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Clematis vitalba (Traveller's-joy) (Ranunculaceae) is invasive on the Sefton Coast sand-dunes, north Merseyside, UK

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Abstract
Increasing concern about the apparent spread of *Clematis vitalba* (Traveller's-joy) in the Sefton Coast sand-dune system, north Merseyside, led to a survey in the summer of 2023 to determine its status. A total of 117 patches of the plant was mapped, covering about 0.64 ha of protected fixed and semi-fixed dune habitats. The pattern of distribution suggested spread by both woody stems and seed. A positive skewness towards smaller and therefore younger patches indicated an early stage in colonisation. The known invasive character of *C. vitalba* on sand-dunes elsewhere provides a strong case for management action. Methods for controlling *C. vitalba* are discussed.

Keywords: clusters; control; fixed-dune; herbicides; increase; patch areas

Introduction

It is widely recognised that one of the major threats to biodiversity is invasive non-native plants (Chyrtrỳ *et al.*, 2008). The open habitats of coastal sand-dunes seem to be particularly susceptible to plant invasions, one of the invasive species in dunes highlighted by Smith (2020) being *Clematis vitalba* (Traveller's-joy). The plant is a rampant climbing perennial with woody stems that can form virtual monocultures on base-rich soils, dispersing readily by means of feathery elongated styles (Fig. 1, 2). It is native and locally abundant in southern Britain but is widely introduced elsewhere, having been a popular horticultural subject for over a century. *Clematis vitalba* is now naturalised in the lowlands of Scotland, Ireland, northern England and Wales, often covering large areas on hedge banks, walls, trees, scrub, disused quarries, ruins and sand-dunes (Fitzgerald, 2023; Redmond & Stout, 2018; Stace, 2019). Ellenberg Indicator Values shows that *C. vitalba* is a plant of well-lit to partial shade (L = 6), fairly dry sites (F = 4), on moderately basic soils (R = 8), with intermediate fertility (N = 5) and is absent from saline sites (S = 0) (Hill *et al.*, 2004).

In the British Isles, the range of *C. vitalba* has increased since the 1960s, especially in Ireland and the western and northern regions of Great Britain, though better recording may account for some of the apparent increases (Fitzgerald, 2023). Houston (2011) reported the vigorous growth of *C. vitalba* at Gibraltar Point and

Saltfleetby-Theddlethorpe National Nature Reserves (NNRs), Lincolnshire, describing it as "invasive". Pearman *et al.* (2019) listed *C. vitalba* as one of the ten most invasive 'natives' in Cornwall, where it was becoming dominant in hedgerows and dune systems. In 2023, J. Houston (personal communication) found abundant *C. vitalba* on several small dune systems in Pembrokeshire, including Barafundle Bay. Earl (2023) describes *C. vitalba* as increasing in frequency in UK vice-county 59 (South Lancashire), which includes Sefton, especially along the coastal fringe. He states that plants are frequently introduced as part of 'urban ecological enhancement programs.'

Clematis vitalba is native in many other parts of continental Europe, south to Spain, also in North Africa and Asia, east to Afghanistan. It has also become naturalised in European countries contiguous to its native range, such as Poland, where it has been described as "one of the most invasive tree and shrub species" (CABI compendium, 2021). This plant has been introduced and has naturalised in many other parts of the world, including North America, Australia and New Zealand (CABI compendium, 2021). It is a serious environmental weed in New Zealand, where it grows so vigorously on forest margins that its weight can bring down trees (Jarvis-Lowry *et al*., 2023). *Clematis vitalba* is considered a threat to remnants of native forests in New Zealand and to their associated biodiversity, justifying millions of dollars spent by governmental agencies on attempted eradication (CABI compendium, 2021; Jarvis-Lowry *et al*., 2023).

