

VEGETATION SURVEY & ASSESSMENT

**Petalwort *Petalophyllum ralfsii* Monitoring at Dawlish Warren National Nature Reserve in
2023**

REPORT TO EAST DEVON DISTRICT COUNCIL

May 2023



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I. INTRODUCTION

I.1 Petalwort

Petalophyllum ralfsii (Wils.) Nees & Gottsche (Petalwort) is a thallose liverwort belonging in the family Petalophyllaceae. *P. ralfsii* thalli can grow in solitary rosettes or in mats, each thallus generally measuring up to 10 mm in diameter and up to 15mm long. A subterranean lipid-packed rhizome-like stem allows it to perennate and withstand long periods of desiccation, with the visible parts of the plant dying back during dry conditions in summer.

P. ralfsii is dioicous and often fertile; Spore-producing capsules are carried by female plants from December to June. The spores are relatively large and may persist in the diaspore bank for long periods until environmental conditions become suitable for new plant growth. No asexual propagules are known, but *P. ralfsii* can reproduce clonally by means of bifurcation whereby the thallus splits into two and underground branches can also give rise to new thalli.



Plate 1. Several thalli of *Petalophyllum ralfsii* at Dawlish Warren

In Britain and Ireland, *P. ralfsii* is mainly a coastal species of calcareous sand dunes and machair where it behaves as a pioneer along the edges of dune slacks subject to inundation in the winter. However, it avoids ground that is deeply flooded in winter or is heavily shaded. In some sites it is strongly dependent on light disturbance and compaction provided by the movements of vehicles, humans and/or large animals. It is invariably a species of base-rich substrates with pH in the range of 7.4-7.7 and is absent from otherwise suitable base-poor habitats. It rarely grows on pure sand, instead preferring more water-retentive peaty sands. *P. ralfsii* has a Mediterranean-Atlantic distribution, and is widespread in the Mediterranean region, including North Africa and Turkey, extending northwards along the Atlantic seaboard to Britain and Ireland (Blokkeel et al., 2014).

P. ralfsii is known from 29 Ordnance Survey 10km grid squares (hectads) in Britain, and 28 in Ireland. Indeed, Ireland holds the highest proportion of the world population of *P. ralfsii* of any country in the

world, and probably also the largest individual populations. There are also some substantial populations in the major Welsh dune systems. In England, there are particularly strong populations at a number of dune complexes in Devon and Cornwall. Whilst some colonies have increased in recent years, others have declined due to a trend of sand-dune stabilisation which over time causes dune slacks to dry out as a result of the processes of natural succession.

P. ralfsii is a species of high conservation importance and it is listed on Schedule 8 of the Wildlife & Countryside Act 1981 (as amended), receiving full legal protection. It is also listed under the Habitats Directive (92/43/EEC) as an Annex II species. In Britain, the species is also recognised as Nationally Scarce (Pescott, 2016) and is regarded as Vulnerable in the current Red List (Callaghan, 2022).

1.2 Dawlish Warren

Dawlish Warren National Nature Reserve is a 505 acre sand spit and dune complex at the mouth of the Exe Estuary. It has been designated as a Site of Special Scientific Interest (SSSI) and is part of the Exe Estuary Special Protection Area (SPA) and Ramsar site.

The site has also been designated as a Special Area of Conservation (SAC) under the provisions of the Habitats Directive. Its humid dune slacks are a type of Annex I habitat that is a primary reason for selection of this SAC and they support the *P. ralfsii* for which the site is also selected.

P. ralfsii was discovered at Dawlish Warren in 1997 by David Holyoak, who monitored the population until 2003. Richard Lansdown subsequently assessed the condition of the population (Lansdown 2012, 2019). The most recent estimate of population size was 1360 thalli occupying eight discrete damp hollows in Greenland Lake Slack in 2019.

Dawlish Warren is an unusual site for *P. ralfsii* as its sandy substrates are generally base-poor. The population is thought to be influenced by the proximity of concrete, masonry debris or limestone gravel, or alternatively from deposition of more basic Old Red Sandstone carried to Dawlish via long-shore drift.

1.3 Project Objectives

As one of the most important species of Dawlish Warren NNR, and its only Annex II species for selection as an SAC, regular monitoring of *P. ralfsii* is essential.

