

## Changing status of *Blysmus compressus* (Flat Sedge) in the Sefton Coast sand-dunes, north Merseyside, UK

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### Abstract

A 2018 survey of the nationally 'Vulnerable' *Blysmus compressus* (Flat-sedge) in the Sefton Coast sand-dunes, north Merseyside (v.c.59, South Lancashire), aimed to update information collected on distribution and habitats a decade earlier. As in 2008, the plant was mainly found in calcareous dune-slacks of recent origin, with short, open, species-rich vegetation on gley soils with a relatively high pH. Sites with a lower sward height supported a higher percentage cover of *B. compressus*. The largest populations were associated with sites that had been disturbed by recreational trampling, occasional vehicle use and/or grazing, especially by rabbits. Twenty-two sites were recorded, seven being new. Overall, the area occupied by *B. compressus* declined by 17%, two 2008 sites being lost. Similarly, an estimate of 15-20,000 plants in the earlier survey fell to 12,600. Losses were attributed to vegetation overgrowth and scrub development, partly resulting from lower rabbit numbers and reduced management input. The plant occurred in a range of vegetation types but matches to known UK National Vegetation Classification communities were generally poor. Management methods to conserve *B. compressus* and other vulnerable taxa are discussed.

### Key words

Declining species; dune management; dune-slacks; grazing; rabbits; vegetation overgrowth.

### Introduction

*Blysmus compressus* (L.) Panz. ex Link (Flat-sedge) (Cyperaceae) (Fig. 1) is a rhizomatous perennial of open vegetation in marshes and fens and in short, sedge-rich, damp grassland, calcareous flushes, dune-slacks, road verges and stream borders that are subject to flooding, especially on base-rich soils. It has also occasionally been found in brackish ditches at the head of saltmarshes and as a constituent of alluvial meadows on stabilised shingle (Graham, 1988; Halliday, 1997; Jermy *et al.*, 2007; Stroh & Walker, 2015; Walker *et al.*, 2017). Ellenberg's indicator values in Hill *et al.* (2004) show that this species is a light-loving plant (L = 8), associated with constantly moist to wet soils (F = 8) that are base-rich (R = 8) and relatively infertile (N = 3) and that the plant is generally absent from saline sites (S = 0).

*Blysmus compressus* occurs from the temperate zone of Western Europe, north to southern Scandinavia, south to North Africa and east, via Turkey and Lebanon, through southern Siberia, Mongolia, Nepal and the mountains of Central Asia as far as Sichuan in China. This plant has been recorded in most English counties but is now extinct in many, being locally abundant only in the north and west. It is confined to one site in Wales and, in Scotland, is found almost entirely to the south of the Central Belt. The species has not been seen in Ireland.

Due to habitat loss, hydrological change, eutrophication, undergrazing and the spread of competitive species, *B. compressus* has greatly declined in Britain, having been lost from more than half its pre-1930 hectads by 1962 and, subsequently, from 40% of its post-1930 hectads. Its change index from 1930 to 1999 was -1.28 (Foley & Porter, 2002). A further decline was reported during the Botanical Society of Britain and Ireland's *Threatened Plants Project* (2008-2013), which quantified changes in the distribution of selected populations present after 1970. *B. compressus* was relocated at 66% of pre-selected sites, which included the Sefton Coast, north Merseyside. The largest populations, with up to 300,000 individuals, were found in flushed grasslands near to streams and rivers in the uplands of Northern England and Southern Scotland (Walker *et al.*, 2017).

Reflecting its recent declines, *B. compressus*, is Red-listed as Vulnerable in the UK and in both England and Wales. *B. compressus* is also a Species of Principal Importance for the Purpose of Conserving Biodiversity in England and Wales under Section 41 of the Natural Environment and Rural Communities Act 2006 and Section 7 of the Environment (Wales) Act 2016, respectively. The plant is Red-listed in many western European countries, including Belgium, Germany, Norway, Croatia, the Czech Republic, Hungary, Finland and Sweden (Cheffings & Farrell, 2005; Dines, 2008; Stroh *et al.*, 2014; Walker *et al.*, 2017).

Smith (2009a) reviewed the distribution of *B. compressus* in Northwest England where it is considered a Species of Conservation Importance (Regional Biodiversity Steering Group, 1999). There are records for 69 tetrads in Cumbria, mostly in vice-county (v.c.) 69, Westmorland (Halliday, 1997). In West Lancashire (v.c.60), the plant recently occurred in two areas: on the banks of the R. Lune and in dune-slacks at Lytham St. Anne's. It is not clear whether it survives at the first locality but a small patch was still present recently at Lytham (D.P. Earl, personal communication, 2018). In v.c.59 (South Lancashire), *B. compressus* is largely confined to the Sefton Coast sand-dunes, the only other sighting being in 1926 at Nelson, Lancashire, where the plant does not seem to have been recorded since. There are no records for Cheshire (v.c.58).



**Figure 1. *Blysmus compressus* in flower at Altcar Training Camp**

### **Status on the Sefton Coast**

*Blysmus compressus* has been known from the Sefton Coast since 1801, the first quantitative study of its distribution and habitats being in 2008 as part of the BSBI *Threatened Plants Project*. Smith (2009a) found the species in 18 calcareous dune-slack and damp grassland sites, occupying a total area of over 3000 m<sup>2</sup>. The estimated total population size was between 15,000 and 20,000 individuals. Most localities were of fairly recent origin and had a history of recreational disturbance and grazing, especially by rabbits (*Oryctolagus cuniculus*). Analysis of quadrat data gave accordance with UK National Vegetation Classification (NVC) dune-slack communities SD15, SD16 and SD17 and two mesotrophic grassland types (MG8 and MG11) (Rodwell, 1991-2000), though statistical matches were generally poor to very poor.

