# NOMINATION OF A TARGET WEED
# FOR BIOLOGICAL CONTROL

## TARGET: *Conyza bonariensis* L. (Asteraceae)

Flaxleaf fleabane

**May 2017**

## Nominating Organisation:

CSIRO, Health and Biosecurity

**Submitted to:** Invasive Plants & Animal Committee
via QLD DAF representative


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## Summary

This document presents issues relevant to determining the suitability of flaxleaf fleabane (*Conyza bonariensis*) for biological control in Australia.

Flaxleaf fleabane is a major weed of cropping in northern New South Wales, southern Queensland and is estimated to cause revenue losses in excess of $43 million for grain producers. Development of resistance to herbicides is making populations increasingly difficult to manage in these agricultural environments. This species has no beneficial aspects in Australia.

Biological control is a potentially useful and valuable tool for the management of flaxleaf fleabane given the success of previous biological control programs against other weeds in the Asteraceae family such as – *Parthenium hysterophorus*, *Chromolaena odorata* and *Ambrosia artemisiifolia.* Preliminary literature searches of over 600 published articles, 10 books and several databases have identified several potentially host specialist fungi, two galling tephritid flies and a newly described mealybug species. Flaxleaf fleabane is taxonomically isolated from native Australian plants as there are no native representatives in the genus *Conyza.* Representatives of Australian native species that were transferred from closely related genus *Erigeron* into a range of new genera, will also be included in host testing of any potential agents.

## 1. Taxonomy

Scientific name: *Conyza bonariensis* (L.)

Synonyms: *Conyza ambigua DC., Conyza crispa* (Pourret) Rupr*., Erigeron bonariensis., Erigeron crispus* (Pourret)*., Erigeron linifolius* wild

Common names: flaxleaf fleabane, fleabane, hairy horseweed, wavy leaf fleabane, rough conyza, Argentine fleabane

Family: Asteraceae

### 1.1 Description

Flaxleaf fleabane grows up to 1 m in height and has erect, multiple-branching stems covered with stiff hairs (Wu 2007). Leaves are grey-green, deeply indented, coarsely toothed and covered in fine hairs (Figure 1A & B). Branches often grow taller than the main plant axis from which small flower-heads are borne in leafy clusters towards the tips of the racemes. This species is characterised by the production of fluffy, cream seed heads (Figure 1C). Flaxleaf fleabane seeds are enclosed singularly in small hard achenes. Attached to the achenes are a tuft of bristles called the pappus (Figure 1D), which gives flaxleaf fleabane its characteristic fluffy seed head look, but also enables long range seed dispersal by wind and water.