Sharon Pilkington (trading as Vegetation Survey & Assessment Ltd) was asked to undertake a repeat condition assessment of the *P. ralfsii* interest feature in 2023. Specifically, this work set out to:

- survey and map the current metapopulation of *P. ralfsii* at Dawlish Warren to update the baseline;
- undertake a condition assessment of the species and the habitat supporting it using the approach of Lansdown (2019) and cross-referencing the results of that assessment and others before it; and
- review the impacts of human activities and other influences on the species and its habitat and make relevant location-specific recommendations to maintain favourable status for *P. ralfsii* going forward.

2. METHODS

2.1 Fieldwork

The monitoring survey was undertaken on 21st March 2023 by Sharon Pilkington, an independent professional botanist and vegetation ecologist specialising in bryophytes.

The survey methodology aimed to replicate the wet hollow-focussed approach of Lansdown (2019). However, it quickly became apparent that this would be impractical because the hollows were not visible as discrete entities within the slack. This problem was compounded by a lack of geographical co-ordinates for individual hollows that could have helped to accurately relocate them.

To counter this, a slightly different approach was taken. A careful search of habitat that appeared to have potential to support *P. ralfsii* thalli in Greenland Lake Slack was undertaken (Figure 1) and, where discrete colonies were found, they were georeferenced using a Garmin GPSMAP64S hand-held navigational receiver¹. A search of the slack just west of the Visitor Centre where *P. ralfsii* had previously been translocated was also made but proved unsuccessful.

Other bryophytes of high conservation importance, including any Nationally Rare and Nationally Scarce species (Pescott, 2016) were not specifically searched for, but were recorded incidentally wherever they were found.

2.2 Evaluation and Condition Assessment

A comparison of the total number of thalli and their distribution across Greenland Lake Slack was made as far as practicable with the two most recent monitoring assessments.

Quantum GIS software (QGIS Development Team, 2023) was used in planning fieldwork and the digitisation, presentation and analysis of results. Use of the Tom.bio QGIS plugin also enabled the overlay of 100m Ordnance Survey grid squares and the visualisation of 10m Ordnance Survey grid square occupancy.

