Field Gentian in Pembrokeshire

Gentianella campestris (L.) Boerner in Pembrokeshire.

Results and analysis of 2016 fieldwork

Project funded by Biodiversity Solutions, The Oakdale Trust and The Species Recovery Trust.

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Summary

Gentianella anglica (field gentian) is one of the most rapidly declining species in the British flora, and it is also becoming much rarer in the rest of Europe. While it is still widespread in Scotland, it is nearing extinction over much of lowland England and Wales.

A project designed to determine reasons for this decline and to propose solutions for its reversal was started by the Species Recovery Trust in 2015.

One of the major strongholds for G. campestris in England and Wales is on the Pembrokeshire coast within the Castlemartin Ranges SSSI and the Stackpole SSSI and NNR. A full survey of populations was conducted here in 2004. The purpose of the work described here was to carry out an up-to-date census of these populations, to collect ecological information from the site and to establish areas within which populations could be monitored over three years in order to investigate population fluctuations and trends.

This work was carried out in late August and early September 2016. Nearly all populations recorded in 2004 were surveyed with the addition of two further sub-populations at the eastern and western extremities of the site.

Numbers of plants and numbers of populations were considerably fewer than in 2004. In 2004 160000 plants were estimated from 928 100m^2 squares, while in 2016, only 3770 plants were estimated from 63 100m^2.

Plants were found in two NVC communities: H7b coastal heathland and MC9b maritime grassland. These are both species-rich vegetation types found in sub-maritime conditions, but sheltered from the full force of salt-laden spray. These vegetation types form a mosaic over much of the upper cliff slopes and cliff-top plateaux. Gentianella campestris favours vegetation that is significantly shorter than adjacent areas without G. campestris.

It is thought likely that the low numbers of G. campestris recorded in 2016 are part of natural fluctuations in numbers of this short-lived species, and this will be further investigated in 2017 and 2018. This species, in common with other Gentianella species may be very susceptible to drought in the earlier stages of its life.

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Introduction

Field Gentian is one of the most rapidly declining species in the British flora. The New Atlas of the British Flora (Pearman et al, 2004) gives this species a change index of -1.28, although its continued wide distribution in Scotland has disguised its catastrophic decline in England and Wales and its disappearance from many sites within its Scottish range. It is now known from only ten sites in southern England (three of which are on The Lizard in Cornwall, and four in Hampshire's New Forest), and has been recorded recently from only 12 10km squares in Wales. It is listed in the Vascular Plant Red Data List for Great Britain (Cheffings and Farrell, 2005) as vulnerable. It is also thought to have undergone a rapid decline throughout the whole of its European range. This species was included by the BSBI in its programme of surveys of Red Data List plants (Threatened Plants Project).

The taxonomy of Gentianella in Britain has been the subject of much speculation and research in recent years (Winfield & Parker, 2002), and the status of some species is still unresolved. Gentianella campestris has however been shown to be genetically distinct from other members of the genus.

Little is known about the ecology of Gentianella campestris in Britain, although some work has been carried out in mainland Europe (eg Lennartson, 1997; Lennartson & Oostermeijer, 2001; Eriksson & Kiviniemi, 1999). In southern Britain it is mainly a species of dry, well-grazed, species-rich acidic grasslands (sometimes on superficial deposits over calcareous substrata) and heathland, habitats that are marginal to modern, intensive agricultural systems. In common with most other members of the genus it is thought to be a short-lived monocarpic perennial, requiring open conditions for seedling establishment, but its germination periodicity and longevity of seed in the soil are unknown for British populations. In Sweden it is known to be a strict biennial, germinating in the spring and flowering in its second summer (Lennartson, 1997), with distinct forms flowering in early July and late august. Early-flowering forms are not known to occur in Britain, and other work suggests that these separate forms are an illusion created by the behaviour of plants under different management regimes (Zopfi, 1990).

It is poorly competitive and frequently confined to shorter vegetation within its sites. Recent unpublished work on other Gentianella species suggests that there are complex relationships with mycorrhizal fungi, and this may make the species particularly susceptible to environmental changes.

While there is some evidence that disturbance and grazing is important for maintaining grassland habitat in favourable condition for this species (Smith & Lockwood, 2011; Price, 2016; Wilson, 2015), this is largely by inference, and there is no direct observational data from the UK to support management practices. A trial in Sweden however (Lennartson, 2000) has demonstrated that "medium" levels of grazing are optimal for the maintenance of populations, although he does not specify what that intensity should be or what the desired sward condition should be. There is also much data regarding other Gentianella spp (eg Wilson, 1998) that shows that populations can fluctuate greatly from year to year. It is suspected that this may also be the case for at least some G. campestris populations but the extent of these fluctuations is not known, and such information is essential in understanding the response of populations to changes in management and in formulating management guidelines for this species.

The overall aim of The Species Recovery Trust's Field Gentian project is to halt the decline of the species in Britain and to investigate possible means for the restoration of populations at sites where it may be extinct. It is hoped that all extant (where Gentianella campestris has been seen since 2000) and recently extinct lowland populations in England and Wales will have been surveyed by 2017.

This project involves research into aspects of the ecology of G. campestris that relate to possible causes of decline, determining management practices that result in a stable or increasing population of G. campestris, establishing contact with owners and managers of G. campestris sites and communicating information on optimal management for G. campestris. Two major concentrations of sites for G. campestris are in The Yorkshire Dales and the Pembrokeshire coast and these are areas within which survey was carried out in 2016.

The principal aims of survey work in Pembrokeshire in 2016 were:

1. Census of populations in Pembrokeshire. This builds on the work already carried out by BSBI as part of their Threatened Plants Project and the considerable amount of survey work already carried out by local botanists, in order to determine trends and patterns of variation between years.

2. Collection of ecological data from all sites. This includes measures of vegetation composition and structure. While a full NVC survey of the whole area from Stackpole to Castlemartin is not feasible, NVC communities within which G. campestris is found will be determined, and standard vegetation quadrats will be collected from each sub-population. There are existing NVC surveys of Stackpole Head and Castlemartin Ranges which will provide valuable background information.

3. Establishment of monitoring plots in which plants will be monitored annually in late summer for a period of three years. This will enable collection of several parameters of population dynamics including presence of seedlings, germination period, survival of seedlings, fluctuations of numbers of plants between years and associations between microhabitat (bare soil, vegetation density) and plant performance.

The survey area

The Castlemartin Peninsula and Stackpole Head are situated in south-west Pembrokeshire, to the south of Pembroke (Figs 1&2)

The underlying geology is carboniferous limestone. Although the most recent glaciation did not reach this far south, previous glaciations affected the area, depositing less-calcareous drift material over the surface of the limestone and creating a relatively level plateau. There are extensive outcrops of limestone rock along the coast, with impressive cliffs and karst features including stacks, blow-holes and small areas of limestone pavement. There is an extensive area of deposition of calcareous Aeolian sand at Stackpole Warren.

The Castlemartin Coast and St Govan's Head are included in the Castlemartin Range SSSI, The Limestone Coasts of Southern Wales SAC and the Castlemartin Coast SPA. Saddle Point is within the Stackpole National Nature Reserve and SSSI and the Limestone Coasts of Southern Wales SAC and the Castlemartin Coast SPA .

Much of the plateaux of Castlemartin Range and Stackpole Head were under arable cultivation until the 1930s. This can be seen from the 1935 Land Utilisation Survey of Britain sheet 99 (http://bit.ly/2jcbJd9), and the differences between the grassland that has developed on former arable land and the much older unenclosed clifftop swards are clear in the field and from examination of aerial photographs.

Castlemartin Ranges have been used as a military training area since 1938. This includes tank training and live firing. St Govan's Head is also within the Castlemartin Ranges, and public access is restricted. While St Govan's Head appears not to have been under recent arable cultivation, past military use has been heavy, and much disturbance is associated with this.

NVC surveys of the Castlemartin Ranges were carried out in 1998 by CEH, and an NVC survey of Stackpole NNR was carried out in 2012 by NRW.

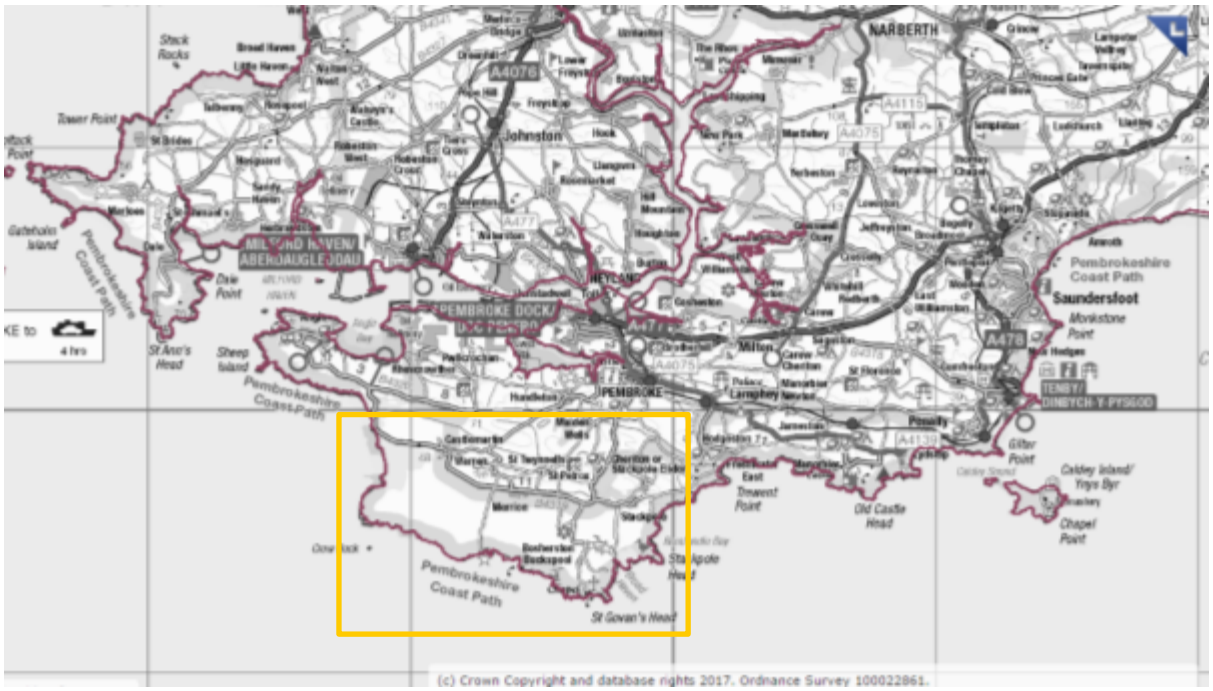


Fig 1. Location of the Castlemartin Peninsula and Stackpole Head.