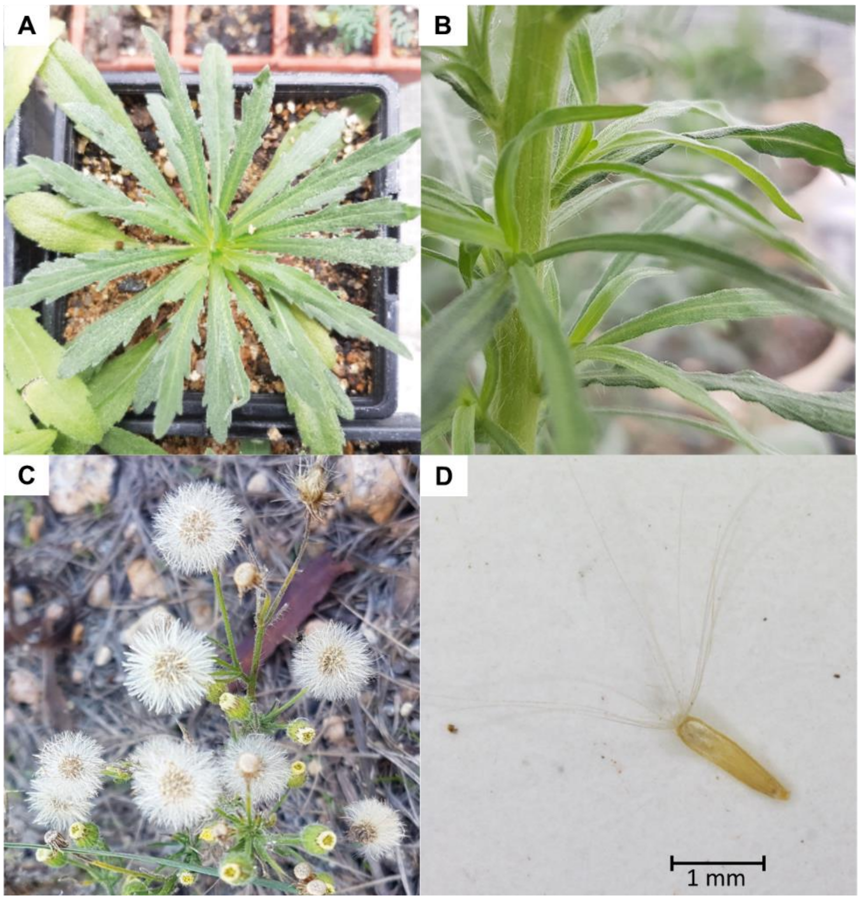


**Figure 1:** Pictures depicting the features of *Conyza bonariensis* A) late stage rosette prior to bolting, B) fine hairs coving the stems and leaves, C) the fluffy cream-coloured seed heads and D) the seed with a tuft of fine bristles.

### 1.2 Close relatives in the Australian region, with comments on their economic, biological and ecological importance and distribution.

*Conyza* is mostly a New World genus of the family Asteraceae, the largest of all plant families (c. 25,000 species worldwide). The Asteraceae in Australia comprises approximately 1,000 native species and hundreds of introduced species, many of which have become weeds (Brown 2014). *Conyza* belongs to the sub-family Asteroideae, tribe Astereae, subtribe Conyzinae (Figure 2) and has arisen from the genus *Erigeron* (Nesom 2008). There are no *Conyza* species native to Australia. There are about a dozen of native species in the genus *Erigeron*, which were transferred years ago to a range of new genera (Nesom 1994, b; APNI 2014). However, there has been little acceptance of this classification by Australian taxonomists (Forbes and Morris 1996, Royal Botanic Gardens Melbourne 2012, Australian Plant Census 2017). Representatives of these closely-related native species would need to be included in host-specificity testing of candidate biological control agents to assess risks they may pose to non-target plant species (Morin, 2012).

Representative species of some of the following Australian native genera outside the subtribe Conyzinae in the tribe Astereae would also have to be tested, such as those in the *Brachyscome* group (e.g *Brachyscome*, *Calotis*), *Olearia* group (e.g. *Olearia*, *Celmisia*), and *Vittadinia* group (e.g. *Vittadinia*, *Ixiochlamys*) (Xiaoping and Bremer 1992). It is noteworthy that there are no economic crops grown in Australia that belong to the tribe Astereae.

Representative species of the tribes most closely related to Astereae, i.e. tribes Anthemideae, Gnaphalieae, Calenduleae and Senecioneae, would also need to be included in the plant test list. Finally, at least one representative species from each of the other main tribes of the sub-family Asteroideae, including crop species such as sunflower, would have to be tested with the candidate biological control agents (Morin, 2012).