Since the 2008 study, several new populations of *B. compressus* have been found in the Sefton dunes. There have also been changes in land-ownership and management. Ten years on, therefore, it was considered appropriate to repeat the 2008 survey, the aims being to establish the current status of this nationally declining and vulnerable plant at one of its important English lowland stations, to clarify its habitat characteristics and make conservation recommendations.

### **Methods**

All known and likely sites for *B. compressus* in the Sefton Coast sand-dune system were visited in June and July 2018. Populations were marked out using bamboo canes, their

areas being measured by tapes or by pacing and number of plants estimated by counting flower spikes individually or in groups of 5 or 100, depending on colony size. National Grid References of sites were determined to an accuracy of about 5 m using a hand-held Garmin Etrex GPS device. For all but the smallest sites, either one or two samples of representative vegetation were recorded in 21 2 m×2 m quadrats using NVC methodology. Reference was made to keys, data tables and community descriptions in Rodwell (1991-2000) to identify vegetation types. Quadrat samples were also analysed using TABLEFIT to determine the degree of fit to known NVC communities and sub-communities (Hill, 2015). Soil type was assessed in each quadrat by visual inspection and a sub-surface soil sample taken, its pH being measured the same day using a Lutron PH-212 soil pH meter buffered at pH 4 and 7. Notes were also taken on habitat type, condition and current management. Relationships between plant numbers and site area and between vegetation height and percentage cover were analysed using Pearson's correlation coefficient. Vascular plant nomenclature follows Stace (2010) and subsequent updates.

## Results

Twenty-two sites supporting *B. compressus* were found (Fig. 2), extending from Altcar Training Camp in the south to Queen's Jubilee Nature Trail, Southport in the north, a linear distance of about 12 km. They are situated in six tetrads and three hectads of the UK National Grid. As in 2008, most colonies were in four main areas: Altcar Training Camp (four sites), Cabin Hill National Nature Reserve (three), Birkdale frontal dunes (south) (five) and Birkdale frontal dunes (north) (six). Outlying colonies were also located at the Devil's Hole in Ravenmeols Local Nature Reserve (LNR), Royal Birkdale Golf Course, Birkdale Sandhills LNR and Queen's Jubilee Nature Trail.

A total of over 12,600 plants was counted (Table 1), with a range of 2 to 5000 and a mean of 600 plants per site. The colonies occupied a total area of nearly 2500 m<sup>2</sup> (range 1-921 m<sup>2</sup>; mean 119 m<sup>2</sup>). As might be expected, a positive relationship was found between colony size and area occupied (Fig. 3). A log<sub>10</sub> transformation of both axes was used to give a more symmetrical distribution of data.

Seven new sites for the target species were located covering 641 m<sup>2</sup> and supporting 3220 plants. *B. compressus* was not re-found in two of the 2008 sites: a marshy pond edge on Royal Birkdale Golf Course and slack no. 26 Birkdale Sandhills LNR. The former covered 6 m<sup>2</sup> and held 10s of plants in the previous survey, while the latter had 100+ plants within 7 m<sup>2</sup>. Another site was reported in 2008 by P.S. Gateley (personal communication, 2009) in a slack on the fairway of the 12<sup>th</sup> hole at Royal Birkdale. However, no plants were found there in 2018. Two sites at Altcar Training Camp's 'I-range' had been mown just before the recording visit and, consequently, only two plants were located in one of them. Previous observations indicated that at least 100 plants were usually present there. While numbers of individuals were only roughly estimated in 2008, site areas were more carefully measured, allowing a direct comparison between the two surveys. Of the sites recorded in both years, nine showed area declines of 23 to 96% while five increased in size from 7 to 144% (Table 1). Greatest area losses were in the Birkdale frontal slacks nos. 31, 49 and 50. All three of

the Cabin Hill sites also showed declines in area, while the largest area gains were in Birkdale frontal slacks 32, 27, 28 and 51/52 (Table 1).

