

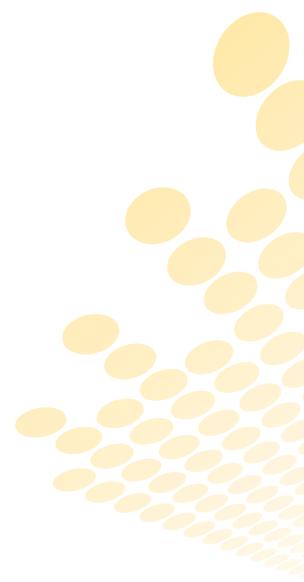
Fireweed

Senecio madagascariensis



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Contents

Summary	3
Introduction	4
Identity and taxonomy	4
Taxonomy	4
Description	5
Reproduction and dispersal	8
Origin and distribution	9
Preferred habitat	9
History as a weed	10
Overseas and interstate	10
Current distribution in Australia and Queensland	11
Introduction and spread	14
Current impact in Queensland	14
Pest potential in Queensland	17
Control	19
Pests and diseases	19
References	20

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Front cover: Fireweed (*Senecio madagascariensis*)

Photo: Sheldon Navie

Summary

Fireweed (*Senecio madagascariensis*) is a short-lived plant native to Madagascar and southern Africa. It was first introduced into Australia (in New South Wales) around 1918. Currently, fireweed is abundant in parts of south-eastern Queensland, with the most substantial infestations in Logan City, Gold Coast City and Scenic Rim Regional councils. Climate-based modelling predicts fireweed will expand its range over time, extending from coastal southern Queensland into coastal central Queensland and upland areas of northern Queensland.

Fireweed is a resilient and persistent weed of both improved and native pastures. While some graziers are not overly concerned about fireweed, others believe it reduces pasture production. Fireweed is also toxic, causing irreversible liver damage in livestock, particularly cattle, if ingested over an extended period. In addition, the species is very closely related to native *Senecio* species, and might hybridise with these species, potentially modifying the native gene pool.

This study was unable to find data on the economic impact of fireweed in Queensland. Such data needs to be collected to inform government policy on this species. In the interim, data from New South Wales, where fireweed has been abundant for decades, provides a useful insight into the species' impact. A survey of 581 graziers in coastal New South Wales revealed a common belief that fireweed's primary impact is on pasture production rather than cattle poisoning. This perception is supported by experiments, which recorded up to 70% decline in pasture yield. When weather conditions are favourable, fireweed can cost New South Wales farmers up to \$5.4 million per annum.

This risk assessment suggests that there is sufficient evidence to treat fireweed as a high-risk species in Queensland; it has the potential to impose significant costs on the grazing industry in coastal southern Queensland.

Introduction

Identity and taxonomy

Species: *Senecio madagascariensis* Poir.

Synonyms: *Senecio incognitus* Cabrera, *Senecio ruderalis* Harv., *Senecio junodianus* O. Hoffm.

Common names: Fireweed, fire weed, Madagascar ragwort, South African ragwort.

Family: Asteraceae

Taxonomy

Senecio madagascariensis (*S. madagascariensis*) was first described by Poiret in Madagascar in 1817. For many years after its introduction to Australia, *S. madagascariensis* was confused with a group of very similar native *Senecio* species that was then called the *S. lautus* complex, but is now largely known as *S. pinnatifolius* (Michael 1992; Radford et al. 2004; Thompson 2005). It was first correctly identified as *S. madagascariensis* and recognised as an introduced plant in 1981 (Michael 1981). Subsequent investigations have shown that *S. madagascariensis* plants in Australia are most similar to plants from the KwaZulu-Natal province in South Africa, and that this region is the species' most likely origin (Radford et al. 2000).

Differentiation between *S. madagascariensis* and native *Senecio* species (particularly *S. pinnatifolius*, which commonly co-occurs with *S. madagascariensis*) is important, as many of the natives are essentially non-weedy (Sindel 1986; Radford and Cousens 2000).

S. madagascariensis was also wrongly identified after being introduced into Argentina, where it was known by various other names (e.g. *S. incognitus* and *S. burchellii*) until it was correctly identified in 1978 (Lopez et al. 2008).

