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Monitoring methods for the threatened Killarney Fern (*Trichomanes speciosum* Willd.) in Ireland

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Monitoring methods for the threatened Killarney Fern (*Trichomanes speciosum* Willd.) in Ireland

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Cover photo: Unfurling *T. speciosum* frond, National Botanic Gardens, Glasnevin © Emer Ní Dhúill

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Executive Summary

Trichomanes speciosum Willd. is categorised as rare and vulnerable in Ireland and is listed under Annex II and IV of the EU Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). *T. speciosum*, commonly known as the Killarney Fern or Bristle Fern, belongs to the Filmy Fern family (Hymenophyllaceae) and is the only European representative of the genus *Trichomanes*. *T. speciosum* is most abundant in the Azores, outside of which it is most frequently found in Ireland and Britain.

T. speciosum differs from 'typical' ferns in that both generations can live independently of each other by reproducing vegetatively, the gametophyte by means of gemmae, which are asexual propagules and the sporophyte by means of rhizome spread. The ability of the gametophyte generation to live independently and reproduce by means of gemmae is considered rare in homosporous ferns and is considered unique among European ferns. Whilst the sporophyte has been known from Ireland since 1804, the gametophyte was first recorded in the wild in Ireland as recently as 1992. The rare occurrence of sporophytic recruitment in conjunction with the persistence of both generations often occurring independently has led to the conclusion that there has been a breakdown in the link in the life cycle between the sporophyte and gametophyte generations of *T. speciosum*.

In Ireland, when the sporophyte and gametophyte generations occur together they occupy similar habitats in dripping caves, cliffs, crevices and gullies by waterfalls, crevices in woodland, and occasionally on the floor of damp woodland - all deeply shaded humid habitats. Sporophyte colonies, however, are more restricted in their distribution in Ireland than gametophyte colonies. The differences in the distribution patterns of the two generations of the species may be, in part, due to over-collecting of sporophytes during the 'Victorian Fern Craze', at its height in the 1850s-1890s, which would have greatly impacted the known populations. Loss of habitat suitable for the sporophyte has also affected its distribution in Ireland. Gametophyte colonies have been found in drier habitats than sporophytes, and can grow in very dark microhabitats where there is little competition from other species. However, niches that the gametophyte can occupy are not always suitable for the growth of sporophytes even though humidity remains high, i.e. shallow crevices in otherwise open habitats that provide adequate shade and humidity for gametophytes, but not for the larger sporophytes.

A field survey of 27 of the 64 known *T. speciosum* populations was undertaken in 2009 – 2011 to record information on population structure, associated vegetation and environmental variables. Using multivariate analysis, that study found no associated species that would be indicative of the presence

of either generation at these populations. The difficulty in classifying the habitats of this species was a reflection of the variety of locations where it occurred. Relative humidity and temperature were relatively uniform throughout study sites, regardless of habitat type. Constant high levels of relative humidity, typically above 90%, were recorded at populations visited. There are a number of factors that may explain the absence of this species from seemingly ideal habitats, such as a lack of suitable substrate, inadequate shading and inadequate relative humidity levels.

Fertile colonies were found in 57% of populations, which was much higher than reported in previous studies. Populations that supported fertile sporophytes, juvenile sporophytes emerging from gametophytes and gametangia were considered to be good indicators of colony health as it provided an indication that historic or recent sexual reproduction may have occurred. Sexual reproduction was considered to be occurring on a limited basis at a number of Irish populations.

Based on the analysis of the ecological data, indicators and associated targets were derived to assess the condition of each population and detailed monitoring methods were developed.

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We wish to thank Dr Fred Rumsey of the Natural History Museum, London for his advice and support during the project period. We are grateful to Dr James Merryweather who kindly gave permission to use his microscope images of gametophytes to aid identification in the field of this cryptic phase in the life cycle of Killarney Fern.

There are a number of people to thank for assistance during field work, in particular Dr Caroline Neinhuis, Niamh Ní Dhúill, Dr Peter Wyse Jackson, Dr Christina Campbell, Dr Evelyn Gallagher, Dr Dara Stanley, Hamish Miller, Kate Mangan, Brónagh Mhic Eochaidh, Treabhor Mac Eochaidh, Nuala Uí Dhúill, Diarmuid Colgan, Jane Maher and Muireann Ní Dhúill.