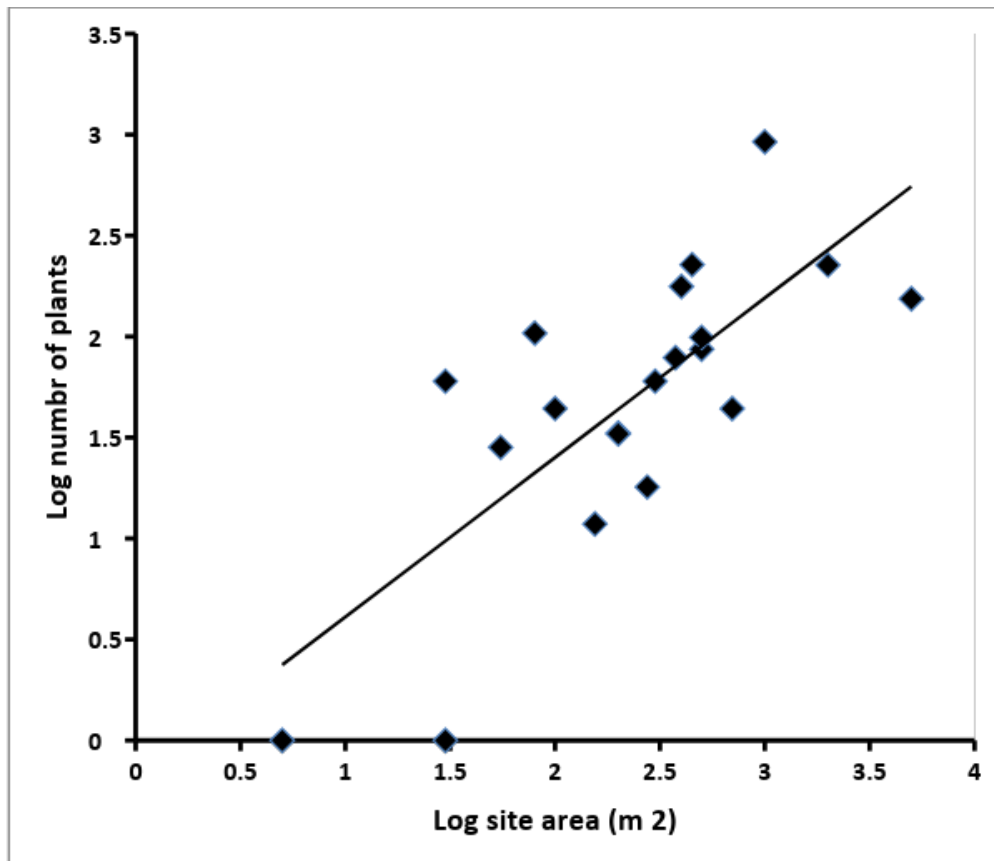


Figure 2. Distribution and area of *Blysmus compressus* patches on the Sefton Coast



**Table 1. *Blysmus compressus* sites on the Sefton Coast, 2018 (south to north).**  
**\* found after 2008; <sup>1</sup> since 2008**

<b>Location</b>	<b>National Grid Ref.</b>	<b>Habitat</b>	<b>Area m<sup>2</sup></b>	<b>% area change<sup>1</sup></b>	<b>No. of plants</b>
Altcar Training Camp scrape 8*	SD28640498	Semi-aquatic	28.3	-	55
Altcar Training Camp scrape 8*	SD28660504	Wet-slack/semi-aquatic	78.6	-	375
Altcar Training Camp scrape 5*	SD28620458	Wet-slack	227	-	450
Altcar Training Camp	SD28870462	Damp grassland	?	?	2
Cabin Hill NNR slack 1	SD28260528	Wet-slack	921	-23	1000
Cabin Hill NNR slack 3	SD28350529	Wet-slack	33.2	-39	50
Cabin Hill NNR slack 20	SD28250521	Wet-slack	9.6	-71	20
Devil's Hole*	SD27830541	Wet-slack	3.1	-	10
Sands Lake carpark, Birkdale frontals (south)	SD30131282	Dry-slack	18	-22	275
Birkdale frontals (south) pipeline slack*	SD30001301	Dry-slack	1	-	30
Birkdale frontals (south) slack 51/52	SD30011310	Wet-slack	53.5	84	200
Birkdale frontals (south) slack 50	SD30071316	Wet-slack	60.1	-84	30
Birkdale frontals (south) slack 49	SD30091330	Wet- slack	11.8	-92	155
Birkdale LNR slack 13*	SD30721362	Wet-slack	226	-	2000
Royal Birkdale GC 5 <sup>th</sup> fairway	SD31631529	Damp grassland	30	-83	20
Birkdale frontals (north) slack 27	SD31341540	Wet-slack	115	98	725
Birkdale frontals (north) slack 28	SD314155	Wet-slack	300	85	1100
Birkdale frontals (north) slack 30	SD32031631	Dry-slack	60.1	7	300
Birkdale frontals (north) slack 31	SD31951619	Wet-slack	4.1	-96	25
Birkdale frontals (north) slack 32	SD31911622	Dry-slack	154	144	5000
Birkdale frontals (north) slack 33	SD31931614	Dry-slack	86.6	-49	500
Queen's Jubilee Nature Trail scrape*	SD32301683	Wet-slack	77	-	300
<b>Total: 22 sites</b>			<b>2498</b>		<b>12622</b>



**Figure 3. The relationship between  $\log_{10}$  number of *B. compressus* plants and  $\log_{10}$  site area (m<sup>2</sup>) ( $r = 0.751$ ;  $p = 0.0001$ )**

Most Sefton Coast sites for *B. compressus* are dune-slacks that have formed secondarily by wind-erosion or by sand-winning and have a seasonally fluctuating water-table (Smith, 2009b). Using Ranwell's (1972) criteria for classifying slack-types, one site was considered to be semi-aquatic, one semi-aquatic/wet-slack, 13 wet-slack and five dry-slack, while two were listed as damp grassland (Table 1). All the soil types were considered to be ground-water gleys of the Greatstone Series as defined by the Soil Survey of England & Wales, though about half approached a peaty-gley condition with large amounts of surface organic matter (Beard *et al.*, 1987). Soil pH was relatively high, ranging from 6.06 to 7.64 with a mean and standard deviation of  $7.0 \pm 0.51$ .

The 21 quadrats contained 80 vascular associates of *B. compressus*, those with the highest frequency being *Agrostis stolonifera* (Creeping Bent) (19 occurrences), *Carex flacca* (Glaucous Sedge) (15), *Holcus lanatus* (Yorkshire-fog) (11), *Hydrocotyle vulgaris* (Marsh Pennywort) (17), *Plantago lanceolata* (Ribwort Plantain) (10), *Salix repens* (Creeping Willow) (14) and *Trifolium repens* (White Clover) (13). Bryophytes were not studied in detail but five quadrats contained a high percentage cover of *Calliergonella cuspidata* (Pointed Spear-moss). The number of vascular taxa per quadrat ranged from 10 to 25 with a mean and standard deviation of  $17.4 \pm 4.55$ . Including *B.*

*compressus*, ten of the taxa identified in quadrats are regionally or nationally notable, eight being Red-listed.