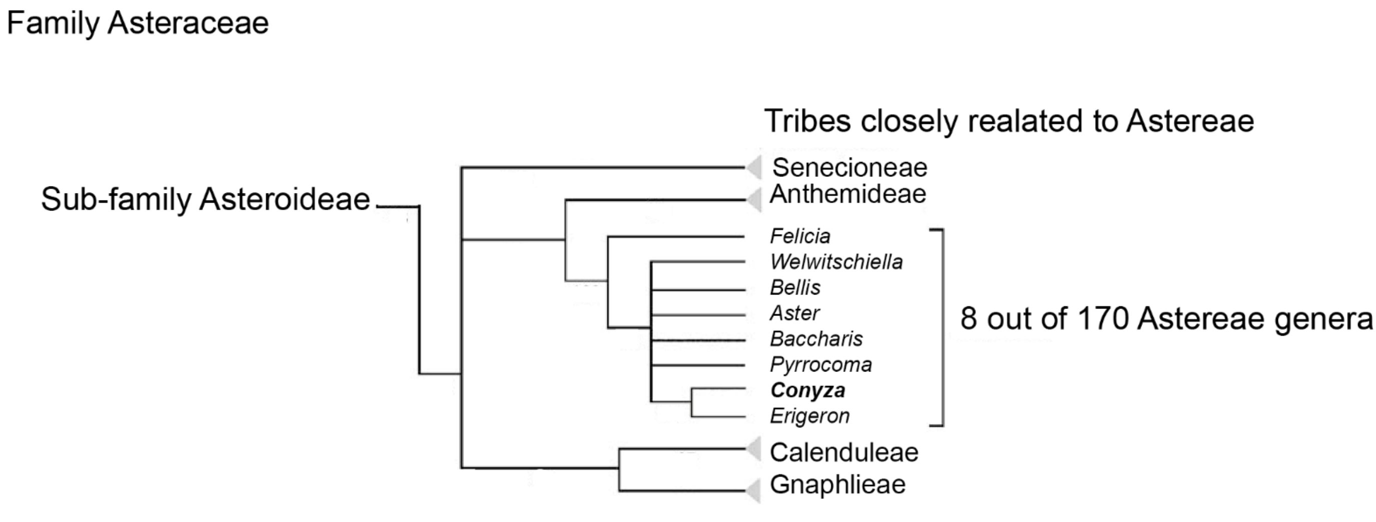


**Figure 2:** A schematic phylogeny showing the tribes closely related to Astereae and the position of *Conyza* relative to 8 of the 170 genera within the tribe Astereae. Figure redrawn based on a phylogeny produced in Brouillet et al. (2009).

## 2. Habitat

### 2.1 Native geographic range

Flaxleaf fleabne was first described in Argentina (Michael 1977) and originates from warm temperate South America (Nesom 2008; Michael 1977; Prieur-Richard et al. 2000; Thebaud & Abbott 1995) (Figure 3). It is widespread in Argentina, Uruguay, Paraguay and Brazil and can also be found in coffee plantations in Colombia and Venezuela (Mangolin et al. 2012). This plant was documented growing in European gardens in the first half of the 18th century (Wein 1932 in Michael 1977). It is therefore conceivable that this species could have been introduced to Australia via both Europe and America (Michael 1977; Wu 2007).