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Introduction

Description of *T. speciosum*

Trichomanes speciosum is commonly known as the Killarney Fern or the Bristle Fern. Other synonyms for this species are: *Trichomanes radicans auct. non* Sw., *Trichomanes andrewsii*, Newman, *Trichomanes radicans* var. *andrewsii* (Newman) H.C. Watson & Dennes, *Hymenophyllum alatum* Sm., *Trichomanes alatum* (Sm.) Hook., *Trichomanes brevisetum* R. Br., *Trichomanes europaeum* Sm., *Trichomanes hibernicum* Spreng., *Trichomanes pyxidiferum sensu* Huds., *non* L., *Vandenboschia speciosa* (Willd.) Kunkel.

T. speciosum differs from 'typical' ferns in that both generations can live independently of each other by reproducing vegetatively, the gametophyte by means of gemmae, which are asexual propagules (Vogel *et al*., 1993; Sheffield, 1994; Rumsey *et al*., 1999) and the sporophyte by means of rhizome spread (Rumsey *et al.,* 1999). Such perennial growth in gametophytes has been reported in Vittariaceae, Grammitidaceae and Hymenophyllaceae, which are all predominantly tropical families (Farrar, 1967; Raine *et al.,* 1991).

T. speciosum sporophyte

The perennial *T. speciosum* sporophyte is a medium to small fern with translucent membranous fronds that are light green when young and a deep-dark green when they mature. Images of *T. speciosum* fronds are shown in Figure 1.1. Fronds often hang from vertical rock surfaces but are also known to occur on damp woodland floors. Frond length is reported to range from 20 - 45 cm (Page, 1997). In the study of 27 Irish populations between 2009 and 2011, frond lengths typically fell within that range, although the longest mature frond measured was 55 cm (Ní Dhúill, 2014). The fronds are ovate to ovate-lanceolate in outline with a stipe that typically occupies 1/3 of the total frond length (Page, 1997). The proportion of stipe to total frond length often fell within this range at the 27 Irish populations monitored between 2009 and 2011, but in some cases the stipes were found to occupy between 40% to 60% of the total mature frond length (Ní Dhúill, *unpublished data*). The fronds are finely dissected with acutely tapering pinnae and a very thin lamina which extends down the pale green rigid stipe forming a wing on either side (Page, 1997). This winged stipe is a characteristic feature of the sporophyte (Figure 1.1 (G)).

Fertile fronds have sporangia that develop within small urn-shaped receptacles that typically occur on the upper edge of each pinna (Page, 1997). The sporangia are attached to a hair-like bristle within these receptacles (Page, 1997). The spore-bearing bristle-like receptacle is a characteristic feature of the genus *Trichomanes* (Figure 1.1 (D - E)).

The rhizome of *T. speciosum* is covered in characteristic dark hair-like scales (Page, 1997; Rumsey, 1997; Parnell & Curtis, 2012). The fronds arise singly from a creeping rhizome which can spread to form a branching rhizome network that can cover considerable areas in colonies that are undisturbed (Page, 1997). Sporophytes are easily identified in the field by a combination of the characteristic features mentioned above (see Figure 1.1 (A-G)).

