groundsel, native fireweed

- perennial or annual of variable height
- found across Australia except for the tropics
- grows in more natural habitats than does fireweed, including grasslands, forest edges, and coastal and inland dunes



- highly variable with many varieties; possibly different species (Schmidt-Lebuhn et al., 2022a)
- leaves undivided or variably divided
- flower heads differ from those of fireweed in generally having fewer bracts (12–21) and ray florets ('petals') (5–14)
- seeds larger than those of fireweed (achene 2.5–3 mm long)
- loose clusters of up to 25 flower heads per flowering stem

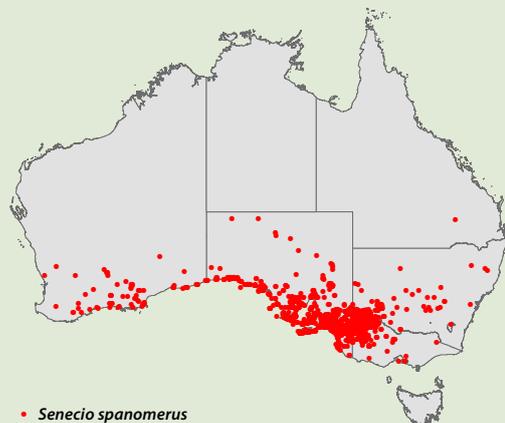


## *Senecio spanomerus*

- perennial to 1 m
- found across southern mainland Australia, particularly in south-central and south-western Australia



- grows in well-drained soils of coastal dunes, rock platforms, salt lake margins, dry riverbeds and drainage lines
- similar to *S. pinnatifolius* but with narrower leaves and 8–13 ray florets ('petals')



## Other exotic, weedy *Senecio* present in Australia

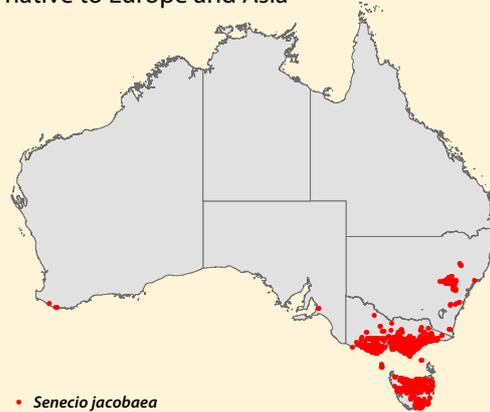
Key information source for this section: Thompson (2015).

### *Senecio jacobaea* (syn. *Jacobea vulgaris*) ragwort

- biennial or perennial up to 1.8 m high
- widespread in open and disturbed farming and natural habitats in cool, high-rainfall areas of Tas, Vic and parts of NSW



- forms a basal rosette (leaves radiate around the base of the stem at the ground) from which tall flowering stems grow
- flower heads all at the same level at the top of the flowering stem
- leaves deeply divided, underside lighter green and downy
- native to Europe and Asia

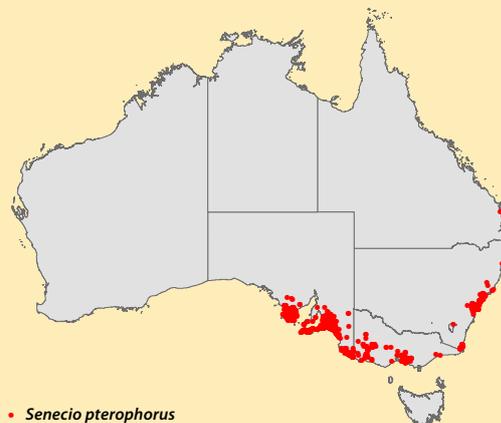


### *Senecio pterophorus* African daisy, winged groundsel, rough senecio

- perennial to 1.5 m high
- widespread in open and disturbed habitats in temperate areas of South Australia (SA), Vic and central eastern NSW