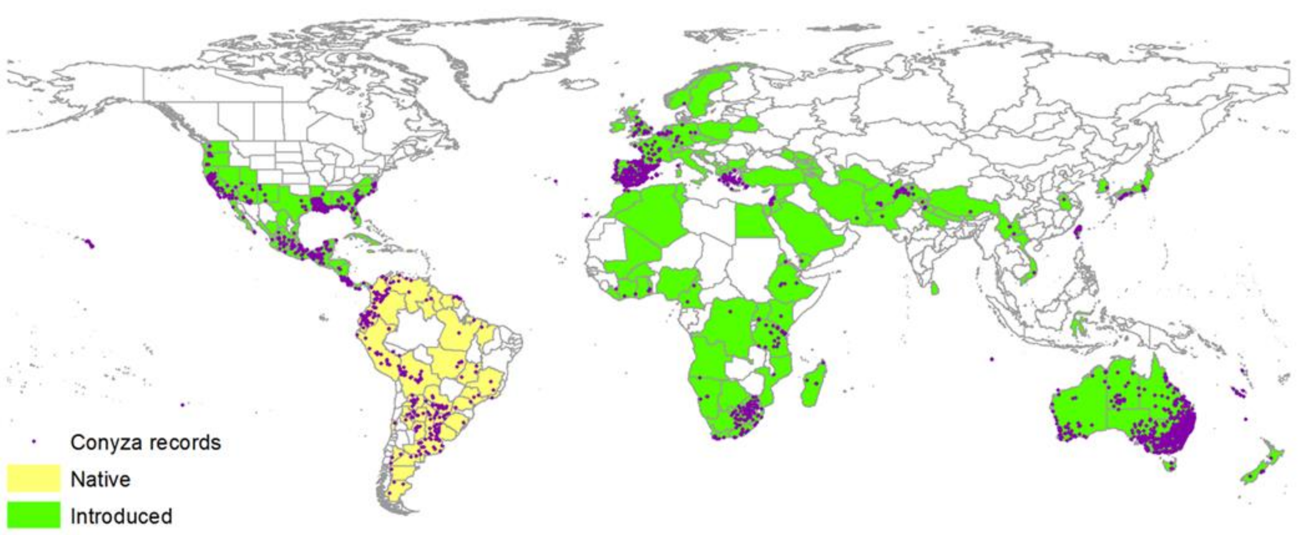


**Figure 3:** The native (shown in yellow) and introduced (shown in green) ranges of *Conyza bonariensis*. Distribution records are shown as purple dots and regions where *Conyza bonariensis* has been reported are shown by the coloured areas. Reproduced from Scott et al. (2016).

### 2.2 Present distribution, both in Australia and elsewhere

Flaxleaf fleabane is a cosmopolitan weed found on all continents except Antarctica (Figure 3). The weed is present in all States of Australia with 10,498 occurrence records in the Atlas of Living Australia (ALA 2017; Michael 1977; Wu et al. 2007) (Figure 3 and 4). Its distribution in Australia is sparse in central regions and the species frequently occurs in temperate regions (Scott et al. 2016) (Figure 4).

Flaxleaf fleabne is considered as introduced in North America (Strother 2006) and Mexico (Rios and Garcia 1998), although it is sometimes listed as native in Central America (Figure 3) (Scott et al. 2016). Elsewhere, the plant is widespread in Europe, the Mediterranean region, southern and eastern Africa and present in Asia, New Zealand and some Pacific Islands (Figure 3) (Michael 1977, Scott et al. 2016).