S. madagascariensis is very similar to *S. inaequidens*, another closely related species from southern Africa. Both are part of a polyploid complex that includes *S. harveianus*, *S. burchellii* and *S. pellucidus*. Hybridisation often occurs among members of the complex in South Africa (Lopez et al. 2008). In fact, there is ongoing debate as to whether these are separate species, or just two forms of a single highly variable species. Some authors believe that *S. madagascariensis* should be included in a wider concept of *S. inaequidens* (Lafuma et al. 2003). However, the dominant current opinion is that *S. madagascariensis* is a distinct species that can be separated by differences in leaf and cypsela morphology as well as geographic distribution (Radford, Muller et al. 2000; Lopez et al. 2008).

The remainder of this assessment is based on the premise that *S. madagascariensis* is a distinct species, and that *S. inaequidens* is a separate (but very closely related) species. Hence, though it may be mentioned to some degree, the impacts of *S. inaequidens* have not been thoroughly investigated here.

Description

The following description of *S. madagascariensis* is adapted from Harden (1992), Parsons and Cuthbertson (1992), Auld and Medd (1996), Sindel, Radford et al. (1998) and Thompson (2005).

S. madagascariensis is an erect or ascending herbaceous plant usually growing to 10–50 cm tall, but occasionally up to 70 cm tall (see Figure 1). It is usually short-lived (i.e. annual or biennial), but may occasionally persist for more than 2 years (i.e. as a short-lived perennial).



Figure 1. Multi-branched habit of mature *S. madagascariensis* (Photo: Sheldon Navie).

The plant can have a single main stem or several stems that develop from a central crown at the base of the plant. These stems are multi-branched towards the top of the plant and bear large numbers of flower heads at their tips.

The alternately arranged leaves (which are 2–12 cm long and 3–25 mm wide) are variable in shape, but usually lanceolate. Leaf margins are usually denticulate to coarsely serrate, with 15 to 25 teeth on each side, but they may sometimes have one or two narrow lobes on each side. These leaves are sessile; the lower ones gradually narrow to the base (i.e. attenuate) and the uppermost ones have broad bases that tend to clasp around the stem (see Figure 2). Stems and leaves are glabrous or pubescent.



Figure 2. The stem-clasping upper leaves of *S. madagascariensis* showing toothed margins (Photo: Sheldon Navie).

The daisy-like flower heads (which are 15–20 mm across) have yellow centres made up of between 35 and 60 small tubular florets, which are 3–5.5 mm long (see Figure 3).



Figure 3. *S. madagascariensis* flower heads (Photo: Sheldon Navie).

The flower heads have between 12 and 15 petal-like ray florets with bright yellow ligules (each 6–14 mm long) and are surrounded by between 9 and 21 involucre bracts (each 4–6 mm long), as shown in Figure 4. These bracts are greenish with brown or blackish tips. The flower heads (i.e. capitula) are loosely clustered into groups of between 2 and 20 at the tips of the branches.



Figure 4. *S. madagascariensis* flower heads from below, showing involucre bracts (Photo: Sheldon Navie).

The seeds (i.e. achenes or cypselae) are somewhat cylindrical in shape, 1.5–3 mm long, less than 0.5 mm wide, brownish in colour and shallowly ribbed. They are covered with minute hairs and topped with a pappus of numerous silky hairs, which are 3.5–6.5 mm long, as shown in Figure 5.



Figure 5. *S. madagascariensis* seed heads showing mature achenes and pappi (Photo: Sheldon Navie).

Reproduction and dispersal

S. madagascariensis reproduces primarily from seeds (but occasionally via crown segments). Most seed dispersal is by wind, but some seeds may be spread by animals, vehicles and in agricultural produce (Navie and Adkins 2008). A survey of graziers in New South Wales (Sindel 1989) found that 24% of graziers had fireweed in pasture or crops used for hay or silage. Since such material is widely sold and transported considerable distances, it may be the primary mode of long-distance dispersal.