Mean vegetation height and standard deviation in quadrats was  $18.5 \pm 7.5$  cm (range 7-35 cm), while percentage cover of *B. compressus* varied from 3 to 30 (mean  $10.3 \pm 7.8$ ). Samples with lower vegetation heights tended to have a higher cover of *B. compressus* (Fig. 4). Shorter swards were found in sites that were either subject to recreational trampling, vehicle passage or, more rarely, rabbit grazing. For example, slack 32 in the Birkdale frontals is situated at the junction of several informal footpaths and had the highest count of *B. compressus* (c.5000 plants). Here the vegetation was greatly suppressed by trampling, with an average height of 7 cm in quadrats (Fig. 5).

Similarly, slack 13 in Birkdale LNR is much visited by dog-walkers. Its large population of 2000 *B. compressus* plants was in wet-slack habitat on the northern side of a flooded excavated scrape. Being moderately trampled, this site had a mean sward height of 10 cm, while the southern shore, which receives much higher visitor-pressure, was devoid of vegetation (Fig. 6). Being occasionally disturbed and rutted by military vehicles, three of the *B. compressus* sites at Altcar Training Camp had a mean vegetation height of 20 cm (Fig. 7). Birkdale slacks 28 and 27 were severely damaged by off-road vehicles in February 2014 (Fig. 8), both showing large area increases in *B. compressus* since 2008 (Table 1).

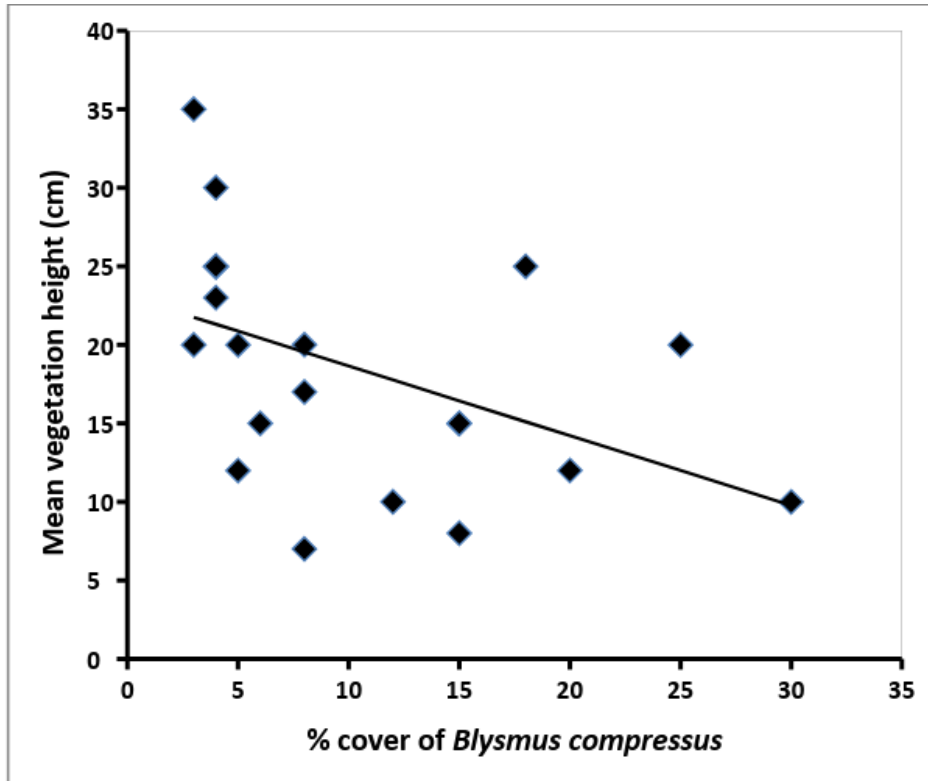
The most unusual locality was the edge of a carpark at Sands Lake, Ainsdale, where 275 plants were counted in a 1 m-wide strip of heavily trampled weedy vegetation only 7 cm tall. This colony was also recorded in 2008, having been first noticed in 1979 (Smith, 2009a). *B. compressus* was also occasionally found in taller slack vegetation, stems of the plant being up to 47 cm long in slack 28, Birkdale frontals, slightly more than the maximum of 45 cm cited in Jermy *et al.* (2007). Rodwell (1991-2000) does not include *B. compressus* as a constituent of any NVC community. However, reference to his keys, data tables and community descriptions suggested that most quadrats had accordance with SD14: *Salix repens-Campylyium stellatum* dune-slack (3 samples), SD15: *Salix repens-Calliargon cuspidatum* (now *Calliargonella cuspidata*) dune-slack (4 samples), SD16: *Salix repens-Holcus lanatus* dune-slack (4 samples) or SD17: *Potentilla anserina-Carex nigra* dune-slack (6 samples).

Two quadrats did not key out satisfactorily, while two had similarities to MG5: *Cynosurus cristatus-Centaurea nigra* grassland or MG6: *Lolium perenne-Cynosurus cristatus* grassland. TABLEFIT analysis based on percentage cover of vascular taxa (Table 2) produced similar results with four samples having accordance with SD14, five with SD15, three with SD16 and four with SD17. One sample (Sands Lake carpark) resembled MG6: *Lolium perenne-Cynosurus cristatus* grassland, while the best fit for Birkdale slack 30 was MG8: *Cynosurus cristatus-Caltha palustris* grassland.

