Large-scale eradication of New Zealand pygmy weed *Crassula helmsii* from grazing marsh by inundation with seawater, Old Hall Marshes RSPB reserve, Essex, England

Paul E. Charlton*, Mark Gurney & Graeme Lyons
Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, UK

*Corresponding author e-mail: paul.charlton@rspb.org.uk

SUMMARY

The invasive New Zealand pygmyweed *Crassula helmsii* was eradicated from approximately 120 ha of coastal grazing marsh at a site in southeast England by shallow flooding of the area with seawater for 12 months. This method of eradication can only be used where saline water can be held on a site (with due regard for potential impacts on non-target species). We have not come across an example of successful *C. helmsii* eradication on this scale by using other methods.

BACKGROUND

New Zealand pygmyweed *Crassula helmsii* is an aquatic vascular plant native to Australia and New Zealand. In Europe it was introduced through the aquarium and horticultural trades and it is now considered aggressively invasive in many areas (OEPP/EPPO 2007). The first record in the wild in Britain was in 1956 (Leach & Dawson 1999). Since then it has spread rapidly and it is now found throughout lowland Britain. It grows throughout the year, it can block drainage ditches, and due to its often vigorous growth is a threat to some native species and plant communities (OEPP/EPPO 2007).

It is extremely difficult to eradicate *C. helmsii* using conventional methods. Herbicides often fail to penetrate the thick mats formed by the plant, either in aquatic habitats or wet marginal areas (Dawson 1996, Gomes 2005), and surviving fragments can break away and grow to form new colonies. Shading with black plastic sheeting for several months can be successful over small areas (Leach & Dawson 1999) but it is impractical over large areas, or where the terrain is uneven or livestock are present. Mechanical removal is best avoided because there is a tendency for fragments of stem to become detached and transferred to new areas via for example, operators' boots, equipment or machinery (Dawson 1996).

C. helmsii was first discovered at Old Hall Marshes nature reserve (managed by the Royal Society for the Protection of Birds) in Essex, southeast England, in 2000. Two small, isolated patches were initially found; these were carefully dug out and buried in plastic sacks to destroy the plants. The next year however, *C. helmsii* was found in a different area of the reserve, growing in an emergent form along the sides of shallow grazing marsh creeks in Joyce's Head fields and as thick vegetative mats on areas of summer drawdown in Irongate fields in the west of the reserve (Fig. 1). Drawdown (fall of high winter water levels during the spring and summer) exposes areas of bare mud, which is an important habitat for some scarce plants and invertebrates. Saltmarsh goosefoot *Chenopodium chenopodioides* occurs in this habitat, and there were fears that *C. helmsii* could displace this nationally rare plant.