Clematis vitalba on the Sefton Coast

Extending for about 25 km between the estuaries of the Mersey and Ribble in Northwest England and covering 2100 ha, the Sefton Coast sand-dune system is the largest extent of this habitat in England. It is exceptionally biodiverse, supporting around 1250 vascular plants (Smith, 2021) and some 3500 insects (Smith, 2023). Although not native in this region (Fitzgerald, 2023), *C. vitalba* has been known to occur in the Sefton dunes since at least 1938, localities being given as Shore Road, Ainsdale and Birkdale (Savidge *et al*., 1963). However, Green (1933) cites an undated record for Birkdale, which must have been earlier than 1938. Dickinson (1851) and Greenwood (1999) give the earliest record for v.c.59 as 1850, while Hall (1839), in his *Flora of Liverpool*, does not provide convincing evidence of an earlier occurrence. Until relatively recently, *C. vitalba* was an infrequent member of the Sefton sand-dune plant community. A comprehensive UK National Vegetation Classification (NVC) survey of the dune system in 2004 recorded this species at Formby Golf Course, Altcar Rifle Range and Blundellsands Key Park but not at Ainsdale & Birkdale Sandhills Local Nature Reserve (LNR) (Gateley & Michell, 2004). Since 2020, it became apparent that *C. vitalba* was well-established and spreading at the latter site (personal observations), while isolated patches were known in Ainsdale and Cabin Hill National Nature Reserves (NNRs) (P. Gahan, personal communication). It was thought that their spread might pose a threat to protected dune habitats, all the areas concerned being within the Sefton Coast Site of Special Scientific Interest (SSSI) and Special Area of Conservation (SAC). It was therefore decided that a baseline survey was justified to determine the extent of *C. vitalba* in the dune system and, if necessary, recommend control measures.

Figure 1. Flowering *Clematis vitalba* at Ainsdale Sandhills Local Nature Reserve

Figure 2. *Clematis vitalba* in fruit, showing the elongated feathery styles

Methods

Between July and September 2023, a survey of *C. vitalba* was conducted on Sefton duneland from Crosby in the south to Birkdale in the north, a linear distance of about 20 km. Unfortunately, it was not possible to arrange access to the restricted area of Altcar Training Camp, where the plant was recorded by PHS in 2007. Similarly, it was not feasible to search the dune golf courses, which cover about 500 ha (Smith, 2009). A large population of *C. vitalba* on waste ground at Hightown noted by PHS in 2010 was subsequently destroyed by housing development. None was found at Blundellsands Key Park (P. Kinsella, personal communication).

Most plants of *C. vitalba* occurred as discrete, sub-circular patches that could be recorded individually (Fig. 3). A UK National Grid Reference was obtained for the centre of each patch to an accuracy of about 5 m using a GPS device. Patch areas were estimated from the mean of two diameters taken at right-angles using πr^2. To avoid duplication, each recorded patch was marked with car-paint from a spray-can. Data were entered into an Excel spreadsheet for further analysis and production of distribution maps. Notes were made on vegetation types occupied by patches of *C. vitalba* and were compared to keys and descriptions of NVC plant communities in Rodwell (2000).

Figure 3. *Clematis vitalba* survey, Ainsdale Sandhills LNR, August 2023

Results

A total of 117 patches of *C. vitalba* was measured and mapped, 115 in Ainsdale & Birkdale Sandhills LNR and singles in each of Ainsdale Sand Dunes and Cabin Hill NNRs (Figures 4, 5). For mapping purposes, patch sizes were divided into large (≥ 150 m^2), medium (100-150 m^2) and small (≤ 100 m^2). These categories contained 5, 11 and 101 patches respectively. The area of duneland with patches of *C. vitalba* was estimated to be about 7.1 ha north of Shore Road, Ainsdale, and 33.6 ha south of Shore Road. The distribution maps show some apparent clusters, 'large' and 'medium-sized' patches being surrounded by 'small' ones. However, there was also a scattering of many smaller patches distant from clusters. Patches had a total area of 0.64 ha, individual patch sizes ranging from about 2.1 to 385.4 m^2, with a mean and standard deviation of 54.2 ± 51.5 m^2. Median patch size was 41.3 m^2. A frequency distribution of patch areas (Fig. 6) shows positive skewness towards smaller patches. Pearson's Second Skewness Coefficient gives a value of 0.75, indicating moderate skewness.