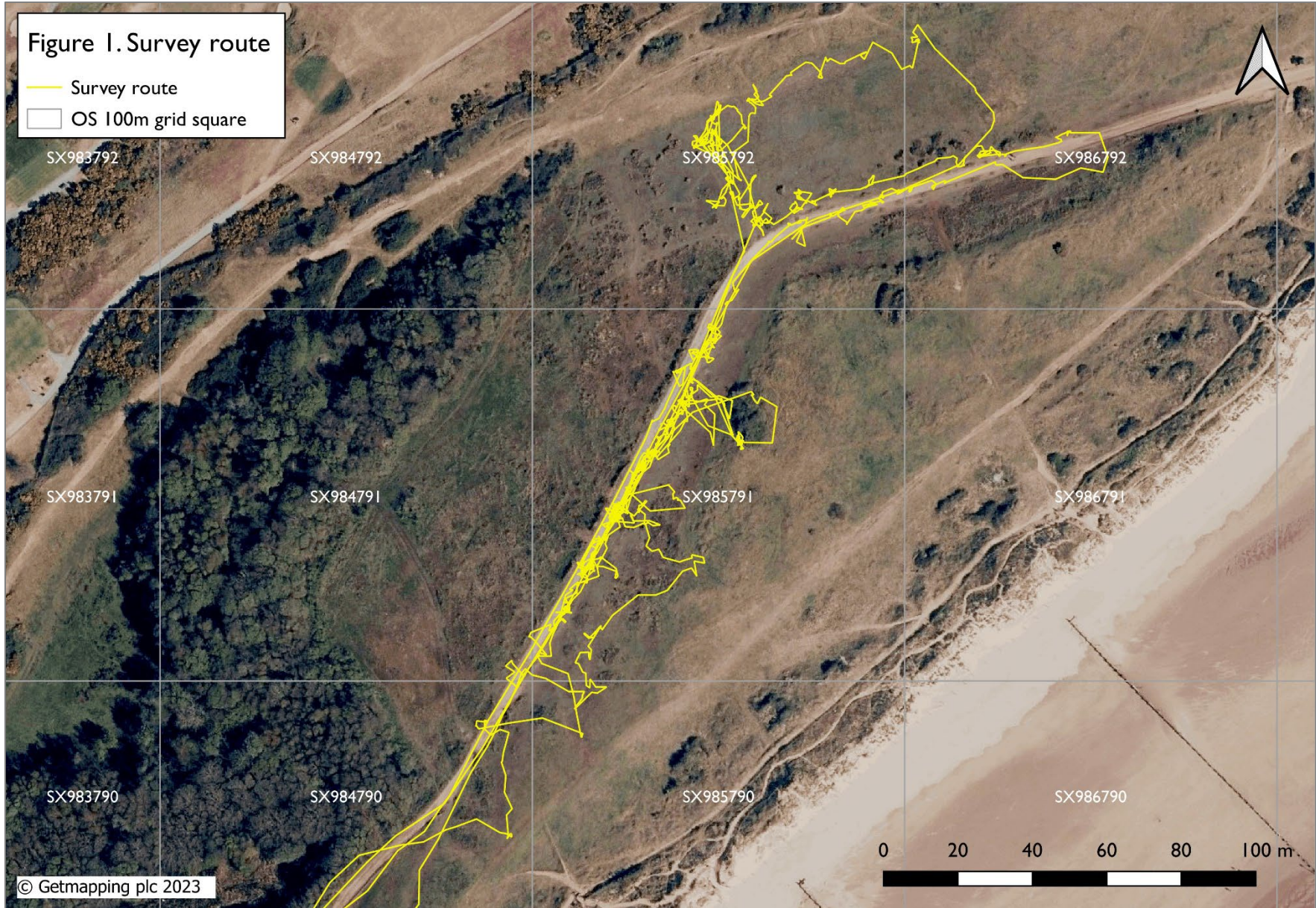
2.3 Limitations

Ground conditions were broadly favourable for the fieldwork, with no surface water lying in any part of Greenland Lake Slack. However, the slack had been flooded for a prolonged period in the winter months prior to the survey and this rendered much of it unsuitable for spring growth of the thalli of *P. ralfsii*. Generally, *P. ralfsii* avoids areas which flood for prolonged periods, but notwithstanding that, any plants present in low-lying parts of the slack that might start into growth later than usual would not have been visible at the time of survey.

2.4 Nomenclature

The nomenclature used in this report follows the taxonomy of Blockeel et al., (2021) for mosses and liverworts and Stace (2019) for higher plants.

¹ This receiver connects to GPS and GLONASS satellite networks to give a typical positioning accuracy of 3m in open terrain.



3. FINDINGS

3.1 Petalwort Metapopulation Size and Extent

619 thalli were found in approximately 300m² of Greenland Lake Slack, in more or less similar places to where it has been seen previously. Figure 2 shows the locations of colonies (some of which are linear and are scattered over some distance (Table 1). Most colonies supported relatively low numbers of individuals (fewer than 100) and a limited number of thalli had reproductive structures, including immature capsules. Across the whole area, *P. ralfsii* was found to have an occupancy of 24 10m OS grid squares (Figure 3).

It was not possible to directly compare the location of the colonies of *P. ralfsii* found in this assessment with those found from previous years because of uncertainty about the precise locations of the damp hollows they were previously mapped in. However, Figure 4 indicates the *approximate* locations of these hollows to assist with broad interpretation of the findings.

The results indicate that the main track verge is currently the most important microhabitat for *P. ralfsii* at Dawlish Warren. 508 thalli (82% of the metapopulation) were found within 1-2 metres of the track edge over a distance of around 190 metres, mainly on its south-eastern verge. Its habitat here is sparsely vegetated and disturbed (compacted and scuffed) ground that lies a few centimetres higher than the adjacent track surface and low-lying slack. Plate 2 shows an example of this.

18% of the metapopulation of *P. ralfsii* (111 thalli) occupied ground north of the main track. There is less disturbance across this area, although the majority of thalli were associated with flat terrain that is compacted and scuffed by either vehicular movements or frequent human footfall (Plates 3 and 4).



Plate 2. 125 thalli along 21m of track verge at PR06. Individual thalli/clusters are marked by sticks.