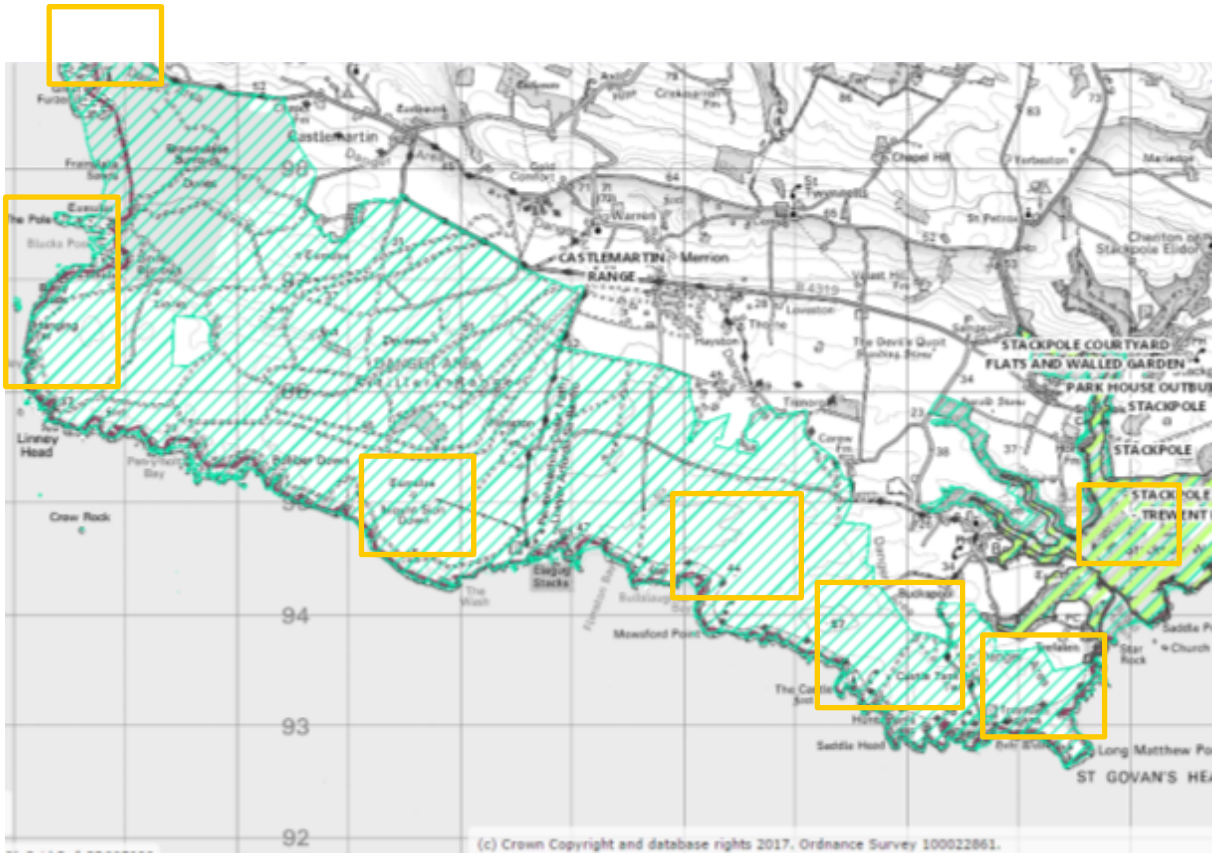


Fig 2. Castlemartin Ranges SSSI and Stackpole SSSI/NNR, including the areas where Gentianella campestris has been recorded recently.

Methods

The survey maps created by Stephen and Anne Coker were used as base maps for the field survey. All of the areas (with a few exceptions) in which Gentianella campestris was recorded in 2004 were visited between 22nd and 23rd August (restricted areas of Castlemartin Ranges) and 7th and 8th September (St Govan's Head and Saddle Point).

Localities where G. campestris was recorded in 2004 were searched. Where plants were found, a 2mX2m quadrat representative of the associated vegetation was recorded including all species of vascular plant, bryophyte and lichen with abundances on the Domin scale (Table 1). In addition, one or more 10cmX10cm quadrats were recorded in order to determine whether Gentianella campestris showed any preference for elements of small-scale variation within the vegetation. Sample measurements of vegetation height and estimates of the cover of bare soil and rock were also made. Quadrat locations and boundaries of populations were recorded using the GPS. Photographs were taken to illustrate habitat conditions at all sites where G. Campestris was recorded.

Numbers of Gentianella campestris plants were counted at all sites. At St Govan's Head, a comparison was made between the numbers of plants detected in a superficial search with the numbers recorded on a careful search within the quadrats.

Additional sites reported by Bob Haycock, the former NRW site manager for the Stackpole Warren NNR, at Furzenip and Saddle Point were also surveyed.

Table 1. The Domin cover/abundance scale.

91–100%	10
76–90%	9
51–75%	8
34–50%	7
26–33%	6
11–25%	5
4–10%	4
<4% Many	3
<4% Several	2
<4% Few	1

Results

NVC Communities

Results from the two quadrat scales were slightly different. Considering the conventional NVC 2mX2m quadrats together, Match gave a good level of fit with H7b Calluna vulgaris-Scilla verna heathland, Viola riviniana sub-community (Table 1). This is a characteristic community of upper cliff slopes and plateaux on deeper soils over base-rich substrata in high-rainfall areas of western Britain. It is typically species-rich, with a variable cover of Calluna vulgaris and less frequent Erica cinerea forming sprawling clumps in a matrix of grasses and herbs that gives an impression of a fine-grained mosaic of heath and maritime grassland. Here, abundant species associated with the dwarf shrubs included the graminoids Festuca rubra, Carex flacca, Agrostis capillaris, Danthonia decumbens, Festuca ovina, Koeleria macrantha and Carex caryophyllea, with other species Lotus corniculatus, Plantago lanceolata, Euphrasia nemorosa, Plantago maritima, Succisa pratensis, Potentilla erecta, Trifolium repens, Hypochaeris radicata, Thymus praecox, Sanguisorba minor and Leontodon saxatilis. The dried remains of the spring-flowering Scilla verna were frequent, and it is likely that this species is abundant here.

The results from the 0.1mX0.1m quadrats were more equivocal. If all the quadrats were analysed together, H7b was still the best fitting community, but MC9c Festuca rubra-Holcus lanatus maritime grassland, Achillea millefolium sub-community was the second-best fit. This is the most species-rich sub-community of MC9, and is a characteristic grassland of cliff slopes that are somewhat sheltered from the full impact of sea-spray, usually on relatively deep soils over base-rich substrata, being replaced by MC8 closer to the sea, and by MC11c where soils over the limestone are thinner. Further analyses of these quadrats divided into groups characterised by the presence or absence of Calluna vulgaris show that this heath was a mosaic of vegetation dominated by Calluna vulgaris, with species-rich MC9c grassland. The MC9c element here is a close-grazed grassland dominated by Festuca rubra, Carex flacca, Plantago lanceolata, Plantago maritima, Agrostis capillaris, Lotus corniculatus and Trifolium repens, with Euphrasia nemorosa, Potentilla erecta, Koeleria macrantha and more locally Succisa pratensis, Festuca ovina, Thymus praecox, Carex caryophyllacea, Sanguisorba minor and Prunella vulgaris. The H7b element is broadly as described for the 2X2m quadrats, but with a lower frequency of Agrostis capillaris, Lotus corniculatus, Koeleria macrantha, Festuca ovina, Carex caryophyllea, Hypochaeris radicata and Sanguisorba minor, all of which are more frequent in the MC9c element of the mosaic.

A DCA (Detrended Correspondence Analysis) (Ter Braak & Smilauer, 2004) of the two sets of quadrats supported these conclusions (Fig 3). This analysis takes the floristic data and allocates scores which relate vegetation samples to each other in terms of their similarities. These scores can then be plotted on axes which will show which samples are most closely related and which are less so. Similar scores are also given to the species.

There is a trend within the 2mX2m quadrats towards the separation of a group of quadrats with high cover of Calluna vulgaris and Erica cinerea and a group with a low frequency of a suite of species including Plantago maritima, Succisa pratensis, Danthonia decumbens, Potentilla erecta and Festuca ovina.

