

Effects of grey willow *Salix cinerea* removal on the floristic diversity of a wet dune-slack at Cabin Hill National Nature Reserve on the Sefton Coast, Merseyside, England

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SUMMARY

Cutting, removal and herbicide stump-treatment of dense grey willow *Salix cinerea* scrub from a 1 ha wet dune-slack was undertaken in a northwest England National Nature Reserve. This resulted, over the next two years, in colonisation by 139 vascular plant taxa. Of these, 11 are nationally or regionally notable, with 28 being new reserve records. The high proportion of ruderal plants in the first year was largely replaced by dune species in the second season after scrub removal.

BACKGROUND

Cabin Hill National Nature Reserve (NNR) forms part of the Sefton Coast, an internationally important sand-dune system in northwest England. The reserve exhibits classic coastal succession from intertidal sand-flats and embryo dunes to fixed dunes with seasonally flooded wet-slacks, the latter supporting a particularly rich biodiversity, including many rare plants and the endangered natterjack toad *Bufo calamita*. Over a period of about 30 years, one large wet-slack had become densely colonised by 4m-high willow scrub, mainly comprising grey willow *Salix cinerea*, with consequent loss of a formerly rich ground flora. In accordance with the site management plan, it was decided to remove the grey willow in an attempt to reinstate the characteristic dune-slack flora and monitor the subsequent effects on floristic diversity.

ACTION

Study site: The management work took place within a 1 ha wet dune-slack at Cabin Hill NNR (National Grid Ref. SD283051), Merseyside,

northwest England. The slack is a shallow basin site, probably formed during sand-winning in the 1940s, which floods to depths of 30-50 cm in most winters. Although detailed records were not kept, it is known that the slack supported a diverse plant community in the early 1970s, including much purple loosestrife *Lythrum salicaria* and sharp-flowered rush *Juncus acutiflorus*. Grey willow colonisation began at that time and, prior to clearance, the ground flora had been virtually eliminated by the dense canopy, with only bittersweet *Solanum dulcamara* a noticeable component of the vegetation.

Willow clearance: In November/December 2005, contractors were employed to cut at ground level (using chain-saws) and stump-treat the larger willows with herbicide. Prior to commencement, bushes of the nationally rare hybrid willow *Salix x friesiana* around the fringes of the main patch were marked to be retained. Roundup "Biactive plus" was selected as the herbicide to be used as this is formulated for use near water and was known to be effective in treatment of willows. It was painted onto each cut stump immediately after felling, treated

stumps being highlighted with a blue dye. Ring-counts of a random sample of newly felled trees gave a range of 15 to 35 years and a mean age of 23.8 years. Despite their relative youth, some of the tree stumps were up to 60 cm in diameter. Cut material and larger dead branches were burnt on site. There was no removal of litter.

Plant monitoring: In late summer (August-early September) 2006 and 2007, visits were made to record the flora within the cleared area. All vascular taxa (species, sub-species and hybrids) found were listed and their relative abundance assessed using the DAFOR scale (where D = dominant, A = abundant, F = frequent, O = occasional, R = rare). Visits continued until no additional taxa were recorded. Notes were made on habitat conditions. It is acknowledged that some early-flowering annuals may have been missed due to the timing of the surveys; therefore plant diversity may have been under-recorded.

CONSEQUENCES

Effect of treatment on willow scrub: Virtually all the grey willow was killed by the combined cutting and stump treatment, any regrowth being effectively controlled by rabbit *Oryctolagus cuniculus* browsing.

2006 plant survey: By September 2006, only about 20% of the slack was bare of vegetation, the substrate being a deep peaty organic matter with abundant dead twigs. Judging by the luxuriance of colonising plants, soil nutrient levels were high.

The 2006 survey identified 108 vascular plant taxa, only 10 (9.3%) being non-native (Table 1). The most abundant species were creeping bent *Agrostis stolonifera*, American willowherb *Epilobium ciliatum*, Yorkshire-fog *Holcus lanatus*, marsh pennywort *Hydrocotyle vulgaris*, purple loosestrife, water mint *Mentha aquatica*, tufted forget-me-not *Myosotis laxa*, dewberry *Rubus caesius*, bittersweet and common nettle *Urtica dioica*. Twenty-one taxa were new to the reserve and four (garden orache *Atriplex hortensis*, Cape-gooseberry *Physalis peruviana*, green nightshade *Solanum physalifolium* and angel's-trumpets *Datura ferox*) were new to the Sefton Coast (Smith 2006), the last named being a new vice-county record. These four species, together with common amaranth *Amaranthus*

retroflexus and thorn-apple *Datura stramonium*, form a group of uncommon alien, ruderals not normally associated with dune-slacks. Presumably, they grew from long-buried seeds but their origin is obscure, bearing in mind that the only known land-use for this site since its formation is extensive livestock grazing by cattle, horses and, latterly, sheep.

