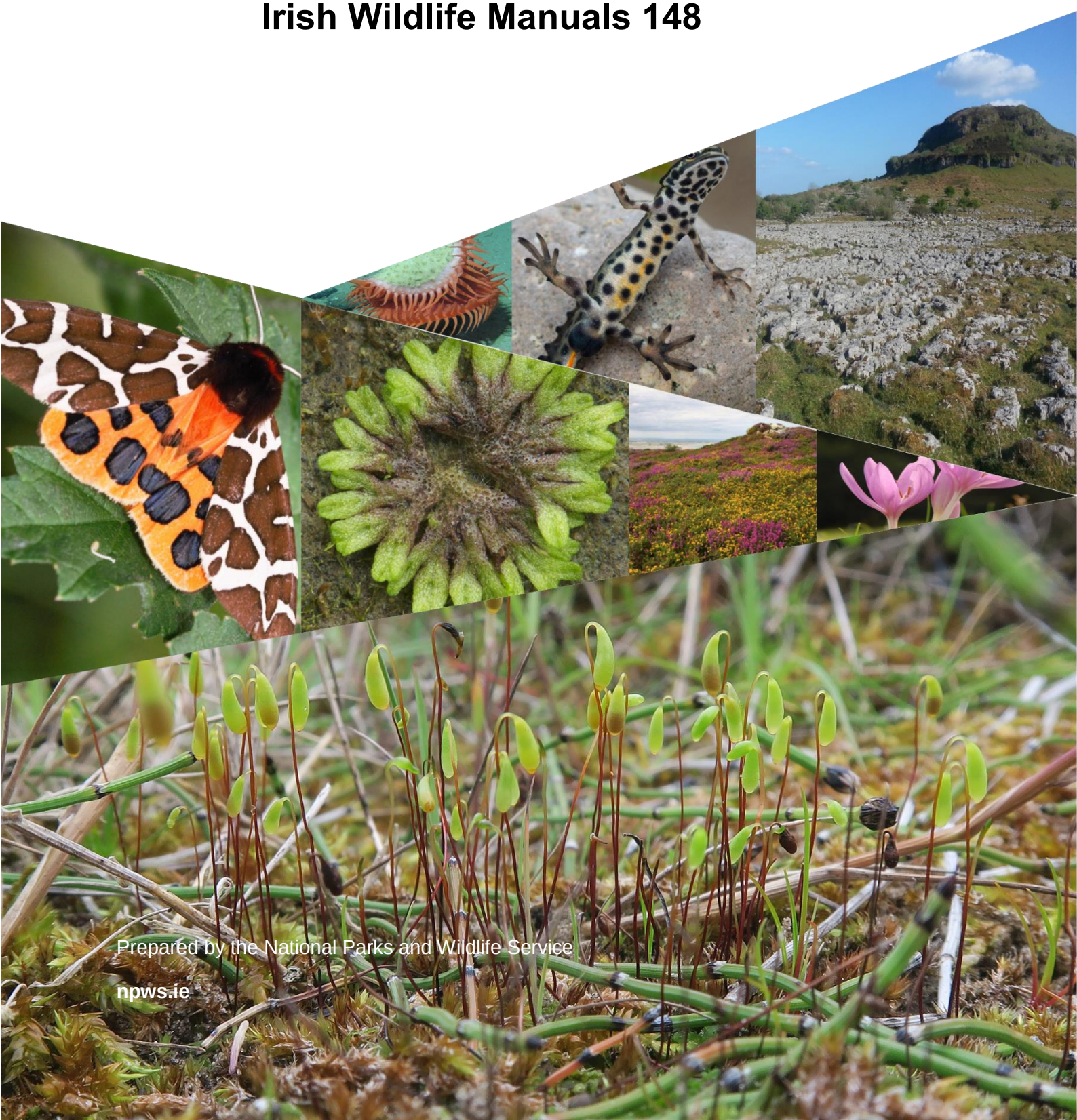
An tSeirbhís Páirceanna Náisiúnta
agus Fiadhúlra
National Parks and Wildlife Service

Bryaceae Survey 2023

Irish Wildlife Manuals 148



Prepared by the National Parks and Wildlife Service

npws.ie

Citation: Holyoak, D.T. & Campbell, C. (2024). Bryaceae Survey 2023. Irish Wildlife Manuals, No. 148. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.

Keywords: Bryaceae, mosses, Ireland, survey, conservation, coastal, grazing, eutrophication

Front cover, from left to right and top to bottom:

A deep water fly trap anemone *Phelliactis* sp., Yvonne Leahy; **Common Newt** *Lissotriton vulgaris,* Brian Nelson; **Limestone pavement**, Bricklieve Mountains, Co. Sligo, Andy Bleasdale; **Garden Tiger** *Arctia caja,* Brian Nelson; **Violet Crystalwort** *Riccia huebeneriana*, Robert Thompson; **Coastal heath**, Howth Head, Co. Dublin, Maurice Eakin; **Meadow Saffron** *Colchicum autumnale*, Lorcan Scott

Bottom photograph: **Cernuous Thread-moss** *Ptychostomum cernuum* (Bryaceae) with capsules, David Holyoak

Bryaceae Survey 2023

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This IWM was edited by Neil Lockhart, Domhnall Finch & Sue Wilson

ISSN 1393 – 6670

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta, 90 Sráid an Rí Thuaidh, Baile Átha Cliath 7, D07 N7CV

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Executive Summary

In Ireland, the moss family Bryaceae has six of its species listed on the Flora (Protection) Order, 2022 because they are seriously threatened, and eight others are regarded as rare or vulnerable. Among these are nine species regarded as being of special conservation concern in Ireland because they are also rare and largely declining in the other countries of north-western Europe. In particular, surveys from 1999–2009 revealed that *Ptychostomum cernuum* (syn. *Bryum uliginosum*) had three surviving populations in Ireland, whereas it became extinct long ago in the United Kingdom and neighbouring continental countries. *Ptychostomum calophyllum*, *P. warneum* and *Bryum marratii* were also strongly represented in Ireland whereas they too had been lost from many of their former localities in southern Britain and on the near-continent. Nevertheless, some losses of important Irish populations had been noted during the past decade and most of the others had not been assessed. Therefore, to obtain up to date information, a comprehensive survey of all sites for these nine species was carried out in 2023.

The results of the new surveys are worrying. *P. cernuum* is still present at two of its three sites, but the overall population in Ireland has declined by about 80%. *P. calophyllum* survives at only one of its four sites, but the population there has declined considerably due to competing vegetation. *P. warneum* has been lost from all four of its former sites, which included some strong populations, but a few stems of it were found at a new site. *Bryum marratii* was not refound at nine of its 14 sites and the overall population appears to have declined by about 70%; only a single strong population was found. *Bryum gemmiparum* previously had three known Irish populations and all have now gone. The causes of these losses and declines are analysed in some detail here: recurrent problems, apparently having arisen from widespread eutrophication or nitrification, leading to increased shade from taller or denser competing vegetation; eutrophication of lakes; cessation or intensification of grazing in different sites; decrease in supply of mobile wind-blown sand.

There has hitherto been very little direct management intervention to protect habitats for rare Bryaceae in Ireland. The existing strong legal protection of the plants themselves and of the land on which they grow is clearly insufficient to combat many changes in natural processes, or in management or neglect of their habitats. These changes can often be subtle, with slight eutrophication causing stronger, healthy growth of native flowering plants which conceals the loss of small unshaded patches of sand or soil needed by the Bryaceae. However, when grazing ceases, vegetation succession to tall grassland and scrub can of course be conspicuous in leaving no unshaded ground after a few years. It is clear, however, that if present trends continue, the Irish populations of *P. cernuum*, *P. calophyllum* and *P. warneum* will all be lost, possibly within the next decade. To prevent this, it is proposed that the surviving populations are monitored regularly by bryologists who should carry out or supervise small-scale work, to maintain the open habitats needed and recognise and seek to avert other threats. As an insurance measure, collections of several populations have been brought into *ex situ* conservation at the National Botanic Gardens of Ireland, with a view to potential reintroduction, should the need arise.

Additional work on a much larger scale is also needed at some key sites, to maintain or recreate open habitats mechanically. Such intervention is needed in order to recreate open areas of substratum large enough to persist on time scales of more than one or two years. Proposed projects outlined here should include clearing a ditch and its banks of young Alder trees at Island Lake, Co. Mayo, scraping away patches of grassland vegetation at key coastal sites at Barnynagappul Strand, Co. Mayo and at Trawmore Strand, Co. Donegal to liberate blown sand, and creation of a new dune slack at North Bull Island, Co. Dublin to produce new early-successional habitats. Botanists and other conservationists have traditionally been reluctant to protect natural populations of native plants by selective “gardening” at their sites. However, a failure to intervene in some of these changing environments will surely lead to local and national extinctions of some of the rarest and most iconic species.

Acknowledgements

Thanks are due to NPWS for funding this work. To Dr Neil Lockhart for arranging and managing the survey, assistance and background information during visits to sites, and valuable discussions. Mel Conway who prepared the maps and Bluesky images for this publication. His help was also valuable in providing mapping and air photos for the project and explaining the intricacies of the relationship between the Irish Grid and Irish Transverse Mercator (ITM) projection. Claire Crowley and colleagues at the National Parks and Wildlife Service for providing the licence to collect voucher specimens of those species covered by Flora (Protection) Order, 2022.

Dr Rory Hodd for assistance in the field in Co. Wicklow and sharing his knowledge of this and other sites visited. Dr Melinda Lyons and Mairéad Stack for assistance on a site visit to North Bull Island and background information on this site. Emer Magee, NPWS Conservation Ranger for Donegal South/West provided helpful information on the Sheskinmore site. To numerous landowners and graziers for help in gaining access to their land and helpful information on its management. To Elizabeth Holyoak for help with fieldwork arrangements and cheerful forbearance during the weeks of writing up and researching the project.

1 Introduction and background

The family Bryaceae includes some of the rarest and most threatened European moss species. Changes in land use over much of north-western Europe have led to extinction of *Ptychostomum cernuum* (syn. *Bryum uliginosum*) in several European countries, and both *Ptychostomum calophyllum* and *Bryum marratii* have now been lost from most of their former localities in southern Britain and on the near-continent. The Irish populations fared better through the late twentieth century and beyond; Lockhart *et al*. (2012a, 2012b) reported that the country had become the last major stronghold in north-western Europe of those species.

A total of nine Bryaceae species appear to be of special conservation concern in Ireland (Table 1). Three others are rare in Ireland (*Ptychostomum creberrimum, P. imbricatulum, P. torquescens*), but they are more common in parts of southern Europe and most of their Irish records probably represented temporary colonies. Two other Bryaceae rare in Ireland (*Ptychostomum elegans*, *P. moravicum*) are also outlying populations of species common in other parts of Europe.

In contrast, seven of the nine Bryaceae species needing special attention in Ireland are northern plants, occurring here close to the southern limits of their global ranges. Warming of global climates may therefore contribute to the risks facing these species. Furthermore, four of the species are confined to coastal habitats in Ireland (*B. marratii* and *Ptychostomum salinum* in and around saltmarsh edges; *P. calophyllum* and *Ptychostomum warneum* on open coastal sands, including disturbed bits of machair), so the ongoing rise of global sea-levels or resulting changes in patterns of sedimentation and saline influences may eventually further threaten them.

The island of Ireland has not been exempt from losses of its special Bryaceae populations. Extinction of *B. marratii* in Co. Derry (1936 record) was due to golf course expansion and loss of *P. cernuum* in Co. Roscommon (lost between 1968 and 2001) followed development of a jetty and amenity area on a lake shore.

By 2022, two of the three populations of *P. cernuum* known to have survived into the present century in Ireland (and thus in all of north-west Europe) also appeared to be at risk from shading, due to vegetation succession: one population's ditch habitat beside Island Lake in east Co. Mayo had already become "very overgrown" between 2003 and 2012; on Bull Island (Co. Dublin) the other population had become threatened by encroaching Sea-buckthorn *Hippophae rhamnoides*, while new tracks from heavy vehicles may either have damaged it or created new habitat. Its third population in Co. Donegal was last assessed in detail in 2011. There was a similar concern with *P. salinum,* resulting from increased shading due to reduction of grazing on saltmarsh near Galway city (not refound since 1957) and possibly also in Co. Kerry where the population found in 2005 could not be refound on a visit some years ago which reported rank vegetation due to undergrazing.

Hence, the need to re-survey the Irish populations of rare Bryaceae had become urgent, with over ten years having passed since the wide-ranging "baseline" surveys for the *Red Data Book* (Lockhart *et al*., 2012a, 2012b) were completed. In 2023, a new survey of the Bryaceae of special conservation concern in Ireland was carried out and its findings are reported in detail here. A subsidiary aim of the fieldwork involved was to provide living material from Irish populations for the newly established *ex situ* cultivation facility at the National Botanic Gardens of Ireland, Glasnevin, needed to commence cultivation in case reintroduction eventually becomes necessary.

The "LIFE on Machair" team was also active in 2022 and concerned with future management of this important habitat. By 2012, machair sites in Ireland were known to house most of the *P. calophyllum* and significant *P. warneum* populations. Nevertheless, there was a complete absence of more recent information on their status in the machair habitats, and doubt therefore

that the habitat management being proposed on machair areas would provide the open bare sand sites needed by these species.

Table 1 Species of Bryaceae of special conservation concern in Ireland. Number of localities and list of vice-counties relate to "recent" records prior to present survey, *i.e.* 1955–2022, which were revisited in 2023. Red List Ireland and Red List Europe follow Lockhart *et al*. (2012a, 2012b) and Hodgetts *et al*. (2019), respectively. Key: (CR) Critically Endangered, (EN) Endangered, (VU) Vulnerable, (LC) Least concern; FPO Flora (Protection) Order, 2022; H1 S. Kerry, H6 Waterford, H16 W. Galway, H20 Wicklow, H21 Dublin, H26 E. Mayo, H27 W. Mayo, H34 E. Donegal, H35 W. Donegal. **P. intermedium* alone has additional records from Northern Ireland. ***P. knowltonii* confirmed from fertile material only from one site in H26, but tentatively identified from several additional sites.

Species	Red List Ireland	Red List Europe	FPO	Number Localities	Vice-counties
Bryum gemmiparum	VU	LC	No	3	H26
B. marratii	LC	EN	No	6	H1, 21, 27, 34, 35
B. riparium	EN	VU	No	7	H6, 16, 20, 27
Ptychostomum calophyllum	EN	EN	FPO	4	H16, 27
P. cernuum	EN	EN	FPO	3	H21, 26, 34
P. intermedium	EN	DD	FPO	2 (+3*)	H21, 26, 38*, 39*
P. knowltonii	EN	VU	FPO	1**	H26
P. salinum	CR	VU	FPO	1	H1
P. warneum	EN	VU	FPO	4	H21, 27, 34, 35

Several biological features of the rarer coastal and other Bryaceae have implications for effective field surveys and conservation of their populations. These are discussed briefly here, in order to explain the rationale of the work that was carried out.

Although the rare Bryaceae include some iconic mosses that were sought after by Victorian collectors, their handsome fruiting capsules are only mature for a few weeks each year and in some species they are infrequently produced. At other seasons, the persistent gametophytes are rather inconspicuous and notoriously difficult to distinguish from those of species that are much more common. Indeed, *P. salinum* can only be distinguished from *P. inclinatum* using microscopic study of mature capsules or DNA sequences. Several of the other species also require microscopic study of mature spores and peristomes to confirm their identity.

Many mosses have "perennial stayer" life strategies which are convenient for conservationists because the plants persist for many years, in predictable locations, in patches that can be measured. In contrast, the shade-intolerant species of rare coastal Bryaceae have "short-shuttle" strategies where individual plants or patches of them live for only a few years. Their persistence in any locality therefore depends on open unshaded conditions being maintained. These conditions can be sustained, *e.g.* by heavy grazing, input of fresh sand, cycles of inundation and drying, or combinations of these influences. Alternatively, the Bryaceae need to colonise new open areas, typically from spores or fragments of leafy stems, although their relatively large spores (>24 µm diameter) tend to limit such local dispersal. Hence, to protect them, we need to consider regional or local "metapopulations", rather than the impersistent individual patches.

Although there is a lack of detailed information, it has been claimed that the relatively large spores of the rarer coastal Bryaceae might persist for years in soils and germinate only when disturbance creates suitable, unshaded conditions. Partly corresponding to this, experience of surveying these mosses annually over a decade in England and Wales has demonstrated

considerable dynamism of their local populations. Nevertheless, some long-distance dispersal of spores undoubtedly occurs, *e.g*. accounting for the arrival of *P. warneum* in newly created gravel pits at Dungeness (Kent), while “scraping” of old sites for the species (Braunton Burrows, North Devon; S. Wales coastal sites) failed to lead to the species reappearing. Elsewhere, after some years the rare coastal Bryaceae are scarce and local populations become shaded by plant succession. Subsequently they frequently recur in the vicinity of known sites following disturbance, *e.g.* in wheel-ruts or ditches, or at edges of pathways.

The rarer Bryaceae with small spores (<20 µm diameter) such as *P. imbricatulum* or *P. creberrimum* have proved much less susceptible to rediscovery near their former sites, probably in part because their small spores remain viable for shorter periods in soils, but perhaps also because these lighter spores disperse much more widely. For these species, the metapopulations probably occupy much larger geographical areas, so it is commonly unrewarding to search at their old localities.

Practical implications of these biological attributes are that, in addition to using the established NPWS methodology for bryophyte surveys, seeking the rare Bryaceae populations should be more effective given: visits at the appropriate seasons, to obtain samples with mature capsules from the key species; access to rapid microscopic checking of samples during fieldwork, when needed, in order to confirm identification; sufficient time to search for appropriate new open habitats around the locations with their most recent records. The value of the survey can also be enhanced if the fieldwork not only collects the usual small voucher specimens to be housed in a public herbarium, but also (a) dried samples for sequencing of DNA barcode markers to check identity of potentially significant non-fertile or otherwise troublesome plants; (b) living material for *ex situ* propagation, since this may provide a fail-safe precaution against eventual loss of the most vulnerable of the natural populations.

1.1 Aims of the new surveys in 2023

(1) To refind populations recorded since 1999 for all species covered in Table 1, at all the localities, and to seek additional subpopulations nearby. To attempt to refind populations with older records (1955–1998) where earlier attempts to refind them may not have been exhaustive. Also, to search in the vicinity, if the plants cannot be refound at the original location.

(2) To revisit sites with modern records of probable *P. knowltonii* that remained unconfirmed because sporophytes were lacking. Besides seeking capsules, it will be desirable to collect samples for DNA sequencing.

(3) To collect DNA samples from *B. gemmiparum* to allow comparison with data already available from other countries. A need for this has arisen because material from Devon previously placed as *B. gemmiparum* differs genetically from typical material of that species from S. Europe and Wales. The Devon specimens somewhat resemble large *B. dichotomum* in morphology, but do not match it well in the sequence data. (This aim was not met because *B. gemmiparum* appears to have become extinct in Ireland, but small parts of older herbarium specimens might still be studied).

(4) To collect representative samples of living material of all target taxa for the *ex situ* conservation project at the Herbarium of the National Botanic Gardens of Ireland (**DBN**), Glasnevin.

(5) To collect small, fully documented voucher specimens to check that Bryaceae populations are being correctly identified. These specimens would then be dried and lodged at the **DBN** herbarium.

(6) To record data on standard NPWS forms for the target Bryaceae at all locations visited. Also to record features of the current condition of habitats where populations, recorded since 1999, cannot be refound.

(7) To record any other rare bryophytes that might be noticed at the Bryaceae sites, *e.g*. *Catoscopium nigritum*. New records for any site to be accompanied by voucher specimens.

(8) To liaise with the "LIFE on Machair" project regarding conservation of Bryaceae on machair and allied habitats. The need was evident to ensure that conservation needs of threatened Bryaceae are integrated with management plans necessary to protect the special vegetation, birds and other biota of these habitats.

(9) Subsidiary aims were to aid in training and encouraging bryologists in Ireland, and to provide materials (via an Irish Wildlife Manual) helpful for them or others to take over survey and other work in future.

2 Methods

Two fieldwork visits were made, throughout June 2023 (concentrating on *B. gemmiparum*, *B. riparium*, *P. calophyllum*, *P. cernuum, P. salinum*, *P. intermedium* and *P. knowltonii*), with a return visit filling all of September 2023 (concentrating on *P. calophyllum*, *B. marratii* and *P. warneum*). The timing of these visits would thus optimise chances of obtaining material with mature spores of both early- and late-fruiting Bryaceae species. *B. marratii* plants are often much larger in the autumn than in early summer, so concentrating on seeking them (at most of the 16 sites) in September was believed to be more effective. Five days in the mountains revisiting sites for *B. riparium* seemed best reserved for warm dry weather in June, but rainy days in that month led to work at two sites being deferred to early September. The split into two separate months of fieldwork proposed also divided the overall work into two roughly equal halves. A purely geographical split of fieldwork on each of the two visits to Ireland would undoubtedly have saved time and money spent travelling, but it would fail to revisit sites for each species at the most appropriate seasons. Hence travel from south Co. Kerry to Co. Mayo was carried out in June, from Co. Mayo to east Co. Donegal in September, as were separate visits to North Bull Island (Co. Dublin) in both months. Beyond that, the mountain site in Co. Waterford was visited at the start of June, and that in Co. Wicklow at the start of the work in September.

All work was based from a campervan, with a microscope available (to check spore sizes, *etc*.). This also provided a retreat in sustained bad weather, including sitting through parts of storm "Agnes" on the west coast of Co. Donegal, besides allowing tidying of notes, *etc.*

The "standard" NPWS field recording methods were used to collect and record data on forms. Two hand-held GPS were used to check locations: one set up for the Irish Grid to relocate old records, and another set up for Irish Transverse Mercator (ITM) for new data. Locations were also marked on copies of aerial photographs and sometimes on copies of 6-inch maps, although the latter were often of little practical value. Digital photography was carried out at almost all sites where rarer Bryaceae were found, seeking to record their exact locations, habitat features and habitat condition. Associated plants and vegetation structure were documented in detail from representative sites where rarer Bryaceae were found. Associated plants from these places were sampled for later checking where necessary.

Where possible, adequate voucher specimens of the target species were collected. These have all been identified, annotated, labelled and fully curated, ready to be passed on to **DBN**. Material needed for *ex situ* cultivation (at **DBN**) and possible DNA sequencing was also collected. This includes ripening capsules when available, or samples of gametophytes, dried rapidly with silica gel, always linked to a herbarium voucher specimen. These living samples are already growing on agar plates at **DBN**.

A good deal of preparatory work was carried out late in 2022, since details of most of the old records had been retained, as had numerous duplicate specimens, copies of site photos, and relevant 1:50,000 scale maps. A substantial proportion of the work proposed to prepare this detailed, illustrated Irish Wildlife Manual was also begun late in 2022, with final updating later

in 2023 and in January 2024, to incorporate the new information gained from fieldwork. During September 2023 a visit to **DBN** was used to deliver recently collected material for *ex situ* cultivation and to see the Bryaceae plants already growing on agar that had been collected previously.

3 Contents and arrangement of this manual

The bulk of this publication consists of completed standard survey forms, one for each of the target species at each site (see Appendix 1). These are numbered consecutively, as Species Site numbers 1 to 49. Hence, they provide a record also of the various successes and failures during the fieldwork. They also note the personnel involved on each site visit, any information on weather or other conditions relevant to site visits and recording, and miscellaneous information on past management, any conservation issues involved, and extent of searching at each site and on adjacent areas. The survey forms were completed for: (a) all target populations of Bryaceae found or refound, (b) evident or apparent losses, (c) a few rare bryophyte species other than Bryaceae for which significant new information was recorded (these are lodged at NPWS but not published here). They emphasise population sizes, habitat details, associated plants, apparent threats, current and past management history of sites, and any conservation recommendations.

In using notes from fieldwork during 1999 to 2008 to refind rare Bryaceae populations and interpret losses and changes in their status during 2023, it often appeared that more or better detail could have been recorded in the past. Hence, in the present survey a more voluminous mass of site-specific detail has been accumulated, not all of which makes interesting reading. It is likely that in future there will be a need for living Bryaceae material from *ex situ* conservation collections to be returned to the wild. No doubt this will often be done by different bryologists to those who have seen the plant growing in the wild, into places that had lost populations as a consequence of deleterious changes to the habitats. Hence, it seems particularly important now to record considerable detail of site conditions where the last lingering populations are surviving. Of course, a full body of habitat data with quantitative measurements of substrate chemistry, water relations, microclimate, *etc*. would be desirable, but this is equally obviously unachievable during wide ranging surveys based on brief site visits. Nonetheless, careful notes on associated plants, extent of open substrata, grazing, flooding, and other factors should be much more useful than records giving only scanty habitat data.

A review summarising the status, threats, prospects and conservation needs of each species in turn precedes the survey forms that give the fuller data. Subsequent sections also consider some general threats affecting several species, such as cessation of grazing, eutrophication and competition from invasive plants. This leads on to consideration of an apparent need for NPWS to become involved as a matter of urgency in habitat management to prevent extinction of several of the Bryaceae species in Ireland, along with some suggestions for sites where this might be least difficult, while offering the greatest potential benefits.

A section on *ex situ* conservation of Bryaceae species collected during this survey follows the recommendations. This includes an introduction and background to *ex situ* conservation, *i.e. in vitro* cultivation and cryopreservation, the methods used and the results from the present survey.

4 Abbreviations used and sources for nomenclature and taxonomy

See list and comments at beginning of Appendix 1.

5 Results

A total of 49 sites, *i.e*. separate locations, were visited. These consisted of sites with records from 1955–2012, as well as new sites with records from the 2023 survey. Population estimates were recorded as the sum of approximate areas occupied by individual patches mentioned in Species Site numbers 1–49 (naively assuming that a patch measured as 5x4 cm in extent represents *c.* 20 cm^2, which will of course always overestimate its real size). "Individual Equivalent Units" (IEU) were recorded and are defined as occupied 1 m^2 grid cells (following Bergamini *et al*., 2019; Hodgetts *et al*., 2019) since this metric is being adopted as a useful and widely applicable means of comparing bryophyte species (*e.g*. by Callaghan, 2022). It is to be noted that the actual extent of the Bryaceae populations studied is very much less than that metric might suggest, *e.g*. for *P. calophyllum*, the six IEU actually represent merely six patches totalling <179 cm^2 (*i.e*. an overall total cover of <0.0179 m^2). Hence, the "percentage (%) change, by population estimate" is >99% decline for the species. In contrast, the "% change, by sites" is >75% decline (three sites lost: W. of Doon Hill, Dooaghtry, Keel Machair, one still occupied: Barnynagappul Strand), and approximate percentage change in IEU is from 179 cm^2 down to 6 cm^2, (*i.e*. >97% decline).

Based on data from the records of Species Site numbers 1–49 (in Appendix 1), the information on each species is summarised in Table 2.

Table 2 Summary data for each species surveyed. “Sites revisited” are those with older data from 1955–2012; “New sites” are new records from the 2023 survey; “Population estimates” are the sum of approximate areas occupied by individual patches; “IEU” are Individual Equivalent Units defined as occupied 1 m^2 grid cells.

Species	Sites revisited	Sites refound	Sites only refound nearby	New sites	% change by sites	% change by population estimate	Current IEU	Comment
Bryum gemmiparum	3	0	0	0	-100%	-100%	0	Now apparently extinct in Ireland. The widely pervasive nature of eutrophication of water of Lough Carra and Lough Mask discussed below suggests it may be unlikely that the species still persists at undiscovered sites on their shores
B. marratii	17	4	4	0	-53%	-70%	35	25 of the IEU are at Gortnalughoge Bay in a sparsely occupied narrow strip; many other sites have very few stems
B. riparium	7	2	1	0	-57%	-50%	6	Four of the IEU are at Fraughan Rock Glen (H20)
Ptychostomum calophyllum	4	1	0	0	-75%	>-99%	6	All six IEU are at Barnynagappul Strand, where largest patches 14x7 cm, 8x6 cm
P. cernuum	3	2	0	0	-33%	-80%	6	
P. intermedium	2	2	0	0	0%	-50%	3	This species is alone among those dealt with here in having modern records from Northern Ireland, from one site in Co. Down and two in Co. Antrim, all with small populations found in 2008 (Lockhart *et al*., 2012)
P. knowltonii	1	0	1	0	0%	-70%	1	
P. cf. *knowltonii*	5	3	1	1	0%	0%	>20	Plants lacking capsules, identification tentative. Not refound at one former site, but likely still present
P. salinum	1	0	1	1	+100%	+200%	2	Identification unconfirmed at site refound nearby; new site in H27 has much larger population than old site in H1
P. warneum	4	0	0	1	-75%	-98%	2	New site in H35 has tiny population; all four former sites now lack suitable habitat

6 Discussion: a review of causes and losses and decline of populations

These surveys in 2023 of rare Irish Bryaceae were made 15 to 24 years after initial wide ranging observations on surveys for NPWS, many of them by the present first author. This possibility to make first-hand comparisons of the populations and their habitats thus provides an unusual opportunity to review changes, and to seek or assess both local and wider causes of losses or gains in the Bryaceae populations.

As discussed in the Introduction above, it was evident from the outset that there would be some "natural mobility" of Bryaceae populations that occupy early-successional habitats on temporarily open patches of ground, *i.e*. as components of metapopulations. This was kept in mind during the fieldwork, so that failure to refind a population invariably prompted a search in appropriate habitats close by, then often at progressively greater distances from the old site. The wider need for constant recreation of appropriate niches for many of these species in order to maintain secure regional populations in Ireland is also considered here.

6.1 Eutrophication of habitats, especially grazed machair and other grasslands

Repeated references are made in the Bryaceae site accounts (Appendix 1) to finding changes, giving longer grasses, thicker closer grass swards, and loss or reduction of exposed soil or sand substrates among grasses. In some cases, vegetation succession had proceeded further, with scrub, or young trees arriving as colonists. It is often difficult to separate eutrophication/ nitrification as a cause of these, from changes in current or past grazing pressures (see below), but both processes are likely to be involved and probably to interact. Appearance of additional species tolerating high levels of nitrogen, phosphorus, or both, such as the mosses *Bryum argenteum* or *Calliergonella cuspidata* may provide the most direct evidence of nutrient enrichment. However, repeated observations imply that denser or taller vegetation in established plant communities may occur long before any floristic change becomes apparent.

The "improvement" of cattle rearing on many Irish farms has followed a similar course over the past few decades to that in other European countries, with reliance on feeding animals inside sheds or yards, on silage, or haylage. From the farmers' point of view this is an efficient use of land and cash resources, allowing higher stocking levels. The consequences for grassland biota are less satisfactory, since the grassland no longer receives dung directly from the cattle. Instead, slurry from the sheds or yards is diluted with water and spread mechanically onto grasslands used to produce silage/haylage. These grasslands are more productive, being fertilised but not trampled, but in becoming more eutrophic with a taller sward, they support a much less diverse flora. The barer less productive patches are lost, there is no cattle poaching, hence most bryophyte habitats in the grassland disappear. The runoff from land where slurry is spread often causes eutrophication of water courses, as does filling and washing of the equipment which often occurs in natural water bodies. Slurry spreading has now become common even in the remotest areas of Ireland, for example around the coasts of the Fanad peninsula in Co. Donegal, and on parts of Achill Island in Co. Mayo, bringing the eutrophication of semi-natural grassland to areas thought of as pristine 30 years ago.

High stocking densities of sheep have been maintained over the past two decades on many of the machair sites visited. Unfortunately, the same density of sheep is now having a worse impact because of the universal use of avermectin veterinary wormers. As in Great Britain, these have drastically reduced populations of dung beetles (Coleoptera: Scarabaeidae and Hydrophilidae) to the point where many species common 30 years ago are now locally extinct or endangered (*e.g*. Hutton & Giller, 2003; O'Hea *et al*., 2010b; Sands & Wall, 2018).

Although dung beetles and their larvae actually consume a very small proportion of sheep and cattle dung (often <1%) they undoubtedly have a much greater and relatively poorly documented impact on rates of dung decomposition (*cf.* O'Hea *et al*., 2010a). Their burrows speed up drying and re-wetting of dung, they allow access to other organisms (*e.g*. Diptera from above, earthworms from below), and these organisms as well as the beetles themselves, facilitate entry of fungi and bacteria throughout the dung. In some Irish coastal grasslands where avermectins are not used, the dung beetles themselves are often important prey of birds, including Rooks *Corvus frugilegus* and, locally, Red-billed Choughs *Pyrrhocorax pyrrhocorax*. The feeding birds often dig into or right through the dung and scatter it widely, greatly speeding its decomposition.

Loss of dung beetles has restricted the food available for birds such as Choughs and Lapwings *Vanellus vanellus*, and the environmental service of removing sheep and cattle dung has been reduced or has disappeared (*e.g*. Beynon *et al*., 2015). In more arid climates, the dung accumulation has often become conspicuous, as have resulting plagues of house flies (Muscidae). Even in regions with high rainfall the effects can be obvious, such as in the accumulation of sheep dung high on the north-eastern slopes of Slievemore on Achill Island, where runoff during rain concentrates dung in rills and small depressions on the hillsides. Unfortunately, more subtle effects of persistence of dung are found in signs of widespread eutrophication, reducing the extent of the "bare soil" niches of bryophytes under more complete cover of increasingly luxuriant graminoids and forbs.

A more general process of atmospheric "nitrification" has been reported in many European habitats over the past decade, and well-documented in the ecological literature (*e.g*. Weldon *et al*., 2022). It has become evident *e.g.* from changes in especially sensitive organisms such as terrestrial, rupestral and epiphytic lichens, but also at a habitat scale on oligotrophic habitats (*e.g*. Dutch dune-heaths). One source of nitrate pollution near busy major roads has often been obvious, but evidence is growing of much more widespread contamination arising from agricultural intensification, and even from inshore shipping.

6.2 Eutrophication of water bodies

As pointed out as long ago as 2003 (Giles, 2003), the year when both *B. gemmiparum* and *P. knowltonii* were first recorded in Ireland, Lough Carra has become more eutrophic: "Lough Carra is a cSAC, protected under the EU Habitats Directive and Water Framework Directive for its very high conservation values. There is clear evidence of changing land-use and agricultural intensification in studied areas of the Carra catchment and observations of increased algal growths and decreased water clarity (Thornton & Huxley, 2003; C. Huxley, pers. comm.); both classic signs of increasing nutrient concentrations. Substantial nutrient inputs are entering the Lough from certain sub-catchments and initial lake bed core samples analysed by scientists from Trinity College Dublin suggest increases in Phosphorus loadings in Lough Carra over an (as yet) unknown time period (Donohue & Irvine, 2003). These results, whilst preliminary, should be taken very seriously".

More recently, Roden & Murphy (2013) reported: decreased water transparency, a reduced euphotic zone, increased water chlorophyll content, and degraded marl crusts – all indications of nutrient pollution. It was concluded that Lough Carra was under considerable ecological stress, and that "the assumption that it is Ireland's best example of a marl lake may cease to be true in the near future".

Both of the two rare Bryaceae that occur in Lough Carra grow mainly on marl crusts covering limestone rocks in the inundation zone. Hence, recent work describing changes in these crusts at Lough Carra may be of direct relevance to the apparently worsening status of the Bryaceae. Doddy *et al*. (2019a, 2019b) showed that parts of the lake are seriously degraded, and that this damage is caused by nutrient pollution. These marl crusts contain complex microbial communities, including many species of cyanobacteria. Some of the filamentous species, especially those of the genus *Schizothrix*, bind together particles of calcium carbonate, forming firm crusts. These crusts can grow to several centimetres in thickness over time. Doddy *et al*.

(2019a) found a significant relationship between increasing phosphorus concentration and declining crust cover in Irish marl lakes. Doddy *et al*. (2019b) showed experimentally that increases in nutrients cause a change in community structure in Lough Carra's marl crusts, with green algae coming to dominate, causing declines in the filamentous cyanobacteria and eventually disintegration of the crusts.

6.3 Grazing of saltmarsh edges

Grazing by sheep has replaced that by cattle in several sites, so poaching in wet hollows has ceased and hummocks are no longer being produced. Other sites have retained intensive grazing, especially by sheep, but Bryaceae populations have been lost as ground cover increased or became thicker (*e.g*. Keel Machair, Mallaranny, Tawny, Binnion). Complete cessation of grazing has also occurred (Catherine's Isle, Fahan), or potentially disastrous temporary cessation (SW of Derrymore Island).

6.4 Loss of mobile sand on coastal sites

Losses of populations of rare Bryaceae have resulted directly from amenity developments, particularly where coastal car parks have been accompanied by restriction of off-road vehicle use and other measures to stabilise sand dunes (*e.g*. Fahan, Catherine's Isle). The same developments are often accompanied by decline or cessation of grazing on dunes (*e.g*. at Glenbeigh, and on machair/saltmarsh edge at Rossbehy). Regular use of these car parks by dog walkers also reduces grazing by rabbits *Oryctolagus cuniculus* (*e.g*. North Bull Island, Catherine's Isle).

Invasion of Sea-buckthorn currently adds to the threats at North Bull, where there is now a clear risk of complete loss of large areas of dune-grassland and slack habitats unless urgent action is taken. Fortunately, the land managers there are well aware of the problem and are taking action. Unfortunately, birds distribute the fruits widely so seedlings appear over a wide area near fruiting plants. There is also evidence at North Bull of local people occasionally planting the species in the dunes, with seedlings appearing in neat rows.

Similar threats are apparent on the coast of the Rossbehy peninsula in Co. Donegal where large stands of Sea-buckthorn exist but currently show less sign of becoming invasive. The potential of this shrub for stabilising dunes is well-known to local people there. At Portnoo, the owner of a large caravan park explained to DTH how his business had been "saved" by planting Sea-buckthorn extensively when a breach occurred in the dunes beside Tramore Strand.

6.5 Changes in mountain habitats

Long-term studies of the vegetation of Irish mountains in relation to changing environmental factors are unfortunately not available for the same long time span and with equivalent level of detail as the results reported by Ross *et al*. (2012) for the NW Scottish highlands. Those authors were able to compare 952 vegetation surveys from 1956–8 from the classic studies by McVean and Ratcliffe with surveys repeated fifty years later in 2007–8. They found considerable "homogenisation" had occurred, affecting grassland and heath vegetation types more than mires. Thus, species richness had declined, as had variation in community composition. Upland graminoids had increased, whereas dwarf-shrub, forb and lichen cover had declined. Species with oceanic distribution types had increased at the expense of those with an arctic-montane distribution. Pooled analyses of individual species preferences using Ellenberg indicator values implied that the main drivers responsible were climatic warming and acidification, although overgrazing may also have been important. The vegetation of Irish mountains, particularly along the western seaboard, has presumably been exposed to similar influences to that in NW Scotland, although details of vegetation changes here will mainly have passed unrecorded over such a long time scale.

Disappearance of the scarce patches of *Bryum riparium* from various montane locations (Mweelrea; Slievemore on Achill Island; northern site at Maumtrasna) is difficult to explain. They grew on rock ledges or in crevices out of the reach of sheep. Some of them may have simply been dislodged by falling rocks, flood water, or minor land-slips. However, they have not been replaced by new patches colonising open substrata nearby. The plants of *B. riparium* are relatively small, and hence vulnerable to becoming overgrown and shaded by vascular plants or other larger bryophytes. In the north-east corrie of Slievemore, larger plants have certainly shaded its original site and the surrounding vegetation of both bryophytes and phanerogams on ledges now seems particularly large and vigorous. As noted above, even in this remote location there was evidence of accumulation of sheep dung in 2023 that may have contributed to more general eutrophication. Fortunately, *B. riparium* may have survived more often in Irish riverine habitats than it has in gullies, slopes and ledges in the mountains.

7 Recommendations

7.1 Revision of threat status

The comprehensive new data from surveys in 2023, summarised above, prompt reassessment of the threat status afforded several of the species in Ireland (from Lockhart *et al*., 2012a, 2012b) based on criterion A of IUCN 2012 (decline): *Bryum gemmiparum* VU to RE; *Bryum marratii* LC to EN, or CR; *Ptychostomum cernuum* EN to CR; *Ptychostomum warneum* EN to CR. A detailed analysis of the current data for these four species may well show other Criteria additional to Criterion A can be invoked.

Treatment of *Bryum riparium* (EN) and *Ptychostomum salinum* (CR) may be best left unchanged as gains and losses of their populations from 2012–2023 are approximately balanced.

The status of *Ptychostomum intermedium* (EN) apparently remains unchanged in Republic of Ireland (ROI) (with two localities) but there is a lack of recent information from Northern Ireland (three localities before 2012).

The status of *P. knowltonii* should perhaps be DD for now. It still has a single Irish site producing a few fertile plants that can be securely identified, while more numerous sites produce only gametophytes which cannot currently be identified securely, but for which decisive molecular data is likely to be obtained.

In view of its widespread decline, *B. marratii* should also be added to the list of species covered by the Flora (Protection) Order in Ireland.

7.2 Suggestions for conservation actions

There is a clear need for regular monitoring of known populations of a few of the most threatened species, coupled with timely management intervention when problems are noticed. Small-scale intervention to remove invading plants, fallen rocks, *etc*. can easily be carried out on monitoring visits, but the operator needs to know exactly which mosses are being protected and what should be done. A quick response may also be needed if site damage is occurring or imminent, such as overstocking with animals (see *e.g*. Keel Bridge), erection of fences (Soldiers Hill; Mallaranny sites), or bonfires (E. of Rosmoney).

Several instances have been found where “hands-on” habitat management is needed to sustain populations of the rarest species. In most of these cases, it is the need to recreate or maintain patches of open early-successional habitat. At the simplest level, it may be to use a sharp knife to trim competing grasses or rushes on the top of a hummock (*e.g*. for *P. salinum* patches at Mallaranny), or to take secateurs to spend an hour or two killing Sea-buckthorn

seedlings and saplings at the *P. cernuum* site (North Bull), or to cut low *Cotoneaster* on limestone pavement immediately adjacent to *P.* cf*. knowltonii* (Keel Bridge).

Much more drastic intervention is clearly needed in other places in order to create open areas of substratum large enough to persist on time scales of more than one or two years, and large enough to support robust populations of the scarcest species. The following section (7.3) expands on these suggestions with examples of projects that are likely to be needed to prevent extinction of several of the Bryaceae species in Ireland.

At a landscape and whole-farm scale, adjusting payments to farmers to secure ecological improvements is clearly a very worthwhile use of public money and the efforts of conservationists. However, a necessary addition to this in dealing with the rarest populations is closely targeted direct intervention, working with landowners. To be most effective, this requires specialised bryological and ecological knowledge, *e.g*. to decide which patch of turf to strip and which should not be trampled in the process, or which bushes to remove and if, when, and where to burn the arisings.

In vitro cultivation now provides a potential fall-back position if a population becomes extinct in the wild. However, there is a serious risk that the detailed and localised understanding of the ecology and requirements of the species will also have been lost, prejudicing any return of cultivated material into the wild. While opportunities to study the most gravely threatened species still exist, detailed ecological studies to identify threats and requirements, with thorough documentation have therefore become more important than ever.

Reintroduction attempts with *Jacobaea paludosa* (Asteraceae) in the Fenland of eastern England provide a well-documented example of difficulties that should be expected (Stroh & Wigginton, 2023). It was thought to be extinct in Britain by 1857, until one large plant was refound in 1972. This plant continued growing and flourished until it had 33 flowering stems in 2019. Since 1992, cultivated plants descended from it have been introduced to 33 locations in or near some of the historic sites, including into protected areas. Nevertheless, all but two of these introductions failed. The very high failure rate was attributed “to three main factors: an inability to replicate its principal dynamic ecological niche, herbivory by deer and slugs, and competition from the surrounding vegetation”. Since *J. paludosa* is a potentially long-lived perennial up to 1.5 m or sometimes 2 m tall, management of introduced plants should be easier than with short-lived mosses <3 cm tall.

7.3 Need for large scale habitat management and suggested projects

The disappointing conclusions of these new surveys are that *Bryum gemmiparum* has probably become extinct in Ireland, that *P. calophyllum* and *P. warneum* are very close to extinction here if predictable patterns of habitat loss are maintained, and that *P. cernuum* is likely also to be lost within the next decade if present trends continue unchecked.

This leads on to consideration of a clear and urgent need for NPWS to become involved in habitat management to prevent extinction of several of the most threatened Bryaceae species in Ireland. While it is unattractive for bryologists and other botanists to become involved in “gardening” to maintain semi-natural habitat rather than recording natural processes, the alternative course of non-intervention will lead to irreversible losses.

As discussed above, *ex situ* conservation and reintroduction can only be part of a longer term solution. Any reintroduction will require suitable habitat to be present, and the ongoing declines of the rarest Bryaceae are apparently due directly to continuing losses of their habitats. Declining knowledge of their detailed habitat requirements in future is also likely to go hand in hand with increasing rarity of the plants.

Ideas of “reactivating dormant spore banks” as a conservation strategy are also of dubious value for these Bryaceae. Unlike the situation with seeds of *Damasonium*, *Agrostemma*, or

Rumex subgenus *Rumex*, the thick-walled spores of *Riccia*, or rhizoidal tubers of *Ditrichum cornubicum*, the spore longevity of the Bryaceae is poorly known. The existing evidence, however, does not suggest their spores are especially long lived. Indeed, it appears that the very large but thin-walled spores in some coastal Bryaceae species such as *P. warneum* may be adaptations not for spore longevity, but instead for limiting widespread but wasteful spore dispersal at exposed coastal sites, while carrying substantial nutrient reserves for initial growth. Thus, several hectares of "scraping" of former dune slack sites for *P. warneum* at Braunton Burrows in north Devon failed to reactivate any spore banks, whereas subsequent deliberate introduction of the plants from Merseyside onto the scrapes (Holyoak, 2005) succeeded at least for several years. "Scraping" of dune slacks at two sites in south Wales likewise failed to revive their former Bryaceae populations (Holyoak, 2015).

The loss of Irish populations of *Bryum gemmiparum* appears to be due mainly to eutrophication of water in Lough Carra and Lough Mask, plus the seemingly irreversible damage to a small area of limestone pavement near Keel Bridge. Since the habitat throughout both loughs now appears unsuitable for the species, thoughts of reintroducing it must be a low priority. The species still occurs on the River Usk (Breconshire, Wales) (Callaghan, 2022 and it is locally common over large areas of southern Europe and in Macaronesia (*e.g*. Holyoak, 2021).

A strategy for sustaining the other three highly endangered species in Ireland (*P. calophyllum, P. cernuum, P. warneum*) is suggested here, involving the sites where this might be least difficult and least costly to achieve, while offering the greatest potential benefits.

The needs of *P. calophyllum* at the last surviving site near Barnynagappul Strand are relatively easy to meet, as set out under Species Site 31 (see Appendix 1). In addition, creation of new areas of loose sand on some small bits of machair at Dooaghtry (Species Site 29) would be very worthwhile and relatively easy to accomplish, perhaps involving use of a rotavator (or tractor-drawn harrow) to clear patches of the turf cover in the most open of the old lost sites, combined with creation of new breaks in the vegetation cover on the nearest dunes.

At Island Lake (Co. Mayo; Species Site 33), *P. cernuum* was lost around ten years ago as an open ditch in the edge of the marl-lake/turlough became overgrown. The ditch now supports substantial Alder trees. Following initial negotiation with the landowner, it might be practicable to fell the line of trees and remove the stumps, then re-excavate a substantial stretch of the ditch with a mechanical digger in order to reveal new open calcareous habitat. If *P. cernuum* does not reappear here from buried spores, there is also the possibility of quickly reintroducing it with material which is thought to still be held in cryopreservation at Royal Botanic Gardens, Kew, United Kingdom (Rowntree *et al*., 2011; M. Ramsay, pers. comm.). With a mechanical digger on-site here, there should also be little difficulty in reducing the developing thick vegetation cover (of *Schoenus nigricans*, *etc*.) threatening the closely adjacent site for *Ptychostomum intermedium* and *Southbya tophacea*, on mounds of marl near an old pond (Species Site 36).

The population of *P. cernuum* at Soldiers Hill (Co. Donegal; Species Site 34) on the bank of a stream-ravine has declined greatly due to encroaching scrub and other vegetation. Collaboration with the two different landowners here should seek to remove brambles and other scrub and the few existing trees from the stream bank, and if at all possible, to realign fences or paths so as to facilitate access to the stream banks by grazing animals.

A relatively small area of dune slack and its edges on North Bull Island (Species Site 32, 35, 45) not only has the only other surviving population of *P. cernuum*, but also one of only two sites in ROI with *P. intermedium*, and a recently lost population of *P. warneum*, so it is now the most important individual site for rare Bryaceae species in Ireland. Nevertheless, the remaining open habitat here is at risk from the ongoing spread of Sea-buckthorn seedlings and saplings, which should be removed immediately and kept under regular surveillance as new seedlings will arise. In addition, careful and judicious small scale scraping to maintain open patches amongst and near the *P. cernuum* should be carried out annually.

Notwithstanding the immediate need for small-scale habitat management, the long-term future of the rare Bryaceae here will remain in doubt unless new sources of wind-blown sand are created, to counter the inevitable vegetation succession in this slack and on the adjacent dunes. Unfortunately, there are no younger slacks on the adjacent, seaward side, to the south-east of the surviving *P. cernuum*, and the dunes there have a closed cover of Marram grass *Ammophila arenaria*. Since the vegetation in these dunes to the south-east is of low ecological and botanical interest, there seems to be an obvious opportunity to create a new slack there by mechanically excavating a long strip parallel to the existing slack. The new slack would need to be deep and extensive enough to reach the winter water-table, but not so deep as to produce a permanent pond. Besides creating potential new habitat for the rare Bryaceae and *Petalophyllum ralfsii*, the excavations should liberate enough loose sand to revive the habitat in the adjacent existing slack to the north-west. Of course, creating breaks in the Marram grass cover could provide open ground that Sea-buckthorn might occupy, so ongoing management of any newly disturbed areas should be envisaged.

8 *Ex situ* conservation

8.1 Background

Ex situ conservation is the preservation of species outside their natural habitat. It is a conservation strategy that should be used in tandem with, and complementary to, *in situ* conservation efforts, *i.e.* preservation of species within their natural habitat, not in place of them. *Ex situ* conservation collections are repositories necessary to ensure the survival of the remaining genetic diversity within rare and threatened species and can act as an “insurance policy” should anything damage or destroy target species populations in the wild (Sabovljević *et al*., 2014; Duckett *et al*., 2004; Ramsay & Burch, 2001).

Ex situ conservation has been supported by the Convention on Biological Diversity and the subsequent Global Strategy for Plant Conservation, Ireland’s National Strategy for Plant Conservation and, more recently, the National Biodiversity Action Plan 2023–2030. *Ex situ* plant collections can comprise long-term storage of germplasm, such as seed banks and cryopreserved collections, and also living collections, including botanic garden and *in vitro* cultivation collections (Pence *et al*., 2020; Mounce *et al*., 2017; Rowntree *et al*., 2011).

In 2019, the Irish Government recognised that we are in a biodiversity loss crisis and declared a National Climate and Biodiversity Emergency. That same year, as part of the Conference Charter “Our Seeds for Nature” at the inaugural National Biodiversity Conference, the Office of Public Works (OPW) committed to developing a National Seed Bank at the Herbarium of the National Botanic Gardens of Ireland (**DBN**) for conserving the Irish flora. This action is further supported through the OPW Biodiversity Action Strategy 2022–2026. Under the scope of this initiative, *ex situ* conservation collections of Ireland’s rare and threatened bryoflora are also being developed through *in vitro* cultivation and cryopreservation. The long-term aim of the **DBN** *ex situ* laboratory is to conserve Ireland’s most rare and threatened bryophyte species as outlined by Lockhart *et al*. (2012a, 2012b), and any subsequent red lists, for their survival into the future.

A report on progress thus far on the *ex situ* conservation of the target Bryaceae species surveyed in 2023 is outlined in this Irish Wildlife Manual.

8.2 *In vitro* cultivation collections

The *in vitro* cultivation laboratory was established at **DBN** in early 2023. *In vitro* cultivation (IVC) is the propagation of plant material under axenic (sterile) conditions in tissue culture on defined, artificial nutrient media. Bryophytes are particularly well-suited to growing in IVC given their totipotent capabilities. They require low nutrient media and cultures can survive for relatively long periods (months) without sub-culturing once sterile conditions are achieved.

Protocols have been developed for collection, sterilisation, propagation and storage and maintenance of bryophyte *in vitro* collections (Sabovljević *et al*., 2014; Campbell, 2013; Rowntree, 2006; Rowntree & Ramsay, 2005; Duckett *et al*., 2004).

8.3 Other living collections

Living collections are also maintained in the "Killarney Fern House", a cool greenhouse at the back of the Curvilinear Range of the National Botanic Gardens of Ireland. It is comprised of stone walls with a glass roof which provide conditions conducive to the maintenance of a relatively cool temperature and high humidity levels. It was constructed *c.* 1870 when originally, the terraced wall at the back allowed the flow of water from a gutter along the top of the wall to trickle in a cascade down the wall. In recent years, the Killarney Fern House is kept humid by means of mist sprayers. It remains closed to the public and houses the iconic Killarney Fern *Vandenboschia speciosa* (syn. *Trichomanes speciosum*) and several other fern species, and now also, a selection of rare and threatened bryophytes.

8.4 Cryopreservation

In vitro cultures of plant material that are continually sub-cultured may become adapted to growth in those conditions over time and in the process lose genetic variability (Sarasan *et al*., 2006). The success of reintroduction programmes utilising such material would be doubtful. Therefore a long-term storage mechanism, where cellular processes are paused and the material kept alive in axenic conditions in suspended animation, is required. Cryopreservation is the storage of material at -196ºC in liquid nitrogen and many protocols have been developed for bryophytes (Tiloca *et al*., 2022; Rowntree & Ramsay, 2009; Burch, 2003; Burch & Wilkinson, 2002; Pence, 1998; Christianson, 1998). Cryopreservation reduces the need for sub-culturing, thus reducing labour and it minimises the risk of genetic drift and somaclonal variation (Christianson, 1998; Fay, 1992). Preparations for the establishment of the cryopreservation laboratory at **DBN** are ongoing.

8.5 Methods

8.5.1 Collection of material

In general, the collection protocol followed Rowntree & Ramsay (2005). Only where there was enough gametophytic material to allow for sampling, shoots and, where possible, sporophytes of the target Bryaceae species were collected by David Holyoak (under FPO licence). The samples were carefully cleaned of excess soil and other debris, wrapped loosely in tissue paper and placed in (Sterilin 60 ml) plastic jars with lids containing *c.* 5 g of silica gel. All species collected were desiccation tolerant. However, *Bryum riparium* showed less desiccation tolerance than the other species and was collected as above, but without the use of silica gel. Material from each sampling point was also collected for an associated voucher herbarium specimen for **DBN**. Samples were processed in the **DBN** laboratory within a maximum of one week from the collection date.

8.5.2 Sterilisation procedure

In the **DBN** laboratory, shoots were carefully selected under a dissecting microscope with a fine forceps from each sample collected and placed in a petri dish containing deionised water. Any remaining debris was removed under the microscope. Under sterile conditions in a laminar flow cabinet (pre-swabbed with 70% alcohol), specimens, *i.e*. gametophytic shoot tips or sporophytes, were placed on a 55 mm filter paper (Sartorius Stedim Biotech; 65 g m^{-2} grade 3h) positioned within a Sartorius stedim 16309 vacuum flask and filter system, which had been autoclaved at 120 ºC and 15 psi (pounds per square inch), connected to a vacuum pump. Sterilisation with a vacuum flask and pump is more effective as it removes air pockets that may

harbour microbial contamination (Evans *et al*., 2003). Specimens were washed through with sterile deionised water five times and given two washes with a sterilising solution of sodium dichloroisocyanurate (NaDCC). NaDCC has low phytotoxicity and controls endophytic contamination (Rowntree, 2006; Niedz & Bauster, 2002; Parkinson *et al*., 1996). The dilution strength and length of immersion of the second wash in the sterilising agent depended on the specimen type. Rowntree & Ramsay (2005) recommend immersion in 1% NaDCC for 3–6 minutes for sporophytes and 2–5 minutes in 0.5% NaDCC for leafy gametophytes and this protocol was followed (see also Duckett *et al*., 2004). After sterilisation, the specimens were washed through five times with sterile deionised water.

8.5.3 Initiation into culture

After the washing procedure, still under the laminar flow hood, the sterile gametophytic shoot tips were transferred onto sterile plates containing ¼ strength Murashige and Skoog (MS) medium (Murashige & Skoog, 1962; see also section 8.5.4 below) either using sterile needles (Sigma Aldrich B-D Precisionlife®) or a fine forceps that had been previously autoclaved. The forceps were kept sterile by placing in a glass bead steriliser heated to 245 ºC for 30–60 seconds. Sporophytes were held with a fine forceps, had the operculum removed with a sterile needle and spores were allowed to fall onto the sterile plates. The petri dishes containing the agar were generally 55 mm diameter sterile plastic dishes (Sarstedt). Plates were sealed with Parafilm®. Deep sterile plastic jars with lids (Sarstedt) were also used.

8.5.4 Culture medium

One litre of culture medium was prepared by adding 1.075 g of Murashige and Skoog Basal Salt Mixture to 900 ml of deionised water with 10 g of agar in a one litre beaker on a stirring plate and the volume brought up to one litre with deionised water. The pH was adjusted to 5.8 with a 1 molar sodium hydroxide (1M NaOH) solution. The medium solution was autoclaved at 120 C and 15 psi for 20 minutes to sterilise. Once cooled sufficiently, the medium was moved to a laminar flow cabinet (pre-swabbed with 70% ethanol) and decanted into the lower half of sterile petri dishes. Lids were placed on the petri dishes once the agar medium had cooled and was almost set, to prevent condensation on the inside of the lids. The petri dishes were then sealed with Parafilm®, to maintain sterility, until required. Alternatively, the medium was poured halfway into deep sterile plastic jars (Sarstedt) with lids closed once cooled.

8.5.5 Maintenance of cultures

Initiated culture plates were maintained in a growth cabinet kept at 20 ± 2 ºC on a 16 hour light/8 hour dark cycle. Once the cultures were established they were monitored for infection and/or exhaustion of the medium. Explants were transferred to new culture plates with or without repeated sterilisation dependent on whether they showed signs of contamination.

8.5.6 Killarney Fern House collections

Remaining material of samples collected were established, where possible, as living collections in the Killarney Fern House of the National Botanic Gardens of Ireland.

8.6 Results

Establishment of species in axenic culture is regarded as successful if three months after the initial sterilisation procedure and initiation into culture, the samples are free from contamination and actively growing (Rowntree & Ramsay, 2005). Details of sampled species and populations successfully initiated into culture and additionally established as living collections in the Killarney Fern House are outlined in Table 3.