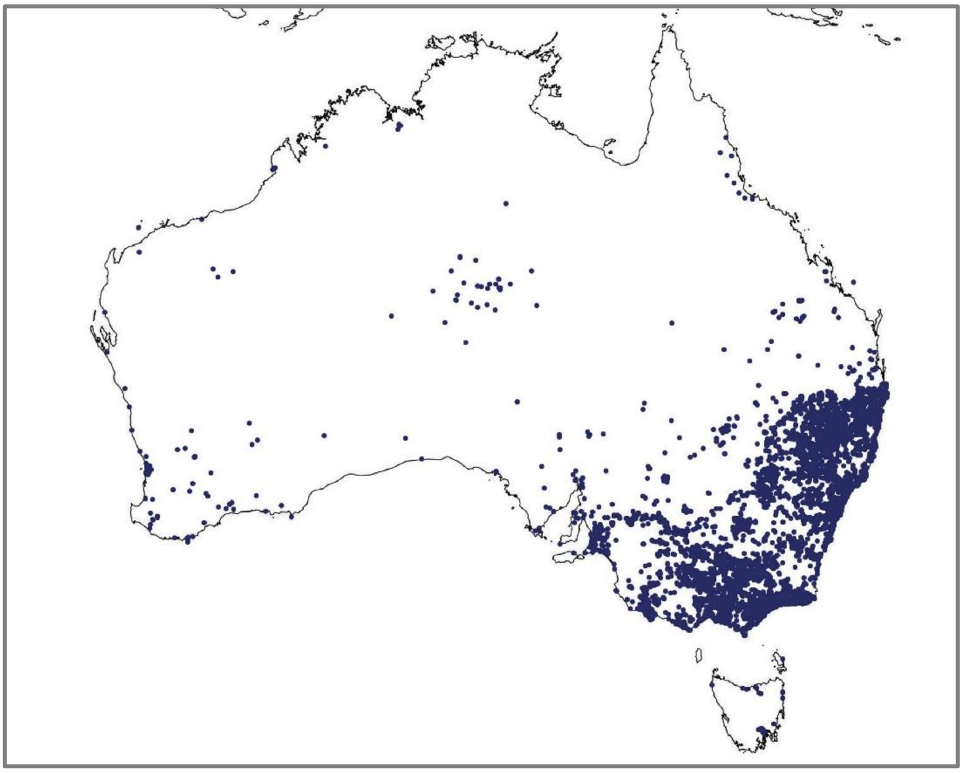

**Figure 4:** Occurrence records of *Conyza bonariensis* as recorded in the Atlas of Living Australia (March 2017) http://biocache.ala.org.au/occurrences/search?taxa=Conyza+bonariensis#tab_mapView.

## 2.3 Potential geographic range of species in Australia

The earliest accounts of flaxleaf fleabane in Australia are eight herbarium records collected during the 1840s (AVH, 2017; Micheal 1977). It may have been accidentally introduced into South Australia initially (Burry and Kloot 1982), as it was widespread in the Adelaide area at the time of first botanical collections in 1847 (Wu 2007). Since then it has spread to all Australian states (Figure 4). Significant areas of Queensland, New South Wales, South Australia and Western Australia have been identified as either optimal or suitable growth environments for this weed (Figure 5), so the distribution and abundance of flaxleaf fleabane in these states could increase (Scott et al. 2016).

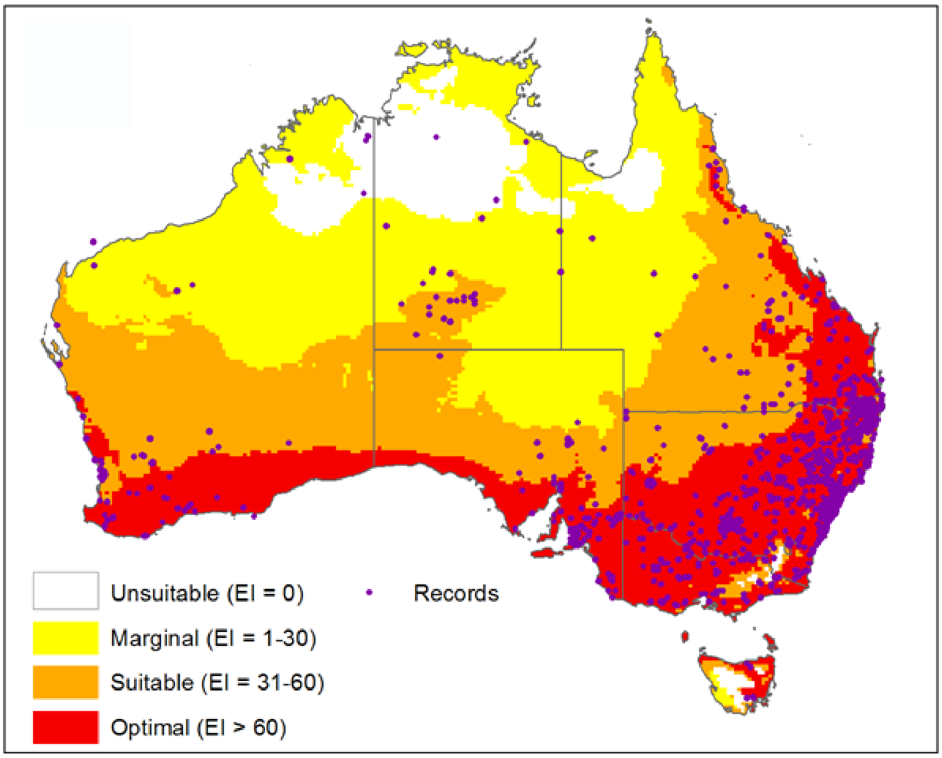


**Figure 5:** Projected climatic suitability model and observed distribution for *Conyza bonariensis* in Australia. Current records of *Conyza bonariensis* are indicated by the purple dots. The projection is under the 1961-1990 climate normals, as modelled using CLIMEX. Climatic suitability and the projected distribution is shown by the Ecoclimatic Index (EI) as indicated by the changing colour scale: Unsuitable (EI = 0) white, Marginal (EI = 1–30) yellow, Suitable (EI = 31–60) orange, Optimal (EI > 60) red. Figure reproduced from Scott et al. (2016).

