

## Sea spurge (*Euphorbia paralias*): using plant development to inform the eradication programme in New Zealand

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**Summary** Sea spurge (*Euphorbia paralias* L.) is a serious weed of coastal sand dunes in Australia and has the potential to establish along much of the New Zealand coastline. It was first detected in February 2012 on the west coast of the North Island. This is the only known site in New Zealand and the propagule pressure from additional seed floating on coastal waters is likely to be extremely low. Therefore the eradication programme is based on maintaining a zero population density to prevent further seed production at the detection site, and will continue until the seed reserve at the site is exhausted. The Ministry for Primary Industries is the lead agency for the programme and is working in collaboration with the Waikato Regional Council and the Department of Conservation.

This paper presents the results of two years of observations on plant growth at the detection site. Germination occurred throughout the year, and some seedlings reached maturity in less than five months. Flowers were present between December and June. Plant height and branching were not reliable indicators of plant maturity.

**Keywords** Sea spurge, eradication, weed management, plant development.

### INTRODUCTION

Sea spurge is a small multi-stemmed perennial plant that reaches up to 0.7 m in height. Clusters of multiple flowers form at the tips of the branches, which die after flowering. Seed is long-lived, and known to survive for up to six years in sea water and up to 16 years in dry-storage (Heyligers 2007). Seed floating on ocean currents is the main dispersal mechanism for this species.

Sea spurge is native to the coastlines of Western Europe and the Mediterranean Sea. It was first detected in Australia in 1927 where it has become a serious coastal weed. Given its native and introduced range sea spurge has the potential to establish along most of the New Zealand coastline (Duthie 2012).

Sea spurge was first detected in New Zealand in February 2012, near the entrance to Aotea Harbour (approximately latitude 38° south) on a remote section of the west coast of the North Island. The population

consisted of over 100 seedlings and approximately 65 flowering plants, some with seed capsules (Beadel 2012).

The Ministry for Primary Industries (MPI) established a working group to provide a collaborative approach to the eradication of sea spurge. MPI is the lead agency and works closely with the Waikato Regional Council and the Department of Conservation.

In Australia much of the southern coastline is heavily infested with sea spurge and consequently there is a continuous source of seed in coastal waters available for re-colonisation. The likely entry pathway into New Zealand is seed floating on ocean currents from Australia. However, invasion in New Zealand is presumably a rare event and the seed load in coastal waters minimal. Consequently, the eradication programme concentrates on exhausting the seed reserve at the detection site and surveillance of the local coastline to prevent daughter populations establishing from seed released from the site during storm surges. Surveillance elsewhere in New Zealand is dependent on raising awareness among communities and organisations that frequent coastal areas.

Various treatment options were considered to reduce the seed reserve at the detection site. Removal of seeds or treatment *in situ* to render the seed non-viable were both discounted because ongoing monitoring would be required to confirm the reliability of these methods, and chemical treatment posed an undesirable environmental risk. A third and preferred option was taken. This required plant removal to prevent seed production until the residual seed reserve at the detection site was exhausted. The success of the eradication programme, now in its third year, depends on preventing further seed production. However, it was unknown how plants would develop under New Zealand conditions. Plant development is thought to be dependent more on growth conditions than the time of year (Heyligers 2002, Paczkowska 1996). On mainland Australia, plants may mature in around six months whereas in cooler parts of Tasmania maturity takes 12 to 15 months (Duthie 2012). Data collected from the New Zealand site would provide useful information for future management.

## MATERIALS AND METHODS

Data gathered from the detection site provided information on seed germination, flowering and seed production periods and the time required for plants to reach maturity. Information was collected on plant height, number of seedlings, and the presence of flowers and branches. Waikato Regional Council undertook the fieldwork with assistance from the Department of Conservation.

Plant height and branching were assessed as potential indicators of plants reaching maturity. The basal crown was inspected for the presence of branching, and plant height was measured from the crown to the tip of the longest stem.

The management policy of maintaining zero population density required that all sea spurge plants be removed as soon as they were detected. All plants were uprooted with the tap root intact to prevent regrowth from the crown. Extra care was taken with mature plants to ensure seed was not released during handling. Seed heads were removed, before the plants were disturbed, and immediately placed in secure polythene bags for disposal off-site. Flowering plants were also bagged and disposed of off-site.