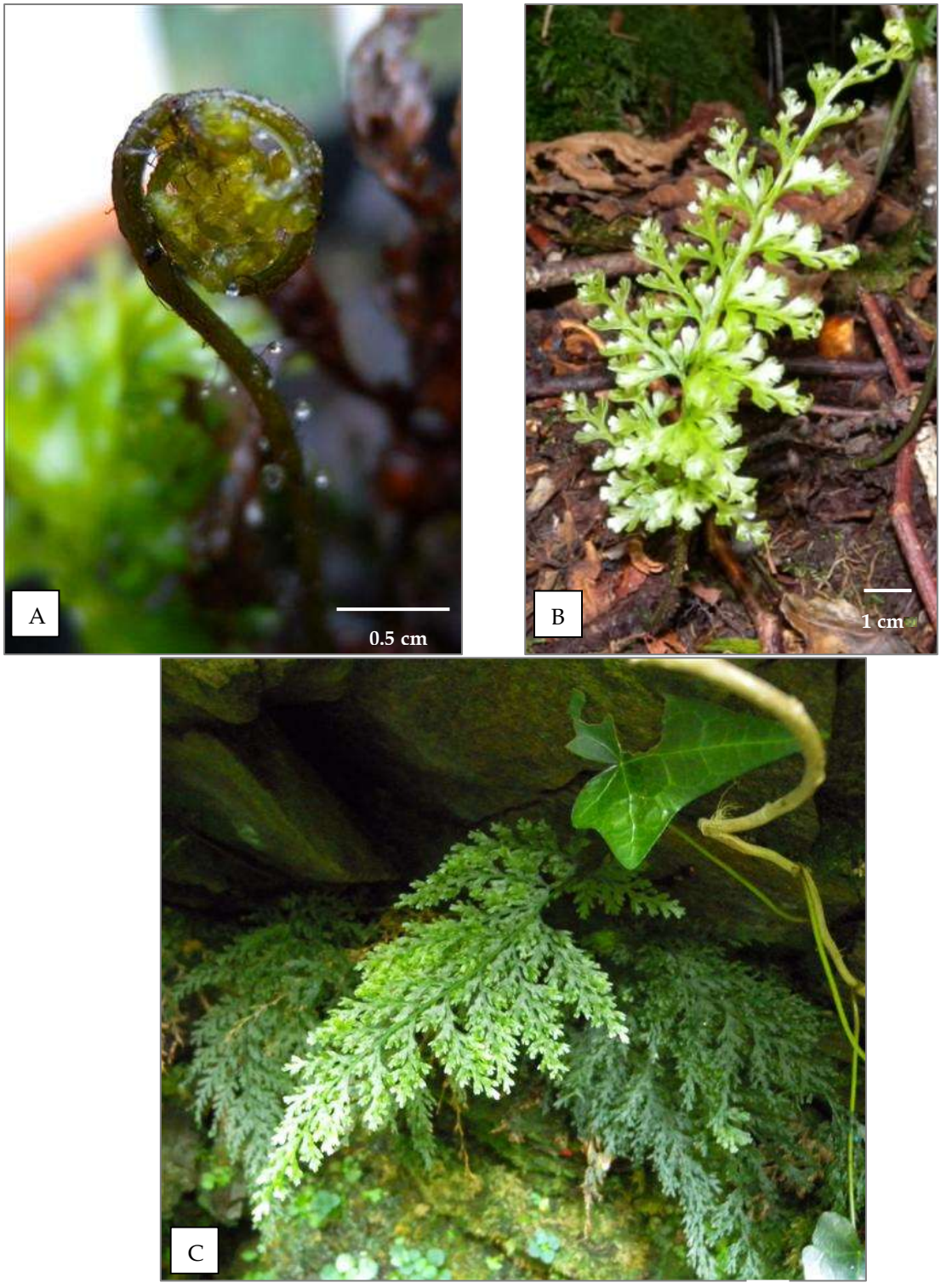

Figure 1.1 (A) Unfurling *T. speciosum* frond, National Botanic Gardens, Glasnevin, 2010; (B) *T. speciosum* young expanding frond, Co. Cork, 2010; (C) Mature *T. speciosum* frond, Co. Carlow, 2011