## 3. Control Methods

Currently control of flaxleaf fleabane is attempted with a combination of chemical and cultural strategies (Wu et al. 2007). All chemical control techniques are most effective when applied to small young plants (one to two month old rosettes) (Walker et al. 2012). Flaxleaf fleabane has a prolonged emergence pattern from seed and once emerged can re-sprout when foliage is damaged or removed (Davies 1999). These growth characteristics mean the weed is present as several growth stages in fields at any point in time, making the timing of herbicide application difficult (Wu et al. 2010). Herbicide application on mature plants is ineffective due to plant physical characteristics such as high trichome (hair) density, high cuticle thickness and low stomatal density, which limits herbicide uptake (Procopio et al. 2003; Wu 2007). For these reasons, a single herbicide application generally results in inconsistent control (Wu et al. 2006; Wu et al. 2008). Therefore, application techniques such as double-knock and residual herbicides are recommended (Wu et al. 2006; Widderick et al. 2011).

Double-knock herbicide application requires that two postemergent herbicides with differing modes of action are applied to a weed population 5-10 days between one another (Werth et al. 2010, Widderick et al. 2011). Residual herbicides can be applied during fallow to control germinating flaxleaf fleabane seed (Widderick et al. 2011). While the use of residual herbicides is effective at minimising the emergence of flaxleaf fleabane (Widerick et al. 2011), these herbicides remain in the soil for a long period, limiting growth of native plant species and successive crops. Planting periods, crop rotation and retention of desirable trees needs to be taken into consideration when considering residual herbicides (Widderick et al. 2011). Drawbacks of both of these chemical control techniques are that they require chemical intensification of the cropping system and may involve the use of herbicides that are not environmentally friendly (Stewart et al. 2011). Continual herbicide use can also lead to resistance development in weed populations (see below).

Alternative non-chemical control options recommended for flaxleaf fleabane include increased species richness and a diverse plant community (Prieur-Richard et al. 2000), decreased row spacing of crops (Wu and Walker 2004), and strategic use of tillage to invert the soil and bury seed below 2 cm depth (Werth and Walker 2007). These techniques are not always viable as they may run contrary to current agricultural practices (e.g. minimum tillage farming adopted to minimise top soil loss).

## 4. Importance of the candidate species

### (a) Detrimental aspects

Flaxleaf fleabane is a major weed of cropping in northern New South Wales, southern Queensland, and is also becoming widespread within southern and western farming systems in Australia (Widderick et al. 2011). It has been identified as one of the most difficult weeds to control in the northern New South Wales and southern Queensland regions (Walker 2004; Wu et al. 2007). The relative abundance of this weed threatens sustainable farming practices such as dryland minimum tillage farming (Walker et al. 2004). Increased prevalence of flaxleaf fleabane is attributed to the practice of minimum tillage, as this system creates a better environment for seed germination and survival (Walker et al. 2004; Wu et al. 2007). This weed has been ranked as the third most problematic weed in summer fallow nationally, and is calculated to affect an area of nearly 3 million ha, causing revenue losses in excess of $43 million annually (Llewellyn et al. 2016).

Flaxleaf fleabane affects crop production through indirect and direct interference mechanisms (Bajwa et al. 2016) and has been reported to impact soybean and cotton yields by 25-68% (Trezzi et al. 2013; Bajwa et al. 2016). The weed has a deep tap root that develops over winter months, while the above ground plant remains as a small rosette (Wu 2007). This growth pattern confers a major advantage to plants in the spring, allowing rapid growth, but it also greatly reduces stored water supplies in fallow (Wu et al. 2010), which impacts on subsequent crop emergence and growth. This species is also a prolific seed producer that can produce up to 120000 seeds per plant (Wu et al. 2007). The seeds have long distance dispersal capabilities by both wind and water, due to the seeds small and light morphology (Andersen 1992, Wu 2007). These reproduction characteristics mean that unmanaged populations of flaxleaf fleabane in areas surrounding arable land generates a large and persistent invasion pressure into cropping land. Flaxleaf fleabane also acts as a reservoir for insect pests and viruses, including tomato spotted wilt virus in Queensland (Helms et al. 1961).