Figure 2. Petalwort distribution and numbers

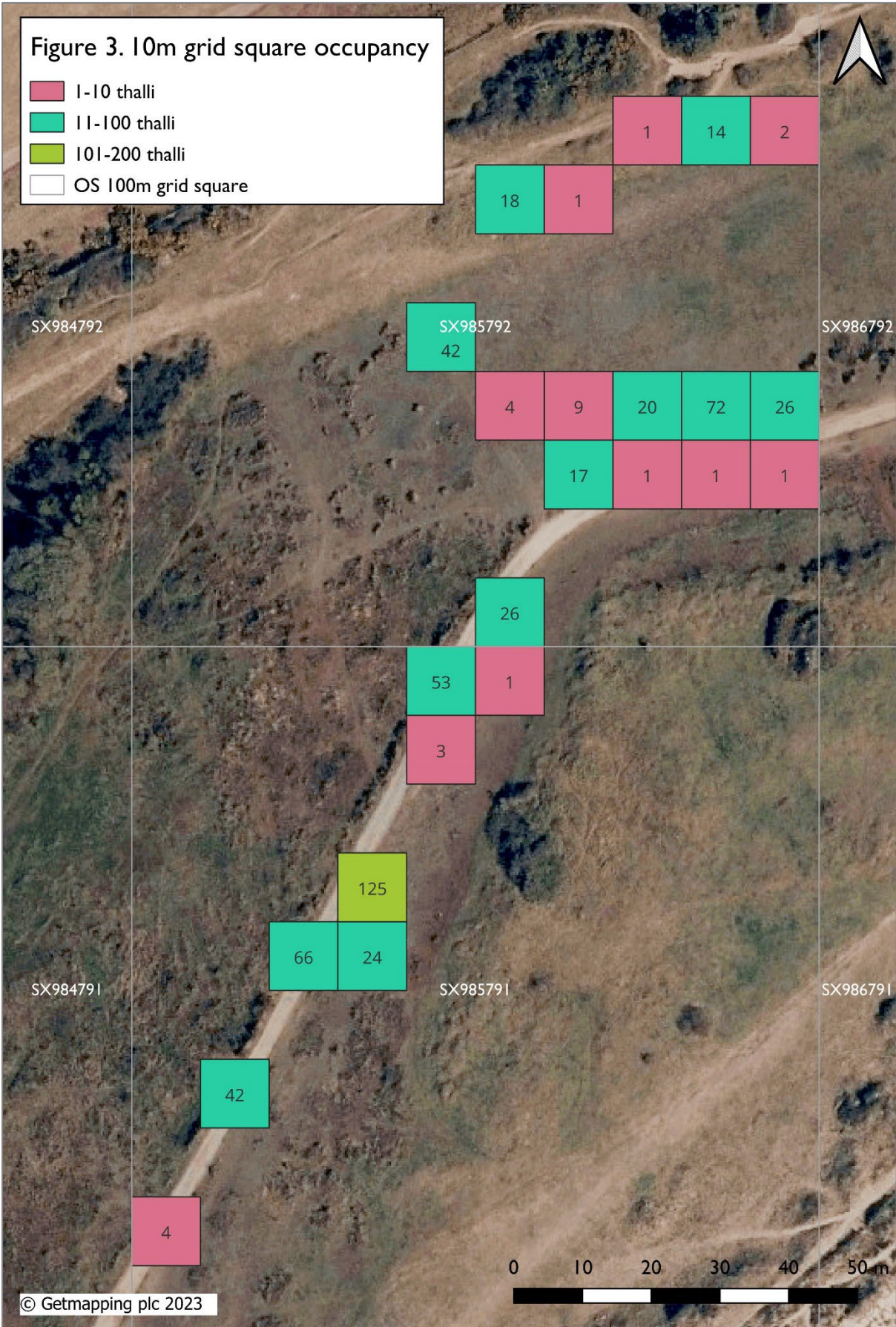
- Point location with map ref and thallus count in ()
- OS 100m grid square



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Table 1. March 2023 *P. ralfsii* population details (see also Figure 2)