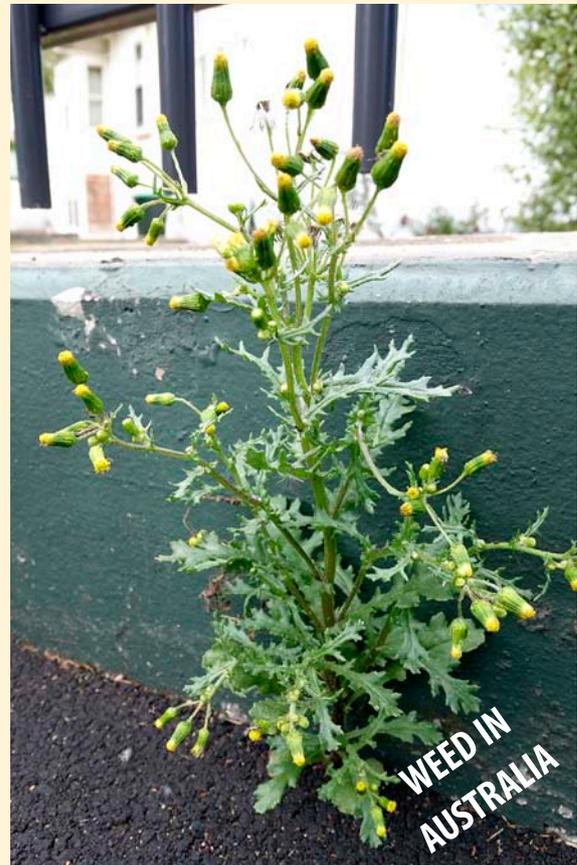
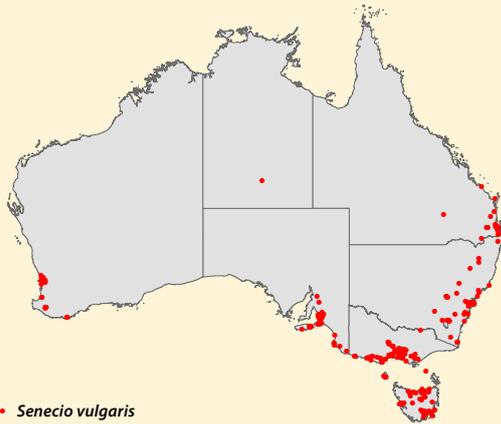
- tall, upright growth with flowers growing in clusters at the end of stems
- stems ribbed and winged
- underside of leaves whitish and downy
- native to southern Africa



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## *Senecio vulgaris* common groundsel

- annual to 0.5 m high
- weed of disturbed areas and cropping
- widespread in cooler areas of Australia
- flower heads with black tipped involucral bracts (a 'cup' of modified leaves at the base of flowers) and no ray florets ('petals')
- divided, sparsely hairy, fleshy leaves
- native to Europe, north Africa and Asia



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## Exotic, weedy *Senecio* not known to be present in Australia

Key information sources for this section: CABI (2022); WFO (2022).

### *Senecio inaequidens*

#### South African ragwort, narrow-leaved ragwort

- perennial to 0.6–1 m high
- very closely related to and similar in appearance to fireweed
- overlapping range in southern Africa but generally grows at higher altitudes than fireweed
- weed in Europe with toxic properties similar to those of fireweed



© Fabien Piednoir iNaturalist Australia Photo 106300439

### *Senecio skirrhodon* gravel groundsel

- perennial to 0.3 m high
- very closely related to and similar in appearance to fireweed
- overlapping range in southern Africa but generally grows as a seashore plant in coastal sands
- naturalised in New Zealand
- fleshy leaves



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### *Senecio brasiliensis* flor-das-almas (flower of souls), hempleaf ragwort

- perennial to 1–2 m high
- native to central South America
- toxic properties similar to those of fireweed
- deeply lobed, pinnate leaves with a whitish-green underside
- grooved stem



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## 1.2 Life cycle of fireweed

Key information sources for this section: Sindel and Coleman (2012); Sindel et al. (1998).

### Key points

- Fireweed mainly grows as a cool season annual.
- Autumn is the peak period for flushes of germination, but some germination also occurs in winter and spring.
- Flowering and seed set can be continuous from winter to early summer.
- Seed dispersal primarily by wind but also long distance by people (e.g. contaminated hay and machinery).
- Most seeds lack dormancy and germinate readily, but some will stay viable at depth in the soil for up to 10 years.
- Fireweed's persistence is driven by its high seed production, backed up by a long-lived soil seedbank.

### 1.2.1 Germination and establishment

Fireweed germinates annually from seed, on the soil surface or buried to a depth of 2 cm (Alonso et al., 1982). Germination occurs in flushes, stimulated after significant rainfall events. Most germination flushes occur in autumn, although seeds also germinate in winter and spring (and even mid-late summer after rain).

Laboratory experiments have shown that fireweed seeds can germinate over a wide range of temperatures: 10–30°C. Levels of seed germination are increased with exposure to light. However, substantial levels of germination can also occur in darkness at cooler temperatures (<20°C) (Sindel et al., 1998; Wijayabandara, 2021).

