

## Eradication of the exotic weeds *Helenium amarum* (Rafin) H.L. and *Eupatorium serotinum* Michx. from south-eastern Queensland

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**Summary** Successful eradication of two potentially serious exotic weeds, *Helenium amarum* (Rafin) H.L. (bitterweed) and *Eupatorium serotinum* Michx. (seroty weed), from separate sites in south-eastern Queensland is documented. Bitterweed was first detected in 1953. It ultimately spread over 50 ha, with a single satellite infestation establishing at 1.6 km from the original infestation, and required 370 person-days over a period of 39 years to eradicate. Seroty weed was discovered in 1962. It spread over a comparatively smaller area (0.5 ha), with one satellite infestation establishing at 1.0 km from the original infestation, and took 50 person-days over an 18 year period to eradicate. While both species are wind-dispersed, the relative positions of satellites suggest that other vectors, e.g. transported soil or vehicular movement, may have been more effective. Both plants were readily controlled by foliar application of 2,4-D herbicides. However, perusal of reports detailing surveillance and control missions suggests that seed dispersal and extended seed longevity prolonged both eradication efforts.

**Keywords** *Helenium amarum*, *Eupatorium serotinum*, eradication.

### INTRODUCTION

Two weedy plants of American origin from the family Asteraceae were eradicated from southern Queensland during the second half of the 20th century. *Helenium amarum* (Rafin) H. L. Rock (bitterweed) is a medium sized herbaceous annual that is a member of the tribe Helenieae. It is native to Mexico and the southern United States. Seroty weed (*Eupatorium serotinum* Michx.) is a rhizomatous perennial member of the tribe Eupatorieae that is also native to Mexico and the southern United States. This paper documents the eradication campaign for both species, drawing upon records held on file at the Alan Fletcher Research Station (AFRS). Details of the respective campaigns are broadly interpreted in terms of what is known about the biology and ecology of each weed.

### ORIGINS AND WEED HISTORY

**Bitterweed** Bitterweed is recorded only from Mexico, the USA and Australia (Holm *et al.* 1979). In the

USA it has spread northward and eastward from the southern states where it is native (Dodd 1960, Baskin and Baskin 1973). Bitterweed is classed as an invasive weed in the USA (Haragan 1991, Southern Weed Science Society, 1998). It is toxic to stock and while the poisonous principles are uncertain, sesquiterpene lactones (mainly tenulin) have been extracted from this species (Everist 1981). It is a serious milk tainter that is reputed to be toxic to horses and mules (Dodd 1960), but there is no evidence that it is toxic to cattle. While no cases of bitterweed poisoning were recorded in Australia, in the USA, several species of *Helenium*, including *H. amarum*, are reported to be poisonous to sheep, causing a condition called 'spewing sickness' (Everist 1981).

**Seroty weed** Seroty weed is native to the southern United States of America and Mexico (Stanley and Ross 1983). It has become widespread in eastern North America, where it is reported to be an aggressive weed (<http://plants.usda.gov>). Apart from the outbreak in Australia, there are no records of this weed becoming established outside North America.

### BIOLOGICAL/ECOLOGICAL FEATURES

**Bitterweed** This species is an annual herb with linear leaves 10–50 mm long and yellow, daisy like flowers 10–20 mm in diameter. The achenes (seeds) are 1–1.5 mm long with a pappus 1 mm in length (Stanley and Ross 1983) and are wind dispersed.

No investigations of the plant have been undertaken in Australia, apart from basic observations made during control operations. Dodd (1960) describes bitterweed as a summer annual with an upright habit reaching 600 mm. Under good conditions it branches to form a compact bushy plant. However, under harsh or competitive conditions bitterweed may grow as a single stemmed plant that is inconspicuous. Plants only 50–75 mm high can produce a single flower. Thus bitterweed can be very difficult to detect amongst pasture.

Local observations indicated that individuals could flower within four weeks and bear ripe seed within eight weeks of germination. The main season

of germination was in spring, although in some years smaller amounts of seedlings appeared during autumn (mid-April to late May). In North America, bitterweed can behave as a winter or summer annual, depending upon when germination occurs (Baskin and Baskin 1973). While freshly-matured seeds are non-dormant and will germinate over a wide range of temperatures in light (Baskin and Baskin 1973), germination is minimal in darkness (Baskin and Baskin 1975). This suggests that buried seeds may fail to germinate owing to enforced dormancy.

**Seroty weed** This species is a large, robust perennial herb, growing to ca. 2 m. Its size and distinctive leaves (5–14 cm × 2–3.8 cm, with serrated margins), make it conspicuous and relatively easy to detect amongst other vegetation. Plants produce rhizomes, leading to the formation of clumps. In southern Queensland, anthesis commences at about 12 months after germination. Flower buds form in late summer (February), with achenes (seeds) maturing in mid autumn (May). Mature plants seed prolifically. Seeds are wind dispersed, being about 1.5 mm long with a pappus of numerous scabrid bristles ca 3 mm long. We were unable to find any information in the literature relating to the seed biology of this species. Perusal of inspection reports indicated that seed germinated in late spring and over summer.