Map ref	Gridref	No. of thalli	Comment
PR01	SX9852579151	66	In 8 x 1m area of eastern track verge. No fertile plants seen.
PR02	SX9850779120	4	In 2 x 1m of eastern track verge.
PR03	SX9851679136	7	In 30 x 30cm area on eastern track verge. None fertile but some plants quite robust.
PR04	SX9851779137	35	In 7m of slightly raised ground on eastern track verge. None fertile. All plants within 60cm of track surface.
PR05	SX9852779158	24	In 16m of slightly raised ground on eastern track verge. All within 1.5m of track.
PR06	SX9853579169	125	Scattered over 21m of eastern track verge where ground is slightly raised. A few more than 2m from track in low raised vegetated 'islands' in slack. Some female plants with capsules present.
PR07	SX9854379186	2	
PR08	SX9854579188	1	Within 30cm of track edge.
PR09	SX9854079191	1	On western verge of track where vehicles cross the verge into the slack.
PR10	SX9854679195	52	A very small but dense patch on eastern verge within 1m of track.
PR11	SX9854979197	1	About 3m from track edge.
PR12	SX9855079199	22	In 1m ² area within 1m of track. Some capsules present.
PR13	SX9855079203	1	At edge of mound raised above slack.
PR14	SX9855379201	3	On raised ground around boulder at track edge.
PR15	SX9857579228	1	On eastern verge 30cm from track.
PR16	SX9858779231	1	On eastern verge of track.
PR17	SX9859279235	1	On eastern verge of track.
PR18	SX9862479249	46	In 3m of raised, trampled track verge (north of track).
PR19	SX9859379241	26	In 2m of raised, trampled track verge (north side of track).
PR20	SX9858379240	72	Male and female thalli on side of low trampled bank on north side of track.
PR21	SX9857679236	20	Growing with <i>Cheilothela chloropus</i> on north side of track.
PR22	SX9856679236	9	On north side of track in area where people walk across dense vegetation.
PR23	SX9856479227	17	Northern verge of track.
PR24	SX9855779237	1	In quite dense <i>Carex flacca</i> - <i>Trichostomum crispulum</i> vegetation.
PR25	SX9855279236	3	On slight north-facing slope in slack.
PR26	SX9855679245	42	Scattered across 27 x 2m area of slack with <i>Cheilothela chloropus</i> .
PR27	SX9855979267	18	Some large thalli in 1m ² area.
PR28	SX9856579263	1	
PR29	SX9857279271	1	On heavily used grassy path below bank.
PR30	SX9858179270	14	At edge of heavily used grassy path below bank.
Total no. of thalli		619	



Important: the locations of the damp hollows shown in this figure should be regarded as approximate