There were two extended periods in which immature plants were left *in situ*, spring-summer 2012 and autumn-winter 2013, so that further information could be gathered on plant development. However, flowering plants were removed before seeds were produced.

## RESULTS AND DISCUSSION

**Seed germination** Seedlings were present at every visit to the site (Table 1). Seedling numbers were considerably higher in January 2013 (187) than in June/August 2012 (14/14) and October 2013 (23). The presence of seedlings in every season is consistent with observations from Australia where seed is shed and germination occurs throughout the year (Wilcock 1999).

The relatively high seedling numbers in summer could not be attributed to seasonal effects due to variations in the time between plant removals, site disturbance and weather conditions. Low seedling numbers in January 2014 (4) could not be explained. Natural loss of viability is likely to be a major contributing factor and sand deposition at the site might also have reduced germination.

In February 2012, when sea spurge was first detected, the plant population was considered to be at least 3–4 years old and included mature plants bearing flowers and seeds (Beadel 2012). Heyligers (2007) reported that fresh seed has a dormancy period of about six months. However, this could not be tested using

data collected from the site because the seed reserve was of mixed age.

**Plant maturity** Approximately 10 seedlings that germinated after August 2012 were in flower (and were removed) when the site was visited in December 2012 and a further five plants were flowering by early January 2013. This represents a period of less than five months (133 days) to reach maturity over spring and summer. However, over the following autumn and winter (February–October 2013) no seedlings had reached maturity within eight months.

Flowers were present in February, April and June 2012; December 2012; January and February 2013; and January 2014 (Table 1). The one plant flowering in June 2012 was an older plant that had been overlooked during plant removal in April. The flowering period at the site was from summer to autumn for seedlings. The season may extend from spring to early winter, and possibly to throughout the year, should older plants be present in a population.

There was considerable overlap in the height of flowering and non-flowering plants. Flowers developed on branched and single-stemmed plants (Figure 1). The January 2013 population consisted of 187 plants (height 2–38 cm) germinated since August 2012. By February 2013 the same population comprised 222 plants (height 4–44 cm).

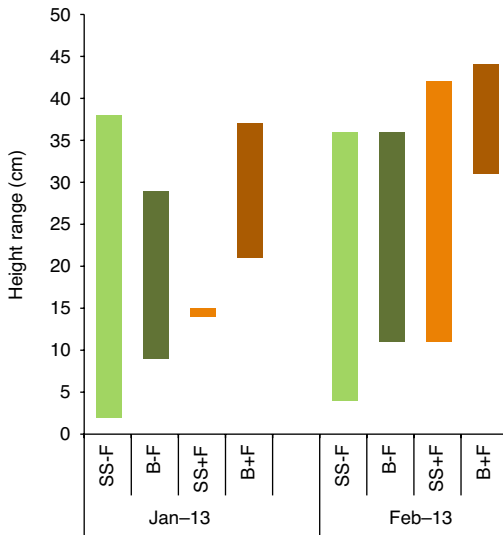
It was also noted that in October 2013 seedlings germinated since February (8 months) were up to 68 cm high but flowers were absent. It was concluded that reproductive maturity could not be predicted by plant height or whether a plant consisted of a single stem or multiple branches.

**Table 1.** Presence of seedlings and flowering plants at the Aotea detection site, New Zealand.

Month	Site visits	Seedlings present	Flowers present
January	2013*	✓	✓
	2014	✓	
February	2013	✓	✓
April	2012	✓	✓
May	2014	✓	
June	2012**	✓	✓
August	2012	✓	
October	2013	✓	
December	2012*	✓	✓

\* Only flowering plants removed.

\*\* One older mature plant removed.



**Figure 1.** Height (cm) of plants in relation to plant development (SS-F Single stem, flowers absent; B-F Branching, flowers absent; SS+F Single stem, flowers present; B+F Branches and flowers present).

**Management** Site management will continue to be based on the time required for germinated seed to reach maturity, which varies depending on the time of year. A conservative approach is required to ensure that no seed is produced, as fresh seed would compromise the eradication programme. Consequently site maintenance is scheduled at 3–4 month intervals from spring to autumn and less frequently in the cooler months.

The sea spurge eradication programme has successfully completed two years without the production of fresh seed. The programme will continue for

approximately eight years, until the seed reserve at the detection site has been exhausted.

The data gathered from the site will be used to improve management decisions for the current eradication programme and will provide valuable information for eradicating future incursions of sea spurge.

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