Fireweed seed, like that of many *Senecio*, germinates in response to disturbance. Greater germination occurs when there is low ground cover (e.g. due to overgrazed pastures, late summer dry conditions or

drought) and bare soils (e.g. roadsides, stock pads and tracks). The enhanced germination sensitivity to light may enable the plant to sense 'gaps' in vegetation to increase the chance of seedlings establishing. Cultivation of soil also causes a flush of germination, which may be a result of increased exposure of seeds to light and/or bringing seeds to the soil surface.



John Virtue

A flush of fireweed triggered by roadside disturbance.

Despite its common name, it is unknown how fire affects fireweed germination. Fire can stimulate germination and establishment of some plants through stimulatory chemicals from smoke and ash, and through enhanced nutrient and light levels. Although a range of native *Senecio* have a flush of germination after bushfires, it is unclear whether fireweed is also triggered to germinate.

Whilst most fireweed seeds germinate readily when exposed to suitable conditions, a small proportion (around 5–20%) have a high initial level of dormancy and will germinate in later years. Green and dark brown seeds are more dormant than the majority light brown seeds (Alonso et al., 1982).

Most seed buried in the soil loses viability after 3–5 years, but in drier environments this may extend to up to 10 years. Deeper buried seeds (down to 10 cm depth) tend to persist ungerminated for longer periods.

Fireweed is shallow rooted and germination late (or very early) in the season leaves seedlings more vulnerable to early death from moisture stress, whether from lack of follow-up rain or competition from other plants. Field research has shown that nearly half of all seedlings perish before flowering (Sindel and Michael, 1996).



John Virtue

*A young fireweed plant emerging through a gap in pasture.*

### 1.2.2 Growth

Fireweed generally grows as an annual, but given sufficient moisture it can over-summer to be a short-lived perennial. Fireweed takes advantage of moist conditions at ground level by growing additional roots along stems resting on the soil surface. It can also use other plants as physical supports to help it to grow both laterally and upwards to get more light.

With their shallow root structure, most fireweed plants die in late spring/summer because of dry soil conditions. Plants are more likely to persist in wetter areas such as drainage lines or during wet summers. Adult plants that have foliage removed such as by slashing or sub-lethal herbicide treatment can be in a better position to over-summer. Where moisture permits, regrowth can occur from the lower stem.

### 1.2.3 Reproduction

Fireweed typically takes 6–10 weeks from germination to first flowering. However, moisture stress has been observed to trigger flowering in small seedlings within several weeks of germination.

Once commenced, flowering is ongoing. The rate of flowering is limited by cool winter temperatures, and by lack of soil moisture reducing plant vigour. Flushes of flowering occur in autumn and spring, but flowering plants can generally be found at any time of year.

**Each flower can produce 50–120 seeds, meaning individual plants can produce thousands of seeds. This scales up to millions of seeds being produced per hectare each year.**

Research has shown that fireweed is an 'obligate outbreeder' in Australia; that is, to set seed it requires pollen from another plant, which is carried by insects. However, field observations in Hawaii have shown instances of self-compatibility in fireweed, where isolated plants have set seed. These observations have been supported by research showing elevated levels of inbreeding in Hawaiian populations of the weed (Le Roux et al., 2010).



John Virtue

*Ongoing flowering and seeding.*

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Figure 1.2 summarises the typical timing of life cycle stages for fireweed in temperate and sub-tropical climates, based on NSW DPI (2012). The actual timing will vary with local climate, seasonal weather, finer-scale site conditions and management. Note that some flowering plants may be found at other times of year, particularly in warmer, wetter regions or otherwise in favourable locations such as roadside ditches. Spring germination of fireweed is more likely in sub-tropical areas and adult plants are also more likely to over-summer.

## 1.2.4 Seed dispersal

Fireweed seed spreads locally mainly by wind, but also as a 'hitchhiker' attached to livestock or on farm machinery. More distant regional spread can occur when seed contaminates produce such as hay or turf, or as a result of being lodged on vehicles and machinery moving long distances.