The two samples from the edge of the trampled scrape at Birkdale slack 13 resembled OV23: *Lolium perenne-Dactylis glomerata* weedy grassland and OV28: *Agrostis stolonifera-Ranunculus repens* muddy grassland. One sample from Birkdale slack 27 matched M22: *Juncus subnodulosus-Cirsium palustre* mire. However, all the samples showed "very poor" statistical fits to these vegetation types (Table 2). A re-run



of TABLEFIT for vascular species presence gave identical NVC matches but levels of fit were higher, ranging from "very poor" to "very good" (Table 2).



**Figure 4. The relationship between mean vegetation height and % cover of *B. compressus* in quadrats ( $r = 0.465$ ;  $p = 0.034$ )**

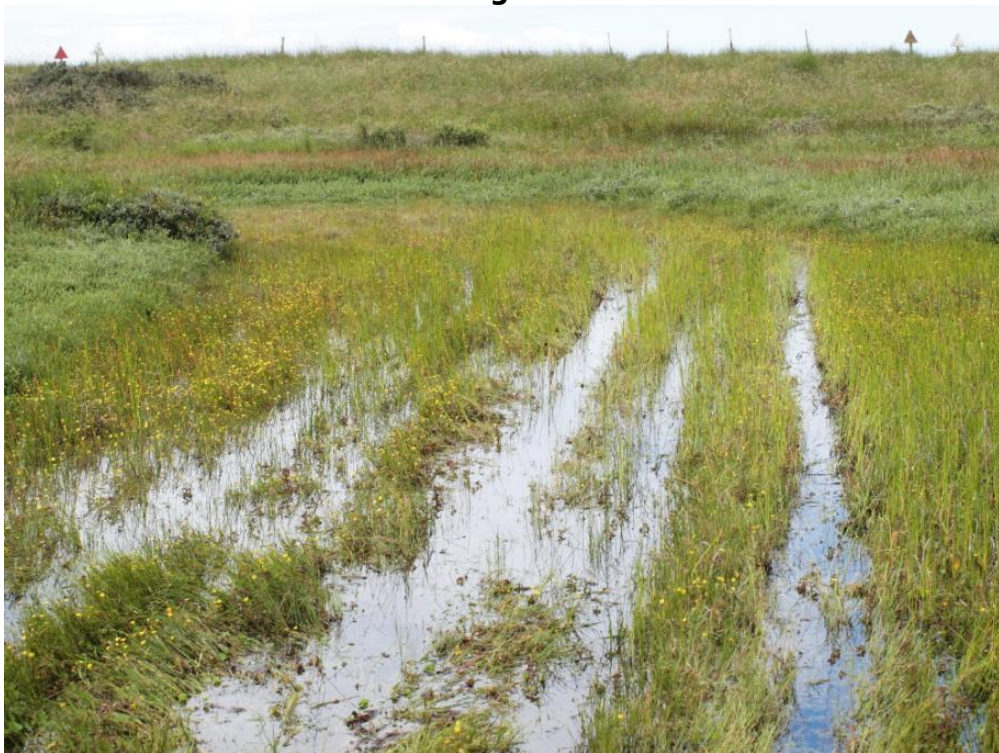


**Figure 5. *B. compressus* habitat on informal footpaths at Birkdale slack 32**





**Figure 6. Heavy trampling at Birkdale Sandhills slack 13. *B. compressus* site upper right**



**Figure 7. *B. compressus* site at Altcar Training Camp showing occasional use by military vehicles**





**Figure 8. Unauthorised off-road vehicle damage, Birkdale slack 27, February 2014**

**Table 2. TABLEFIT analysis of quadrat samples**

<b>NVC code</b>	<b>Community</b>	<b>Sub-community</b>	<b>No. of samples</b>	<b>% fit cover</b>	<b>Match</b>	<b>% fit species</b>	<b>Match</b>
SD14	<i>Salix repens-Campylium stellatum</i> dune slack		1	22	Very poor	44	Very poor
SD14d	<i>Salix repens-Campylium stellatum</i> dune slack	<i>Festuca rubra</i>	3	29-36	Very poor	59-73	Poor-good
SD15	<i>Salix repens-Calliargon cuspidatum</i> dune slack		3	21-46	Very poor	43-93	Very poor-very good
SD15a	<i>Salix repens-Calliargon cuspidatum</i> dune slack	<i>Carex nigra</i>	1	24	Very poor	49	Very poor
SD15b	<i>Salix repens-Calliargon cuspidatum</i>	<i>Equisetum variegatum</i>	1	29	Very poor	59	Poor

	dune slack						
SD16b	<i>Salix repens-Holcus lanatus</i> dune slack	<i>Rubus caesius</i>	2	33-36	Very poor	66-72	Fair-good
SD16d	<i>Salix repens-Holcus lanatus</i> dune slack	<i>Agrostis stolonifera</i>	1	34	Very poor	69	Fair
SD17	<i>Potentilla anserina-Carex nigra</i> dune slack		1	32	Very poor	65	Fair
SD17b	<i>Potentilla anserina-Carex nigra</i> dune slack	<i>Carex flacca</i>	1	31	Very poor	63	Fair
SD17d	<i>Potentilla anserina-Carex nigra</i> dune slack	<i>Hydrocotyle vulgaris-Ranunculus flammula</i>	2	38-45	Very poor	77-91	Good-very good
MG6a	<i>Lolium perenne-Cynosurus cristatus</i> grassland	Typical	1	29	Very poor	58	Poor
MG8	<i>Cynosurus cristatus-Caltha palustris</i> grassland		1	30	Very poor	61	Fair
M22	<i>Juncus subnodulosus-Cirsium palustre</i> mire		1	20	Very poor	40	Very poor
OV23c	<i>Lolium perenne-Dactylis glomerata</i> weedy grassland	<i>Plantago major-Trifolium repens</i>	1	28	Very poor	56	Poor
OV28a	<i>Agrostis stolonifera-Ranunculus repens</i> muddy grassland	<i>Polygonum hydropiper-Rorippa sylvestris</i>	1	22	Very poor	45	Very poor