#### AUSTRALIAN INFESTATIONS

**Bitterweed** Bitterweed was first found in 1953 at Lowood, 80 km west of Brisbane. It is thought to have been introduced by aircraft or associated equipment, since the infestation was in the general vicinity of an airfield that had been used by the United States Air Force during 1942–1944. This weed ultimately spread over 50 ha, with a single satellite infestation establishing at 1.6 km from the main area. Records indicate that transportation of soil was responsible for this spread. Two specimens have been lodged with the Queensland Herbarium, AQ NR 247950 and AQ NR 247951, both collected from the Mt. Tarampa aerodrome in February 1953.

**Seroty weed** Seroty weed was first discovered in 1962, growing beside the disused railway line at Nerang, 65 km south of Brisbane. The time and mode of introduction are unknown. It appeared to have the potential to spread rapidly. When first discovered in 1962, plants covered an area of ca 10 m<sup>2</sup>, but by May 1963 this area had expanded to 230 m<sup>2</sup>. By November 1963, the infestation had spread even further. The only satellite infestation was detected in 1970, when two plants were found on a roadside about 1 km from the

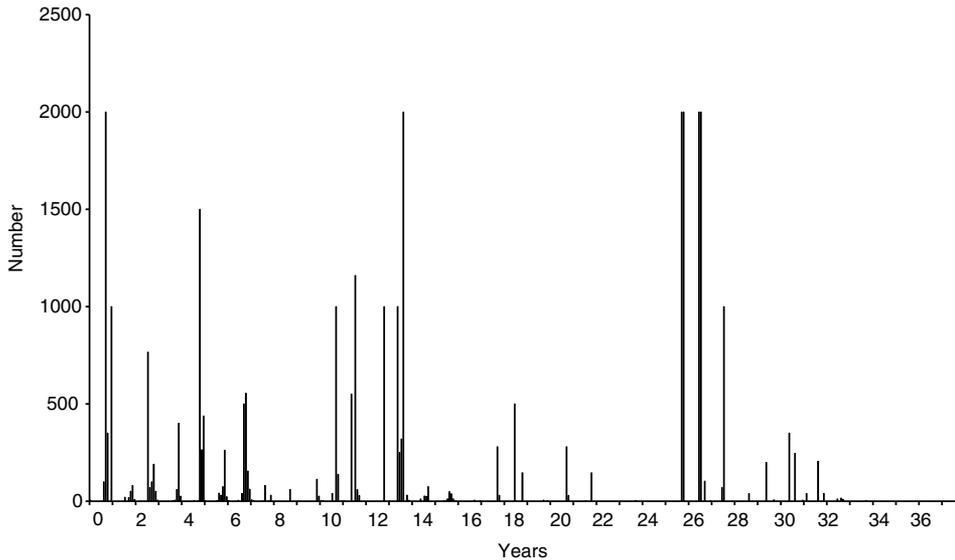
main infestation. The plants in this latter infestation are more likely to have been transported by human activity than by wind, as no plants were ever found between these two locations. Compared with bitterweed, seroty weed spread over a comparatively smaller total area of ca. 0.5 ha. Two specimens have been lodged with the Queensland Herbarium: 247533, 4 April 1963, collected from the Nerang railway property, and 247532, 12 February 1970, collected from the satellite infestation south of Nerang.

#### ERADICATION PROGRAMS

**Bitterweed** The eradication of bitterweed was the responsibility of the former Biological Section (AFRS) of the Department of Lands. A total of 187 separate visits to the site by officers of this group is documented. In the early stages, local authority officers were also involved in a minor way, but extent of this activity is unknown. Dodd (1960) claimed that the basis of the control program was to check for plants at not more than four week intervals in order to locate and destroy plants.

Trials in 1953 showed that bitterweed was susceptible to 2,4-D, and this herbicide was used until about 1967. The residual herbicides, picloram (Tordon 50-D) and 2,4-D/atrazine were then used until operations ceased in 1992. During the early stages of the program, boom sprays were employed to cover the area; scattered plants were either sprayed or hand pulled. Where seeding plants were found, they were removed bagged and burnt. The immediate surrounding area was then thoroughly sprayed. Within three years of discovery, the large patches of bitterweed had been reduced to smaller patches and single plants. Plant numbers then generally declined. However, there were various peaks in the population from time to time (Figure 1), suggesting that seeds were capable of persisting in the soil seed bank. Dodd (1960) observed that bitterweed would germinate irregularly through most of the summer and this did not appear to correlate with the amount of preceding rainfall. However, there are six occasions listed when numbers peaked following 'good' rains. These events often followed periods of dry weather during which pasture height of the lightly grazed site was reduced.