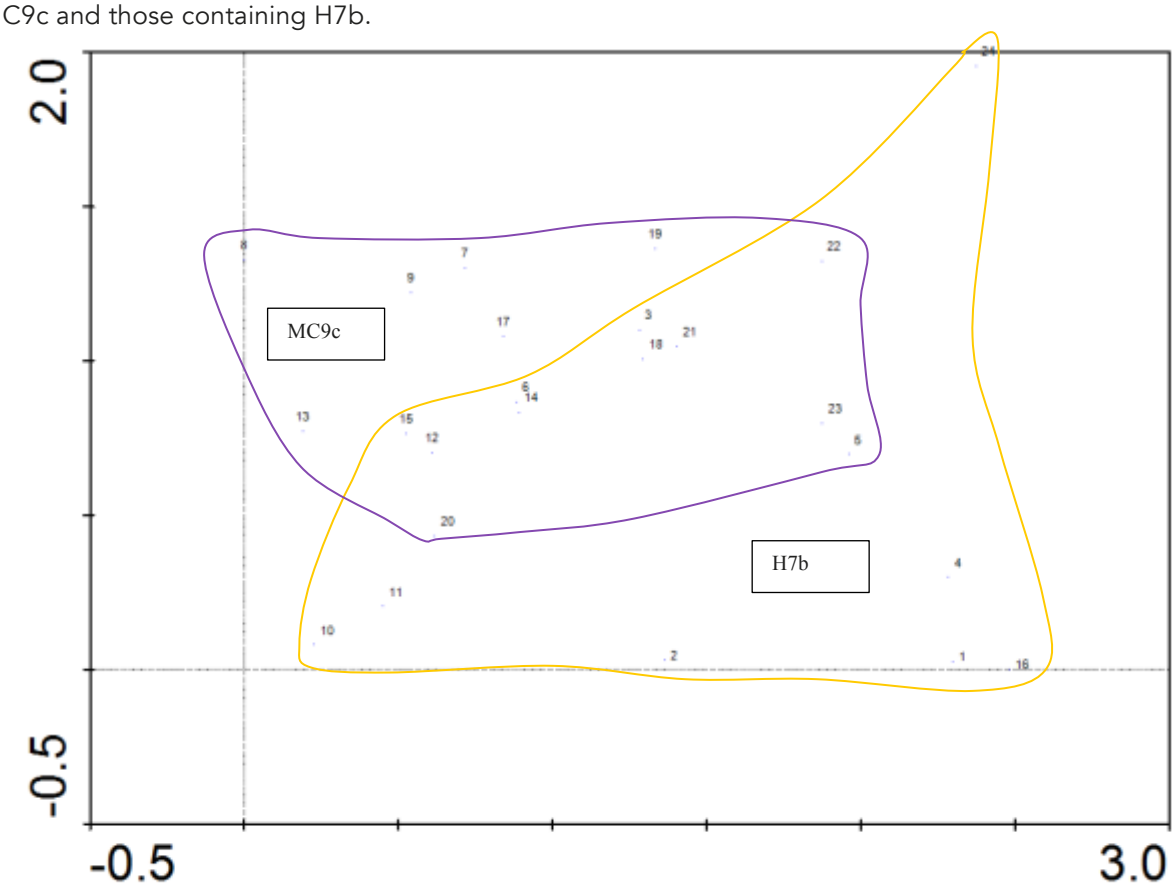
The 0.1mX0.1m quadrats are separated into groups with and without Calluna vulgaris which correspond to MC9c maritime grassland and H7b heathland respectively. There is however considerable overlap between these quadrat groups.

Table 1. Match analyses of quadrat data. Coefficients (0-100) for the top five matched sub-communities.

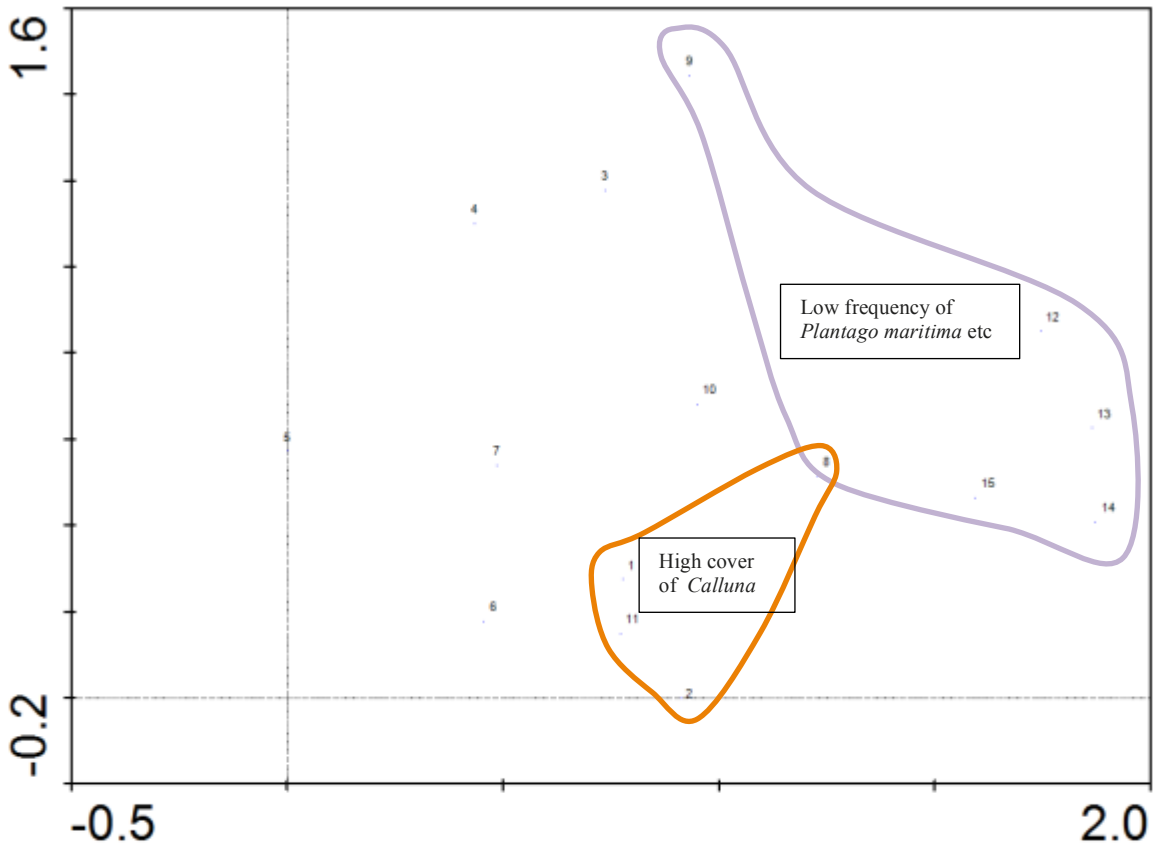
2mx2m quadrats				
H7b	H7	H7e	H7d	H7c
66.4	63.6	58.2	57.0	56.5
0.1mx0.1m quadrats				
H7	H7b	MC9c	H7d	H7e
59.7	58.4	55.8	54.9	53.4
0.1mx0.1m quadrats, maritime grassland				
MC9c	H7	MC9a	H7b	MC9
57.1	56.6	55.3	53.6	52.7
0.1mx0.1m quadrats, Calluna vulgaris dominated				
H7b	H7	H7d	H7e	MC9c
64.1	63.0	57.4	55.1	54.9

Fig.3. DCA analysis scatter diagrams.

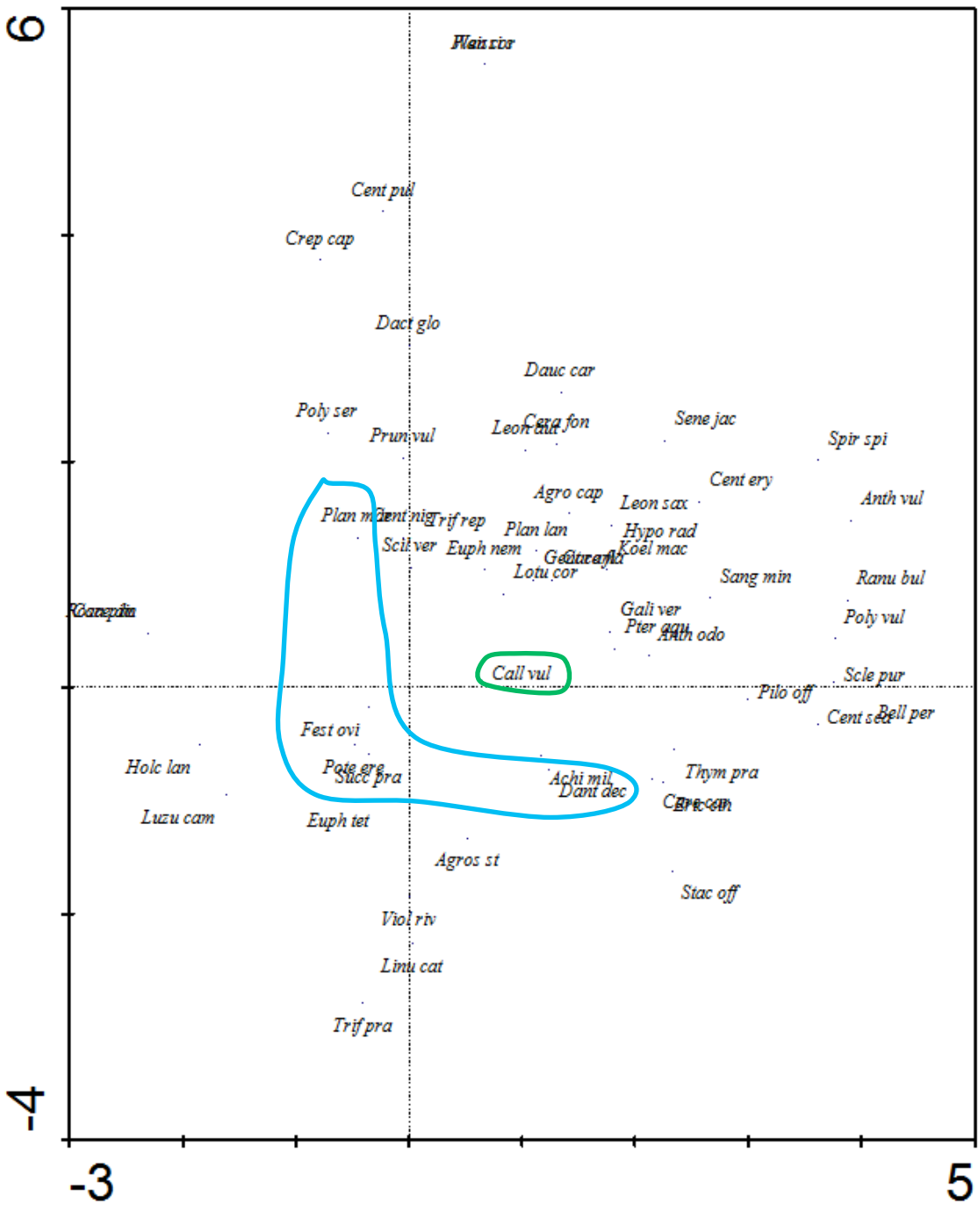
a. 0.1mX0.1m quadrats, showing the separation of quadrats containing vegetation related to MC9c and those containing H7b.