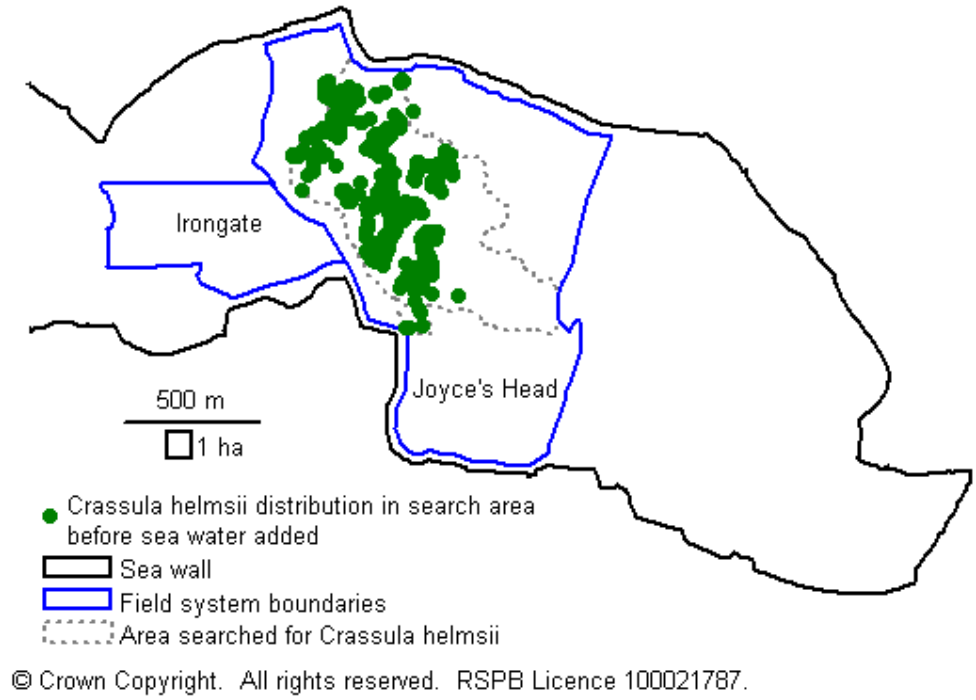

Figure 1. Old Hall Marshes, showing *Crassual helmsii* distribution prior to seawater inundation and location of field systems referred to in the text.

The area occupied by *C. helmsii* was too large (patchily distributed over 8 ha) to be covered by plastic, so the patches were treated with herbicide. Alternate treatments of glyphosate and diquat were applied between July and December 2001. Both chemicals were diluted in 16 litres of water (400 ml of glyphosate, 200 ml of diquat) to cover 750 m². After treatment, it appeared that the plant had been eliminated, but the following summer as water levels fell, just as much *C. helmsii* as observed in the previous year prior to treatment was revealed. Herbicide treatment continued for another five years to try to contain the plant but eradication was not achieved. We therefore sought an alternative method that would allow eradication over a large area, and we considered using salt water inundation to kill the plant.

ACTION

Initial trials: On 26 January 2005, 12 turfs (each about 15 x 15 cm) of *C. helmsii* were dug from the marsh and each was placed in a 15 litre plastic bucket. Brackish water (conductivity approximately 2,000 micro siemens) collected from the turf removal location was added to four of the buckets; freshwater was added to another four; and seawater (conductivity approximately 30,000 micro siemens) was added to the remaining four. The buckets were left outdoors in the shade, and the turfs were checked every six to seven days for signs of die-back, the first indications of which occurred after three months in the seawater-filled buckets. After five months, the *C. helmsii* in these four buckets appeared to be dead. *C. helmsii* in the other eight buckets (brackish and freshwater) had formed new shoots after 2-3 months, and it was still growing at the end of the 5-month trial. Based upon these initial results, it was decided to progress with larger scale eradication trials.

Field-scale trial: The next stage was a field-scale trial over the 8 ha of grazing marsh, bare mud, and former saltmarsh creeks in Irongate field (Fig. 1). Here, *C. helmsii* was widespread on bare mud and along the creeks, growing in dense vegetative mats within the water and along the creek edges. Various consents and approvals were sought and obtained from the appropriate UK governmental regulatory bodies (the Environment Agency, Natural England and the Rural Payments Agency) to allow the trial to proceed. The field is hydrologically isolated from the rest of the

marsh. On 10 March 2006, the brackish water was drained through a sluice at low tide. Most of the remaining open water was removed using diesel pumps over the following 30 days. On 20 April 2006, the field was flooded with seawater by opening sluices at high tide. The water was held at 5 cm above the usual winter peak water level to ensure all the *C. helmsii* was immersed. More seawater was pumped in to the field in May and June 2006 to maintain this level of inundation. The seawater was pumped out between 15 and 30 January 2007, and freshwater was pumped back into the area from 31 January. Initial surveys revealed no *C. helmsii* in the treated area.

After the seawater was removed, aquatic invertebrates were sampled using pond nets in ditches at 20 points in Irongate field in December 2007. These samples were compared with 20 from similar ditches in Joyce's Head fields that had not been flooded with seawater.