Table 3 Details of target Bryaceae species initiated into *in vitro* cultivation (IVC) and Killarney Fern House (KFH) living collections at the National Botanic Gardens of Ireland. * Collected in September 2023 - Voucher Reference DTH 23-096 of *P. cernuum* for **DBN** from North Bull Island was collected previously, in June 2023.

Species name	Voucher Reference	Source locality	Vice-county	IVC initiation material	KFH collection
Bryum marratii	DTH 23-089	E. of Rosmoney	H27	Gametophyte	No
Bryum marratii	DTH 23-135	Gortnalughoge Bay	H35	Gametophyte	Yes
Bryum marratii	DTH 23-152	SE of Sheskinmore Lough	H34	Gametophyte	Yes
B. riparium	DTH 23-077	SE of Maumtrasna, beside Srahnalong River	H16	Gametophyte	Yes
B. riparium	DTH 23-100	Fraughan Rock Glen	H20	Gametophyte	Yes
B. riparium	DTH 23-103	Fraughan Rock Glen	H20	Gametophyte	Yes
Ptychostomum calophyllum	DTH 23-099	SE of Barnynagappul Strand	H27	Gametophyte Spores	Yes
P. cernuum	DTH 23-128	Soldiers Hill (S. slope)	H34	Gametophyte	No
	None*	North Bull Island	H21	Spores	Yes
P. cf. *knowltonii*	DTH 23-079	NW of Keel Bridge	H26	Gametophyte	Yes
P. cf. *knowltonii*	DTH 23-080	Inishcoog, shore of Lough Mask	H26	Gametophyte	Yes
P. cf. *knowltonii*	DTH 23-081	SW of Inishard, shore of L. Mask	H26	Gametophyte	Yes
P. cf. *knowltonii*	DTH 23-082	SW of Inishard, shore of L. Mask	H26	Gametophyte	Yes
P. cf. *knowltonii*	DTH 23-091	SW of Inishard, shore of L. Mask	H26	Gametophyte	Yes
P. cf. *knowltonii*	DTH 23-083	near Brownstown, E. shore of Lough Carra	H26	Gametophyte	Yes
P. cf. *knowltonii*	DTH 23-084	near Brownstown, E. shore of Lough Carra	H26	Gametophyte	Yes
P. cf. *knowltonii*	DTH 23-085	near Brownstown, E. shore of Lough Carra	H26	Gametophyte	No
P. cf. *knowltonii*	DTH 23-086	near Brownstown, E. shore of Lough Carra	H26	Gametophyte	Yes
P. knowltonii	DTH 23-088	near Brownstown, E. shore of Lough Carra	H26	Gametophyte	Yes
P. intermedium	DTH 23-094	Island Lake (E. side)	H26	Gametophyte	Yes
P. salinum	DTH 23-074	SW of Derrymore Island	H1	Gametophyte	Yes
P. salinum	DTH 23-090	S. of Mallaranny	H27	Gametophyte	Yes
P. warneum	DTH 23-153	Magheramore (inland of Trawmore Strand)	H35	Spores	No

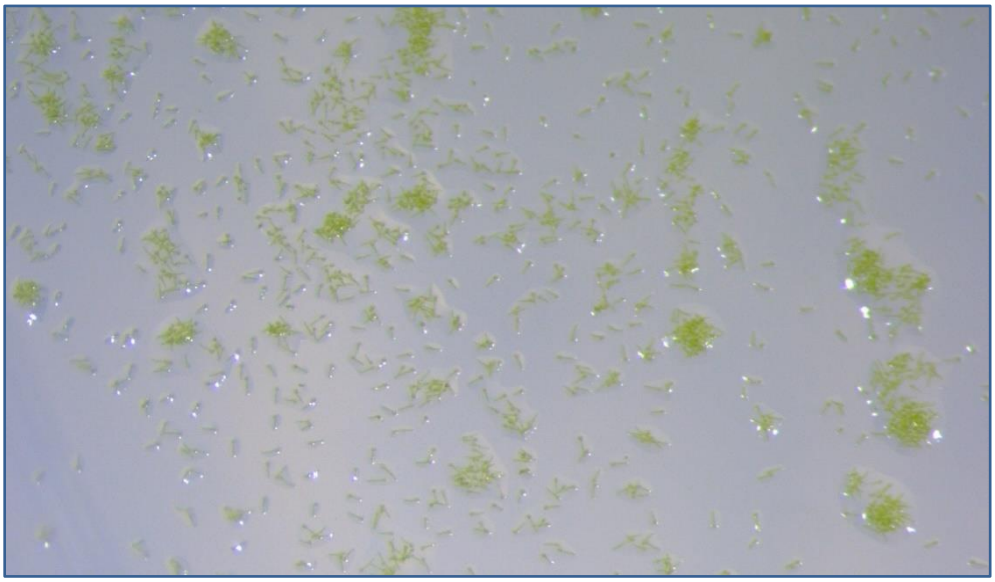

Figure 1 Germinating spores of *Ptychostomum cernuum* from North Bull, Dublin three days after initiation into *in vitro* cultivation. Photograph Christina Campbell.

Figure 2 Protonema growing from shoot tip of *Ptychostomum calophyllum* (DTH 23-099) *c*. one month after initiation into *in vitro* cultivation. Photograph Christina Campbell.

8.7 Discussion

The establishment of the target species into *in vitro* cultivation (IVC) has been successful for all target species (e.g. Figures 1 and 2). Maintenance of the *in vitro* cultures is ongoing and sub-culturing (and re-sterilisation where necessary) minimises the levels of infection present on the plates. The *in vitro* technique has many advantages, as development from initial spore germination to sporophyte production can be studied closely, and it allows experimental investigation of a wide variety of biological and ecological conservation issues (Campbell *et al*., 2023). From very little initiation germplasm of rare species, IVC can also be used to increase material for genetic analyses (Campbell *et al*., 2017). However, upkeep of an *in vitro* cultivation collection is rather labour-intensive and samples from the collection are to be transferred into cryopreservation for long-term storage in 2024.

Weaning of cultured material onto natural substrate in the Killarney Fern House is a possibility for many of the species. This technique was successful in a previous study involving *P. cernuum* where gametophytic material, originally collected from Bull Island and grown in culture from spores, was transferred onto sterilised sand (collected from near to the *in situ* population) and maintained in the Killarney Fern House. Sporophytes were produced and spores sown onto agar medium, thus the species completed its life cycle in *ex situ* conditions (Campbell, 2013).

The *ex situ* collections can be a source of material for recovery programmes (Pence, 2004) to reintroduce species to former locations in the wild or to augment existing ones. Care must be exercised with this approach, however, with appropriate guidelines (IUCN/SSC, 2013) followed and genetic analysis undertaken where necessary (Rowntree *et al*., 2010).

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Appendix 1. Species Site data sheets

A form with standardised headings was used to record data on each of the target species at each locality. An edited version of these data sheets is presented here, with the standard headings shown in bold blue type.

Each sheet is given a Species Site number. The sheets are arranged in alphabetical order of the names of the target species. Within each species they are presented in order of vice-county numbers, then approximately from south-west to north-east within the vice-county.

Each sheet is accompanied by an abstract of the 1:50,000 Discovery Series map. Almost all sheets also have an abstract of the Bluesky digital aerial imagery for the same locations. The extent of coverage of the Bluesky image is shown on the Discovery map as a square bounded by dashed red lines. The two sheets lacking Bluesky images were for poorly localised old records for which it was not possible to specify the location with sufficient precision. Because the surveys for the Discovery Series maps and the Bluesky imagery were made in different years, some topographic detail may have changed. In particular, the coastline has moved outwards at the Sheskinmore locality.

The same red symbols for the location of Bryaceae records are used on both Discovery maps and Bluesky images, as follows:

□ for records made during the present survey, in 2023;

+ for records made between 1950 and 2022.

Records shown on the maps, whether new or old, are plotted on the Irish Transverse Mercator (ITM) map projection. Each is identified by a 'Map letter' (a, b, c, etc.), in red font, corresponding to the relevant coordinate for the records cited in the Species Site data sheets. New records (from 2023) were recorded on ITM. Older records were usually recorded in Irish Grid (IG), and these have been converted to ITM for the maps. The re-projection was done using a high accuracy NTv2 transformation. A few of the old records (1950–1995) were so imprecise that they could only be located to within a 1 km square. In these cases alone the convention has been adopted of placing the symbol **+** at the south-western corner of the appropriate 1 km square.

All photographs used in this publication were taken by the first author, David Holyoak. Two pieces of equipment used in the field appear in many of the photos to mark location of finds, provide a scale, or both. The black penknife (with a long bright orange tape attached) has blade 80 x 16 mm, black handle 104 mm. The dayglo pink clipboard measures 225 x 330 mm, a bit larger than A4 paper size.

The photos were taken using a Canon Powershot G7X compact camera, as large .jpg images. A total of 954 images from the fieldwork have been kept and annotated, which include a small number recording rough field maps of site locations. Most of the images were intended to record (a) location information potentially helpful for refinding the target Bryaceae on future visits, (b) the character and condition of the vegetation at the time of the surveys, and occasionally (c) to document appearance of the Bryaceae at a few localities where the mosses found were too scarce to allow collection of voucher specimens.

Only a selection of these images is published in this Appendix to the *Irish Wildlife Manual*, where the 92 photos used also include a few from earlier years that provide significant comparisons with the situation in 2023. However, the full set of photos is archived with NPWS, along with many of the Bryaceae sites from bryophyte surveys during 1999–2009. The data sheets below give the four-digit image numbers (i.e. file names, prefaced by IMG) for the photos from 2023 for each site in order to facilitate access to them for future studies.

Abbreviations used in this Appendix: BBS (British Bryological Society), **BBSUK** (Herbarium of British Bryological Society, now incorporated into that of National Museum of Wales, Cardiff, as **NMW**), BRC (Biological Records Centre, United Kingdom), CC (Dr Christina Campbell), c.fl. (flowering), c.fr. (with capsules), **DBN** (Herbarium at National Botanic Gardens of Ireland, Glasnevin, Dublin), DTH (Dr D.T. Holyoak), **E** (Herbarium at Royal Botanic Garden, Edinburgh), FPO (Flora (Protection) Order, 2022), GPS (Global Positioning System; Garmin Etrex High Sensitivity and Etrex 10 were used), MHWS (mean high-water spring tide level), IG (Irish Grid), IMG (photo image numbers from fieldwork in 2023, see above), ITM (Irish Transverse Mercator map grid), IVC (*in vitro* cultivation), NHA (Natural Heritage Area), NPWS (National Parks and Wildlife Service), NVCR (new vice-county record), ROI Republic of Ireland, SAC (Special Area of Conservation), s.n. (specimen without a collector's number), v.c. (vice-county).

Throughout this *Manual* and the Appendix, taxonomy and nomenclature of bryophytes follow Hodgetts *et al*. (2020); Stace (2019) has been followed for vascular plants.

Copyright information

Species Site 1

Species *Bryum gemmiparum*	**County** Mayo	**Vice-county** H26
Locality SW of Caher (Cahir)		**Discovery Map** 38
SAC/NHA Lough Carra/Mask Complex SAC 001774		
Grid References (from hand-held GPS) **ITM** Not recorded	**IG** M1404 6316 (Map letter a)	
Comments The IG reference given is that recorded on 21 May 2003. Our appraisal of the rocky shoreline habitats on 13 June 2023 implied that this grid reference was somewhat imprecise, being tens of metres east of the most likely places. However, no *B. gemmiparum* was refound despite a search effort over *c.*90 minutes by two observers in good dry weather conditions with lower than usual lake-water levels.		
Elevation (m) 17		
Survey date 13 June 2023	**Observers present** DTH & CC	
Population recorded None		
Previous records here/close by Discovered here on 21 May 2003; see below for details.		
Fertile? Capsules lacking from 2003 gathering (they are unknown for this species in Ireland or Great Britain).		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types See “Previous records” below and fuller information in NPWS files.		
Associated plant species No new information		
Current land-use/grazing Not grazed by farm stock		
Photographs of site No		
Field sketch map photographed No		
Apparent threats/any existing conservation measures No immediate threats to the site were obvious. The attractive macrophyte vegetation on the upper part of the lake inundation zone was in good condition. The rough terrain on the limestone rocks here and lack of direct access protect the site from the numerous visitors to the pier. There has been no targeted monitoring or conservation management work directed at Irish populations of this species.		
Other comments Low water levels in Lough Mask in June 2023 facilitated our survey.		
Details of Previous Records Discovered here during fieldwork for NPWS by DTH. Data on the voucher specimen (DTH) records: “21 May 2003, E. shore of L. Mask, SW of Caher, E. Co. Mayo, v.c. H26, M1404 6316 (Map letter a), on unshaded thin soil of crevices in horizontal limestone rock *c.*50 cm above water at edge of lake, near sparse grasses & herbs, *c.*15 m alt., Holyoak 03-140”.		
Reasons for loss or decline There was no obvious change in the site conditions here between 2003 and 2023. The vegetation was still in good condition; *Ptychostomum pseudotriquetrum* was found in numerous spots in the lake inundation zone and a single tuft of *P. capillare* was noticed. No accumulated marl was present on and among the rocks and some places may be exposed to strong wave action. At its few known sites in Ireland and Great Britain, and larger numbers of them in Portugal and Spain, *B. gemmiparum* grows in clean, shallow water or marginal inundation zones of water bodies, over a very wide range of rock types, from base-poor sandstones and granite to limestones, even mortar and concrete locally (Holyoak 2021:136, and pers. obs.). However, it does not grow in or beside eutrophic lowland waters and it does not withstand prolonged or regular desiccation. Progressive eutrophication of the water of Lough Mask over the past fifty years has been well-documented (e.g. Irish Water Report 2014; Murnaghan, Taylor & Jennings 2015). There is also a well-documented history of large amplitude fluctuations in lake levels (as measured e.g. at Caher Pier, station 30081, site of the *B. gemmiparum* record discussed here) over the past two decades. Some deviations from the historic pattern of high winter water levels and		

low summer levels have been noticed, with some years having lower summer water levels (including in June 2023). There is concern that global warming and changes in local rainfall may increase these extremes. Hence, there is room for suspicion that eutrophication of the lake water and alteration of wetting and drying cycles in the inundation zone have had a deleterious effect on *B. gemmiparum*.
Recommended conservation measures No action for this species at this site. Wider issues of water quality in Lough Mask are already receiving attention, which will hopefully minimise further damage.

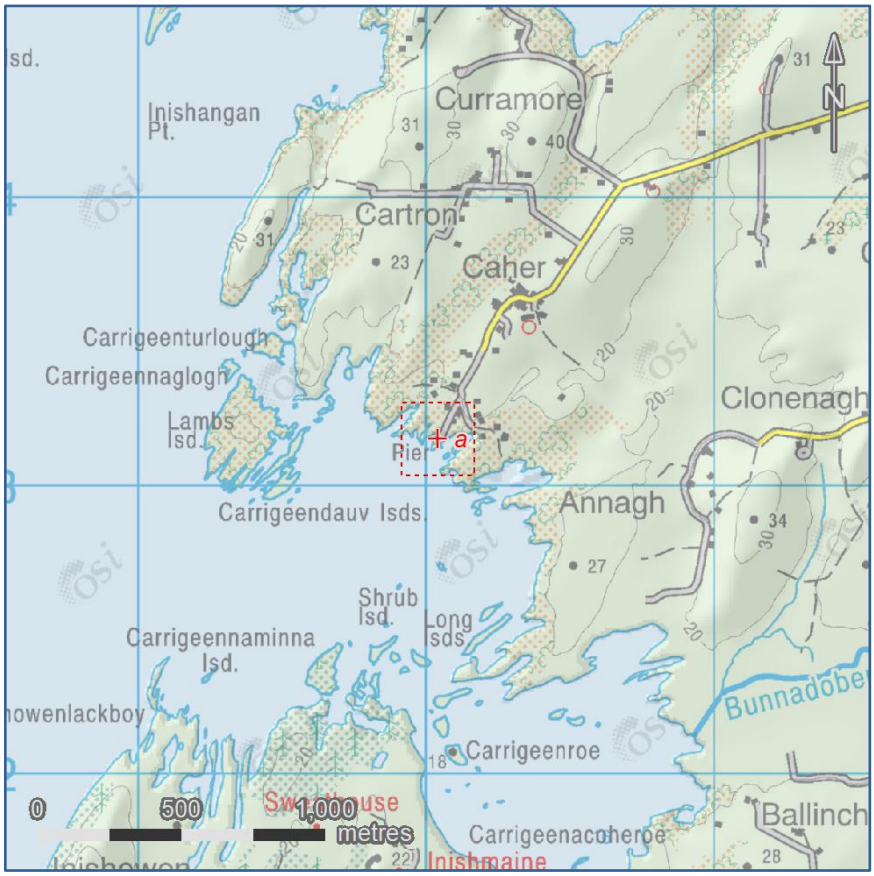

Figure 3 Species Site 1, Discovery map abstract. Location (a) was recorded on 21 May 2003.

Figure 4 Species Site 1, Bluesky image abstract. Location (a) was recorded on 21 May 2003.

Species Site 2

Species *Bryum gemmiparum*	**County** Mayo	**Vice-county** H26
Locality NW of Keel Bridge		**Discovery Map** 38
SAC/NHA Lough Carra/Mask Complex SAC 001774		
Grid References (from hand-held GPS) **ITM** 515932 768175 **IG** M1596 6816 (Map letter a) **Comments** IG reference is that recorded on 22 May 2003. This was relocated as M15964 68168 on 12 June 2023 when the ITM grid reference (waypoint 32) was recorded for the same spot.		
Elevation (m) 19		
Survey dates 12 & 19 June 2023	**Observers present** DTH	
Population recorded None**,** see "Reasons for loss or decline" below		
Previous records here/close by Discovered here on 22 May 2003; see below for details.		
Fertile? Not refound		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Originally (2003) recorded from "small unshaded damp crevices in limestone pavement" (see NPWS files for details).		
Associated plant species See NPWS files for details of associates recorded in 2003. No phanerogams or bryophytes survived within 10 m of this site on 12 June 2023 (see below).		
Current land-use/grazing No sheep or cattle in this area at time of visits in June 2023, but see "Reasons for loss or decline" below.		
Photographs of site Representative photos from series illustrating condition of the *B. gemmiparum* site here after destruction of all of its bryological interest (5013, 5014, 5016, 5021, 5017, 5024, 5053).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures The original *B. gemmiparum* site has now been destroyed, see "Reasons for loss or decline" below.		
Other comments A much more extensive search of adjacent areas was made on 19 June 2023 to seek possible "new" sites for *B. gemmiparum* and *Ptychostomum knowltonii*. The adjacent pavement areas, mainly to the north, and one strip to the east, were found to lack the moist fissures and "furrows" that provide the more persistently damp habitats for these Bryaceae. Further east and across to the Keel River almost the whole area is fen, with a ditch and a few wetter hollows. A group of rock outcrops in the middle of the fen did not provide appropriate habitats. Likewise, exposed limestone close to the north-west side of the minor road (to Aghinish) was unproductive.		
Details of Previous Records Discovered here during surveys for NPWS by DTH. Data for the voucher specimens (**BBSUK**, now **NMW**; **DBN**) are as follows: "22 May 2003, NW of Keel Bridge (S. of Partry), M1596 6816 (Map letter a), small unshaded damp crevices in limestone pavement, *c.*15 m alt., Holyoak 03-149 & 03-150". Apparently not reported subsequently.		
Reasons for loss or decline On 12 June 2023 it was found that a large part of the interesting area of limestone pavement for bryophytes at this site had been irreparably damaged (see photos). From a northern point at (ITM) 515956 768225 to almost the south-eastern extremity of this area of limestone pavement (ITM 515915 768134) the limestone surface had a coating of dried, compressed, cattle dung. The area affected measured roughly 90 m from north to south and 10 to 30 m wide from east to west. Within that area, dung covered 100% of most 1 metre squares, with some dung present in most of the remainder. On top of the dung in an eastern area of *c.*35 x 9 m (centred on ITM 515974 768214) was a thin cover of hay, evidently brought here as cattle feed, with associated wrappers (green and white synthetic netting; black plastic sheet) embedded in the dung in several places. Tyre marks gave evidence of repeated access by		

vehicles onto the dung-covered area. Clearly, cattle had been fed repeatedly and persistently on this area for a long period of time.
Air photos freely available on Google Earth Pro show no damage to the site on 11/24/2016 or on 5/4/2020 (i.e. 4 May 2020), but their image from 3/14/2023 is too poor to show anything. The recent damage has apparently caused loss of *B. gemmiparum* from the Keel Bridge site (one of three known in Ireland) and also destroyed one of the two localities there for *Ptychostomum* cf. *knowltonii* (see separate Species Site 41). The record of *Scapania gymnostomophila* made at Keel Bridge on 22 May 2003 was at M1595 6821 (IG), so close to the second (surviving) place for *Ptychostomum* cf. *knowltonii*. *S. gymnostomophila* was not refound there on 12 or 19 June 2023, but the preceding long spell of dry weather had dried the bryophyte vegetation completely and rendered the search for such a tiny liverwort almost hopeless. The “undamaged” areas are nevertheless within 7 m of the edge of the area coated with cattle dung and 3–4 m from scattered cow pats, so it remains to be seen if eutrophication arising from the dung close by will adversely affect them.

Recommended conservation measures

It is important to limit damage to the flora of any adjacent limestone pavement area within this part of the SAC in the future, especially as rare bryophytes apparently still survive very close by on a reduced area of interest. Those responsible for persistently feeding livestock on the limestone pavement should be prevented from doing so. It may be that high water levels in the surrounding fen resulted in their cattle congregating on the higher and drier limestone pavement, where they needed supplementary feeding. If so, future repetition of the dunging and need for supplementary feeding should be prevented by removing stock promptly if the fen becomes too wet. Vigilance by local NPWS rangers might be necessary to ensure similar damage does not occur here or elsewhere.

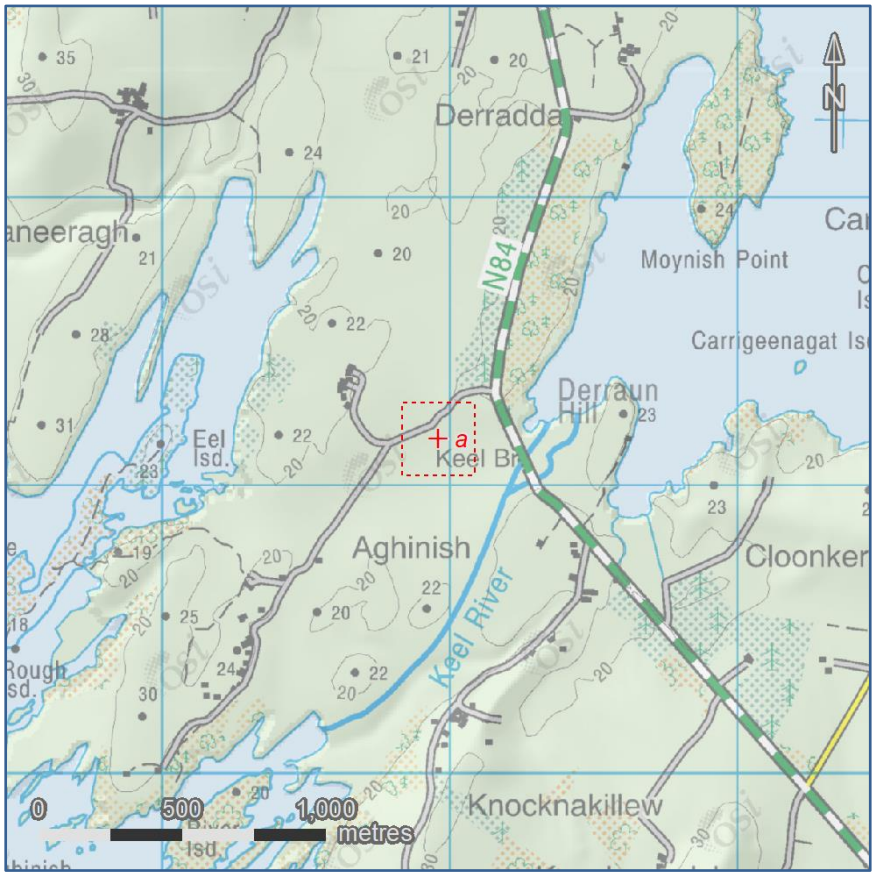

Figure 5 Species Site 2, Discovery map abstract. Location (a) was recorded on 22 May 2003.

Figure 6 Species Site 2, Bluesky image abstract. Location (a) was recorded on 22 May 2003.

Figure 7 Species Site 2, showing location of *Bryum gemmiparum* beside knife in foreground on 22 May 2003.

Figure 8 Same location on 12 June 2023 with extensive and almost complete cover of cattle dung.

Figure 9 Species Site 2, showing detail of ground cover on 12 June 2023.

Species Site 3

Species *Bryum gemmiparum*	**County** Mayo	**Vice-county** H26
Locality near Brownstown, E. shore of Lough Carra		**Discovery Map** 38
SAC/NHA Lough Carra/Mask Complex SAC 001774		
Grid References (from hand-held GPS) **Site (1) 15 June 2023:** **ITM** 519613 770849 (waypoint 42) **IG** M19646 70830 (near Map letter d) **Comments** Probably extinct here. An unsatisfactory record was made of a few stems mixed with other mosses, studied with a hand lens in the field. It was apparently of this species, but too sparse for collection of a voucher specimen for detailed checking. Its location was not among those recorded in 2003, despite it being accessible in shallow water then. The lake water level on 15 June 2023 was described as "unusually low, but I have seen it lower" by the attendant at the Brownstown pumping station. This year, wading to shore rocks in wellington boots combined with calm weather (so no waves) took DTH 50 cm or more deeper into the lake than on either visit in 2003. **Site (2) 16 June 2023:** **ITM** 519556 770633 (waypoint 53) **IG** *c.*M1958 7061 **Comments** Another voucher specimen (23-087) was collected at a new site, but determination subsequently revised tentatively to *Ptychostomum* cf. *knowltonii*. **Site (3) 16 June 2023:** **ITM** 519587 770729 (waypoint 51) **IG** M19618 70703 (+/- 3–4 m) (near Map letter a) **Comments** The source of Holyoak 03-163 from 23 May 2003 was precisely relocated using a photo of the lakeside boulder taken that day. New grid references for the same location are given here; the original (IG) grid reference of M1963 7070 was slightly imprecise, but based on poorer equipment. *B. gemmiparum* was no longer present and "Reasons for loss or decline" below records changes in the microhabitat.		
Elevation (m) 18		
Survey dates 15 & 16 June 2023	**Observers present** DTH	
Population recorded None identified with certainty. Possible material from two sites probably not of this species. (Site (1) few stems only (no voucher specimen); site (2) 1 patch 4.5 x 4 cm; site (3) definitely none here now; sites (2–4 from 2003) apparently none now, and none on adjacent rocks.		
Previous records here/close by Discovered here at three (perhaps four) adjacent spots in 2003, see below for details.		
Fertile? Capsules lacking in all known Irish material.		
Voucher specimen(s) None (Misidentified material from site (2) Holyoak 23-087)		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types For site (2): On almost flat (0–20°) part of top of large boulder in inundation zone at edge of marl lake, currently 40 cm above water up to 90 cm deep (but lake level unusually low); unshaded. Growing on marl covered surface with other low mosses.		
Associated plant species N/A		
Current land-use/grazing Lake shore is not grazed here. Small-boat moorings are present near site (2); site (1) is adjacent to small beach (by car park) used for swimming/paddling by local people, and the official pumping station for extraction of drinking water. Signs at the car park emphasise the need to keep the lake water clean and keep animals out of it.		
Photographs of site From 15 June 2023, to show former locations, closer views of habitat. From 16 June 2023, new images of site recorded on 23 May 2003 from which *B. gemmiparum* now lost, found by comparison with old photographs, showing location, habitat and evidence of use as perch by gulls causing eutrophication (5204, 5202, 5207, 5206). For general comparison when lake water level was higher, see habitat photo from 2003 published in Holyoak (2021: 342).		
Field sketch map photographed Yes, from 15 June 2023 (5956).		

Apparent threats/any existing conservation measures

Only obvious threat is of eutrophication from gulls perching regularly on some of the rocks. No conservation measures directed at the species exist, but there is wider action being taken to stop deterioration in water quality.

Other comments

Much of the long shoreline of Lough Carra and its islands is distant from any road access. On 16 June 2023 limited searching on the eastern shore northwards to Muckloon (IG: M1913 7419) did not disclose any sections of shore with substantial rocks, or rocks emergent from shallow water. Other sections of shore were visited during the surveys in 2003, including near Rinneen and around the south-western extremity of the lake shore. Some of the emergent limestone rocks and small islands accessible only by boats might offer better opportunities, but gull colonies may have affected their suitability.

Details of Previous Records

Discovered here in 2003 during surveys for NPWS by DTH, on E. shore of Lough Carra, S. of Brownstown, E. Co. Mayo, v.c. H26, *c.*19 m alt. Other data on the voucher specimens is as follows:

"23 May 2003, M1963 7070 (Map letter a), on unshaded thin patch of sandy soil on top of limestone boulder in edge of lake, *c.*0.8 m above water level, Holyoak 03-163";

"23 May 2003, M1966 7082 (Map letter b), on unshaded thin sandy soil on limestone boulders in water at edge of lake, 10–30 cm above water level, Holyoak 03-169";

"23 May 2003, M1966 7087 (Map letter c), habitat as for (b), Holyoak 03-171";

Tentative record of young plants, "15 Oct. 2003, M1964 7084 (Map letter d), with other low mosses on thin marl on unshaded limestone boulder at edge of marl lake, Holyoak 03-603".

Reasons for loss or decline

Detailed searching under ideal conditions (low lake level, warm, calm weather) allowed a comprehensive survey of the rocks in and beside the lake edge, from the pumping station (IG) *c.*M1960 7090 southwards to M1958 7060. *B. gemmiparum* was not refound at any of the three (perhaps four) locations that supported it in 2023.

Because site (3) from 23 May 2003 was precisely relocated (see above) it was examined in detail and closely but unsuccessfully searched for any surviving *B. gemmiparum* (see photos 5202–5207). The top of this rock was 1.3 m above current (low) lake levels, with water 4–10 cm deep around its base, which was only 1.3 m laterally from the stony lakeshore. The top of the rock had 35% cover of *Poa annua* (c.fl. & c.fr., some now dried and dead) on the rock surface which was otherwise bare except for a few abraded bits of bryophytes amid bird dung, a regurgitated pellet, feather sheaths, fish scales and a body feather of a gull (doubtless a Common Gull *Larus canus*, since they perched persistently on rocks nearby during the two days of survey, as if holding nest-site territories). Bryophytes on the sides of the rock included *Cratoneuron filicinum* (plenty on N. side, some c.fr.), *Cinclidotus fontinaloides* (fringe on upper S. and E. sides), and small bits of *Bryum dichotomum*, *Ptychostomum pseudotriquetrum*, *Orthotrichum* cf. *cupulatum* and *Didymodon insulanus*. Loss of the *B. gemmiparum* and associated bryophytes from the top of this rock thus seems likely to have been associated with its use by gulls for perching, causing mechanical abrasion and extreme eutrophication.

The smaller rocks that produced records (2)–(4) in 2003 were not being used by gulls in this way and they appeared unchanged, although possibly their marl coatings were less complete or thinner.

There is clear evidence that the water of L. Carra has become more eutrophic in recent decades and that pollutants have reduced marl production in the lake, as discussed in detail in other sections of this *Irish Wildlife Manual*. As discussed above under Species Site 1, *B. gemmiparum* may be intolerant of eutrophic waters, so there is a likelihood that its apparent decline near Brownstown between 2003 and 2023 is related to overall changes in quality of the lake water.

Recommended conservation measures

Probably now extinct here. Further surveys of the shorelines of Lough Carra and Lough Mask are desirable to seek more populations of the species, ideally using a small boat for access since numerous otherwise inaccessible small islands and offshore rocks could then be searched.

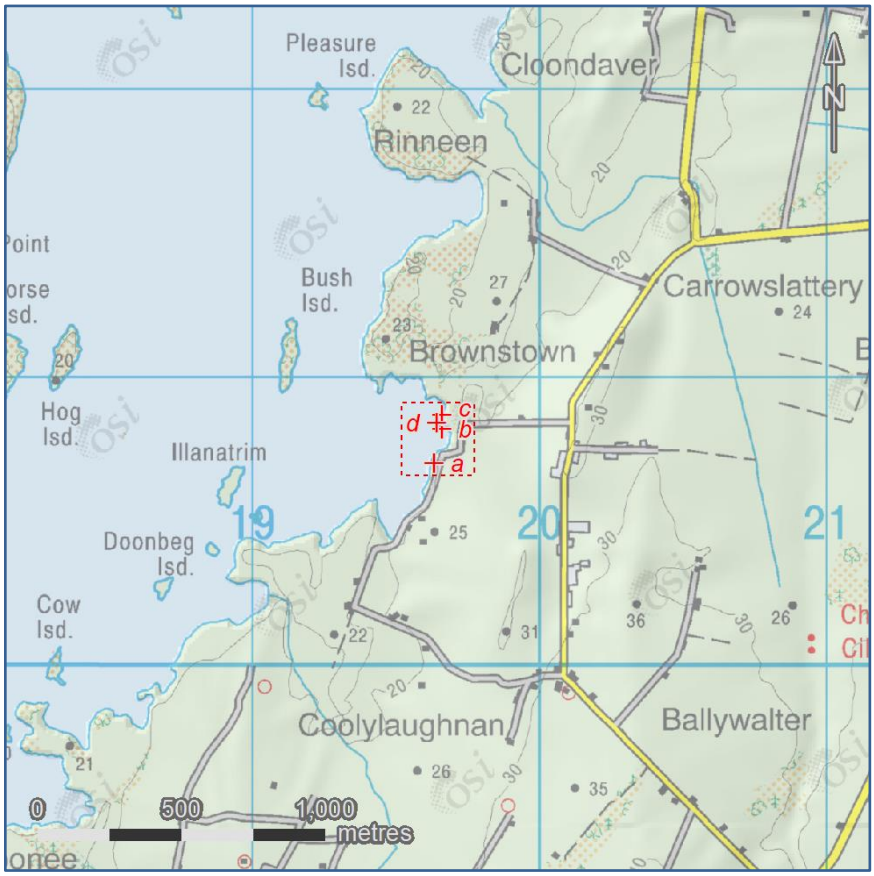

Figure 10 Species Site 3, Discovery map abstract. Locations (a) to (d) were all recorded in 2003.

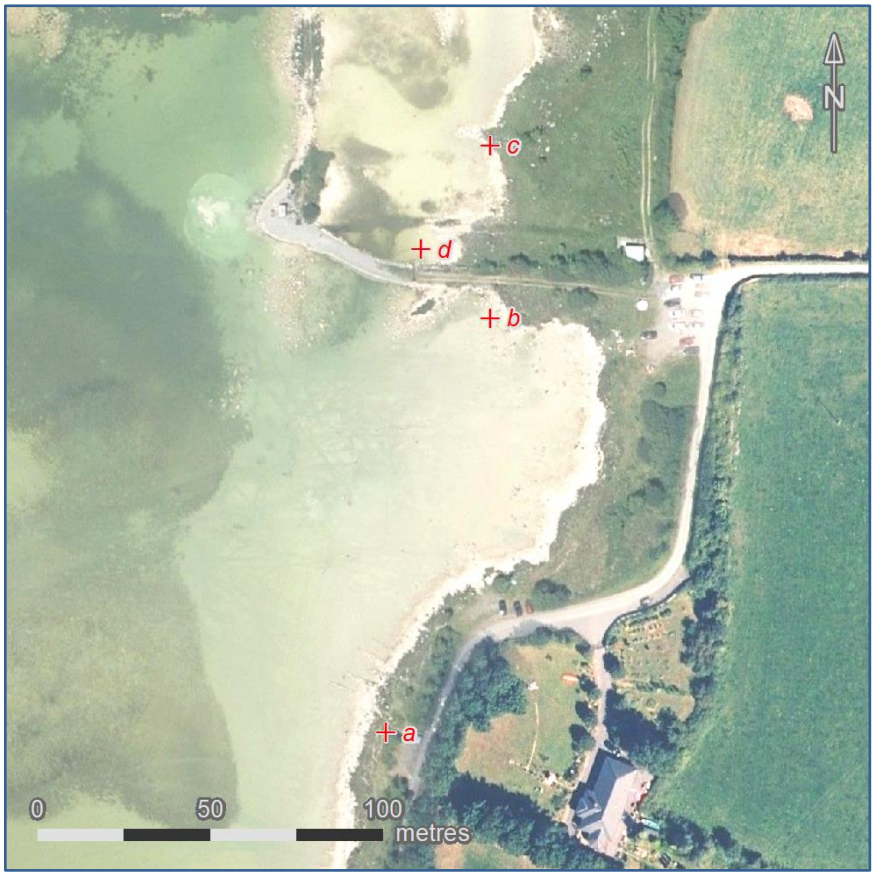

Figure 11 Species Site 3, Bluesky image abstract. Locations (a) to (d) were all recorded in 2003.

Figure 12 Species Site 3, former location (a) with *Bryum gemmiparum* on 23 May 2003, on top of boulder in left foreground.

Figure 13 Same location (a) on 16 June 2003, with lower water level granting easier access to sites.

Figure 14 Species Site 3, detail of same location (a) as in Figures 12 and 13 on 16 June 2023, with dead *Poa annua* and evidence of eutrophication by perching gulls.

Species Site 4

Species *Bryum marratii*	**County** Kerry	**Vice-county** H01
Locality Glenbeigh, Rossbehy		**Discovery Map** 78
SAC/NHA Location unrecorded, but probably within Castlemaine Harbour SAC 000343		
Grid References (NOT from hand-held GPS) **ITM** Not recorded **IG** V64-92- (Map letter a; monad) **Comments** Only record in 1983 did not include a grid reference, so subsequent allocation of one for distribution mapping was apparently only an approximation.		
Elevation (m) location unrecorded, but <5		
Survey dates 2 & 3 June 2023	**Observers present** DTH	
Population recorded None (in 2023)		
Previous records here/close by In 1983 only, see below for details		
Fertile? Capsules lacking from 1983 specimen		
Voucher specimen(s) None since 1983		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Known only from 1983 data, see below. That site was evidently somewhere along the eastern side of the Rossbehy peninsula, an area where species-rich dune grassland still adjoins the upper edges of saltmarsh.		
Associated plant species Not recorded in 1983		
Current land-use/grazing All of the Rossbehy peninsula appeared to be completely ungrazed, with dense low grass cover around upper fringes of saltmarsh. The White Strand beach car park attracts hundreds of carloads of visitors on summer weekends. At other times people walking dogs use the car park and traverse the saltmarsh edges and dunes with dogs running freely. Hence it is unsurprising that grazing by sheep and cattle has been abandoned and there are no signs on the peninsula of fences to restrain movements of stock and no obvious signs of rabbit activity. Some pathways around the saltmarsh edge are used regularly by heavy horses carrying "pony trekking" tourists, but these appear to contribute dung and heavy hoofprints without significant grazing. A small area away from the peninsula, just north of the R564 road (ITM 465049 591053) includes a mildly saline ditch at the edge of a grazed marshy pasture. This is in a fenced-off field. It provides possible habitat for *B. marratii*, although none was found there.		
Photographs of site To record current unfavourable state of representative areas of vegetation at upper edges of saltmarsh on eastern side of peninsula (4808, 4811, 4815) and the more promising small ditch area near R564 noted above (4823, 4824).		
Field sketch map photographed Not applicable		
Apparent threats/any existing conservation measures *B. marratii* is almost certainly extinct at this locality, at least along the Rossbehy peninsula.		
Other comments A determined but unsuccessful effort was made to refind *B. marratii* here, spread over an evening and all of the following day. The searches were made in pleasant warm sunny weather, with rather dry ground conditions after several weeks without rain. A 2 km long stretch of the eastern side of the Rossbehy peninsula was criss-crossed (N. to the "Middens"), then a 1.3 km stretch of saltmarsh edge N. of the R564 on the S. side of the estuary inlet. The habitat of the 1983 record was presumably at or near the saltmarsh edge as usual for *B. marratii*, since the species does not normally occur in dune slacks lacking saline influences. The Rossbehy saltmarsh was found to be ungrazed and it mainly had long vegetation of grasses (*Festuca rubra*) or rushes (*Juncus maritimus*), leaving few open niches with bare substrata suitable for *B. marratii*. Patches of shorter cover of *Juncus gerardii* and *Armeria maritima*, etc., occurred at lower levels on more frequently inundated saltmarsh. Attention was therefore focussed on pathways and drainage channels, but bare areas mainly occurred where trampling by horses had caused disturbance too recent to have been grown over by grasses. Unsuccessful searches were also focussed on places with freshwater flushing of the saltmarsh edges from adjoining sand-dune slopes, but these too mainly had long, closed,		

vegetation cover. Several walks into the dunes revealed mainly dry hollows, with a few slack areas producing nice closed vegetation with *Dactylorhiza*, etc., but these were non-saline and mainly supported closed herb-rich grassland cover. Edges of shallow creeks extending into lower parts of the saltmarsh were evidently too saline, e.g. with *Salicornia* sp. The only bryophyte widespread in the saltmarsh edges was *Drepanocladus polygamus*, which was frequent locally, tolerating shade at the base of phanerogam cover.

Details of Previous Records

Based only on specimen at **E** from Herb. J.A. Paton, identification of which was confirmed by DTH, although the plants are rather small and non-fertile. Original data on the packet are: "24 July 1983, Glenbeigh, Rossbehy, v.c. H1 S. Kerry; damp track on dunes near estuary, J.A.P. & D.G. Long". Subsequently, this gathering was assigned number Paton 2543 by J.A.P. Someone else gave the record the Irish Grid reference 00/64-92- (= V64-92-) (Map letter a; monad), probably for BBS/BRC distribution mapping, this probably being a best guess or approximation based on the locality and habitat data. It was not refound during the more recent NPWS bryophyte surveys of Co. Kerry.

Reasons for loss or decline

Cessation of grazing, which in turn was likely to have been related to increased numbers of visiting tourists and heavy use of the area by dog walkers.

Recommended conservation measures

None, it's too late now. The southernmost localities for this essentially northern species may anyway be at special risk from consequences of regional climate warming, and sea-level rise may also add to pressure on habitat at upper limit of saltmarshes.

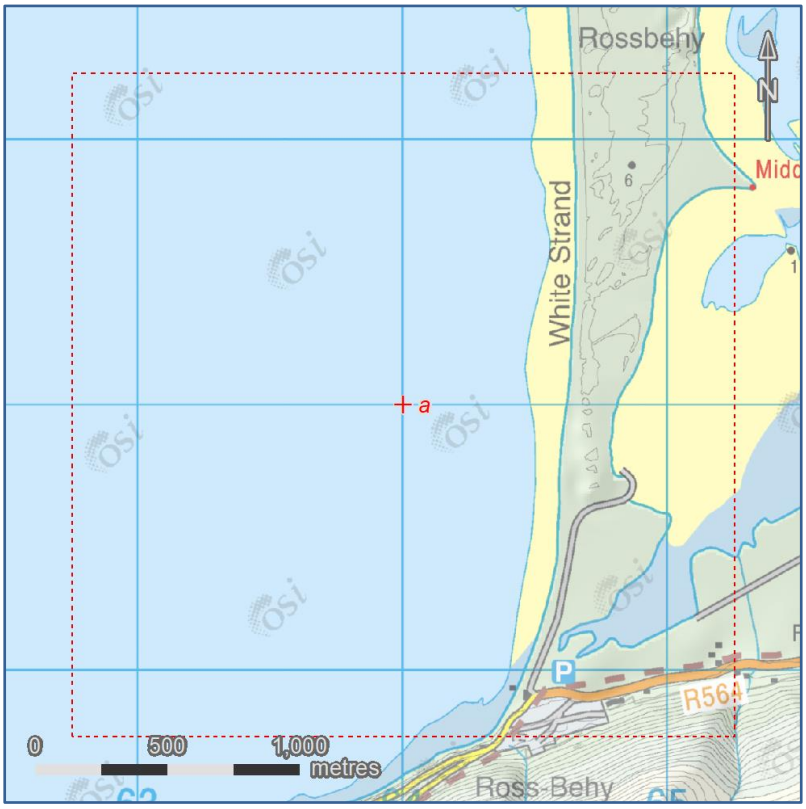

Figure 15 Species Site 4, Discovery map abstract. Imprecise location from 1983 assigned only to the most likely one kilometre grid square, with SW corner at (Map letter a; monad).

Figure 16 Species Site 4, Bluesky image abstract. Imprecise location from 1983 assigned only to the most likely one kilometre grid square, with SW corner at (Map letter a; monad).

Figure 17 Species Site 4, representative photo of dense closed vegetation at upper edge of saltmarsh at Rossbehy on 3 June 2023, with open ground only on heavily trampled footpath.

Figure 18 Species Site 4, upper edge of saltmarsh at Rossbehy on 3 June 2023, with *Juncus maritimus* in tall dense grass sward and open ground only in runnel that floods.

Species Site 5

Species *Bryum marratii*	**County** Dublin	**Vice-county** H21
Locality North Bull Island		**Discovery Map** 50
SAC/NHA North Dublin Bay SAC 000206		
Grid References (from hand-held GPS) **ITM** The location but not the plant was refound on the ground in 2023 and the N. end recorded as 722307 735574 (Waypoint 101), the S. end as 721993 735556 (Waypoint 102) **IG** O2212 3556 (Map letter a) (in 2004), O2212 3555 (Map letter b) (in 2007), location refound on the ground in 2023 and the N. end re-recorded as O22113 35548, the S. end as O22068 35530. **Comments** *B. marratii* not refound in 2023, probably gone.		
Elevation (m) 3		
Survey dates 3 & 4 September 2023	**Observers present** DTH (on 4 September 2023 also with CC, Melinda Lyons & Mairéad Stack)	
Population recorded None		
Previous records here/close by In 2004 and 2007 only (see below for details)		
Fertile? Capsules were not found in 2004 or 2007		
Voucher specimen(s) None, not refound		
***Ex situ* cultivation material collected** No, not refound		
Site description/geology/slope/drainage/shading/vegetation types See “Details of Previous Records” below and fuller data held by NPWS.		
Associated plant species See “Details of Previous Records” below and fuller data held by NPWS		
Current land-use/grazing Since before 2004, the whole of the area open to the public at North Bull has had no grazing except by rabbits. In 2023 there was no sign whatever of rabbit activity in the wet area in which *B. marratii* occurred. Bull Island is regularly used by large numbers of dog walkers and there are no fences to facilitate grazing.		
Photographs of site IMG 6236–6242 record the current vegetation in the areas formerly supporting *B. marratii*.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures *B. marratii* now appears to be extinct at this site.		
Other comments The site from 2004 and 2007 was relocated and described at its N. end as “a stretch of ill-defined wet pathway 2–5 m wide, with dominant low sward of *Juncus articulatus* (around 20 cm tall and seeding), along with sparse *Potentilla anserina* and *Juncus gerardii* and occasional small plants of *Lysimachia maritima*. Bare muddy sand is visible under the thick cover in many places, but usually partly shaded, with sparse cover of *Calliergonella cuspidata*, *Cratoneuron filicinum* and *Drepanocladus aduncus*, and rare *Bryum argenteum*. The area just to the north is a wetter and wider continuation of the same pathway, with closed cover of *Juncus articulatus* and almost no substratum visible, other than in hollows with muddy sand beneath 2–5 cm deep standing water; sparse *Juncus gerardii* was present at the edge of this area”. A search over 2 hours by DTH on 3 September 2023 and by four people for over 30 minutes on 4 September did not reveal any *B. marratii*. Although some tiny areas of suitable microhabitat seem to exist, and searches were focussed on these; the species is apparently no longer present. There is clearly much heavier shading of the substratum than in 2004 and 2007 (see notes in next section). Occurrence now of considerable amounts of *Calliergonella cuspidata* and some *Bryum argenteum* point to eutrophication of the habitat. Development of a large *Phragmites* bed on the opposite side of the same slightly saline depression may also have been associated with enrichment, which has been attributed to regular dumping nearby of stranded masses of fucoid seaweeds cleaned from adjacent sandy beaches.		

Details of Previous Records

Found here by DTH and Neil Lockhart during surveys for NPWS in 2004 and 2007. Data recorded then included:

"17 Nov. 2004, O2212 3556 (Map letter a), unshaded muddy sand at base of sparse low grasses & *Juncus articulatus* beside path in edge of dune slack, Holyoak 04-478, found in scattered small patches along strip 30 m long between two paths".

"14 Sept. 2007, O2212 3555 (Map letter b), on partly bare mud among very sparse *Juncus gerardii* and *Glaux maritima* near edges of paths in dune slack with saline influence, Holyoak 07-424, very sparse scatter of small plants over few sq. m (1 denser patch, but this rather sparse, 12 x 6 cm)".

Reasons for loss or decline

As noted above, *B. marratii* apparently declined from "along strip 30 m long" in 2004 to "over few square metres" in 2007. Although the same plant associates are still present, the habitat is apparently unsuitable now due to much heavier shading, and signs of eutrophication of the substratum.

Recommended conservation measures

None, although it is unfortunate to lose the only population of *B. marratii* known on the eastern coast of Ireland. It is a much higher priority at North Bull to maintain the now seriously threatened population of *P. cernuum*, or to attempt to reinstate the recently lost population of *P. warneum* which is now almost extinct in Ireland.

Figure 19 Species Site 5, Discovery map abstract. Record from 2004 at (a), from 2007 at (b).

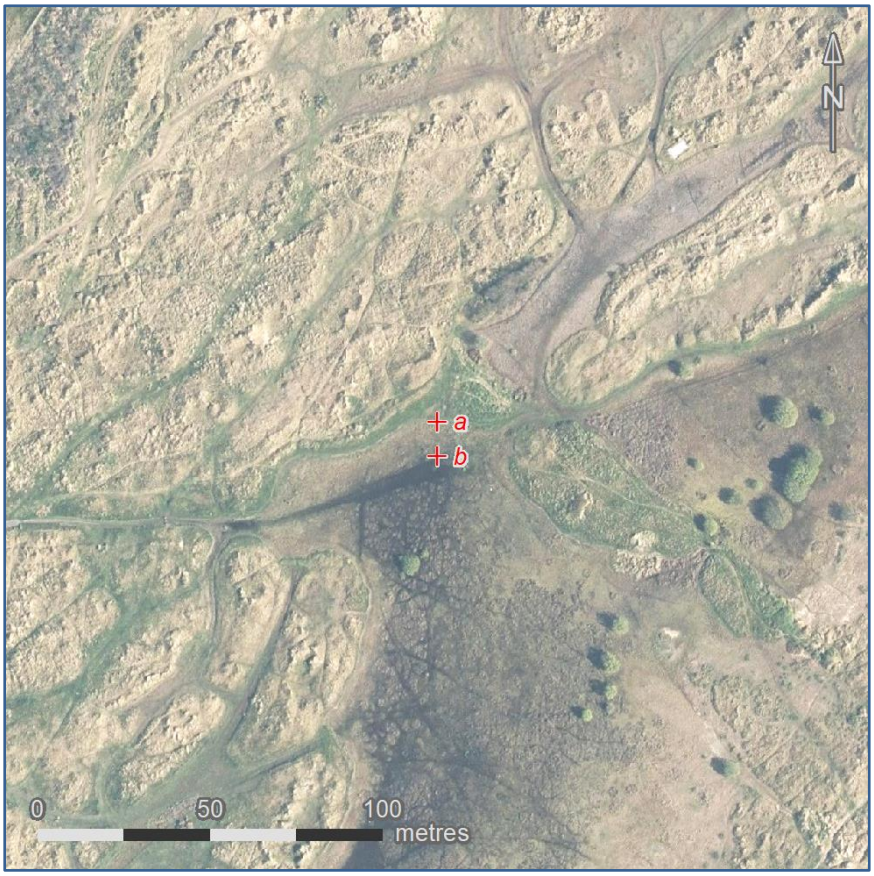

Figure 20 Species Site 5, Bluesky image abstract. Record from 2004 at (a), from 2007 at (b).

Figure 21 Species Site 5, former sites for *Bryum marratii* on North Bull Island on 3 September 2023, showing dense closed vegetation dominated by *Juncus*.

Figure 22 Species Site 5, detail of former sites for *Bryum marratii* on North Bull Island on 3 September 2023.

Species Site 6

Species *Bryum marratii*	**County** Mayo	**Vice-county** H27
Locality S. of Killadoon, SE of Dooaghtry		**Discovery Map** 37
SAC/NHA Mweelrea/Sheeffry/Erriff Complex SAC 001932		
Grid References (from hand-held GPS) **ITM** 475620 768360 (waypoints 18 & 19) (Map letter a) **IG** L7564 6835 (revised in 2003) **Comments** The IG reference was recorded as L7563 6835 (Map letter b) in 2003, which would seem to imply a site exclusively above the W. bank of the small stream, which now offers very little likely habitat and the species was not found there. Nevertheless, a contemporary photo confirms it was indeed on the western side, on flat ground above the stream. The only find in 2023 was on the eastern bank of the stream at L7564 6835 and thus slightly to the east of the previous coordinates.		
Elevation (m) 3		
Survey date 9 June 2023	**Observers present** DTH	
Population recorded 7 very small stems (2–3 mm)		
Previous records here/close by See below for details of previous record, in 2003.		
Fertile? Plants seen were too immature to bear capsules, but they are anyway scarce on this species in Ireland.		
Voucher specimen(s) Holyoak 23-076 (for **DBN**)		
***Ex situ* cultivation material collected** No, plants too few for additional collecting, and this species is available in greater quantity elsewhere.		
Site description/geology/slope/drainage/shading/vegetation types On steeply sloping middle part of east bank of small stream at its estuary, above deep (1.5 m?) pool of standing water. Growing 20 cm upstream from edge of sloping slaty rock (outcrop or buried block), 25 cm above water level, on moist sandy-clay soil with small low pleurocarpous moss and film of green alga, almost unshaded. Strandline debris at higher levels nearby of bits of aquatic algal mat (from the stream) imply it was flooded to depths of 30 cm or more in the recent past, presumably with fresh water. Loose old fragments of *Fucus* were scattered nearby, but these were likely to have arrived as wind-blown debris. Vegetation within a 25 cm quadrat (relevé) at the site was recorded as: completely bare wet sand 20%, cover only of other low bryophytes or filamentous green alga 45%, *Juncus gerardii* 15% (15–20 cm tall, some stems c.fl.), *Plantago coronopus* 10% (non-flowering), *Lysimachia* (syn. *Glaux*) *maritima* 5%, *Isolepis cernua* 5% (1 tuft, c.fl.), *Bryum marratii* <<1%.		
Associated plant species N/A		
Current land-use/grazing Area nearby is heavily grazed by sheep, although the steep bit of stream bank with the *B. marratii* on it has longer *Juncus gerardii*, implying it may be grazed less than the closed-cropped *Festuca rubra* grassland on top of the bank.		
Photographs of site Overview, closer views and detailed close-up (4943, 4947, 4942, 4948)		
Field sketch map photographed No		
Apparent threats/any existing conservation measures No immediate threats apparent. During recent years the creation of a large car park nearby and erection of fences, gate and footbridge close to this site have been accomplished without damage. Given its proximity to the car park and beach-head, caution may still be needed to avoid any further development nearer to the site with *B. marratii*.		
Other comments Similar steep streambank microhabitat was extensive laterally over 10 metres or more and it is likely to support more *B. marratii*, but it was difficult to search effectively because the stream water was too deep to wade in wellington boots. *B. marratii* was not found by extensive searching in the flatter grazed saltmarsh vegetation immediately adjacent on top of the low bank. This more extensive area was rather dry at the time of the visit, following prolonged dry weather in preceding weeks. Since the 2003 record was from that area and the plants found today in the moister microhabitat on the bank were tiny, it is possible that growth of the species has been delayed this year.		

A wide-ranging search on 8 June 2023 around the saltmarsh fringe S. and SE from the car park failed to reveal any other obvious habitats with *B. marratii*. Flushed areas at the landward edge of the saltmarsh there supported tall growths of *Iris pseudacorus* or *Eleocharis palustris*, apparently without any smaller bare areas, despite intensive sheep-grazing of the upper intertidal saltmarsh.

Details of Previous Records

Discovered at this locality during surveys for NPWS by DTH in 2003. Data on the voucher specimen (now at **DBN**) are: 11 July 2003, S. of Killadoon, SE of Dooaghtry, W. Mayo (v.c. H27), L 7563 6835 (Map letter b), on unshaded damp sand with sparse low vegetation beside estuary of stream at top edge of saltmarsh, Holyoak 03-335.

Reasons for loss or decline

Not applicable. Only part of the steep stream bank could be searched effectively. Also, in view of the dry weather in May–June 2023, plants of *B. marratii* above the stream edge at this site may not have grown up, so there is no clear evidence of decline.

Recommended conservation measures

Periodic monitoring (at least annually?) of site conditions is desirable with vigilance regarding possibility of changes resulting from close proximity to the beach access point here. Monitoring of presence of *B. marratii* by a bryologist at longer intervals, maybe every five years.

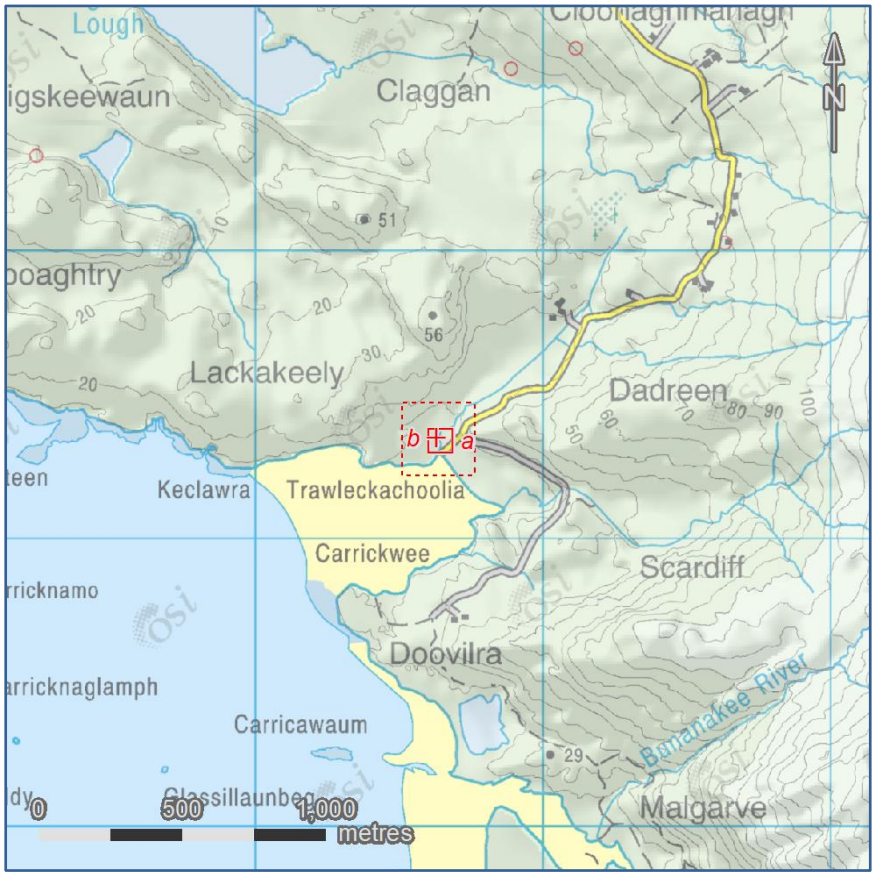

Figure 23 Species Site 6, Discovery map abstract. *Bryum marratii* was found at location (a) in 2023, (b) in 2003.