b. 2mX2m quadrats. Showing the separation of quadrats with a low frequency of Plantago maritima, Festuca ovina, Potentilla erecta, Succisa pratensis, Danthonia decumbens and Achillea millefolium and those with a high cover of Calluna vulgaris.



c. 2mX2m quadrats. Species diagram.



Populations of Gentianella campestris recorded in 2016

Locality	Grid reference	Number of plants
Furzenip	SR88806 98785	4
Linney Head	SR883856 96554 SR88380 96579 SR88384 96552	7
Flimston Down	SR91829442 SR91769446, 91779446	25
Mewsford Point West	SR94443 93911, SR94534 93897	190
Mewsford Point East	SR94711 93911	50
Newton Down	SR95610 93472	8
St Govan's Head (dropping zone)	SR97239308	70
St Govan's Head (end of trench)	SR97302 92910	5
St Govan's Head (seaward end)	SR97449264 SR97519263 SR97519288 SR97479290	287
Saddle Point	SR98217 94023	106
Total		742

Detailed counts were made in quadrats at St Govan's Head and Saddle Point to compare numbers of plants estimated on superficial examination and numbers actually present. Seventy four plants were estimated in six quadrats, but on careful examination there proved to be 377, many of which were very small. This suggests that the numbers actually present may be five times greater than those estimated initially. In fact there may have been as many as 3770 plants present in the surveyed localities in 2016.

Site descriptions

With the exception of Furzenip, all maps are the aerial photographs from the 2004 report. On these, the presence of Gentianella campestris in 2016 is indicated in yellow, other colours indicate its presence in 2004.

Furzenip

SR88806 98785 This site was not surveyed in 2004. Four plants of Gentianella campestris were present at the south-western end of a low bank surrounding a small pit to the south-west of a fenced radar station. The plants were 24m from the corner of the fence surrounding the radar station, in species-rich H7b heathland. There may be some aeolian deposition of calcareous sand here.

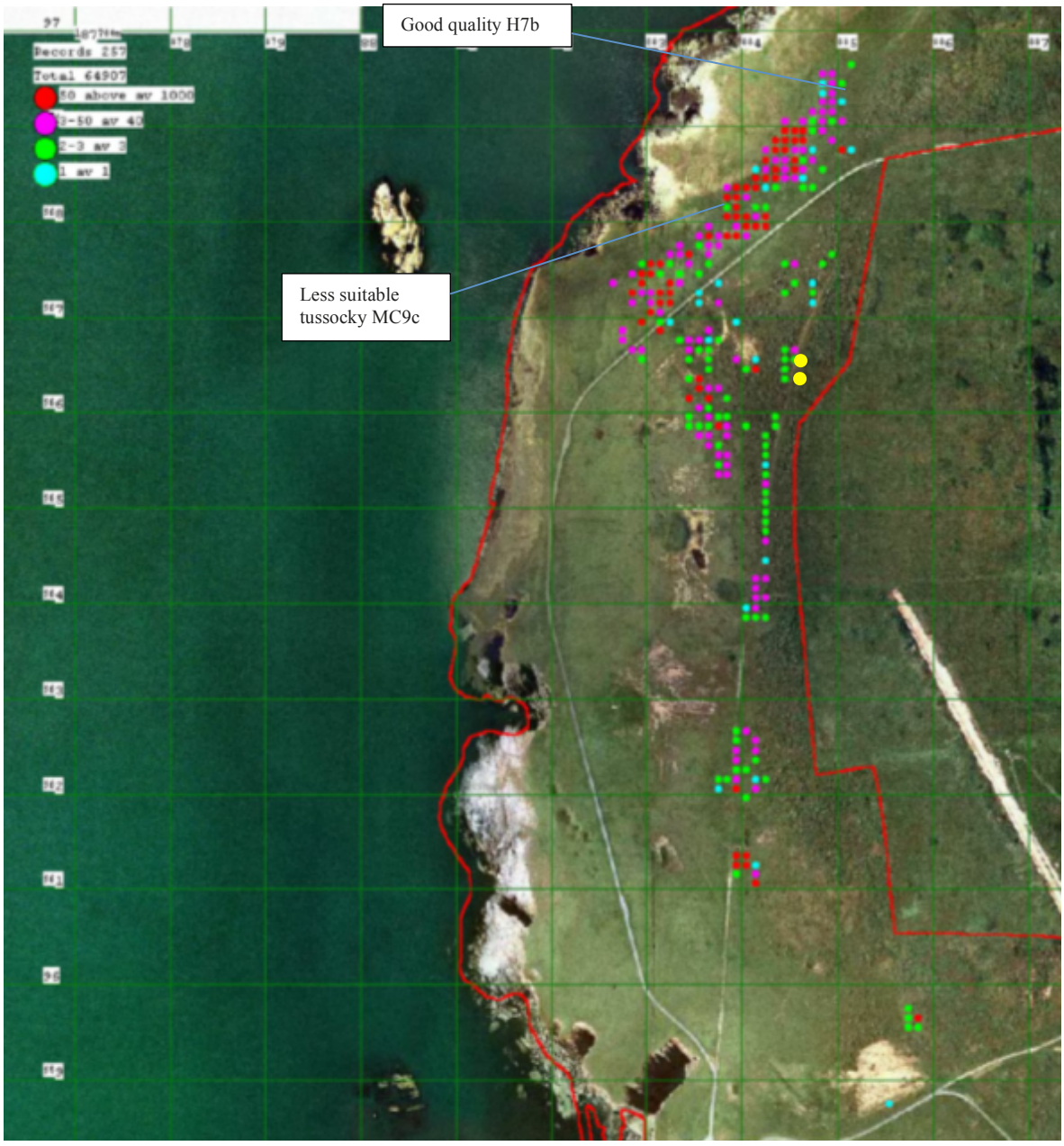
2mX2m quadrat data.

Grid reference	88806
	98785
Calluna vulgaris	7
Festuca rubra	5
Plantago lanceolata	5
Thymus praecox	5
Carex caryophyllea	5
Carex flacca	4
Agrostis capillaris	4
Festuca ovina	4
Erica cinerea	4
Lotus corniculatus	3
Euphrasia nemorosa	3
Trifolium repens	3
Pilosella officinarum	3
Galium verum	3
Plantago maritima	2
Koeleria macrantha	2
Hypochaeris radicata	2
Sanguisorba minor	2
Leontodon saxatilis	2
Dactylis glomerata	2
Euphrasia tetraquetra	2
Centaurium erythraea	2
Polygala serpyllifolia	2
Gentianella campestris	1
Viola riviniana	1
Achillea millefolium	1
Bare soil	4

Linney Head

Linney Head and Linney Down have substantial areas of high quality H7b heath and M9c maritime grassland. In 2007 there were large populations of Gentianella campestris probably on tracks and paths across the heathland of Linney Down and on clifftop grassland to the north of Linney Down. By 2016 some of the heathland had been burnt, although much suitable cattle-grazed heath and grassland remained.

Only seven plants could be found in 2016. Five plants were present on a rabbit track at SR883856 96554 and a single plant at SR88380 96579. There was a single plant on open H7b at SR88384 96552.



2mx2m quadrat data.

Grid reference	88385
	96554
Festuca rubra	6
Rosa pimpinellifolia	6
Plantago lanceolata	5
Succisa pratensis	5
Calluna vulgaris	4
Lotus corniculatus	4
Plantago maritima	4
Potentilla erecta	4
Festuca ovina	4
Holcus lanatus	4
Carex flacca	3
Agrostis capillaris	3
Euphrasia nemorosa	3
Trifolium repens	3
Polygala serpyllifolia	3
Gentianella campestris	2
Koeleria macrantha	2
Hypochaeris radicata	2
Scilla verna	2
Erica cinerea	2
Dactylis glomerata	2
Euphrasia tetraquetra	2
Carex distans	2
Viola riviniana	1
Leontodon autumnalis	1
Luzula campestris	1
Bare soil	4

Flimston Down

SR91829442 Well-grazed, species-rich H7b. 17 Plants in a slightly lower area approximately 7.5m from the road edge, possibly an old path or just a rabbit track.

SR91769446, 91779446 Well-grazed, species-rich H7b. Eight plants of Gentianella campestris on two old tyre tracks through otherwise closed vegetation. Furthest plant approximately 17.5m from the track edge.