## Discussion

Almost all of the *B. compressus* localities are in seasonally-flooded, calcareous dune-slacks where the plant is subject to occasional inundation by base-rich freshwater. Waterlogged conditions seem to favour this species (Jermy *et al.*, 2007; Walker *et al.*, 2017), perhaps because tolerating oxygen deficiency in the soil gives it a competitive advantage (Stroh & Walker, 2015). The target species was restricted to about 2500 m<sup>2</sup> of dune-slack and damp grassland. This is a small proportion of the potentially available habitat, the Sefton Coast having over 114 ha of slacks and freshwater wetland, amounting to 33% of the dune-slack resource in England (Edmondson, 2010; Radley, 1994). However, many of the slacks originated over 100 years ago and, being heavily vegetated (Smith, 2009b), are probably unsuitable for *B. compressus*.

Distances between the three groups of sites supporting the plant are approximately 12 km and 2.8 km, suggesting that dispersal and establishment of new colonies may be problematic. Little seems to be known about dispersal mechanisms in this species (Stroh & Walker, 2015), though Pignotti & Mariotti (2004) described particularly long perianth bristles surrounding the nut that may assist attachment to mammals and birds.

Smith (2009a) reported “encouraging findings” that fewer than ten sites in the Sefton dunes for *B. compressus* in the early 1980s had increased to 18 by 2008. Only two sites had been lost since the 1970s. However, considerable changes have taken place in the distribution and abundance of *B. compressus* in the decade since the 2008 survey. First, seven new colonies were found, representing 25.7% and 25.5% of the current total area and population, respectively. Nevertheless, there has been an overall reduction in abundance and colony size. An estimated 15-20,000 plants in the earlier survey declined to 12,600 ten years on. Similarly, the total area of sites occupied by *B. compressus* fell by 17%, despite the addition of new sites. Many of the surviving sites are small, 73% supporting  $\leq 1000$  plants, while 64% are  $\leq 100\text{m}^2$  in area. This makes them potentially vulnerable to habitat change.

Walker *et al.* (2017) concluded that *B. compressus* was highly susceptible to competition from taller-growing plants, the main threats being absence of grazing or cutting, changes to the hydrological regime and repeated disturbance by vehicles or people causing trampling and soil compaction. Smith (2009a) provided evidence that most of the *B. compressus* sites on the Sefton dunes were of fairly recent origin and had a history of recreational disturbance and grazing, especially by rabbits. Some were winter-grazed by livestock and others had been mowed annually. All the newly discovered locations are also relatively young. The three Altcar sites are in scrapes dug in 1976, the Birkdale pipeline slack was formed by wind-erosion in the mid-late 1970s, the Birkdale slack 13 population borders a scrape excavated in 1977 and the Queen’s Jubilee population is in a 1994 scrape. The youngest is the Devil’s Hole, a dune blowout in which slack vegetation began to colonise in 2003, *B. compressus* being found in 2015 (Smith, 2017a). Thus, none of these habitats is much more than 40 years old, though the fact that *B. compressus* did not appear in the Devil’s Hole until 12 years of vegetation development suggests that it is not a pioneer species. As slacks age, their

initially open plant communities become colonised by coarser, taller vegetation, including shrub species (Rodwell, 1991-2000; Davy *et al.*, 2006). *B. compressus* is therefore likely to decline in older slacks unless these are managed to maintain short swards which this study has shown are associated with higher frequencies of the plant.

An Ellenberg N value of 3 indicates adaptation of *B. compressus* to infertile conditions (Hill *et al.*, 2004). Millington *et al.* (2010) showed that Sefton dune soils generally have relatively low nitrogen levels which tends to increase in the older parts of the system. Increases in nitrogen and other nutrients in dune-slack soils during succession is well-established (e.g. Grootjans *et al.*, 1998; Olf *et al.*, 1993), probably making older slacks less suitable for *B. compressus*. Eutrophication is likely to be exacerbated by aerial deposition of nitrogen from industrial and agricultural sources (Jones *et al.*, 2004).