Figure 24 Species Site 6, Bluesky image abstract. *Bryum marratii* was found at location (a) in 2023, (b) in 2003.

Figure 25 Species Site 6, location (a) with *Bryum marratii* found on 9 June 2023, in right foreground marked by orange tape, above edge of water.

Figure 26 Species Site 6, closer view of same location (a).

Species Site 7

Species *Bryum marratii*	**County** Mayo	**Vice-county** H27
Locality E. of Rosmoney		**Discovery Map** 31
SAC/NHA Clew Bay Complex SAC 001482		
Grid References (from hand-held GPS) **ITM** 494098 786888 (Map letter a) (waypoint 58)		**IG** L94126 86875
Comments Original (IG) grid reference from 2003 was at L9413 8691. This was relocated using old photos (ITM 494107 786929, waypoint 56), but it is now in an area of fine calcareous fen with no hint of saline influence. It seems likely therefore that this grid reference was imprecise, especially as it was obtained with poorer hand-held Garmin GPS equipment than that currently in use. The grid references given above are from the northern part of the small area where *B. marratii* was refound in 2023.		
Elevation (m) 0		
Survey date 18 June 2023	**Observers present** DTH	
Population recorded Prolonged searching revealed only a very sparse scatter of plants, with only 1–4 stems together in several spots, over a total extent of 6 m at and southwards from the grid references given above.		
Previous records here/close by Found here in 2003 (see "Previous records" below).		
Fertile? Capsules recorded in 2003 (see below) but no capsules found in 2023.		
Voucher specimen(s) Holyoak 23-089 (for **DBN**)		
***Ex situ* cultivation material collected** Yes, at **DBN**		
Site description/geology/slope/drainage/shading/vegetation types At edge of a shallow brackish pool/coastal inlet in a narrow zone of transition from saline marsh to fenny grassland (see sketch map photo 5960, and schematic cross-section photo 5958). The *B. marratii* grows here on moist, dark, organic debris at the base of an open sward dominated by short rushes (*Juncus gerardii*). The vegetation here is characteristic of slightly saline edges of saltmarshes, with several halophytic species as close associates (see next section). The area where it grows is only a few metres westwards of slightly higher ground with *Festuca rubra* grassland, so it is likely to receive some fresh water draining from upslope in addition to that provided by the ample regional rainfall.		
Associated plant species Grows in open sward of *Juncus gerardii* (15–30 cm high, c.fr.), with lesser amounts of *Agrostis stolonifera* (not flowering) and *Schoenoplectus tabernaemontani* (27–35 cm high, c.fl., but dwarfed and sparse), and single plant nearby of *Lysimachia* (syn. *Glaux*) *maritima*. A few metres further west on fractionally lower ground the vegetation cover is dominated by *Eleocharis uniglumis*, with some *Samolus valerandi*. Higher ground 2 m to the east has *Festuca rubra* grassland that includes *Holcus lanatus*, *Trifolium pratense* and *Plantago lanceolata*. All of these vegetation types are unshaded, but the very small *B. marratii* itself gets some shade from associated *J. gerardii*. This shading and the organic surficial soil layer produced by the rush differ from the microhabitat at other Irish sites that hold more *B. marratii*, which are typically slightly shaded at the most, with substrata of clay, silt or sand mixtures.		
Current land-use/grazing The site is ungrazed at present and there were no signs of recent grazing. Indeed, a clear impression was gained that the adjacent fen vegetation had grown taller and richer in species than it was in 2003. Since there are no fences to confine sheep or cattle on the areas around this brackish pool it seems unlikely that it has been grazed in the past few years.		
Photographs of site No Images of location, habitat and plants (5358, 5354, 5351, 5352, 5350), and of preparations for very large bonfire 12 m away upslope from the *B. marratii* (5345, 5344, 5360, 5361, 5362).		
Field sketch map photographed Yes (5960, with schematic diagram of vegetation zonation 5958).		
Apparent threats/any existing conservation measures An immediate and serious threat to the population of *B. marratii* exists because its site is only 12 m from a large and imposing fuel pile for a big bonfire, and immediately downslope from the fire site. On 18 June 2023, the fuel pile was over 3 m high and of similar diameter,		

comprising wooden pallets, old wood, plastic sacks, etc. (see photos). Some of the plastic rubbish clearly originated on a cattle farm. The bonfire pile is on ground that was partly burnt in recent years, with spreads of fruiting *Funaria hygrometrica*. There was no similar bonfire heap in 2003. Air photos on Google Earth Pro show no sign of any disturbance in June 2009, but apparent loss of vegetation in the fire-heap area from April 2017 onwards through 2019, 2020 and in 14 March 2023 (over a larger area). Eutrophication from fires here will probably lead to enrichment of water downslope, taller growth of rushes etc., and loss of the *B. marratii*.

On a longer timescale, the loss of grazing of saltmarsh edges at this site probably led to the substantial decline of *B. marratii* between 2003 and 2023.

Other comments

The small area of land just beyond the north-eastern edge of the saltmarsh (around ITM 494107 786929), just below the road verges, supports fine calcareous fen vegetation. It has much *Schoenus nigricans* and patchy *Molinia caerulea*, with more open marly hollows, supporting *Cirsium dissectum*, *Dactylorhiza fuchsii*, *Briza media*, *Triglochin palustris*, *Ranunculus flammula*, *Anagallis tenella* and *Pinguicula vulgaris*. Unfortunately heavy tractors have repeatedly crossed part of this fen and the upper saltmarsh fringe to the south, apparently taking a roundabout route to build the large bonfire pile referred to above under "Apparent threats".

Details of Previous Records

Discovered at this locality during fieldwork for NPWS by DTH in 2003. Data on the voucher specimens (**DBN**, Herb. DTH) are: "23 Sept. 2003. E. of Rosmoney, W. Co. Mayo, v.c. H27, L9413 8691 (Map letter b), on unshaded clay-mud with sparse low vegetation at edge of brackish pool, flushed from landward side, Holyoak 03-464, 465 and 633". This is one of a very few records from Ireland of this species bearing capsules; Holyoak 03-633 comprises a few stems grown-on indoors until the capsules ripened.

Reasons for loss or decline

The cessation of grazing of saltmarsh edges probably led to the substantial decline of *B. marratii* between 2003 and 2023, as the slightly saline open areas gained taller, denser vegetation. This lack of grazing has, however, resulted in an attractive fen developing beside the north-eastern corner of the pool.

Recommended conservation measures

The recent use of the saltmarsh edge here as a regular location for bonfires should be discouraged, especially as the land is within an SAC.

Survival of *B. marratii* at this site is likely to depend on cessation of use of the bonfire location. In the longer term, reintroduction of light grazing would be beneficial, especially if cattle were to be used, because poaching of the ground would create open microhabitats and more varied hummocky topography.

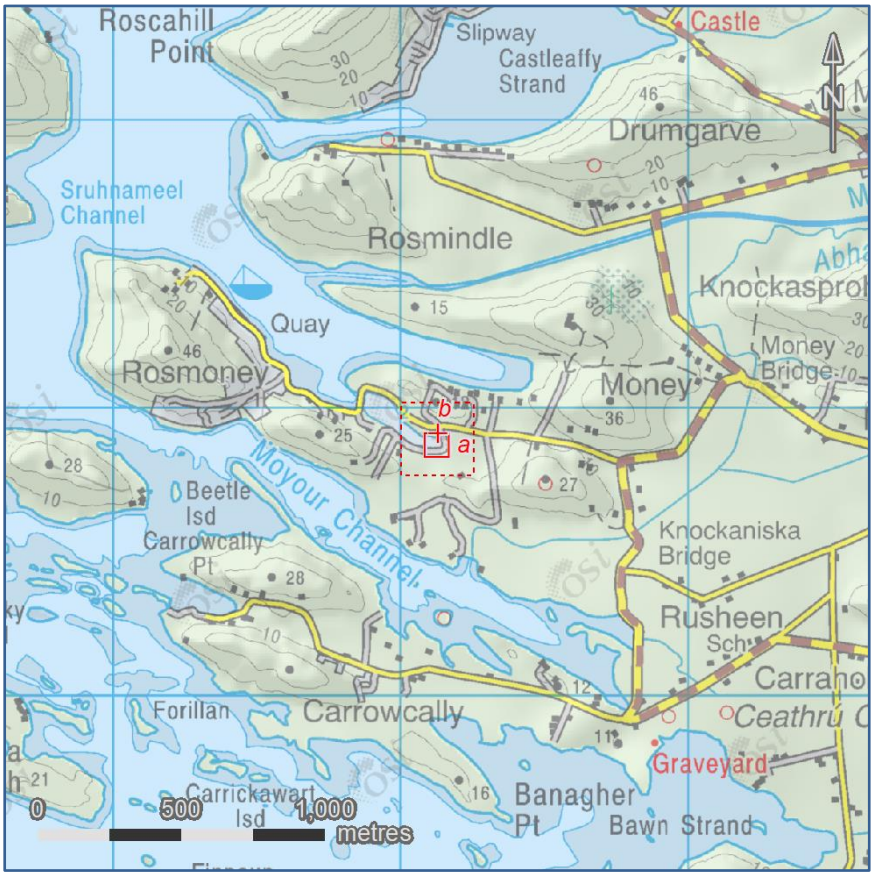

Figure 27 Species Site 7, Discovery map abstract. *Bryum marratii* was found at location (a) in 2023, at (b) in 2003.

Figure 28 Species Site 7, Bluesky image abstract. *Bryum marratii* was found at location (a) in 2023, at (b) in 2003.

Figure 29 Species Site 7, location (b) where *Bryum marratii* was found on 23 September 2003, with much open ground.

Figure 30 Species Site 7, another part of location (b) where *Bryum marratii* was found on 23 September 2003, again showing much open ground.

Figure 31 Species Site 7, location (a) where *Bryum marratii* was found on 18 June 2023, in centre of foreground marked by knife with orange tape attached. Note large heap of material on bonfire site behind to left.

Figure 32 Species Site 7, closer view of location (a) where *Bryum marratii* was found on 18 June 2023, showing ground partly shaded by almost closed cover of *Juncus*.

Species Site 8

Species *Bryum marratii*	**County** Mayo	**Vice-county** H27
Locality S. of Mallaranny, W. site		**Discovery Map** 30
SAC/NHA Clew Bay Complex SAC 001482		
Grid References (from hand-held GPS) **ITM** 482449 796115 (Waypoint 104) **IG** L82473 96102 (replacing L8247 9611 (Map letter a)) **Comments** Not refound, but the exact spot was relocated on 5 September 2023 using a photo from 2003, allowing new grid references noted above to be obtained.		
Elevation (m) 3		
Survey dates 18 & 19 June 2023, 5 September 2023		**Observers present** DTH
Population recorded None		
Previous records here/close by Recorded only in 2003 (see below)		
Fertile? Specimen from 2003 has inflorescences but no capsules		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Exact site not relocated. See notes under "Previous records" below and data from 2003 filed with NPWS.		
Associated plant species Record from 2003 was "with sparse low grasses".		
Current land-use/grazing Site is within a fenced field, with recent close grazing by sheep evident throughout.		
Photographs of site Images of site and habitat where species found in 2003, but not refound in 2023 (5384, 5376, 5377, 5378, 5379, 5381). Distant view of same area from east, looking across intertidal saltmarsh (5366).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Site not relocated despite prolonged efforts.		
Other comments Prolonged searches on 18 & 19 June 2023 along edges of small streams within the field revealed no trace of *B. marratii*, even though moist conditions prevailed following overnight rain. Several small areas of possible habitat for it still exist, with flushing from slopes to landward onto banks of tiny streams at the upper limit of saltmarsh vegetation. It was noted that another search in late autumn when stems of the species typically grow to full size might yet reveal a small population. However, intense sheep-grazing has produced a dense low sward in most places. Another return visit was made anyway, on 5 September 2023, because the exact location from which voucher 03-303 was collected had been revealed by finding a photo taken at the spot on 3 July 2003. This revealed that the site was actually just outside the fence of the field searched in June 2023, at the base of an old stone wall built of boulders. Nevertheless, no *B. marratii* was present there, despite some bare soil existing. More or less in the same place, there was a strong patch of *Tortella flavovirens*. Wider searching in that field also revealed no *B. marratii*. The whole area showed signs of intensive use by sheep, with footprints and much dung lying. Leaves of *Taraxacum* and *Cochlearia* had been bitten off from the edge of the *T. flavovirens* patch.		
Details of Previous Records Discovered here in 2003 during surveys for NPWS by DTH. Voucher specimen (**DBN**) has data recorded as: "3 July 2003, S. of Mallaranny, W. Mayo v.c. H27, L8247 9611 (Map letter a), on unshaded, damp, humic soil on bank of small stream just above upper edge of saltmarsh, with sparse low grasses, Holyoak 03-303"; specimen had inflorescences but no capsules.		
Reasons for loss or decline See "Other comments above". Intense grazing by sheep may have reduced the extent of suitable habitat.		
Recommended conservation measures None		

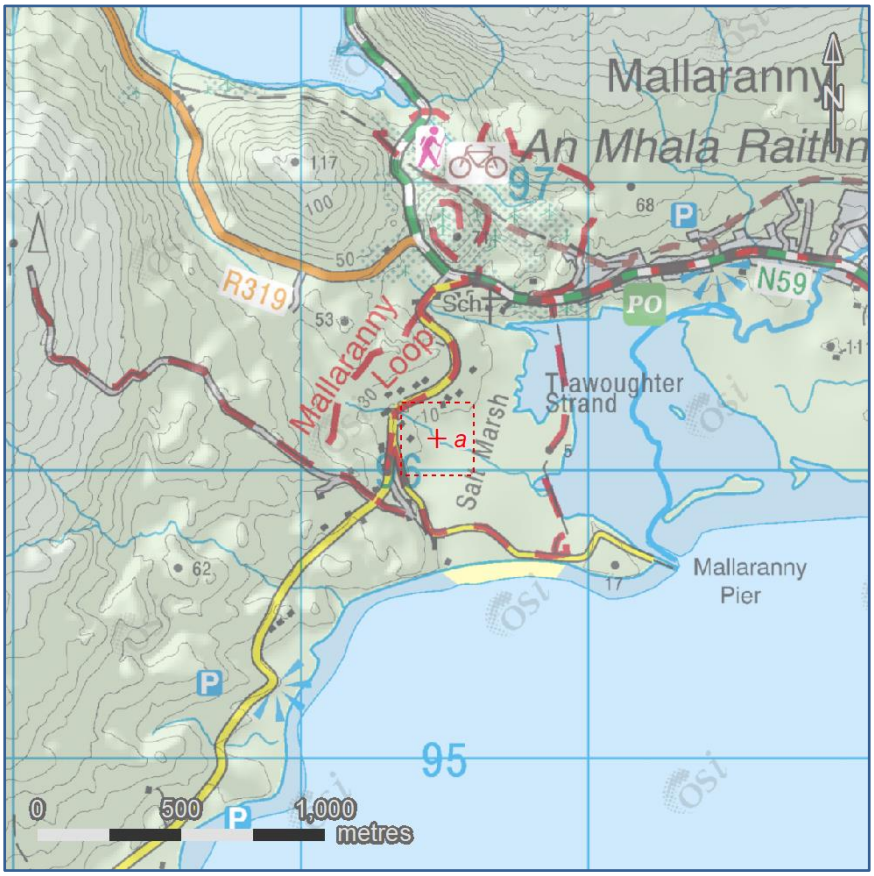

Figure 33 Species Site 8, Discovery map abstract. *Bryum marratii* was found at location (a) in 2003.

Figure 34 Species Site 8, Bluesky image abstract. *Bryum marratii* was found at location (a) in 2003.

Figure 35 Species Site 8, upper edge of saltmarsh with rather dense grass sward and almost no bare moist ground, 19 June 2023.

Species Site 9

Species *Bryum marratii*	**County** Mayo	**Vice-county** H27
Locality S. of Mallaranny, E. site		**Discovery Map** 30
SAC/NHA Clew Bay Complex SAC 001482		
Grid References (from hand-held GPS) **ITM** 482943 795785 (Waypoint 107) **IG** L82967 95773 (replacing L8296 9577 (Map letter a)) **Comments** On 18 June 2023 the general area of the site from 2003 was refound, and the IG reference recorded in 2003 appeared to be correct. After finding a photo showing the exact location of voucher 03-301 taken on 3 July 2003, a return visit on 5 September 2003 allowed the exact spot to be searched again, and the new grid references given above to be obtained. Nevertheless, no *B. marratii* was relocated.		
Elevation (m) 3		
Survey dates 18 June 2023 & 5 September 2023		**Observers present** DTH
Population recorded None		
Previous records here/close by Recorded only in 2003, see "Previous records" below.		
Fertile? Specimen from 2003 lacks capsules		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Not refound; for details from 2003 see "Previous records" below and data filed with NPWS.		
Associated plant species Not refound; in 2003 it grew "at base of low grasses"; see NPWS files for details.		
Current land-use/grazing Within fenced field currently ungrazed, as it was in 2003. The next field which is now intensively grazed by sheep was grazed only by cattle in 2003 (visible in the old photos).		
Photographs of site Images of location and habitat where *B. marratii* found in 2003, but not refound (5369, 5371, 5372, 5373). Distant view of same area from west, looking across the intertidal saltmarsh (5386).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures *B. marratii* was not refound and it may have been lost from this site.		
Other comments The small areas with possible habitat for *B. marratii* were searched intensively on 18 June 2023 without success. The largest ditch in the field now appears deeper, with mainly vertical unvegetated muddy edges that are shaded by overhanging grasses. The banks above support a closely-grazed sward that does not offer suitable open patches for the moss. Another return visit was made on 5 September 2023, because the exact location from which voucher 03-301 was collected had been revealed by finding a photo taken at the spot on 3 July 2003. This was a few metres outside the area searched previously, in the adjacent field, just against the boundary wire-fence and old wall, with a less conspicuous, overgrown, currently dry ditch. The field was ungrazed, much as it was in July 2003, probably because it has a different owner since access is from a different direction. A patch of *Juncus maritimus* here has spread inland along the bank of the ditch, past the find spot of 2003, but vegetation conditions otherwise looked similar. Nevertheless, no *B. marratii* was refound at the same spot, which had become almost completely shaded by *Agrostis stolonifera*, with some *Festuca rubra* and *Plantago maritima*; the only bryophyte here was *Tortella flavovirens*, in small amounts. A close search revealed few other bits of bare soil within ten metres along the ditch. Those lower down the ditch had more *T. flavovirens*; those on a bank slightly higher up had a bit more *T. flavovirens*, along with patches of *Archidium alternifolium* and *Ptychostomum pseudotriquetrum.*		
Details of Previous Records Discovered here in 2003 during surveys for NPWS carried out by DTH. Voucher specimen (**DBN**) has data recorded as: "3 July 2003, S. of Mallaranny, West Mayo, v.c. H27, L8296		

9577 (Map letter a), on partly bare, unshaded, wet soil at base of low grasses on edge of shallow ditch in pasture at edge of saltmarsh, Holyoak 03-301”.
Reasons for loss or decline Probably loss of habitat due to development of thicker grass mats shading the muddy soil. Nearby, the current sustained intensive grazing by sheep confined in the next field by fences has replaced the cattle grazing that occurred in 2003. This has resulted in a denser, closer grass sward extending to the edges of the ditches and leaving very few open patches. Deepening of the main ditch on the slope here has probably been due to “natural” erosion of its banks and bed by runoff after heavy rainfall.
Recommended conservation measures None

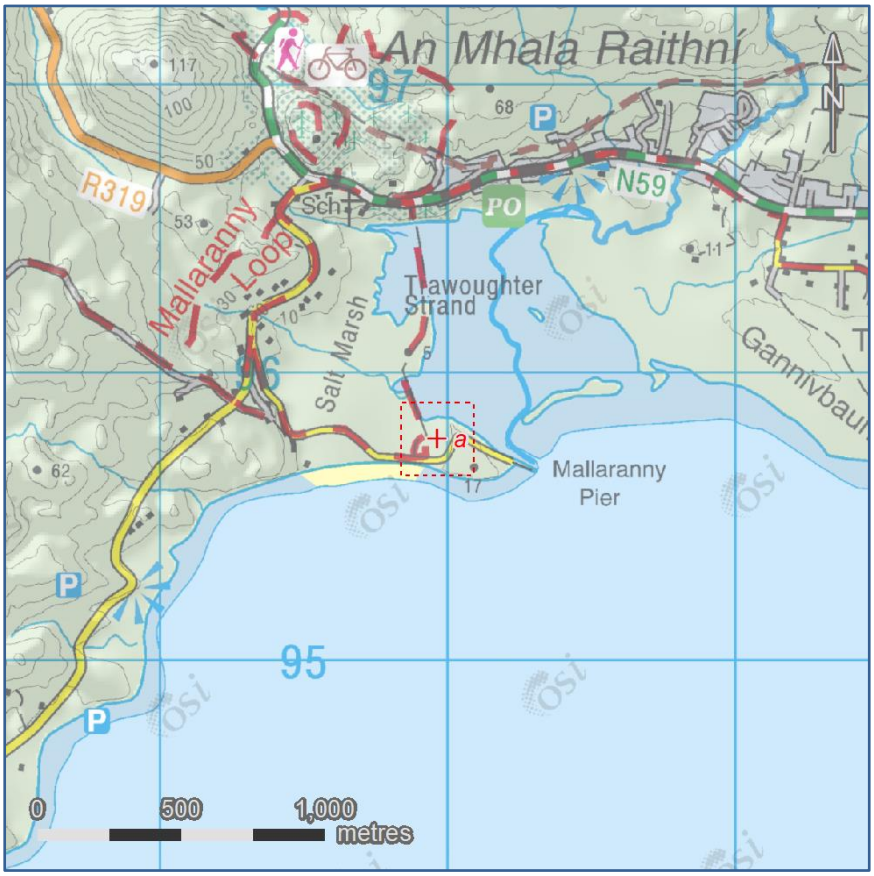

Figure 36 Species Site 9, Discovery map abstract. *Bryum marratii* was found at location (a) in 2003.

Figure 37 Species Site 9, Bluesky image abstract. *Bryum marratii* was found at location (a) in 2003.

Figure 38 Species Site 9, former location (a) for *Bryum marratii* on 19 June 2023, when thick grass sward left very little bare moist ground.

Species Site 10

Species *Bryum marratii*	**County** Mayo	**Vice-county** H27
Locality Elly Harbour		**Discovery Map** 22
SAC/NHA Mullet/Blacksod Bay Complex SAC 000470		
Grid References (from hand-held GPS) **Site 1** **ITM** 464887 826485 (Map letter a) (waypoint 082) **IG** F64908 26479 **Site 2** **ITM** 464891 826481 (Map letter b) (waypoint 083) **IG** Not recorded **Comments** Site 2 was 5.5 m to east of Site 1, both being different to the location found in 2003 (at IG reference F6489 2644 (Map letter c), see "Other comments" below).		
Elevation (m) 2–3		
Survey date 26 June 2023	**Observers present** DTH (with E. Holyoak)	
Population recorded Very small: Site 1 had patch *c.*1 cm across (of short stems, *c.*3 mm high), with another smaller cluster of stems *c.*14 cm distant plus 2 single stems adjacent to those. Site 2 had 8 stems (2–3 mm high) forming loose cluster measuring 11 x 4 mm.		
Previous records here/close by Discovered at closely adjacent spot in 2003 (see "Previous records" below).		
Fertile? No capsules found in 2003 or 2023		
Voucher specimen(s) Holyoak 23-098 (for **DBN**), few stems from Site 1		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types At upper limit of saltmarsh fringing a drying, brackish pool. Growing on damp blackish organic-rich surface of sand exposed at base of shallow hollow, the hollow probably resulting from past movement of vehicles turning at end of a small track.		
Associated plant species N/A		
Current land-use/grazing Area is currently ungrazed and unfenced.		
Photographs of site Images of habitat/ plants (5633, 5635, 5630, 5629, 5637, 5627, 5640).		
Field sketch map photographed Yes (5968)		
Apparent threats/any existing conservation measures The spot where *B. marratii* was found in 2003 had become unsuitable by 2023, with ungrazed vegetation forming a thick low carpet, almost completely shading the ground. Barer patches in the vicinity were more localised now, and mainly at lower levels with conditions probably too saline for *B. marratii* to flourish, although *Hennediella heimii* was present locally. Both of the closely adjacent Sites 1 and 2 found in 2023 seem likely to be at risk from increased shading by *Festuca rubra*, unless more disturbance of the ground surface occurs.		
Other comments There are doubtless other small groups of *B. marratii* within the general areas described for Sites 1 and 2 above, but more than one hour of "hands and knees" searching did not reveal any more distant plants.		
Details of Previous Records Discovered here in 2003 during surveys for NPWS carried out by DTH. Data recorded on the voucher specimen (**DBN**) are: "29 Sept. 2003, Elly Harbour, W. Mayo, v.c. H27, F6489 2644 (Map letter c), on sandy mud at upper limit of saltmarsh near brackish pool, almost unshaded, Holyoak 03-498". Notes at the time recorded an "interrupted patch 20 x 12 cm & few scattered small patches".		
Reasons for loss or decline The record from 2003 was from a different spot to those from 2023. The old site had become unsuitable by 2023, due to development of thicker vegetation cover. The patch found in 2003 (20 x 12 cm and a few smaller) was much larger than any found in 2023.		
Recommended conservation measures It is desirable to reintroduce grazing of the saltmarsh here, but the lack of fencing and proximity to a through-road currently discourage this. Targeted scraping of the ground surface could usefully be considered as an alternative means of maintaining patches of open habitat. The population of *B. marratii* should be monitored at intervals.		

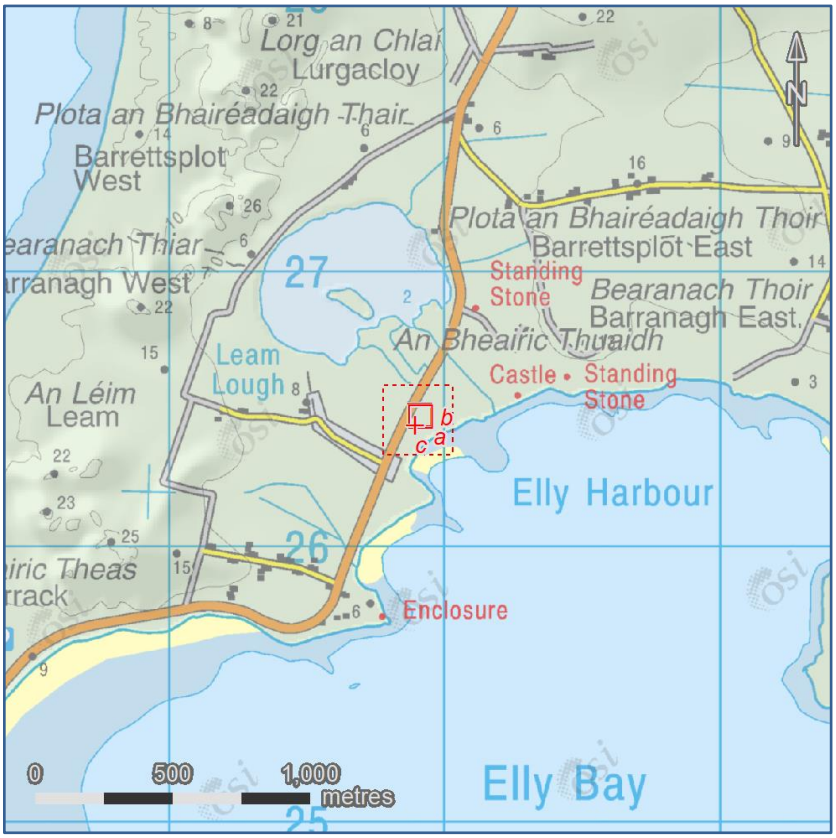

Figure 39 Species Site 10, Discovery map abstract. *Bryum marratii* was found at locations (a) and (b) in 2023, at location (c) in 2003.

Figure 40 Species Site 10, Bluesky image abstract. *Bryum marratii* was found at locations (a) and (b) in 2023, at location (c) in 2003.

Figure 41 Species Site 10, location (b) where *Bryum marratii* was found on 26 June 2023, to left of centre of foreground marked by orange tape.

Figure 42 Species Site 10, details of location (b) where *Bryum marratii* was found on 26 June 2023, with almost closed vegetation cover leaving very little exposed damp soil.

Species Site 11

Species *Bryum marratii*	**County** Mayo	**Vice-county** H27
Locality below S. slope of Garter Hill		**Discovery Map** 22
SAC/NHA Glenamoy Bog Complex SAC 000500		
Grid References (from hand-held GPS) **ITM** 482222 839999 (Map letter a)		**IG** F82245 39997
Comments Refound within *c.*2 m of the spot where it was recorded in 2003, noted then as F8224 4000 (Map letter b).		
Elevation (m) 2		
Survey date 25 June 2023	**Observers present** DTH (with E. Holyoak)	
Population recorded A tiny and highly localised population: on N. bank of stream as 4 small patches up to 55 cm apart (patches 2 x 1, 1 x 1, 1 x 2, 2 x 1.5 cm, all of small plants 2–3.5 mm high); on S. bank of stream almost opposite, 2 patches *c.*9 cm apart (2 x 0.5, 1 x 0.5 cm), with few solitary stems beyond, all <3 mm high**.**		
Previous records here/close by Found here in 2003 (see "Previous records" below) and not reported subsequently.		
Fertile? Capsules lacking		
Voucher specimen(s) Holyoak 23-097 (for **DBN**), a very small specimen		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Banks of small stream just above beach-head in area of machair. Growing 25 cm and 35 cm above either water in stream or its stony bed, on slightly raised "terracette", unshaded, with short and incomplete vegetation cover. The site occupied has a high water table due to the proximity of the stream and also from diffuse through-flow from sandy slopes adjacent.		
Associated plant species N/A		
Current land-use/grazing Site and surrounding land heavily grazed by sheep.		
Photographs of site Images showing location, habitat and plants (5555, 5552, 5550, 5547, 5545, 5540). In some photos, light-coloured stones (or the knife), show position of individual small patches of *B. marratii*.		
Field sketch map photographed Yes (5966)		
Apparent threats/any existing conservation measures A tiny population that is potentially vulnerable to accidental damage e.g. from trampling sheep, erosion by the small stream, or burial beneath seaweed and other debris blowing up over the beach. Rising sea level may cause changes in sedimentation that could affect this population.		
Other comments A small population was recorded in 2003 as "scattered small patches, largest 4 x 3 cm", so there is no clear evidence of decline even though the largest patch was only 2 x 1.5 cm in 2023 (and doubtless not in precisely the same spot).		
Details of Previous Records Discovered here in 2003 during surveys carried out for NPWS by DTH. Data on the voucher specimen (**DBN**) records: "30 Sept. 2003, below S. slope of Garter Hill, W. Mayo, v.c. H27, F8224 4000 (Map letter b), on damp calcareous mud *c.*15 cm above small stream a few metres from shore, with sparse *Agrostis stolonifera*, unshaded".		
Reasons for loss or decline There is no clear evidence of decline, see above.		
Recommended conservation measures None, except that occasional monitoring of the size of this population is desirable.		

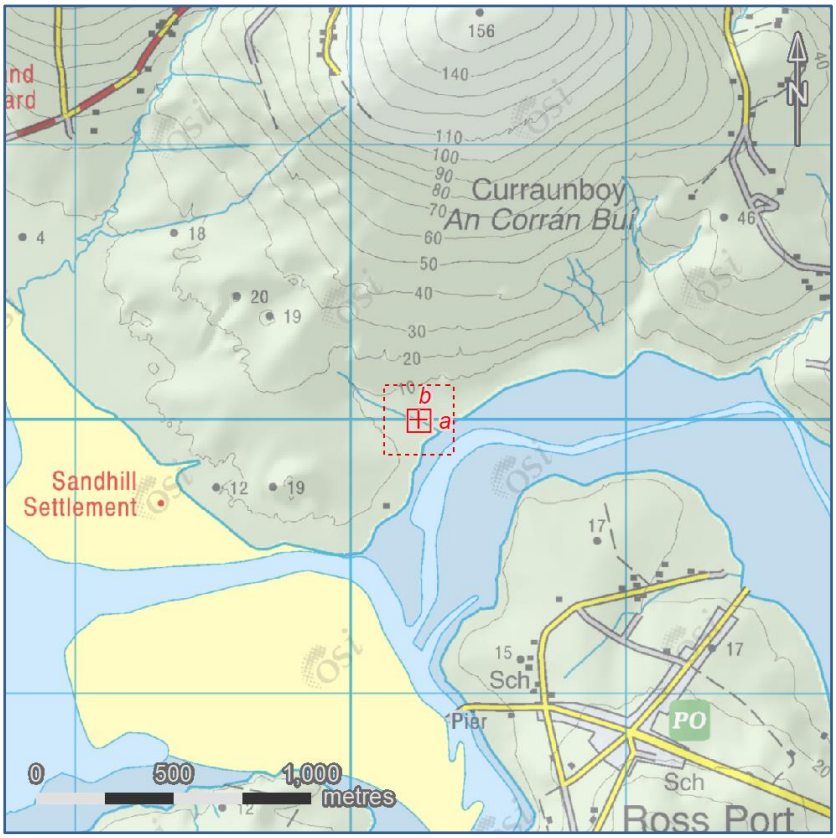

Figure 43 Species Site 11, Discovery map abstract. *Bryum marratii* was recorded at location (b) in 2003 and refound at location (a) in 2023.

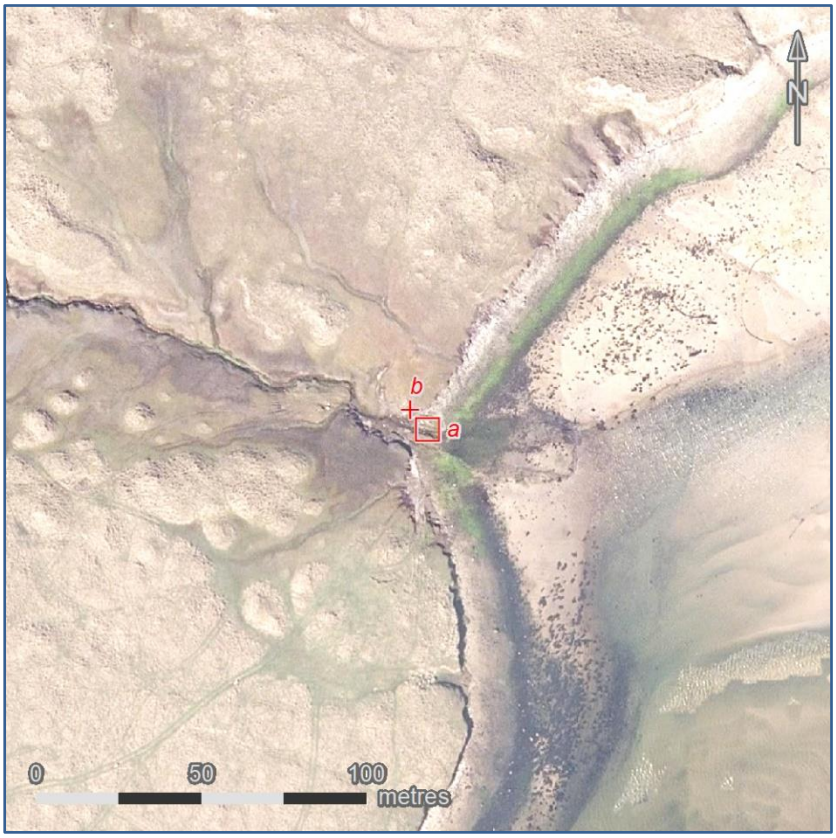

Figure 44 Species Site 11, Bluesky image abstract. *Bryum marratii* was recorded at location (b) in 2003 and refound at location (a) in 2023.

Figure 45 Species Site 11, location (a) where *Bryum marratii* was found on 25 June 2023 on N. bank of stream, marked by knife with orange tape.

Figure 46 Species Site 11, location (a) where *Bryum marratii* was found on 25 June 2023 on S. bank of stream, marked by knife with orange tape.

Species Site 12

Species *Bryum marratii*	**County** Donegal	**Vice-county** H34
Locality Binnion (NW of Clonmany)		**Discovery Map** 3
SAC/NHA North Inishowen Coast SAC 002012		
Grid References (from hand-held GPS) **ITM** Not recorded **IG** C3593 4808 (Map letter a) **Comments** Not refound in 2023. The grid reference given was that recorded in 2002. This appears somewhat imprecise since it falls closest to the point where the E. end of the deep ditch intersects the edge of the road, whereas DTH recollects that the site was a few tens of metres back westwards from the edge of the road.		
Elevation (m) 2		
Survey date 9 September 2023	**Observers present** DTH	
Population recorded None, not refound		
Previous records here/close by Discovered here 2002; see "Details of Previous Records" below.		
Fertile? Capsules were not recorded here in 2002		
Voucher specimen(s) None, not refound		
***Ex situ* cultivation material collected** No, not refound		
Site description/geology/slope/drainage/shading/vegetation types Record from 2002 was "on unshaded wet sandy mud in saline ditch at edge of pasture, with sparse grasses".		
Associated plant species The 2002 record noted "sparse grasses". More detailed data are held with NPWS.		
Current land-use/grazing No farm animals were present in fields on either side of the road. However, fields on both sides had old pats of cow dung, and different neighbouring fields further away held sheep or cattle. The saltmarsh vegetation along the fringes of the ditch where *B. marratii* was found in 2002 remained open in places.		
Photographs of site No		
Field sketch map photographed No		
Apparent threats/any existing conservation measures *B. marratii* was not refound, despite thorough searches and presence of possible habitats for it. See "Other comments" below.		
Other comments Almost the whole *c.*100 m length of ditch from the road westwards to the river was searched thoroughly (over 2.5 hours) in good conditions without finding any *B. marratii*. The ditch had a firm sand bed and it contained only shallow water, so comprehensive searches by wading in wellington boots were easy. Scattered small patches of *Ptychostomum* cf. *inclinatum* type were seen in several places, growing on hard muddy sand, but none of them c.fr. *Tortella inclinata* was locally plentiful, its presence perhaps pointing to conditions too dry for *B. marratii*. Unsuccessful searches were also carried out along the shallower ditches east of the road, along the river to the west, and in various places much further east by following the Clonmany River eastwards then northwards to its estuary on the beach.		
Details of Previous Records Discovered here by DTH in 2002 during surveys for NPWS. Data recorded were: "15 May 2002, Binnion, NW of Clonmany, H34, C3593 4808 (Map letter a), on unshaded wet sandy mud in saline ditch at edge of pasture, with sparse grasses, *c.*5 m alt., Holyoak 02-500; at least four small patches".		
Reasons for loss or decline Apparently absent from the site now, despite existence of possible habitat niches. There seems no obvious reason for its disappearance, although it is possible that the ditch banks have become drier, or more exposed to intermittent incursions of saline water, or both.		
Recommended conservation measures None		

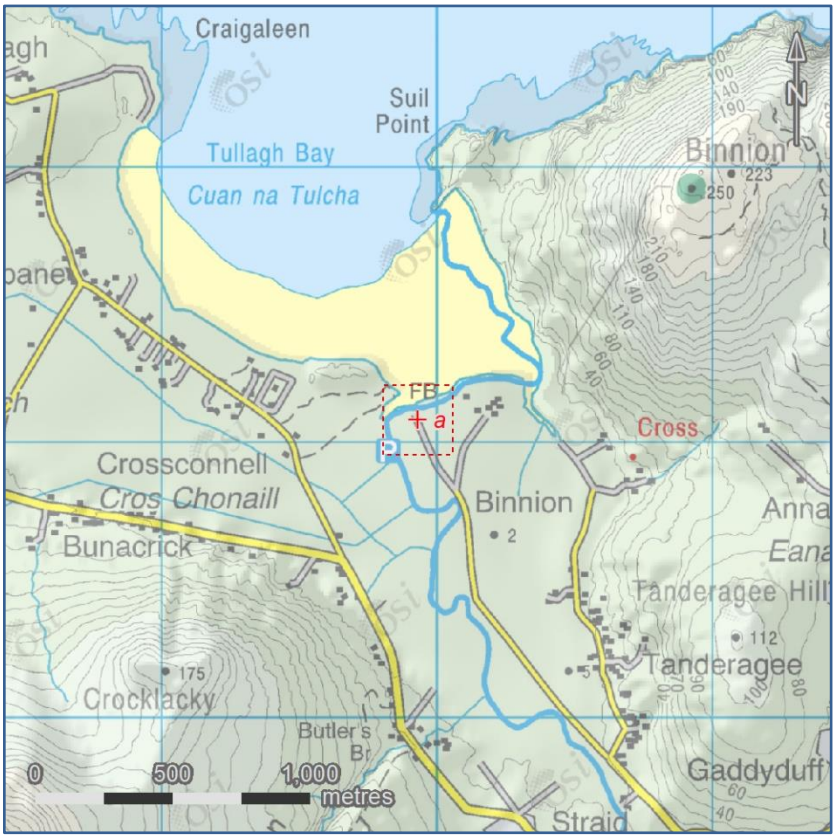

Figure 47 Species Site 12, Discovery map abstract. *Bryum marratii* was recorded at location (a) in 2002, but the grid reference is tens of metres too far to the east.

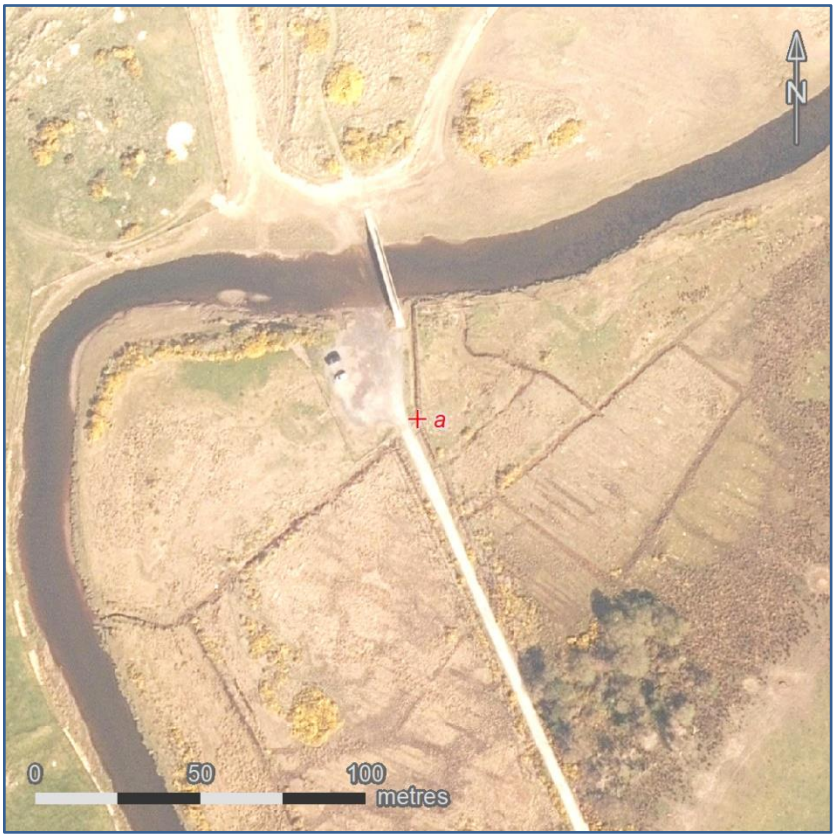

Figure 48 Species Site 12, Bluesky image abstract. *Bryum marratii* was recorded at location (a) in 2002, but the grid reference is tens of metres too far to the east.

Species Site 13

Species *Bryum marratii*	**County** Donegal	**Vice-county** H35
Locality SE of Sheskinmore Lough		**Discovery Map** 10
SAC/NHA West of Ardara/Maas Road SAC 000197		
Grid References (from hand-held GPS) **ITM** 570564 894625 (Map letter a) (Waypoint 167) **IG** G70608 94634 **Comments** Grid references are for a "new" location. The record from 1999 was from "G703949" (Map letter b).		
Elevation (m) 2		
Survey dates 27 & 28 September 2023	**Observers present**	DTH, with CC & N. Lockhart on 28 September 2023
Population recorded Four closely adjacent small patches, respectively 3 x 3, 1.5 x 1.5, 1 x 1 and 1 x 1 cm in extent. Apparently restricted to a small zone (<1 m square) on a bank here and very scarce, although tall vegetation impeded searching.		
Previous records here/close by A record from 1999 was from "G703949", *c.*300 m further north, in an area that is now unsuitable for the species (see "Other comments" below).		
Fertile? Capsules lacking		
Voucher specimen(s) Holyoak 23-152 (for **DBN**)		
***Ex situ* cultivation material collected** Yes, IVC sample for work at **DBN** collected.		
Site description/geology/slope/drainage/shading/vegetation types On damp sand sloping at 20–35°, on edge of small inlet beside N./E. edge of small tidal river in upper part of saltmarsh. Found in one spot with *c.*50% bare substratum beneath tall (30–50 cm) but sparse phanerogam cover.		
Associated plant species Sparse cover of *Phragmites australis*, *Schoenoplectus tabernaemontani*, *Lysimachia maritima*, with scanty *Agrostis stolonifera*, *Festuca rubra*. Near seedlings of *Cochlearia officinalis*, *Plantago coronopus*, *Tripolium pannonicum* and sparse *Ptychostomum pseudotriquetrum* (including the "*neodamense*" morphotype).		
Current land-use/grazing Saltmarsh here is currently grazed rather lightly by cattle.		
Photographs of site IMG 6766–6788		
Field sketch map photographed No		
Apparent threats/any existing conservation measures No immediate threats apparent. Much larger adjacent areas with similar substratum and same phanerogam species lack *B. marratii*, perhaps because they are more exposed intermittently to strong currents from higher-stage river flows, and perhaps wave action during the highest tides. The protected "niche" on bank of a small inlet may thus be critical to survival of the rather fragile stems of *B. marratii*.		
Other comments The record of *B. marratii* from 1999 (see below) was undoubtedly far to the north of the present-day limit of saltmarsh vegetation. However, its precise location is uncertain because the record was made using only a 1:50,000 map, rather than any GPS. The contemporary northern limit of evident saline influence on the vegetation was at G70523 94645. Close to this at G70536 94639 (ITM 570491 894629, waypoint 166) false hopes of refinding *B. marratii* were raised by discovery on 27 September 2023 of plants of the "*neodamense*" phenotype of *Ptychostomum pseudotriquetrum* (voucher Holyoak 23-151). Small plants of this phenotype look quite similar to *B. marratii*, but differ in having their well-developed stems developing orange coloration. This form of *P. pseudotriquetrum* var. *pseudotriquetrum* does not normally grown in saltmarsh edges, its usual habitats being at margins of marl lakes, in open rich (calcareous) fens, or open calcareous dune slacks without obvious saline influences (Holyoak & Hedenäs 2006, Holyoak 2021 p. 216). *B. marratii* was eventually discovered further south on 28 September at G70608 94634, as documented above. *P.* "*neodamense*" also occurred at that location, so care is needed in any future monitoring of the population of *B. marratii* to ensure that it is correctly identified.		
Details of Previous Records Discovered here by DTH during surveys for NPWS (seeking *Petalophyllum*) in 1999, with data recorded as: "2 Aug. 1999, SE of Sheskinmore Lough, H35, G703949 (Map letter b),		

on damp bare soil with patchy short vegetation close to tidal stream, Holyoak 99-755A & B; small population of non-fertile plants, mainly immature, at numerous spots in three areas; relevé recorded".

Reasons for loss or decline

The population of *B. marratii* found in 1999 "at numerous spots in three areas" was clearly larger than that discovered in 2023 at a location *c.*300 m distant (4 small patches all within <1 m^2). The retreat of the saltmarsh edge southwards in this location is apparently due to natural sedimentation processes, which probably include variations in input of blown sand near the tidal river and its removal by both fluvial and tidal actions.

Recommended conservation measures

No immediate action is recommended, but the loss of numerous sites for *B. marratii* in Ireland implies that future monitoring of the species is desirable at all extant sites, say every three years.

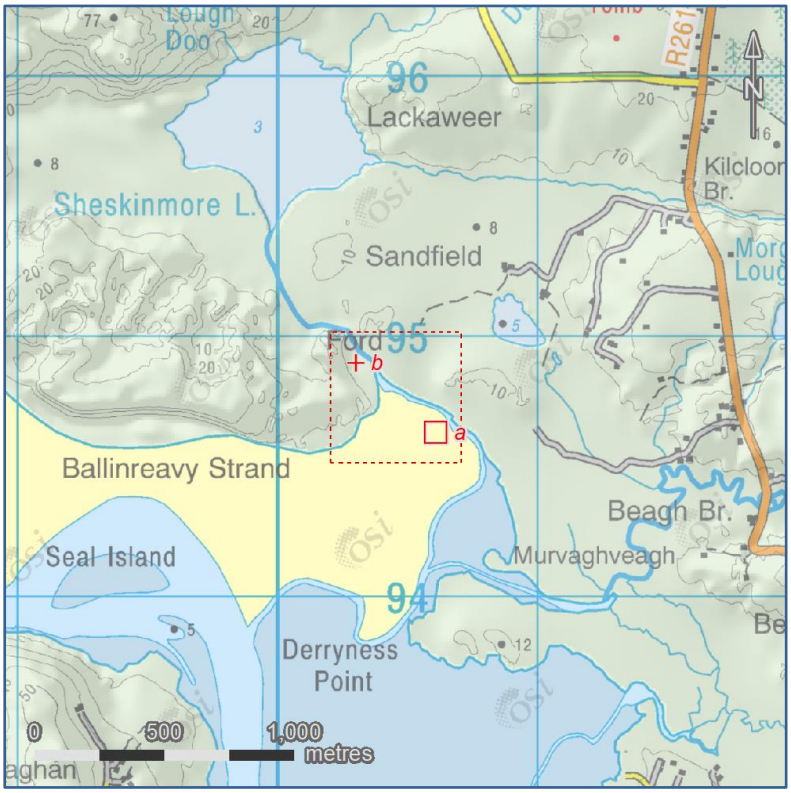

Figure 49 Species Site 13, Discovery map abstract. *Bryum marratii* was found at location (a) in 2023 and location (b) in 1999. The upper limit of the intertidal saltmarsh had moved several hundreds of metres to the south-east between these visits, with an intermediate limit shown on the Discovery map.

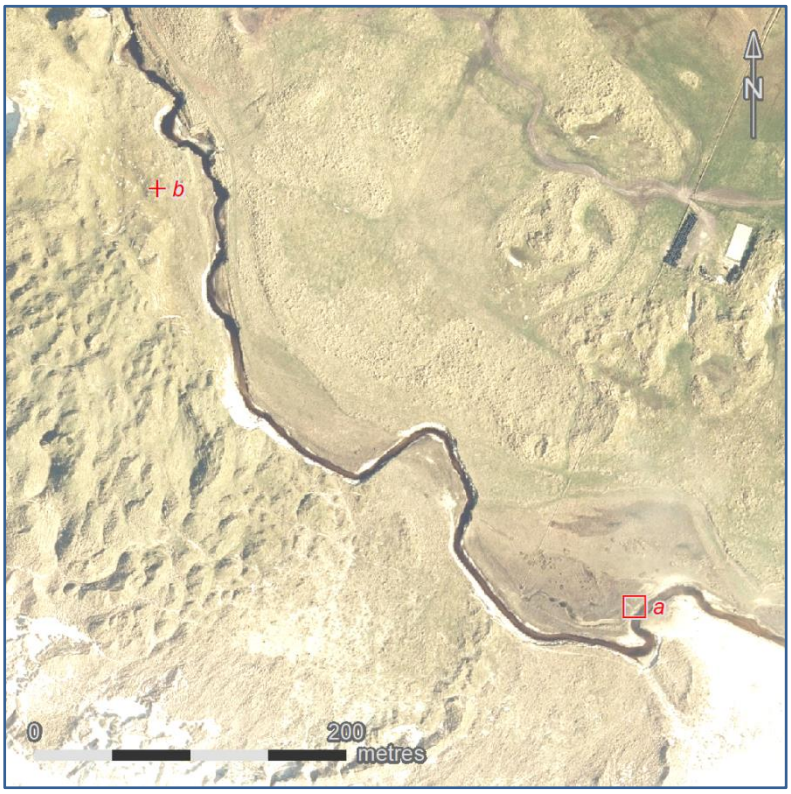

Figure 50 Species Site 13, Bluesky image abstract. *Bryum marratii* was found at location (a) in 2023 and location (b) in 1999. The upper limit of the intertidal saltmarsh had moved several hundreds of metres to the south-east between these visits, with an intermediate limit shown on the Bluesky image that is lower than that on the Discovery map abstract.

Figure 51 Species Site 13, location (a) where *Bryum marratii* was found on 28 September 2023, marked by orange tape, partly shaded by sparse *Phragmites*, etc.

Figure 52 Species Site 13, patch of *Bryum marratii* found at location (a) on 28 September 2023, cut out of substrate with knife for checking, photos and sampling, then replaced.

Species Site 14

Species *Bryum marratii*	**County** Donegal	**Vice-county** H35
Locality SW of Kincaslough		**Discovery Map** 1
SAC/NHA Gweedore Bay and Islands SAC 001141		
Grid References (from hand-held GPS) **ITM** 573925 918663 (waypoint 159)		**IG** B73971 18678
Comments These are new grid references obtained after the exact location of the record from 2002 was relocated using a photograph.		
Elevation (m) 2		
Survey date 24 September 2023	**Observers present** DTH	
Population recorded None		
Previous records here/close by Found here in 2002, see "Details of Previous Records" below.		
Fertile? Found with capsules in 2002; species not refound here in 2023.		
Voucher specimen(s) None; not refound		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types See "Details of Previous Records" below		
Associated plant species See "Details of Previous Records" below and fuller data in NPWS files.		
Current land-use/grazing There is now no grazing by domestic animals and it apparently ceased years ago.		
Photographs of site IMG 6608–6818 show present condition of site; image "*Bryum marratii* 027" shows location and condition of site on 25 April 2002.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Apparently extinct at this site, see "Other comments" below.		
Other comments A contemporary photograph allowed exact relocation of the small areas where a strong population of *B. marratii* was found on 25 April 2002. On that date, it occurred "on unshaded damp muddy sand at edge of little-used track on upper limit of saltmarsh, with sparse low sedges, grasses and herbs". The same place is now unsuitable for the moss, with a thick carpet of *Festuca rubra*, plus some *Carex arenaria*, exposing no unshaded damp sand. The track near MHWS is now much more heavily used, for access to intertidal sand and rock areas from which seaweed is harvested commercially. The track in this and lower parts appears to have been "improved", by surfacing with cobble-size rocks. The adjoining land above MHWS is unfenced and ungrazed, supporting thick tall grassland (*Festuca rubra*, *Dactylis glomerata*, *Molinia caerulea*), passing upwards into extensive areas of *Pteridium aquilinum* with grasses, and developing scrub of *Rubus fruticosus* agg. and *Salix cinerea*. There is very little sign of open blown sand anywhere on this slope. The cover of bracken and bushes has clearly increased greatly since 2002. The lower track edges *c.*5 m to north retain short saltmarsh vegetation, but apparently these are in a zone too low, too exposed to wave action from seawater flooding, and lacking any freshwater drainage from the landward side. Wider areas of the neighbouring coastal zone around MHWS were searched without success. They are similar to the original site, in now having strandline debris of fucoid seaweeds extending onto the lower edge of closed grass swards (dominated by *Festuca rubra*).		
Details of Previous Records Discovered here in 2002 by DTH during surveys for NPWS. Data recorded for the voucher specimen are as follows: "25 April 2002, SW of Kincaslough, H35, B7396 1868 (Map letter a), on unshaded damp muddy sand at edge of little-used track on upper limit of saltmarsh, with sparse low sedges, grasses & herbs, Holyoak 02-384, c.fr., 10 patches, the largest 30 x 10 cm".		

Reasons for loss or decline Cessation of grazing leading to general loss of open habitat in zone around MHWS. Heavier and more regular use of closely adjacent track by motor vehicles used for harvesting seaweed and surfacing of part of track with stone may also have destroyed possible habitat for *B. marratii*.
Recommended conservation measures Extinct at this location; no action recommended.

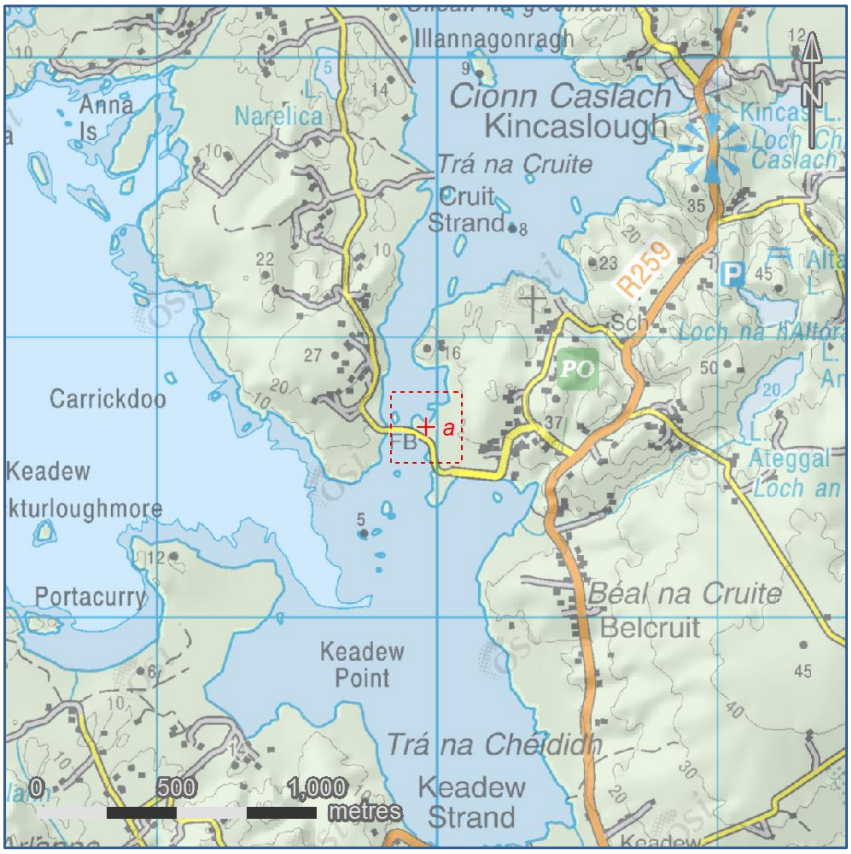

Figure 53 Species Site 14, Discovery map abstract. *Bryum marratii* was found at location (a) in 2002.