The vegetation comprised a roughly 50:50 mix of typical slack and ruderal plants, the ruderal component having a close similarity to the UK National Vegetation Classification's OV33 (*Polygonum lapathifolium* – *Poa annua* community). This community is characteristic of damp, eutrophic soils in disturbed places (Rodwell 2000). Management activities caused soil disturbance which must have enhanced growing conditions for the ruderal species.

2007 plant survey: The second survey took place in late August/early September 2007 and, although rabbit grazing was apparent throughout, the vegetation had achieved a ground cover of over 95%. A total of 111 vascular plants were identified. There had been a considerable turnover of species, 31 (29%) being additional to those listed the previous year, while 28 taxa (26%) were not refound (Table 1). Fourteen of the additional taxa are typical slack plants, 12 are usually associated with fixed-dunes and five are characteristic of disturbed ground. The lost plants include 23 ruderals, two fixed-dune plants and only three slack species (small-fruited yellow-sedge *Carex viridula* ssp. *viridula*, celery-leaved buttercup *Ranunculus sceleratus* and marsh yellow-cress *Rorippa palustris*).



Figure 1. Cabin Hill slack, August 2007, with abundant flowering purple loosestrife and *Salix* scrub around the periphery (Photo: Philip Smith).

Table 1. Frequency and status of vascular taxa recorded at the study site, 2006-2007.**Frequency (DAFOR scale):** d = dominant; a = abundant; f = frequent; o = occasional; r = rare**Status:** NR = Nationally Rare; NS = Nationally Scarce; NT = Near Threatened; SCI = Species of Conservation Importance in northwest England; n = new to Cabin Hill NNR; * = non-native

Taxa	English name	2006	2007	Status
<i>Agrostis capillaris</i>	Common bent		locally o	
<i>Agrostis stolonifera</i>	Creeping bent	locally a	a	
<i>Amaranthus retroflexus</i> *	Common amaranth	r		n
<i>Anchusa arvensis</i>	Bugloss	r		
<i>Arctium minus</i>	Lesser burdock	o	o	
<i>Arrhenatherum elatius</i>	False oat-grass		very locally o	
<i>Asparagus officinalis</i> *	Garden asparagus	r	locally o	
<i>Atriplex hortensis</i> *	Garden orache	r		NS n
<i>Atriplex patula</i>	Common orache	r	r	n
<i>Blackstonia perfoliata</i>	Yellow-wort		o	
<i>Cardamine hirsuta</i>	Hairy bitter-cress	r		
<i>Cardamine pratensis</i>	Cuckooflower	r	r	
<i>Carex arenaria</i>	Sand sedge	r	locally o	
<i>Carex flacca</i>	Glaucous sedge		o	
<i>Carex hirta</i>	Hairy sedge	very locally f	f	
<i>Carex otrubae</i>	False fox-sedge	r	o	
<i>Carex pendula</i> *	Pendulous sedge		r	n
<i>Carex viridula viridula</i>	Small-fruited yellow-sedge	r		SCI
<i>Centaureum erythraea</i>	Common centaury	r	o	
<i>Cerastium fontanum</i>	Common mouse-ear	o	o	
<i>Chamerion angustifolium</i>	Rosebay willowherb	r	o	
<i>Chenopodium album</i>	Fat-hen	o	r	
<i>Chenopodium rubrum</i>	Red goosefoot	o		SCI n
<i>Cirsium arvense</i>	Creeping thistle	o	o	
<i>Cirsium vulgare</i>	Spear thistle	r	o	
<i>Coryza canadensis</i> *	Canadian fleabane	r		n
<i>Crepis capillaris</i>	Smooth hawk's-beard	o	o	
<i>Cynoglossum officinale</i>	Hound's-tongue	r	r	NT
<i>Dactylorhiza</i> sp.	Marsh-orchid		very locally o	
<i>Datura ferox</i> *	Angel's-trumpets	r		NS n
<i>Datura stramonium</i> *	Thorn-apple	o		n
<i>Eleocharis palustris</i>	Common spike-rush		r	
<i>Epilobium ciliatum</i> x <i>E. obscurum</i>	Hybrid willowherb	r		n
<i>Epilobium ciliatum</i> *	American willowherb	f	o	n
<i>Epilobium hirsutum</i>	Great willowherb	r	o	
<i>Epilobium montanum</i>	Broad-leaved willowherb	r	r	
<i>Epilobium obscurum</i>	Short-fruited willowherb	o	o	
<i>Epilobium palustre</i>	Marsh willowherb		o	
<i>Epilobium parviflorum</i>	Hoary willowherb	o	o	
<i>Epilobium</i> x <i>rivulare</i>	Hybrid willowherb	r		n
<i>Equisetum arvense</i>	Field horsetail	r	locally o	
<i>Equisetum fluviatile</i>	Water horsetail	r	r	
<i>Equisetum palustre</i>	Marsh horsetail	very locally f	o	
<i>Equisetum</i> x <i>litorale</i>	Shore horsetail	r	locally f	n
<i>Erodium cicutarium</i>	Common stork's-bill	r		