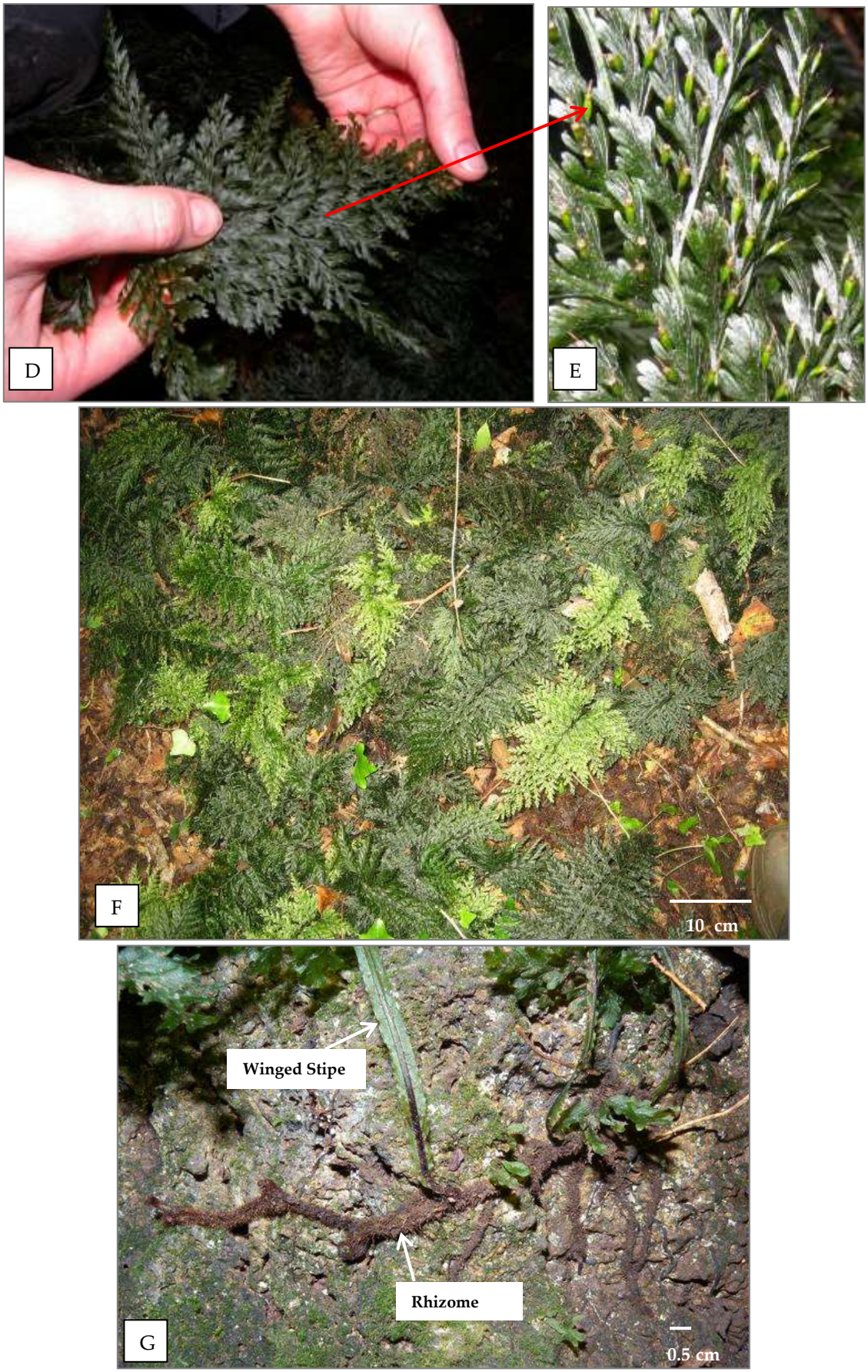

Figure 1.1 (D) Fertile *T. speciosum* frond, Cork site, 2010. (E) Close-up of fertile frond's bristles, Cork site, 2010. (F) *T. speciosum* colony with many fronds, Cork site, 2010. (G) *T. speciosum* rhizome and winged stipe, Azores, 2010

T. speciosum gametophyte

The bright green gametophytes of *T. speciosum* form mats of repeatedly branching filaments that can cover extensive areas (Rumsey *et al*., 1990) and have a felt-like texture when touched. This filamentous perennial gametophyte is considered unique among European fern genera (Rumsey *et al*., 1998). Key identifying features of *T. speciosum* gametophytes are green filaments, the presence of short brown unicellular rhizoids, gemmae (asexual propagules), and gemmifers (specialised cells upon which gemmae are produced) (Rumsey *et al*., 1990; 1998). Figure 1.2 is a microscope image of the gametophyte filaments showing the rhizoids and Figure 1.3 shows a close up of gemmifers and a gemma (Merryweather, 2012). The individual cells are typically 40-55 µm wide and between 150-300 µm in length and are never more than 3 times longer than their width (Rumsey *et al*., 1998). Each cell contains numerous discoid chloroplasts (Rumsey *et al*., 1990). Gametophytes can often be identified by experts or those trained in its identification based on touch (the felt-like texture). Gametophytes are identifiable in the field using a hand lens or Trekker (x 35) Portable Microscope (GX Microscopes) which is particularly useful for definitively identifying gametophytes that are heavily intermingled with bryophytes.