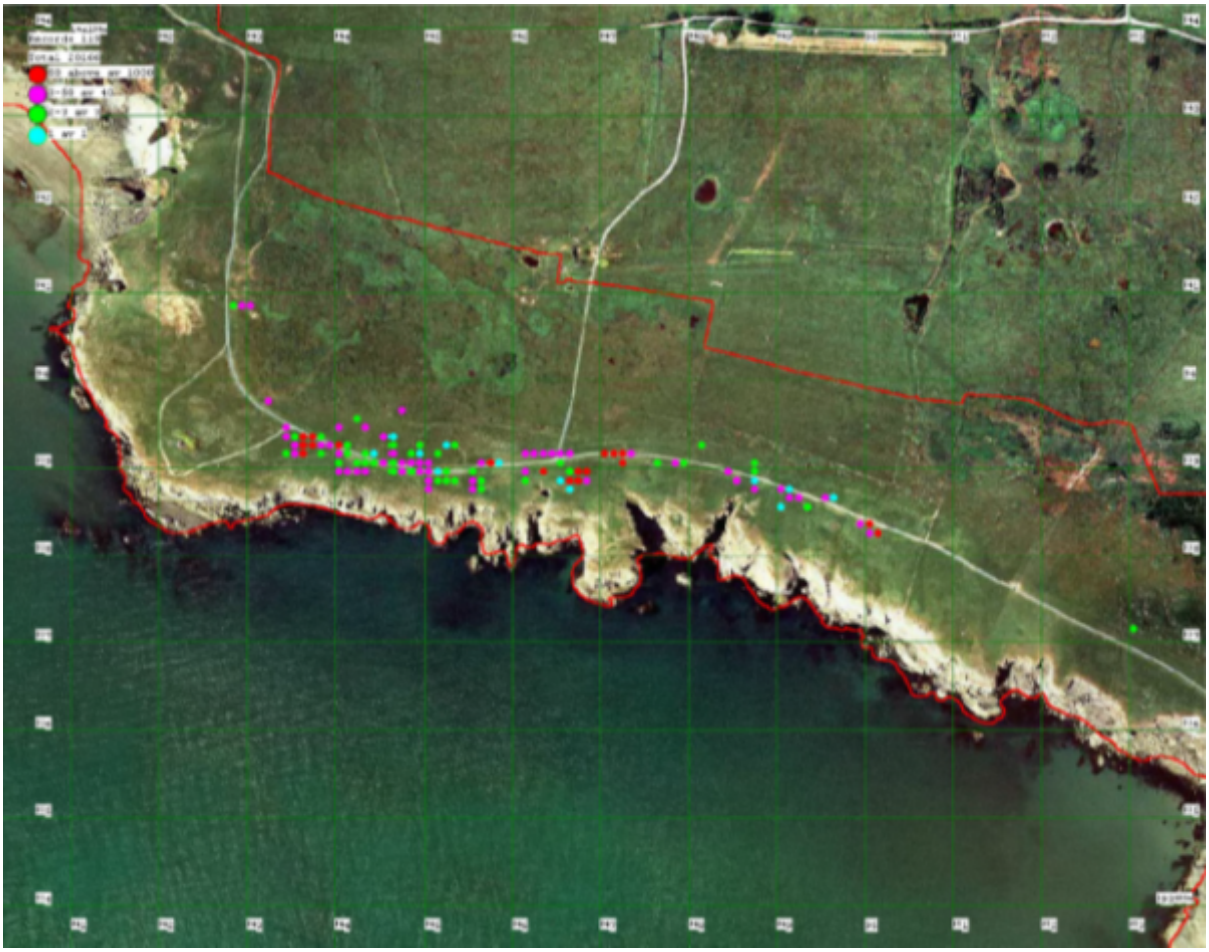
2mx2m Quadrats at Flimston Down

Grid reference	91824	91775
	94421	94463
Calluna vulgaris	7	7
Festuca rubra	5	6
Plantago lanceolata	5	5
Erica cinerea	5	5
Succisa pratensis	5	4
Lotus corniculatus	4	4
Festuca ovina	4	4
Trifolium repens	4	4
Carex flacca	4	3
Danthonia decumbens	3	5
Plantago maritima	3	4
Thymus praecox	3	4
Euphrasia nemorosa	3	3
Agrostis capillaris	3	
Koeleria macrantha	2	4
Viola riviniana	2	4
Potentilla erecta	2	3
Gentianella campestris	2	2
Trifolium pratense	1	3
Scilla verna	1	2
Hypochaeris radicata	1	
Centaurea nigra	1	
Achillea millefolium	1	
Stachys officinalis		4
Carex caryophyllea		3
Sanguisorba minor		2
Leontodon saxatilis		2
Euphrasia tetraquetra		2
Daucus carota		1
Pilosella officinarum		1
Bare soil	3	

Mewsford Point

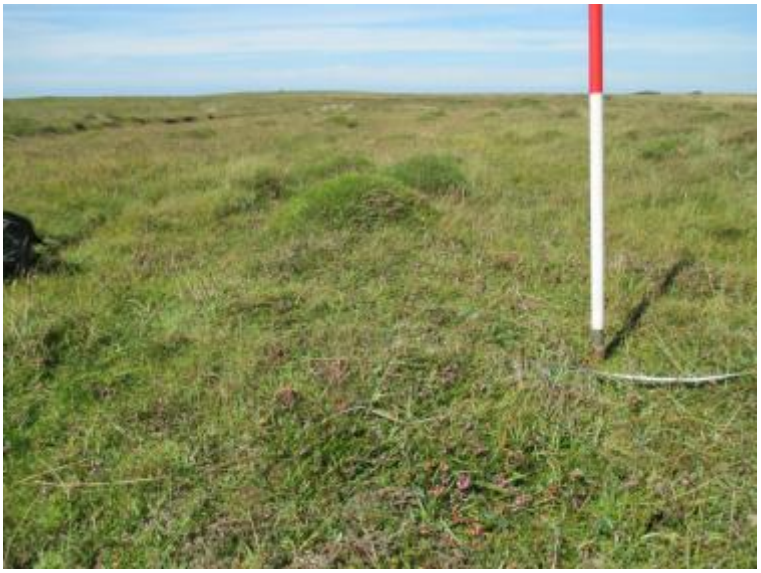
SR94443 93911 to SR94534 93897 Species-rich MC9c on lightly trampled trackways parallel and to the south of the main road. Calluna vulgaris present but at a low cover. Confined to a strip no more than 15m from the track, grading into limestone pavement to the south with much exposed rock. Approximately 190 plants.
SR94724 93913, 94718 93917, 94711 93911, 94715 93910, 94703 93917

Approximately 50 plants in species-rich MC9c approximately 4m to the south of the main track. While some of the plants were on a lightly trampled track, the majority were on grassland. Calluna vulgaris present but at a low cover.



2mx2m Quadrats at Mewsford Point

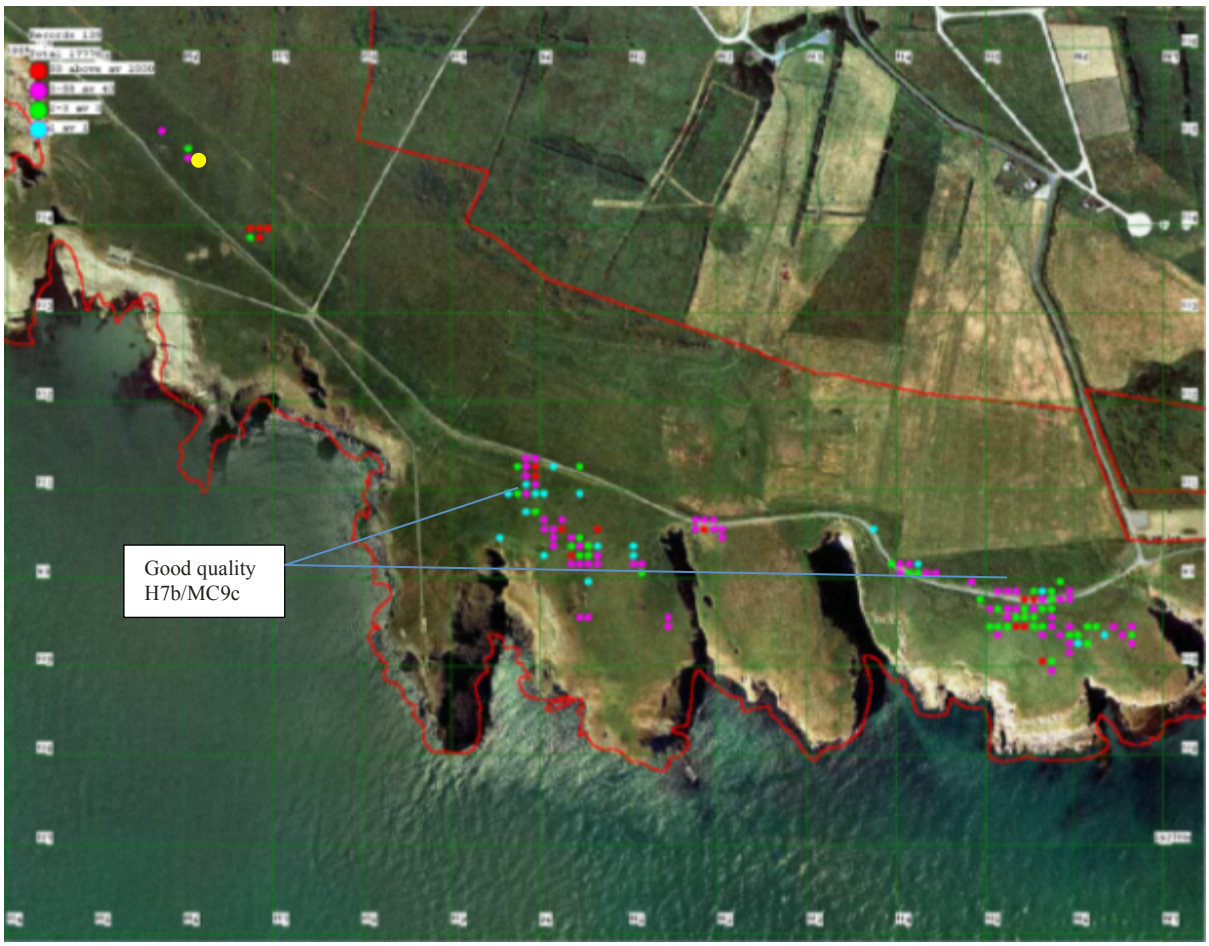
	Mewsford point	Mewsford Point	Mewsford Point
Grid reference	94440	94490	94715
	93912	93899	93913
Festuca rubra	6	4	6
Plantago lanceolata	5	5	
Carex flacca	5	4	5
Lotus corniculatus	5	4	4
Plantago maritima	4	7	6
Agrostis capillaris	4	4	4
Trifolium repens	4	4	4
Festuca ovina	4	4	3
Euphrasia nemorosa	4	3	3
Koeleria macrantha	4		2
Daucus carota	4		
Calluna vulgaris	3	4	4
Bare soil	3	4	
Gentianella campestris	3	2	3
Dactylis glomerata	2	4	
Succisa pratensis	2	3	5
Prunella vulgaris	2	3	
Potentilla erecta	2	1	5
Hypochaeris radicata	2	1	2
Leontodon saxatilis	2	1	2
Centaurea nigra	2		
Leontodon autumnalis	2		
Scilla verna	1	2	3
Senecio jacobaea	1		
Centaurium pulchellum	1		
Crepis capillaris		1	
Danthonia decumbens			3
Euphrasia tetraquetra			3