<i>Erodium lebelii</i>	Sticky stork's-bill		r	NS n
<i>Euphrasia nemorosa</i>	Eyebright		locally o	
<i>Fallopia convolvulus</i>	Black bindweed	r		n
<i>Festuca rubra</i>	Red fescue	very locally a	locally a	
<i>Fumaria muralis</i>	Common ramping-fumitory	r		n
<i>Galium aparine</i>	Cleavers		r	
<i>Galium palustre</i>	Marsh bedstraw	o	f	
<i>Galium verum</i>	Lady's Bedstraw		very locally f	
<i>Geranium molle</i>	Dove's-foot crane's-bill	r		
<i>Gnaphalium uliginosum</i>	Marsh cudweed	r		
<i>Hieracium umbellatum</i>	Umbellate hawkweed		r	
<i>Holcus lanatus</i>	Yorkshire-fog	f	locally a	
<i>Hydrocotyle vulgaris</i>	Marsh pennywort	locally a	a	
<i>Hypochaeris radicata</i>	Cat's-ear	r	locally o	
<i>Iris pseudacorus</i>	Yellow iris		r	n
<i>Juncus acutiflorus</i>	Sharp-flowered rush		locally o	
<i>Juncus articulatus</i>	Jointed rush	r	o	
<i>Juncus bufonius</i>	Toad rush	r	very locally f	
<i>Juncus inflexus</i>	Hard rush	very locally f	o	
<i>Juncus subnodulosus</i>	Blunt-flowered rush	very locally a	locally a	SCI n
<i>Lathyrus pratensis</i>	Meadow vetchling	r	o	
<i>Leontodon autumnalis</i>	Autumn hawkbit	very locally f	o	
<i>Leontodon saxatilis</i>	Common hawkbit		r	
<i>Linaria vulgaris</i>	Common toadflax		r	
<i>Linum catharticum</i>	Fairy flax	locally o	locally o	
<i>Lotus corniculatus</i>	Common bird's-foot-trefoil		locally o	
<i>Lotus pedunculatus</i>	Greater bird's-foot-trefoil		locally o	
<i>Luzula campestris</i>	Field woodrush	r		
<i>Lycopersicon esculentum*</i>	Tomato	r		n
<i>Lycopus europaeus</i>	Gypsywort	very locally f	locally f	
<i>Lythrum salicaria</i>	Purple loosestrife	a	a	
<i>Mentha aquatica</i>	Water mint	f	f	
<i>Myosotis laxa</i>	Tufted forget-me-not	locally a	f	
<i>Odontites vernus</i>	Red bartsia	r	r	
<i>Ononis repens</i>	Common restharrow	r	locally o	
<i>Parentucellia viscosa</i>	Yellow bartsia	r	locally f	SCI
<i>Persicaria hydropiper</i>	Water-pepper	r	locally f	n
<i>Persicaria lapathifolia</i>	Pale persicaria		r	n
<i>Persicaria maculosa</i>	Redshank	o	o	
<i>Phalaris arundinacea</i>	Reed canary-grass	very locally a	locally a	
<i>Phragmites australis</i>	Common reed	very locally a	locally a	
<i>Physalis peruviana*</i>	Cape-gooseberry	o		NS n
<i>Plantago lanceolata</i>	Ribwort plantain	locally o	o	
<i>Plantago major</i>	Greater plantain	r	r	
<i>Poa annua</i>	Annual meadow-grass	o	o	
<i>Polygonum aviculare</i>	Knotgrass	o		
<i>Potentilla anserina</i>	Silverweed	o	o	
<i>Potentilla reptans</i>	Creeping cinquefoil	o	locally o	
<i>Prunella vulgaris</i>	Selfheal	r	locally f	
<i>Pulicaria dysenterica</i>	Common fleabane		r	
<i>Ranunculus acris</i>	Field buttercup	r	r	
<i>Ranunculus aquatilis</i>	Common water-crowfoot		o	
<i>Ranunculus flammula</i>	Lesser spearwort	o	f	