Large-scale trial: The final phase was to extend the field-scale trial to a more extensive area of the reserve, covering approximately 120 ha (one third) of the grazing marsh area surrounding Joyce's Head Fleet (Fig.1). This area consisted mainly of grazing marsh dominated by creeping bent *Agrostis stolonifera*, with vegetation similar to the National Vegetation Classification communities MG6d and MG13 (Rodwell 1992). There was also a deep-water channel with a fringe of common reed *Phragmites australis*, and several brackish creeks. The whole area was contained within sea walls and secondary flood defences. With the aid of a mechanical excavator, all isolated pools and ditches were connected to the deep-water channel to enable the grazing marsh and associated water bodies to be drained towards the end of 2008, via gravity through the same sea wall sluice used earlier. Once drainage was completed, the drainage controls were reversed (in January 2009) and the marsh was replenished with sea water, to a depth of approximately 5 cm above the usual winter peak water level. The seawater was allowed to remain on the site for almost 12 months, when it was drained off (sluice opened) into the adjacent estuary in December 2009. The marsh was then allowed to naturally refill with freshwater derived from winter rainfall and snow melt.

In August and December 2007, all suitable areas for *C. helmsii* were searched across most of Joyce's Head fields before seawater was introduced. Patches of the plant were recorded using a GPS, and the distribution mapped (Fig.1). The plant was searched for again in the summer of 2009, in December 2009 and August 2010.

CONSEQUENCES

Field-scale trial results: Although *C. helmsii* distribution was not recorded methodically in Irongate Field, the plant was abundant and widespread prior to seawater flooding in February 2006. In December 2006, August 2007 and December 2007, Irongate Field was resurveyed and no *C.helmsii* was found. Most of the invertebrate samples from Irongate Field contained only one or two species. This was similar to the samples from ditches in Joyce's Head, which had not been flooded with sea water, and there was no significant difference between the two sets of samples. Neither was there a difference in the number of individuals (interquartile ranges were 22–70 for Irongate and 20–99 for Joyce's Head). *Neomysis integer* (a brackish water shrimp) accounted for most of the biomass in both sets of the samples, and no scarce or rare species were found in either field. The amount of ground covered by vegetation was reduced by the flooding from about 75% to 30% cover.

Large-scale trial results: On the Joyce's Head fields, *C. helmsii* was widespread when it was surveyed in August 2007 prior to seawater flooding. In August and December 2007, all suitable areas for *C. hemsii* were searched across most of the fields. In the summer of 2009, prior to topping up the system with sea water, and again following the drainage of sea water from the site in December 2009, no *C. helmsii* was observed. A further visit in August 2010 failed to find any *C. helmsii*. In August 2010, three scarce plant species (saltmarsh goosefoot *Chenopodium chenopodioides*, sea barley *Hordeum marinum* and stiff saltmarsh-grass *Puccinellia rupestris*) were found in the area that had been flooded. Approximate costs of the operations were:

2007	Surveying and mapping *C. helmsii*	£480
2008	Training of excavator operator	£400
	Excavator hire	£2,000
	Excavator operating costs	£3,600
2009	Manipulating water levels, and monitoring *C. helmsii*	£1,200
Total:		£7,680

Conclusions: *C. helmsii* was successfully eradicated from approximately 120 ha of coastal grazing marsh by shallow flooding of the area with seawater for 12 months. This method of eradication can only be used where saline water can be held on a site and should only be used with due regard for potential negative impacts on non-target species. Some scarce plants typical of the bare margins of brackish pools and creeks, such as *C. chenopodioides* and *H. marinum*, re-colonised and appeared to benefit from saline inundation through elimination their competitors. Other taxa, e.g. terrestrial invertebrates, may not survive inundation, although only part of the site was flooded at Old Hall Marshes so there were potential refuge areas available. Thus the benefit of *C. helmsii* eradication by this method needs to be weighed against possible detrimental outcomes. In our case, we were persuaded that the effects of saltwater inundation would be less damaging than site-scale *C. helmsii* infestation, and the method proved efficient and effective. We have not come across an example of successful *C. helmsii* eradication on this scale by using this or any other techniques.

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