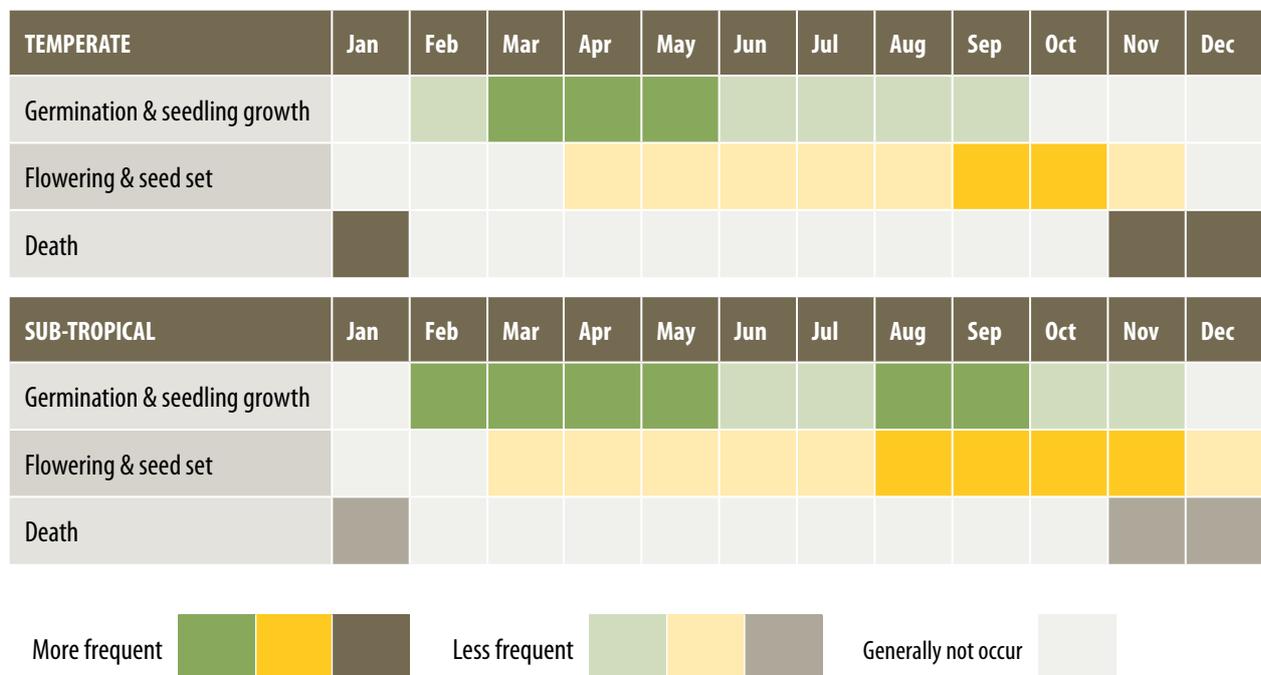
## Wind

Fireweed's main method of natural seed spread is wind. Its seed is small relative to the size of the hairy pappus attached to it. The pappus is caught by the wind to carry seeds away from the parent plant.



John Virtue

Roadside cuttings provide exposed sites for seed to be blown away by wind and vehicles.



**Figure 1.2** Typical timing of fireweed germination and seedling growth, flowering and seed set, and death in temperate and sub-tropical areas.

Fireweed seed has a slow settling velocity relative to other *Senecio*, meaning it floats in the air for a longer period (Mickaill et al., 2020). Wind dispersal modelling on the similar *S. inaequidens* predicted 63% of seeds would land within 10 m and 99.8% within 100 m (Monty et al., 2008). However, taking account of the high seed production per plant, the model suggested capacity for dispersal out to 200 m under common wind conditions.

Contributing factors for long-distance spread by wind include open habitats, occasional updrafts, higher elevations and windy locations (e.g. coasts, roadsides, hills and ridge lines).

### **Animals**

The small hairs on the seeds of fireweed, plus the hairy pappus, assist them to loosely cling to the coats of animals as they move through pastures. Fireweed seed has also been observed to germinate from manure of sheep and cattle (Moxey, 2016). Potential for dispersal by these means should be kept in mind when moving livestock within and between properties. lines).

### **People**

People may also inadvertently move fireweed seed on shoes and clothing.

### **Machinery and vehicles**

When moving through patches of fireweed, seeds may be drawn up into radiators and crevices of utes, tractors, and other vehicles and machinery. Fireweed seed may also be present in mud and soil attached to tyres, mudguards and on soil cultivation equipment.

Mowers, mulchers and slashers present a high risk of seed spread. Cut plant material sticks on the undersides of these machines and falls off at a later time. These machines may also dislodge and locally spread seed from plants that are seeding at the time.

Many other weeds are also spread by these means—hence the importance of vehicle and machinery



John Virtue

*The hairy pappus enables fireweed seed to float and also lodge on vehicles and animals.*

hygiene within and between properties, including when working on roadsides.

### **Produce contaminant, including hay and turfgrass**

Cutting of fireweed-infested pasture for hay risks long-distance seed dispersal, in addition to the risk of livestock poisoning. Silage presents a lower risk as its acidic nature typically reduces weed seed viability.

Uncontrolled fireweed growing in seed crops (e.g. grain and pasture) is a contamination risk in terms of it being unintentionally planted in new regions.

Fireweed seed in turf harvested as rolls of lawn grass can lead to long-distance spread. Infestations in suburban Canberra arrived by this means, leading to a legal requirement that turf imported into the ACT must be certified as having been grown on a turf farm surrounded by a 2 km fireweed-free zone (ACT Government, 2014).