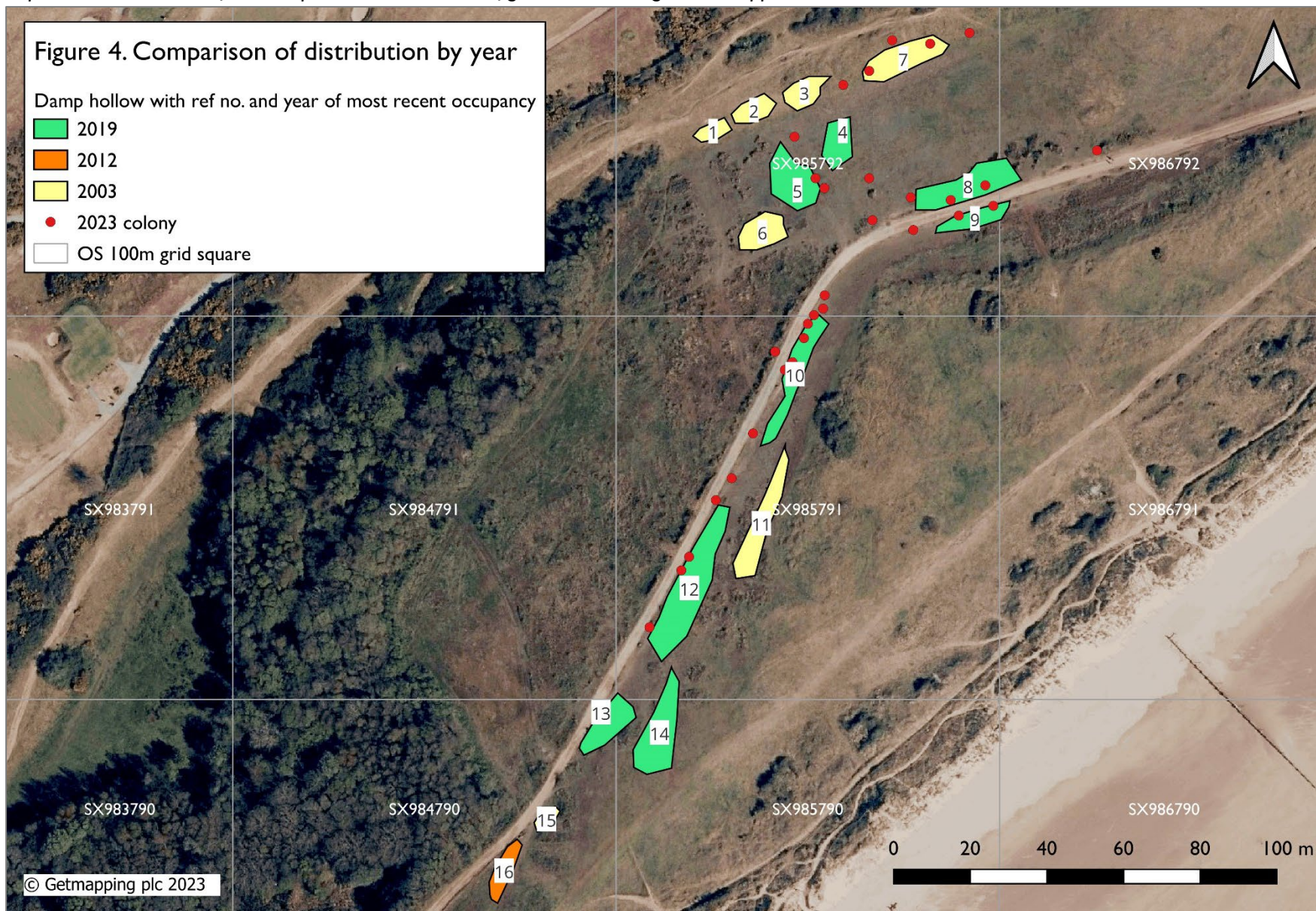




Plate 3. 42 thalli marked by sticks in trampled ground at PR26.



Plate 4. Heavily trampled path supporting *P. ralfsii* at PR31 (golf course to the right of the bank)

3.2 Other Rare Species

Dawlish Warren is the only place in Britain where *P. ralfsii* grows with *Cheilothela chloropus* (Rabbit-moss). This Nationally Rare moss is known from a handful of sites in Somerset and south Devon. In all of its other sites it is found in dry, unimproved Carboniferous limestone grassland, so its population in Greenland Lake Slack is highly unusual. The slack supports a very large population of *C. chloropus*, probably numbering many thousands of plants across an area approximately 50m x 40m and possibly more (Figure 5 and Table 2).