<i>Ranunculus repens</i>	Creeping buttercup	o	f	
<i>Ranunculus sceleratus</i>	Celery-leaved buttercup	r		
<i>Rorippa palustris</i>	Marsh yellow-cress	r		n
<i>Rubus caesius</i>	Dewberry	f	o	
<i>Rubus tuberculatus</i>	Bramble	r	r	n
<i>Rumex conglomeratus</i>	Clustered dock	r	o	
<i>Rumex crispus</i>	Curled dock	o	o	
<i>Rumex obtusifolius</i>	Broad-leaved dock	o	locally f	
<i>Rumex x pratensis</i>	Hybrid dock		r	n
<i>Sagina nodosa</i>	Knotted pearlwort		r	
<i>Sagina procumbens</i>	Procumbent pearlwort	o	o	
<i>Salix cinerea</i>	Grey willow	o	o	
<i>Salix repens var. argentea</i>	Creeping willow	very locally a	very locally a	
<i>Salix x friesiana</i>	Hybrid willow	o	o	NR
<i>Salix x rubens*</i>	Hybrid crack-willow		r	n
<i>Sambucus niger</i>	Elder	r		
<i>Samolus valerandi</i>	Brookweed	r	r	SCI
<i>Senecio jacobaea</i>	Common ragwort	o	o	
<i>Senecio vulgaris</i>	Groundsel	r		
<i>Silene latifolia</i>	White campion	r		
<i>Silene x hampeana</i>	Hybrid campion		r	
<i>Solanum dulcamara</i>	Bittersweet	f	o	
<i>Solanum nigrum</i>	Black nightshade	o	r	n
<i>Solanum physalifolium*</i>	Green nightshade	r		n
<i>Sonchus arvensis</i>	Perennial sow-thistle	r	locally o	
<i>Sonchus asper</i>	Prickly sow-thistle	f	o	
<i>Sparganium erectum</i>	Branched bur-reed		o	n
<i>Stellaria media</i>	Common chickweed	r		
<i>Taraxacum sp.</i>	Dandelion	r	r	
<i>Trifolium arvense</i>	Hare's-foot clover		r	
<i>Trifolium campestre</i>	Hop trefoil		r	
<i>Trifolium dubium</i>	Lesser trefoil		r	
<i>Trifolium repens</i>	White clover	r	o	
<i>Urtica dioica</i>	Common nettle	f	o	
<i>Urtica urens</i>	Small nettle	r		
<i>Veronica arvensis</i>	Wall speedwell		r	
<i>Veronica catenata</i>	Pink water-speedwell	r	locally f	
<i>Veronica scutellata</i>	Marsh speedwell	r	locally o	
<i>Vicia cracca</i>	Tufted vetch	r	o	
<i>Vicia sepium</i>	Bush vetch	r	r	
<i>Viola arvensis</i>	Field pansy	o	r	
Total in each survey year		108	111	

Note: Nomenclature follows Stace, 1991.

Of the commonest plants recorded in 2006, *A. stolonifera*, *H. lanatus* and *L. salicaria* had greatly increased in frequency, while *E. ciliatum*, *M. laxa*, *S. dulcamara*, *R. caesius* and *U. dioica* were much reduced in quantity (Fig.1). Both common reed *Phragmites australis* and reed canary-grass *Phalaris arundinacea* were spreading into the slack from the fringes.

Conclusions and discussion: Overall, during the course of this study 139 vascular taxa (12 non-native: 8.6%) were recorded colonising the scrub-cleared slack. Of these, 11 are nationally or regionally notable (one Nationally Rare, four Nationally Scarce, one Near Threatened and five Species of Conservation Importance in Northwest England (Cheffings & Farrell 2005; Regional Biodiversity Steering Group 1999). A further seven new plants for the reserve list were added in 2007, making a total of 28 over the two seasons.

The rapidity of colonisation and the high diversity of the new plant community were unexpected but can be attributed in part to the availability of a bare, nutrient-rich, organic matter surface and a seed-bank in the disturbed soil. Slack and fixed-dune vegetation nearby could also have contributed wind-blown seed.

The vegetation of other slacks in the reserve has been developing for a much longer period and therefore has a different species composition. Thus, the dryer slacks tend to be dominated by creeping willow *Salix repens*, while the wettest, semi-aquatic slacks support dense stands of club-rushes *Bolboschoenus/Schoenoplectus*, rushes *Juncus*, horsetails *Equisetum* and *P. australis*. Damp slacks are characterised by grasses Poaceae and sedges *Carex*, often with marsh-orchids *Dactylorhiza* and grass-of-Parnassus *Parnassia palustris*.

In terms of reinstating the dune-slack flora, the cleared slack's current condition represents a major biodiversity gain. However, due to their propensity to form dense mono-species stands, the spread of *P. australis* and *P. arundinacea*, perhaps encouraged by residual nutrients in the soil, could have longer-term adverse effects on species-richness. The current management regime, which includes winter-grazing by sheep, may help to control these invasive species. Site monitoring will continue so that further changes over time can be observed.

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