Flowering is prolonged, usually from late autumn to midsummer, but some plants flower until late summer if conditions are favourable. Germination occurs whenever the soil is moist, but mainly from March to June (Parsons and Cuthbertson 1992). Optimum temperature for germination is between 15°C and 27°C (Parsons and Cuthbertson 1992). Single plants have been recorded to produce between 25 000 and 30 000 seeds per annum, with up to 150 seeds per flower head (Parsons and Cuthbertson 1992). Total seed production of 9163 seeds per square metre (per annum) was recorded in New South Wales (Radford and Cousens 2000). The latter authors also reported that an average of 42% of seedlings survived to maturity, that the species was reproductive in all months except December and January and that 50% of plants flowered before they were 3 months old. In combination with other factors (such as rainfall), seeds germinate in response to light. After 22 months, approximately 42% of seeds germinated when stored in dark (covered) experimental conditions, whereas more than 70% of seeds germinated when subject to periodic light (Radford and Cousens 2000). Most seeds (about 80%) have either no dormancy or a very low level of dormancy and will germinate as soon as conditions are suitable. A small proportion of seeds can remain viable for up to 10 years (Sindel, Radford et al. 1998), presumably when the site is being shaded by other vegetation. When this is considered along with data on seed production, it is clear that fireweed can produce a substantial soil seed-bank that is capable of rapid germination when conditions are favourable (i.e. when there is sufficient light).

S. madagascariensis and the native *S. pinnatifolius* share the two most abundant floral visitors, honeybees and hoverflies (White 2008). However, *S. pinnatifolius* was shown to host a greater total abundance and richness of herbivores (White 2008). Therefore *S. madagascariensis* is unlikely to be constrained by a lack of pollinators in its new range and may benefit from levels of herbivory lower than that of its native congener, *S. pinnatifolius*.

Origin and distribution

S. madagascariensis is native to southern Africa (i.e. South Africa, Lesotho and Swaziland) and Madagascar. It has become naturalised in parts of South America (e.g. Argentina, Brazil, Colombia and Uruguay), Australia, Japan and Hawaii (Sindel, Michael et al. 2008).

The closely related *S. inaequidens* is native to parts of southern Africa (i.e. Botswana, Lesotho, Mozambique, Namibia, South Africa and Swaziland). It has become widely naturalised in Andorra, Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, England, Wales, Northern Ireland, Hungary, Iceland, Italy (including Sardinia), Luxembourg, the Netherlands, Norway, Poland, Spain, Sweden, Switzerland, Canada and Mexico.

Note: Due to confusion between these two species, and differing opinions as to their status as separate species, it is possible that the above distribution ranges are not entirely accurate (i.e. some records of *S. inaequidens* may actually pertain to *S. madagascariensis*, and vice versa).

Preferred habitat

Climatically, *S. madagascariensis* prefers subtropical and warm temperate areas, generally where annual rainfall is at least 800 mm. It can survive in drier areas, but tends to be much less abundant.

Its preferred habitat includes disturbed sites such as open pastures, open woodlands, grasslands, margins of suburban bushland, roadsides, waste areas and parks (Navie and Adkins 2008). It is generally absent from undisturbed bushland. It can survive on a range of soils. In Natal (in its native range), *S. madagascariensis* is found only on disturbed land fallows, contour banks, road verges and the like (Sindel 1989).

The visible frost injury and mortality rate of greenhouse-grown *S. madagascariensis* seedlings indicated that young seedlings were more sensitive to frost than older plants were (Sindel and Michael 1989). Frosting also made plants more prone to disease, so that even when regeneration of shoots occurred, plants often died. These results suggest that frost is an important factor in limiting the distribution of *S. madagascariensis* in Australia (Sindel and Michael 1989). Carthew (2006) further investigated the effect of frost on fireweed and suggested that fireweed can become cold acclimated and that frost may not be as important a factor in limiting the spread of fireweed as first thought.

History as a weed

Overseas and interstate

S. madagascariensis is a ‘serious weed problem’ in Hawaii, due to the threat of livestock poisoning (Gardner et al. 2006) and its ability to dominate pastures on fertile soils (see Figures 6 and 7).



Figure 6. *S. madagascariensis* dominating a pasture in Hawaii (Photo: Forest and Kim Starr, USGS; used with permission under a Creative Commons Attribution License).



Figure 7. *S. madagascariensis* dominating a hillside pasture in Hawaii (Photo: Forest and Kim Starr, USGS; used with permission under a Creative Commons Attribution License).

Iwatsukia (2006) comments that in Japan *S. madagascariensis* is a relatively recent introduction but is 'rapidly invading and increasing its distribution'. It has also naturalised in Argentina, Columbia and Uruguay (Gardner et al. 2006; Sindel, Michael et al. 2008). Sindel (1989) reports that *S. madagascariensis* is causing considerable problems in the highlands of Kenya.