Vegetation types occupied by *C. vitalba* were almost always calcareous semi-fixed and fixed-dune, referable to NVC communities SD7: *Ammophila arenaria-Festuca rubra* semi-fixed dune or SD8: *Festuca rubra-Galium verum* fixed dune (Rodwell, 2000).

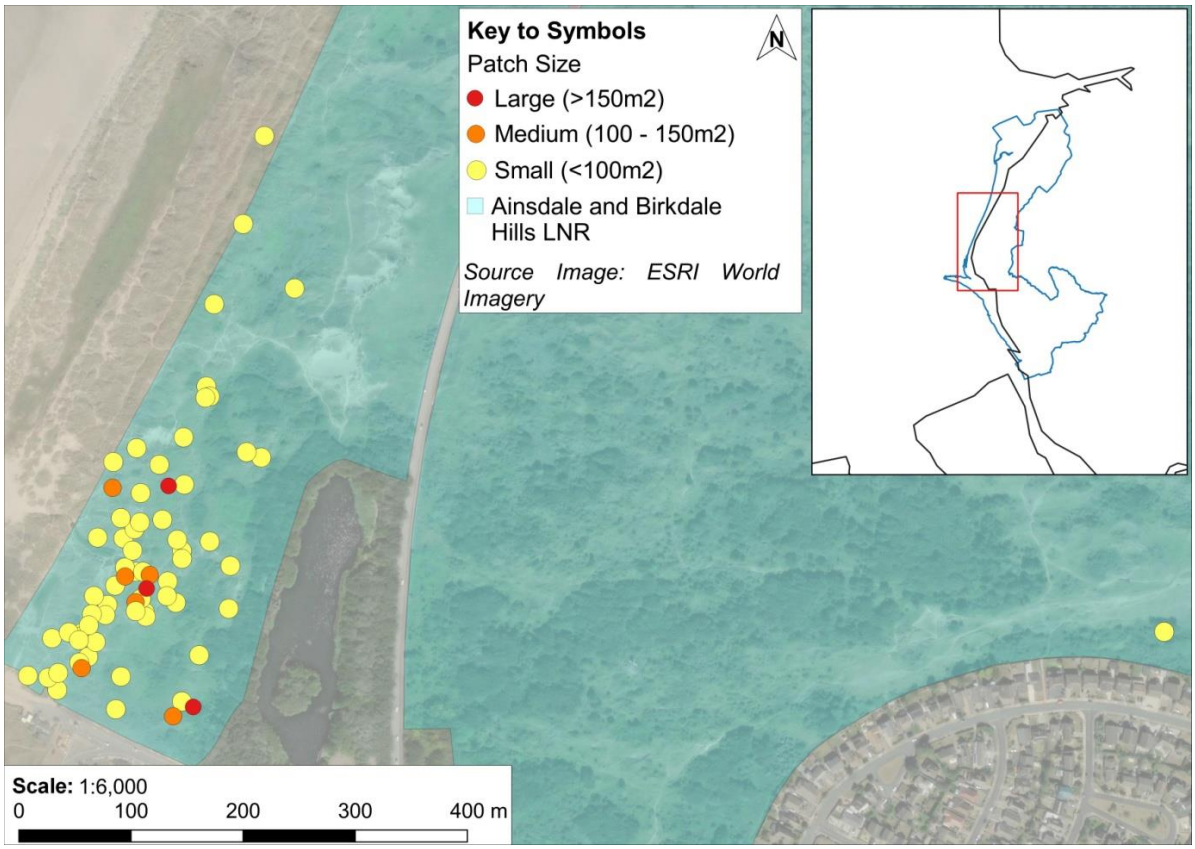

Figure 4. Distribution of *C. vitalba* in Birkdale LNR. Inset: location of Sefton Coast and study area in Northwest England