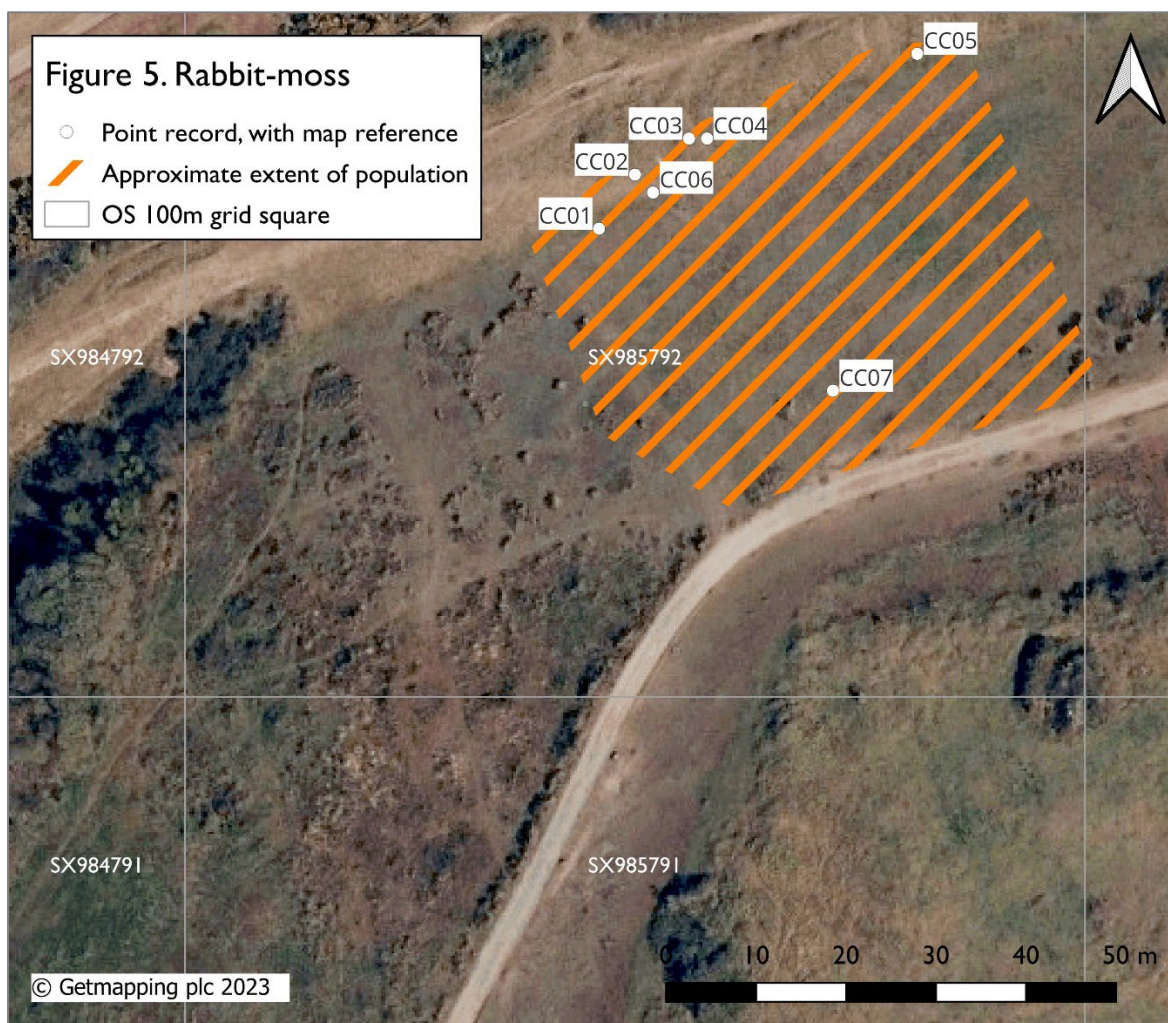


Table 2. *Cheilothela chloropus* population details

Map ID	Gridref	Comment
CC01	SX9854679251	A few patches, looking moribund after winter flooding of slack.
CC02	SX9855079257	About 100cm ² , with <i>Petalophyllum ralfsii</i> .
CC03	SX9855579262	30 x 20cm patch.
CC04	SX9855879261	Thousands of shoots growing across an area at least 30m x 40m, likely to cover a wider area going north.
CC05	SX9858179270	
CC06	SX9855179256	Numerous plants going north.
CC07	SX9857279233	Near track. Around 15 healthy-looking patches with scattered <i>Petalophyllum</i> in area 1m ² .

4. DISCUSSION

4.1 Condition Assessment

Monitoring of the metapopulation of *P. ralfsii* at Dawlish Warren has now been undertaken for 20 years. In that time, the counts of *P. ralfsii* have varied greatly (Table 3).

Table 3. Comparison of *P. ralfsii* monitoring results

Survey Month and Year	Visitor Centre Slack	Greenland Lake Slack	Notes
April 1997	Few	No information	Brief survey following discovery of species new to site
May 1997	76	3	Probably too late in the spring to be effective
December 1999	>1000	1,000-10,000	Survey under good conditions
December 2001	ca. 200	ca. 250	Survey probably inadequate
April 2003	ca. 600	ca. 2500	Slacks flooded January to March 2003
February 2012	1	1250-1600	3 dry winters prior to survey
April 2019	0	ca. 1360	Hollow no. 9 inundated, not surveyed
March 2023	0	619	Good survey conditions after slacks flooded over winter

It is unclear how many thalli were present before 2003, although the figures in Table 3 indicate that at least 2000 were counted from the site at that time. The most reliable count is from 2003, with a total of ca. 3100 thalli in the two slacks. Lansdown (2019) suggested that counts fell after that and stabilised in 2012, although by then the population was confined to Greenland Lake Slack.

The current findings indicate that numbers of thalli have halved since 2019. It is not clear if the prolonged flooding of parts of Greenland Lake Slack may have played a significant role in the numbers of visible thalli at the time of the current assessment. It is telling that east of the main track, the only thalli seen were in areas where the microtopography would have elevated the plants above the main flood zone.

As Lansdown (2019) noted, direct comparison between the results of the most recent monitoring and the older ones is not straightforward. The current assessment reinforces the position that reliance on a monitoring approach that requires clear delimitation of damp hollows is no longer practical. The 2019 monitoring provided an opportunity to test the condition assessment attributes and targets previously recommended (Lansdown 2012). As it did not work well, he proposed an alternative target encompassing extent and abundance expressed in a simple form:

If five or more hollows support *P. ralfsii* and the total number of thalli recorded exceeds 1,000, including male and female individuals, then the metapopulation may be considered to be in favourable condition.

Because of the difficulty of locating and identifying the wet hollows, it is unclear how many were occupied in March 2023. Figure 4 indicates that a minimum of five hollows were occupied, possibly more. Both sexes were represented but the total thallus count falls well short of the stated target. On this basis, the population would be considered to be in unfavourable condition.

For future monitoring, it would be pertinent to employ an alternative target for metapopulation extent. Using GIS, it is easy to calculate occupancy of 10m OS grid squares and therefore, it is proposed that future condition assessment should this modified target:

If *P. ralfsii* occupies 20 or more 10m OS grid squares and the total number of thalli recorded exceeds 1,000, including male and female individuals, then the metapopulation may be considered to be in favourable condition.