S. madagascariensis is a major weed of coastal pastures in New South Wales. It is subject to statutory restrictions and enforced control in the Australian Capital Territory and parts of New South Wales. It is a prohibited import in Western Australia.

Current distribution in Australia and Queensland

S. madagascariensis is widely naturalised and common in coastal southern Queensland and eastern New South Wales, but is more sparingly naturalised in the Australian Capital Territory and Victoria (Bostock and Holland 2007; Australia's Virtual Herbarium 2009), as shown in Figure 8.

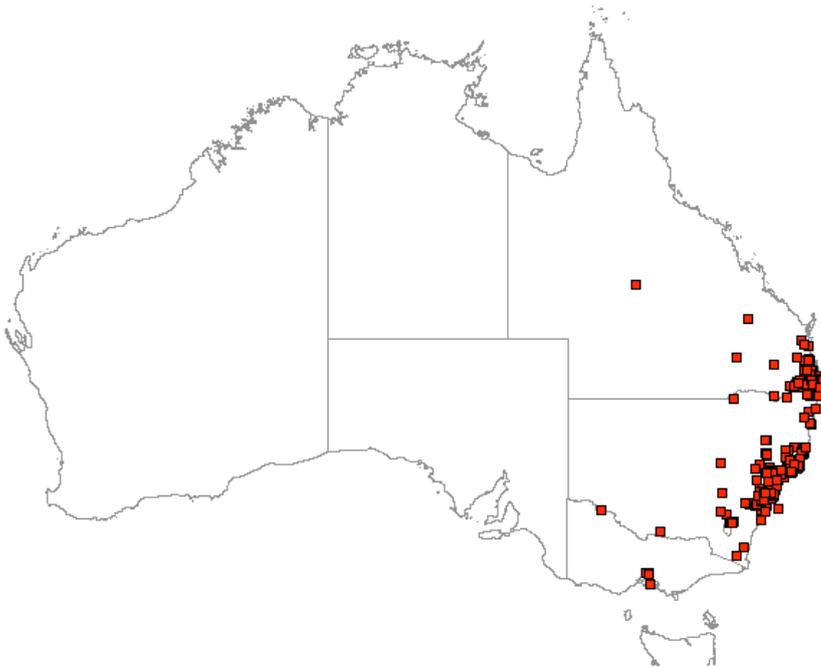


Figure 8. Distribution of *S. madagascariensis* in Australia according to herbarium records (Specimen data reproduced from Australia's Virtual Herbarium 2009 with permission of the Council of Heads of Australasian Herbaria Inc.).

In New South Wales, *S. madagascariensis* is widespread in the Bega area, where once it occurred only in isolated patches. It is reported to be spreading in the Dorrigo area on the northern tablelands and in the Monaro region on the southern tablelands of New South Wales. This suggests that *S. madagascariensis* has not yet reached its potential distribution in Australia.

In south-eastern Queensland, the most extensive infestations of *S. madagascariensis* exist in Logan City, Gold Coast City and Scenic Rim Regional councils. Although locally abundant, it is generally less common in Brisbane City, Redland City, Ipswich City and Moreton Bay Regional councils.

Outside these areas, *S. madagascariensis* generally exists as isolated and small populations scattered across inland parts of New South Wales and southern Queensland (including Somerset, Gympie and Sunshine Coast regional councils), as shown in Figure 9. New populations continue to be detected, with specimens recently collected in coastal parts of central and northern Queensland, including the Atherton Tableland and Roma (Holland 2008).