Inclusion of seeding fireweed plants when making mulches and composts may risk seed spread if it has not been subject to adequate heat and microbial decay to kill seeds. Fireweed growing adjacent to mulch piles and gravel pits risks seed contamination and movement to other sites.

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Jenny Conolly, ACT Parks and Conservation Service

*Fireweed contamination in laid turf.*

## **Other means of seed spread**

As with many weed seeds, fireweed seed may be washed along soil surfaces and watercourses in heavy rain and flooding events.

## **1.2.5 Summing up...**

Fireweed's reproductive strategy appears to 'hedge its bets'. Stands of fireweed have plentiful, ongoing seed production. Most seeds lack dormancy and readily take advantage of disturbance and rainfall events to germinate. A small proportion of viable seeds remain in the soil because of dormancy and/or deep burial. This enables fireweed infestations to persist long term even if there is control of emerged plants and poor seasons for growth. The ability to form a persistent seed bank means that it is difficult to eradicate fireweed unless it is a relatively recent introduction. Even then, efficient wind dispersal from surrounding areas means that reinvasion can occur.

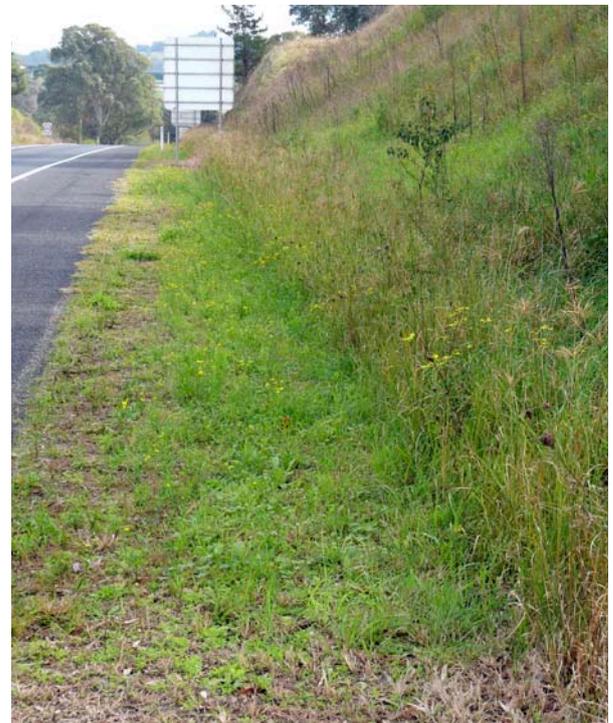
## **1.3 Environments suitable for fireweed**

### **1.3.1 Habitat**

Fireweed is most prolific in open habitats subject to regular disturbances. This includes areas where soils have been exposed by:

- intense livestock grazing or trampling
- use of non-selective herbicides
- very short mowing
- cultivation
- earthworks and landscaping.

Land uses posing particular risk are pastures and annual crops, mown or sprayed roadsides, amenity and industrial areas. In contrast, dense pastures suppress fireweed germination and establishment, though some plants can still emerge in gaps, even in tall kikuyu.



John Virtue

*Fireweed favours areas of high disturbance, such as roadsides.*



John Virtue

*Fireweed in heavily grazed pasture.*

Intact natural areas tend not to be heavily invaded by fireweed unless they are more open habitats subject to regular disturbance and of higher soil fertility. This includes riparian areas, swamp edges, degraded native grasslands and areas adjacent to tracks. Fireweed does not grow well in dense, woody vegetation where it is too shady. However, fireweed has been observed growing in such areas following clearing of the canopy, such as by bushfire.

In Australia (Figure 1.1) and elsewhere fireweed mainly grows in humid coastal, temperate and sub-tropical climates. It can also grow in the tropics at cooler, high altitudes, such as the Atherton Tablelands in FNQ. Fireweed can grow on a wide range of soils.

### 1.3.2 Potential distribution

Fireweed was once thought to be limited by severe winter temperatures. However, it is now established in or invading high-altitude tableland areas that experience frequent, extreme winter frosts and even snow. Frost can kill young seedlings but older established plants are more tolerant. Fireweed has invaded areas of around 1000 m in altitude; for example Tenterfield, Ebor and Nowendoc in the Northern Tablelands, Wallerawang in the Central Tablelands, and Nimmitabel in the Southern Tablelands of NSW (ALA, 2022; Jones, 2022; McIntyre, 2022).