4.2 Reasons for Decline

P. ralfsii is a species that is relatively mobile and it can move around both vegetatively and via spores to take advantage of fresh habitat opportunities. However, its area of occupancy at Dawlish has never been very large, and so its opportunities to disperse are limited.

The likely reasons for the decline in number of thalli seen in the current assessment may be complicated and, without further investigation of e.g., ground hydrology, entirely speculative. However, it may have been driven by the interplay of three main factors:

- natural succession and gradual drying of Greenland Lake ;
- changed patterns of recreational trampling by visitors and vehicular movements by staff across Greenland Lake Slack; and
- climate change-linked increased summer desiccation and winter flooding of slack habitat reducing the availability of suitable *P. ralfsii* habitat. It is also possible that climate change could be affecting the water table. 2022 was the hottest year on record in England and the driest since 1935.

5. RECOMMENDATIONS

As Greenland Lake Slack will be vulnerable to saline incursion flooding after relaxation of local sea defences in the future, it is recommended that the next management steps to maintain its population of *P. ralfsii* should take a twin-headed approach.

Firstly, it is important to halt the decline in the size and extent of the metapopulation in Greenland Lake Slack by implementing short-term measures to create new habitat niches.

It is clear from the current work that *P. ralfsii* has a high fidelity to ground that is regularly trampled by human footfall, or vehicular movements. It avoids parts of the slack which are regularly flooded. Although there are various informal paths across the slack, only the main surfaced track and a heavily walked grass track south of the golf course bund (connecting to the main track) are currently occupied by *P. ralfsii*.

In sites elsewhere in SW England, *P. ralfsii* also prefers tracks but they do not need to be wide or heavily used to support it. At a site near Hayle, it follows the lightly but regularly used path of donkeys moving across paddocks. At Braunton Burrows it can be found in lightly trampled but regularly used dog-walker's paths.

Much of the vegetation in Greenland Lake Slack is currently too tall and closed to support *P. ralfsii*, but encouragement of more directed footfall or vehicular movements (Figure 6) would help to create new habitat niches. Any such action should of course avoid areas where other rarities are known.

Secondly, for the long-term survival of *P. ralfsii* at Dawlish Warren, the population must be encouraged to establish away from Greenland Lake Slack. Translocation has been attempted into a slack close to the Visitor Centre; the first was unsuccessful and it remains to be seen how successful another translocation (to a different place) in 2023 will be. In the slack immediately west of the Visitor Centre, promotion of greater public access across the edge of the slack may naturally restore suitable trampled habitat within a few years. Hence, even if *P. ralfsii* does not find its own way there, future translocation of turves containing *P. ralfsii* from Greenland Lake Slack may 'take' better than into other receptor sites.

6. ACKNOWLEDGMENTS

The author would like to express grateful thanks to Neil Harris and Phil Chambers for their help with survey organisation, background information and access to Dawlish Warren for this round of monitoring.



REFERENCES

- Blockeel T.L., Bell N.E., Hill M.O., Hodgetts N.G., Long D.G., Pilkington S.L. and Rothero G.P. 2021. **A new checklist of the bryophytes of Britain and Ireland, 2020.** *Journal of Bryology* 43: 1-97.
- Blockeel T.L., Bosanquet S.D.S., Hill M.O. and Preston C.D. 2014. **Atlas of British and Irish Bryophytes.** Pisces Publications, Newbury.
- Callaghan D.A. 2022. **A new IUCN Red List of the bryophytes of Britain, 2023.** *Journal of Bryology*, 44:4, 271-389.
- Holyoak D.T. 2003. **Status and conservation of Petalwort (*Petalophyllum ralfsii*) at Dawlish Warren NNR, South Devon.** Unpublished report to Teignbridge District Council.
- Lansdown R.V. 2012. **Survey of *Petalophyllum ralfsii* at Dawlish Warren, 2012.** Unpublished report to Teignbridge District Council.
- Lansdown R.V. 2019. **Conservation Assessment and Prognosis for Petalwort (*Petalophyllum ralfsii*) at Dawlish Warren.** Unpublished report to Teignbridge District Council.
- Pescott O. 2016. **Revised lists of nationally rare and scarce bryophytes for Britain.** *Field Bryology* 115: 22-30.
- QGIS Development Team. 2023. **QGIS Geographic Information System.** Open Source Geospatial Foundation Project.
- Stace C.A. 2019. **New Flora of the British Isles** 4th edition. C & M Floristics, Middlewood Green.