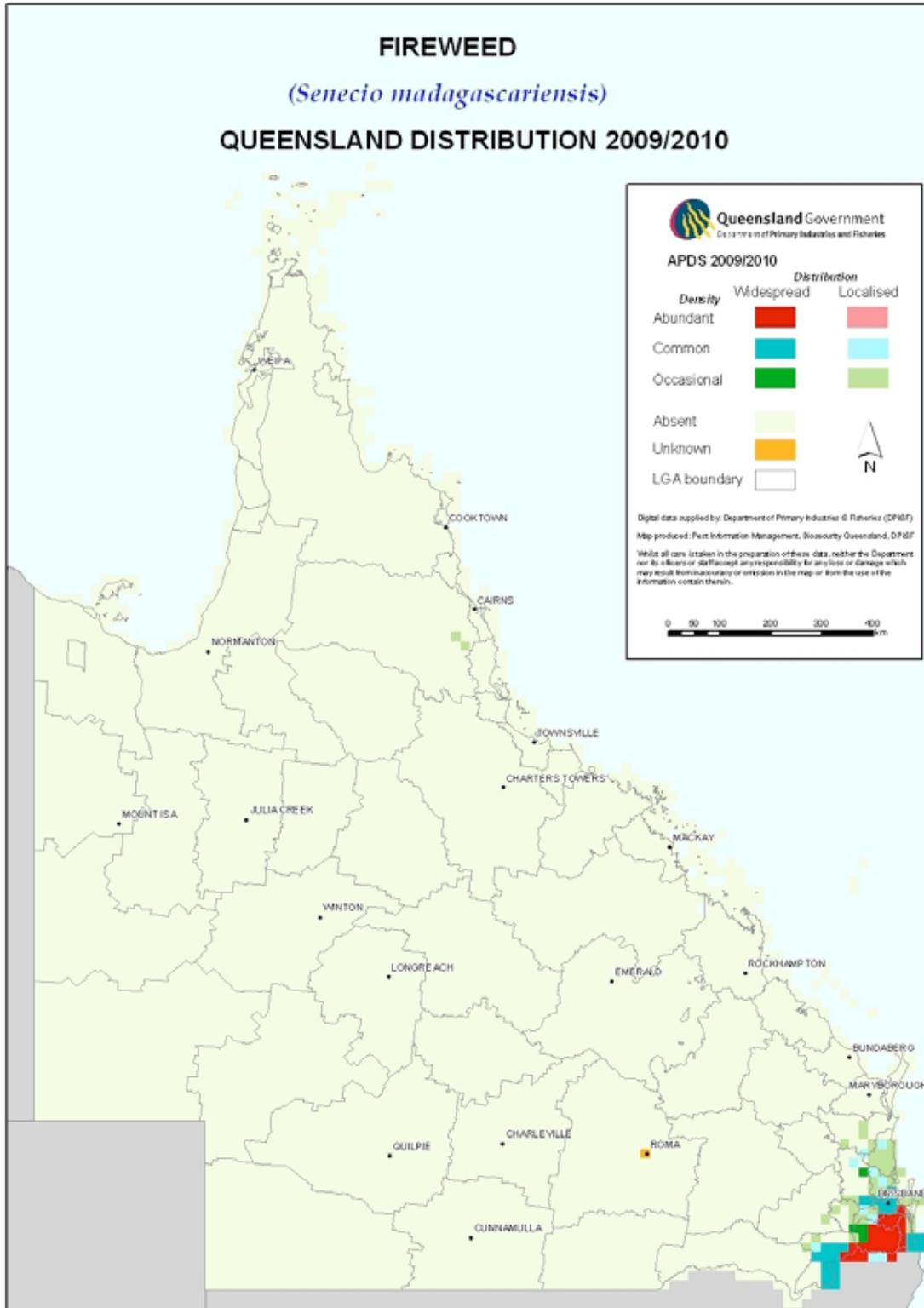


Figure 9. Distribution of *S. madagascariensis* in south-eastern Queensland in 2009–10 (Data from Biosecurity Queensland, in partnership with local governments).

Introduction and spread

S. madagascariensis was first introduced to the Hunter Valley in New South Wales around 1918, probably through shipping (Sindel, Michael et al. 2008). It subsequently spread north along the coast and was first detected in the (former) Beaudesert Shire in the 1960s. By the late 1980s it was abundant in New South Wales and southern parts of coastal Queensland, from just north of Brisbane, south to Nowra in New South Wales (Sindel, Michael et al. 2008). Until recently, it was restricted to the coastal districts south of Maryborough, but it was reported near Rockhampton and near Millaa Millaa on the Atherton Tableland in northern Queensland in 2007. Shortly afterwards, it was detected at Roma in semi-arid southern Queensland (Holland 2008).

Current impact in Queensland

S. madagascariensis is primarily a weed of pastures, both native and improved. In certain areas (mainly coastal areas of southern Queensland), it has become an abundant and conspicuous component of pastures (see Figures 10 and 11).