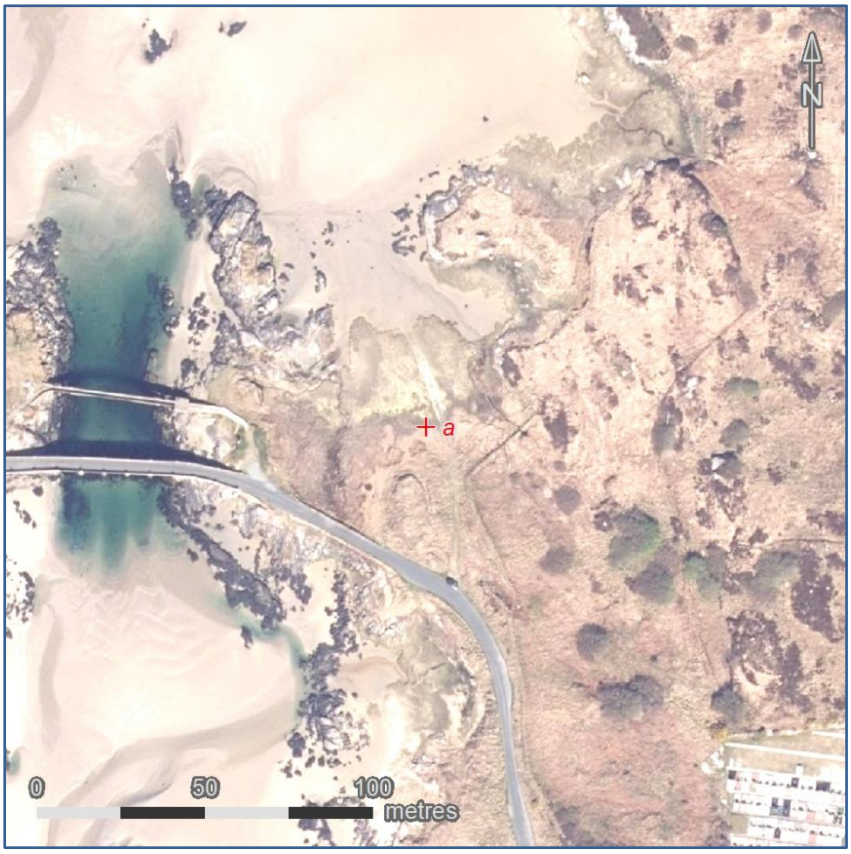

Figure 54 Species Site 14, Bluesky image abstract. *Bryum marratii* was found at location (a) in 2002. The grid reference recorded then was too far to the west.

Figure 55 Species Site 14, former location (a) for *Bryum marratii* revisited on 24 September 2023, marked with pink clipboard.

Figure 56. Species Site 14, closer view of former location (a) for *Bryum marratii* revisited on 24 September 2023, showing dense closed grass sward, without any open soil away from heavily used track.

Species Site 15

Species *Bryum marratii*	**County** Donegal	**Vice-county** H35
Locality NW of Falcarragh (just E. of Black Rock)		**Discovery Map** 1
SAC/NHA Ballyness Bay SAC 001090		
Grid References (from hand-held GPS) **ITM** 592324 933536 (Map letter a) (waypoint 165)		**IG** B92371 33555
Comments These are new grid references for same spot (within 2 m) of that recorded in 2002, judged from photo. The IG grid references are anyway virtually the same as those from 2002.		
Elevation (m) 2		
Survey date 26 September 2023	**Observers present** DTH	
Population recorded Tiny, with 5 stems in single loose group *c.*1 x 0. 5 cm, 10 more small and rather weak stems in loose group 35 cm further east. Prolonged wider searches revealed no others.		
Previous records here/close by Discovered at same spot in 2002; see "Details of Previous Records" below.		
Fertile? Capsules lacking		
Voucher specimen(s) Not collected because population tiny; plants photographed *in situ*.		
***Ex situ* cultivation material collected** Not collected		
Site description/geology/slope/drainage/shading/vegetation types On wet, muddy, organic-rich sand, a few cm above shallow standing water in edge of cattle-poached area by tiny stream, part-shaded by vegetation. Location is 15 m (paced) southwards into the field from the barbed wire fence, on the western fringe of the western stream; 6.5 m north of the nearest (lowest) patch of *Iris pseudacorus* leaves.		
Associated plant species N/A		
Current land-use/grazing In a field with barbed-wire fencing. Site fairly recently grazed by cattle, judging from dung pats, but none in field now.		
Photographs of site IMG 6690–6715; also copy of photo from 8 May 2002 (*Bryum marratii* 015) for comparison.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Most potential habitat close by is too heavily shaded by grasses growing on hummock tops and on low banks beside the tiny stream. As usual in such situations, the bottoms of hollows among the hummocks are too wet and disturbed to support *B. marratii*, with loose, bare, muddy sand that is often inundated.		
Other comments The visit was made on a fine sunny day, during a westerly gale. It required 30 minutes to refind the spot despite using an old photo. Further sustained searches in similar spots within a 5 m radius did not reveal any more *B. marratii*, although weak growths of *Amblystegium serpens* and *Ptychostomum pseudotriquetrum* were seen. Another 40 minutes of wider searching allowed all accessible spots nearby to be examined without success. Thus, there is little doubt that the population has declined from that recorded in 2002 as "strong patches over 15 x 10 cm area, few more small patches nearby". The "unshaded mainly bare patch of damp humic sand" recorded then was no longer present, only part-shaded potential habitat, and that mainly on near-vertical sides of hummocks.		
Details of Previous Records Discovered here by DTH during surveys for NPWS in 2002, when following data was recorded: "28 May 2002, NW of Falcarragh, just E. of Black Rock, H35, B9237 3355 (Map letter b), on unshaded mainly bare patch of damp humic sand near upper limit of saltmarsh, beside tiny trickle from freshwater flush in pasture above, Holyoak 02-452; strong patches over 15 x 10 cm area, few more small patches nearby". Return visit on 21 August 2002 recorded plants with inflorescences, Holyoak 02-862.		
Reasons for loss or decline Decline is apparently due to reduction in extent of the small patches of open habitat: a small population has become much smaller.		

Recommended conservation measures

Poaching around the tiny stream by cattle provides the small patches of bare habitat needed by *B. marratii*, but heavier grazing pressure from more cattle (or restriction of the cattle temporarily to part of the field) could make more such niches available.

The loss of numerous sites for *B. marratii* in Ireland implies that future monitoring of the species is desirable at all extant sites, say every 3 years. If existing proposals for shellfish culture in Ballyness Bay are approved there may be potential of increased risk from eutrophication of the sea water that approaches the site on the highest tides.

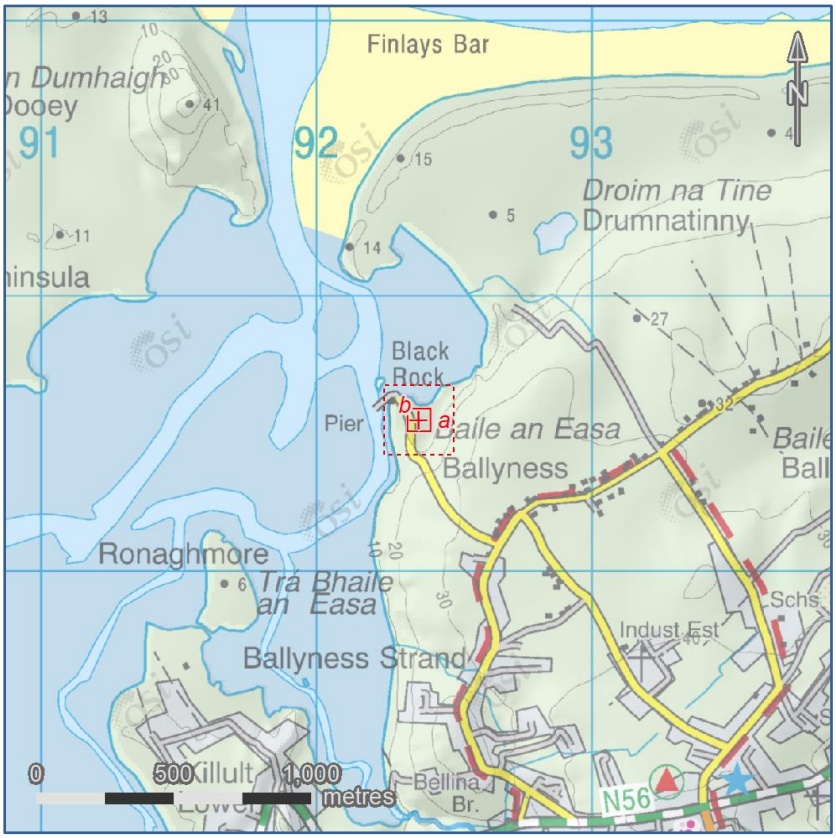

Figure 57 Species Site 15, Discovery map abstract. *Bryum marratii* locations (a) and (b) from 2023 and 2002 were apparently less than 5 m apart.

Figure 58 Species Site 15, Bluesky image abstract. *Bryum marratii* locations (a) and (b) from 2023 and 2002 were apparently less than 5 m apart.

Figure 59 Species Site 15, location (a) where *Bryum marratii* was found on 26 September 2023, marked with orange tape (just right of the pink clipboard).

Figure 60 Species Site 15, detail of location (a) where *Bryum marratii* was found on 26 September 2023, showing the very small extent of open damp soil amongst the dense grass sward.

Species Site 16

Species *Bryum marratii*	**County** Donegal	**Vice-county** H35
Locality opposite Inishmeane (coast NW of Derrybeg)		**Discovery Map** 1
SAC/NHA Gweedore Bay and Islands SAC 001141		
Grid References (from hand-held GPS) **ITM** Not recorded **IG** B799 803 (approximately) **Comments** No longer present; see "Details of Previous Records" for correction of the grid reference used previously for the record from 1991.		
Elevation (m) Not recorded (but <10 m)		
Survey date 25 September 2023	**Observers present** DTH	
Population recorded Not refound		
Previous records here/close by Collected only in 1991; see "Details of Previous Records" below.		
Fertile? Specimen from 1991 lacks capsules.		
Voucher specimen(s) None (although voucher for 1991 record is in collection at RBG Edinburgh).		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types In 1991, "On damp ground by stream in sand dunes". There are no new data; see below.		
Associated plant species No data		
Current land-use/grazing Machair, currently heavily grazed by sheep and some cattle.		
Photographs of site None		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Suitable habitat for *B. marratii* is no longer present; see "Other comments" below.		
Other comments Two minor roads run westwards from the R257 at Carrick village, providing the only easy access to the "coast opposite Inishmeane". We took the northerly of these, reaching the coast at B799804 (ITM 579899 928519, waypoint 163). From that point we walked southwards to the western end of the southerly road where it reaches a beach and the jetty for boats to Inishmeane at B799802. In between the two roads lies a small stream, the only one to reach this section of the coast, so the locality found by D.G. Long was surely here. There is no longer any habitat suitable for *B. marratii* at this stream. The stream does not extend to the beach, except when in flood, as it currently ends about halfway through the tall dune ridge within a deep gully floored with bare sand. The dunes either side of this gully are dry with complete cover of tall *Ammophila arenaria*. Inland of the dunes is an extensive machair plain, now heavily grazed. Where the stream reaches the landward side of the dunes there is now no obvious sign of salinity and little damp open low-lying habitat. An old tractor-track with some wheel ruts crosses the stream here, but it no longer has any open moist sand or mud. Hollows nearby have *Juncus articulatus* with patches of *Calliergonella cuspidata*, but nothing suitable for *B. marratii*. The stream edges further inland lack open sparsely vegetated patches.		
Details of Previous Records Collected here by D.G. Long in 1991, with data recorded as follows: "5 Aug. 1991, opposite Inishmeane, coast NW of Derrybeg, on damp ground by stream in sand dunes, Long 20225 (E)". The identity of the specimen has been confirmed by DTH, who noted the plants as "rather small, non-fertile". A grid reference B80-27- has been assigned to this record, possibly by Nick Stewart during early work on Irish bryophytes for a Red Data Book. Although this is in accordance with "coast NW of Derrybeg", it was most likely to have been added subsequent to the field collection and it appears to be incorrect. Instead, "opposite Inishmeane" combined with "by stream in sand dunes" would refer to the eastern edge of B79-28- (Map letter a; monad) (or possibly the western edge of B80-28-); the former monad includes the pier for boats to Inishmeane, the latter includes more of the stream.		

Reasons for loss or decline Loss of *B. marratii* from this site is likely to have occurred decades ago, perhaps because the dune sand became more stable with development of full *Ammophila* cover, and the vicinity of the stream just inland of the dunes acquired closed vegetation cover.
Recommended conservation measures *B. marratii* is extinct at this site, which no longer provides suitable habitat for it.

Figure 61 Species Site 16, Discovery map abstract. The imprecisely located record of *Bryum marratii* from 1991 was noted as “opposite Inishmeane, coast NW of Derrybeg, on damp ground by stream in sand dunes”. It is mapped only as point (a) in the south-west corner of the most likely one km grid square.

Species Site 17

Species *Bryum marratii*	**County** Donegal	**Vice-county** H35
Locality SE of Rosepenna		**Discovery Map** 2
SAC/NHA Sheephaven SAC 001190		
Grid References (from hand-held GPS) **ITM** No data **Comments** Not refound	**IG** C123 369 (in 1999), C1235 3693 (Map letter a)	
Elevation (m) 2		
Survey date 18 September 2023	**Observers present** DTH	
Population recorded None		
Previous records here/close by Recorded here in 1999 and 2002, see "Details of Previous Records" below.		
Fertile? Capsules were not recorded when it was seen here in 1999 and 2002 (see "Details of Previous Records" below).		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types The records from 1999 and 2002 were from "silty-clay mud in wheel-rut at top edge of saltmarsh, with incomplete cover of *Carex flacca*, *Juncus gerardii*, grasses, etc."		
Associated plant species See data filed with NPWS for relevé recorded by DTH on 5 August 1999.		
Current land-use/grazing Currently ungrazed or lightly grazed only by rabbits. The whole area is unfenced and showed no signs of grazing by domestic animals in recent years.		
Photographs of site None		
Field sketch map photographed No		
Apparent threats/any existing conservation measures None		
Other comments The site of the 2002 record at C1235 3693 was relocated, with close search showing vestiges of the former deep wheel-ruts. It now has closed cover of *Festuca rubra* grassland, with some intermixed *Lysimachia maritima* and taller patchy cover of *Juncus maritimus* growing through this sward. No bare substratum was visible, and there was clearly no remaining habitat suitable for *B. marratii*. Likely spots across the top of the saltmarsh within several hundred metres of the 1999/2002 finds were also searched without success. The whole area now lacks obvious wheel ruts. Some small-scale disturbance is evident from trampling by horses (probably only exercised here) and, to the north, from golfing practice causing small localised scrapes by skimming off the top of the grass sward. The only well used track now is much further to the west, with very shallow rutting, but this is above the edge of the saltmarsh, on machair with signs of rabbit grazing. Another small area within the uppermost limit of the saltmarsh, shows circular skid marks that probably resulted from handbrake turns by a light car or similar vehicle, revealing organic-rich sand, but these openings in the turf are too recent to have any plant colonists. At lower levels an elongate depression to the north was examined, but it appeared to be too regularly flooded by salt water and also too prone to dry out at times. Drier and higher ground around its edges mainly had closed phanerogam cover, although a few open spots supported bits of *Tortella flavovirens* and a scrap of *Amblystegium serpens*. Around the parking areas at C124 372 the upper fringe of the saltmarsh has hollows regularly disturbed by vehicles, so the vegetation was kept open. These had *Drepanocladus polygamus*, with smaller amounts of *Hennediella heimii*, and *Kindbergia praelonga* and a few tiny young plants of Bryaceae (with pointed leaf apices, so not *B. marratii*). Overall, it appears that cessation of grazing has led to development of the thicker grass cover at the saltmarsh edge. Despite existence of hectares of what at first sight seems to be potential habitat for *B. marratii* in the vicinity, suitable patches of open habitat for it are now fewer and small, and it could not be found there with prolonged searches.		

Details of Previous Records

Discovered here in 1999 by DTH during surveys for NPWS. Data recorded for voucher specimen were as follows: “5 Aug. 1999, S. & SE of Rosepenna, H35, C123369, on silty-clay mud in wheel-rut at top edge of saltmarsh, with incomplete cover of *Carex flacca*, *Juncus gerardii*, grasses, etc., Holyoak 99-759; several patches found, each of a few square centimetres; relevé recorded.”

A return visit on 30 May 2002 by DTH and Neil Lockhart found it at C1235 3693 (Map letter a), “patch 3 x 2 cm” “in wheel-rut at upper limit of saltmarsh”.

Reasons for loss or decline

Disappearance of patches of open habitat on upper edge of saltmarsh, caused by development of denser sward mainly of *Festuca rubra*, associated with cessation of grazing and changes in routes taken by vehicles driving off-road.

Recommended conservation measures

None

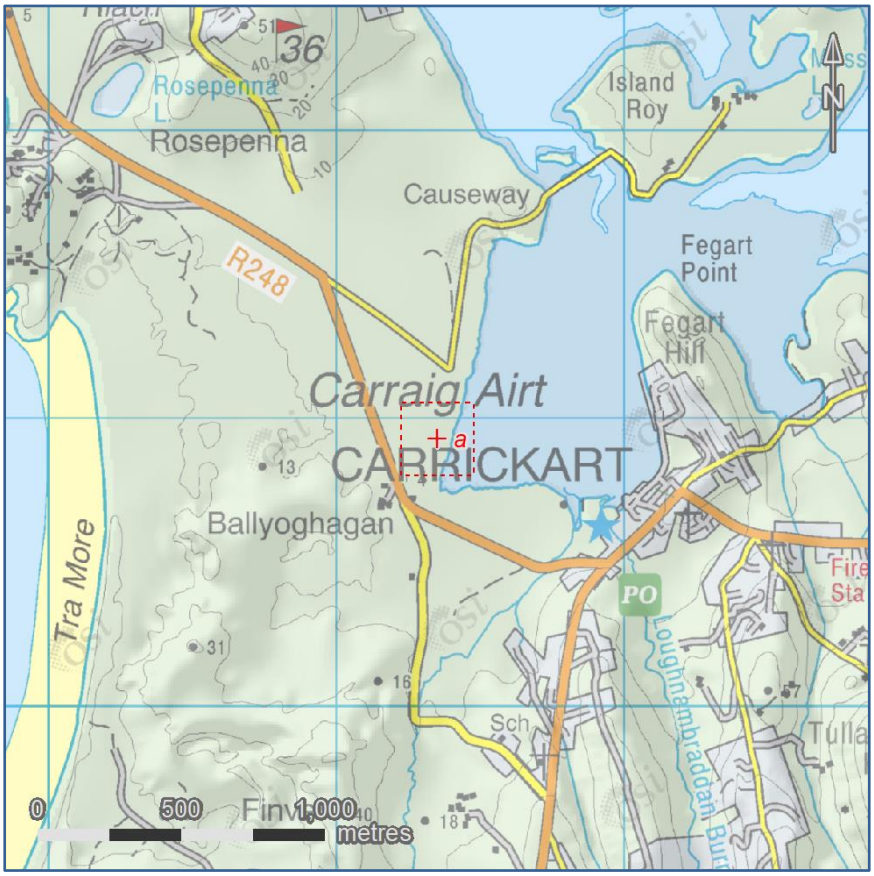

Figure 62 Species Site 17, Discovery map abstract. *Bryum marratii* was found at location (a) in 2002.

Figure 63 Species Site 17, Bluesky image abstract. *Bryum marratii* was found at location (a) in 2002.

Species Site 18

Species *Bryum marratii*	**County** Donegal	**Vice-county** H35
Locality Gortnalughoge Bay		**Discovery Map** 2
SAC/NHA Tranarossan and Melmore Lough SAC 000194		
Grid References (from hand-held GPS) ***Ca* 1 m from eastern limit:** **ITM** 613164 942171 (Map letter a) (waypoint 146) **IG** C13217 42194 **At western limit:** **ITM** 613142 942178 (Map letter b) (waypoint 149) **IG** C13195 42198 **Comments** *B. marratii* was found to occur continuously along a strip 25 m long (paced), following the base of the slope beneath a steep bank of sand forming the edge of the dunes. The western limit of its occurrence was 17 m (paced) from the nearest (eastern) corner of the water in the residual pool in the slack (the pool itself extending west to almost reach the line of the wire fence).		
Elevation (m) 3		
Survey date 15 September 2023	**Observers present** DTH	
Population recorded Present rather sparsely but continuously along a strip 25 m long, mainly in clusters of 3–6 stems, or as scattered stems, without any larger patches.		
Previous records here/close by Discovered here in 1999, see "Details of Previous Records" below.		
Fertile? Capsules were not seen in 1999 or 2023		
Voucher specimen(s) Holyoak 23-135 (for **DBN**)		
***Ex situ* cultivation material collected** Sample passed on for cultivation at **DBN**		
Site description/geology/slope/drainage/shading/vegetation types On damp (not wet) partly bare sand, with scanty humic layer, exposed at base of *Agrostis stolonifera* and sparse herbs, etc., along base of bank. This bank is at the foot of steep eroding dune slopes ("blow-outs") 2 to 10 m away that provide the obvious source of fresh blown sand here. The location is *c.*200 m from the sea-beach, close to the landward edge of the dune ridges, on the N. side of a small valley which narrows as it passes eastwards through the dunes to the beach. The site is on the north-eastern fringe of the small valley, on the edge of a depression resembling a dune slack, with salt-tolerant vegetation. At the time of this visit, the depression retained a substantial pool with *Chara* near its western edge. However, the depression floods much more extensively at times, e.g. in April 2023 (*fide* Google Earth Pro image). Indeed, during DTH's visit the remnants of a strandline (scatter of dry stem and rhizome fragments) extended along the bank to fractionally higher levels than the *B. marratii* population. This flooding is probably due to rising groundwater levels, rather than to direct ingress of sea water, since the sand floor of the passage to the sea-beach is higher than the depression behind.		
Associated plant species A representative area *c.*1 m from eastern limit of occurrence of *B. marratii* here had *c.*40% exposed substratum on which 1–2% cover of *B. marratii* was associated with sparser *Drepanocladus polygamus* and small young *Ptychostomum* (*P. compactum* occurred nearby). These were at the base of 45% cover of *Agrostis stolonifera*, with lesser amounts of *Plantago maritima*, and few plants of *Sagina nodosa* and *Lysimachia maritima*, plus a single rosette of *Leontodon saxatilis*. Close associates elsewhere at this site included *Hennediella heimii* and other Bryaceae (immature *Ptychostomum* cf. *compactum*; *Bryum dichotomum*).		
Current land-use/grazing Whole area of the slack and adjacent dunes is currently unfenced and ungrazed by domestic animals, although cattle are kept within 150 m away westwards behind a barbed-wire fence in a large field of rough machair pasture. Evidence of rabbits (dung) was visible in the dunes closer to the slack.		
Photographs of site IMG 6563–6566 (general views of area) and 6573–6585 (for population found in 2023).		
Field sketch map photographed No		

Apparent threats/any existing conservation measures

No immediate threats were apparent. This is the largest Irish population of *B. marratii* found to have survived from the NPWS surveys of 1999–2003. Despite lack of grazing here, it seems that the close proximity of a sand supply from an eroding dune, likelihood of freshwater flushing from the bank above, frequent flooding, and lack of really active erosion have maintained suitable conditions for the species. It is also in a region with low intensity farming and hence little obvious risk from eutrophication.

A threat in the longer term may nevertheless exist from strong populations of Sea-buckthorn *Hippophae rhamnoides* nearby, although none occurs close to the site at present. At C134427 at the extreme N. end of Gortnalughoge Bay a large Sea-buckthorn population covers a cliff slope below the caravan park, forming a dense closed stand *c.*2 m high over >100 m^2. There is another strong patch of it at the western side of the road S. of Gortnalughoge. Vigilance is needed because of a considerable risk of bird-sown seed reaching the *B. marratii* site, e.g. with Song Thrushes *Turdus philomelos* feeding among the dunes in dry or cold weather.

Other comments

The grid reference for the record from 1999 was recorded by studying a 1:50,000 scale map, without use of any GPS device. Nevertheless, the population found in 2023 was of similar extent and likely to have been in almost the same area. The substratum on which it grew in 1999 was recorded as “damp silty mud” whereas the population in 2023 was on rather bare damp sand, a change possibly due to recent deposition of fresh blown sand.

Wider searching around the “slack-like depression” failed to reveal its presence elsewhere in the vicinity.

Details of Previous Records

Discovered here in 1999 by DTH during surveys for NPWS (of *Petalophyllum ralfsii*). Data recorded were as follows: “6 Aug. 1999, near Gortnalughoge Bay, H35, C132422 (Map letter c), on damp silty mud at base of low *Agrostis stolonifera* at top edge of saltmarsh, Holyoak 99-760 & 761; small patches (each of few square centimetres) numerous along strip of bank top measuring 30 x 0.5 m; relevé recorded”.

Reasons for loss or decline

No decline evident

Recommended conservation measures

This is the largest population of *B. marratii* found in Ireland during the present study, which revisited every site with modern records. The loss or decline at most sites for the species in Ireland over the past two decades implies that future monitoring of its population is desirable at all extant sites, say every 3 years. For reasons noted above, particular vigilance is needed because of a possibility of Sea-buckthorn reaching this site.

Figure 64 Species Site 18, Discovery map abstract. Location (c) is an imprecise location of a single record of *Bryum marratii* made in 1999, locations (a) and (b) are where it was refound in 2023.

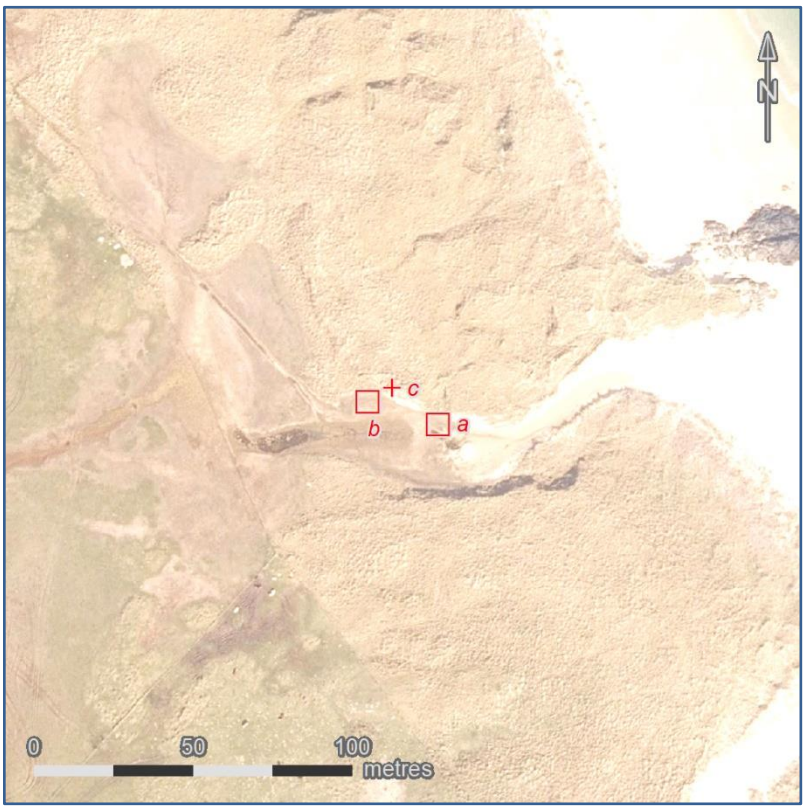

Figure 65 Species Site 18, Bluesky image abstract. Location (c) is an imprecise location of a single record of *Bryum marratii* made in 1999, locations (a) and (b) are where it was refound in 2023.

Figure 66 Species Site 18, part of area (a) where *Bryum marratii* was found on 15 September 2023, marked with orange tape. Note the close proximity of a source of blown sand and flushing with fresh water from upslope.

Figure 67 Species Site 18, *Bryum marratii* found at location (a) on 15 September 2023, forming a small patch in centre of photo, as part of the largest population found during the surveys in 2023. Persistent presence here of partly bare surfaces of damp sand has allowed extensive populations to be maintained from 1999–2023.

Species Site 19

Species *Bryum marratii*	**County** Donegal	**Vice-county** H35
Locality W. of Lough Nagreany		**Discovery Map** 2
SAC/NHA Lough Nagreany Dunes SAC 000164		
Grid References (from hand-held GPS) **ITM** 613867 941636 (Map letter a) (waypoint 141)		**IG** C13922 41654
Comments Grid references above are for a new site. The site found in 2002 (see "Details of Previous Records below") was relocated precisely from a photo ("*Bryum marratii* 025"), this allowed more precise coordinates to be newly recorded as, ITM 613894 941675 (waypoint 139), IG C13947 41699.		
Elevation (m) 1		
Survey date 13 September 2023	**Observers present** DTH	
Population recorded Occurring very sparsely over 70 cm on N. bank of tiny streamlet (5 stems only 3 mm high in one patch, 6 stems up to 4 mm high in another); another tiny patch with few stems *c.*1 m away on S. bank of streamlet. See sketch map (IMG 6791) for location. This was paced as 65 m S. along the tractor-track (rutted locally, but with recent wheel marks elsewhere) from an old galvanised-iron sheep shelter/feeding station. The precise spot was on the E. side of the tractor-track (at point with a few flat rocks on and in the track edge, which was otherwise almost entirely on sand), 2 m east of track edge, mainly on N. bank of tiny streamlet, but a bit also opposite it on S. bank.		
Previous records here/close by Found nearby at different site in 2002, *c.*50 m distant (see "Comments" above and "Details of Previous Records" below).		
Fertile? No capsules were present in 2002 or 2023		
Voucher specimen(s) Holyoak 23-132 (for **DBN**, few stems)		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types (New site) On damp sand part-shaded under cover of grasses and rushes on banks of tiny streamlet, near tractor-track at edge of extensive grassland prone to annual flooding with fresh to saline water, *c.*100 m inland of sand dunes with some areas of recently disturbed and eroding sand.		
Associated plant species (New site) Growing beneath 60–70% cover of *Juncus articulatus* and *Agrostis stolonifera* (in rather even mixture); other phanerogams close by were sparse *Potentilla anserina* (more of it was present on slightly higher ground), *Isolepis* cf. *cernua* and a few stems each of *Lysimachia maritima* and *Triglochin palustris*. Other very sparse low bryophytes on the sand here were *Amblystegium serpens*, *Drepanocladus polygamus*, *Fissidens* (few non-fertile stems of a small sp.) and *Ptychostomum* (few immature stems of *P.* cf. *pseudotriquetrum*).		
Current land-use/grazing Both old and new sites for *B. marratii* are within fenced grassland areas regularly grazed by both sheep and cattle, as they have been throughout the recent past.		
Photographs of site Photo showing location and habitat from 25 August 2002 (image: "*Bryum marratii* 025"); new photos of 2002 site (IMG 6510–6515); new site, N. bank (IMG 6517–6530); new site, S. bank (IMG 6533–6542).		
Field sketch map photographed IMG 6791		
Apparent threats/any existing conservation measures No immediate threats are apparent. The current need for change in arrangements for draining this land (see "Other comments" below) may alter the frequency of flooding, the salinity ranges of the flood water, or both. Such changes may already have resulted in the loss of the population that was recorded in 2002, but its loss appears also to have been associated with development of taller and denser grass cover on the ditch bank (see below).		
Other comments An old photo ("*Bryum marratii* 025") allowed precise relocation of the locality found in 2002. Although the ditch is in the same place and of similar size, the large boulder on the W. side of this ditch (on left looking northwards in photos) has clearly been moved slightly and rotated. The detailed form of the adjacent bank has also changed. The landward edge of the dunes in the background is now much more thickly vegetated, lacking the large areas of		

exposed sand present in 2002. However, beyond the area shown in the photos, there has been recent disturbance of the middle and foredunes for access to a drainage pipe (see below).

Close study of the ditch banks at the 2002 site revealed very little "steep damp sandy soil of unshaded low bank close to edge of brackish ditch". Instead, the tops of the ditch banks now have thick closed cover of grasses, especially *Agrostis stolonifera*. Since the banks beside the ditch are mainly vertical to overhanging now, probably due to intensified erosion in recent years, their top edges mainly have grasses overhanging and shading from above, while the steepest banks are bare of vegetation. Thus, no *B. marratii* could be found on either bank of the main ditch with searches for *c.*100 m back from the pipe at the N. end of the ditch. Little suitable habitat was seen and the only bryophyte present in quantity was *Amblystegium serpens*. The low water level in the ditch, its firm sand bed, and use of wellington boots also made searching easier and more effective than it was on the visit in 2002.

A local man explained that the ditch here is very old (>50 years) and the pipe forming its outlet onto the beach dates back to the construction of the stone sea wall (its top still visible in the 2002 photo) which was erected at the head of the beach under the direction of Lord Leitrim. Coastal sedimentation changed after the sea wall was constructed, resulting in appearance of sand dunes and their subsequent expansion northwards. Thus the southern edge of the dunes no longer consists of eroding foredunes.

Another consequence of the northwards spread of the dunes has been burial and obstruction of the seaward end of the drainage pipe, so the efficiency of the ditch in draining the land has declined. In some recent winters failure of the ditch to empty seawards has led to very extensive flooding. This has not only covered the grassland around the sites with *B. marratii*, but also extended far inland. At its worst, the flooding rendered the tarmac highway at C143407 and nearby impassable, when a continuous sheet of water extended *c.*1.5 km from the edge of the dunes to Lough Naporte. Donegal County Council were unwilling to remedy the flooding by improving the drainage at the seaward end because the few local residents have other access roads. Thus no funding has been obtained for a pump or other works to improve drainage.

The deep seasonal flooding in recent years and consequent large but intermittent discharges of flood water along the ditch may account for loss of *B. marratii* there, or at least the steepening of the ditch banks. The tiny, newly discovered population may be safer from erosion because it is at the extreme edge of the valley, rather than directly upstream of the outlet pipe. The intermittent deep flooding also implies that the northern part of the ditch will have suffered wider variations in salinity than hitherto: with low salinity when flood water became impounded, but potentially higher salinity when high tides and low ditch discharge coincided.

Details of Previous Records

Discovered here in 2002 during fieldwork by DTH for NPWS. Data on the voucher specimen were recorded as: "25 Aug. 1999, W. of Lough Nagreany, H35, C1394 4170 (Map letter b), on steep damp sandy soil of unshaded low bank close to edge of brackish ditch, Holyoak 02-884A (**DBN**)".

Reasons for loss or decline

The small population found in 2002 on the bank of the main ditch has almost certainly been lost, due to increased shading from grasses, perhaps associated with steepening of the banks due to a recent increase in erosion. The new site with a tiny population found in 2023 was most likely not checked in 2002.

Recommended conservation measures

The loss or decline at most sites for *B. marratii* in Ireland over the past two decades implies that future monitoring of its population is desirable at all extant sites, say every 3 years.

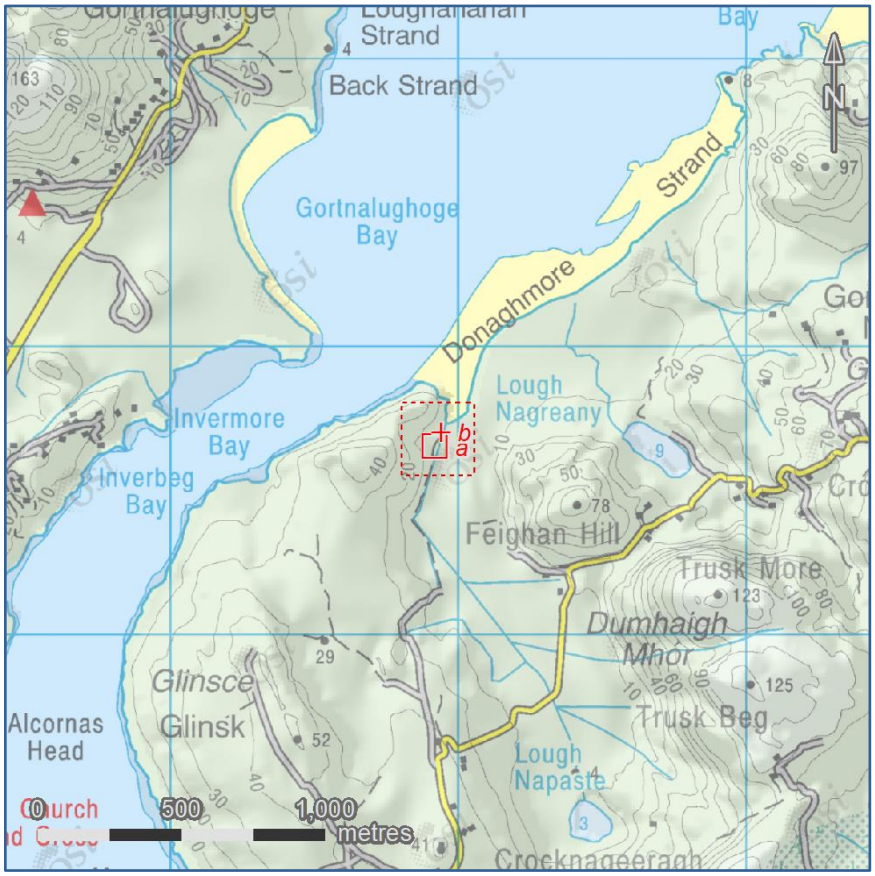

Figure 68 Species Site 19, Discovery map abstract. *Bryum marratii* was found at location (b) in 2002 and at (a) in 2023.

Figure 69 Species Site 19, Bluesky image abstract. *Bryum marratii* was found at location (b) in 2002 and at (a) in 2023.

Figure 70 Species Site 19, location (b) where *Bryum marratii* was found in 2002, near the pink clipboard. It was not refound when this photo was taken on 13 September 2023, when various changes were noted, including alteration of the form of the ditch banks.

Figure 71 Species Site 19, new location (a) where *Bryum marratii* was found in small quantity on 13 September 2023, marked by knife with orange tape. A second tiny patch occurred less than 1 m to the left.

Species Site 20

Species *Bryum marratii*	**County** Donegal	**Vice-county** H35
Locality Tawny (W. of)		**Discovery Map** 2
SAC/NHA Mulroy Bay SAC 002159		
Grid References (from hand-held GPS) **ITM** 619249 939454 (waypoint 136) **IG** C1930 3947 (Map letter a) **Comments** Not refound in 2023. The IG reference is that recorded in 2002; its exact coordinates at a spot with generally similar habitat were refound and the new ITM grid reference was then recorded.		
Elevation (m) "2" (although this seems too high, cf. Figs. 74–75)		
Survey date 12 September 2023	**Observers present** DTH	
Population recorded None		
Previous records here/close by Found here in 2002, see "Details of Previous Records" below.		
Fertile? Capsules not recorded in 2002 (although inflorescences present)		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types In 2002 found on "almost unshaded soil among rocks on low bank at upper edge of saltmarsh beside tidal bay".		
Associated plant species See notes from 24 August 2002 on file with NPWS		
Current land-use/grazing Not grazed by domestic stock		
Photographs of site IMG 6491–6496 show present condition of site		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Not refound, apparently gone from this site.		
Other comments The exact IG coordinates of the 2002 locality were refound, with generally similar topography and habitat to that described then. However, the narrow (4–5 m) fringe of low saltmarsh vegetation beneath and around HWST level below the low bank was found to be almost blanketed beneath a level spread of fragments of fucoid seaweeds. The fringing saltmarsh appears to be narrower than it was in 2002, and its saltmarsh vegetation now appears to be at risk of disappearing completely. Intensive searching along 30 m of bank on each side of the grid reference revealed no *B. marratii*. The only bryophytes found were very scanty *Tortella flavovirens* represented by stunted or immature plants and scanty *Amblystegium serpens*. Much more widespread searches southwards to around the Wee Sea (C193 390) were also unsuccessful, although some non-fertile *P. inclinatum/salinum* was located.		
Details of Previous Records Discovered here by DTH in 2002 during surveys for NPWS. Data recorded for the voucher specimen were: "24 Aug. 2002, W. of Tawny (SE shore of Canal Bay), C1930 3947 (Map letter a), almost unshaded soil among rocks on low bank at upper edge of saltmarsh beside tidal bay, Holyoak 02-876; with inflorescence."		
Reasons for loss or decline Loss of *B. marratii* here since 2002 was due to disappearance of "almost unshaded soil … at upper edge of saltmarsh", leaving only vertical or steeper open soil on unvegetated banks likely to be wave-washed. It appears that cessation of grazing has led to development of a thick, closed *Festuca rubra* sward on top of the bank. Therefore, steepening of the bank might in part be due to the lack of activity from grazing animals, to cohesive grass cover protecting the bank more effectively from erosion, or to relatively recent intensified erosion cutting into the bank more rapidly than in the past.		
Recommended conservation measures None, apparently extinct at this site.		

Figure 72 Species Site 20, Discovery map abstract. *Bryum marratii* was found at location (a) in 2002.

Figure 73 Species Site 20, Bluesky image abstract. *Bryum marratii* was found at location (a) in 2002.

Figure 74 Species Site 20, area where *Bryum marratii* was found in 2002 but not refound when photo was taken on 12 September 2023.

Figure 75 Species Site 20, detail of area where *Bryum marratii* was found in 2002 but not refound when photo was taken on 12 September 2023. Since 2002, the low bank appears to have become steeper, the *Festuca rubra* sward above it is taller and denser, and extensive spreads of stranded fucoid seaweed debris have appeared.

Species Site 21

Species *Bryum riparium*	**County** Waterford	**Vice-county** H06
Locality Above Sgilloge Loughs		**Discovery Map** 75
SAC/NHA Comeragh Mountains SAC 001952		
Grid References (from hand-held GPS) **ITM** 629806 611379 (Map letter a) **IG** S29-11- (1966 record) (Map letter b; Monad) **Comments** (DTH waypoint #006, the second of two almost similar readings; steepness of hillside with crags higher up is likely to have reduced accuracy of readings). Found only at one site upslope and well above SE edge of the larger, eastern/northern of the two Sgilloge Loughs, estimated as *c.*150 m laterally from nearest part of that lough. Location *c.*10 m below the lowest small waterfall on stream, on steep low rocks just to south of stream (with a pool, and impermanent tiny cairn of loose stones).		
Elevation (m) "522" based on grid reference from foot of crag		
Survey date 1 June 2023	**Observers present** DTH	
Population recorded Very small indeed: two patches, upper patch 3 x 1 cm, lower patch almost round in outline, 1 cm diameter, located *c.*75 cm vertically below.		
Previous records here/close by A poorly localised record in 1966; not found in more recent surveys by NPWS of Comeragh Mountains or elsewhere in Co. Waterford.		
Fertile? Capsules lacking as usual.		
Voucher specimen(s) Holyoak 23-072 (comprising a few stems from each of the two small closely adjacent patches) (for **DBN**). Identification confirmed microscopically (tubers present).		
***Ex situ* cultivation material collected** No, population too small to withstand additional collections.		
Site description/geology/slope/drainage/shading/vegetation types On part of outer southern wall of base of gully, below small waterfall but not normally affected directly by water flow or spray. At this site exposed bedrock of low crag is of light grey hard sandstone breccia (of rounded clasts), with quartz inclusions. The *B. riparium* forming small part of low carpets of bryophytes on near-vertical rock surfaces facing roughly N. to NW, in positions easily accessible and visible using hand lens. Site thus on acidic/base-poor rocks, receiving little direct sunlight, slight flushing from above, and partial protection from drying by surrounding bryophytes, yet not or hardly shaded by macrophytes or larger bryophytes. Location near small waterfall and not far above lake imply conditions of moderate to high humidity prevail here.		
Associated plant species Upper patch mixed with *Scapania undulata* (partly dried on day studied, following dry weather); close to *Hyocomium armoricum*, *Racomitrium aciculare* and sparse stems of *Anthoxanthum odoratum*; lower patch slightly mixed with, or touching, *Scapania undulata*, *Pellia epiphylla* and weak growths of *Epilobium brunnescens* and *Hyocomium armoricum*. Taller closed cover of grasses present on ledges nearby, but not shading the *B. riparium.*		
Current land-use/grazing Surrounding slopes are rather lightly grazed by sheep, but these cannot reach the surfaces with *B. riparium.*		
Photographs of site Yes, comprising views of whole hillside looking E. or SE from beyond the lake (4776), closer views from around base of gully (4751, 4754), detail of the rock surface with bryophyte mat containing *B. riparium* (4755), and close-ups of patch (A) (4758) and patch (B) (4763).		
Field sketch map photographed Not applicable, marked photos (4776, 4751, 4754) used instead.		
Apparent threats/any existing conservation measures The *B. riparium* has a tiny population here, vulnerable to encroachment of other and often larger plants, including grasses and herbs, as well as the closely associated bryophytes. It would be lost very quickly if thoughtless collection of specimens was to occur, yet a few leafy stems need to be taken occasionally for microscopic study to confirm the species identification. There are no existing conservation measures for this recently rediscovered population, beyond the SAC designation of the region.		

Other comments

Much of 1 June 2023 was devoted to searching more widely for this species on hillsides "above Sgilloge Loughs", but without success. In afternoon sunshine, these hillsides showed a series of shallow gullies, the upper parts of which are virtually inaccessible. Visits to the lower parts of several of the gullies and various low crags closest to the loughs revealed that bases of most of these gullies are rather dry, without the communities of bryophytes on flushed rock characterised by stands of *Scapania undulata*, the edges of which often support *B. riparium*. Only the one stream course with small waterfalls had much wet habitat and this was surely the location of Mrs Paton's record, it being an obvious target for a hepaticologist searching here, and readily accessible in its lower parts. Searches higher in the same gully revealed large stands of *S. undulata* and other plants of flushed rock adjacent to waterfalls (e.g. much *Saxifraga spathularis*, *Luzula sylvatica*), but often rather sharp transitions to drier acidic rocks adjacent with much *Diplophyllum albicans*. Further searching by rock-climbing in the steep upper part of the gully might nevertheless disclose more *B. riparium*.

Searching for *B. riparium* in this location is simplified a little because no other species occurs in the wet acidic habitats, not even the usual *Ptychostomum pseudotriquetrum* or *P. pallens*. A single tuft of *P. capillare* was found on a boulder west of the lough.

Details of Previous Records

Specimen in **NMW** (ex **BBSUK**) det. confirmed by H.L.K. Whitehouse, collected 28 August 1966 by Mrs J.A. Paton s.n., original data: "above Sgilloge Loughs, Comeragh Mts, H06 Co. Waterford, on *Scapania undulata*, damp rocks on cliffs above Sgilloge Loughs". Fieldwork at that time would probably have relied on old half-inch/mile maps and grid references were usually not assigned, although an old grid reference 02/2-7- has been added, possibly based on the BSBI grid. Using the Irish Grid, S29-11- (Map letter b; Monad) seems to be correct.

Reasons for loss or decline

Information is lacking on its past status, so it might always have been very scarce here.

Recommended conservation measures

None, beyond perhaps occasional monitoring of its presence in future, accompanied by repetition of searches in the vicinity of the population found in 2023.

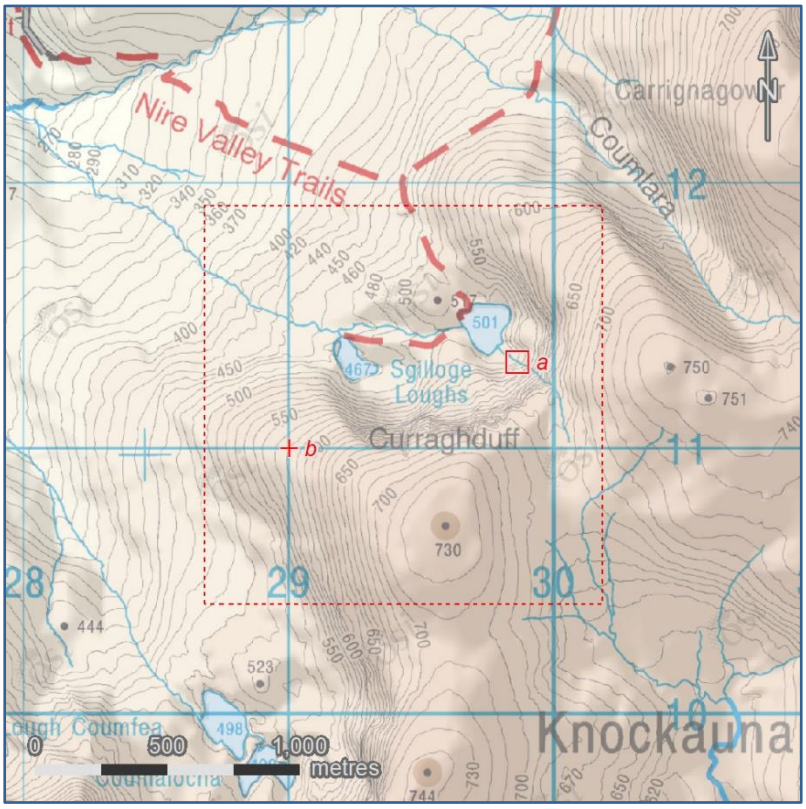

Figure 76 Species Site 21, Discovery map abstract. *Bryum riparium* was refound at location (a) in 2023; location (b) is the SW corner of the one kilometre grid square to which the record from 1966 had been allocated.

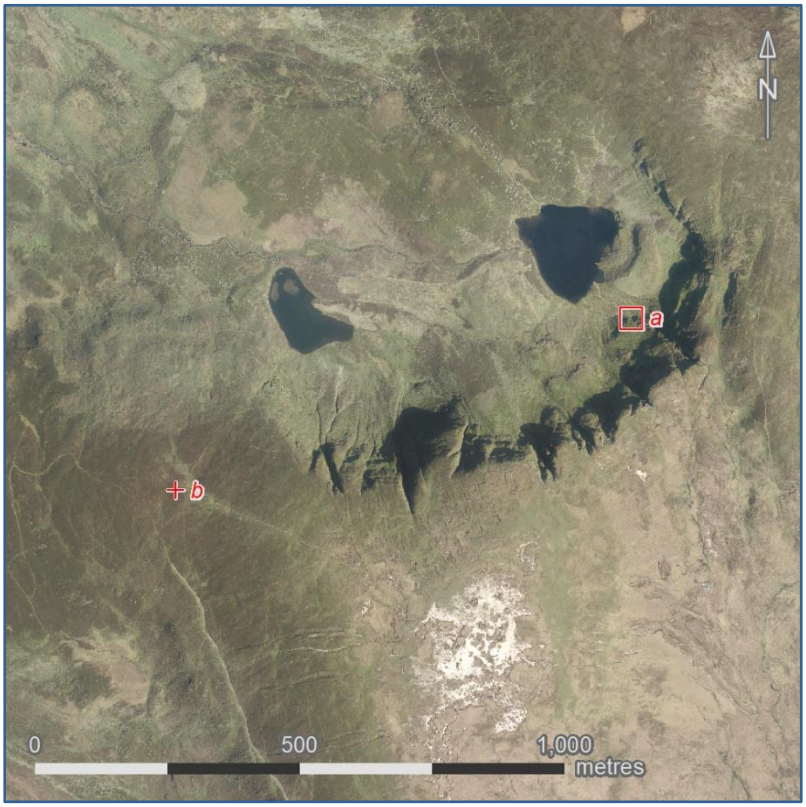

Figure 77 Species Site 21, Bluesky image abstract. *Bryum riparium* was refound at location (a) in 2023; location (b) is the SW corner of the one kilometre grid square to which the record from 1966 had been allocated.

Figure 78 Species Site 21, location (a) where *Bryum riparium* was refound on 1 June 2023, marked with orange spot (low in centre of photo).

Figure 79 Species Site 21, detail of location (a) where *Bryum riparium* was refound on 1 June 2023, on steep surface just behind the white notebook in left foreground.

Species Site 22

Species *Bryum riparium*	**County** Galway	**Vice-county** H16
Locality NE slope of Benchoona		**Discovery Map** 37
SAC/NHA The Twelve Bens/Garraun Complex SAC 002031		
Grid References (from hand-held GPS) **ITM** No data	**IG** No data, estimated as L769 619 (Map letter a)	
Comments Record from 1957 has not been relocated; only grid reference associated with that record is clearly incorrect and probably added after the record was made.		
Elevation (m) Not known because locality too imprecise		
Survey date 7 June 2023	**Observers present** DTH	
Population recorded None		
Previous records here/close by In 1957 only, see below		
Fertile? Specimen from 1957 lacks capsules, which are anyway completely unknown in *B. riparium.*		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Site not relocated. Largest stream and most likely locality extends from ITM 476488 762784 (at 109 m) upwards to 476426 762652 (177 m), where it decreases greatly in size and loses its identity as a feature of the landscape on an extensive gentle peaty slope with much *Molinia*. Between those grid references the stream is steep in places, with hard siliceous rock exposed in many places on its banks, between stretches with peaty soil. The stream/gully there supported a rich bryoflora, with e.g. *Pleurozia purpurea*, *Scapania undulata*, *Sphagna* and *Ptychostomum pseudotriquetrum*.		
Associated plant species Not known		
Current land-use/grazing Whole area sheep-grazed, not obviously overgrazed. Rocky streamside habitats are anyway unlikely to suffer directly from grazing pressure.		
Photographs of site Possible habitats in stream gully NE of Benchoona (4901, 4903) (IG, L761626; see above for ITM grid references).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures It remains uncertain whether a small population exists somewhere on Benchoona.		
Other comments Three hours were spent searching the most likely site (see above). Plenty of possible habitat seems to exist there for *B. riparium*, except perhaps that the altitude (109–177 m) is rather low. Good segments of the stream bank there were in ideal condition for study, with bryophytes hydrated and many of the usual associates of *B. riparium* present. Indeed, it was possible that the growth of other bryophytes was rather too luxuriant to leave many niches for the small plants of *B. riparium*. The steep slopes higher on the north-east side of Benchoona, and further south, have only streams that are smaller, impermanent, or both.		
Details of Previous Records Known at Benchoona only from a specimen collected on 25 August 1957 by Mrs Joan Appleyard, with habitat and locality recorded only as “stream on NE side of Benchoona Mountain”. A grid reference 84/83 was added, probably later for BBS/BRC mapping, but it appears to be incorrect (L76 is probably correct). The identity of the specimen was confirmed by Dr H.L.K. Whitehouse during his review of *B. riparium*. The collection was made during a BBS excursion, but the published account gives no additional information. The plant was not sought at this locality during NPWS fieldwork by DTH in 2004 because of its imprecise nature and age.		
Reasons for loss or decline Because of the imprecision of the original locality, doubt must remain about whether a small population still exists here, even though it seems not to occur in the most obvious place.		
Recommended conservation measures None, in view of uncertainties expressed above.		

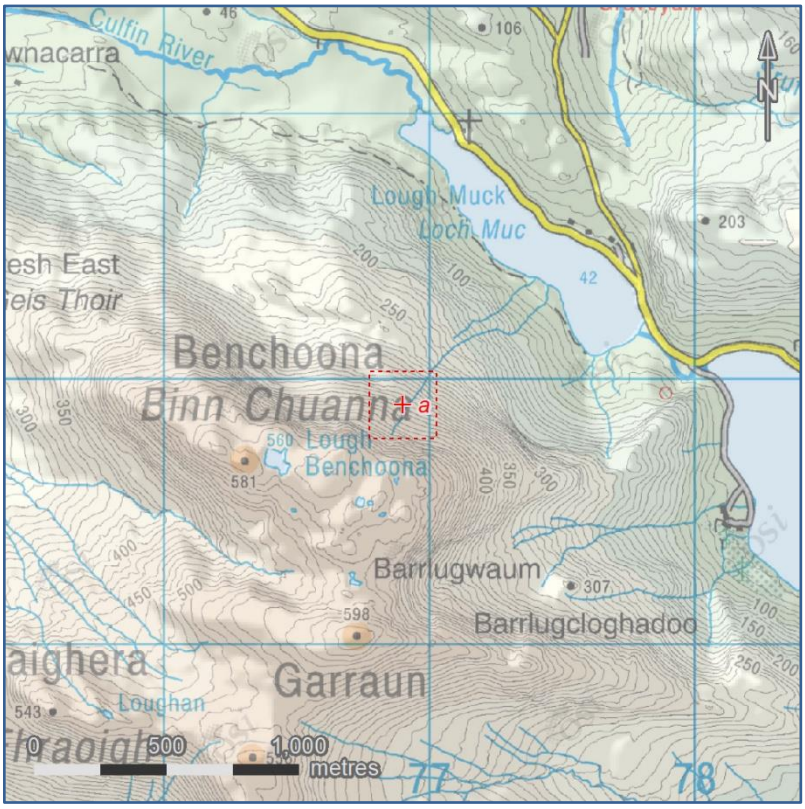

Figure 80 Species Site 22, Discovery map abstract. Location (a) is rough estimate of the location “stream on NE side of Benchoona Mountain” where *Bryum riparium* was collected in 1957.