Figure 1.2. Microscope image of *T. speciosum* gametophyte filaments showing brown unicellular rhizoids (magnification x 100) (image from Merryweather (2012); reproduced with permission)

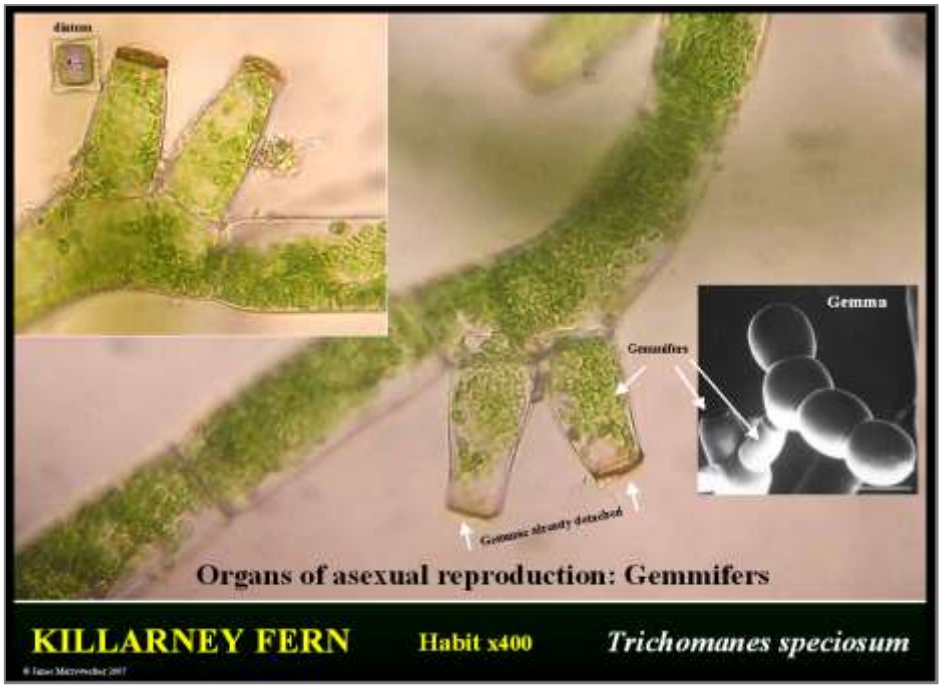

Figure 1.3. Microscope image of *T. speciosum* gametophyte filament showing gemmae (asexual propagules) and gemmifers (specialised cells upon which gemmae are produced). The upper left hand corner of the image shows a diatom beside the gemmifers for scale (magnification x 400) (image from Merryweather (2012); reproduced with permission)

An image of a large gametophyte colony observed hanging from a ravine wall in Co. Waterford is shown in Figure 1.4. Note that the hand shown in this is behind a section of a gametophyte colony that was already detached from the rock, yet still attached to the extensive mat of the colony. Under no circumstances should gametophytes be detached from the substrate on which they are growing unless removing material for identification purposes, in which case no more than 0.5 cm^2 should be removed, depending on the colony size, and only once a licence for collection has been granted by NPWS.

Figure 1.4. *T. speciosum* gametophyte colony hanging from ravine wall at a sporophyte & gametophyte population in Co. Waterford, 2010. (Image by Ní Dhúill, 2014)

Distribution of *T. speciosum*

T. speciosum Willd. (syn. *Vandenboschia speciosa* (Willd.) Kunkel) is a Macaronesian-European endemic (Tutin *et al*., 1993; Rumsey *et al*., 2000). The distribution of *T. speciosum* sporophytes is believed to be confined to a limited area of Europe (Ireland, Britain, Western France, Spain, Italy) and the Atlantic Islands of the Azores, Madeira and the Canaries (Ratcliffe *et al*., 1993). The gametophyte generation has a wider distribution and is reported also in Germany (Rumsey *et al*., 1998), on the Czech-German border (Vogel *et al*., 1993), in Luxembourg (Krippel, 2001) and Poland (Krukowski & Świerkosz, 2004). *T. speciosum* is the only European representative of the genus *Trichomanes (*Vogel *et al*., 1993; Rumsey *et al*., 2000; Makgomol & Sheffield, 2001) and is most abundant in the Azores, outside of which is it most frequently found in Ireland and Britain (Ratcliffe *et al*., 1993; Rumsey *et al*., 2000).