Some records of fireweed plants in inland NSW and the ACT (Figure 1.1) have been associated with wetter areas in the landscape, including roadside drains and areas subject to supplementary irrigation such as lawns, gardens and irrigated pastures (ALA, 2022). Fireweed's shallow root system makes it vulnerable under seasonally dry conditions. However, it does

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grow as a winter annual and may be able to persist in inland areas that have reliable, winter-dominant rainfall.

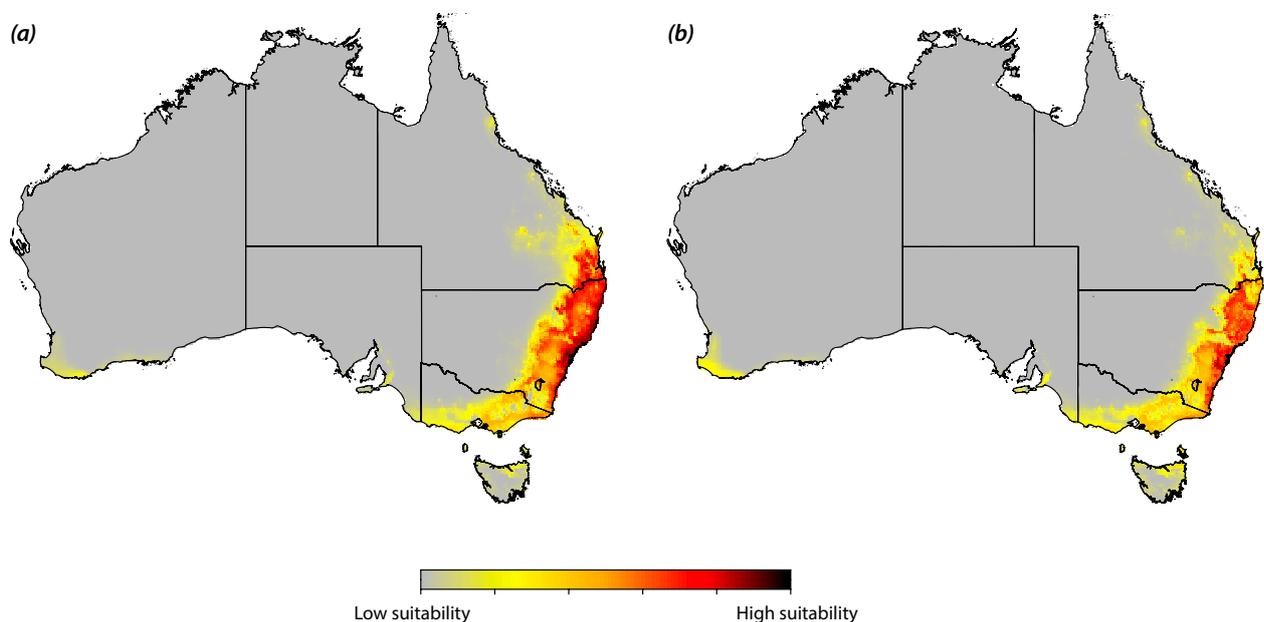
The predicted potential distribution of fireweed in Australia is shown in Figure 1.3, under current climatic conditions (a) and under predicted climatic conditions in 2050 (b).

Beyond the main current distribution of coastal NSW and south-eastern Qld, the model predicts suitability for fireweed establishment in both cold tableland areas and drier environments west of the Great Dividing Range. Small areas of high rainfall Tasmania (Tas), SA and WA are also predicted to be at risk of invasion. The modelling in Figure 1.3 is conservative, based on current locations of fireweed in Australia.

An alternative modelling approach, using overseas distribution data and validating it against current Australian locations of fireweed (Wijayabandara et al. 2022), has predicted even more areas of temperate, higher rainfall areas of Tas, SA and WA at risk. Expansion into western NSW, and further north along the Qld coast and central Qld was also predicted.

### *Implications of climate change*

Figure 1.3b predicts the potential distribution of fireweed will be slightly more restricted in 2050 under higher temperatures of the SSP2-4.5 intermediate greenhouse gas emissions scenario (Riahi et al. 2017). Western NSW and Qld would be somewhat less favourable.



**Figure 1.3** Areas of climatic suitability for fireweed under (a) current climatic conditions and (b) predicted climatic 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, then decrease but do not reach net zero by 2100 (Riahi et al. 2017).

## 1.4 Impacts of fireweed

### Key points

- Fireweed contains toxic chemicals called pyrrolizidine alkaloids.
- Fireweed is highly toxic to cattle and horses; however, it is also highly unpalatable to them, reducing the risk of poisoning to situations where they cannot avoid eating it.
- Sheep and goats are much more tolerant to fireweed's toxins.
- The competitiveness of fireweed in pastures varies with pasture species, seasonal conditions and grazing practices.
- Fireweed reduces pasture utilisation as cattle and horses avoid grazing close to it.