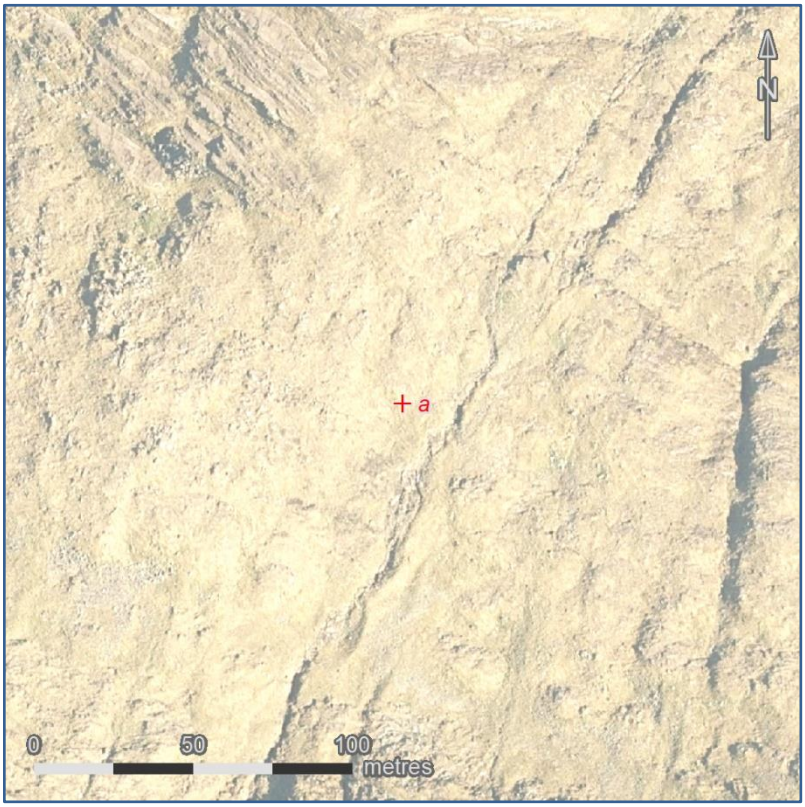

Figure 81 Species Site 22, Bluesky image abstract. Location (a) is rough estimate of the location “stream on NE side of Benchoona Mountain” where *Bryum riparium* was collected in 1957.

Figure 82 Species Site 22, a small area of rocky stream gully providing possible habitat for *Bryum riparium*, but where none was refound.

Figure 83 Species Site 22, another small area of rocky stream gully providing possible habitat for *Bryum riparium*, but where none was refound.

Species Site 23

Species *Bryum riparium*	**County** Galway	**Vice-county** H16
Locality SE of Maumtrasna, beside Srahnalong River, southern site		**Discovery Map** 38
SAC/NHA Not in SAC		
Grid References (from hand-held GPS) **ITM** 499445 761984 (Map letter a) (waypoint 20)		**IG** L99473 61963
Comments Not refound at the grid reference of the original collection from 2003 (see below), but found a short distance further upstream.		
Elevation (m) 106		
Survey date 11 June 2023	**Observers present** DTH	
Population recorded Single pure patch 17 x 4–6 cm in extent.		
Previous records here/close by Discovered in 2003 at site slightly further downstream (see below).		
Fertile? Capsules lacking (only female plants known in this species).		
Voucher specimen(s) Holyoak 23-077 (for **DBN**); determination confirmed microscopically (tubers present).		
***Ex situ* cultivation material collected** Yes		
Site description/geology/slope/drainage/shading/vegetation types On thin accumulation of sandy sediment on gently sloping (20–30°) surface of hard siliceous rock (arenite) in upper edge of inundation zone on east bank of small river. In position sheltered from upstream side by steeper rock; almost unshaded.		
Associated plant species N/A		
Current land-use/grazing Surrounding area is grazed by sheep, at moderately high densities. However, these appear to have little or no direct impact on parts of the river inundation zone lacking grasses and herbs.		
Photographs of site Location and details of habitat and plant (5004, 5000, 4991, 4997).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures The single patch found could be vulnerable to accidental damage from being dislodged by trampling sheep or humans, collapse of the bank above, or by water movements when the river is in spate.		
Other comments The stretches of river within about 100 m of this site were closely searched without finding any more *B. riparium*. Nevertheless, the lengthy lower section of the river above and below the area searched appears likely to have more habitat for the species, with both accessible and almost inaccessible places involved. Further upstream, e.g. around (IG) L985627, the valley floor is less steep and the river becomes wider, with braided channels and a boulder bed, and this stretch appears to offer little or no habitat for *B. riparium*. The steeper rocky sections still further upstream, as the head of the corrie is approached, have produced a record of *B. riparium* in the past and these are discussed in the following account of Species Site 24.		
Details of Previous Records Discovered here during surveys for NPWS by DTH. Voucher specimen (**DBN**) Holyoak 03-607 has following data: “16 Oct. 2003, SE of Maumtrasna beside Srahnalong River, L9949 6192 (Map letter b), on unshaded thin soil (humic sand) over sloping siliceous rock at upper edge of inundation zone beside small river, *c.*115 m alt.”		
Reasons for loss or decline Since the only records are of one patch in 2003 and a different strong patch in 2023, it is unclear whether or not the population of the species is holding its own here.		
Recommended conservation measures No direct action appears to be needed, but occasional monitoring of this population and more searches nearby are desirable.		

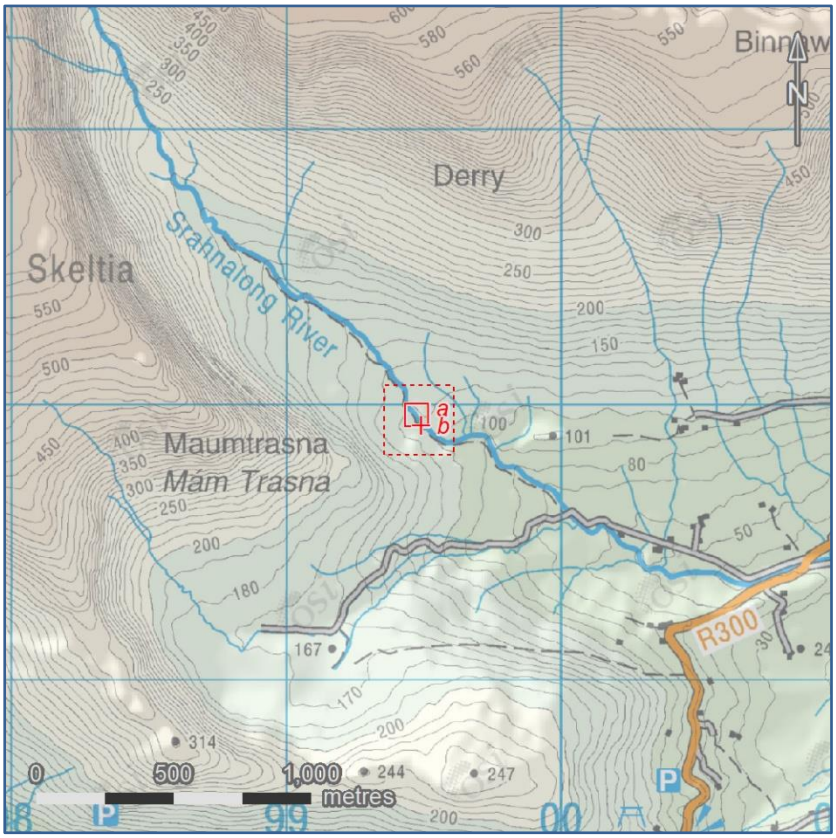

Figure 84 Species Site 23, Discovery map abstract. *Bryum riparium* was found at location (b) in 2003 and at location (a) in 2023.

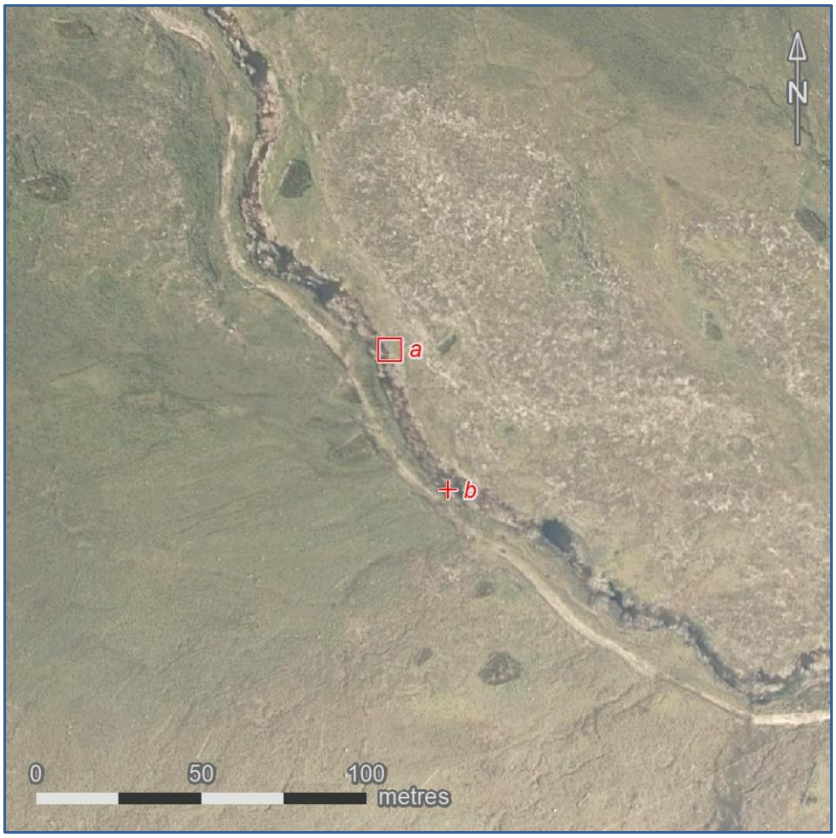

Figure 85 Species Site 23, Bluesky image abstract. *Bryum riparium* was found at location (b) in 2003 and at location (a) in 2023.

Figure 86 Species Site 23, location (a) where *Bryum riparium* was found on 11 June 2023, marked with orange tape (right foreground, to right of the black rucksack).

Figure 87 Species Site 23, location (a) where *Bryum riparium* was found on 11 June 2023, marked with orange tape. Note that the large patch here is sheltered from the main force of high-stage river flows.

Species Site 24

Species *Bryum riparium*	**County** Galway	**Vice-county** H16
Locality SE of Maumtrasna, beside Srahnalong River, northern site		**Discovery Map** 38
SAC/NHA Not in SAC		
Grid References (from hand-held GPS) **ITM** 497973 763845	**IG** L98005 63827	
Comments The population found in 2003 was no longer present, but old photos and notes allowed the precise position to be relocated. Hence, the grid references given above are revised versions recorded by using better hand-held GPS devices than that used in 2003.		
Elevation (m) 391		
Survey date 11 June 2023	**Observers present** DTH	
Population recorded None		
Previous records here/close by Discovered in 2003 (see details below).		
Fertile? Only female plants are known in this species		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types See notes below for brief description from 2003 and files at NPWS for fuller account.		
Associated plant species See files at NPWS		
Current land-use/grazing Surrounding area is grazed by sheep, at moderately high densities. However, these appear to have some but not much direct impact on parts of the river inundation zone lacking grasses and herbs.		
Photographs of site Habitat photo from 2003 published in Holyoak (2021, *European Bryaceae*, p. 227). The site appeared virtually unchanged on 11 June 2023.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures There are no obvious threats; there have been no active conservation measures here.		
Other comments The precise position of the record from 2003 was relocated. Contrary to the contemporary notes, it was on a roughly S.-facing bank (on the right bank when facing upstream). Almost an hour was spent searching unsuccessfully within 30 m of the old site, and another hour searching over a wider area within 60 m, including a substantial rock scramble to climb further upstream. Since relatively small areas are involved and not much of the inundation zone is inaccessible, it has surely gone unless a few small stems (or just tubers) persist somewhere among other bryophytes. Evidence of erosion of bryophytes by water in the inundation zone is common here on this steep section of stream, as is limited damage from scrambling sheep, and occasional bits of loose bank falling away. However, the river water is clean and the riverine vegetation is varied and remains in good condition.		
Details of Previous Records Discovered here during surveys for NPWS by DTH. Voucher specimen (**DBN**) Holyoak 03-612 has following data: “SE of Maumtrasna beside Srahnalong River, L9798 6380 (Map letter a), in unshaded crevice of sloping flushed siliceous rock exposure on steep E.-facing stream bank at head of corrie, *c.*385 m alt.” (The E.-facing should be corrected to roughly S.-facing).		
Reasons for loss or decline Reasons remain uncertain, although accidental dislodgement is a possibility, or overgrowth by other bryophytes. As noted above, there is still a possibility of scarce stems or viable tubers surviving here.		
Recommended conservation measures No action is recommended, other than including this section of river in future surveys seeking the species.		

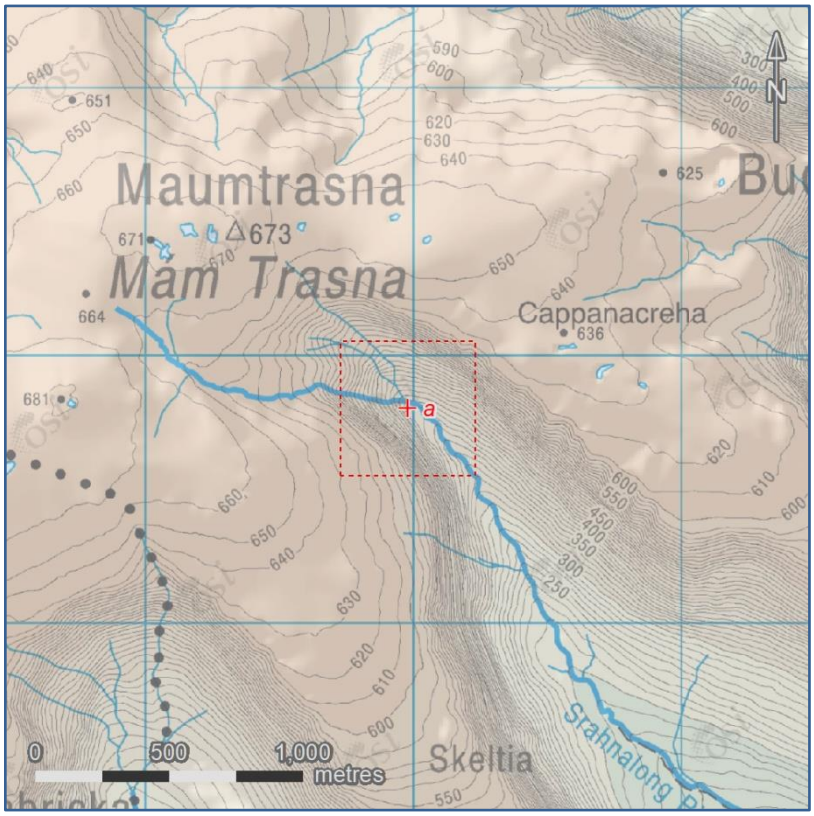

Figure 88 Species Site 24, Discovery map abstract. *Bryum riparium* was found at location (a) in 2003.

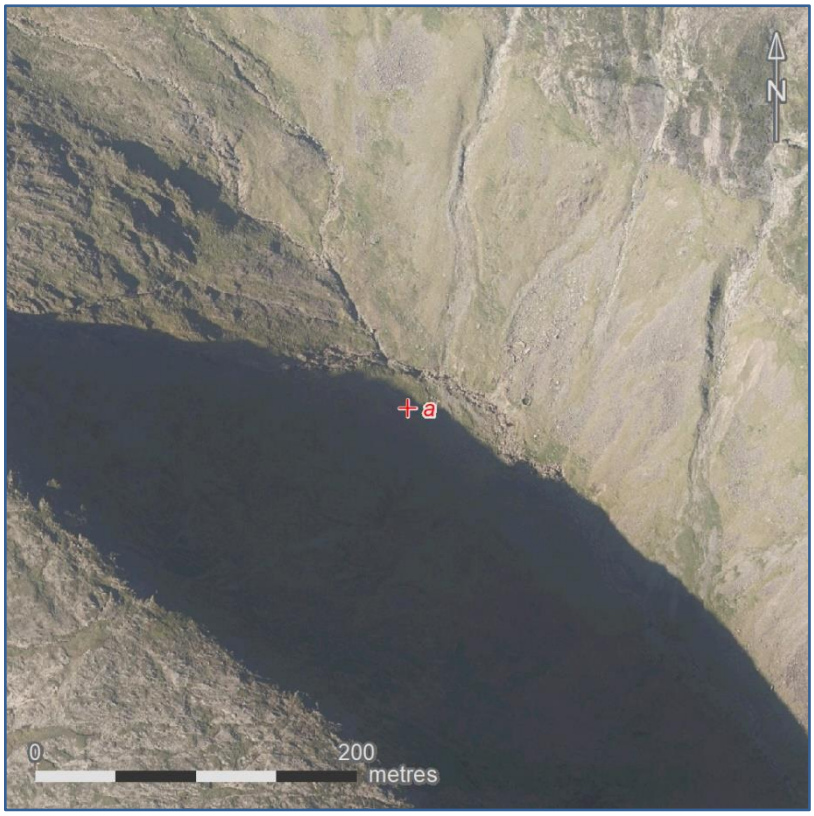

Figure 89 Species Site 24, Bluesky image abstract. *Bryum riparium* was found at location (a) in 2003. The grid reference was somewhat imprecise because the moss was found to the north of the + symbol, low on the north bank of the stream.

Species Site 25

Species *Bryum riparium*	**County** Wicklow	**Vice-county** H20
Locality Fraughan Rock Glen		**Discovery Map** 56
SAC/NHA Wicklow Mountains SAC 002122		
Grid References (from hand-held GPS) **ITM** 704982 693577 (Map letter a) (waypoint 093) **IG** T05056 93540 **ITM** 704977 693563 (Map letter b) (waypoint 094) **IG** T05052 93527 **ITM** 704903 693479 (Map letter c) (waypoint 095) **IG** T04978 93446 **Comments** These grid references were recorded on 1 September 2023. In 2015 it was recorded at (IG) T0505 9352 (Map letter d), but it is unclear whether or not this corresponds exactly to the location (b) (see "Other comments" below).		
Elevation (m) location (a) 313, location (b) 314, location (c) 325		
Survey date 1 September 2023	**Observers present**	DTH, Rory Hodd & Neil Lockhart
Population recorded Location (a) Strip 9 x 3 cm, plus patch 2.5 x 1.5 cm; location (b) Patch 8 cm high x 5 cm wide; location (c) Patch 6 x 2.5 cm, described in detail; plus two other patches of 12 x 6 cm (but rather sparse) and 5 x 5.5 cm		
Previous records here/close by See "Details of Previous Records" below.		
Fertile? Capsules lacking as in every previous report of this species		
Voucher specimen(s) (all for **DBN**), location (a) Holyoak 23-100, location (b) Holyoak 23-102, location (c) Holyoak 23-103. Identification of all three specimens was confirmed microscopically, with tubers present in all of them		
***Ex situ* cultivation material collected** Additional samples corresponding to the vouchers noted in the preceding section were collected for IVC at **DBN** from locations (a) and (b).		
Site description/geology/slope/drainage/shading/vegetation types Along northern fringe of small, fast-flowing river, on or among coarse granitic rocks, above water level at time of survey, but within the periodically inundated zone. All finds were in sparsely vegetated places. Location (a) Among boulders and gravel 3.5 m from edge of river and 5–10 cm above water in tiny pool somewhat above present river level. In place protected from strong high-stage river flows by boulders immediately upstream and by overhanging grasses; also near a higher bank from which a bush of *Ulex gallii* gives slight shade. Location (b) 5–13 cm above present water level near river edge on steep (*c.*60°) sloping surface of very large boulder (one of several almost blocking the river); growing sheltered by this boulder low on its downstream face, close to outer bank of the main river channel. Location (c) Patch in crevice between small boulders on sloping bank *c.*1 m above present river surface. Other patches within 1.5 m of first patch, nearer river in upstream direction, respectively 90 cm apart; third patch on top of boulder on bank.		
Associated plant species Location (a) in contact mainly with *Marsupella emarginata*; also *Pohlia flexuosa* (tiny patch of 1.5 x 1 cm, voucher specimen Holyoak 23-101), small amounts of *Festuca vivipara* (with proliferating inflorescence) and *Anthoxanthum odoratum*. Close to *Racomitrium aciculare* (a bit) and *Pellia epiphylla* (almost touching). Other plants close by were *Nardus stricta*, *Agrostis capillaris*, *Taraxacum* sp., *Potentilla erecta* and *Polytrichum commune*; seedlings also of *Digitalis purpurea*, *Viola palustris* and *Cirsium palustre*. Location (b) only close associates were poor dirty growths of *Scapania* cf. *undulata* and bits of *Campylopus atrovirens*. It grew below patches of *Racomitrium aciculare* and *Marsupella emarginata*. More distant plants on the same large boulder or shading its edges were *Saxifraga umbrosa*, *Agrostis capillaris*, *Nardus stricta*, *Brachytheciastrum plumosum* and *Blechnum spicant*. Location (c) at first patch there were no close associates. *Festuca ovina* (with seeds) grew close by, and somewhat less close, *Viola riviniana*, *Potentilla erecta*, *Scapania undulata*, *Atrichum undulatum* and *Polygala serpyllifolia*. Second patch was partly accompanied by *Atrichum undulatum* and slightly shaded by *Festuca* sp.		
Current land-use/grazing There was no evidence of recent grazing alongside the river at this site, with long grasses growing around the inundation zone and tall bracken, gorse and heathers higher on the slopes by the river.		

Photographs of site Location (a) IMG 6182–6200. Location (b) IMG 6201–6222. Location (c) IMG 6223–6235.

Field sketch map photographed No

Apparent threats/any existing conservation measures

No immediate threats were apparent. Although individual patches of *B. riparium* could be damaged or lost when the river is in spate, its erosion probably helps to create new habitat for the species. Young coniferous plantations are present upslope on land managed by Coillte, so care may be needed eventually to avoid damage to the river channel and pollution of the catchment upstream if and when the timber is harvested.

Other comments

The original find by Rory Hodd (pers. comm.) was made while seeking a convenient place to cross the rocky river in order to gain access to the steep hillside to the south, so no detailed survey was made of the river banks. It is uncertain whether his find corresponds precisely to location (a) or (b) of the present survey, or to neither of them.

No other Bryaceae species were noticed along the river at this site. The apparent absence of *P. pseudotriquetrum* at this base-poor locality considerably simplifies the search for *B. riparium*

Details of Previous Records

Discovered here by Rory Hodd in 2015, with data recorded as: “Fraughan Rock Glen, Glenmalur, Co. Wicklow (H20), T0505 9352 (Map letter d), between rocks at edge of river, 15 July 2015, voucher specimen R.L. Hodd s.n.”

Reasons for loss or decline

No decline is evident.

Recommended conservation measures

No action is urgently needed, but future monitoring of the *B. riparium* populations should be envisaged, say every five years.

The species has no other known sites in the Wicklow Mountains. Brief but unsuccessful searches for it were made on 2 September 2023 along the Avonbeg River northwestwards from Baravore Car Park. Large parts of the river banks there are shaded by conifer plantations and some of the other parts are difficult to reach. Possibly suitable habitat was seen around (IG) T031 963. The other headwater stream (e.g. at T030 970) was not visited, but it merits searching for *B. riparium.*

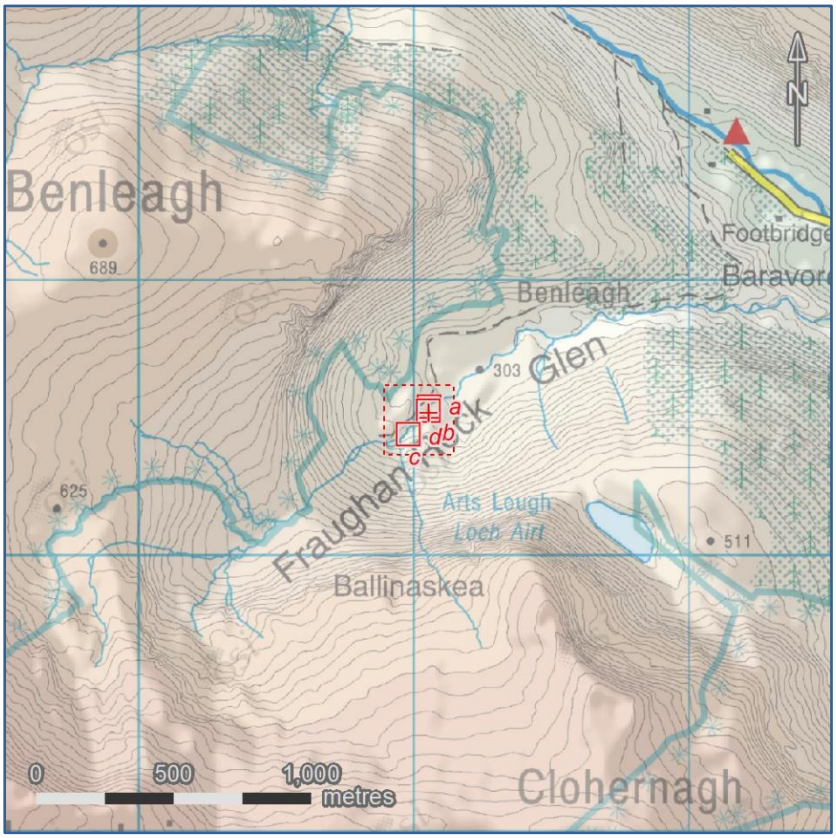

Figure 90 Species Site 25, Discovery map abstract. *Bryum riparium* was found at locations (a), (b) and (c) in 2023, at site (d) in 2015.

Figure 91 Species Site 25, Bluesky image abstract. *Bryum riparium* was found at locations (a), (b) and (c) in 2023, at site (d) in 2015.

Figure 92 Species Site 25, location (a) where *Bryum riparium* was found on 1 September 2023, marked with orange tape beside the pink clipboard (at front, right-hand side of photo).

Figure 93 Species Site 25, location (b) where *Bryum riparium* was found on 1 September 2023, marked with orange tape below the pink clipboard, not far above water level.

Figure 94 Species Site 25, patch of *Bryum riparium* at location (b) found on 1 September 2023.

Species Site 26

Species *Bryum riparium*	**County** Mayo	**Vice-county** H27
Locality Mweelrea (N. corrie)		**Discovery Map** 37
SAC/NHA Mweelrea/Sheeffry/Erriff Complex SAC 001932		
Grid References (from hand-held GPS) **ITM** Not recorded **IG** see below for details of records from 2003–2014 **Comments** Not refound. Caution is needed in interpreting the coordinates of past records because of the very steep topography below crags and the partly enclosed nature of the north corrie. Hence digital coordinate data will inevitably have been based on few available GPS satellites and thus at risk of much greater errors than those encountered on flat terrain.		
Elevation (m) "210–450" based on grid references that are clearly imprecise. No new data, but see comments below under "Details of Previous Records".		
Survey date 10 June 2023	**Observers present** DTH	
Population recorded None, not refound		
Previous records here/close by Several records, see below for details.		
Fertile? The species has never been found with capsules, only female plants are known.		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types No new information. See Lockhart *et al.* (2012:493) for review of older data.		
Associated plant species No new information. See Lockhart *et al.* (2012:493) for review of older data.		
Current land-use/grazing Whole area is still grazed by sheep, but not obviously overgrazed. Many sites for *B. riparium* are on steep banks or among rocks, so inaccessible to sheep, or of minimal interest to them.		
Photographs of site General views of sites and habitats searched on 10 June 2023, to show character of sites and current condition of vegetation (4972, 4974; 4978, 4979, 4982).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures No clear threats were noticed, but individual small tufts of this species have doubtless always been vulnerable to overgrowth or shading by other plants including larger bryophytes, as well as to rockfalls or collapse of earthy banks. There was no evidence of overall vegetation change on 10 June 2023 compared to several visits DTH made to the north corrie between 2003 and 2008. However, the vicinity of sites on the E. side of the corrie that held *B. riparium* on those visits no longer had it in the same places and DTH was unable to find it close by. The alien willowherb *Epilobium brunnescens* was already established there by 2008, but it has now been joined by the congeneric alien *E. pedunculare* growing in similar places on rock ledges and open banks, sometimes intermixed. Both thus grow in places that could be occupied by *B. riparium*, but neither on its own is likely to exclude the moss. At 210–281 m (approximate) elevations those two sites were the lowest on Mweelrea with definite recent records. Consequently, if indeed they have completely disappeared, some effect of climatic warming might be involved.		
Other comments DTH's visit on 10 June 2023 was made on a day with some light and some heavy rainfall, but a period of over four hours of dry weather was enjoyed searching in the north corrie from 11:00 to 15:30 hours. The two former sites in the E. part of the corrie were revisited. Attention was focussed initially on the gully where *B. riparium* was found on 15 May 2008 (L8166 6787, with 7 cm diameter patch) and other places on the sides of this gully, covering virtually all of its length. However, it was not refound despite checking all obvious and likely sites and the other bryophytes being in fine hydrated condition. The adjacent stream bank (previous record on 22 September 2003 at L8173 6784) was also checked extensively without success, as were bits of a third gully to the south. A long steep walk then led to the higher western part of the corrie. The area around L80904 67880 at *c.*450 m elevation was searched (where *B. riparium* was found in very small quantity		

on 13 May 2008), but it was not refound there. Very little suitably moist/flushed habitat with its usual associates (*Scapania undulata*, *Hyocomium armoricum*) was present. Further searches were made higher up and further westwards, covering several of the more accessible places with flushed rock. The exact location (L8080 6796) of the record from 31 May 2014 by a team of six bryologists could not be refound, although parts of that grid reference were in steep rocky areas difficult to access, and no details were available of the nature of the habitat from which it was reported.

Details of Previous Records

There are several old records of *B. riparium* from the N. corrie of Mweelrea that are poorly localised. Among the most notable of these are specimens at **DBN** from D. Synnott s.n. collected 17 August 1987, from "high in N. corrie W. side" and "lip of N. corrie". The latter of these has not been reported since, and it is noteworthy in implying an elevation of *c.*725 m (from Google Earth Pro, at only accessible point where main route up mountain leaves the upper corrie), higher than subsequent records confirmed from Ireland (maximum 472 m), but a bit lower than the 750 m maximum reported from Great Britain (Holyoak 2021:226).

More recent records from the W. side of the N. corrie are: Holyoak 08-237 (**DBN**), "L80904 67880 (Map letter a), 13 May 2008, on almost unshaded small patch of part-bare loamy soil among rocks and sparse vegetation on slightly damp N.-facing rocky slope, *c.*450 m alt.; with a few stems & only 1 tuber"; J.L. Denyer, R.L. Hodd, G.P. Rothero, J.E. Smith, C. Rickerby, S. Yardy s.n., "L8080 6796 (Map letter b), 31 May 2014, rocky corrie", without altitude or other data.

There are two recent records localised within the E. part of the N. corrie: Holyoak 03-460 (**DBN**), "L8173 6784 (Map letter c), with sparse bryophyte cover on soil on stony bank beside stream gully, in N.-facing corrie, *c.*281 m alt., in 2003"; Holyoak 08-249 (**DBN**), "L8166 6787 (Map letter d), on steep (70°) rocky soil of bank of gully on NW-facing slope, *c.*210 m alt., patch 7 cm in diameter, in 2008".

All the coordinates and altitude data from 2003–2014 were based on hand-held GPS data that were of questionable precision and apparently often not reproducible, because of the steep mountain terrain (see Figs 95 & 96).

Reasons for loss or decline

It was disappointing not to refind *B. riparium* at its best known Irish locality and the place with the most numerous recent records. However, as a colonist of exposed soil as well as rock ledges among other bryophytes, it is very likely that its small patches are impersistent in any one spot. On a timescale of decades it might well occupy a succession of adjacent localities. Or it might persist locally as a few weak stems among other bryophytes, or as a few loose tubers, unlikely to be detected by surveys. Hence it is premature to assume it has declined here without more extensive searching.

Recommended conservation measures

None, in view of lack of clear evidence of any decline, or obvious reasons why it is likely to have declined, except possibly as a result of climatic warming.

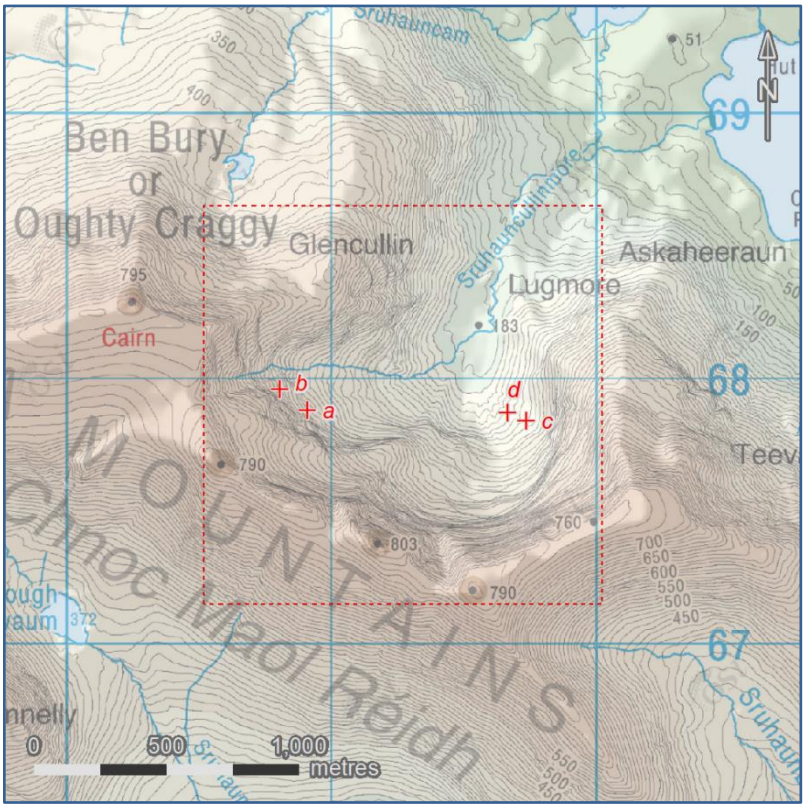

Figure 95 Species Site 26, Discovery map abstract. Records of *Bryum riparium* made from 2003 to 2014 marked here as locations (a) to (d). Location (a) from 2014, location (b) from 2008, location (c) from 2008, location (d) from 2003.

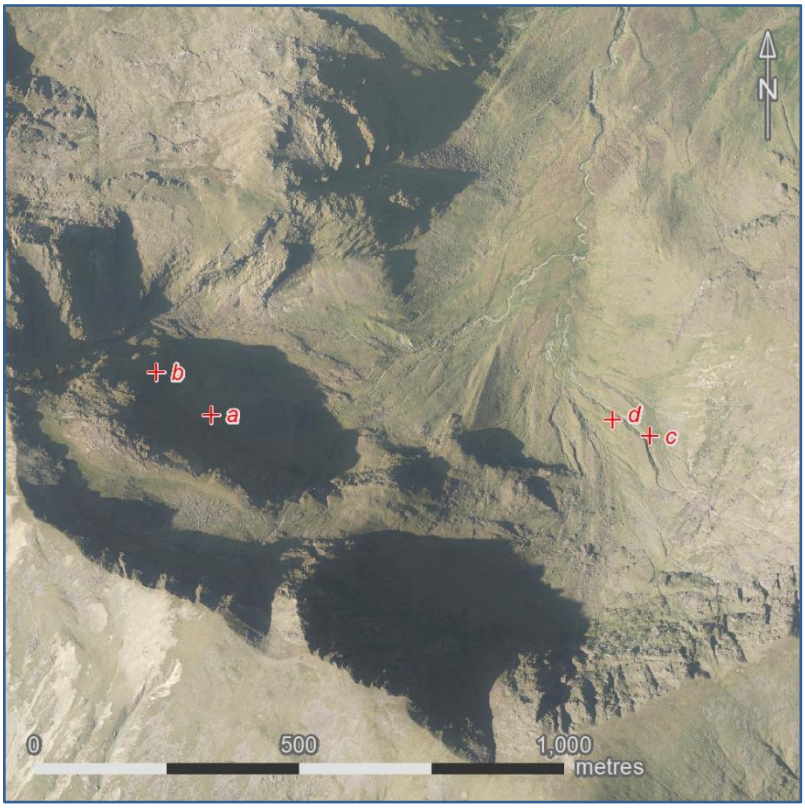

Figure 96 Species Site 26, Bluesky image abstract. Records of *Bryum riparium* made from 2003 to 2014 marked here as locations (a) to (d). Location (a) from 2014, location (b) from 2008, location (c) from 2008, location (d) from 2003.

Figure 97 Species Site 26, view of E. part of N. corrie photographed on 10 June 2023 from higher slope to the S. Photo shows gully and stream banks (locations mapped as (c) and (d) in Figs 95 and 96) searched for *Bryum riparium* again in 2023.

Figure 98 Species Site 26, view of W. part of N. corrie photographed on 10 June 2023 from slope to N. Photo shows base of main line of crags (locations mapped as (a) and (b) in Figs 95 and 96) which were searched for *Bryum riparium* again in 2023 (around mid-height of photo).

Species Site 27

Species *Bryum riparium*	**County** Mayo	**Vice-county** H27
Locality Slievemore (NE corrie)		**Discovery Map** 30
SAC/NHA Croaghaun/Slievemore SAC 001955		
Grid References (from hand-held GPS) **ITM** 465348 808711 (Waypoint 108)		**IG** F65402 08770
Comments The exact spot where the species was found in 2003 was relocated using a photograph, allowing new grid references to be recorded, which differ appreciably from those noted in the past (see below). However, little reliance can be placed on the precision of any of these and even less on the readings for elevation, since the location is at the base of a high, steep crag, with a steep slope below, in a partly enclosed corrie, so data from only a few satellites were available.		
Elevation (m) "418–611" based on interpretation of grid references from same spot; variously read from hand-held GPS on different visits as 444–510 m for the same spot.		
Survey date 6 September 2023		**Observers present** DTH
Population recorded None, no longer present at this spot. See "Other comments" below.		
Previous records here/close by Recorded in 2003 and 2016, apparently at the same spot.		
Fertile? Capsules are unknown in this species.		
Voucher specimen(s) None, not refound		
***Ex situ* cultivation material collected** No, not refound		
Site description/geology/slope/drainage/shading/vegetation types On sloping ledge at base of N.-facing quartzite crag in corrie. See NPWS files for other details recorded in 2003.		
Associated plant species See NPWS files for details recorded in 2003, and "Other comments" below.		
Current land-use/grazing High sheep stocking levels were noted in 2023, as in 2003, but sheep could not reach the sloping rock surface on which *B. riparium* occurred. Substantial accumulations of sheep dung were noted on paths in the NE corrie in 2023, yet there was no *Tetraplodon mnioides* seen on it, although it was recorded in the corrie on DTH's earlier visits.		
Photographs of site IMG 6277–6279 show the general location on the crags of the NE corrie (marked with orange spot). IMG 6285–6287 showing the exact spot were also taken in 2023, with photos of same spot from 2003 for comparison.		
Field sketch map photographed No, for location see marked IMG 6279 reproduced below.		
Apparent threats/any existing conservation measures Species apparently no longer present.		
Other comments Two photos taken on 1 July 2003 were used to refind the exact spot on 6 September 2023, when a close search of the small area involved left no doubt that *B. riparium* was no longer present. The amount of vegetation at the precise spot had increased considerably, and it now comprised a sheet of *Marsupella emarginata*, with some *Campylopus atrovirens* and *Pleurozia purpurea*. The small ledge just above (within 30 cm) was now covered by taller *Racomitrium lanuginosum*, through which seeding plants of *Agrostis stolonifera* and *Carex binervis* were now growing. The *B. riparium* thus appears to have been displaced by other plants previously present nearby, either due to their greater competitive vigour, or greater tolerance of persistent wetness, more humic conditions, or slightly more shading. On 6 September 2023 most of the other easily accessible crag bases in the NE corrie were searched for *B. riparium*, without success, a result similar to that obtained there in 2003. There is doubtless potential habitat higher on the same crags, but there seems no reason it should be any better than the numerous spots examined with less risk at the crag base. Most of the possible places there seem to have other larger bryophytes forming robust tufts and mats, leaving little if any space for the much lower-growing *B. riparium*.		
Details of Previous Records Discovered here by DTH during surveys for NPWS in 2003, when the following data were recorded: "1 July 2003, Slievemore, Achill Island, F 6548 0873 (Map letter a), with other		

bryophytes on small sloping flushed ledges near base of N.-facing quartzite crag, *c.*472 m alt., Holyoak 03-287, new to H27 (**BBSUK**) ".
The species was refound on Slievemore by Rory Hodd in 2016, with following data: "11 March 2016, Slievemore, Achill Island, F 65608 08722 (Map letter b), on wet cliff in corrie, R.L. Hodd s.n. (**DBN**)". Discussion with RLH suggests that his locality was the same as that recorded in 2003, at the base of the crags high in the western part of the north-east corrie. As noted above, grid references from hand-held GPS are likely to be imprecise at this locality, below high crags.

Reasons for loss or decline

The single small population has been replaced by patches of the former bryophyte associates (see above under "Other comments" for details, and the photos). The small stature of *B. riparium* may make it vulnerable to competition from larger bryophytes, but it is unclear whether any environmental changes (e.g. moisture levels, nutrients, humification) have altered a competitive balance.

Recommended conservation measures

None

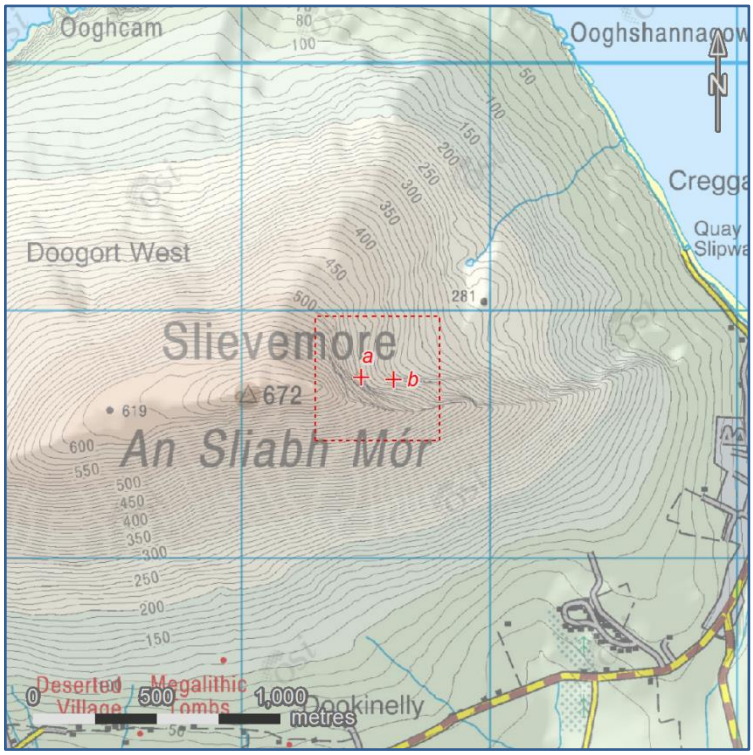

Figure 99 Species Site 27, Discovery map abstract. *Bryum riparium* was recorded from location (a) in 2003 by DTH and location (b) in 2016 by Rory Hodd, with the differing coordinates mapped here being obtained using hand-held GPS. However, as discussed in the legend to Fig. 100 below, only a single patch of the moss was involved.

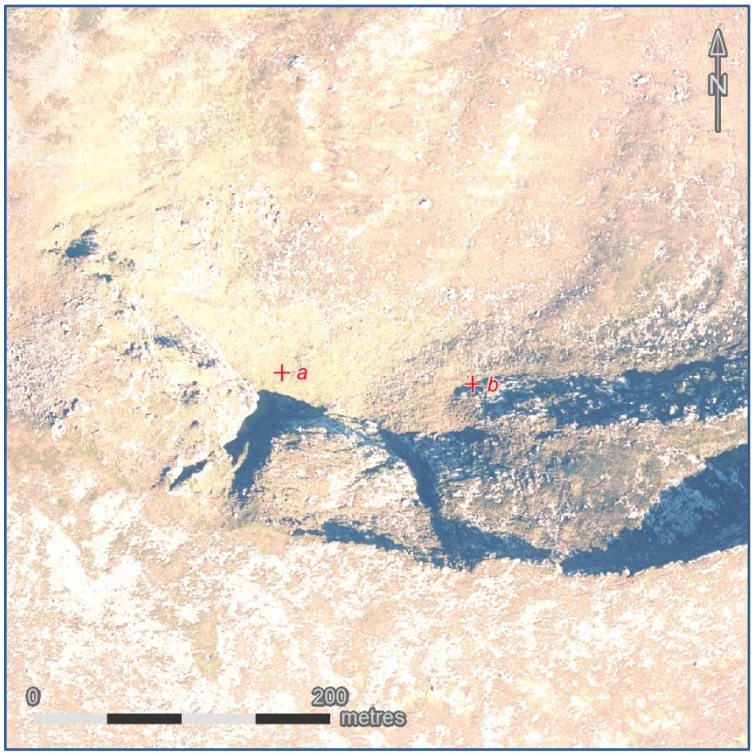

Figure 100 Species Site 27, Bluesky image abstract. *Bryum riparium* was recorded from location (a) in 2003 by DTH and location (b) in 2016 by Rory Hodd, with the differing coordinates mapped here being obtained using hand-held GPS. From discussion, it nevertheless seems clear that only a single location was involved as shown in Figs. 101–103 below. Neither set of coordinates was accurate. A third set of coordinates obtained at the same spot on 6 September 2023 (see text above) was different again and also demonstrably inaccurate.

Figure 101 Species Site 27, view of crags in N. corrie of Slievemore viewed from downslope to N. at base of upper part of corrie on 6 September 2023. The orange spot shows the approximate location where *Bryum riparium* was found and photographed (see Fig. 102) on 1 July 2003, but not refound in 2023.

Figure 102 Species Site 27, photograph showing location (a) with *Bryum riparium* (beside knife) photographed on 1 July 2003.

Figure 103 Species Site 27, photograph of same location as in Fig. 102 photographed on 6 September 2023, when *Bryum riparium* was not refound. The adjacent cover of other vegetation had increased greatly since 2003.

Species Site 28

Species *Ptychostomum calophyllum*	**County** Galway	**Vice-county** H16
Locality W. of Doon Hill, Ballyconneely		**Discovery Map** 44
SAC/NHA Slyne Head Peninsula SAC 002074		
Grid References (from hand-held GPS) **ITM** No data	**IG** L58-42- (Map letter a; monad)	
Comments The IG reference (based on 02/58-42- from 1988 or allocated for mapping during the 1990s) is at best imprecise, in that the one-kilometre square involved covers much of the Aillebrack Machair as well as areas further east and nearer Doon Hill.		
Elevation (m) Not known because location details imprecise, presumably <5		
Survey date 6 June 2023	**Observers present** DTH, CC & N. Lockhart	
Population recorded None		
Previous records here/close by From 1988 only, see below		
Fertile? No capsules in material collected in 1988		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Information only from 1988, see below (under "Other Comments" and "Details of Previous Records").		
Associated plant species No information		
Current land-use/grazing The whole area is heavily grazed by sheep.		
Photographs of site No		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Species probably lost from this area.		
Other comments Fieldwork for NPWS by DTH in 2004 failed to refind the original 1988 record. However, the original locality data from 1988 lacked precision and searching in 2004 was restricted to within *c.*0.5 km west and south-west of Doon Hill, based on a narrow interpretation of "W. of Doon Hill", since this is a prominent landmark and close to convenient roadside parking places. During the fieldwork on 6 June 2023 we realised that a specimen of *Petalophyllum ralfsii* was collected by David Long on the same date as his *P. calophyllum* (3 April 1988) with identical locality and habitat notes. Since *P. ralfsii* is well known only further west of Doon Hill, on machair west of Aillebrack, and that area and habitat much better matches the "sandy flats" noted in 1988, it can reasonably be surmised that *P. calophyllum* also came from further west. This is reinforced by accumulated information from the post-2000 records of Irish localities for *P. calophyllum*, showing its occurrence only in damp habitats with input of loose or mobile sand, which would also point to a former locality further west from Doon Hill. On 6 June 2023 we walked extensively from (IG) L578 425 eastward to L585 425 and from L581 429 southwards to L580 422. Following prolonged dry weather most of the machair surface was dry, but the phanerogam vegetation was in good condition for assessing site conditions. Very little loose dune sand was apparent, so our searching was focussed in areas near a small "blow-out" in the dunes and a bank with exposed sand along the NE border of this part of the machair (i.e., W. of the Gaelic Football field and to the N. of it). However, the moister areas near these sources of sand all had moist humic soils and almost closed vegetation of stable dune slack types, lacking communities of bryophytes colonising loose sand. Some other areas known to support populations of *Petalophyllum ralfsii* within the Aillebrack machair were also checked, but these are mainly on disturbed ground with vehicle ruts or pathways and they evidently dry out in summer. Whereas *P. ralfsii* often persists along diffuse pathways or vehicle ruts as humic soils develop and phanerogam cover shades much of the ground, *P. calophyllum* does not appear to tolerate much trampling or much accumulation of organic-rich soil. *P. calophyllum* also tolerates summer falls in the water table much less than does *P. ralfsii*, presumably because it makes much of its growth and		

matures its capsules over the summer season to ripen spores in autumn, whereas *P. ralfsii* makes much of its growth between autumn and spring when water levels rise to the ground surface, producing ripe spores in late winter and spring.

Details of Previous Records

P. calophyllum has been recorded here only by the herbarium specimen of the original gathering, D.G. Long 1488 at **E** registered as E00147662, of tall non-fertile plants. It was accepted as the first record for W. Galway (v.c. H16) and the determination was confirmed again by DTH through loan of the specimen. Original data on the packet are "W. of Doon Hill, Ballyconneely, W. Galway (H16), [IG]02/58-42- (Map letter a; monad), 3 April 1988".

Reasons for loss or decline

Presumably there were more areas affected by loose sand on the Aillebrack Machair in 1988 than have persisted until 2023. This might be related to heavier grazing prior to 1988, or to other disturbance of the ground surface in the dune areas being more prevalent in the past.

Recommended conservation measures

None, unless deliberate and extensive disturbance of parts of the machair to liberate wind-blown sand can be envisaged. This could be accomplished by extensive mechanical stripping of turf, or removing a segment of the foredunes. The large spores of *P. calophyllum* might possibly be long-lived and thus still surviving in a "spore bank" in the soils, so the species could reappear spontaneously if suitable habitats were recreated. However, there might be local opposition to causing loss of some grassland areas currently used for sheep grazing, or to increased problems from wind-blown sand on roads.

Figure 104 Species Site 28, Discovery map abstract. The record of *Ptychostomum calophyllum* from 1988 was imprecisely recorded as "west of Doon Hill", without any grid reference (see above). It is quite arbitrarily placed here in the most likely one-kilometre square (Map letter a; monad) located on the south-western corner of that square.

Species Site 29

Species *Ptychostomum calophyllum*	**County** Mayo	**Vice-county** H27
Locality Dooaghtry		**Discovery Map** 37
SAC/NHA Mweelrea/Sheeffry/Erriff Complex SAC 001932		
Grid References (from hand-held GPS) **ITM** (a) 474563 768902 (waypoint 016), (b) 474723 768922 (waypoint 017) **IG** (a) L7458 6888 (Map letter a) ("over several square metres") (b) L7474 6890 (Map letter b) & L7474 6891 (Map letter c) ("over tens of square metres"). **Comments** The large population found in 2003 and described in detail then appears to have become completely extinct here by 2023. The IG grid references given were those recorded during detailed surveys in 2003 when the population here was discovered. The ITM grid references were recorded in the field in June 2023 after exact relocation of these places on the ground and from the old IG data in order to (a) seek any *P. calophyllum* present at site or close by (none were found), and (b) record the current composition and condition of the vegetation for comparisons with the original records.		
Elevation (m) 10–11		
Survey dates 8 & 9 June 2023	**Observers present** DTH	
Population recorded None		
Previous records here/close by Mainly from dates of discovery of the Dooaghtry populations in 2003 (see below), (a) "over several square metres"; (b) "over tens of square metres".		
Fertile? Species not refound in 2023; a few patches had capsules when discovered in 2003.		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types In 2003 population occurred "on damp unshaded sand of open machair".		
Associated plant species Detailed notes on the character and composition of the vegetation occurring with *B. calophyllum* in 2003 are filed with NPWS.		
Current land-use/grazing As in 2003, the whole of the machair area remains intensively grazed by sheep. Irish Hares are also present in small numbers; a few small rabbit warrens are present.		
Photographs of site These are representative photos of the current condition of vegetation in areas where *P. calophyllum* was recorded in 2003 (4911 & 4913; 4923 & 4926, 4928). For comparison, see habitat photo from 2003 published in Holyoak (2021, *European Bryaceae*, p. 342).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures As noted above, the large population found in 2003 appears to have become completely extinct here by 2023. No deliberate conservation measures were introduced in the interim and the decline of the species and loss of suitable habitat were not monitored.		
Other comments Unsuccessful searches for *B. calophyllum* at the sites where it occurred in 2003 were made over several hours on 8 June 2023, in warm, still, sunny weather. The search effort was initially focussed on areas tens of metres across around the three exact grid references recorded from 2003, with frequent hands and knees study of the vegetation, and compilation of detailed notes on its character and composition (see below). It was immediately apparent that the area of exposed partly bare sand here had almost disappeared, with little or no sand remaining visible under the short grazed sward. Following this, another two hours were spent searching intensively on the nearest area with eroding sand, on a small bank adjacent to moist ground at ITM 474658 768918. This area had a wide scatter of plants of *Amblyodon dealbatus* and plenty of *Moerckia* and *Pohlia wahlenbergii*, but the only Bryaceae present were *P. pallens*, *P. pseudotriquetrum* (some c.fr.) and bits of *B. dichotomum*. It seemed that the most open patches of sandy surface there were humic, blackish, with low cover of *Nostoc* and *Mesoptychia turbinata*, hence unsuited to *P. calophyllum*.		

On 9 June 2023 a long afternoon walk around the periphery of the whole area of wet machair near Dooaghtry Lough (IG: L745693) was devoted to seeking other sources of blown sand that reaches edges of the wet ground. However, the large eroding bank of sand east of the lake borders a steep valley-side that almost lacks habitat transitional between its steep dry side slopes and the wet machair of the nearly flat ground below. Thus, no promising habitat for *P. calophyllum* was found. Substantial banks of eroding sand were also seen on the low hills N. of Trawleckachoolia (bay) which is itself a potential source of blown sand. Here, the neighbouring areas of machair, and the dune grassland areas of Lackakeely, all appear too dry to hold *P. calophyllum*, lacking any low-lying sand surfaces which had remained moist during the current dry weather.

Details of Previous Records

The population at Dooaghtry was discovered in 2003, during fieldwork by DTH for NPWS, with records from two adjacent sites, labelled as (a) and (b) here. The voucher specimens are in **DBN** and Herb. DTH. Full details of site conditions and associated plants are filed with NPWS.

(a) 19 Oct. 2003, at L7458 6888 (Map letter a), over several square metres, on damp unshaded sand of open machair with sparse low vegetation;

(b) 16 July 2003 and 19 Oct. 2003, at L74746890 (Map letter b) and L7474 6891 (Map letter c), over tens of square metres, in similar habitat to that at (a), some patches with capsules (immature on 16 July, mature or near-mature on 19 October).

Reasons for loss or decline

During the fieldwork on 8 June 2023 it was quickly realised that the large areas of bare sand present near the *B. calophyllum* at Dooaghtry in July and October 2003 had almost disappeared. The 1:50,000 ortho-photography of the area supplied by NPWS (of 2005/2012 age) shows very much more bare sand exposed nearby than was present in 2023. Scrutiny of the sequence of air-photos freely available on Google Earth Pro shows a large decline in the nearest areas of bare sand between 23 May 2004 and 30 April 2009, with further decline by 4 August 2012.

Observations elsewhere show that *P. calophyllum* is an early colonist of calcareous sand. Suitable sand may be of aeolian or water-borne origins, and it often persists to form thin surficial layers in places with fresh water at or near the ground surface for much of the year. *P. calophyllum* disappears when moist sandy areas gain a closed vegetation cover of herbs, sedges and grasses, and it is soon reduced in quantity even in their barer patches if a closed cover of liverworts, *Nostoc*, filamentous algae and other low-growing plants develops.

On 8 June 2023 the vegetation of an area of *c.*25 m radius around former site (a) was described as: “sheep-grazed quite heavily, like the surrounding drier machair; now a closed carpet of hygrophilous bryophytes, especially *Calliergonella cuspidata*, with a rather even cover of low sedges, *Carex flacca*, *Eleocharis*, 7–15 cm tall, and of herbs, especially *Hydrocotyle vulgaris*, *Bellis perennis*, *Anagallis tenella*; also *Triglochin palustris* (rare), *Trifolium repens*, *Festuca rubra*, *Ranunculus acris*, *R. flammula*, *Dactylorhiza incarnata* (rare), *Lotus corniculatus*. Low vegetation hummocks are beginning to form, dominated by *Calliergonella cuspidata* and *Palustriella falcata*, occasionally by *Ptychostomum pseudotriquetrum*, or *Philonotis calcarea*, accompanied by low *Salix repens*. There is no sign of damp unshaded sand, or of “sparse low vegetation..., so pointless seeking *P. calophyllum* at this place now”.

Likewise, for area (b) description of the vegetation over a 12 m radius states: “again a closed carpet of plants now, but drier ground and vegetation is shorter than in area (a); grazed in part by rabbits (warren nearby) as well as by sheep; moss-cover prominent, of *Rhytidiadelphus squarrosus*, *Brachythecium* cf. *mildeanum*, *Ptychostomum pseudotriquetrum* (and scarcer *Abietinella abietina*, *Entodon concinnus*, *Thuidium*, *Climacium dendroides*, *Ditrichum gracile*), the forbs shorter, 4–12 cm mainly, *Bellis perennis*, *Trifolium dubium*, *Equisetum palustre*, *Trifolium repens*, *Linum catharticum*, *Euphrasia*, *Cerastium fontanum*, *Carlina vulgaris* (rare), *Festuca rubra*, *Cynosurus cristatus*, *Leontodon taraxacoides*, *Lotus corniculatus*, *Thymus drucei*, *Prunella vulgaris*, *Luzula campestris*, *Hydrocotyle vulgaris* (rare); only the merest hint of bare sand (<1% cover) in patches no bigger than 4 cm across, probably arising from earthworm casts; no sign of *P. calophyllum* here now, even in the barest bits checked”.

It is noteworthy in these plant lists that *Calliergonella cuspidata* or *Rhytidiadelphus squarrosus* are plentiful in different areas, both of them maybe hinting at eutrophicated surface conditions. The absence of *Sagina nodosa* is also noteworthy since it was a conspicuous colonist of moist bare sand that was prominent here in 2003.
Recommended conservation measures None, other than to mention the possibility of reactivating a buried spore-bank at the sites which held *P. calophyllum* in 2003. This might be achieved by localised turf-stripping, possibly with other disturbance on neighbouring slopes to liberate more blown sand. The grazier might oppose loss of productive grassland if such measures were taken, so financial compensation could be involved.