Newton Down

In 2004 a large, diffuse population of Gentianella campestris was recorded between the vedette post at St Govan's Chapel and Buckspool Down in three discrete areas at St Govan's Chapel, Huntsman's Leap and Buckspool Down. In 2016, plants could only be found at Buckspool Down. There are large areas of H7b and MC9c here that appear suitable for Gentianella campestris.

SR95610 93472 Vegetation closest to well-grazed, species-rich MC9c, but with a scattered cover of Calluna vulgaris. Eight plants recorded 20m to the north of the main track, north-north-east of the radar station and 16.5m from the "danger" sign, on the edge of a shallow crater.



2mx2m Quadrats at Mewsford Point

Grid reference	95610
	93472
Festuca rubra	5
Plantago lanceolata	5
Carex flacca	5
Lotus corniculatus	5
Plantago maritima	5
Succisa pratensis	5
Festuca ovina	5
Calluna vulgaris	4
Agrostis capillaris	4
Potentilla erecta	4
Trifolium pratense	4
Euphrasia nemorosa	3
Danthonia decumbens	3
Trifolium repens	3
Carex caryophyllea	3
Anthoxanthum odoratum	3
Gentianella campestris	2
Euphrasia tetraquetra	2
Holcus lanatus	2
Agrostis stolonifera	2
Centaurea nigra	1
Cerastium fontanum	1
Luzula campestris	1

St Govan's Head

St Govan's Head is a small peninsula at the south-eastern corner of Castlemartin Ranges. To the southwest, the plateau of the peninsula is bounded by a sheer cliff, while to the east, there is a less abrupt slope descending to a lower cliff. To the north is the steep-sided valley of a small sea inlet and beach at New Quay. The plateau has been extensively used for military training in the past, with several large blast shelters, trenches, soil scrapes and one area with concentric rings of stone which may have been a parachute dropping zone. There is much public access at some times of the year, and the south-western cliffs are popular with rock-climbers. Despite this, there are substantial areas of species-rich H7b maritime heath, MC9c maritime grassland and smaller areas of CG1a limestone grassland where soils are thin and limestone rock is exposed at the surface. To the north with declining maritime influence, and possibly a higher incidence of burning, the H7b is replaced by H8, Ulex europaeus scrub, Pteridium aquilnum and, particularly along tracks where there has been nutrient enrichment, MG1 grassland.

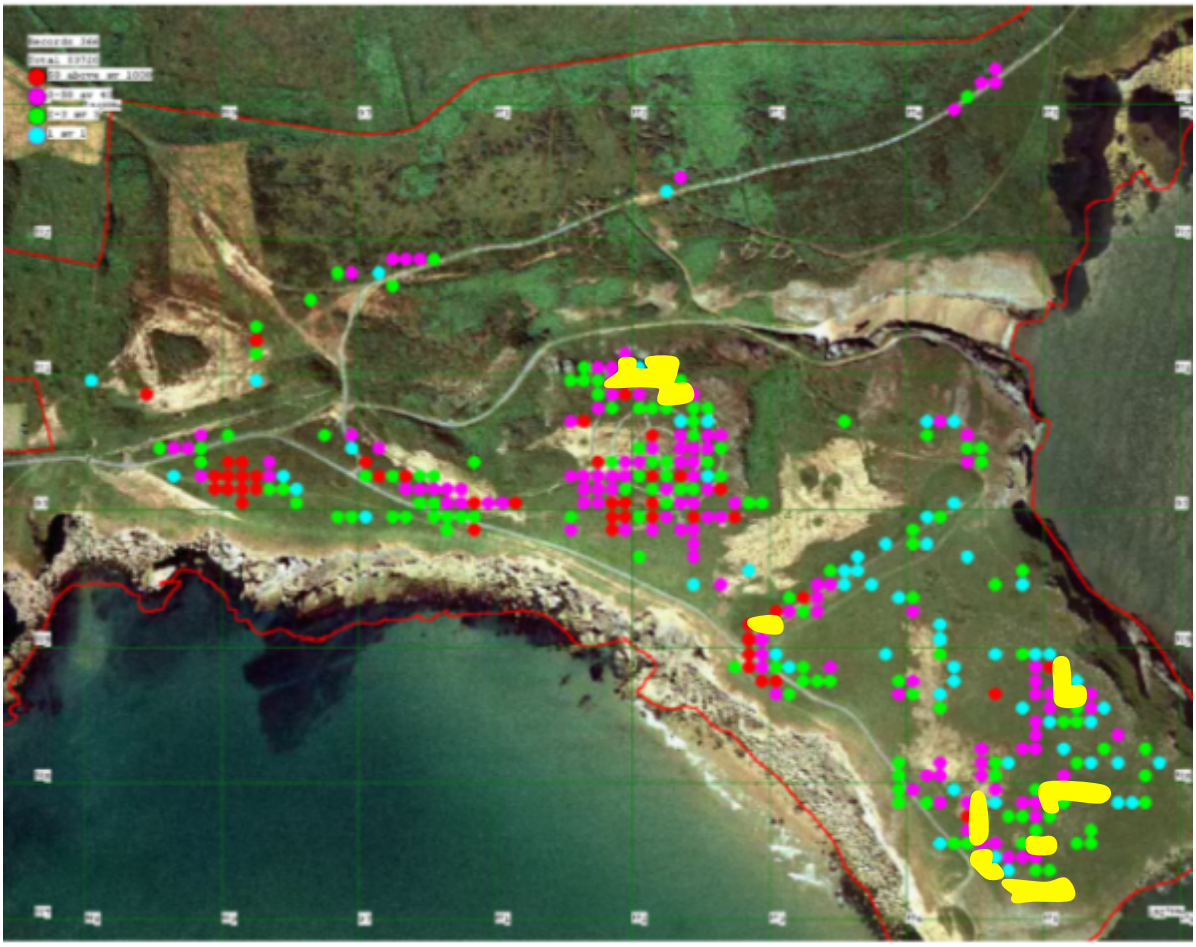
In 2004 Gentianella campestris was found over much of St Govan's Head where there were stands of H7b and MC9c. While avoiding the most heavily disturbed areas, it seemed particularly concentrated along the margins of tracks and paths, and was also present along the track to the north of St Govan's Head leading from the car park towards Broad Haven.

In 2016, Gentianella campestris was only found in three areas, although much high-quality H7b and MC9c grassland remained. The tracksides and associated grasslands and heath to the north of St Govan's Head appeared less suitable than in 2004, with the development of closed stands of tall Ulex europaeus, Ulex gallii and coarse grassland, although small patches of better-quality grassland were still present.

The main population was on the exposed plateau at the south-eastern end of the peninsula. This extended from SR97449264 to SR97519263 and northwards to SR97519288 and SR97479290, although this was very diffuse and patchy. The majority of plants were in species-rich, short, well-grazed H7b maritime heath, although at the most maritime southern end, this graded into MC9c. Plants were not present in the very drought-prone CG1 around areas of exposed limestone. A total of 287 plants were counted, although this was felt likely to be an underestimate. A careful count was made in the 2mX2m quadrats, and compared with the numbers counted in a superficial search. This suggested that actual numbers were up to seven times greater than those counted superficially, so that actual numbers would have been approximately 2000.

A small population was recorded at the south-western end of the trench that divides St Govan's Head into two at SR97302 92910. Four plants were present here in high-quality H7b heath, with a further plant approximately 10m to the north.

The third population was located to the north of the parachute dropping zone marked by circles of stone, from SR97189309 in the west to SR97229710 and SR97239308 in the east. Approximately 70 plants were estimated to be present in this area of species-rich H7b heathland. This heathland was closely grazed with most ericoid shrubs in the pioneer/pseudo-pioneer stage. Succisa pratensis was particularly abundant and Brachypodium pinnatum was present.