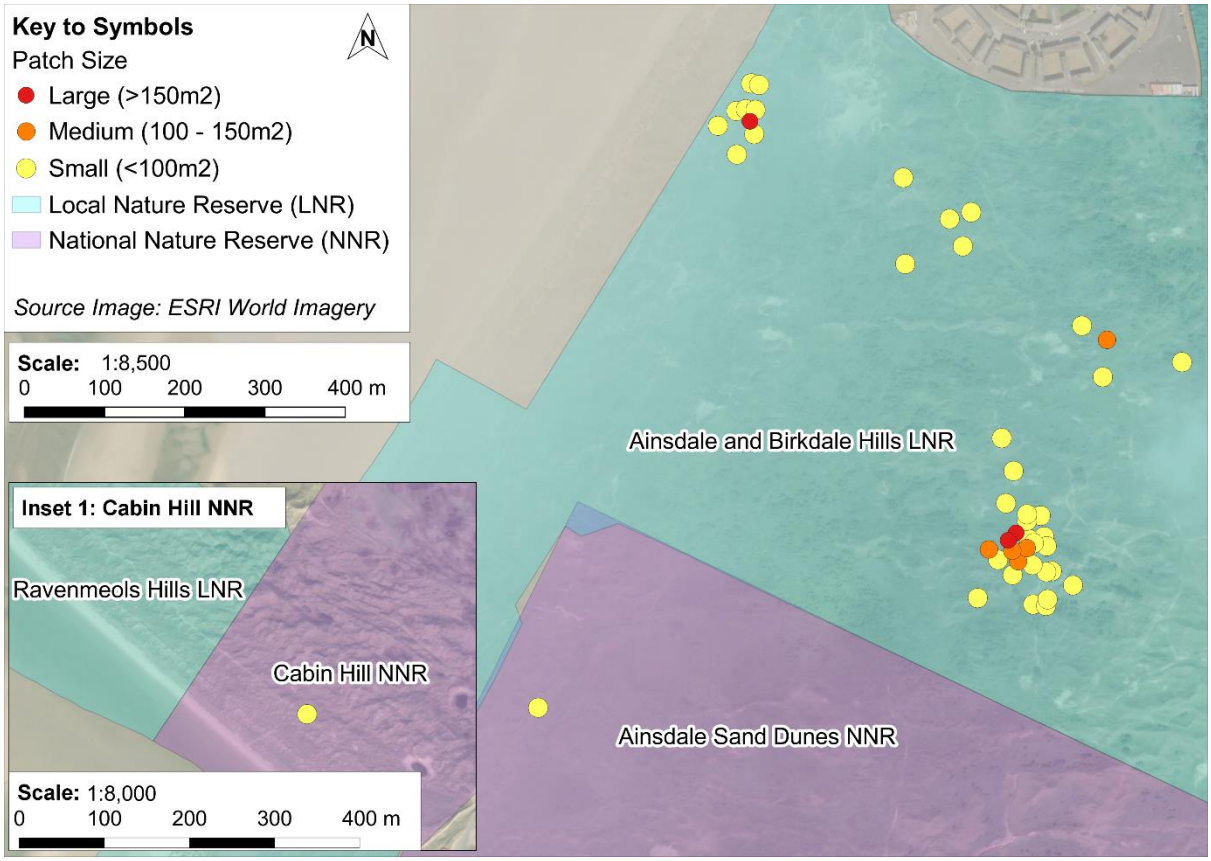

Figure 5. Distribution of *C. vitalba* in Ainsdale LNR, Ainsdale and Cabin Hill NNRs