Figure 10. *S. madagascariensis* in a pasture near Beaudesert, south-eastern Queensland (Photo: Sheldon Navie).



Figure 11. *S. madagascariensis* in a healthy pasture in winter (Photo: Sheldon Navie).

While this study did not survey landholders to assess their views, a comprehensive survey of landholders by Sindel (1989) in New South Wales (discussed in detail in the following section) found that many landholders believed the primary impact of *S. madagascariensis* was on pasture productivity rather than livestock poisoning. A similar situation probably exists in Queensland.

S. madagascariensis contains pyrrolizidine alkaloids that are poisonous to domestic livestock, especially cattle and horses. If grazed over an extended period, *S. madagascariensis* can cause irreversible liver damage. However, once livestock are familiar with the weed, they tend to avoid it. Hence, there are conflicting opinions as to the risk posed by *S. madagascariensis*. Poisoning is more likely to occur when other feed is limited, when plants are young and not easily differentiated from the rest of the pasture, when contaminated hay is consumed, or when stock are newly introduced to the weed (Sindel, Radford et al. 1998). The most common effect from ingesting *S. madagascariensis* is ill thrift and poor growth in young cattle (Sindel 1989). However, this assessment was unable to find data on stock losses in Queensland.

Sheep and goats, although not immune, are much less susceptible to poisoning (Parsons and Cuthbertson 1992). *S. madagascariensis* is not generally a problem in irrigated pastures or crops (Sindel 1989), presumably due to regular cultivation. While other *Senecio* species can cause a drop in milk production, *S. madagascariensis* has not been implicated (Sindel 1989). The New South Wales Food Authority believes that 'the amount of pyrrolizidine alkaloids present in milk are too low to present a risk to public health' (Noxious Weeds Advisory Committee 2008).

The plant's ability to germinate and flower for most of the year makes control difficult and time consuming (Sindel and Michael 1996). Therefore, graziers who are concerned at the plant's potential effects on stock health and pasture production could potentially spend thousands of dollars on control. This study was unable to find data on the number of graziers who undertake control in Queensland, or any data on current expenditure on control. Impact data needs to be collected to better inform government policy on this species.

A dense pasture sward helps to reduce the establishment of *S. madagascariensis* seedlings, increases their rate of mortality, and reduces the vigour and seeding capacity of surviving plants. This finding has led to the view that fireweed is simply a management problem which individual farmers need to deal with. However, given the weed's apparent continuing spread and the continued dry conditions in many regions leading to low pasture cover with few economical options available to many farmers, there is a case for considering biological control (Sindel, Michael et al. 2008).

S. madagascariensis is regarded as an environmental weed in Queensland and New South Wales, due to the risk of hybridisation with closely related native *Senecio* species.

In Queensland, *S. madagascariensis* is a declared pest (Class 2), as defined in the Queensland *Land Protection (Pest and Stock Route Management) Act 2002*. All landowners are required to take reasonable steps to keep their land free of this species.

It is worth noting that the closely related native *S. lautus* complex (now known as *S. pinnatifolius*), which is widespread across much of southern and central Queensland (and much of southern Australia), has caused cattle deaths (Seaman 1987; Walker and Kirkland 1981; Kirkland et al. 1982). For example, 226 cattle died from *S. pinnatifolius* in central Queensland between 1988 and 1992 (Noble et al. 1994). The latter species can become abundant following favourable rainfall events such as unseasonal autumn and winter rains after a dry summer, as in the case mentioned above (see Figure 12). Due to a lack of data, it is difficult to assess which species, *S. pinnatifolius* or *S. madagascariensis*, poses the greater threat to cattle health.



Figure 12. A native species of *Senecio*, known locally as *S. brigalowensis*, dominating an area in central Queensland (Photo: Plant Science, AgriScience, DEEDI, Emerald).

Pest potential in Queensland

Field studies have shown that where *S. madagascariensis* and *S. pinnatifolius* occur together in mixed populations, a high frequency of hybrids develop in open pollinated seeds of both species, but mature hybrids are absent from these sympatric populations. That is, the seeds are viable, but after germination they have low vigour compared to both parental species. However, a hybridisation advantage was observed for *S. madagascariensis*, with the production of significantly more progeny than expected, given the proportional representation of the two species in the population. Due to this asymmetric hybridisation, *S. pinnatifolius* appears to be under threat if *S. madagascariensis* increases in areas of contact (White 2008).