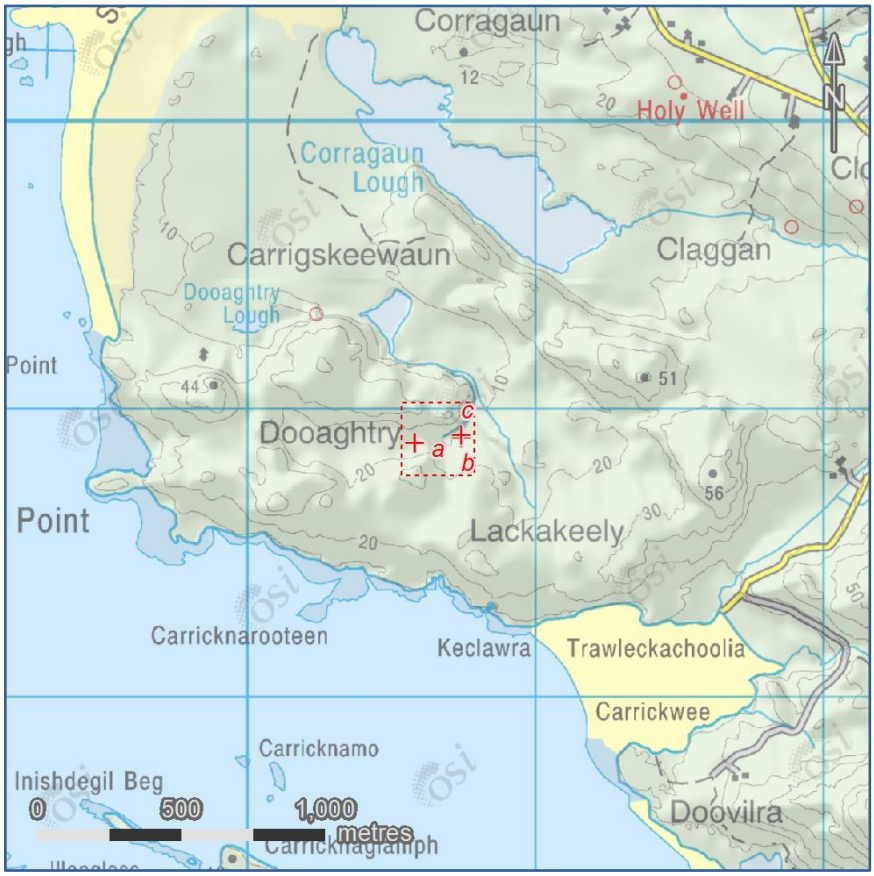

Figure 105 Species Site 29, Discovery map abstract. *P. calophyllum* was recorded at locations (a–c) in 2003.

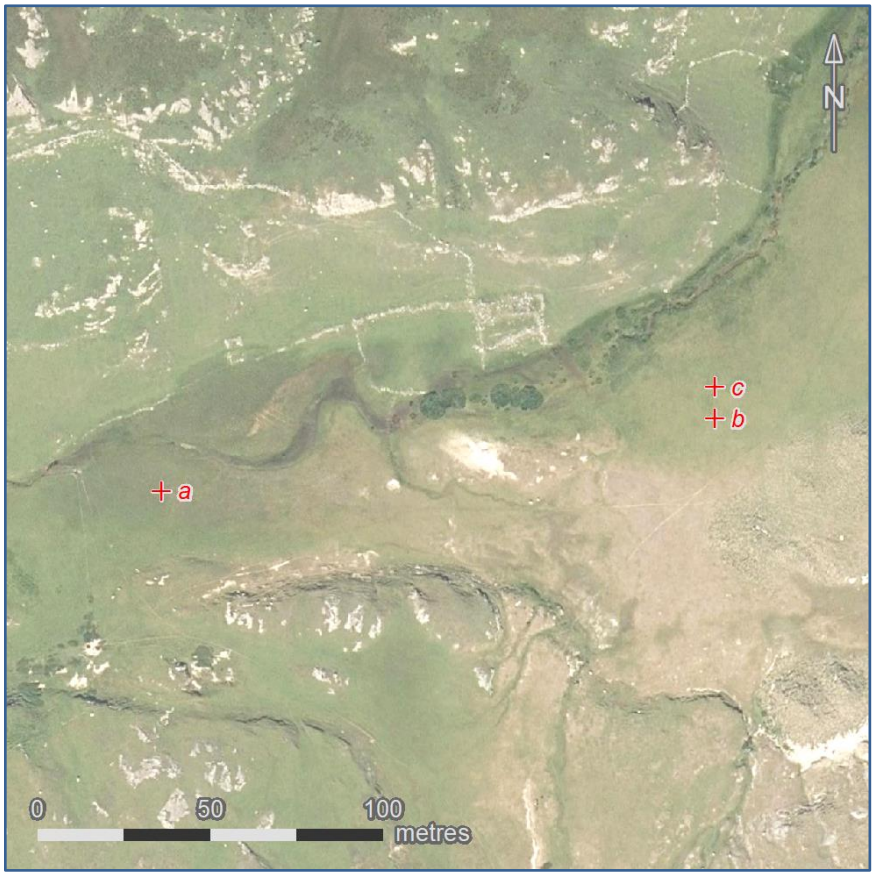

Figure 106 Species Site 29, Bluesky image abstract. *P. calophyllum* was recorded at locations (a–c) in 2003.

Figure 107 Species Site 29, photograph taken on 19 October 2003 showing location of large populations of *Ptychostomum calophyllum* (orange spot) in relation to extensive areas to the right with freshly accumulated blown sand.

Figure 108 Species Site 29, habitat with *P. calophyllum* photographed on 19 October 2003, showing open low vegetation with 30–40% cover of damp bare sand visible.

Figure 109 Species Site 29, representative part of same area as in Fig. 106 photographed on 8 June 2023 showing complete cover by grass sward with herbs. No bare sand was visible in the vicinity.

Figure 110 Species Site 29, detail of representative part of same area as in Fig. 106 photographed on 8 June 2023 showing complete cover by grass sward with herbs, above a carpet of pleurocarpous mosses, with no bare sand visible.

Species Site 30

Species *Ptychostomum calophyllum*	**County** Mayo	**Vice-county** H27
Locality E. of Keel/Trawmore		**Discovery Map** 30
SAC/NHA Keel Machair/Menaun Cliffs SAC 001513		
Grid References (from hand-held GPS) **Site 1** **ITM** 464714 804324 (waypoint 086) **IG** F6473 0431 (Map letter a) **Site 2** **ITM** 464837 804211 (waypoint 089) **IG** F6485 0421 (map letter b) **Site 3** **ITM** 464873 804193 (waypoint 090) **IG** F6489 0418 (Map letter c) **Comments** The IG references are those obtained in 2003 (see "Previous records" below; Site 1 was recorded on 28 June 2003, Sites 2 and 3 were recorded on 9 Oct. 2003). All ITM grid references were recorded only on 27 June 2023 when the species was not refound, but each of the older grid references was relocated, then searched without success and recorded again in ITM format.		
Elevation (m) 3–4		
Survey dates 27 June 2023 & 7 September 2023		**Observers present** DTH
Population recorded None		
Previous records here/close by In 1978 and again in 2003 (see "Previous records" below).		
Fertile? Capsules have been recorded from this site only in the material collected in 1987 by D.G. Long (see "Previous records" below).		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Habitats recorded in 2003 were on "unshaded partly bare damp sandy soil with vegetation/low vegetation, just inland of shingle (i.e. cobbles) bank, at seaward edge of machair".		
Associated plant species Species not refound here in 2023; for older data see records of surveys in 2003 lodged with NPWS.		
Current land-use/grazing Intensively grazed by sheep, including areas just inland used as part of golf course that has been present here since before 2003.		
Photographs of site Images of areas where *P. calophyllum* was found in 2003 showing condition of vegetation on 27 June 2023 (5854, 5855, 5850, 5851, 5852).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Species not refound here in 2023.		
Other comments On 27 June 2023, at Site 1, habitat at first sight apparently not much changed between 2003 and 2023; the areas just inland of the cobbles of the sea-bank, on the seaward edge of the machair, being heavily sheep-grazed everywhere in both years. On the 2023 visit the bryophytes were well hydrated, following a night with heavy rain, and light rain or drizzle during the survey. Nevertheless, yellow-brown grasses on the higher ground still gave evidence of atypically dry weather conditions during several weeks preceding the survey. No trace of *P. calophyllum* could be found. On returning to the area close to the original grid reference, it was not possible to find more than tiny bits of "partly bare damp sandy soil with sparse vegetation". Even the shortest and most open vegetation was almost completely covered by a stable carpet of low mosses, especially *Barbula convoluta* and *Didymodon vinealis*, with much *Hypnum cupressiforme s.s.* on drier ground. There was much less sand visible on the ground surface than on the 2003 visit, and more obvious abundance of sheep droppings on the ground surface. Thus, the supply of blown sand must have diminished; eutrophication from persisting sheep droppings may have actually increased, or at least merely been sustained throughout the past twenty years. Sites 2 and 3 were relocated at points just below a flat edge of the machair now used (mown) as part of the golf course. As at Site 1, areas of "partly bare damp sandy soil with sparse		

vegetation" were lacking. Instead, a closed, stable low vegetation cover was present virtually everywhere. It was clearly heavily grazed by sheep and perhaps receiving atypical amounts of their dung since some places offered slight shelter from extreme winds along with a persistently well drained substratum. A few representative photos (see below) record the condition of this vegetation.

A return visit on 7 September 2023 was used to cover some of the same ground again, after two months with much more rainfall, but again no damp areas with open blown sand were located and no *P. calophyllum* was found anywhere. Judging from the uneven surfaces remaining, closure of the outlet of the stream estuary around F650039 appears to have been carried out deliberately with heavy machinery rearranging large areas of coarse shingle. It was probably this closure that cut off the supply of blown sand from the beach to the areas that supported *P. calophyllum* in 2003 (F6473 0431 eastwards to F6489 0418). The shingle/cobble bank remaining to block the stream remains lower than the unmodified bank on either side. It is evidently still breached at MHWS under some conditions because an old strandline of marine flotsam exists along the landward edge. New searches E. of the stream did not reveal any open sandy habitat. Near to the blocked stream exit, a strip of soil 5 m long in a damp hollow had some apparently recent bryophyte colonists (*Funaria hygrometrica*, *Bryum dichotomum* c.fr., *Microbryum davallianum* c.fr.) and a second smaller hollow held *Archidium alternifolium*.

The dunes inland of the W. end of Trawmore (around F640045) do have some open eroding sandy slopes and blow-outs that liberate blown sand. Unfortunately, the areas just inland of these are relatively dry, with damp machair grassland closely grazed by sheep, and further westwards, a large camping ground is kept like a lawn by regular mowing.

Details of Previous Records

Discovered here by D.G. Long in 1987, with voucher specimen at (E) confirmed by DTH, comprising good material, c.fr. Data recorded with his specimen are: "11 Aug. 1987, Dunes near Keel, Achill Island, W. Mayo, 03/64–04-, hollow on sand dunes".

Refound in similar area by DTH during surveys for NPWS in 2003, as follows: "28 June 2003, dunes E. of Keel, Achill Island, W. Co. Mayo, v.c. H27, F6473 0431 (Map letter a), unshaded partly bare damp sandy soil with sparse vegetation, just inland of shingle bank, at edge of machair, Holyoak 03-252 (**DBN**) ". Also, "9 Oct. 2003, Trawmore Sand, v.c. H27, F6485 0421 (Map letter b) and F6489 0418 (Map letter c), scattered among other mosses, on unshaded partly bare damp sandy soil with sparse low vegetation, just inland of shingle beach, no specimen collected". On both dates in 2003 it was found sparingly, with small non-fertile plants widely scattered in suitable open habitat.

Reasons for loss or decline

Apparently lost between 2003 and 2023 due to decline in supply of blown sand, probably due to deliberate closure of the stream exit onto the beach at F650039, along with eutrophication of the ground surface associated with heavy grazing/overstocking with sheep. The resulting development of closed ground-cover excludes *P. calophyllum*, which requires "partly bare damp sandy soil with sparse vegetation".

Recommended conservation measures

None proposed, although judicious removal of patches of turf or more extensive (but shallow) mechanical scraping of the ground surface might still produce regrowth of *P. calophyllum* from a "spore-bank" close to the soil surface. Nevertheless, the neighbouring site with surviving but decreased *P. calophyllum* at Barnynagappul Strand (see Species Site 31 below) is apparently a higher priority for intervention to assure its survival.

Figure 111 Species Site 30, Discovery map abstract. *P. calophyllum* was found at locations (a–c) in 2003.

Figure 112 Species Site 30, Bluesky image abstract. *P. calophyllum* was found at locations (a–c) in 2003.

Figure 113 Species Site 30, habitat photographed on 28 June 2003 when *Ptychostomum calophyllum* was collected from the same spot, recorded as (Irish Grid) F64730431 (Map letter a) and described as “unshaded partly bare damp sandy soil with sparse low vegetation”.

Figure 114 Species Site 30, photograph of same general area as in Fig. 113 on 27 June 2023, following weeks of unusually dry weather. Grass cover everywhere was thicker and denser than in 2003, yellowish on drier soils, remaining green in moister places which had no bare sand visible.

Figure 115 Species Site 30, another photograph of same general area as in Fig. 113 taken on 27 June 2023, showing complete low grass cover on damper areas.

Species Site 31

Species *Ptychostomum calophyllum*	**County** Mayo	**Vice-county** H27
Locality SE of Barnynagappul Strand		**Discovery Map** 30
SAC/NHA Doogort Machair/Lough Doo SAC 001497		
Grid References (from hand-held GPS) **Southern limit of extent:** **ITM** 469631 808816 (Map letter a) (waypoint 091) **IG** F69651 08837 **Northern limit of extent:** **ITM** 469655 808846 (Map letter b) (waypoint 092) **IG** F69675 08837 **Source of voucher specimen, etc.:** **ITM** 469632 808818 (Map letter c) (waypoint 093) **IG** F69653 08808 **Comments** These coordinates were all recorded on 28 June 2023, based on patches of *P. calophyllum* found then. The southern and northern limits correspond to extremities of a strip of occupied habitat 36 m long and 8–17 m wide (paced out). The area occupied in 2003 was coextensive with that in 2023, but larger, exceeding the 67 x 2–3 m strip noted on 27 June 2003.		
Elevation (m) 3		
Survey date 28 June 2023	**Observers present** DTH & CC	
Population recorded On 23 June 2023, six patches found: at southern limit, 2 x 2 cm; at northern limit, 7 x 3 and 2 x 2 cm; approximately midway between these limits, 2 closely adjacent patches, 2 x 2 and 8 x 6 cm. In addition, at *c.*2 m northwards from southern limit, patch 14 x 7 cm, was used for photos and collection of voucher and *ex situ* cultivation material, as well as preparation of the list of associated plants.		
Previous records here/close by From 2003, see "Previous records" below.		
Fertile? No capsules were found in 2023. In contrast, the much larger population in 2003 had plenty of patches with capsules, although these were in the minority (see "Previous records" below).		
Voucher specimen(s) Holyoak 23-099 (for **DBN**)		
***Ex situ* cultivation material collected** Yes (for **DBN**)		
Site description/geology/slope/drainage/shading/vegetation types On open sandy area close to bank of freshwater stream at head of sand beach. The *P. calophyllum* growing only in small open patches with semi-stable moist sand exposed, not colonising loose and drying sand surfaces, not occurring where grasses, rushes and herbs shade most or all of the ground.		
Associated plant species Voucher specimen was from damp humic sand with some *Nostoc*, in area with *c.*60% cover of low phanerogams. In order of decreasing abundance, the adjacent cover was of: *Festuca rubra*, *Juncus articulatus*, *Agrostis stolonifera*, *Sagina nodosa* and *Sagina procumbens*, with <1% also of *Bellis perennis*, *Mentha aquatica*, *Lysimachia maritima* (syn. *Glaux*), *Eleocharis* sp., *Cardamine pratense* (seedling). Also present nearby were *Rhytidiadelphus squarrosus*, *Climacium dendroides* and *Leontodon saxatilis*. The northernmost finds were on a more open patch with *c.*70% sand exposed, lacking *Nostoc*, with additional associates including *Ptychostomum pseudotriquetrum* c.fr. and some *Poa annua*.		
Current land-use/grazing The whole area is unfenced and still heavily grazed by sheep. An Irish Hare was also seen nearby. Fortunately, despite proximity to holiday accommodation to the south-west, the site is "off the beaten track", protected from those walking to the beach by the stream fringing the south-western side of the site.		
Photographs of site Images of locations, habitats and plants (5870, 5872, 5874, 5882, 5860, 5862, 5863, 5865, 5867).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Loss of habitat (see below).		

Other comments

In June 2003, *P. calophyllum* was recorded as "occurring more or less continuously over a strip 67 m long and 2–3 m wide, with pure patches *c.*7 cm in diameter". There were far too many patches to count them, and the visit in October 2003 showed other strong subpopulations outside the 67 m strip.

In June 2023, a concentrated search effort over >1 hour found only six patches, albeit with the largest measuring 14 x 7 cm (three of the others were all only *c.*2 x 2 cm). No capsules were found in 2023, whereas they occurred sporadically over a large area in 2003. Overall, a rough estimate was that the total population in 2023 was <2% of that in 2023.

In 2003 it was noted that the *P. calophyllum* occurred in places with 30–80% bare sand (i.e. within centrally placed 0.5 x 0.5 m quadrats). This had not changed for the finds in 2023, which were in places e.g. with *c.*60% and *c.*70% bare sand (see above).

Comparisons of photos from 2003 (e.g. in the PDF with the NPWS website data on FPO bryophytes) and 2023 (see above) emphasise that the extent of bare sand patches within the area occupied by *P. calophyllum* had declined greatly over this twenty-year period. Before comparing the photos, it was noted during the June 2023 visit that: generally, more of the open sandy patches were becoming colonised by grasses and herbs compared to the situation in 2003. It was also noted that the stream edge had gained more fringing vegetation of *Glyceria maxima* and *Eleocharis palustris*.

Thus, it is clear that the overall area occupied by *P. calophyllum* has been reduced, and that it occurs at much lower density within its remaining area. The population decline is associated with a great reduction in patches with "30–80% bare sand" and this undoubtedly results from expansion of phanerogam cover. It is uncertain how far "natural vegetation succession" inevitably leads to loss of such open habitat patches in the absence of fresh erosion and sediment input events, or of the timescales involved. Nutrient inputs from sheep dung may accelerate "natural succession" if the sheep rest here, or slow the succession if they do not. However, if present trends continue there seems little doubt that *P. calophyllum* will be lost from the site within a timescale of maybe five or ten years.

Details of Previous Records

Discovered here in 2003 during surveys for NPWS by DTH. Data recorded with voucher specimens (**DBN**, Herb. DTH to be lodged at E) were: "10 Oct. 2003, SE of Barnynagappul Strand, Achill Island, Co. Mayo, v.c. H27, F6963 0877 (Map letter d), unshaded partly bare damp sand near stream close to head of beach, with sparse low vegetation, Holyoak 03-559 & 03-560". Other material was collected that day from F6964 0878 (Map letter e) as Holyoak 03-561 (including a few possibly hybrid sporophytes involving *P. pseudotriquetrum*) and seen also at F6971 0884 (Map letter f); all of these gatherings had capsules present. A previous sample collected 27 June 2003, from F6967 0881 (Map letter g), was associated with occurrence almost continuously along a strip 67 m x 2.3 m, with immature capsules on some of the plants.

Reasons for loss or decline

Reduction of area occupied and of habitat patches within it due to colonisation of bare sand patches by phanerogams. This is the only population of *P. calophyllum* in Ireland that was refound in 2023. The other two populations found in 2003, seem certain to be extinct (at Dooaghtry machair) and now at least exceedingly rare if not extinct (at Keel machair). At both of those sites, loss of bare-sand habitat to low vegetation cover appears to have caused local extinction of the species. It is predicted that in the absence of intervention at Barnynagappul Strand, this last Irish population will also become extinct within five to ten years.

Recommended conservation measures

As discussed above, this is now the only site in Ireland for the species and it will soon be lost if present conditions there are maintained. *P. calophyllum* has already become extinct in England, Wales, Germany and Latvia. There are five post-1990 records from Scotland, with scanty recent information on those sites. Hence, its survival within Europe is probably only assured now by populations in Iceland and northern Scandinavia, since climatic warming may be adding to pressures on this predominantly boreal and arctic species. Furthermore, the Barnynagappul population is potentially vulnerable to global sea level rise, whereas that formerly at Dooaghtry was unusual in not being at risk from this.

In 2003, Co. Mayo with three sites appeared to be the last stronghold of the species on the coasts of western Europe. It seems now that it will only survive here if deliberate interventions are made to enlarge the habitat remaining at Barnynagappul Strand and possibly also at Dooaghtry machair. Deliberate and closely judged removal of surficial vegetation probably offers the best hopes of extending the bare sand patches it needs. In doing this, great care will be needed to avoid damaging the few surviving patches of the plant while creating additional suitable habitat close to these. Thus, licenced management work needs to be linked closely to detailed population mapping and surveys. This need for regular small-scale recreation of habitat is likely to remain in future years, unless new erosional events help the process.

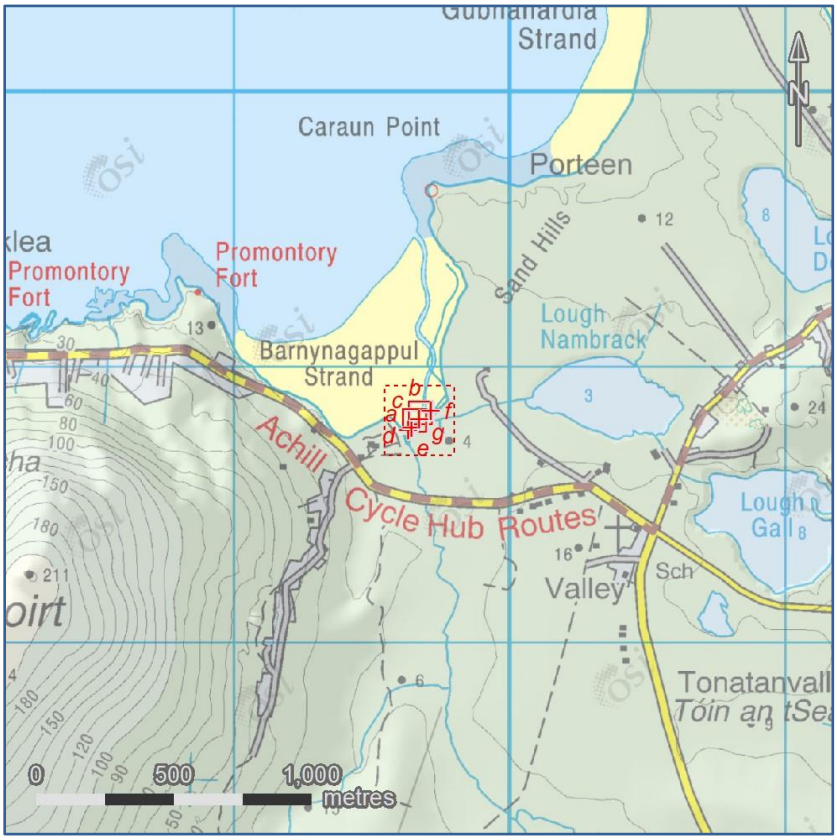

Figure 116 Species Site 31, Discovery map abstract. Ptychostomum *calophyllum* was found at locations (a–c) in 2023, (d–g) in 2003.

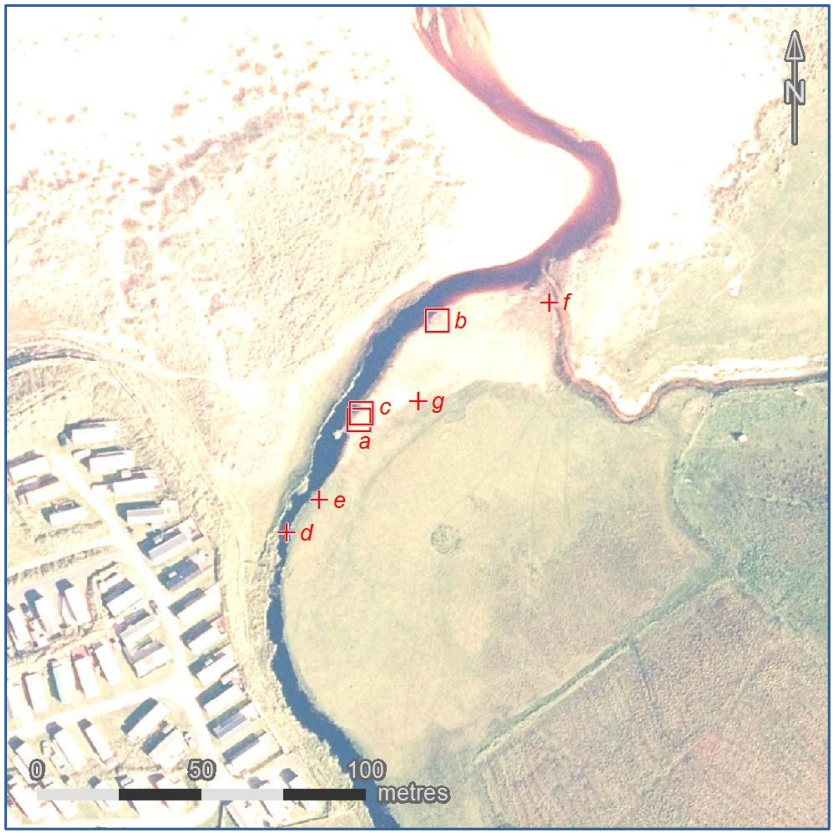

Figure 117 Species Site 31, Bluesky image abstract. *Ptychostomum calophyllum* was found at locations (a–c) in 2023, (d–g) in 2003.

Figure 118 Species Site 31, view on 28 June 2023 showing most of area in which *Ptychostomum calophyllum* was refound, extending southwards for *c.*67 metres from spot on right-hand side of photo marked with orange tape.

Figure 119 Species Site 31, habitat with *Ptychostomum calophyllum* photographed on 28 June 2023, showing low open vegetation, but with the extent of visible bare sand declining as grass cover increases.

Species Site 32

Species *Ptychostomum cernuum*	**County** Dublin	**Vice-county** H21
Locality North Bull Island		**Discovery Map** 50
SAC/NHA North Dublin Bay SAC 000206		
Grid References (from hand-held GPS) **ITM** 722782 736316 (Map letter a) (waypoint 072) **IG** O22860 36289 **Comments** The grid references above relate to the "1st patch", from which the small voucher specimen was collected. This spot was paced-out as 17 m beyond the lone (polycormic) *Salix cinerea* bush in the slack, walking directly away from it along the floor of the slack towards the distant power-station chimneys. Notes below on "Population recorded" add details of closely adjacent patches.		
Elevation (m) 3		
Survey date 23 June 2023	**Observers present** DTH (with E. Holyoak)	
Population recorded Total of 6 patches within overall area measuring 5 x 2 m. Unless otherwise stated, all distances/directions are noted in relation to position of the 1st patch. 1st patch (voucher specimen, grid references above), 5 x 3 cm; 2nd patch (1 m to SE), 2 x 1 cm, with 7 capsules; 3rd patch (1 m to SW), 2 capsules arising from a patch mainly of *P. pseudotriquetrum*; 4th patch (2 m to SW), 5 x 5 cm, with capsules; 5th patch (5 m almost due W., at ITM 722785 736322 (Map letter b), IG O22861 36298, 12 m from the lone *Salix cinerea* bush), patch 9 x 4 cm; 6th patch (20 cm NE from 5th patch in similar setting), 3 capsules.		
Previous records here/close by See "Details of Previous Records below". The population recorded here has been known in the same small area since 2007, on nearly square patches of habitat largely created by past thefts of grassy turf.		
Fertile? All patches recorded had capsules fully formed but still immature (green). Generally, the plants appeared rather small by comparison with old specimens from the sites in vice-counties H26 and H34.		
Voucher specimen(s) Holyoak 23-096 (for **DBN**)		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types For 1st patch. Partly bare (35% open) damp sand on floor of dune slack, in one of several small hollows where turf was removed in the past. (Other patches were all in generally similar settings).		
Associated plant species For 1st patch. With *Calliergonella cuspidata*, *Equisetum variegatum*, *Molinia caerulea* (small plants), near *Carex flacca*; three seedlings of Sea-buckthorn *Hippophae rhamnoides* (the largest 20 cm tall) were growing within 30 cm. Different associates for other patches were noted as follows: 2nd patch, also with *Juncus articulatus*; 3rd patch, arising from patch of *Ptychostomum pseudotriquetrum*; 4th patch, with *Aneura pinguis* agg., sparse *Agrostis stolonifera*; 5th patch, growing from low cover of *Calliergonella cuspidata*, with sparse *Agrostis stolonifera*, *Festuca rubra*, *Carex flacca*.		
Current land-use/grazing Area is ungrazed by domestic animals but rabbits are clearly present nearby.		
Photographs of site Images of location, habitat and plants (5475, 5472, 5473, 5483, 5468, 5482); images of invading seedlings of Sea-buckthorn close by (5485, 5486, 5487).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Three seedlings of Sea-buckthorn (the largest 20 cm tall) were growing within 30 cm of 1st patch described above. These were cut off with a knife and destroyed by DTH. More small Sea-buckthorn close by urgently need to be removed (or killed *in situ* with very careful use of a Weedwiper).		

Other comments

A fuller survey seeking *P. cernuum* in adjacent areas was made in early September 2023, without revealing any more populations.

Details of Previous Records

Known by very old records on the coast of Co. Dublin, e.g. at Malahide, but discovered at this site during surveys for NPWS by DTH in 2007. Data on the voucher specimen (**BBSUK** now **NMW**; **DBN**) records: "14 Sept. 2007, North Bull Island, Co. Dublin, v.c. H21, O22855 36291 (Map letter c), in low bryophyte mat on low bank by E. edge of track through dune slack, on damp sand among sparse low *Festuca rubra*, *Equisetum*, *Carex*, etc., Holyoak 07-429", with capsules.

Noteworthy subsequent records from closely adjacent sites are as follows (from NPWS website for FPO bryophytes):

3 Oct. 2008, at O22851 36293 (Map letter d), on damp sand with sparse low vegetation on bank by edge of track, DTH *et al*.;

7 Oct. 2009 & 15 Oct. 2010, at O22853 36292 (Map letter e), on slightly exposed clayey sand on NW-facing slope beside track, Christina Campbell & Noeleen Smyth (**DBN**), c.fr.;

15 Oct. 2010, at O22833 36262 (Map letter f), at corner of bank cut-out from foredune slack, above track, Christina Campbell & Noeleen Smyth (**DBN**), c.fr.

Reasons for loss or decline

Much of the decline is apparently due to increased cover of herbaceous plants in the dune slack and on its edges.

Recommended conservation measures

It is urgent that the Sea-buckthorn seedlings and saplings are removed from this area as soon as possible, i.e. in 2024 (see also Species Site 35 below).

Future conservation of rare Bryaceae on North Bull Island should include regular monitoring. In any sites where Sea-buckthorn occurs close to those Bryaceae, the monitoring should be annual and include simultaneous removal of young Sea-buckthorn plants growing from seed or old roots. Creation of new habitat by judicious localised turf-stripping should be considered if habitat suitable for these species declines in extent.

Figure 120 Species Site 32, Discovery map abstract. *Ptychostomum cernuum* was found at location (a) and (b) in 2023, at (c–f) during 2007–2010.

Figure 121 Species Site 32, Bluesky image abstract. *Ptychostomum cernuum* was found at location (a) and (b) in 2023, at (c–f) during 2007–2010.

Figure 122 Species Site 32, part of last remaining area with *Ptychostomum cernuum*, photographed on 23 June 2023 close to knife with orange tape (just right of centre). These hollows where it grows result in part from illegal turf-stripping in the past. Note the recent arrival of Sea-buckthorn saplings here.

Figure 123 Species Site 32, habitat of *Ptychostomum cernuum* photographed on 23 June 2023, on almost bare damp sand just right of the knife point. See front cover photo for illustration of the fruiting plants.

Species Site 33

Species *Ptychostomum cernuum*	**County** Mayo	**Vice-county** H26
Locality Island Lake (E. side)		**Discovery Map** 32
SAC/NHA River Moy SAC 002298		
Grid References (from hand-held GPS) **ITM** No data	**IG** M4822 8204 to M48218 82036	
Comments Last recorded at this site in 2009 and apparently gone by 2011; the IG references are for areas occupied in 2003 to 2009.		
Elevation (m) 78–79		
Survey date 21 June 2023	**Observers present** DTH & CC	
Population recorded None		
Previous records here/close by See "Details of Previous Records" below.		
Fertile? Previous records were all based on plants bearing capsules.		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Previously grew on unshaded or partly shaded marl exposed on bank of ditch. See NPWS Bryophyte FPO website for details.		
Associated plant species See NPWS Bryophyte FPO website for details.		
Current land-use/grazing The area of the turlough is lightly grazed by cattle, but these do not enter the tall vegetation on the ditch banks.		
Photographs of site Images showing condition of vegetation at former site for *P. cernuum* on 21 June 2023 (5464, 5465), with line of ditch apparent only from location of *Phragmites* stems. For comparison, see habitat photo from 21 July 2003 published in Holyoak (2021, *European Bryaceae*, p. 343) which show the open ditch within a year or two of it being cleared.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures *P. cernuum* has apparently been lost from this site.		
Other comments Our visit on 21 June 2023 established that the former sites along the northern bank of the ditch are now heavily shaded by *Alnus* trees exceeding 5 m in height and forming a continuous strip of marginal vegetation (see photos). The bottom and southern bank of the ditch have an almost continuous tall sward of *Carex*, *Phragmites* or *Epilobium hirsutum*. Small open areas of ditch had a small stream of flowing water, much of it shaded by growths of *Nasturtium officinale*. Evidently, the ditch has not been cleared again within the past twenty years. On 21 June 2023 an open area further east where cattle get access to the ditch (ITM 548230 782050, waypoint 69; IG M48268 82034) provided the nearest area of open habitat. Close searching revealed small amounts of *Ptychostomum pseudotriquetrum* and *P. pallens* on the slopes around the southern edge of this part of the ditch, but certainly not any *P. cernuum*.		
Details of Previous Records Discovered here in 2003 during surveys for NPWS by DTH. Voucher specimens (**BBSUK** now **NMW**; **DBN**) have data as follows: "21 July 2003, E. edge/SE corner of Island Lake, M4822 8204 (Map letter a), on sandy marl at edge of ditch, Holyoak 03-404". Plentiful, with maturing capsules. Return visit on 7 Oct. 2003 produced fully mature capsules (Holyoak 03-539). The population was subsequently studied by Christina Campbell (as part of Ph.D. research based at **DBN**) and Neil Lockhart. Records by them include M48218 82034 (Map letter b), bank of ditch, exposed marly peat, on 15 Oct. 2009 and again on 26 August 2010; M48231 82036 (Map letter c) and M48231 82041 (Map letter d), on bank of ditch, marly sand, 28 September 2009 and 15 Oct. 2009. Those visits recorded increasing phanerogam cover on the ditch banks with corresponding reduction in open habitats and in turn of the population of *P. cernuum* (see NPWS FPO bryophytes website for documentation). The species was		

not refound at all during bryological monitoring by NPWS at Island Lake in October 2011 and October 2016 when the ditch banks were entirely shaded by tall vegetation.

Reasons for loss or decline

In 2003 it was predicted that the strong population of *P. cernuum* would be lost as saplings of *Alnus glutinosa* continue to grow up on the ditch bank and shading removed the last of the open habitat. This process was indeed completed by 2011, when no suitable open habitat remained and *P. cernuum* could not be found.

Recommended conservation measures

P. cernuum has moderately large spores (22–30 µm in diameter) and these may well be long-lived in soils, forming "spore banks". Hence there is a strong possibility that renewed clearance of the ditch at this former site would result in reappearance of the species. Such deliberate management intervention here would need to be on a large scale to be effective; requiring removal of the strip of young *Alnus* trees over a few tens of metres, followed by excavation of the ditch bed and bank to shallow depths with a mechanical digger. Past experience would imply that this intervention may need repeating at intervals of about ten years to retain open habitat for *P. cernuum* in the longer term.

Since 2003, *P. cernuum* has been known in western Europe only from the three sites in Ireland. This has now been reduced to two sites with loss of this one at Island Lake, and it is now also at high risk of loss from North Bull Island (see Species Site 32 above). Deliberate habitat management seeking to reinstate it at Island Lake would therefore be worthwhile. Further justification for the negotiations required with the landowner and expense of having a mechanical digger on the site would be to use the same opportunity to strip vegetation judiciously from parts of the closely adjacent marl spoil bank supporting *Ptychostomum intermedium* and *Southbya tophacea*, both of them also FPO protected species.

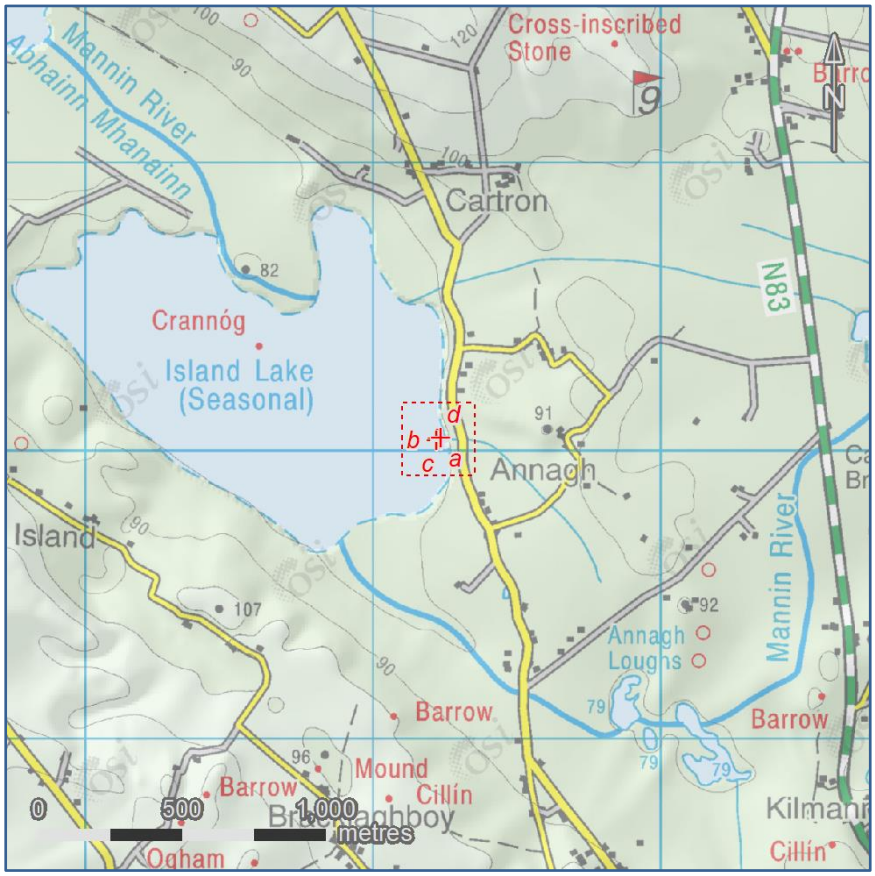

Figure 124 Species Site 33, Discovery map abstract. *P. cernuum* was found at locations (a–d) between 2003–2009.

Figure 125 Species Site 33, Bluesky image abstract. *P. cernuum* was found at locations (a–d) between 2003–2009.

Figure 126 Species Site 33, location of *Ptychostomum cernuum* (by knife in foreground, right of centre) on 21 July 2003. It grew on marl that had been exposed by mechanical clearance of the ditch. Note that Alder saplings were already present further north along the ditch bank.

Figure 127 Species Site 33, same location as Fig. 126, photographed on 21 June 2023, around 12 years after *Ptychostomum cernuum* was last recorded here. Young Alder trees now form a dense grove along the E. bank of the ditch, with *Salix* bushes and tall herbs elsewhere.

Species Site 34

Species *Ptychostomum cernuum*	**County** Donegal	**Vice-county** H34
Locality Soldiers Hill (S. slope)		**Discovery Map** 3
SAC/NHA North Inishowen Coast SAC 002012		
Grid References (from hand-held GPS) **ITM** 642767 953391 (Map letter a) (waypoint 132)		**IG** C42827 53416
Comments These grid references are for the few plants found here in one spot in 2023, as are other details in the following sections, except where otherwise stated.		
Elevation (m) 32 for 2023 record. 24–37 for older records based on hand-held GPS locations, but the steep-sided ravine may imply that horizontal precision of such locations will be reduced.		
Survey dates 10 & 11 September 2023	**Observers present**	DTH, with CC & N. Lockhart on 11 September 2023
Population recorded Three patches, all within single area of steep bank 2 m across, measured as 10 x 4 cm (in top right-hand part of cleared area, a rather thin scatter with *c.*15 capsules), 9 x 12 cm (lower, on vertical *Pellia endiviifolia*), and 5 x 3 cm (on surface with *c.*40% cover of *P. endiviifolia*) in extent. Also few smaller patches slightly lower down nearby (4 x 3, 2 x 3 cm, and a single capsule).		
Previous records here/close by Discovered here in 2002 and monitored again in 2009–2011; see "Details of Previous Records" below.		
Fertile? All records regarded as reliable here are based on fertile plants with well-grown capsules and at least a few mature or almost mature spores, since the species coexists with *P. pallens* that sometimes bears capsules. See Holyoak (2021 pp. 79, 202–203) for a review of the characters differentiating these two species.		
Voucher specimen(s) Holyoak 23-125, 23-126 & 23-128 (for **DBN**); identification of all three samples was confirmed microscopically, although part of 23-126 may be fertile *P. pallens.*		
***Ex situ* cultivation material collected** Yes, capsules from same patch as Holyoak 23-128 were collected for *in vitro* cultivation at **DBN**.		
Site description/geology/slope/drainage/shading/vegetation types See PDF on NPWS website for FPO bryophytes for data from 2002. The 2023 record was from: fairly low on steep S. bank of stream (*c.*3–5 m above the stream, 1.5–3.5 m W. of conspicuous recent rockfall). Growing at and just above DTH head height, mainly in carpets of *Pellia endiviifolia* on 50–80° slopes of consolidated sand of a bank area that collapsed/slipped some years previously.		
Associated plant species See PDF on NPWS website for FPO bryophytes for data from 2002. The 2023 records were associated most conspicuously with *Pellia endiviifolia*, that formed almost pure sheets in places; other plants present were *Amblyodon dealbatus* c.fr., *Ptychostomum pallens* (sometimes intermixed), sparse *Calliergonella cuspidata*, *Didmodon spadiceus* and *Linum catharticum*. Weak shade from above was provided by *Equisetum arvense* and *Succisa pratensis*. Much stronger shade and shelter at the right-hand edge of the cleared area was from overhanging *Festuca rubra* with a few stems of *Ammophila arenaria* and herbs intermixed. We cut back the thicker *F. rubra* which was evidently spreading onto the open parts of the steep bank.		
Current land-use/grazing The land south of the stream is regularly grazed by both sheep and cattle, as it has been for many years. However, the course of the stream with the *P. cernuum* sites now receives much less grazing and less erosion causing bank slippage than in 2002, due to fences along the stream and developing bramble patches, other scrub, tall herbs, and several sycamore trees.		
Photographs of site IMG 6476–6481, 6486–6490		
Field sketch map photographed No		
Apparent threats/any existing conservation measures The residual population is on a single bank, so it is potentially vulnerable to accidents such as small land-slips. It is also apparently declining due to mats of *Pellia endiviifolia* expanding to cover the open sand surfaces, and to increasing shade from *Festuca rubra* growing above the open bank and at its sides.		

Other comments

On 10 and 11 September 2023 all likely habitat on both N. and S. banks of the stream-ravine was visited and searched. In 2002 it was noted that the species was confined to the S. bank, occurring only rather low on this bank in steep places that receive little or no direct sunlight. Likewise, in 2023 none was found on the N. bank, where the more open sunny patches of sandy or calcareous substratum generally appeared too dry.

Western parts of the S. bank were searched closely and none was found. There was little sign of recent erosion/slippage there and the short vegetation on consolidated sand surfaces gave some evidence of leaching of surface layers, with much more *Hymenostylium recurvirostrum* than in the past.

The E. part of the ravine was mainly too dry to provide appropriate niches for *P. cernuum*.

The central part contains the places with all the records from 2009–2011, and it is just one small part of this that now supports the species. Here, the only site where *P. cernuum* was refound was in a small area of the S. bank combining relatively recent bank slips low above the stream, with lack of direct sunlight, and a steep sand surface consolidated by calcareous concretions from water flushing it. In this last refuge there is no hint of leaching of the sand surface. However, vigorous growth of *Pellia endiviifolia* may be reducing the area of open surfaces suitable for *P. cernuum*, and grasses encroaching from above and on both sides are beginning to shade out the areas where it currently grows.

It is noteworthy that *P. cernuum* was found at its southernmost/westernmost localities at Soldiers Hill (C4273 5335 to C4275 5337) only in 2002. It was not refound in this area during 2009–2011, when the number of separate colonies found further north was probably similar to that in 2002.

The population of *P. cernuum* remaining is at just one of four or more locations in the central part of the ravine where it occurred in 2009–2011. The overall total of only *c.*30 capsules in 2023 (at a single location) compares unfavourably with an overall total of >162 in 2011 (at six locations) (data assembled by Christina Campbell, with assistance from Neil Lockhart and Noeleen Smyth). Hence, the total population remaining in 2023 is now <19% of that in 2011 and almost certainly <10% of that which existed in 2002.

This long-term decline appears to result from a decline in the extent of suitable habitat. The steep open banks of calcareous sand in the W. parts of the ravine apparently lost the species between 2002 and 2009. They are now mainly too dry for it, mainly covered by a closed vegetation mat, and apparently have leached rather than highly calcareous sandy surfaces. In the central part of the ravine there are now few recent bank-slips with fresh sand for it to colonise. The residual population is on a single bank, and apparently at risk of decline due to loss of open substrate to liverwort mats and shading from grasses.

Details of Previous Records

Discovered here in 2002 by DTH during surveys for NPWS. Records in that year included the following: “20 May 2002, Soldiers Hill, S./SW slope (NW of Malin), C4273 5335 (Map letter b), vertical damp sand of N.-facing bank above stream, Holyoak 02-561”. Other records were along the same ditch/stream bank, at C4275 5336 (Map letter c), C4275 5337 (Map letter d) and C4287 5246; all samples had capsules. Other patches c.fr. were seen in 2002 around C428534, but only those sampled for checked voucher specimens were formally recorded.

During 2009–2011 several visits by Christina Campbell, Neil Lockhart and Noeleen Smyth continued to monitor its populations. The records included: 1 September 2009 at C4276 5368, and on 23 August 2010 at C42811 53406 (Map letter e), C42812 53408 (Map letter f), C42834 53413 (Map letter g) and C42818 53409 (Map letter h). For a full list of documented records see the PDF on the NPWS website for FPO bryophytes.

Reasons for loss or decline

Loss of habitat accounts for the decline to <10% of the population present in 2002, and from several subpopulations to only one. The supply of steep part-shaded banks with open moist sand which *P. cernuum* colonises was renewed in the past by frequent small land-slips above the stream. Nowadays, secure fencing along the stream is becoming impassable in places through growth of patches of brambles and other vegetation, leading to less activity there by grazing animals. This has in turn reduced bank and slope erosion by the stock, and reduced grazing to control growth of taller vegetation shading the slopes.

Recommended conservation measures

Regular, ideally annual visits by a bryologist are needed not only to monitor population sizes and locations of *P. cernuum* but also to carry out small-scale management work at and close to the site with the last remaining small patches of it. The work involved should aim to reduce shading from grasses and herbs, check competing liverworts or common mosses, and expose new calcareous sand substratum.

On a wider scale throughout the stream ravine, collaboration with the landowner should seek to remove brambles and other scrub and the few existing trees from the stream bank, and realign fences or paths to facilitate access to the stream banks by grazing animals (and bryologists).

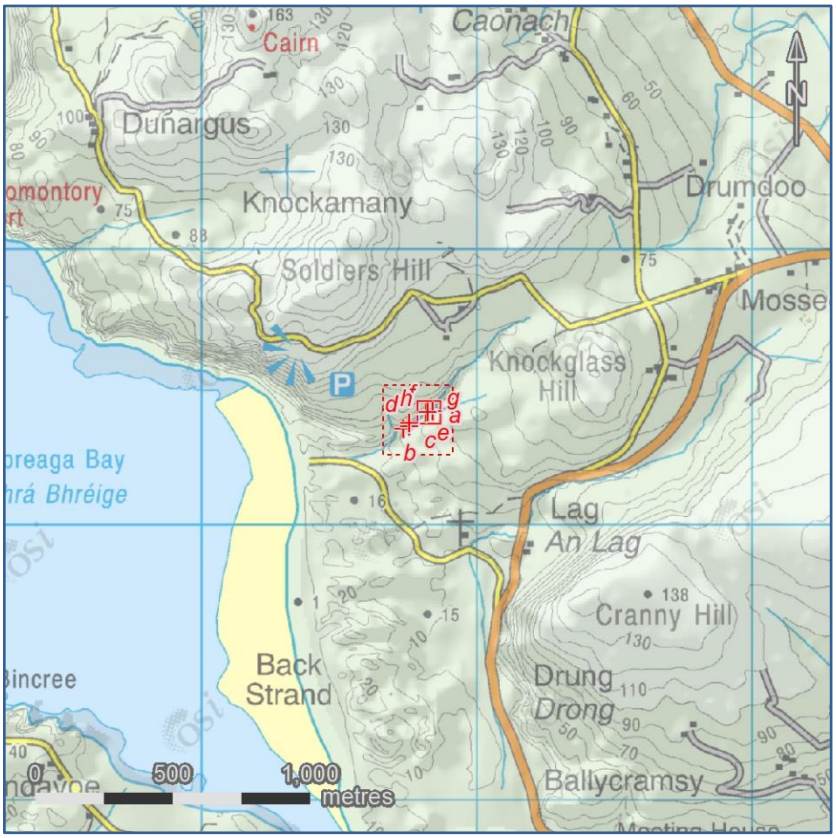

Figure 128 Species Site 34, Discovery map abstract. *Ptychostomum cernuum* was found at location (a) in 2023, at (b–h) variously from 2002–2011.

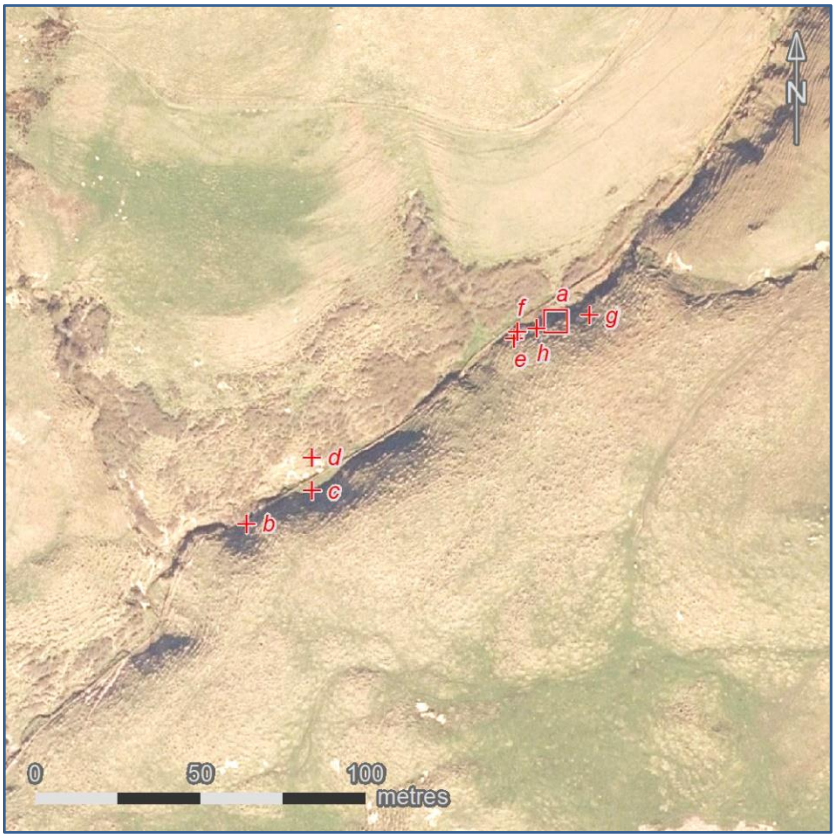

Figure 129 Species Site 34, Bluesky image abstract. *Ptychostomum cernuum* was found at location (a) in 2023, at (b–h) variously from 2002–2011.

Figure 130 Species Site 34, habitat in the last small area here occupied by *Ptychostomum cernuum*, a patch of which is marked by orange tape, photographed on 10 September 2023. Shading from encroaching grasses and herbs threatens this population.

Figure 131 Species Site 34, another small patch of *Ptychostomum cernuum* (beside knife) photographed on 10 September 2023. This patch and a few more were only revealed after cutting back thick growths of overhanging *Festuca rubra.*

Species Site 35

Species *Ptychostomum intermedium*	**County** Dublin	**Vice-county** H21
Locality North Bull Island		**Discovery Map** 50
SAC/NHA North Dublin Bay SAC 000206		
Grid References (from hand-held GPS) **ITM** 722783 736331 (Map letter a)		**IG** O22859 36306
Comments Found at one spot on 23 June 2023. The new find was at 8 m due SE of the lone (polycormic) *Salix cinerea* bush in the slack, 1 m above the ill-defined path.		
Elevation (m) 3		
Survey date 23 June 2023	**Observers present** DTH (with E. Holyoak)	
Population recorded Several small patches, the larger ones 7 x 4 and 5 x 4 cm.		
Previous records here/close by See "Details of Previous Records" below. The find on 23 June 2023 was close to one of those made on 14 September 2007, but clearly not in the same spot.		
Fertile? A few mature capsules present, along with numerous setae lacking capsules.		
Voucher specimen(s) Holyoak 23-095B (for **DBN**), identification confirmed microscopically.		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types On partly bare sand at base of small slope bordering dune slack.		
Associated plant species In small almost pure patches, on opening amongst taller grasses. Growing closest to sparse *Ammophila arenaria*, low *Molinia caerulea* and bits of *Equisetum variegatum*, *Polygala vulgaris*, *Cerastium fontanum* and *Catapodium rigidum.*		
Current land-use/grazing Area is ungrazed by domestic animals but rabbits are clearly present nearby.		
Photographs of site No		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Since 2003, Sea-buckthorn *Hippophae rhamnoides* has begun to colonise the vicinity of this site. This invasive shrub readily forms scrub on sand dunes and in dune slacks, that casts heavy shade and excludes the rare Bryaceae species. Small numbers of Sea-buckthorn seedlings and saplings occurred within a few metres of the *P. intermedium* and even closer to *P. cernuum* (see Species Site 32 above).		
Other comments A fuller survey for *P. intermedium* in early September 2023 did not locate any more patches.		
Details of Previous Records Discovered at this locality in 2007 during surveys for NPWS carried out by DTH. Data on the voucher specimens (**BBSUK** now **NMW**; **DBN**) were recorded as follows: "14 Sept. 2007, North Bull Island, Co. Dublin, v.c. H21, O2275 3616 (Map letter b), in low bryophyte mat near track edge in dune slack, with sparse low grasses, sedges & herbs, Holyoak 07-425A". On same day, "O22850 36284 (Map letter c), in similar habitat, with low *Equisetum variegatum* and *Festuca rubra*, Holyoak 07-428", and field record (no voucher specimen), on same day, "O22815 36248 (Map letter d), in similar habitat". The NPWS website for FPO bryophytes does not record any subsequent records of the species, but unlike *P. cernuum*, it was not intensively studied here.		
Reasons for loss or decline Not applicable, there is no evidence (as yet) of any decline.		
Recommended conservation measures It is urgent that the Sea-buckthorn seedlings and saplings are removed from this area as soon as possible, i.e. in 2024 (see Species Site 32 above). Future conservation of rare Bryaceae on North Bull Island should include regular monitoring. In any sites where Sea-buckthorn occurs close to those Bryaceae, the monitoring should be annual and include simultaneous removal of young Sea-buckthorn plants growing from seed or old roots. Creation of new habitat by judicious localised turf-stripping should be considered if habitat suitable for these species declines in extent.		

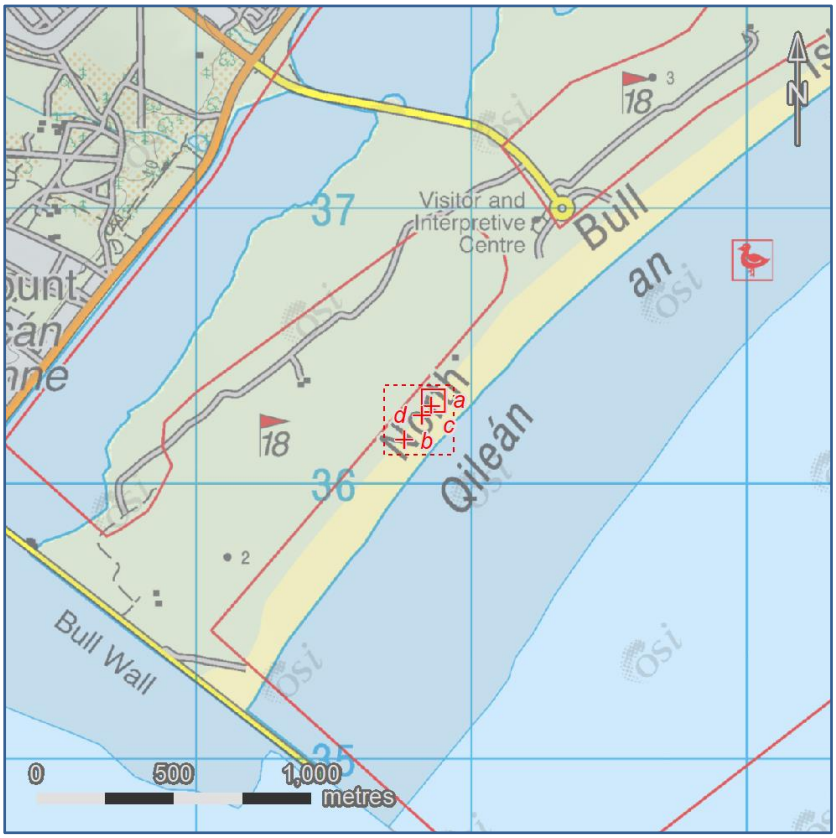

Figure 132 Species Site 35, Discovery map abstract. *Ptychostomum intermedium* was found at location (a) in 2023, at (b–d) in 2007.