### 1.4.1 Grazing impacts

#### Toxicity to livestock

*Key information sources for this section: Giaretta et al. (2014); NSW DPI (2012); Panziera et al. (2018); QDAF (2022); Thorne et al. (2005).*

Fireweed leaves, stems, flowers and seed contain pyrrolizidine alkaloids (PAs). These chemicals can cause irreversible liver damage (chronic liver sclerosis) in livestock. Such 'Seneciosis' poisoning can cause a range of health effects from listlessness and reduced growth, to loss of weight, brain damage and sudden death from liver failure (Box 1.1), depending on whether there is low level (chronic) or acute exposure.

#### Box 1.1 Symptoms of fireweed poisoning in cattle and horses

*Note that this is general information only. Only a vet can give a formal diagnosis.*

- reduced growth rates and milk yields
- loss of condition ('ill thrift')
- loss of appetite
- weakness
- abdominal straining and chronic scouring (diarrhoea)
- skin sensitisation to sunlight (reddening and peeling)
- jaundice
- confusion, aimless wandering, poor coordination (particularly in horses, arising from brain damage)
- sudden death (including with fat cattle or after having been moved off fireweed pastures for several months)



*Calf thought to have fireweed poisoning.*

Unknown photographer

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Cattle and horses are highly susceptible to poisoning from the types of PAs found in fireweed if they eat the plant. Alpacas, donkeys, pigs and chickens are also highly susceptible (Hooper, 1978 ; Vaughan, 2018). The toxin cannot be broken down, accumulating in and causing scarring of liver tissue. Fortunately, cases of poisoning do not occur frequently as fireweed is extremely distasteful to these livestock. They avoid eating it when they can. Poisoning can occur when there is no alternative pasture or other feed available, or following slashing, or cutting for hay or silage. Cut fireweed is more palatable and is also mixed in with other forage. Young, hungry or new stock not previously exposed to fireweed are at greater risk of poisoning.



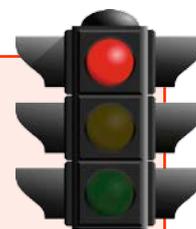
Michael Coleman

*Dairy cattle in a paddock with fireweed present.*

Sheep and goats are much more tolerant to the PAs in fireweed and will graze it generally with no apparent ill effect. This is thought to be because the PAs are deactivated by microorganisms in the rumen, and by liver enzymes. NSW DPI has not recorded any definitive clinical cases of fireweed poisoning in sheep or goats (Schaefer, 2023). However, a historical case was documented in sheep in the Hunter Valley by Seaman (1987) and *Senecio* toxicity in sheep has been observed in sheep in Brazil (see Section 2.7). PA poisoning can occur in sheep, for example in consuming large amounts of common heliotrope (*Heliotropium europaeum*), with liver damage by PAs

## Risk factors for livestock poisoning

- new stock unfamiliar with fireweed
- overgrazing of palatable pasture species leaving animals forced to eat fireweed as the only food source
- drought years where feed production is low and becomes more limiting over time as it gets eaten out
- fireweed cut in hay or silage
- grazing of clippings in mown paddocks containing fireweed, before pasture regrows
- diet high in copper (for sheep)



increasing the risk of copper toxicity (Salmon, 2011). A precautionary approach is recommended where sheep or goats also have alternative pasture species available when grazing in paddocks with dense fireweed infestations.

## Pasture competition and utilisation

*Key information source for this section: Sindel and Coleman, 2012.*

The competitiveness of fireweed in pastures is highly variable, and it does not consistently reduce pasture yields. Fireweed's effect on the growth of pasture plants will vary with the type of pasture, its activity in the cooler parts of the year, growing conditions (e.g. rainfall and soil fertility), grazing pressure and livestock type.

Fireweed is active in the cooler part of the year. In temperate regions, such as the South Coast and Southern Tablelands of NSW, fireweed can have a growth advantage at that time of year over warm season perennial pasture grasses such as kikuyu



John Virtue

Fireweed in cattle pasture.



John Virtue

Kikuyu left untouched by cattle avoiding eating fireweed.

(*Pennisetum clandestinum*), paspalum (*Paspalum dilatatum*) and kangaroo grass (*Themeda triandra*). Winter-active pasture grasses such as ryegrass (*Lolium* spp.) and oats offer more competition. In warmer, subtropical regions such as the North Coast of NSW and south-eastern Qld, warm season perennial pasture grasses are more competitive throughout the year.