Sindel and Michael (1992) applied BIOCLIM, a climate-based computer program, to predict the potential range of *S. madagascariensis* in Australia and suggested a potential range in Queensland from the southern border along the southern coast and north to about Gympie. However, climate-based predictions of potential distribution using the computer program Climex suggest *S. madagascariensis* could spread north from its current range into coastal central Queensland and higher elevation areas of northern Queensland such as the Atherton Tableland (see Figure 13). These areas have climates comparable to the species' native range. Spread west of coastal and subcoastal areas is expected to be limited, due to insufficient rainfall.

Carthew (2006) investigated the effects of frost and found that *S. madagascariensis* grown under cool conditions became more frost resistant than plants grown under warm conditions, suggesting an ability to adapt to frost to some degree, and perhaps an ability to spread into western districts and upland areas along the coast.

As *S. madagascariensis* gradually increases its range and becomes more abundant within its range, its impact on primary production and the environment will increase. It is difficult to predict what the cost of its potential impact on grazing land might be. Experience in parts of New South Wales where *S. madagascariensis* has been abundant for many decades may provide an insight into its long-term impact in Queensland. In a survey of 581 graziers (of which 64% were dairy farmers and 35% beef cattle graziers), Sindel (1989) found that *S. madagascariensis* was present on 90% of respondents' properties. Of these, less than 10% of graziers considered it to be under control on their properties. In areas where *S. madagascariensis* was abundant, 46% of respondents said it was a moderate problem and 51% said it was a major problem. However, over the total survey area, 12% believed *S. madagascariensis* was a major problem, 33% said it was a moderate problem, 36% said it was a minor problem and 19% said it was not a problem.

Over the survey area, 45% of graziers said the main reason *S. madagascariensis* was a problem was that 'it looks bad'. Only 4% said the main reason was that it poisons stock. Similarly, only 4% said it caused poor stock growth. This result confirmed the small but constant number of animals affected by *S. madagascariensis* poisoning presenting at veterinary stations in coastal New South Wales (Sindel 1989).