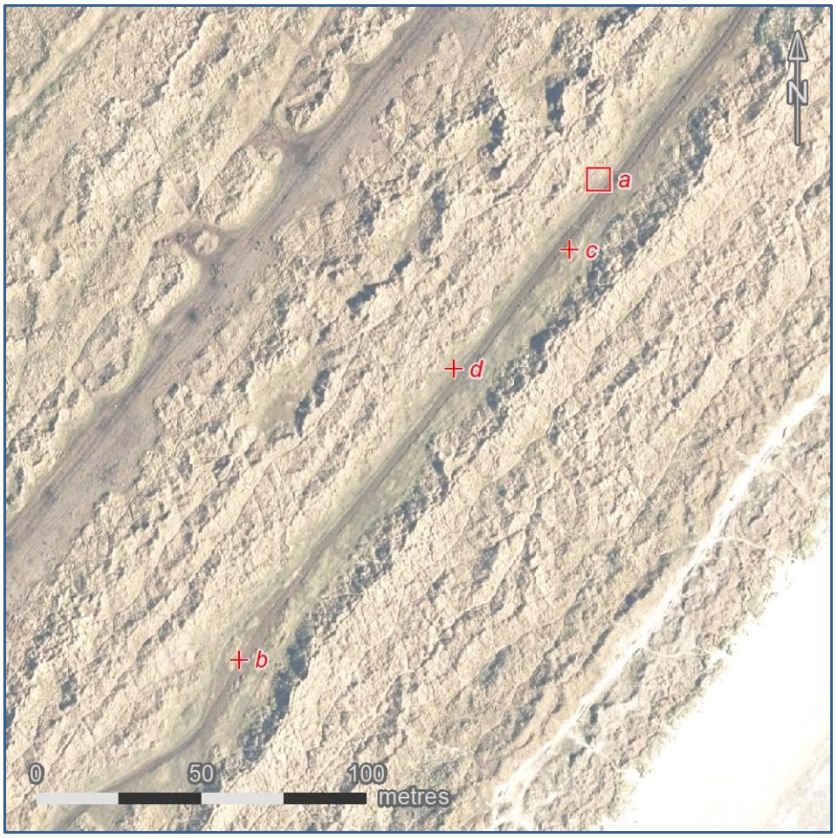

Figure 133 Species Site 35, Bluesky image abstract. *Ptychostomum intermedium* was found at location (a) in 2023, at (b–d) in 2007.

Species Site 36

Species *Ptychostomum intermedium*	**County** Mayo	**Vice-county** H26
Locality Island Lake (E. side)		**Discovery Map** 32
SAC/NHA River Moy SAC 002298		
Grid References (from hand-held GPS) **Site (A)** **ITM** 548156 782279 (Map letter a) (waypoint 68) **IG** M48196 82264 **Site (B)** 3 metres SSW of site (A) **Comments** Recorded at IG reference M4821 8227 (Map letter b) in 2003 (see below), on sloping ground of side of the marl bank. Refound in adjacent but different spots in 2023, on nearly horizontal ground near the highest point on the low marl bank (grid references given above).		
Elevation (m) 78		
Survey date 21 June 2023	**Observers present** DTH & CC	
Population recorded Site (A) with scattered plants bearing capsules and very small groups of them (<2% of total ground cover), over 40 x 50 cm area forming part of an open patch of vegetation; Site (B) four capsules on a small patch.		
Previous records here/close by Discovered here in October 2003 (see "Details of Previous Records" below). Not reported from visits in October 2011 and October 2016, but the small plants are difficult to find unless capsules are detected and October visits may often be too late in the year for them to survive in good condition.		
Fertile? Small numbers of mature capsules present.		
Voucher specimen(s) Site (A) Holyoak 23-094, Site (B) 23-095A (both for **DBN**); identification confirmed microscopically from good fertile specimens.		
***Ex situ* cultivation material collected** Collected from Site (A) (for **DBN**).		
Site description/geology/slope/drainage/shading/vegetation types In two small open patches on top of low bank of marl spoil from pool excavated in edge of turlough (prior to 2003). Almost unshaded, but partly surrounded by cover of *Molinia caerulea* and *Schoenus nigricans*.		
Associated plant species Site (A) with nearly complete ground cover of low bryophytes, mainly of *Southbya tophacea* (see Species Site 33 above), with some *Hypnum cupressiforme s.s.*, *Didymodon fallax*, *Campylium protensum* and *Ptychostomum inclinatum* (c.fr.). Small and sparse low phanerogams present were *Selaginella selaginoides*, *Achillea millefolium* (a seedling), *Pinguicula vulgaris* (seedling) and *Linum catharticum*. Site (B) had nearly complete low ground cover of similar character, but different composition, with *Mesoptychia turbinata*, *Riccardia* sp., *Pellia endiviifolia*, *Dicranella varia* and a few stems of *Funaria hygrometrica* c.fr.		
Current land-use/grazing The area is lightly grazed by cattle, but the marl bank showed little sign of their activity.		
Photographs of site Images showing location, habitats and plants (5459, 5460, 5447, 5450, 5443).		
Field sketch map photographed Yes (5964)		
Apparent threats/any existing conservation measures Discovered here in 2003 but apparently not detected on subsequent visits until 2023. See "Recommended conservation measures" below.		
Other comments Additional small patches of *P. intermedium* may have been present but lacking capsules. At site (A), distinction in the field from coexisting *P. inclinatum* was based on the smaller size of *P. intermedium* gametophytes with costa more shortly excurrent and smaller/shorter and less symmetrical capsules.		
Details of Previous Records Discovered here in 2003 during surveys for NPWS carried out by DTH. Data on the voucher specimen (**BBSUK** now **NMW**; **DBN**) records: "7 Oct. 2003, SE edge of Island Lake, E. Co. Mayo, v.c. H26, M4821 8227 (Map letter b), on unshaded slopes of heap of calcareous marly		

gravel resulting from pond excavation on lake edge, with sparse grasses and herbs, Holyoak 03-540". Mature capsules were present.
Reasons for loss or decline The evidence is of small populations persisting from 2003 to 2023, rather than of decline.
Recommended conservation measures Although *P. intermedium* has apparently persisted here over the twenty years from 2003–2023, it seems clear that the vegetation cover around it on the marl bank has increased, from "sparse grasses and herbs" in 2003 (see accompanying photo: Figure 136) to predominance of a closed sward of *Molinia caerulea* and *Schoenus nigricans* in 2023. Future monitoring of the *P. intermedium* population (and that of *Southbya tophacea*) is therefore needed, ideally at intervals of three years or less. Such frequent monitoring would allow small-scale clearing to be carried out promptly if the unshaded or lightly shaded habitat required by *P. intermedium* and *S. tophacea* becomes scarcer.

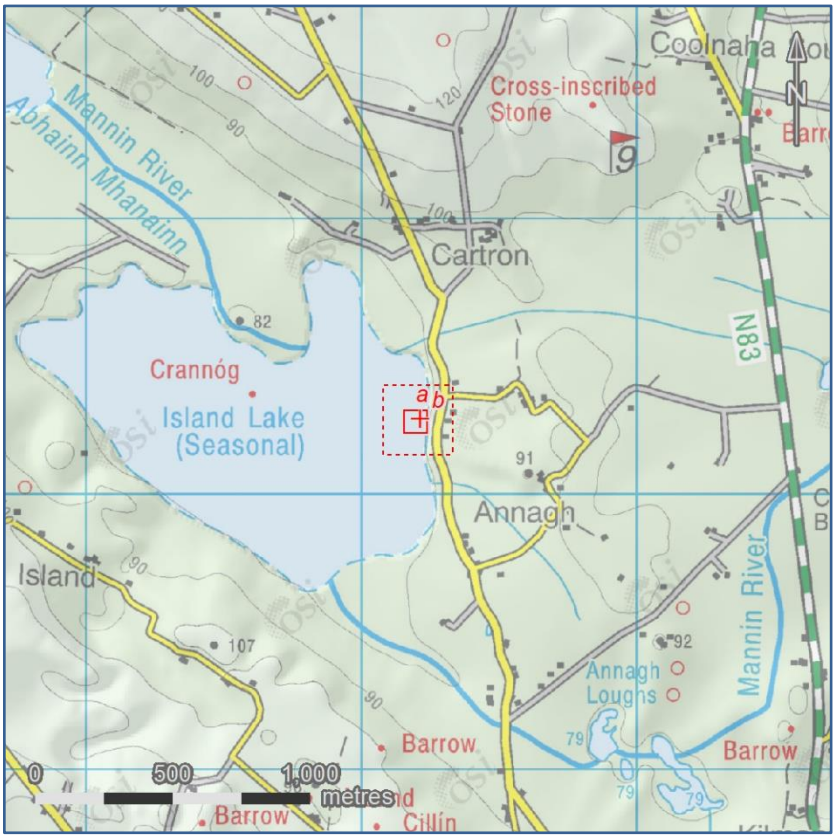

Figure 134 Species Site 36, Discovery map abstract. *Ptychostomum intermedium* was found at location (a) in 2023, at (b) in 2003.

Figure 135 Species Site 36, Bluesky image abstract. *Ptychostomum intermedium* was found at location (a) in 2023, at (b) in 2003.

Figure 136 Species Site 36, habitat where *Ptychostomum intermedium* was found on 7 October 2003, by knife with cream handle in foreground left of centre. Note the predominantly open and sparse vegetation on the marl heap, with scattered tussocks of *Schoenus nigricans*.

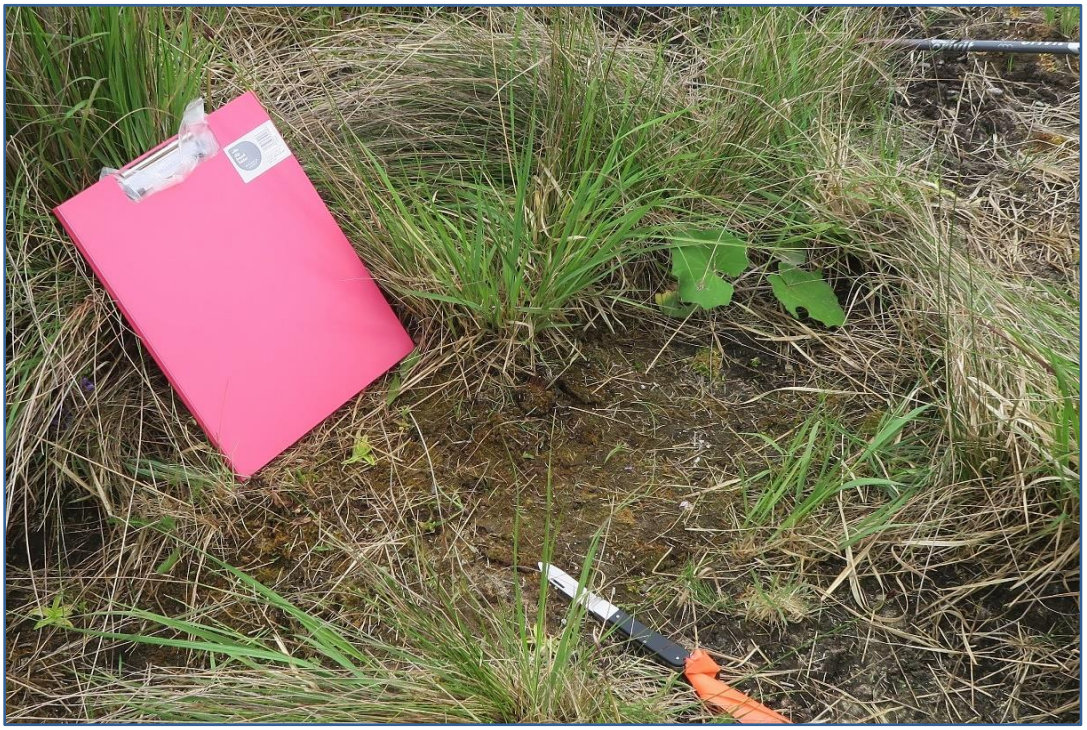

Figure 137 Species Site 36, detail of same habitat where *Ptychostomum intermedium* was refound on 21 June 2023 (near knife point). It grows here within an extensive patch of the rare liverwort *Southbya tophacea*, which also persists only in the small areas of unshaded habitat.

Figure 138 Species Site 36, habitat where *Ptychostomum intermedium* was refound on 21 June 2023, in foreground near point of knife with orange tape. Cover of *Schoenus nigricans*, etc., is now almost complete on the marl heaps.

Species Site 37

Species *Ptychostomum* cf. *knowltonii*	**County** Galway **Vice-county** H15
Locality W. edge of Cloghballymore Lough	**Discovery Map** 52
SAC/NHA Lough Fingall Complex SAC 000606	
Grid References (from hand-held GPS) **ITM** 538619 713806 (waypoint 11) **IG** M38656 13776 **Comments** Grid references from 2004 revised on new site visit to same spot in 2023.	
Elevation (m) 10	
Survey date 5 June 2023	**Observers present** DTH
Population recorded None, but effective survey impossible because almost all bryophytes at the site were coated with layer of marl from recent high-stand of water level in the lake.	
Previous records here/close by On 2 July 2004 (see below)	
Fertile? Lacking capsules	
Voucher specimen(s) None	
***Ex situ* cultivation material collected** No	
Site description/geology/slope/drainage/shading/vegetation types Habitat described in 2004 “unshaded calcareous marl over low flat limestone rock at upper edge of inundation zone of turlough” apparently remained in very good condition on 5 June 2023, but continued presence of this moss could not be confirmed.	
Associated plant species Not recorded	
Current land-use/grazing No sign of grazing animals seen, but this unproductive rocky and lacustrine habitat apparently does not need grazing.	
Photographs of site Yes, showing features of site sampled in 2004 (4862, 4866) and marl encrusting bryophytes, including *Scorpidium scorpioides* (4869, 4874, 4877).	
Field sketch map photographed No	
Apparent threats/any existing conservation measures Protected as SAC. No active conservation measures seen.	
Other comments This and other records of non-fertile *Ptychostomum* cf. *knowltonii* await molecular study to confirm or refute the species identification. With only a single Irish record confirmed by capsule characters, *P. knowltonii* would appear to be a rarity in Ireland, as in Britain, meriting conservation action. However, if all the known non-fertile Irish material is confirmed as this species it would be regarded as much less rare.	
Details of Previous Records Discovered here on 2 July 2004 during NPWS surveys of bryophytes in Co. Galway. Specimen in Herb. Holyoak (destined for E) has data: *Bryum* cf. *knowltonii*, W. edge of Cloghballymore Lough, SE Co. Galway (v.c. H15), M 3865/1377 (Map letter a), unshaded calcareous marl over low flat limestone rock at upper edge of inundation zone of turlough, Holyoak 04-321. The grid reference was checked and slightly revised on the site visit on 5 June 2023 (see above).	
Reasons for loss or decline Not applicable?	
Recommended conservation measures No evidence that any action needed.	

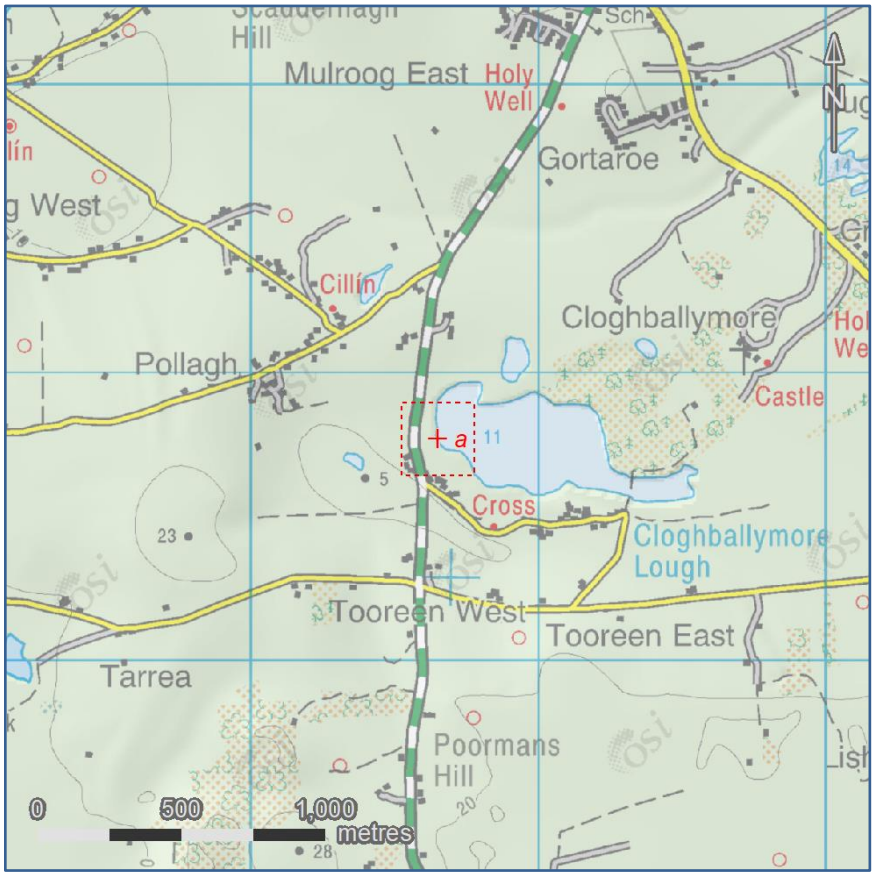

Figure 139 Species Site 37, Discovery map abstract. Location (a) is where *P.* cf. *knowltonii* was found in 2004.

Figure 140 Species Site 37, Bluesky image abstract. Location (a) is where *P.* cf. *knowltonii* was found in 2004.

Figure 141 Species Site 37, location where *Ptychostomum* cf. *knowltonii* was collected on 2 July 2004, photographed on 5 June 2023.

Figure 142 Species Site 37, detail of habitat where *P.* cf. *knowltonii* was collected on 2 July 2004, photographed on 5 June 2023. The fresh covering of marl prevented any effective bryological survey of the marl lake inundation zone in 2023, although shoot tips of the large moss *Scorpidium scorpioides* were just visible in some places.

Species Site 38

Species *Ptychostomum* cf. *knowltonii* **County** Mayo **Vice-county** H26

Locality SW of Inishard, shore of L. Mask, southern sites **Discovery Map** 38

SAC/NHA Lough Carra/Mask Complex SAC 001774

Grid References (from hand-held GPS)

Site (A)

ITM 512637 759745 (Map letter a) (waypoint 40) **IG** M12667 59726

Comments Refound on the same discrete patch of exposed limestone just SE of the track (see sketch map, photo 5952) as the record from 2003, but probably not in exactly the same spot. Grid references above are new.

Site (B)

ITM 512596 759723 (Map letter b) (waypoint 41) **IG** M12626 59702

Comments Refound probably in the same spot (see sketch map photo 5954) as in 2003, in hollow just NW of the track. Grid references above are new.

Elevation (m) 17

Survey date 14 June 2023 **Observers present** DTH

Population recorded (A) 1 patch 4.5 x 3.0–3.5 cm, (B) Forming part of carpet of closely intermixed mosses at sampled specimen/grid reference spot and in several other spots within 3 m in the same depression.

Previous records here/close by Both sites (A) and (B) discovered in 2003; see "Previous records" below for details. See also "Comments" above.

Fertile? Capsules not present

Voucher specimen(s) (A) Holyoak 23-081, (B) Holyoak 23-082; (both for **DBN**)

***Ex situ* cultivation material collected** Yes, from site (A) and site (B), for **DBN**

Site description/geology/slope/drainage/shading/vegetation types

(A) On lower edge of gently sloping almost flat exposure of limestone rock, a few metres laterally from lake shore, adjacent to short grassland rich in mosses on deeper soil at slightly lower level (see sketch map photo 5952, and schematic cross section photo 5950). Growing as domed patch adjacent to other mosses, on thin (1–2 cm) layer of blackish humic soil; unshaded. Other parts of the narrow strip with *P*. cf. *knowltonii* established was disturbed in places due to surficial water flow, whereas regular drying probably prevents phanerogams becoming established. More drastic disruption was evident here and there, probably due to sheep trampling.

(B) In shallow runnel on limestone pavement, *c.*10–12 m laterally from closest part of lake shore (currently a 1.5 m cliff, due to low lake level). Growing as part of carpet of intermixed mosses growing on thin film of marly/stony soil; completely unshaded.

Both sites (A) and (B) are close to but above the inundation zone of L. Mask, but likely to receive spray when gales coincide with high lake water levels. At the high winter water levels both sites will be on a narrow isthmus of land projecting southwards into the enlarged lake, so humidity levels should be persistently high and temperatures moderated.

Associated plant species (A) Associates of the single patch, a few bits of *Ditrichum gracile*, even less *Didymodon insulanus* and *Cratoneuron filicinum*. Others within 20 cm, *Cinclidotus fontinaloides*, much *Cratoneuron filicinum*, some *Calliergonella cuspidata*; on deeper soil, *Poa annua*, *Sedum acre*; a bit further away, *Climacium dendroides*, *Bellis perennis*, *Plantago lanceolata*, *Brachythecium* sp.

(B) Intermixed with *Didymodon insulanus* (commonest), *Cinclidotus fontinaloides*, *Ptychostomum* cf. *pseudotriquetrum* (small plants), *Cratoneuron filicinum*, *Calliergonella cuspidata*; in same runnel, within 20 cm: weak dead plants that died before flowering of *Poa annua* and *Festuca rubra*; slightly higher limestone (<10 cm above) with continuous carpet mainly of *Cinclidotus fontinaloides* and *Cratoneuron filicinum*. Nearby sites in same depression had *P.* cf. *knowltonii* intermixed with the same bryophytes associated.

Current land-use/grazing Area currently grazed by sheep, with a few horses. Presence of old dung locally suggests cattle also grazed here at times. Irish Hares seen.

Photographs of site Images showing locations, habitats and details of plants, respectively for site A (5085, 5087, 5088, 5075, 5077) and for site B (5097, 5098, 5095, 5094, 5092).

Field sketch map photographed Yes, respectively for site A (5952, with schematic section 5950) and for site B (5954).
Apparent threats/any existing conservation measures No immediate threats apparent, beyond possibility of localised damage from sheep trampling at (A). The sites have not been monitored or received any conservation management between 2003 and 2023. Resurfacing of the rough track could threaten both sites.
Other comments This and other records of non-fertile *Ptychostomum* cf. *knowltonii* await molecular study to confirm or refute the species identification. With only a single Irish record confirmed by capsule characters, *P. knowltonii* would appear to be a rarity in Ireland, as in Britain, meriting conservation action. However, if all the known non-fertile Irish material is confirmed as this species it would be regarded as much less rare.
Details of Previous Records Both sites (A) and (B) were discovered during fieldwork for NPWS by DTH in 2003. Details of the voucher specimens are as follows: (A) “26 May 2003, SW of Inishard, v.c. H26, M1267 5973 (Map letter c), with other mosses in small unshaded hollow in near-horizontal limestone pavement, Holyoak 03-188” (non-fertile; branches with concave imbricate leaves. (B) “14 Oct. 2003, shore of L. Mask, SW of Inishcoog, v.c. H26, M1262 5969 (Map letter d), with other mosses on thin soil in unshaded depression in limestone pavement near lake shore, Holyoak 03-586” (non-fertile plants, bud-like).
Reasons for loss or decline No population loss or decline apparent; habitats in good condition and apparently unchanged between 2003 and 2023, although much drier this year following prolonged dry weather.
Recommended conservation measures See “Other comments above”. Any conservation measures should await a combined molecular and morphological study to check the species identity of these and other samples.

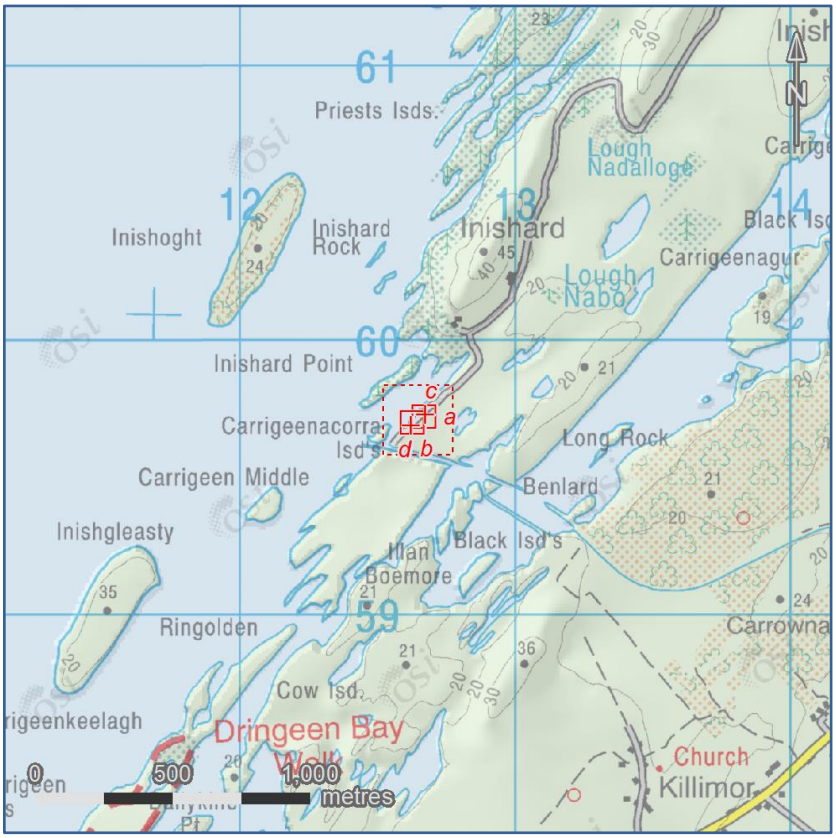

Figure 143 Species Site 38, Discovery map abstract. *Ptychostomum* cf. *knowltonii* was found at locations (a) and (b) in 2023, at (c) and (d) in 2003.

Figure 144 Species Site 38, Bluesky image abstract. *Ptychostomum* cf. *knowltonii* was found at locations (a) and (b) in 2023, at (c) and (d) in 2003.

Figure 145 Species Site 38, photograph taken on 14 June 2023 when *Ptychostomum* cf. *knowltonii* was found at location (a), marked on right-hand edge of photo by orange tape on knife just left of the pink clipboard. Much of the grass here appeared dead and yellowish following weeks without rain, but the moss was in good condition still.

Figure 146 Species Site 38, photograph taken on 14 June 2023 when *Ptychostomum* cf. *knowltonii* was found at location (b), near pink clipboard in middle of image.

Species Site 39

Species *Ptychostomum* cf. *knowltonii*	**County** Mayo	**Vice-county** H26
Locality SW of Inishard, shore of L. Mask, northern sites		**Discovery Map** 38
SAC/NHA Lough Carra/Mask Complex SAC 001774		
Grid References (from hand-held GPS) **Site (A)** **ITM** 512696 759935 (Map letter a) (waypoint 61) **IG** M12725 59913 **Site (B)** **ITM** 512649 760068 (Map letter b) (waypoint 63) **IG** M12679 60047 **Comments** These newly discovered sites are to north of previous finds "SW of Inishard".		
Elevation (m) Site (A) 17, Site (B) 19		
Survey date 20 June 2023	**Observers present** DTH	
Population recorded Site (A): Three almost circular patches, diameters 9, 5.5 and 3 cm, two other small patches intermixed with other bryophytes 3 x 2 and 2 x 2 cm in extent; Site (B): as parts of small mats of intermixed mosses, the *P.* cf. *knowltonii* forming patches 3 x 3 cm (pure) and (intermixed) 4 x 2, 3 x 2, 2 x 1 cm.		
Previous records here/close by None		
Fertile? Capsules lacking at both sites. Specimen from Site (A) has many inflorescences developed.		
Voucher specimen(s) Site (A) Holyoak 23-091, Site (B) Holyoak 23-092		
***Ex situ* cultivation material collected** From Site (A) (now passed on to **DBN**)		
Site description/geology/slope/drainage/shading/vegetation types Site (A): In upper part of inundation zone (or splash zone) on lake shore, in three adjacent rounded hollows on upper near-horizontal to slightly sloping surfaces of limestone boulders, lightly shaded by *Rhamnus cathartica* bush. Site (B): Forming part of small moss mats on horizontal to gently sloping (domed) surface of low pitted limestone rock (top of outcrop or boulder), just above inundation zone on lake shore, in grassy area among open growth of saplings 4–6 m tall of *Crataegus monogyna* and *Rhamnus cathartica*, with lower *Prunus spinosa*.		
Associated plant species Site (A): In hollows with *Cratoneuron filicinum*, *Cinclidotus fontinaloides*, *Didymodon insulanus* and bits of *Ctenidium molluscum*; adjacent rock surface has much *Ctenidium molluscum* and bits of *Ditrichum gracile*, the difference probably reflecting drier conditions in the hollows. Slightly overhung but not appreciably shaded by sparse *Molinia caerulea*; also sparse small (grazed) bushes of *Prunus spinosa* and few stems of *Rubus saxatilis* and *Filipendula ulmaria*. Site (B): Adjoining or intermixed with *Didymodon insulanus*, *Cratoneuron filicinum*, *Ctenidium molluscum* and *Trichostomum crispulum*; also near *Cinclidotus fontinaloides* and a bit of *Calliergonella cuspidata*.		
Current land-use/grazing This and surrounding areas grazed by sheep, sometimes with fewer cattle and horses.		
Photographs of site Images show successively the location, habitat and plants, at Site (A) (5414, 5406, 5405, 5401, 5395, 5391) and Site (B) (5428, 5426, 5416, 5422).		
Field sketch map photographed For Site (A) (5962).		
Apparent threats/any existing conservation measures At Site (A) the vicinity of a small pathway and frequent grazing probably maintain shading by shrubs and saplings at a low level. If grazing ceased the site could quickly become more heavily shaded by adjacent saplings of *Alnus glutinosa*, which are currently *c.*2 m high. In addition, closely adjacent bushes of *Prunus spinosa* (60 and 25 cm high) show evidence of grazing so if unconstrained these would also be likely to grow to produce more shade. At Site (B) the low rock is surrounded by grassland with herbs (*Molinia caerulea*, *Rubus* subgenus *Rubus*, *Leontodon taraxacoides*, *Plantago lanceolata*, *Festuca rubra*), which could readily shade the low rock surface and eventually grow over it. This site is also very likely to experience splashing from waves at times when high lake levels and strong winds coincide, so it may be kept clear of debris by occasional wave action, but presumably put at risk if strandline debris is ever deposited here.		

Other comments This and other records of non-fertile *Ptychostomum* cf. *knowltonii* await molecular study to confirm or refute the species identification. With only a single Irish record (hitherto) confirmed by capsule characters, *P. knowltonii* would appear to be a rarity in Ireland, as in Britain, meriting conservation action. However, if all the known non-fertile Irish material is confirmed as this species it would be regarded as much less rare.
Details of Previous Records Not applicable
Reasons for loss or decline Not applicable
Recommended conservation measures None (see “Other comments” above).

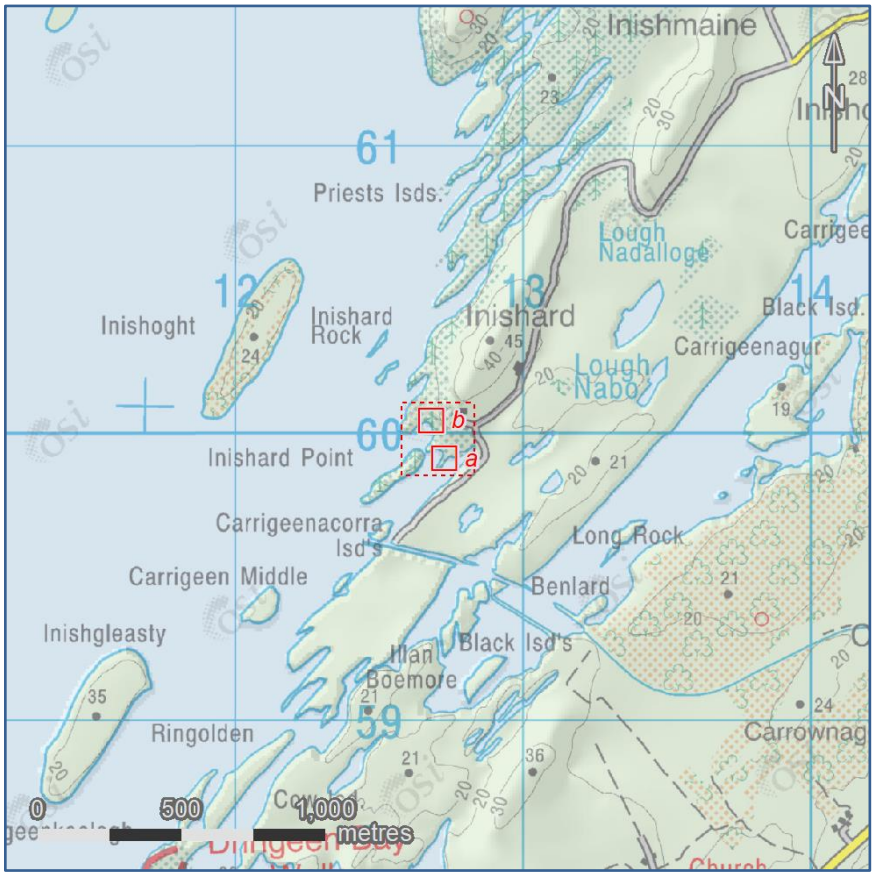

Figure 147 Species Site 39, Discovery map abstract. *P.* cf. *knowltonii* was found at locations (a) and (b) in 2023.

Figure 148 Species Site 39, Bluesky image abstract. *P.* cf. *knowltonii* was found at locations (a) and (b) in 2023.

Figure 149 Species Site 39, photograph from 20 June 2023 of location (a), a “new” find of *Ptychostomum* cf. *knowltonii*, in rock crevice, marked by orange tape (right of centre).

Figure 150 Species Site 39, detail of location (a), a “new” find of *Ptychostomum* cf. *knowltonii* in rock crevice by point of knife, photographed 20 June 2023.

Figure 151 Species Site 39, photograph from 20 June 2023 of location (b), a “new” find of *Ptychostomum* cf. *knowltonii*, marked with orange tape (in foreground at right-hand side of image).

Figure 152 Species Site 39, detail of location (b), a “new“ find of *Ptychostomum* cf. *knowltonii* photographed 20 June 2023, on rock near point of knife.

Species Site 40

Species *Ptychostomum* cf. *knowltonii*	**County** Mayo	**Vice-county** H26
Locality Inishcoog, shore of Lough Mask		**Discovery Map** 38
SAC/NHA Lough Carra/Mask Complex SAC 001774		
Grid References (from hand-held GPS) **ITM** 514332 761558 (Map letter a) (waypoint no. 038)		**IG** M14361 61538
Comments Not refound at the original site where recorded on 24 May 2003, at M1440 6148 (Map letter b), where there now appears to be no suitable habitat. Possibly that grid reference was imprecise. The following details are based on a somewhat featureless specimen, probably from a different place, that will need molecular study to check the species determination.		
Elevation (m) 16 based on grid reference (Fig. 152); but note that Google Earth Pro shows lake surface at 17 m.		
Survey date 13 June 2023	**Observers present** DTH & CC	
Population recorded Several adjacent patches 4 x 8 cm, and rounded with approximate diameters 7 cm and 5 cm.		
Previous records here/close by In 2003, see "Previous records" below and "Comments" above.		
Fertile? Capsules lacking		
Voucher specimen(s) Holyoak 23-080 (for **DBN**)		
***Ex situ* cultivation material collected** Yes (for **DBN**)		
Site description/geology/slope/drainage/shading/vegetation types In inundation zone at edge of lake, currently (with low lake-water level) *c.*6 m from edge of lake water and *c.*0.5 m above it. Growing on soil with thin crust of marl and bare patches, between near-horizontal limestone rocks, almost unshaded.		
Associated plant species With low *Molinia caerulea* and *Carex flacca*, bits of *Lotus corniculatus*, *Ranunculus flammula* and (small) *Salix repens*.		
Current land-use/grazing In open area adjacent to grassland grazed by sheep.		
Photographs of site Images showing location and habitat (5069, 5071, 5067, 5068).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures No immediate threats apparent, but potentially vulnerable to overgrowth or shading by vascular plants, or erosion by wave action at times of high lake levels.		
Other comments This and other records of non-fertile *Ptychostomum* cf. *knowltonii* (having "branches with concave imbricate leaves") await molecular study to confirm or refute the species identification. With only a single Irish record confirmed by capsule characters, *P. knowltonii* would appear to be a rarity in Ireland, as in Britain, meriting conservation action. However, if all the known non-fertile Irish material is confirmed as this species it would be regarded as much less rare.		
Details of Previous Records Discovered here in 2003 during surveys for NPWS carried out by DTH. Data on the voucher specimen are as follows: "24 May 2003. Shore of Lough Mask at Inishcoog, E. Co. Mayo, v.c. H26, M1440 6148 (Map letter b), with other mosses on unshaded thin soil over horizontal limestone rock *c.*40 bove water on shore of lake, Holyoak 03-177".		
Reasons for loss or decline There is no direct evidence of any decline here, where vegetation of lough shore remains in good condition.		
Recommended conservation measures No action recommended; the uncertainty over the species identification of non-fertile "*Ptychostomum* cf. *knowltonii*" needs to be resolved by combined molecular and taxonomic studies (see "Other comments" above).		

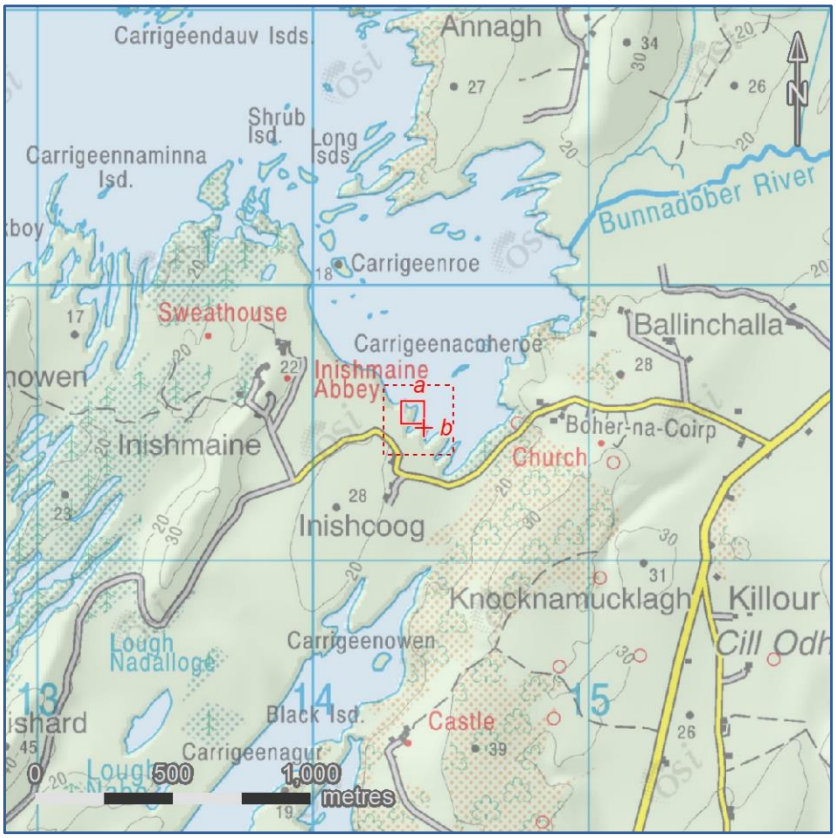

Figure 153 Species Site 40, Discovery map abstract. *Ptychostomum* cf. *knowltonii* was found at location (a) in 2023, at (b) in 2003.

Figure 154 Species Site 40, Bluesky image abstract. *Ptychostomum* cf. *knowltonii* was found at location (a) in 2023, at (b) in 2003.

Figure 155 Species Site 40, location (a) where *Ptychostomum* cf. *knowltonii* was found on 13 June 2023, marked by orange tape left of centre of image.

Figure 156 Species Site 40, habitat at location (a) where *Ptychostomum* cf. *knowltonii* was found on 13 June 2023, just to right of the penknife handle.

Species Site 41

Species *Ptychostomum* cf. *knowltonii*	**County** Mayo	**Vice-county** H26
Locality NW of Keel Bridge		**Discovery Map** 38
SAC/NHA Lough Carra/Mask Complex SAC 001774		
Grid References (from hand-held GPS) **Site (A)** **ITM** 515925 768156		**IG** M1595 6813
Comments IG reference from 22 May 2003 was relocated on 12 June 2023, when the ITM grid reference was recorded. The population here had been destroyed (all of surrounding 10 metre radius was covered with cattle dung) along with that of the *B. gemmiparum* close by; see Species Site 2 above for details		
Site (B1) **ITM** 515938 768218 (Map letter a) (waypoint 36)		**IG** M15969 68202
Site (B2) **ITM** 515942 768222 (Map letter b) (waypoint 37)		**IG** M15973 68203
Comments Sites (B1) and (B2) both correspond to site (B) from 22 May 2003 recorded as (IG) M1595 6820. The old grid reference appears to extend only 7 m from the roadside wall in a narrow strip of flat limestone pavement without fissures, so it was apparently imprecise. The nearest potentially suitable habitat is at (IG) M15962 68208, with the finds nearby as recorded above under (B1) and (B2).		
Elevation (m) 19		
Survey dates 12 & 19 June 2023 (supplementary observations on 19 June 2023)		**Observers present** DTH
Population recorded Population at site (A) had been destroyed. At site (B1) forming small part of moss carpet in hollow 1 m in diameter; at (B2) locally quite plentiful as part of moss mat in larger depression.		
Previous records here/close by See “Details of Previous Records” below and notes under the “Grid references” above.		
Fertile? All material from 2003 and 2023 lacks capsules.		
Voucher specimen(s) Site (B1) Holyoak 23-078 (scruffy material), Site (B2) Holyoak 23-079 (comprising several small subsamples from different spots); both to be lodged at **DBN**.		
***Ex situ* cultivation material collected** Yes		
Site description/geology/slope/drainage/shading/vegetation types Site (B1) Part of moss carpet in 1 m diameter shallow hollow in surface of unshaded limestone pavement; Site (B2) Part of moss mat on thin soil in shallow stony depression in open surface of limestone pavement.		
Associated plant species Site (B1) in intricate mixture with other small mosses that were dry and mainly in poor condition; Site (B2) in close mixture with *Gymnostomum aeruginosum*, *Didymodon insulanus*, *Trichostomum crispulum*, *Cratoneuron filicinum*, sparse dry dead *Saxifraga tridactylites*, annual *Cerastium*, sterile grass stems. Similar hollows closely adjacent have *Sesleria caerulea*, *Plantago maritima*, *Antennaria dioica*, *Euphrasia* sp. and *Briza media*.		
Current land-use/grazing No sheep or cattle in this area at time of visits in June 2023, but see “Reasons for loss or decline” under Species Site 2.		
Photographs of site Representative photos from series illustrating condition of a large part of this site after destruction of its bryological interest at site (A): (5013, 5014, 5016, 5021, 5017, 5024, 5053). Photos of location, habitat and details of surviving *P.* cf. *knowltonii* at sites (B1) and (B2): (5063, 5062, 5065, 5061, 5059), just outside the area covered by animal dung.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Despite SAC protection, population at site (A) destroyed; see Species Site 2 above for detailed notes. Sites (B1) and (B2) were not directly damaged, but both are nevertheless within 7 metres of the edge of the area coated with cattle dung and 3–4 metres from scattered dried cow pats,		

so it remains to be seen if eutrophication arising from the dung close by will adversely affect them.
Site (B2) is only 2 m and 3 m from separate small prostrate bushes of *Cotoneaster*, which were broken off by DTH. These and other invasive phanerogams may pose a significant threat in future, especially if eutrophication aids their growth.

Other comments

This and other records of non-fertile *Ptychostomum* cf. *knowltonii* (noted as having "branches with concave imbricate leaves") await molecular study to confirm or refute the species identification. With only a single Irish record hitherto confirmed by capsule characters, *P. knowltonii* would appear to be a rarity in Ireland, as in Britain, meriting conservation action. However, if all the known non-fertile Irish material is confirmed as this species it would be regarded as much less rare.
See notes under Species Site 2 above regarding unsuccessful searches made on 19 June 2023 for additional habitat in surrounding areas that might be suitable for this species and for *B. gemmiparum*.

Details of Previous Records

Found at two sites during surveys for NPWS by DTH on 22 May 2003, at localities "NW of Keel Bridge, S. of Partry" with other data as follows:
Site (A) "M1595 6813 (Map letter c), with other mosses in thin damp unshaded crevice of limestone pavement, Holyoak 03-144";
Site (B) "M1595 6820 (Map letter d), unshaded very thin, damp soil of small hollow in limestone pavement, with other low mosses; Holyoak 03-158".

Reasons for loss or decline

See account under Species Site 2 above of destruction of habitat of the population at Site (A). Notes above under "Apparent threats" also consider ongoing threats to populations (B1) and (B2).

Recommended conservation measures

These are mainly dealt with under Species Site 2 above, which considers urgent need to prevent further eutrophication or other destruction of the remaining bryophyte interest at the site.
In addition, the general condition of the vegetation at sites (B1) and (B2) should be monitored for the next few years and *Cotoneaster* plants close by should be killed. Future visits by a bryologist are desirable to seek to refind *Scapania gymnostomophila*, and monitor the *P.* cf. *knowltonii* very close by at sites (B1) and (B2).

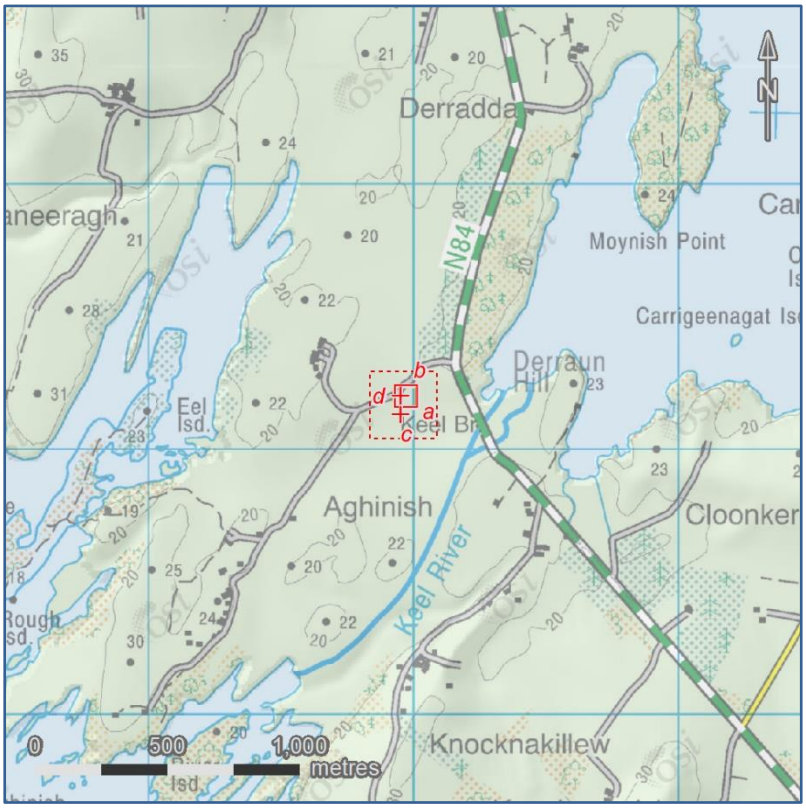

Figure 157 Species Site 41, Discovery map abstract. *Ptychostomum* cf. *knowltonii* was found at locations (a) and (b) in 2023, at (c) in 2003. Location (d) from 2003 was apparently an imprecise grid reference corresponding to location a or b.

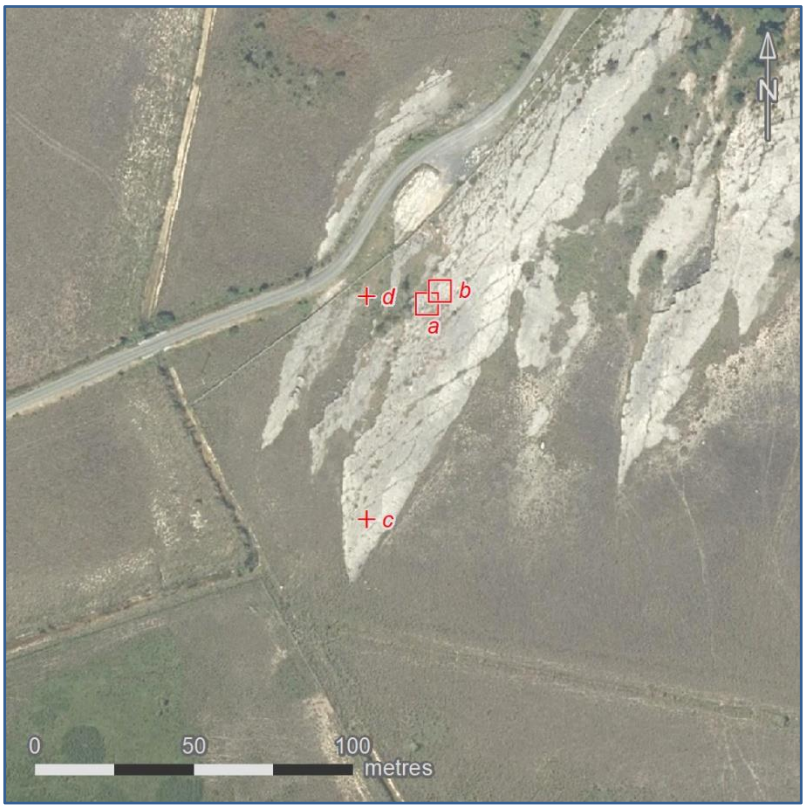

Figure 158 Species Site 41, Bluesky image abstract. *Ptychostomum* cf. *knowltonii* was found at locations (a) and (b) in 2023, at (c) in 2003. Location (d) from 2003 was apparently an imprecise grid reference corresponding to location a or b.

Figure 159 Species Site 41, photograph taken on 12 June 2023 at location (c) where *P.* cf. *knowltonii* was found along with *Bryum gemmiparum* on 22 May 2003. In 2023 this area was mainly covered with drying cattle dung and hay, with no bryophytes.

Figure 160 Species Site 41, location (a) where *Ptychostomum* cf. *knowltonii* was found on 12 June 2023, by point of knife, with orange tape attached (foreground, left of centre of image). This area was undamaged but only *c.*7 metres away from areas damaged by accumulation of cattle dung.

Species Site 42

Species *Ptychostomum knowltonii* **County** Mayo **Vice-county** H26

Locality near Brownstown, E. shore of Lough Carra **Discovery Map** 38

SAC/NHA Lough Carra/Mask Complex SAC 001774

Grid References (from hand-held GPS)

Site/Date	ITM	IG
C / 15 June 2023	519601 770835 (Map letter a) (waypoint 43)	M19632 70818
D / 15 June 2023	519603 770840 (Map letter b) (waypoint 44)	-
E / 15 June 2023	519604 770841 (Map letter c) (waypoint 45)	-
F / 15 June 2023	519604 770841 (waypoint 47)	-
G / 15 June 2023	519611 770839 (Map letter d) (waypoint 48)	-
H / 15 June 2023	519612 770839 (Map letter e) (waypoint 49)	M19644 70821
K / 16 June 2023	519555 770619 (Map letter f) (waypoint 54)	M19588 70600

Comments Locations of sites C to H are shown on the rough sketch map (photo 5956).

Elevation (m) 18

Survey dates 15 & 16 June 2023 **Observers present** DTH

Population recorded

Site C 3 patches, 18.5 x 6, 4.5 x 5 (C-shaped), 1.5 x 1 cm
Site D 3 patches, 6 x 4, 4 x 3, 5 x 2.5 cm
Site E 3 patches, 5 x 4, 3.5 x 3, 8 x 2 (but thin cover) cm
Site F 3 patches, 2 x 2, 2 x 1.5, 1 x 1 cm
Site G 1 patch, 7 x 5.5 cm
Site H 4 patches, 8 x 6, 5 x 2.5, 3 x 3, 2.5 x 2 cm
Site K 1 patch, 3 x 2.5 cm

Previous records here/close by See detailed list below

Fertile? Sporophytes seen only at site K, with 5 mature capsules (identification of this material was confirmed microscopically).

Voucher specimen(s) Site C Holyoak 23-083, Site D Holyoak 23-084, Site G Holyoak 23-085, Site H Holyoak 23-086, Site K Holyoak 23-088 (all for **DBN**). Sites with smaller populations were not sampled.

***Ex situ* cultivation material collected** Yes, from sites C, D, G, H and K (now at **DBN**; samples mainly corresponding to dried herbarium vouchers.

Site description/geology/slope/drainage/shading/vegetation types

All sites are on boulders of hard grey limestone of lower Carboniferous age, located within the inundation zone at the lake edge. All of the moss patches involved are essentially unshaded, although some do not receive direct sunlight. Photos (see below) and sketch map (photo 5956) should aid in relocation of sites. In the notes 0° = horizontal, 90° = vertical.

Site C On sloping (40–50°) NE corner of large boulder; 40 cm above water level where water 25 cm depth.
Site D On steep (60–80°) NE corner of medium-sized boulder; 30–40 cm above water level where water 10 cm depth.
Site E On N. and NE sides (at 50°, 90°) of medium-sized boulder, 20–35 cm above water level where water 5–10 cm depth.
Site F On bulge on NW side (at 45°) of large boulder, 35 cm above water level where water 12 cm depth.
Site G On sloping (20–30°) NE end of top of boulder; 20 cm above water level where water depth 10 cm.
Site H On flat (0°) to gently sloping (20°) top of boulder; 15–20 cm above water level where water depth 15 cm; bits also on steeper W. side at 60°.
Site K In small depression on marl cover on steep (55°) side of medium boulder, 35 cm above water level where water depth 3–6 cm (very close to lake edge with current low water level). Adjacent to a large boulder used as perch by gulls, but this rock not used by them.

Associated plant species

Site C *Cratoneuron filicinum* only;
Site D *Cratoneuron filicinum* below; *Cinclidotus fontinaloides* above;
Site E *Cratoneuron filicinum* (a bit); nearby young *Juncus* cf. *articulatus* (1 patch), with bit of *Cinclidotus fontinaloides* beyond it;
Site F None, but *Cinclidotus fontinaloides* close by;
Site G Two seedlings of *Juncus* cf. *articulatus*; almost associated were more *Juncus articulatus* (c.fl. on same boulder), three small seedlings of *Salix* sp. (cf. *S. cinerea*); top of same rock had more *Cratoneuron filicinum*, with *Ptychostomum pseudotriquetrum* further away;
Site H Small seedlings of *Juncus* cf. *articulatus* (few) and 1 minute *Salix* seedling; probable *Ptychostomum pseudotriquetrum* in very small amount elsewhere on same boulder;
Site K No associates. Same rock has *Cratoneuron filicinum*, *Cinclidotus fontinaloides.*

Current land-use/grazing Lake shore is not grazed here. Moorings for small boats are present near site (K); sites (C) to (H) are adjacent to a small beach (by car park) used for swimming/paddling by local people, and the official pumping station for extraction of drinking water. Signs at the car park emphasise the need to keep the lake water clean and keep animals out of it.

Photographs of site From 15 June, general views of site (5123, 5125); series of images showing location, habitat, details of plants, respectively for Site C (5148, 5145, 5144, 5140), Site D (5161, 5158, 5152, 5154), Site E (5168, 5163, 5165, 5166), Site F (5176, 5174, 5173), Site G (5189, 5186, 5185, 5183), Site H (5200, 5198, 5191).
From 16 June, showing plants with capsules, location, habitat, then detailed photos (5241, 5238, 5236, 5223, 5228).
For general comparison when lake level higher, see habitat photo from 2003 published in Holyoak (2021, *European Bryaceae*, p. 342).

Field sketch map photographed From 15 June (5956)

Apparent threats/any existing conservation measures

No obvious threats at present; no conservation management of this species here in the past. Recorded presence of seedlings of *Juncus* and *Salix* as close associates probably does not pose any threat since these plants are unlikely to prosper for long on such thin layers of substratum.

Other comments

Records of non-fertile *Ptychostomum* cf. *knowltonii* await molecular study to confirm or refute the species identification. With only two Irish records from this single site confirmed by capsule characters, *P. knowltonii* would appear to be a rarity in Ireland, as it is with modern records in Britain, meriting conservation action. However, if all the known non-fertile Irish material is confirmed as this species it would be regarded as much less rare.

Details of Previous Records

Discovered at “E. shore of Lough Carra, S. of Brownstown, E. Co. Mayo, v.c. H26” during surveys for NPWS carried out by DTH in 2003. Other data on voucher specimens recorded as follows:
“15 Oct. 2003, M1963 7083 (Map letter g), part of moss mat on unshaded dry top of limestone boulder in inundation zone of marl lake, Holyoak 03-601” (**BBSUK**, now **NMW**). Material with mature capsules, the first and hitherto the only confirmed record of the species in Ireland.
“23 May 2005, M1966 7082 (Map letter h), on unshaded thin sandy soil on limestone boulders in edge of lake, 10–30 cm above water level, Holyoak 03-170”. (Non-fertile, branches with concave imbricate leaves).
“15 Oct. 2003, M1953 7099 (Map letter i), in moss cushion on unshaded marl on top of large boulder in inundation zone at edge of marl lake, Holyoak 03-604”. (Non-fertile, young stems with concave imbricate leaves).

Reasons for loss or decline

There is no direct evidence of decline between 2003 and 2023, especially since it was recorded in seven separate locations in 2023 compared to only three in 2003. However, searching was much more sustained in 2023, partly because more time was devoted to the site as the present study was aimed only at rare Bryaceae rather than covering all bryophytes, but also because searching was much easier due to the atypically low lake level

and warm still weather resulting in a lack of waves. The impression was also gained in 2023 that the marl coverings on the boulders in the lake were less extensive, thinner, or both, and the abundance of *P.* cf. *knowltonii* perhaps lower. The single small specimens with capsules found on each survey came from different locations.

Recommended conservation measures

The populations of this species and *B. gemmiparum*, if any can be refound, should be monitored at intervals of a few years by a competent bryologist. If possible, the extent and condition of the marl on selected boulders should be recorded. It would be worthwhile using the detailed location data assembled here for checking on the persistence or non-persistence of individual patches of the plant, and frequency of colonisation of new sites.

There is much concern about effects of eutrophication of Lough Carra and Lough Mask on their rare Bryaceae, as discussed above in this *Irish Wildlife Manual*. Hence, wider boat-based surveys of this species and of *B. gemmiparum* in both lakes are desirable to ascertain the full extent of their current distribution, habitats and population sizes.

Combined molecular and morphological study of non-fertile "*P.* cf. *knowltonii*" is needed to check the species identifications as this may determine whether *P. knowltonii* is a high or lower priority for conservation in Ireland.