Although Walker *et al.* (2017) highlight soil compaction and trampling damage as a threat to the plant, Smith (2009a) found that human trampling benefited *B. compressus* by reducing sward height and the dominance of *Salix repens*. This was also apparent in the current study, the heavily trampled slack 32 in the Birkdale frontals (Fig. 5) having both the largest population of *B. compressus* and the greatest increase since 2008. Vegetation height at the important colony at Birkdale slack 13 was similarly reduced by recreational pressure (Fig. 6). As in 2008, several sites were associated with the edges of informal footpaths where vegetation, especially *S. repens*, has been suppressed (Fig. 9). Examples include the Birkdale pipeline slack, frontal slacks 27, 28, 33 and 51/52 and the heavily disturbed fringe of Sands Lake carpark. Smith (2009a) described the latter site as "sub-optimal" for *B. compressus*, expressing surprise that the plant had survived here since 1979. He also found that it had persisted and increased after severe churning by illegal motor-cycling in the northern Birkdale frontal slacks during the late 1970s and early 1980s. Occasional passage of military vehicles similarly created more open, disturbed swards at some of the Altcar sites (Fig. 7), while off-road vehicle damage to Birkdale slacks 27 and 28 in 2014 (Fig. 8) was followed by an increase in *B. compressus*. The loss of the Birkdale slack 26 population and declines at slacks 49, 50 and 31 seem to be partly associated with reduced footfall and the overgrowth of informal footpaths by coarse vegetation dominated by tall *S. repens*. K. Walker (personal communication, 2008) reported that the densest populations of *B. compressus* he found in the Yorkshire Dales National Park, including thousands of plants at Gordale Scar campsite, were hard-grazed or kept open by trampling. It was also apparent that four sites in the Birkdale frontals (slacks 30, 31, 50 and 51/52) were being colonised by larger shrub species: *Hippophae rhamnoides* (Sea Buckthorn) and *Salix cinerea* (Grey Willow) (Fig. 10). This may have contributed to declines of *B. compressus* at slacks 31 and 50. Smith (2009a) also drew attention to the growth of larger willow taxa as a potential threat to *B. compressus*.

Annual late-summer mowing of sites at Altcar Rifle Range, Ainsdale slack 49 and Royal Birkdale was highlighted by Smith (2009a) as a way of maintaining lower sward heights. Mowing has continued at Altcar "I" range and Royal Birkdale but seemingly did not prevent a decline of *B. compressus* at the golf course 5<sup>th</sup> fairway. This grassland is rarely inundated in winter and may now be too dry for the plant to thrive.



The Cabin Hill NNR sites and Birkdale slack 13 are winter-grazed by livestock but a large rabbit population at Cabin Hill that helped to maintain shorter swards throughout the year has declined to near extinction, probably due to disease. Formerly supporting the largest duneland population of *B. compressus*, the number of plants at Cabin Hill's site 1 has fallen by about 90%. This site was mowed on four occasions in the 1990s but less often since and most recently in 2011/12 and 2017/18. Birkdale frontal slack 49, which has lost 92% of its colony area, was mowed annually, with removal of arisings, from 1996 to about 2010 but not subsequently. Slack 49 had a moderate rabbit population in 2008 (Smith, 2009a) but rabbit activity was noted only at Devil's Hole during the 2018 survey. These grazers are known to have a major influence on sand-dune vegetation, including seed dispersal (Dellafiore *et al.*, 2010; Potter & Hosie, 2001) but tend to be excluded once coarse vegetation becomes established (Drees & Olf, 2001).



**Figure 9. *B. compressus* on an informal footpath through *Salix repens*-dominated vegetation**





**Figure 10. Scrub invasion of *B. compressus* site at Birkdale slack 33**

Relatively high values for soil pH measured in this study are similar to those published by Millington *et al.* (2010) for Sefton Coast dune-slacks, reflecting the presence of calcium carbonate derived from marine mollusc shells. However, these authors included a number of older and more acidic slacks in their samples. Their mean pH value of 6.7 is therefore lower than the 7.0 found in the younger slacks supporting *B. compressus*. An Ellenberg reaction value of 8 (Hill *et al.*, 2004) confirms the association of this plant with base-rich soils, as reported more widely (Stroh & Walker, 2015; Walker *et al.*, 2017).

*Blysmus compressus* habitats were found to support a diverse plant community, 80 associated vascular taxa being recorded in 21 quadrats, compared with 90 in 51 quadrats during the 2008 survey. Of the most frequent associates, all except *Plantago lanceolata* were also ubiquitous in the 2008 quadrats (Smith, 2009a). A high species-richness is characteristic of many younger dune-slacks on the Sefton Coast (Smith, 2006). The slacks are also renowned for their rare plants, nine associated taxa in 2018 (11%) being regionally or nationally notable, the comparable figure in 2008 being 12 (13%). Remarkably, only two taxa (2.5%) found were non-native, in contrast to the Sefton sand-dune flora as a whole, which has about 37% alien vascular plants (Smith, 2015).

The allocation of most 2018 quadrats to SD14, SD15, SD16 or SD17 accords with the earlier survey which found that 37% of samples equated to SD16, 27% to SD15 and 18% to SD17 (Smith, 2009a). That study also recorded a small number of samples

with a best fit to MG11: *Festuca rubra*-*Agrostis stolonifera*-*Potentilla anserina* grassland or MG8: *Cynosurus cristatus*-*Caltha palustris* grassland (Rodwell, 1991-2000). However, most of the matches were “poor” or “very poor”. As previously noted, *B. compressus* is not given as a component of NVC sand-dune slack communities by Rodwell (1991-2000). Walker *et al.* (2017) report that most populations of *B. compressus* recorded during the *Threatened Plants Project* were in fen meadows and rush pastures, especially M22: *Juncus subnodulosus*-*Cirsium palustre* fen-meadow, M24: *Molinia caerulea*-*Cirsium dissectum* fen meadow, M26: *Molinia caerulea*-*Crepis paludosa* mire and MG8: *Cynosurus cristatus*-*Caltha palustris* grassland. Fen meadows and rush pastures are not typically associated with calcareous sand-dunes (Rodwell, 1991-2000). The 2003/04 NVC survey of the Sefton Coast mapped only 0.03 ha of M22, consisting of dense patches of *Juncus subnodulosus* (Blunt-flowered Rush) (Gateley & Michell, 2004). The present study noted a few stems of *B. compressus* on the edge of one of these patches at the Devil’s Hole but this association was not found during a coastwide survey of *J. subnodulosus* in 2013 (Smith, 2014). *B. compressus* seems unlikely to be able to compete with dense stands of *J. subnodulosus* (Walker *et al.*, 2017). TABLEFIT analysis determined one 2018 sample (Birkdale slack 27) as M22 but statistical matches were “very poor” for both percentage cover and species only. Hill (2015) recommends that if goodness-of-fit is “very poor” the vegetation should probably not be assigned to any NVC type. The same should perhaps apply to the two OV communities ascribed by TABLEFIT to Birkdale slack 13. Percentage cover gave “very poor” fits while, for species only, the matches were “poor” to “very poor”.