There is great secrecy surrounding the exact locations of this species in Ireland and Britain due to historic over-collection to the point of extinction of the sporophyte in some localities (Rumsey, 1994; Rumsey *et al*., 1998). There are currently 64 known extant *T. speciosum* populations in the Republic of Ireland (Ní Dhúill & Smyth, 2013), the majority being located in the south/south-west in Counties Kerry (almost half of known populations), Cork, Limerick, Tipperary and Waterford, where the largest known population occurs. This species is, however, widely distributed in the country, with extant populations also occurring in Counties Carlow, Donegal, Galway, Kilkenny, Mayo, Sligo, Wexford and Wicklow (Curtis & McGough, 1998; Rumsey *et al*., 1998; Preston *et al*., 2002; NPWS unpublished data, 2009; 2010; 2011; 2013). All Connacht populations comprise gametophyte-only

colonies except for one population in Co. Sligo, where both sporophyte and gametophyte colonies are found. All populations in Leinster are represented by gametophyte-only populations, with the exception of one population in Co. Carlow where both generations occur. Previously, *T. speciosum* sporophyte also occurred in Cos Clare and Wicklow, but has not been recorded from these counties since the 19th century, probably being lost to over-collection and/or habitat change. The gametophyte is currently extant in Co. Wicklow (Appendix 1, Populations 3 and 4), but there are no recent records of either generation from Co. Clare. Despite this, the geographical range of the species is still very well-represented. Figure 1.5 shows the current distribution and range of *T. speciosum* in Ireland.