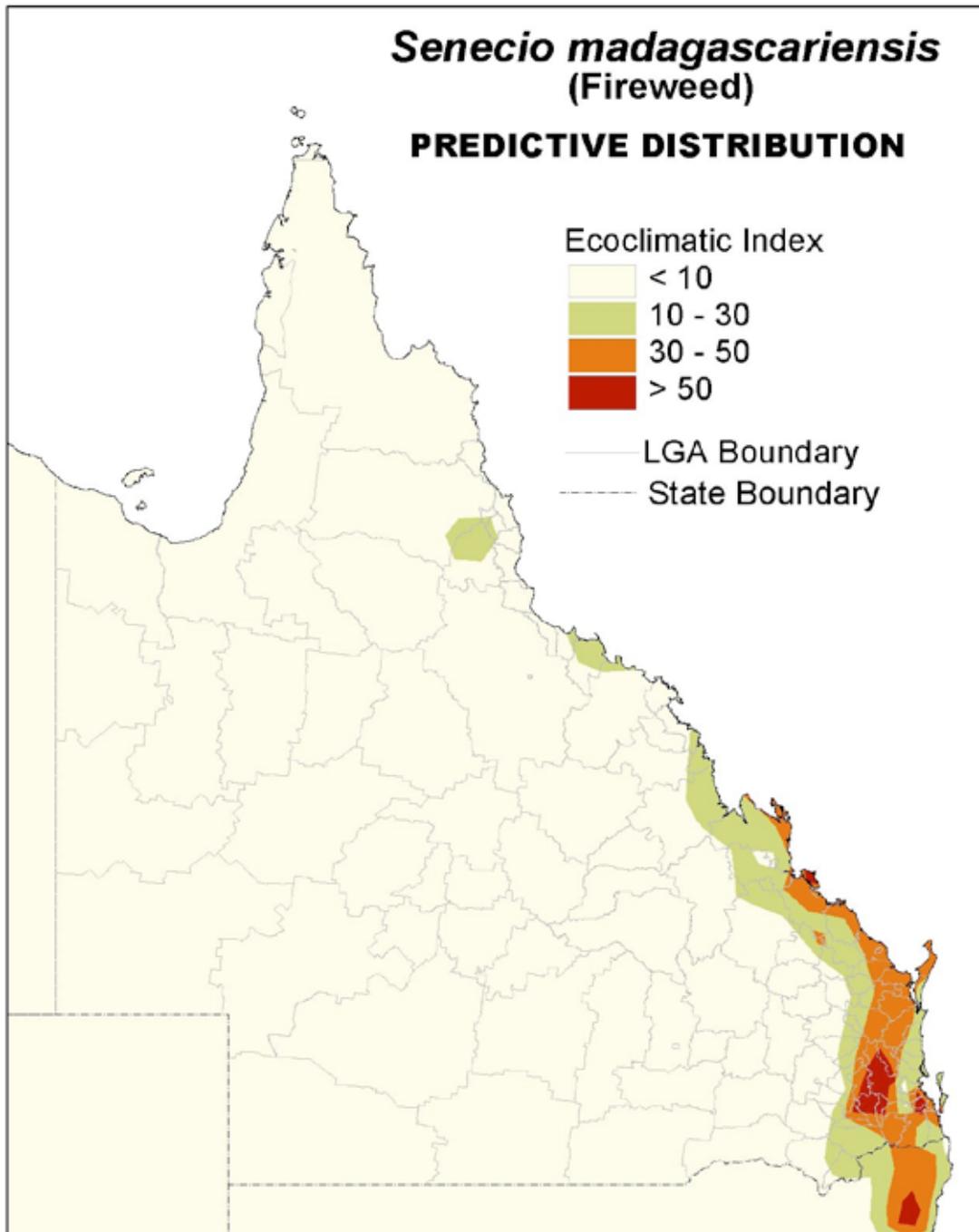


Figure 13. Potential distribution of *S. madagascariensis* in Queensland, as predicted by Climex computer software. Also, 57% of respondents said the main reason *S. madagascariensis* was a problem was that it competes with crops or pasture. This result supports field observations (in New South Wales) that the species can reach densities of up to 5000 plants per square metre (Sindel 1989). However, 30% of respondents said the main reason it was a problem was because it prevents stock grazing among it and 24% said it contaminates crops or pastures used for hay or silage.

Sindel (1998) stated that in an experimental crop of grazing oats, fireweed at a density of 40 plants per square metre, reduced pasture yield by over 70% and reduced the available grazing area by over half. However, experiments by Radford et al. (1995) designed to quantify

actual production losses in existing pastures due to fireweed were inconclusive, mainly due to drought conditions during the period of study.

Sindel and Michael (1988) estimated that when weather conditions are favourable, fireweed can cost New South Wales farmers up to \$5.4 million per annum. Such conditions occur about once every 5 years, but in some years costs can be very low or nil. Total costs to the New South Wales dairy industry have been estimated at \$250 000 per annum.

Of all respondents in the New South Wales survey, 43% felt *S. madagascariensis* was their worst weed. Hence, the primary potential impact of *S. madagascariensis* in Queensland is likely to be on pasture production rather than stock poisoning. While stock poisoning may occur, it is likely to occur at low levels and it is difficult to conclude that such an impact will have a significant effect on total (statewide) beef production.

Control

Healthy, dense pasture helps reduce the establishment of *S. madagascariensis* seedlings and reduces the vigour of surviving plants (Sindel, Michael et al. 2008). Hence, some people believe *S. madagascariensis* is simply a pasture management problem. However, *S. madagascariensis* can still become abundant over time within seemingly well-managed pastures, presumably increasing in abundance whenever the pasture becomes weak during prolonged dry conditions. While herbicides that effectively kill fireweed are available, year-long management is made difficult because of the ability of the weed to germinate and flower throughout much of the year (Sindel and Michael 1996).

This study does not attempt to provide advice on control using herbicide. For such information, consult Anderson and Panetta (1995), visit Biosecurity Queensland's website or contact your local government.

Biological control is an option. However, previous preliminary investigations with *Phycitodes* species and *Lobesia* species moths from Madagascar showed that their host ranges were too wide and that native *Senecio* species may sustain damage if such insects were introduced (McFadyen and Sparks 1996).

Pests and diseases

The rust fungus *Puccinia lagenophorae* commonly infects fireweed in Australia in wet weather. However, the extent to which this pathogen constrains fireweed in Australia is largely unknown (Sindel, Michael et al. 2008).

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