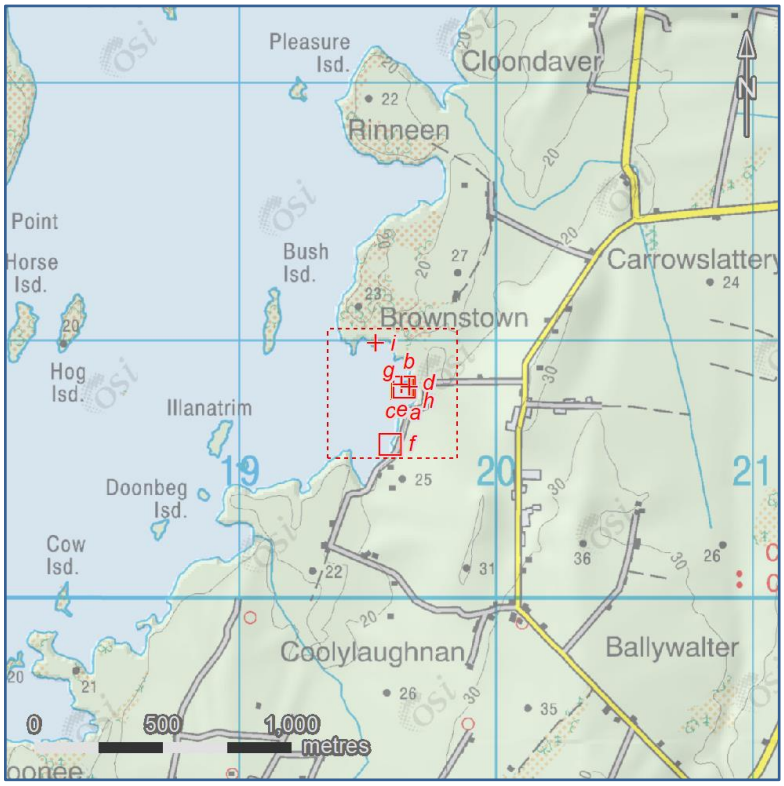

Figure 161 Species Site 42, Discovery map abstract. Confirmed *P. knowltonii* (with mature capsules) was found at location (f) in 2023, and at location (g) in 2003; *P.* cf. *knowltonii* (non-fertile) was found at locations (a–e) in 2023, at locations (h) and (i) in 2003.

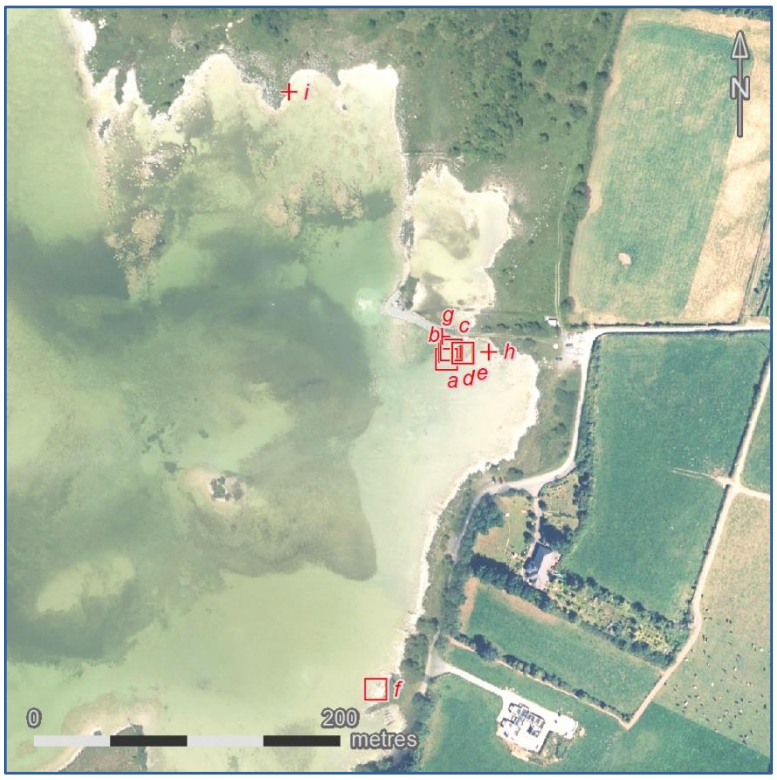

Figure 162 Species Site 42, Bluesky image abstract. Confirmed *P. knowltonii* (with mature capsules) was found at location (f) in 2023, and at location (g) in 2003; *P.* cf. *knowltonii* (non-fertile) was found at locations (a–e) in 2023, at locations (h) and (i) in 2003.

Figure 163 Species Site 42, location (f) below knife with orange tape where *Ptychostomum knowltonii* was found with capsules on 16 June 2023 (site K, voucher specimen 23-088, allowing confident species identification).

Figure 164 Species Site 42, photograph taken on 15 June 2023 showing line of boulders in lake edge from which *P.* cf. *knowltonii* was collected, extending across middle of image from left to right. Location (a) (Site C) was at the left-hand (outer) end, location (e) (site H) at the right-hand (landward) end.

Species Site 43

Species *Ptychostomum salinum*	**County** Kerry	**Vice-county** H01
Locality SW of Derrymore Island		**Discovery Map** 71
SAC/NHA not in SAC		
Grid References (from hand-held GPS) **ITM** 474261 612297 (Map letter a) (Waypoint 11) **IG** Q74283 12244; the different location found in 2005 was at Q7423 1232 (Map letter b) **Comments** Discovered here in 2005, in area that had become unsuitable by *c.*2012 (see notes under Reasons for Loss or Decline, below). Found at different locality in same field in 2023, as follows.		
Elevation (m) 2		
Survey date 3 June 2023	**Observers present** DTH	
Population recorded Identification only tentative (see below), with three patches on one hummock, 12 x 3–6 cm (with setae only), 7 x 4 cm (2 capsules) and 1 x 2 cm (2 capsules); closely adjacent hummock with single non-fertile patch 11 x 7 cm.		
Previous records here/close by Found nearby on 26 May 2005, see below.		
Fertile? Only 4 intact mature capsules, but more numerous setae lacking capsules. Microscopic study revealed that the capsules are too decayed to confirm species identification.		
Voucher specimen(s) Holyoak 23-074 (for **DBN**), not identifiable to species from morphology, but material kept in case DNA sequencing is possible.		
***Ex situ* cultivation material collected** Yes, from non-fertile patch on hummock adjacent to that providing voucher specimen.		
Site description/geology/slope/drainage/shading/vegetation types Within open field of grazing marsh that supports vegetation of saltmarsh fringe locally due to water leaking through break in coastal bank. Growing on two hummocks in shallow depression *c.*10 m long that floods intermittently with brackish water and supports rather low and sparse *Schoenoplectus tabernaemontani* (*c.*50 cm tall, growing from dried mat of fine filamentous algae). The *P. salinum* on partly bare humic clay of top and upper part of side of hummock *c.*25 cm across and 20–30 cm high. This and adjacent hummocks were doubtless produced originally by cattle poaching. A few signs of burning of some hummock tops were visible, resulting from the grazier controlling *Juncus* within the past one or two years. The hummocks are located 30 m (paced) eastwards from a conspicuous lone *Salix* bush, within a hollow supporting a *Schoenoplectus* patch. Photos of the site include one of a sketch map prepared in the field.		
Associated plant species *P. salinum* was growing in small patches, mainly without admixture of other plants. Growing closely adjacent to it were *Sagina procumbens* (partly overgrowing one patch), *Holcus lanatus* (flowering) and a few small weak *Juncus* stems. Base of the main hummock also had *Ranunculus sceleratus* and *Juncus bufonius* agg. The top of the adjacent hummock also had a tiny patch of *Funaria hygrometrica* c.fr.		
Current land-use/grazing See unpublished notes regarding ownership and the following sections below.		
Photographs of site Include representative images showing present-day vegetation around the 2005 site (4840, 4830, 4831) and the setting and details of the new site found in 2023 (4855, 4846, 4847, 4850).		
Field sketch map photographed Yes (5948)		
Apparent threats/any existing conservation measures Loss or reduction of open habitat through cessation of cattle grazing or undergrazing poses the main threat. Since the habitat of the *P. salinum* is on large hummocks produced by poaching of the wetter areas of ground by cattle, substitution of grazing by sheep would almost certainly be deleterious. Possible herbicide use to control *Juncus* could be harmful, unless carefully restricted to areas lacking soil hummocks.		

Other comments

This and the adjacent fields have been grazed for the past three years. Towards the end of the visit on 3 June 2023, the grazier arrived to erect electric fence-wire around parts of the field including the *P. salinum* localities, he then transferred *c.*20 young bullocks through the gate from the adjacent field. The lucky coincidence of DTH's visit allowed discussion with him of the high conservation importance of the flora, demonstration of the newly found *P. salinum*, and discussion of its management needs (see below). He mentioned that the owner ceased to put grazing animals in this field 10 or 11 years ago and that since then the field has remained ungrazed by domestic stock, whereas some grazing has occurred on adjacent fields. Small-scale management to benefit cattle grazing in the *P. salinum* field had been carried out in the past year or two, including burning of the tops of a few hummocks (producing the very localised habitat where *P. salinum* was refound on the visit).

Details of Previous Records

Discovered at this locality on 26 May 2005 during surveys by NPWS, new to Co. Kerry, and the second Irish record for the species. It was present then in one small area, from which voucher specimens (**NMW** ex **BBSUK**, **DBN**) have following data: SW of Derrymore Island, S. Kerry (v.c. H1), Q7423 1232, on damp part-bare clay soil on low hummocks in cattle-poached saltmarsh edge, with patchy & sparse low grasses, *c.*5 m alt, Holyoak 05-213; the specimens had mature capsules, allowing secure identification. It was not refound there on a subsequent visit by Neil Lockhart (*c.*2012), who reported that the site had become overgrown with reduced grazing pressure. The same locality was relocated by DTH on 4 June 2023 and an extensive search was made in the vicinity, resulting in the notes given in the following section.

Reasons for loss or decline

On 4 June 2023 the grid reference (IG) Q7423 1232 (Map letter b) recorded in May 2005 was relocated using a hand-held GPS and found to be reasonably accurate, lying in an area of transition from freshwater grazing marsh to saltmarsh edge, forming part of a large field immediately behind the bank dividing the main intertidal saltmarsh from fields on slightly higher ground. The 2005 locality is in part of the field with the ground now 100% shaded by a closed sward dominated by low grasses, mostly *Agrostis stolonifera*. In detail, it is at the junction of a band of young *Phragmites australis* (40–50 cm tall, giving 10–45% cover above the *Agrostis*) with shorter vegetation and scattered *Juncus* clumps (mainly *J. maritimus*, some *J. effusus*), and scattered herbs. The ground surface concealed beneath the grass mat still shows some low hummocks. However, there are no patches of open partly bare soil, or of patches dominated by bryophytes. Indeed, no bryophytes whatever could be found within 10 m of the grid reference recorded in 2005. Hence, there seems no chance of *P. salinum* surviving here, except possibly as a spore bank in the soil.

This large field was clearly left ungrazed by farm stock or almost ungrazed for about ten years up to 4 June 2023. It was noted that rabbits were plentiful along the dune ridge fringing the north-west edge of the field. They graze the adjacent relatively dry fringe of the field, but not so far as the 2005 site for *P. salinum*, which seems now to be shielded from rabbit activity by the encroaching *Phragmites.*

Recommended conservation measures

NPWS should arrange a site visit to establish contact with the grazier on this land. As noted above (under "Other comments"), he knows about this survey for NPWS and something of the presence, location and needs of *P. salinum*. Contact with him could lead to appropriate regular grazing by cattle in future, and discourage any use of herbicides to control *Juncus* in its vicinity. Occasional burning off of vegetation from large *Juncus* tussocks that he has carried out in the past might be worth encouraging in future.

Monitoring of the population size of the *P. salinum* and of the extent of suitable habitat for it should ideally occur annually in May or June. Such visits by a bryologist could allow judicious micro-management using a sharp knife to trim competing vegetation on hummock tops.

Any alteration of the drainage within the field (e.g. ditch digging or renovation) should be strongly discouraged. Supply of brackish water at high tides to maintain salinity of the *P. salinum* site is critical. Hence, repair work or "improvement" of the leaking sea bank that currently allows ingress of tidal water should be discouraged.

Figure 165 Species Site 43, Discovery map abstract. *P. salinum* was found at location (b) in 2005, *P.* cf. *salinum* was found at location (a) in 2023.

Figure 166 Species Site 43, Bluesky image abstract. *P. salinum* was found at location (b) in 2005, *P.* cf. *salinum* was found at location (a) in 2023.

Figure 167 Species Site 43, photograph taken on 4 June 2023 at location (b) where *Ptychostomum salinum* was collected on 26 May 2005. No suitable habitat for the moss was present here in 2023.

Figure 168 Species Site 43, patch of *Ptychostomum* cf. *salinum* found on 4 June 2023 from location (a). Unfortunately the few remaining capsules were too poorly preserved to allow confident distinction from *P. inclinatum*.

Figure 169 Species Site 43, location (b) where *Ptychostomum* cf. *salinum* was found on 4 June 2023, on hummock marked with pink clipboard.

Species Site 44

Species *Ptychostomum salinum*	**County** Mayo	**Vice-county** H27
Locality S. of Mallaranny		**Discovery Map** 30
SAC/NHA Not in SAC		
Grid References (from hand-held GPS) **ITM** 482421 795994 (waypoint 59)		**IG** L82446 95984
Comments Identity of voucher confirmed microscopically.		
Elevation (m) 2		
Survey date 19 June 2023	**Observers present** DTH	
Population recorded Small patches locally frequent, on at least nine low hummocks within radius of *c.*2.5 m.		
Previous records here/close by A new record (and NVCR)		
Fertile? Mainly lacking capsules, but total of 6 mature capsules and *c.*20 mature setae (having lost capsules?).		
Voucher specimen(s) Holyoak 23-090 (confirmed microscopically from good fertile specimen).		
***Ex situ* cultivation material collected** Yes (now at **DBN**)		
Site description/geology/slope/drainage/shading/vegetation types Tops of low hummocks in closely sheep-grazed pasture at extreme upper edge of saline influence from saltmarsh downslope.		
Associated plant species With very short (3–5 cm) *Festuca rubra*, *Carex demissa*, *Juncus articulatus*, *Sagina procumbens*, and few bits of *Rhytidiadelphus squarrosus* and *Lysimachia* (syn. *Glaux*) *maritima*; near *Juncus maritimus* leaves and sward of *Agrostis stolonifera*.		
Current land-use/grazing Field has signs of intensive recent grazing by sheep. Hummocks are, most likely, a relict from past poaching by cattle or possibly by horses.		
Photographs of site View from access road above the field (5383); Holyoak 23-090 was collected from high up in the closely grazed field, in the left foreground.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures No immediate threats were apparent. Cessation of grazing could lead quickly to loss of the habitat through shading as grasses grow up. Continued sustained grazing by sheep may lead to loss of the hummocks.		
Other comments A new record from typical habitat for the species, with a moderately strong population present.		
Details of Previous Records No previous records here		
Reasons for loss or decline Not applicable		
Recommended conservation measures This is the only record from Ireland that could be confirmed during the present survey. Regular monitoring of the population is desirable in future, which should also ensure that short vegetation with open patches remains on the hummocks it occupies. Small-scale scraping or trimming of vegetation may be necessary to maintain niches suitable for this species.		

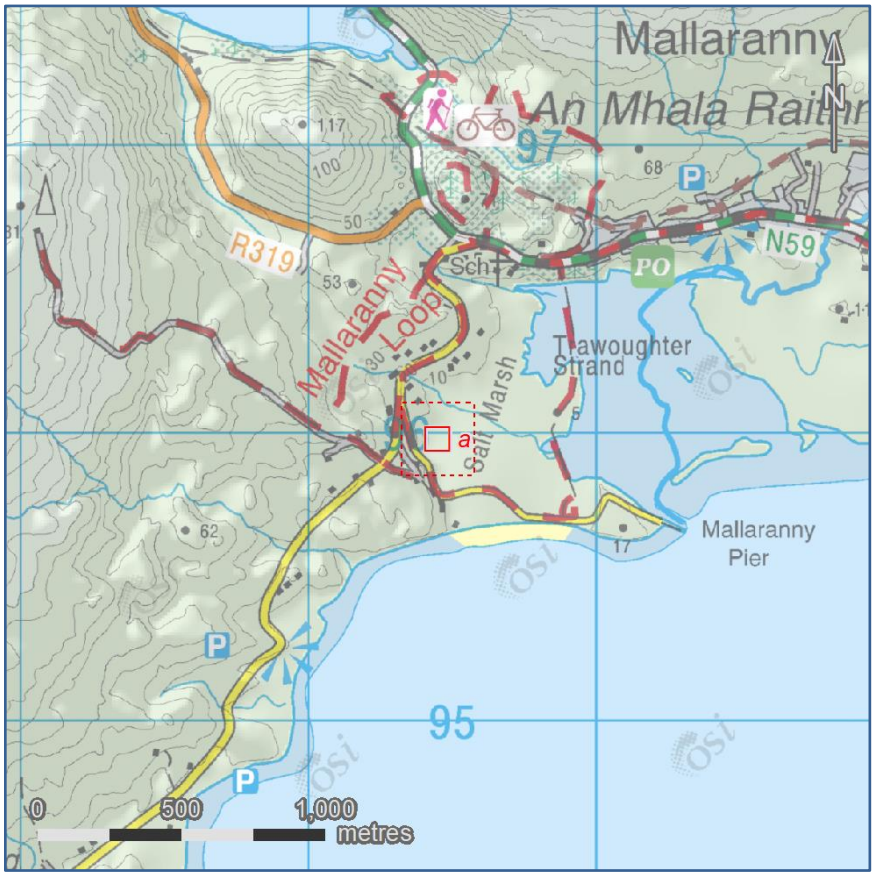

Figure 170 Species Site 44, Discovery map abstract. *P. salinum* was found at location (a) in 2023.

Figure 171 Species Site 44, Bluesky image abstract. *P. salinum* was found at location (a) in 2023.

Figure 172 Species Site 44, general view of location a where *Ptychostomum salinum* was collected on 19 June 2023, photographed from edge of road above. The exact position was at or near the extreme left-hand edge of the image, on low hummocks in very short grassland at the upper fringe of any saline influence.

Species Site 45

Species *Ptychostomum warneum*	**County** Dublin	**Vice-county** H21
Locality North Bull Island		**Discovery Map** 50
SAC/NHA North Dublin Bay SAC 000206		
Grid References (from hand-held GPS) **ITM** No data **IG** Recorded in 2007 as O22906 36364 (Map letter d) southwards to O22747 36159 (Map letter a) **Comments** None refound in 2023		
Elevation (m) 3		
Survey dates 3 & 4 September 2023	**Observers present** DTH (on 4 September also with CC, Melinda Lyons & Mairéad Stack)	
Population recorded None refound in 2023		
Previous records here/close by In 2007, see "Details of Previous Records" below		
Fertile? All records from 2007 were based on specimens collected with capsules.		
Voucher specimen(s) None, not refound in 2023		
***Ex situ* cultivation material collected** None, not refound in 2023		
Site description/geology/slope/drainage/shading/vegetation types Formerly on damp partly bare sand in several places along edges of a dune slack; see NPWS data from surveys in 2007.		
Associated plant species See "Details of Previous Records" below and NPWS data from surveys in 2007.		
Current land-use/grazing As already noted, since before 2004 the whole of the area open to the public at North Bull has had no grazing except by rabbits. In 2023 there were some signs of rabbit activity in the areas near where *P. warneum* had occurred, but these are regularly used by dog walkers with freely roaming dogs and the rabbit populations there are probably small.		
Photographs of site No		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Now extinct on North Bull.		
Other comments The sites from which *P. warneum* was recorded in 2007 (see next section for list) were all relocated on 3 September 2003 and searched thoroughly, without refinding the species: Site at O22747 36159 (Map letter a) was refound to within 5 m. There are now no areas here with "sparse" low vegetation. All sufficiently moist ground in appropriate settings had full cover of low vegetation. Sites at O2275 3616 (Map letter b) and O22761 36183 (Map letter c) were both relocated. Again, these had full ground cover of low phanerogams, which were growing over a closed carpet of bryophytes, so no sand was exposed. The area around O22906 36364 (Map letter d) was also unsuitable. Near to it (at O22908 36352; ITM 722848 736376, Waypoint 103) were six large (up to 2 x 1 m) and several smaller nearly bare patches of sand from which turf had recently been stripped. Information obtained on 4 September (per Mairéad Stack & Melinda Lyons) confirmed that these areas were stripped with a mechanical digger over the past few years to remove Sea-buckthorn *Hippophae rhamnoides*, some of them still being shaded by low regrowth or saplings of that shrub. The search of all these "bare" areas did not reveal any *P. warneum*, although patchy colonisation by *P. pseudotriquetrum* is occurring (along with e.g. *Sagina nodosa*, *Equisetum variegatum*, *Aneura pinguis*). The areas from which the turf was stripped are unfortunately still on the edge of a growing patch of Sea-buckthorn bushes, which now needs to be removed again.		
Details of Previous Records Recorded at North Bull only by observations and fruiting specimens obtained by DTH during surveys for NPWS on 14 September 2007, as follows:		

O22747 36159 (Map letter a), southernmost population, in low bryophyte mats near track edge in dune slack, with sparse low grasses, sedges and herbs;
O2275 3616 (Map letter b), voucher specimens Holyoak 07-425B & 426 (**BBSUK**, **DBN**);
O22761 36183 (Map letter c), similar habitats to preceding;
O22906 36364 (Map letter d), northernmost population, in similar habitats, Holyoak 07-427.

Reasons for loss or decline

A single rich section of this single slack on North Bull has all the present (and past) locations on the island for *P. cernuum* and *P. intermedium*, and all the recorded past locations there for *P. warneum*. This richness was probably related to input of blown sand from the dunes on its seaward (SE) side prior to 2007. This sand input has now ceased, largely because of ongoing formation of new foredunes further to the south-east that is evident from study of old air-photos. Thus the loss of all habitat there for *P. warneum* has resulted from the loss of open sand substrata that is documented above, while loss of much of that for *P. cernuum* is covered elsewhere in this *Irish Wildlife Manual*.

Recommended conservation measures

The surveys during the present study reveal that *P. warneum* has become extinct at all four of the Irish sites at which it has been recorded since 2000, demonstrating that the "Endangered" status in Lockhart *et al.* (2012: 471–473) underestimated its vulnerability. This pattern parallels its loss somewhat earlier from several English sites, where it also disappeared as the supply of fresh blown sand declined and the open habitat on moist sand disappeared due to vegetation succession.

P. warneum has very large spores and these are possibly persistent in a "spore bank" at its historic sites, although no detailed information is available on their longevity. There is also an urgent and widely acknowledged need to remove Sea-buckthorn at North Bull: this is a high priority in the slack with the surviving population of *P. cernuum*; removing it will necessitate considerable disturbance to the vegetation. If well managed to avoid damaging existing populations and to expose potential new Bryaceae habitats, the same turf-stripping, surface scarification and disturbance could provide new habitat for all three rare Bryaceae and potentially liberate dormant spores of *P. warneum*.

The benefit of this could also be enhanced and prolonged if disturbance of the dune vegetation on the seaward fringes of the slack was carried out on a sufficient scale to refresh and maintain the supply of blown sand reaching the open wet ground on the sides of the slack. One possibility could be to excavate a new "foredune slack" parallel to the existing slack but further to the south-east. To be effective, this would need to be extensive and deep enough to intercept the seasonally high water table, but not so deep as to form a pool.

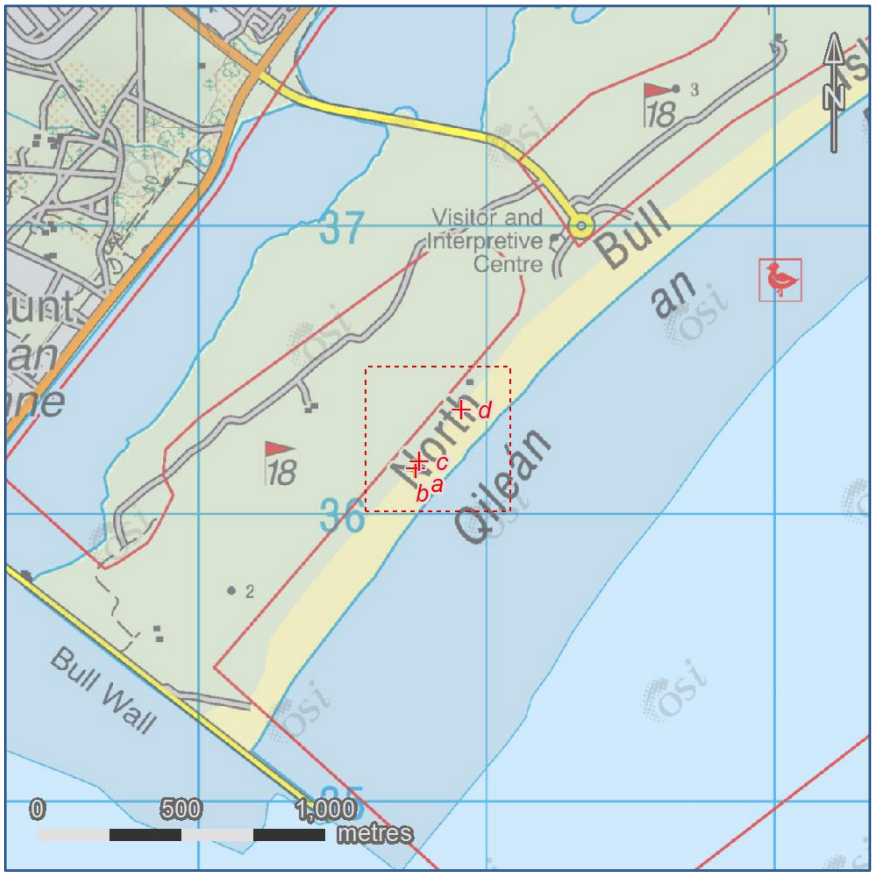

Figure 173 Species Site 45, Discovery map abstract. *P. warneum* was found at locations (a–d) in 2007.

Figure 174 Species Site 45, Bluesky image abstract. *P. warneum* was found at locations (a–d) in 2007.

Species Site 46

Species *Ptychostomum warneum*	**County** Mayo	**Vice-county** H27
Locality SW of Garter Hill		**Discovery Map** 22
SAC/NHA Glenamoy Bog Complex SAC 000500		
Grid References (from hand-held GPS) **ITM** 480599 840648 (waypoint 080)		**IG** F80622 40646
Comments The IG reference was recorded as F8069 4065 (Map letter a) in 2003. Part of the site was precisely relocated in 2023, allowing new grid references to be recorded that are given above.		
Elevation (m) 3–4		
Survey date 25 June 2023	**Observers present** DTH (with E. Holyoak)	
Population recorded None		
Previous records here/close by Discovered in 2003 but not reported subsequently.		
Fertile? Species not refound; capsules were present in 2003.		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types Unshaded area of damp sand close to “estuary” of small stream, just inland of boulder beach, in area of machair.		
Associated plant species See NPWS website for FPO bryophytes for data on associated plants recorded in 2003, most of which had gone from the site in 2023.		
Current land-use/grazing Whole area intensively grazed by sheep, including the site where *P. warneum* occurred in 2003.		
Photographs of site Images showing location of former site for *P. warneum* and present condition of the vegetation (5531, 5529, 5535, 5534).		
Field sketch map photographed No		
Apparent threats/any existing conservation measures Not refound and little doubt population has gone from this site, see below.		
Other comments On 25 June 2023 the whole of the area of possible habitat remaining was subjected to a “hands and knees” search, without any success in refinding the species. Hence there can be no doubt that no fertile plants were present and little doubt that substantial patches lacking capsules were absent. The very small open sandy areas with short vegetation supported small amounts of *Ptychostomum pseudotriquetrum*, while higher ground on its seaward side had a few small patches of *P. compactum* (synonym *B. algovicum*) with capsules. There was much less “unshaded damp sand with sparse low vegetation” than in 2003, with total of only *c.*3 m^2 remaining, compared to tens of square metres occupied by *P. warneum* in 2003. This small area remaining with loose sand shows little evidence of any saline influence, the only halophyte present being a small patch of *Lysimachia maritima* (syn. *Glaux maritima*). The decrease in open sandy habitat at the site appears to have resulted from a natural change in sedimentation processes over the past 20 years, with the boulder beach becoming higher where it blocks the stream estuary, causing more frequent flooding with fresh water from the stream, and perhaps also reducing the supply of sand from the beach.		
Details of Previous Records Discovered here in 2003 during surveys carried out for NPWS by DTH. Data on the voucher specimens (**BBSUK** now **NMW**; **DBN**) record: “30 Sept. 2003, SW of Garter Hill, W. Mayo, v.c. H27, F8069 4065 (Map letter a), on unshaded damp sand with sparse low vegetation, near stream-course and close to head of beach, Holyoak 03-501 & 502”. The plants had capsules and grew scattered over tens of square metres, individual patches mainly being 2–4 cm across, the largest 8 x 6 cm.		
Reasons for loss or decline Population probably lost due to change in natural sedimentation processes: see “Other comments” above.		
Recommended conservation measures None proposed.		

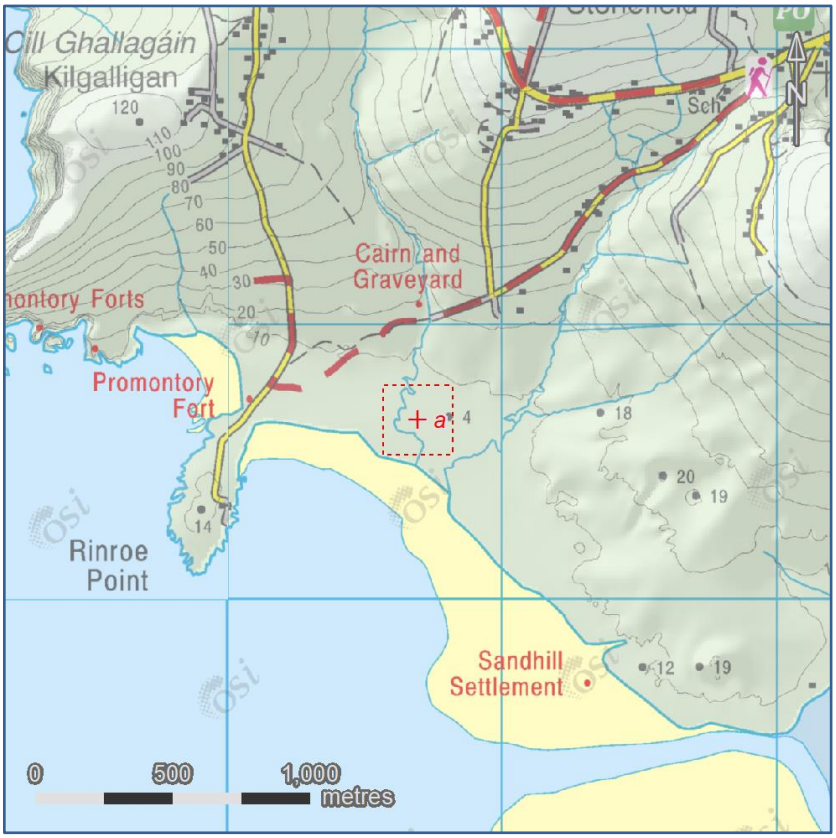

Figure 175 Species Site 46, Discovery map abstract. *P. warneum* was found at location (a) in 2003. Note that the position of the small streams and their estuaries near this location differed widely in 2003 and 2023 and also on the Discovery map and Bluesky image.

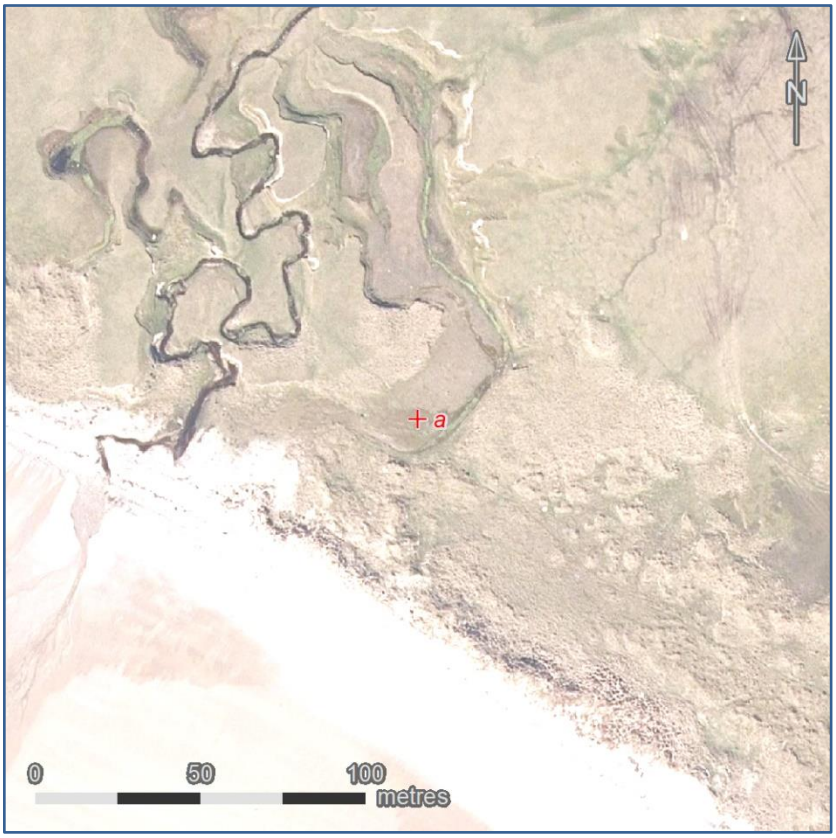

Figure 176 Species Site 46, Bluesky image abstract. *P. warneum* was found at location (a) in 2003. Note that the position of the small streams and their estuaries near this location differed widely in 2003 and 2023 and also on the Discovery map and Bluesky image.

Figure 177 Species Site 46, photograph taken on 25 June 2023 showing possible habitat for *Ptychostomum warneum* (near pink clipboard) adjacent to the area where it was found on 30 September 2023.

Figure 178 Species Site 46, detail of possible habitat for *Ptychostomum warneum* (near knife with orange tape) photographed on 25 June 2023. The small area with exposed damp sand was closely searched but the species was not refound.

Species Site 47

Species *Ptychostomum warneum*	**County** Donegal	**Vice-county** H34
Locality N. of Fahan		**Discovery Map** 2
SAC/NHA Lough Swilly SAC 002287		
Grid References (from hand-held GPS) **ITM** No data **IG** (a) C3323 2780 (Map letter a), (b) C3324 2782 (Map letter b), (c) C3334 2805 (Map letter c) **Comments** Not refound in 2023 when no suitable habitat remained and species was doubtless extinct here. The IG grid references are from the visit in 2002.		
Elevation (m) 2–3		
Survey date 9 September 2023	**Observers present** DTH	
Population recorded None, no longer present here		
Previous records here/close by Discovered here in three places in 2002, see "Details of Previous Records" below.		
Fertile? Records from 2002 were all of plants c.fr., with ripe or nearly ripe spores.		
Voucher specimen(s) None, no longer present here		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types For brief descriptions from 2002 see "Details of Previous Records" below. For more details of the sites from 2002 see PDF attached to NPWS website for FPO bryophytes.		
Associated plant species For details of associated plants in 2002 see PDF attached to NPWS website for FPO bryophytes.		
Current land-use/grazing Whole area has been ungrazed by domestic stock for at least 20 years. In 2023 there was no sign of rabbit grazing in the moist areas visited.		
Photographs of site Three images ("*Bryum warneum* 022, 029, 063") from 7 August 2002 show habitat of specimens collected at locations (a) and (b). For additional photos from the same day see PDF attached to NPWS website for FPO bryophytes. Images from 9 September 2023 show current condition of the vegetation at location (a) IMG 6396–6403; (b) IMG 6405–6410; (c) IMG 6411–6417.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures No suitable habitat remains in 2023, so species is doubtless extinct here.		
Other comments In 2002 the road through the Lisfarnon Beach car park continued southwards as a heavily used track. Erosion in the dune slack beside this track and into adjoining sand dune edges provided the open partly-bare sand habitat required by *P. warneum*. By 2023 the exit for vehicles southwards out of the car park was securely blocked off with a row of boulders and strong wooden stakes. According to local men who walk their dogs here, this vehicle access to the dunes was first closed off many years ago. The size of alder saplings along the former track suggests it fell into disuse by vehicles more than ten years ago, more likely fifteen years ago. The open habitats with loose sand present in 2002 are almost unrecognisable now. The dune slack has tall grass/sedge/herb vegetation, with an alder grove developing. The former location (a) at C3323 2780, is still damp, but now with 100% vegetation cover, of *Potentilla anserina* and *Agrostis stolonifera*, and a moss carpet beneath them of *Calliergonella cuspidata*. Former location (b) at C3324 2782 now has a shallow pool with *Schoenoplectus tabernaemontani* and a single bush of *Salix cinerea* located where there was formerly a track. The bank beside the pool has 30–40 cm high *Carex arenaria*, *Potentilla anserina*, *Vicia cracca*, *Filipendula ulmaria*, *Festuca rubra* and *Poa pratensis* agg. The former location (c) at C3334 2805 in 2002 was "close to pool edge" with "partly bare damp sand among sparse grasses". There is now no trace of open sand here, instead a closed vegetation cover exists: *Schoenoplectus tabernaemontani* in the wettest areas, grading through a community dominated by *Agrostis stolonifera*, to an admixture of *A.*		

stolonifera with *Potentilla anserina* and *Carex arenaria* on dried places. *Salix cinerea* bushes fringe the N. edge of the former pool area, closed cover of *Alnus glutinosa* saplings has overwhelmed the eastern (roadside) edge.

Details of Previous Records

Discovered here by DTH in 2002, during surveys for NPWS. Data recorded with the voucher specimens all collected on 7 August 2022, N. of Fahan, H34, and c.fr., was: "(a) C3323 2780 (Map letter a), damp muddy sand at base of sparse *Carex arenaria* and *Agrostis stolonifera* in edge of dune slack, Holyoak 02-774; (b) C3324 2782 (Map letter b), damp muddy sand at base of sparse *Agrostis stolonifera* and *Eleocharis palustris* in edge of dune slack, Holyoak 02-769 & 770; (c) C3334 2805 (Map letter c), partly bare damp sand among sparse grasses close to edge of pool on coast, Holyoak 02-763, 765 & 766".

Reasons for loss or decline

Locally extinct due to development of taller vegetation, now forming closed communities, entirely replacing areas of open sand in damp dune slack areas. The change resulted partly from cessation of grazing (sites a, b, and c) and prevention of erosion of sand through exclusion of off-road driving (sites a and b).

Recommended conservation measures

None: no suitable habitat remains here. The measures needed to "rehabilitate" the site for *P. warneum* would be difficult to implement here, at edges of a busy car park used for beach access and by numerous local residents for walking their dogs.

Figure 179 Species Site 47, Discovery map abstract. *P. warneum* was found at locations (a–c) in 2003.

Figure 180 Species Site 47, Bluesky image abstract. *P. warneum* was found at locations (a–c) in 2003.

Figure 181 Species Site 47, habitat where *Ptychostomum warneum* was found on 7 August 2002, growing at location (a) “on damp sand at edge of dune slack, at base of open cover of *Agrostis stolonifera* – left of trackway” (i.e. near the end of the puddle, in foreground on left-hand side of the image).

Figure 182 Species Site 47, photograph taken on 9 September 2023 close to the location (b) for *Ptychostomum warneum* recorded on 7 August 2002, now completely shaded by tall vegetation.

Figure 183 Species Site 47, photograph taken on 9 September 2023 close to the location (c) for *Ptychostomum warneum* recorded on 7 August 2002, now completely shaded by tall vegetation.

Species Site 48

Species *Ptychostomum warneum*	**County** Donegal	**Vice-county** H35
Locality Magheramore (inland of Trawmore Strand)		**Discovery Map** 10
SAC/NHA West of Ardara/Maas Road SAC 000197		
Grid References (from hand-held GPS) **ITM** 568000 895539 (Map letter a) (Waypoint 168) **IG** G68042 95552 **Comments** New record at this location, confirmed from small voucher specimen with good mature capsules and spores.		
Elevation (m) 1		
Survey date 28 September 2023	**Observers present** DTH, CC & N. Lockhart	
Population recorded A few scattered plants within a single area of less than 1 square metre; 1 immature capsule in similar spot *c.*20 m further south.		
Previous records here/close by None		
Fertile? Tiny population mainly detected from presence of capsules (2 immature, green; 1 ripening; 4 mature, dehisced, dark brown).		
Voucher specimen(s) Holyoak 23-153 (for **DBN**)		
***Ex situ* cultivation material collected** Single ripening capsule collected for work at **DBN**.		
Site description/geology/slope/drainage/shading/vegetation types On damp, humic sand with short open vegetation in western edge of dune slack, close to a very small "blow-out" area liberating sand at the adjacent edge of the dunes.		
Associated plant species With *Moerckia flotoviana*, *Petalophyllum ralfsii*, *Aneura pinguis* agg., low mosses including *Ptychostomum pseudotriquetrum*, and sparse *Linum catharticum* and *Agrostis stolonifera*; near *Parnassia palustris*, *Sagina nodosa*, etc.		
Current land-use/grazing We did not see any grazing animals or signs of their activity on this large unfenced area of dune slack and sand dunes.		
Photographs of site None (because of heavy rain during visit to site)		
Field sketch map photographed No		
Apparent threats/any existing conservation measures The tiny population found is at immediate risk of being excluded by competing bryophytes. Fewer than 10 stems were seen, detected from sporophytes, with their leafy gametophytes mostly concealed already beneath vigorous growth of *Moerckia* and *Aneura*. Other open habitat needed by *P. warneum* was almost lacking in the vicinity.		
Other comments Study of Google Earth Pro images shows that the large dune slack here was totally absent in 1985, whereas it had achieved its present extent by March 2009 when extensive dune ridges had accumulated to the west of the slack; no images from this source were available for intervening years. The dunes bounding the western side of the slack appear to have had thinner cover of *Ammophila* in September 2019 than in February 2021. By the time of our visit, the eastern and central parts of these dunes had almost completely closed cover of *Ammophila* grassland. They lacked significant "blow-outs", so there was now no supply of loose sand blowing into the slack. They also lack any moist hollows among the dunes, and the tall grassland doubtless acts as a wide barrier to ingress of sand from the beach and foredunes further to the west. This hitherto unknown population of *P. warneum* was found on an exploratory visit to the site. Widespread initial searching in the northern part of the extensive dune slack here failed to reveal any rare Bryaceae, although *P. pseudotriquetrum* was locally abundant and often c.fr., and smaller patches of *P. pallens* were present. It soon became clear that *P. warneum* would not be found there, since most of the slack lacked open habitats with fresh loose sand. Instead, the extensive areas with short vegetation had an almost closed cover of bryophytes on a humic surface layer, including much *Moerckia flotoviana*, *Aneura pinguis* agg., sparser *Petalophyllum ralfsii* and *Marchantia quadrata*, acrocarpous mosses including *Didymodon* and *Hymenostylium recurvirostrum*, *Nostoc*, and an attractive phanerogam flora with plentiful *Parnassia palustris*, *Sagina nodosa*, etc. Much of the slack is currently being invaded by seedlings and small saplings of *Salix cinerea*, with some low patches of *Alnus glutinosa* also		

established. Thus, development of scrub, becoming groves of small trees can be envisaged through the next decade if there is no intervention to stop the natural vegetation succession. Since the dune ridges to the west lacked any other damp hollows or slacks, a more focussed search was made for parts of the main slack likely to have received some recent input of blown sand. This successful search was concentrated on small areas around G680955, where very small "blow-out" areas were present at the edge of the dunes. Observations there were hindered by steady rain that was heavy at times, but the small extent of the population was established.

Details of Previous Records

No previous records

Reasons for loss or decline

Lack of previous records here prevents any detailed analysis. Nevertheless, it seems clear that the *P. warneum* population remaining here is declining due to competition with other bryophytes as open blown-sand habitat is lost (see above).

Recommended conservation measures

The present survey has confirmed the local extinction of *P. warneum* at all four of the other sites in Ireland with modern records, due essentially to loss of the damp open sand habitat. The tiny "new" population here will also be lost very soon unless more open sand habitat is created deliberately, and then maintained year by year. At present, a few hours of judiciously located work with a shovel could create more habitat, (a) by scraping closely adjacent bits of slack edge (within 5–10 m) clear of all other vegetation, and (b) by enlarging the small "blow-out" at the adjacent edge of the dunes. On a longer timescale, mechanical scraping of larger areas should be combined with removal of *Salix* and *Alnus* saplings, at locations guided by close monitoring of the population of *P. warneum*.

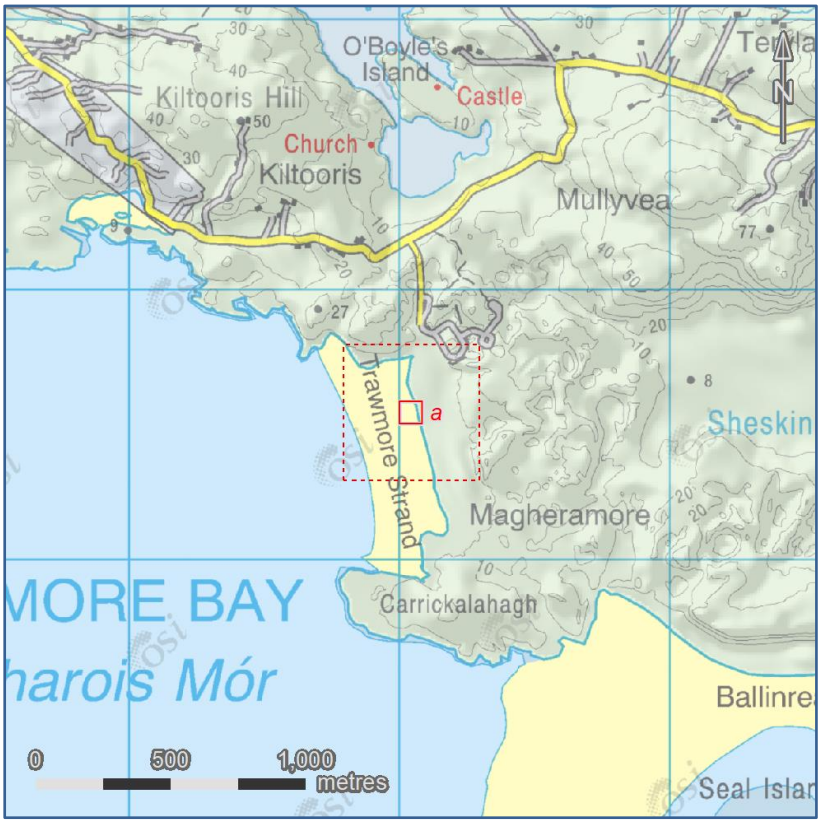

Figure 184 Species Site 48, Discovery map abstract. *P. warneum* was found at location (a) in 2023.

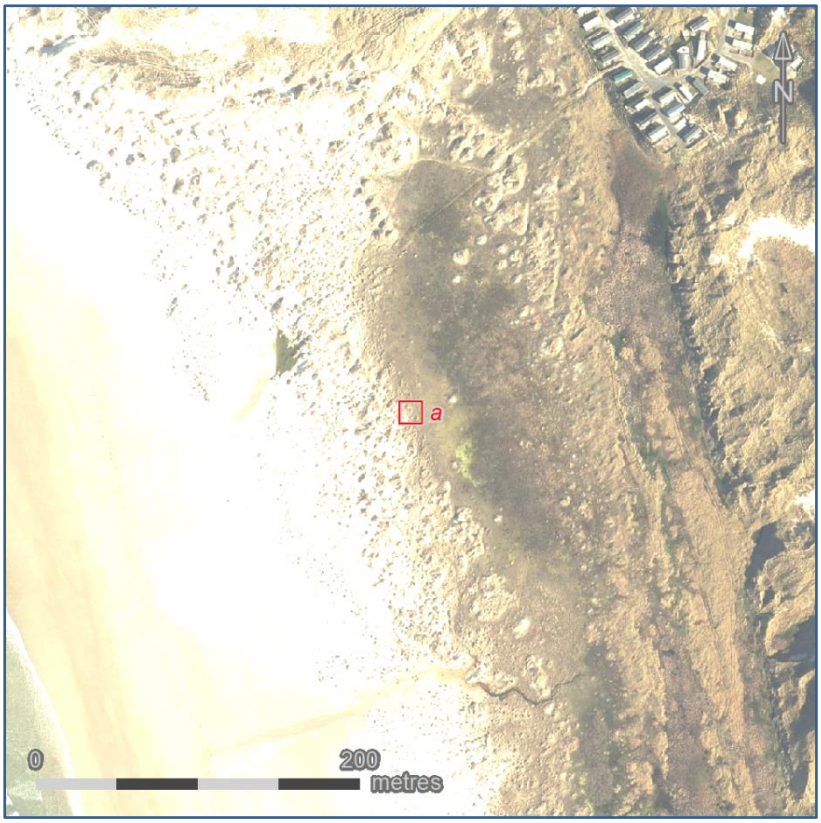

Figure 185 Species Site 48, Bluesky image abstract. *P. warneum* was found at location (a) in 2023. Note that the sand dunes to the west had much less vegetation of *Ammophila arenaria* when this image was acquired compared to the situation in 2023.

Species Site 49

Species *Ptychostomum warneum*	**County** Donegal	**Vice-county** H35
Locality Catherine's Isle		**Discovery Map** 2
SAC/NHA Not in SAC		
Grid References (from hand-held GPS) **ITM** not recorded in 2002, but approximately 602790 937647 (waypoint 154) **IG** C0280 3766 (Map letter a) **Comments** The Irish Grid reference is that recorded in 2002; species now extinct at this site.		
Elevation (m) 3		
Survey date 19 September 2023	**Observers present** DTH	
Population recorded None; now extinct at this site.		
Previous records here/close by Recorded in 2002; see "Details of Previous Records" below.		
Fertile? Plants recorded in 2002 had capsules.		
Voucher specimen(s) None		
***Ex situ* cultivation material collected** No		
Site description/geology/slope/drainage/shading/vegetation types In 2002, found on "partly bare damp sand at base of patchy low herbs, grasses and sedges on disturbed ground (near car park) at edge of dune slack".		
Associated plant species For detailed data from 2002 see PDF attached to NPWS website for FPO Bryophyte species.		
Current land-use/grazing The only grazing now is by rabbits and that occurs mainly on the dunes. The area is heavily used for walking dogs, as judged by observations and extensive occurrence of dog dung, and this probably limits rabbit grazing close to the car park. Lack of any fences and proximity to the golf course edge also imply the site has been ungrazed by domestic stock for years.		
Photographs of site IMG 6594–6607 show current condition of site and of vegetation in vicinity. See PDF attached to NPWS website for FPO Bryophyte species for two photos from 2002.		
Field sketch map photographed No		
Apparent threats/any existing conservation measures *P. warneum* is extinct at the site. See "Other comments" below.		
Other comments The NPWS survey on 21 August 2002 noted: "Survival of species here will depend on constant recreation of open damp sandy habitats allowing early stages of dune slack succession. Stability and lack of sand input will allow vegetation succession and shade-out the *B. warneum*". "Excessive trampling and disturbance will also be deleterious. Best part of present site is very close to edge of car park and close behind two chemical loos". By 2023 the chemical toilets had been moved to the SE corner of the car park, and the car park area had received a new tarmac surface. *P. warneum* could not be refound at the original site, or within several hundred metres of it, and a general lack of suitable habitat was noted. The "partly bare damp sand … on disturbed ground (near car park)" has gone, except for a small area that is too dry and much too disturbed for *P. warneum*. It has mainly been replaced by grassland of *Festuca rubra*, with *Ammophila arenaria* and various herbs, giving dense, continuous cover. Several hours of wider searches in the vicinity were unsuccessful. The original site is bordered on the landward (southern) side by a large golf course. The dune ridges are now covered with tall *Ammophila arenaria*, with very few "blow-outs" on the landward side. A slack behind the dunes at C029376 still supports interesting short vegetation, with damp mossy turf including plenty of *Dactylorhiza* and *Parnassia*, but it has closed ground-cover unsuited to *P. warneum*, even on the trampled central pathway. The edge of the slack had been used recently for a large dump of grass cuttings tipped from the edge of the golf course. An open area near the slack on golf-course land (C030376) has completely bare sand, bull-dozed to make a vehicle parking place, but this area is too dry for *P. warneum*.		

Details of Previous Records Recorded here by DTH during survey for NPWS in 2002. The voucher specimen had the following data: “21 Aug. 2002, Catherine’s Isle (ENE of Dunfanaghy), H35, C0280 3766 (Map letter a), partly bare damp sand at base of patchy low herbs, grasses and sedges on disturbed ground (near car park) at edge of dune slack, Holyoak 02-859 & 860, c.fr.; scattered over 6 x 1 m strip”. Fuller details of observations made then are available online in the PDF attached to NPWS website for FPO Bryophyte species.
Reasons for loss or decline Population locally extinct due to loss of open damp sandy habitats allowing early stages of dune slack succession. The main cause of this loss was apparently cessation of grazing by domestic stock in the dunes and slacks. Rabbit grazing has probably remained ineffective due to extensive use of the car park area for walking dogs.
Recommended conservation measures None: population extinct at this site and the intensive recreational use of the site would impede efforts to rehabilitate open habitat.

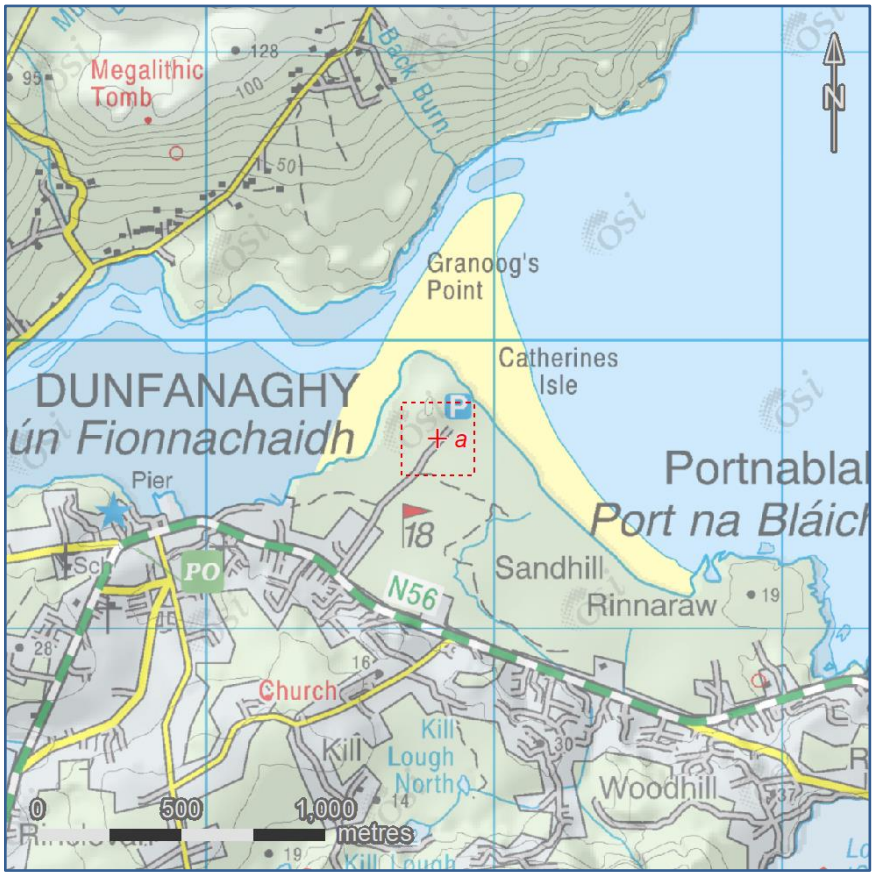

Figure 186 Species Site 49, Discovery map abstract. *P. warneum* was found at location (a) in 2002.

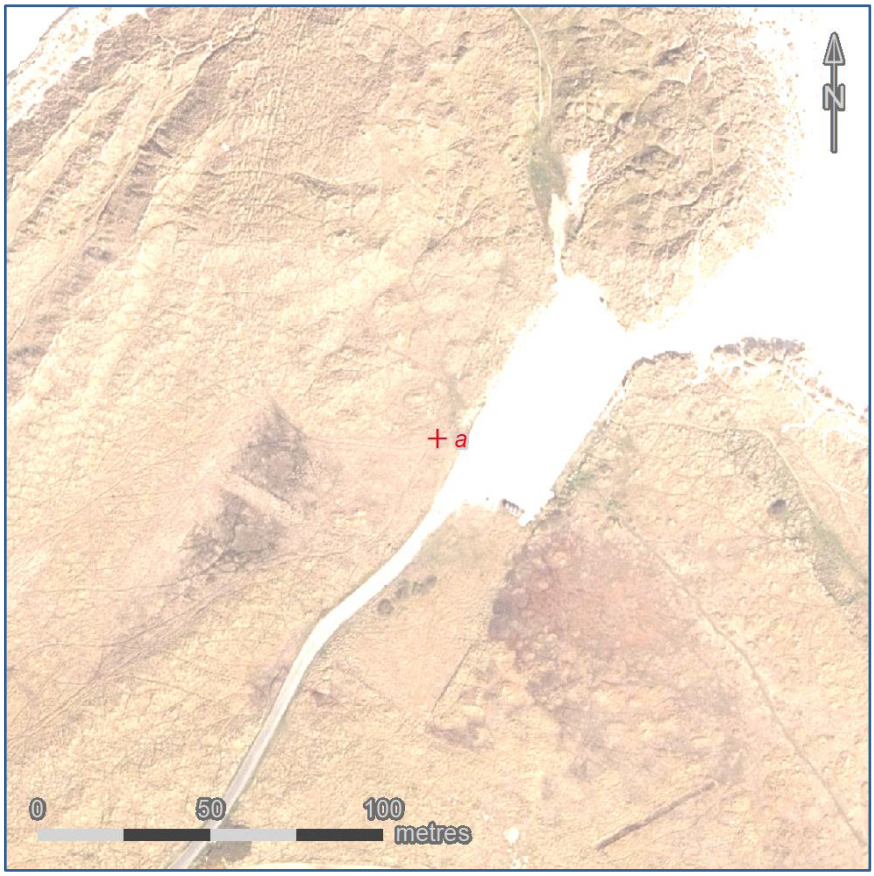

Figure 187 Species Site 49, Bluesky image abstract. *P. warneum* was found at location (a) in 2002.

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