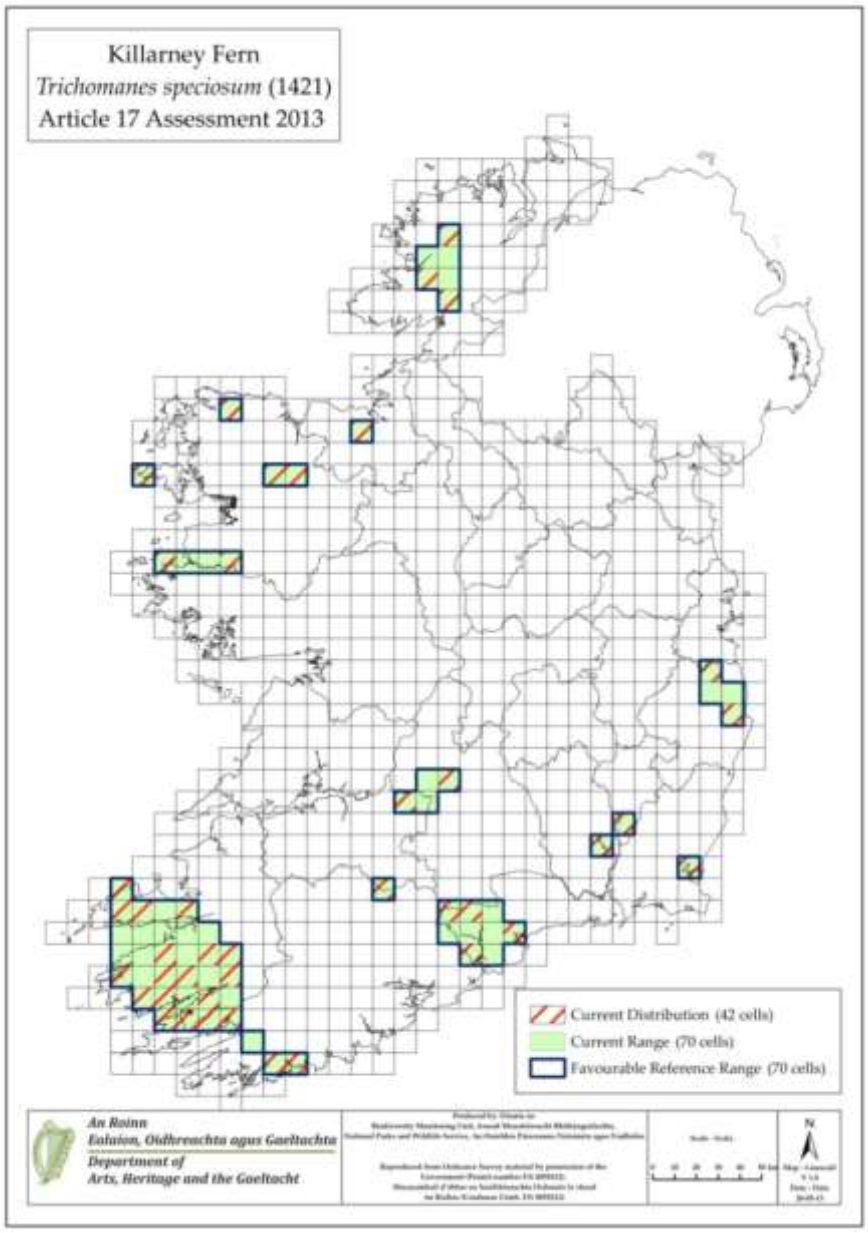

Figure 1.5. Range and distribution map of *T. speciosum* in Ireland (10 x 10 km), as documented in the 2013 Article 17 reporting. Red lines represent the current distribution

A study of Irish populations found 21 of the 55 monitored colonies where *T. speciosum* sporophytes occurred to be fertile (38%), which represented 57% of populations where sporophytes occurred as having fertile colonies (Ní Dhúill, 2014). This was much higher than fertility levels reported in previous studies (Ratcliffe *et al*., 1993; Rumsey, 1994). Based on observations from a study of 27 Irish populations, the main mode of reproduction was vegetative with sexual reproduction occurring on a limited basis (Ní Dhúill, 2014).

T. speciosum has been cited in literature as being a tetraploid (Rumsey, 1994) with a chromosome number of n = 72 (Manton, 1950; Mehra & Singh, 1957), however, variation in cytotypes found in the wild in Ireland would not support this (Ní Dhúill, 2014). A study of a selection of Irish populations revealed that there was a mix of cytotypes of *T. speciosum* which were inferred as diploid, triploid and tetraploid for the sporophyte generation, and haploid and diploid cytotypes for the gametophyte generation, with the predominant cytotype for the gametophyte generation at the sampled populations being diploid (Ní Dhúill, 2014).

Genetic analysis of Irish populations of *T. speciosum* using Amplified Fragment Length Polymorphism (AFLP) revealed that genetic diversity was partitioned within and among populations of both generations analysed (Ní Dhúill, 2014). Samples analysed showed the majority of *T. speciosum* populations to be genetically distinct and as such each is of conservation importance throughout its distribution range in Ireland (Ní Dhúill, 2014). Genetic diversity was revealed in both generations with the gametophytes exhibiting genetic diversity not present in the sporophyte generation. This is a potential source of novel genetic variation in a future sporophyte generation in the event of sexual reproduction resulting in successful sporophyte recruitment.

Habitat of *T. speciosum*

T. speciosum occurs in Irish populations as colonies of sporophytes and gametophytes co-occurring (whereby gametophytes occur intimately or closely associated with sporophytes), sporophyte-only or gametophyte-only.

T. speciosum occurs at a range of altitudes from sea level to 380 m in Ireland and in both open and wooded habitats where relative humidity is constantly high. In the open habitats, shade is usually provided by aspect and often by boulders, cliff overhangs or crevices where *T. speciosum* occurs. In wooded habitats, shading is also provided by the overhead canopy. *T. speciosum* occurs on sites with a predominately north or north-east-facing aspect, and on acidic substrates such as quartzite, slates and sandstones (Ratcliffe *et al.,* 1993; Page, 1997; Kingston & Hayes, 2005). Whilst the sporophyte has been

known from Ireland since 1804, the gametophyte was first recorded in Britain in 1989 (Rumsey *et al*., 1990; Rumsey, 1994) and in Ireland in 1992 (Rumsey *et al*., 1998).