Poor statistical fits to NVC communities have been found in several previous studies of Sefton Coast vegetation (Smith, 2017b). This may be due to the complex environmental gradients that operate in dune systems, to the difficulty in selecting “typical” stands in the mosaic of dune vegetation and the fact that the data used to derive dune NVC communities were based on a limited number of quadrats and may not be particularly representative (Natural England, 2014).

## Conservation

Colonies of *B. compressus* on the Sefton Coast are mostly found in younger dune-slacks, in which succession is likely to reduce habitat suitability over time. Due to over-stabilisation, there is a low rate of slack formation on the Sefton Coast (Smith, 2009b), with limited potential for suitable new habitat to form without human intervention. Since the mid-1980s, a 66 ha mosaic of saltmarsh, embryo dunes and slacks, known as Birkdale Green Beach, has developed on the shore between Birkdale and Ainsdale (Smith, 2007). Smith (2009a) suggested that this might provide suitable habitat for *B. compressus*. However, despite careful searches, only the related *B. rufus* (Saltmarsh Flat-sedge) has been found there.

As more than 60% of the *B. compressus* colonies known in 2008 have declined over the last decade, active management is likely to be needed to prevent further losses. Walker *et al.* (2017) recommend maintaining an open, short sward, a dynamic hydrological regime and reducing eutrophication. The current study suggests that these approaches could help to conserve *B. compressus* in the Sefton dunes and would have

wider benefits, as the slack habitat supporting *B. compressus* is rich in other biota (Smith, 2009b).

Shorter swards in slacks can be achieved by livestock grazing and mowing (Houston, 2008), while the present study shows that light to moderate recreational trampling or low levels of vehicle use can have the same effect. However, only four of the 22 sites recorded in 2018 are within Sefton duneland units grazed by livestock. Rabbits have greatly declined in recent years and resources for mowing slacks have been much reduced since about 2010. Trampling tends to be concentrated near to access points and its intensity is difficult to manage, over-use being deleterious (Walker *et al.*, 2017). Colonies threatened by scrub invasion, especially of *Hippophae rhamnoides*, *Salix cinerea* and *S. repens* require targeted scrub control. In recent years, this has relied increasingly on volunteers using hand-tools, rather than the machinery needed to tackle older and larger scrub patches.

Turf-stripping to return slacks to an earlier successional stage has been used on the Sefton Coast to create over 50 small breeding pools (scrapes) for Natterjack Toads (*Epidalea calamita*) (Smith, 2009b). This has benefited some early successional stage slack plants, such as *Carex oederi* (Small-fruited Yellow-sedge) (Smith, 2017b). Declerck (2008) reports the appearance of *B. compressus* after large-scale restoration of dune slacks in Belgium, suggesting colonisation from a long-lived seed-bank. However, the plant was found in only four Sefton scrapes and not as a pioneer. Turf-stripping, mowing and grazing may help to counter eutrophication, though Plassmann *et al.* (2009) showed that, while it helped to keep competitive grasses in check and maintain species-rich swards, duneland grazing did not mitigate all the negative effects of N-deposition.

Detailed hydrological studies provide no evidence of a consistent decline in the Sefton sand-dune water-table over the last 46 years (Clarke & Sanitwong Na Ayutthaya, 2010). However, Natural England (2014) found a 36% and 44% reduction in wetland area at Ainsdale and Birkdale respectively between 1989 and 2012 due to slack habitats becoming drier. Climate change may cause average dune water-levels to fall by as much as 1.5 m by the end of the century (Clarke & Sanitwong Na Ayutthaya, 2010), giving rise to concerns for the long-term future of slack species, including *B. compressus*.

It is hoped that two coast-wide projects will augment funding for dune management and contribute to conservation of *B. compressus* and other threatened Sefton dune biota. Part of the *Back from the Brink* project supported by Heritage Lottery (HLF) and other partners, *Gems in the Dunes* targets six Section 41 species for recovery management in the dunes. *B. compressus* is one of the secondary targets for the project which runs from 2017 to 2020. Relevant management includes scrub control, small-scale turf-stripping and scrape creation, as well as public engagement to encourage survey work, monitoring and volunteer recruitment. *Dynamic Dunescapes* is a joint HLF and EU Life project covering seven coastal dune systems in England and Wales, including the Sefton Coast. The delivery phase, from 2019 to 2023, proposes capital works, such as re-mobilisation, turf-stripping, mowing and scrub control. There is also an emphasis on public involvement and citizen science. However, both these

initiatives are time-limited. A longer-term vision for duneland management is provided by the Sefton Coast Plan (<https://indd.adobe.com/view/88432262-8368-42b2-8d91-97ef25ddec4c>) and a Nature Conservation Strategy, currently being developed by the Sefton Coast Landscape Partnership.

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