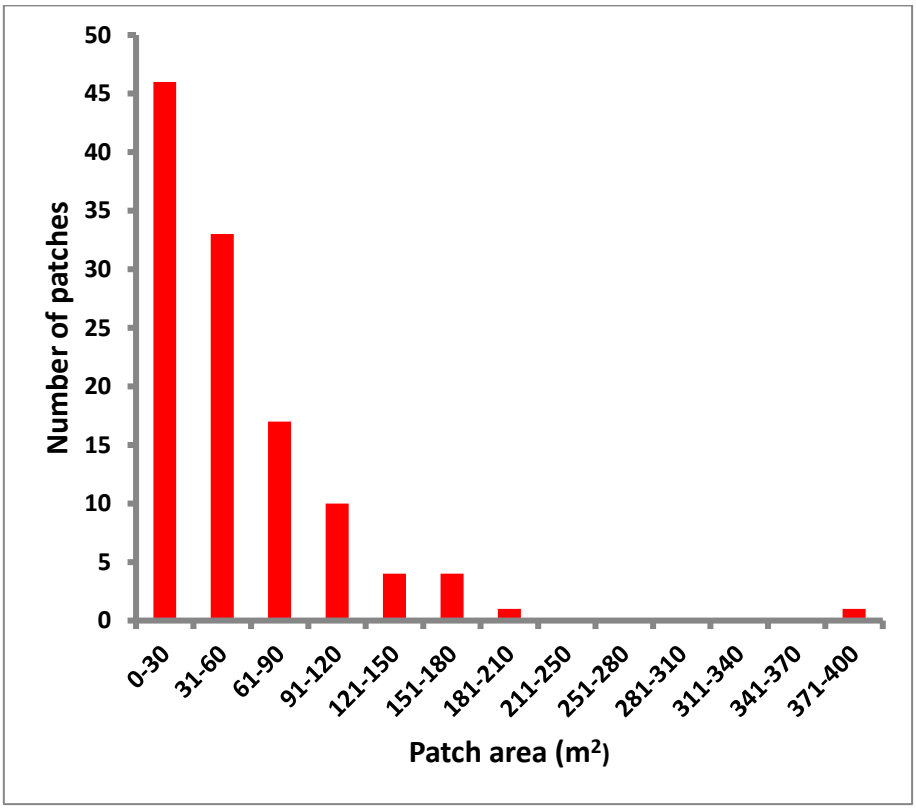

Figure 6. Frequency distribution of *C. vitalba* patch sizes

Discussion

In a detailed account of non-native plants on the Sefton Coast, Edmondson (2010) made no mention of *C. vitalba.* A decade later, Smith (2020) listed *C. vitalba* as both present in the dunes and 'invasive', commenting that it was largely confined to about 10 ha of semi-fixed and fixed-dune north of Shore Road, Ainsdale, within the Birkdale Sandhills LNR. He added that, in the last decade, it had increased markedly. The current study has confirmed and added to these findings, showing that, as well as the area north of Shore Road, LNR duneland south of Shore Road has also been invaded by *C. vitalba*. Evidently, following establishment in the LNR after the 2004 NVC survey, the plant has undergone rapid expansion, presumably by both vegetative growth and wind dispersed propagules. DJ remembers a patch at Ainsdale LNR in the 1990s that showed little sign of spreading for many years but now supports a large cluster (Fig. 4). Crooks (2005) pointed out that there may be a prolonged lag phase before an alien plant becomes invasive. The dispersion pattern of some larger (i.e. older) patches of *C. vitalba* surrounded by smaller (younger) ones is probably due to vegetative propagation and seed germination around the older patches.