Populations of flaxleaf fleabane have evolved resistance to multiple herbicides including glyphosate, paraquat, atrazine, simazine, chlorsulfuron and diquat (Bajwa et al. 2016; ISHRW 2017). Herbicide resistant populations require alternative control strategies, such as rotation of different chemical herbicides and integration of cultural control methods (Bajwa et al. 2016). These alternative strategies can involve herbicides that are more expensive and less environmentally friendly (Stewart et al. 2011).

Flaxleaf fleabane has also been reported to cause contact dermatitis in South Australia (Burry and Kloot 1982), as the sap can cause skin irritation (Cunningham et al. 1981).

### (b) Beneficial aspects

Historically the seed of fleabane were crushed and the aroma used to repel insects (Cunningham et al. 1981). Ethnobotanical studies of flaxleaf fleabane report that the plant can be used medicinally (Maia et al. 2002; Pereira et al. 2005) and identified plant constituents screened for anti-inflammatory (Souza et al. 2003) and antifungal (Gautam et al. 2003; Kuiate et al. 2005) properties have been found to have some activity. No beneficial aspects of this species have been recorded to date in Australia.

## 5. Stakeholders

Stakeholders for flaxleaf fleabane are primarily those people or organisations negatively impacted by this weed. In these cases, we expect biological control will be beneficial.

These stakeholders include:

- Agricultural landholders
- Grains Research and Development Corporation
- Cotton Research and Development Corporation
- Meat and Livestock Australia
- Rail and Road infrastructure managers
- Environmental stakeholders – National parks

## 6. Potential for biological control

Literature searches of over 600 published articles, 10 books and several databases resulted in a compilation of 42 fungal, 28 insect and one nematode species known from this host.

Fungal species described from flaxleaf fleabane were distributed across the phyla Ascomycota and Basidiomycota while a single record was from the Oomycota. Of the 22 Ascomycota genera found to infect flaxleaf fleabane only 6 were determined to be likely specialist fungal pathogen. These species include *Aporellula erigerontis*, *Cercospora* sp., *Cercospora nilghirensis*, *Lasiostemma melioloides*, *Lasiostemma coronatum* and *Septoria erigerontis*. In contrast to the Ascomycota, the majority of Basidiomycete species were identified as likely specialists infecting leaves of only *Conyza* or *Erigeron* species. These were from the genera *Aecidium*, *Caeoma*, *Coleosporium*, *Micropuccinia*, *Puccinia* and *Uredo* and were represented by *Aecidium conyzae-colombiensis*, *A. erigerontis*, *Caeoma cyclostoma*, *Coleosporium erigerontis*, *Micropuccinia spegazzinii*, *Puccinia doloris*, *P. conyzella* and *Uredo erigerontis*.

Insect species identified to use flaxleaf fleabane as a host were distributed across 15 families including Lygaeidae, Tephritidae, Agromizidae, and Aphididae. Most of the insect species identified to use flaxleaf fleabane as a host were determined to have generalist host ranges. However, two gall flies, *Trupanea bonariensis* and *Eutreta rhinophora* (Tephritidae), were identified as likely host specialists (McKay and Gandolfo 2001; Stoltzfus 1977), although their impact on the weed is not documented. A new mealybug species, *Paracoccus galzerae (*Pseudococcidae), has recently been described from the roots of *C. bonariensis* in vineyards in southern Brazil (Pacheco Da Silva et al. 2016). New descriptions such as this gives us confidence that other potential candidate biological control agents are likely to be found during systematic field surveys in the native range.

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