Fireweed germinates earlier than annual clovers (*Trifolium* spp.) and can grow above and shade them. Fireweed's early growth rate is also faster than that of white clover (*T. repens*) in early winter.

Although the effect of fireweed on pasture yield may be variable, another impact is its effect on pasture availability. Cattle and horses wanting to avoid fireweed's bitter taste will leave alone pasture growing among fireweed plants, so that not all pasture is utilised. Where fireweed is at medium to high densities in pastures this considerably reduces the carrying capacity or productive potential of a pasture. Fireweed can continue to grow unimpeded through pasture as stock graze around it. Additional feed for livestock may need to be purchased if the weed is not controlled.

### **Loss of potential hay and silage**

Pastures and fodder crops containing fireweed cannot be used to make hay or silage because of the risk of toxic contamination. There is also the risk of fireweed seed spread via hay if it is harvested when setting seed.

### **Costs of control in pastures**

Because of the risks of poisoning and the reduced carrying capacity arising from fireweed's unpalatability, competitiveness and growth throughout much of the year, fireweed needs to be controlled in pastures. This requires an integrated approach including competitive pastures, grazing management, supplementary feeding, herbicides and/or manual removal, as detailed in Chapter 2. This represents a substantial annual management cost to properties that graze cattle, horses and other susceptible livestock.

A 2011 survey of fireweed-affected farmers in coastal and hinterland NSW and south-eastern Qld by researchers at the University of New England indicated that nearly half spent more than 50 hours and at least \$1000 annually controlling fireweed (Sindel et al., 2012). A follow-up survey by the University of Queensland in 2019/20 of northern NSW and south-eastern Qld found that approximately 30% spent \$200–1000 per year and a further ~20% spent \$1000–5000 per year controlling fireweed on their farms (Wijayabandara, 2021).

### **1.4.2 Impacts on cropping**

Fireweed germinates readily following cultivation in establishing crops in autumn. However, provided appropriate herbicides are used, fireweed is readily controlled along with other broad-leaved weeds and has minimal impacts on yields, as well as low risk of seed contamination. Similarly, the risk of fireweed contamination in cereal and legume fodder crops used for hay, chaff or silage is low where herbicides are used to control fireweed seedlings.

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Fireweed can contaminate turf crops, growing when planted out as lawns. This can limit access to markets for affected turf farmers, and risks non-compliance where legal prohibitions apply to the movement of fireweed. For example, there is a prohibition on the import of turf into the ACT from turf farms in areas of NSW where fireweed is known to occur (ACT Government, 2014). This follows multiple incursions of the weed detected on imported turf in new housing developments.

Although fireweed may grow in horticultural crops, such as in vineyards, it is not known to have any substantial impacts.



John Virtue

Scattered fireweed in soil cultivated for cropping.

## 1.4.3 Impacts on people

Key information source for this section: Johnston, 2007.

The main social impact of fireweed is the time its control can take away from other farm and land management, recreation, social and community activities. Another is the social impact of tension with neighbours over differing levels of control and subsequent risks of spread between properties.

Fireweed can also take an emotional toll, including concerns over livestock health, difficulties in achieving satisfactory levels of control and the need for constant vigilance to address new incursions.

Long term, there can be perceptions of a reduction in the value of infested properties and of placing a burden on future profitability and management requirements.

Some in the community are concerned about direct human health impacts of fireweed, either through direct skin contact or consuming animal products (but noting livestock avoidance of grazing fireweed). There is no definitive scientific evidence that there are significant food safety risks posed by fireweed in Australia. Nonetheless, the broader issue of PAs and food safety continues to be examined by the Australia/New Zealand and international food standards organisations (FSANZ, 2020; WHO and FAO, 2020).

## 1.4.4 Environmental impacts

Fireweed is not a major environmental weed of concern with regard to biodiversity or conservation. It generally does not invade undisturbed and/or dense natural habitats such as forests, woodlands, heathlands and intact coastal dunes. However, some concerns have been raised about its potential to invade native grasslands in coastal and tablelands settings, because these are usually subject to a high level of native animal (or livestock) grazing and associated disturbance.

Observations of neighbouring populations of fireweed and the closely related *S. pinnatifolius* showed they have subtly different habitats. Fireweed tended to only grow in highly disturbed pastures, roadsides, lawns, path edges, cleared lands and river beds, and was rarely found growing in the intact native vegetation where *S. pinnatifolius* was found (Radford and Cousens, 2000).

Recent genetic studies have shown that fireweed is not closely related to Australian native *Senecio* and the risk of cross-pollination to produce adult hybrid plants is low (Schmidt-Lebuhn et al., 2022a).