2mx2m quadrats

Grid reference	97504	97502	97522	97518	97517
	92734	92759	92798	92885	92886
Festuca rubra	6	7	5	7	6
Plantago lanceolata	5	6		5	5
Carex flacca	5	5	5	5	5
Plantago maritima	5	3	4		
Lotus corniculatus	4	5	4	3	5
Agrostis capillaris	4	5		4	4
Calluna vulgaris	4	4	5	4	4
Sanguisorba minor	4		4	5	3
Trifolium repens	4		3		
Dactylis glomerata	4				3
Koeleria macrantha	3	4	2	4	
Euphrasia nemorosa	3	3	3	1	3
Danthonia decumbens	2	3	3	2	4
Leontodon autumnalis	2	3	2		
Gentianella campestris	2	2	2	2	3

Centaurium erythraea	2	2		2	3
Scilla verna	2		2		3
Leontodon saxatilis	2			3	3
Polygala serpyllifolia	2				
Weissia sp	2				
Daucus carota	1			1	1
Cerastium fontanum	1				
Plantago coronopus	1				
Succisa pratensis		5	6	3	
Centaurea nigra		4			
Thymus praecox		3	4	3	5
Potentilla erecta		3	3		2
Hypochaeris radicata		3		3	2
Anthoxanthum odoratum		3			3
Viola riviniana		2	3		
Prunella vulgaris		2	2		1
Pteridium aquilinum		2			1
Galium verum		1			
Festuca ovina			5		2
Carex caryophyllea			3	3	
Stachys officinalis			3	3	5
Linum catharticum			2		
Erica cinerea				6	6
Pilosella officinarum				3	3
Scleropodium purum				2	3
Ranunculus bulbosus				2	
Polygala vulgaris					2
Bellis perennis				2	
Senecio jacobaea				1	
Centaurea scabiosa				1	1

St Govan's Head. South-eastern end of the head, view towards the south-west.

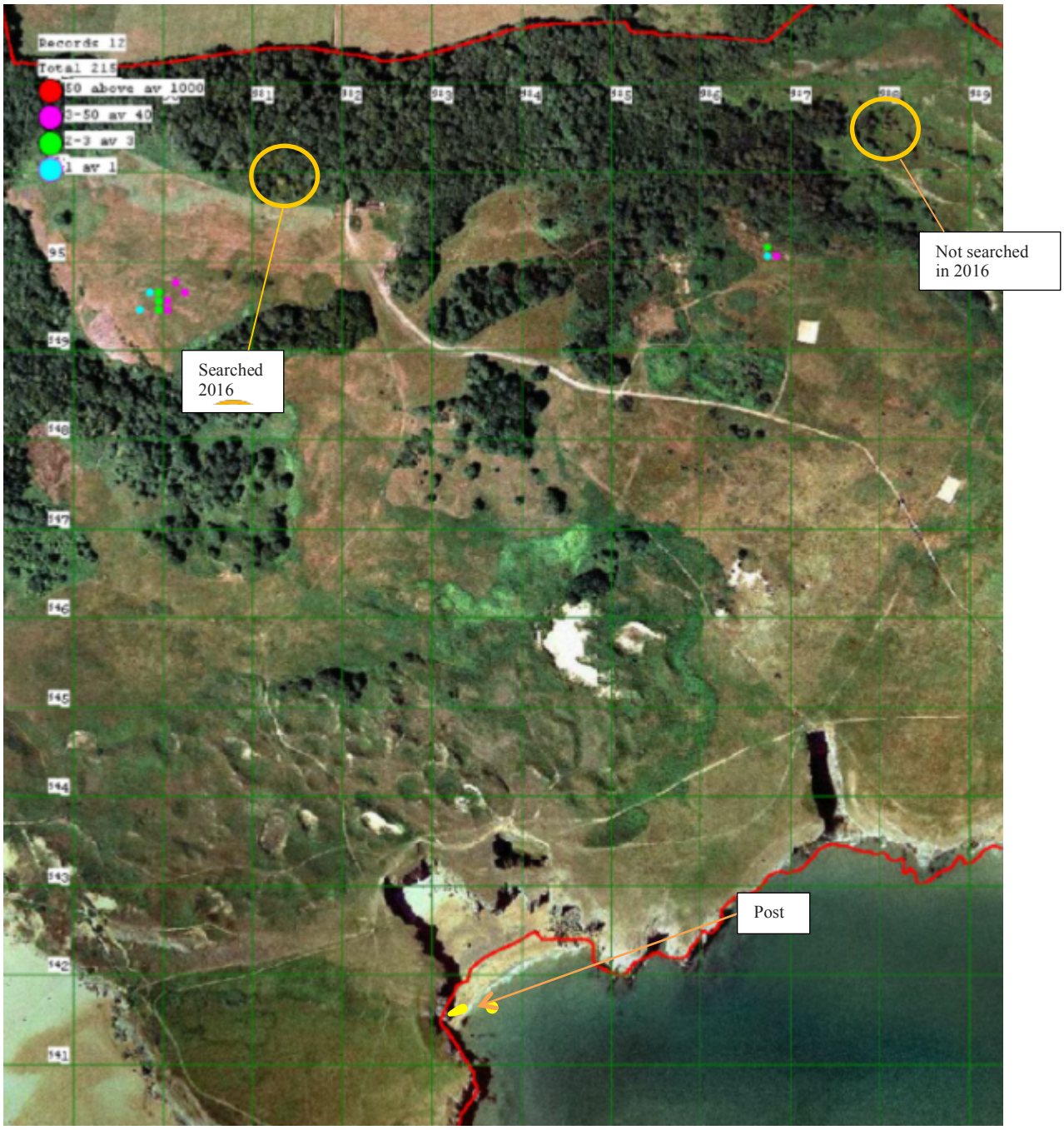
St Govan's Head. Circular parachute dropping zone.

Saddle Point and Stackpole Warren

Small populations of Gentianella campestris were recorded from two separate localities (SR98004495; SR98679500) in the north of the Stackpole Warren National Nature Reserve in 2004. Only the first of these was searched in 2016 and no plants could be found. This is an area of stabilised dune sand over limestone with localised rock outcrops. Although rather undergrazed in 2016, there were patches of good quality CG1 with Calluna vulgaris in places, and potentially suitable for G. campestris.

A further population, not recorded in 2004 was reported by Bob Haycock (former NNR site manager) from Saddle Point. A total of 106 plants were counted in 2016. Vegetation was a mosaic of species-rich MC9c and H7b with a patchy cover of well-grazed and wind-pruned Calluna vulgaris and Erica cinerea. Spiranthes spiralis was occasional. The Gentianella campestris population was divided into two patches, 26m to the east (SR98183 94014 to SR98196 94034) and 26m to the west (SR98240 94037 to 98245 94037) of a metal post to the south of the cliff-top path at SR98217 94023. It is possible that further populations may occur elsewhere in the cliff-top grassland here that has not been under arable cultivation in the past.

A population further east on Stackpole Head was reported in the NRW Phase II survey of the Stackpole NNR. This will be investigated in 2017.


Records 12
Total 215
10 above av 1000
5-50 av 40
2-3 av 3
1 av 1
Searched 2016
Not searched in 2016
Post

2mx2m quadrats

Grid reference	98240	98195
	94033	94024
Festuca rubra	6	7
Agrostis capillaris	5	5
Koeleria macrantha	5	4
Trifolium repens	5	4
Plantago lanceolata	5	3
Anthoxanthum odoratum	5	
Carex flacca	4	6
Lotus corniculatus	4	4
Thymus praecox	4	4
Sanguisorba minor	4	4
Anthyllis vulneraria	3	4
Euphrasia nemorosa	3	3
Carex caryophyllea	3	3
Leontodon autumnalis	3	
Gentianella campestris	2	3
Hypochaeris radicata	2	3
Ranunculus bulbosus	2	1
Danthonia decumbens	2	
Pilosella officinarum	2	
Centaurium erythraea	2	
Calluna vulgaris	1	3
Cerastium fontanum	1	
Spiranthes spiralis	1	
Erica cinerea		4
Scleropodium purum		3
Polygala vulgaris		3
Scilla verna		1
Agrostis stolonifera		1
Bellis perennis		1

Saddle Point. Photograph looking west from the post.

Saddle Point. Photograph looking east from the post.

Discussion

Numbers of plants of Gentianella campestris and the numbers of 100m^2 squares occupied on the Castlemartin Ranges and Stackpole Head in 2016 are considerably fewer than in 2004. In 2004 it was recorded in 928 100m^2 squares and these held a total of approximately 160000 plants. In 2016 however, it could only be found in 63 100m^2 squares, and the total numbers of plants recorded was 3770.

Small numbers of plants were found at most sites at which it was present in 2004, although none could be found at Huntsman's Leap, St Govan's Chapel or the north of Stackpole Warren. The highest numbers and the most extensive populations were at St Govan's Head.

This appears to be a catastrophic decline in both numbers and population extent. Low numbers in one year may however not be cause for serious concern, although one of the aims of this project is to establish whether population fluctuations are normal for this species, and whether populations can recover from years when numbers are very low. It has been suggested that Gentianella species and G. campestris in particular have no persistent seed-bank (Pons, 1991), with a seed viability of no longer than 10 months (Milberg, 1995). Clearly this is a poor survival strategy for an annual or biennial plant, and if correct would mean that populations are entirely reliant on the results of annual seed-production with very limited ability to recover after an unsuccessful year. It is however recognised that the seeds of Gentianella species can be very difficult to germinate in cultivation, and that there are complicated interactions with mycorrhizal fungi (H. Wendt, unpublished data). Other work suggests that G. germanica and G. amarella can have a persistent seed-bank (Schenkeveld & Verkaar, 1984; Kelly, 1989a), and this would provide a mechanism for buffering populations against adverse conditions, allowing rapid recovery in subsequent years.