The introduction of the pre-emergent herbicide atrazine, combined with subdivision and closer settlement of the site around 1980, saw a steady decline in plant numbers. Landholders were made aware of the problem. The site was inspected on 11 occasions between 1987 and 1992. During that period, only three plants were found (in autumn 1987) and it was assumed that bitterweed had been eradicated. No plants were detected during an examination of the area by



**Figure 1.** Number of bitterweed plants in the period since counts began. Plants were too numerous to estimate during the first three years of the eradication program.

the authors during February 2002. In total, this weed required 370 person-days over a period of 39 years to eradicate.

Seroty weed was discovered in 1962 and surveillance and control measures commenced in mid-1963. The basis of eradication was to define the extent of the infestation and to kill or remove any plants that germinated, ensuring that no plants produced seed. Small plants were hand pulled and larger plants were sprayed with herbicide. Initially 2,4-D was used, but in later years this was replaced by picloram-2,4-D (Tordon 50-D).

There were five major peaks in the population over the 18-year period before the weed was eradicated (Figure 2). One of these peaks corresponded to a 21 month interval between inspections, but in the 1975 peak, 200 plants were found in disturbed soil on the side of a newly constructed road through the area. As few plants were found in the previous 5 years, this suggested that buried seed remained viable for some time. From 1975 onwards numbers remained relatively low.

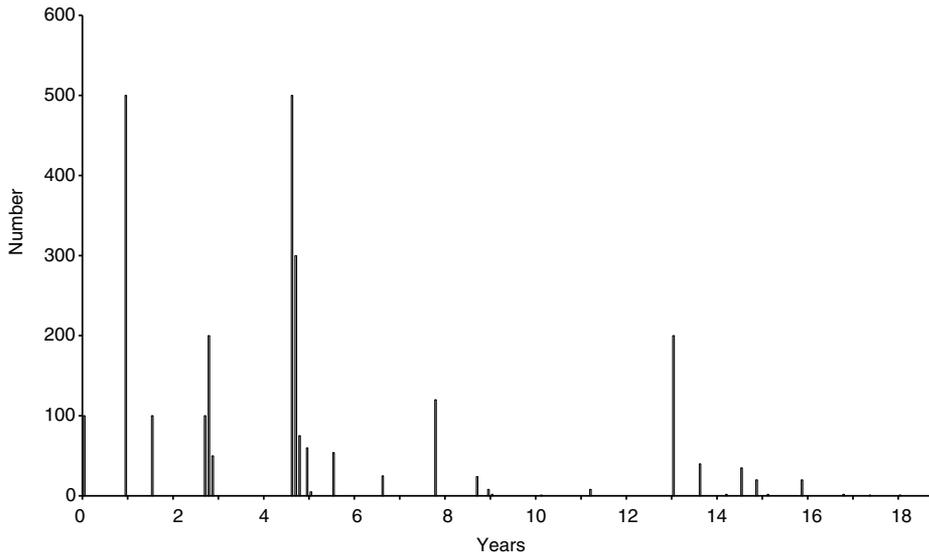
The original site is now so heavily developed that it is difficult to determine its exact location. There have been no records of the plant around the Nerang district or indeed, in south-eastern Queensland, since the last plant was found in December 1980. The eradication effort consisted of a total of 50 person-days over an 18-year period, involving at least 40 separate visits to the primary site.

#### DISCUSSION

The success of these eradication attempts is consistent with Rejmanek's (2000 and unpublished data) generalisation that the likelihood of eradicating infestations smaller than 100 ha is substantially greater than for larger infestations. It is notable that a considerably larger effort was required to eradicate bitterweed (total infestation approximately 50 ha), as compared with seroty weed (0.5 ha). Both species shared common features, such as the production of wind dispersed seeds that appeared to persist in the soil seed bank. However, there were also fundamental differences, e.g. a longer juvenile period for the perennial seroty weed (approximately 12 months, *cf.* four weeks for the annual bitterweed) and the relatively inconspicuous nature of bitterweed. This latter aspect caused considerable difficulty in the detection of both juvenile and adult individuals.

The pattern of formation of satellite infestations for both species, with no satellite closer than 1 km to the main infestation, suggests that vectors other than wind (e.g. transported soil or vehicular movement) may have been responsible. No doubt the low rate of satellite formation over the years was a major contributing factor to eradication success.

While relatively small amounts of effort were required to ensure eradication (370 person-days for bitterweed, 50 person-days for seroty weed), the large number of years involved (39 and 18 respectively) is particularly striking. This indicates that planning and



**Figure 2.** Estimates and counts of seroty weed plant numbers over the period of the eradication effort.

cost estimates for future eradication efforts may have to take into account much longer timeframes than are typically considered. According to estimates of the potential distributions of both species (results not presented), rather large areas of Australia are at risk of invasion. This point, in conjunction with information on weed history, suggests that both eradication campaigns were probably highly cost effective.

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