Dolkin-Lewko & Zajączkowska (2022) noted that stems of *C. vitalba* grew an average of 2.3 m per annum, producing 20 new nodes. We measured current year's stem growth of up to 3.2 m, indicating potential rate of vegetative spread. The scatter of younger patches in the study area was presumably by wind dispersion, aided by the elongated feathery styles on the achenes. Dolkin-Lewko & Zajączkowska (2022) quoted an average seed-fall of 65 per m^2 per annum, with an estimated life of seed in the soil of 8 – 10 years. Positive skewness towards smaller patches in the frequency distribution supports the idea that colonisation is at an early stage.

Redmond & Stout (2018) found that *C. vitalba* was capable of uniparental reproduction in Ireland via geitonogamy and autonomous selfing, though at a reduced rate compared with outcrossing. The plant was visited by at least ten native pollinators, mainly hoverflies (Syrphidae). Given the lack of reproductive constraint, they considered that *C. vitalba* could easily spread in suitable habitats and expressed concern that it was already prevalent in floristically diverse regions of Ireland.

Our study showed that *C. vitalba* patches cover 0.64 ha within about 40.7 ha of semi-fixed and fixed-dune on the Sefton Coast. Although we did not investigate the direct impact of *C. vitalba* growth on other members of the plant community, casual observations suggested that few other species could compete with its dominance. Furthermore, the perceived increase of *C. vitalba* in recent years suggests that it is likely to continue its rapid spread, leading to a significant loss of habitat and biodiversity. Fixed-dune grassland is 'Annex 1 priority' under the EU Habitats Directive and is also a 'priority for conservation of biodiversity in England' under Section 41 of the Natural Environment and Rural Communities Act 2006. Section 41 habitats are those that are most threatened, in greatest decline or where the UK holds a significant proportion of the world's total area.

While *C. vitalba* currently occupies a relatively small area of Sefton duneland, its known invasive characteristics and recent rapid spread into high quality habitats (Fig. 7) provide a strong case for urgent management action.

Figure 7. *Clematis vitalba* invading fixed-dunes, Ainsdale & Birkdale Sandhills LNR

Techniques for controlling *C. vitalba*

Attempts to control *C. vitalba* at Saltfleetby-Theddlethorpe NNR began in 2021 on about 10 ha of heavily invaded duneland under the auspices of the *Dynamic Dunescapes* project (C. Layton, personal communication). Contractors were employed mechanically to remove and burn vegetation supporting the plant, followed by on-site burial of ash, at a total cost of £30,000. It was recognised that monitoring would be needed for several years to deal with regrowth. This was treated by spraying the herbicides Doxstar Pro (containing Fluroxypyr and Trichlopyr) or Pastor (Fluroxypyr, Trichlopyr and Chloropyralid). In addition, Glyphosate was trialled on 1 ha; this was more effective at killing *C. vitalba* roots but had a wider impact on other plants. At the time of writing (November 2023), the success of this control operation had yet to be fully quantified, though a decrease in *C. vitalba* was observed (C. Layton, personal communication).

In New Zealand, two biocontrol agents, an agromyzid fly and a fungal pathogen, were released against *C. vitalba* in 1996. Both species established quickly and spread widely but neither caused sufficient damage to produce effective control (Paynter *et al.*, 2006).

Detailed studies into mechanical and chemical control of *C. vitalba* in New Zealand by Jarvis-Lowry *et al.* (2023) showed that cutting stems was ineffective, leading to vigorous regrowth with multiple shoots being produced at each node. A range of selective herbicides was trialled. For climbing stems in trees, Trichlopyr in oil, applied near the base of intact woody stems, was highly effective, giving over 95% mortality with no damage to nearby trees. Glyphosate gel applied to cut stems

was less effective, with 56% mortality after two years. Creeping stems in grass-dominated ruderal sites were treated in autumn with three selective herbicide sprays. Effective control was achieved with Metasulphuron, Trichlopyr and a mixture of Trichlopyr, Picloram and Aminopyralid, though Metasulphuron had a negative effect on grass growth. The latter was important because an intact grass sward prevented *C. vitalba* establishing from seed.

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