Other species of Gentianella are known to experience considerable population fluctuations, and this is well-documented for G. anglica (Wilson, 1998). Numbers of this species at a site can change from hundreds of thousands one year to near zero in the next. While the occurrence of plants is related to the presence of exposed soil for germination and the presence of plants in the previous year (Wilson, 2001), it has been suggested that the massive fluctuations may be the result of periods of dry weather at crucial points in the life-cycle. Particularly vulnerable times are in the spring when seedlings are germinating and when overwintering buds are growing leaf rosettes. Such dry weather is likely to be particularly detrimental on very freely-draining soils over limestone or sand. This is supported by results from elsewhere in Europe, although Kelly (1989b) showed no connection between soil moisture and survival of Gentianella amarella on chalk in eastern England.
Further assessments in 2017 and 2018 will help determine the extent of population fluctuations.

All sites surveyed appeared to be in ideal condition for Gentianella spp. The entire area is grazed by cattle, which in combination with the extreme weather conditions and nutrient-poor soils has maintained a fine-grained mosaic of largely scrub-free maritime heathland and grassland on the plateau inland from the very exposed cliff slopes. Management has also maintained a mosaic of vegetation structures, with small-scale variation of height even in apparently uniform swards. Height measurements were made from 35 vegetation stands including Gentianella campestris and 20 from adjacent areas without G. campestris. Mean height where G. campestris was present was 2.1cm, whereas height where G. campestris was absent was 5.0cm. Using a Mann-Whitney U test, the probability of this difference occurring by chance is less than 0.001. In a survey of sites in the Yorkshire Pennines, mean vegetation height was 3cm (Price, 2016). This suggests that closely-grazed areas

within the vegetation mosaic are essential for the survival of G. campestris populations here. Any relaxation of grazing pressure which leads to increase in overall sward height will therefore reduce the area available. Gentianella anglica and Gentianella amarella have also been shown to require a maximum sward height of c3cm (Wilson, 2001; Kelly, 1989b).

In Pembrokeshire all populations of Gentianella campestris were found in H7b heathland and MC9b maritime grassland. No plants were found in H8 heathlands and more mesotrophic grasslands further inland nor in the more maritime MC9a, MC11 and CG1 on thinner limestone soils nearer the sea.These communities are characteristic of relatively moisture-retentive soils, base-rich but poor in other nutrients, close to the sea but not fully exposed to maritime conditions. On the Lizard in Cornwall, the small population of G. campestris is restricted to a very narrow strip of short H4c heathland along an ancient trackway through otherwise tall, closed-canopy heath, while in the Pennines, G. campestris can be found in a range of calcareous grassland communities including CG2b, CG10a and CG9. The New Forest sites are mostly in species-rich U1a acidic grassland in a mosaic of U1a grassland and heath.

It appears therefore to be found mainly in vegetation communities that are typical of nutrient-poor soils. It however is rare on the soils that impose the greatest environmental stress, and in Pembrokeshire where conditions vary over very small areas, G. campestris favours sites where maritime influences, drought-stress and, by inference from the associated vegetation, pH, are moderate only. Much of this apparent preference may be due to the sensitivity of early growth-stages to drought.

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Appendix 1.

Constancy tables. Constancy is the proportion of quadrats occupied by a species on a 5-point scale. N = number of quadrats.

a. 2mx2m quadrats. (N=15)

	Constancy	Maximum Domin score
Festuca rubra	5	7
Calluna vulgaris	5	7
Plantago lanceolata	5	6
Carex flacca	5	5
Agrostis capillaris	5	5
Lotus corniculatus	5	5
Euphrasia nemorosa	5	4
Gentianella campestris	5	3
Plantago maritima	4	6
Succisa pratensis	4	6
Danthonia decumbens	4	5
Potentilla erecta	4	5
Festuca ovina	4	5
Koeleria macrantha	4	5
Trifolium repens	4	5
Hypochaeris radicata	4	3
Scilla verna	4	3
Erica cinerea	3	6
Thymus praecox	3	5
Carex caryophyllea	3	5
Sanguisorba minor	3	5
Leontodon saxatilis	3	3
Stachys officinalis	2	5
Anthoxanthum odoratum	2	5
Viola riviniana	2	4
Centaurea nigra	2	4
Daucus carota ssp gummifer	2	4
Dactylis glomerata	2	4
Trifolium pratense	2	4
Euphrasia tetraquetra	2	3
Pilosella officinarum	2	3
Prunella vulgaris	2	3
Leontodon autumnalis	2	3
Centaurium erythraea	2	3
Polygala serpyllifolia	2	3
Scleropodium purum	2	3
Ranunculus bulbosus	2	2
Cerastium fontanum	2	1
Rosa pimpinellifolia	1	6
Holcus lanatus	1	4
Anthyllis vulneraria	1	4

Galium verum	1	3
Polygala vulgaris	1	3
Carex distans	1	2
Agrostis stolonifera	1	2
Weissia sp	1	2
Pteridium aquilinum	1	2
Linum catharticum	1	2
Bellis perennis	1	2
Achillea millefolium	1	1
Senecio jacobaea	1	1
Centaurium pulchellum	1	1
Crepis capillaris	1	1
Luzula campestris	1	1
Plantago coronopus	1	1
Spiranthes spiralis	1	1
Centaurea scabiosa	1	1
Bare soil		

b. 0.1mx0.1m quadrats. (N=29)

	Constancy	Maximum Domin score
Festuca rubra	5	8
Plantago lanceolata	5	7
Carex flacca	5	7
Gentianella campestris	5	4
Plantago maritima	4	8
Agrostis capillaris	4	5
Lotus corniculatus	4	5
Trifolium repens	4	5
Euphrasia nemorosa	4	4
Calluna vulgaris	3	7
Potentilla erecta	3	5
Koeleria macrantha	3	4
Succisa pratensis	2	6
Danthonia decumbens	2	5
Festuca ovina	2	5
Thymus praecox	2	5
Carex caryophyllea	2	5
Sanguisorba minor	2	4
Leontodon saxatilis	2	4
Stachys officinalis	1	5
Rosa pimpinellifolia	1	5
Hypochaeris radicata	1	4
Erica cinerea	1	4
Anthoxanthum odoratum	1	4
Viola riviniana	1	4
Dactylis glomerata	1	4
Prunella vulgaris	1	4
Daucus carota ssp gummifer	1	3
Scleropodium purum	1	3
Holcus lanatus	1	3
Anthyllis vulneraria	1	3
Scilla verna	1	2
Pilosella officinarum	1	2
Galium verum	1	2
Polygala vulgaris	1	2
Luzula campestris	1	2
Pedicularis sylvatica	1	2
Polygala serpyllifolia	1	1
Ranunculus bulbosus	1	1
Cerastium fontanum	1	1
Linum catharticum	1	1
Achillea millefolium	1	1
Crepis capillaris	1	1

c. 0.1mx0.1m quadrats, Calluna vulgaris absent. (N=14)

	Constancy	Maximum Domin score
Festuca rubra	5	7
Carex flacca	5	6
Plantago lanceolata	5	5
Gentianella campestris	5	4
Plantago maritima	4	8
Agrostis capillaris	4	5
Lotus corniculatus	4	5
Trifolium repens	4	5
Euphrasia nemorosa	4	4
Potentilla erecta	3	4
Koeleria macrantha	3	4
Succisa pratensis	2	6
Festuca ovina	2	5
Thymus praecox	2	4
Carex caryophyllea	2	4
Sanguisorba minor	2	4
Prunella vulgaris	2	4
Danthonia decumbens	2	3
Crepis capillaris	2	1
Trifolium pratense	1	5
Leontodon saxatilis	1	4
Hypochaeris radicata	1	4
Erica cinerea	1	4
Anthoxanthum odoratum	1	4
Dactylis glomerata	1	4
Viola riviniana	1	3
Daucus carota	1	3
Holcus lanatus	1	3
Anthyllis vulneraria	1	3
Scleropodium purum	1	2
Scilla verna	1	2
Pilosella officinalis	1	2
Polygala vulgaris	1	1
Luzula campestris	1	1
Ranunculus bulbosus	1	1
Cerastium fontanum	1	1
Linum catharticum	1	1

d. 0.1mx0.1m quadrats, Calluna vulgaris present (N=15)

	Constancy	Maximum Domin score
Plantago lanceolata	5	7
Calluna vulgaris	5	7
Festuca rubra	5	6
Carex flacca	5	4
Gentianella campestris	5	3
Plantago maritima	4	5
Trifolium repens	4	5
Potentilla erecta	4	4
Euphrasia nemorosa	4	3
Succisa pratensis	3	6
Agrostis capillaris	3	5
Lotus corniculatus	3	5
Danthonia decumbens	3	5
Thymus praecox	3	5
Koeleria macrantha	3	4
Stachys officinalis	2	6
Festuca ovina	2	5
Carex caryophyllea	2	5
Leontodon saxatilis	2	3
Rosa pimpinellifolia	1	6
Erica cinerea	1	4
Anthoxanthum odoratum	1	4
Viola riviniana	1	4
Hypochaeris radicata	1	3
Dactylis glomerata	1	3
Holcus lanatus	1	3
Trifolium pratense	1	3
Sanguisorba minor	1	2
Galium verum	1	2
Luzula campestris	1	2
Pedicularis sylvatica	1	2
Scleropodium purum	1	1
Scilla verna	1	1
Polygala vulgaris	1	1
Polygala serpyllifolia	1	1
Achillea millefolium	1	1

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The Species Recovery Trust is a charity set up to tackle the loss of some of the rarest species in the UK.

There are over nine hundred native species in the UK that are classed as under threat, with several hundreds more currently widespread but known to be in significant decline. The countryside is now bereft of many species that were a familiar sight a mere generation ago.

A small number of these species are on the absolute brink of existence, poised to become extinct in our lifetimes; our goal is to stop them vanishing.

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