In Ireland, where *T. speciosum* sporophyte and gametophyte generations occur together they occupy similar habitats in dripping caves, cliffs, crevices and gullies by waterfalls, crevices in woodland, and occasionally sporophytes occur on the floor of damp woodland - all deeply shaded humid habitats (Ratcliffe *et al*., 1993; Rumsey, 1994; Johnson *et al.,* 2000; Kingston & Hayes, 2005; Ní Dhúill, 2014). Sporophyte colonies, however, are more restricted in their distribution in Ireland than gametophyte colonies. Sporophytes usually occur on permanently wet rock faces, caves or river/stream banks, with constant dripping of water a typical feature of their habitat. Gametophyte colonies have been reported from less humid habitats (Ratcliffe *et al*., 1993; Rumsey, 1994; Kingston & Hayes, 2005, Ní Dhúill, 2014). Gametophytes can grow in very dark habitats where there is little competition from other species. However, niches that the gametophyte generation can occupy may not always be suitable for the growth of sporophytes, i.e. shallow crevices in otherwise open habitats that provide adequate shade and relative humidity for gametophytes, but not for the larger sporophytes.

T. speciosum occurs in scattered populations and occupies small specific microhabitats within these larger, more recognised habitats such as damp woodlands and open uplands. The sporophyte generation often occurs in ravines and near streams in damp woodland habitats and near mountainous cascades and waterfalls in open upland habitats, all highly characteristic habitats, which aids determining likely locations for the sporophyte generation. The habitat of the gametophyte generation, however, is not so easily determined as it can survive in drier, although still very humid microhabitats.

Previous studies carried out on the ecology and conservation of *T. speciosum* which included Irish populations, reported both generations occurring in species-poor microhabitats typically dominated by bryophytes (Ratcliffe *et al*., 1993; Rumsey, 1994; Kingston & Hayes, 2005). Relative humidity and temperature were considered to be the most important environmental factors controlling the growth of *T. speciosum* (Ratcliffe *et al.,* 1993; Rumsey *et al.,* 1999; Kingston & Hayes, 2005).

A field survey of 27 *T. speciosum* populations was undertaken in 2009 – 2011 to record information on population structure, associated vegetation and environmental variables (Ní Dhúill, 2014). Using multivariate analysis, the study found no associated species that would be indicative of the presence of either generation at these populations (Ní Dhúill, 2014), as supported by previous studies (Ratcliffe *et al*., 1993; Rumsey, 1994; Kingston & Hayes, 2005). Species found occurring in association with *T. speciosum* include *Calypogeia arguta, Conocephalum conicum, Diplophyllum albicans Dumortiera hirsuta, Fissidens* sp., *Heterocladium heteropterum, Hookeria lucens, Kindbergia praelonga. Marchanthia polymorpha,*

Mnium hornum, *Pseudotaxiphyllum elegans* (syn. *Isopterygium elegans*), *Riccardia chamedryfolia, Thamnobryum alopecurum, Thuidium tamariscinum, Chrysosplenium oppositifolium, Hedera helix*, *Molinia caerulea*, *Potentilla erecta* and *Saxifraga hirsuta* (Ní Dhúill, 2014). Although most species recorded were relatively common in their respective habitats (woodland or open upland), there were a number of less common species recorded, such as the liverwort *Jubula hutchinsiae,* which shares a similar range to *T. speciosum* (Rumsey, 1994; Atherton *et al*., 2012) and *Radula* sp. (Ní Dhúill, 2014). The difficulty in classifying the habitats of this species was a reflection of the variety of locations where it occurred. Sporophyte-only and gametophyte-only colonies were reported to occupy slightly different ecological niches with gametophyte-only colonies occurring in deeper shade with rock seepage being the main water source, whereas sporophyte-only colonies tended to occur in higher light conditions with constant dripping water a typical feature of its habitat (Ní Dhúill, 2014). Sporophyte and gametophyte co-occurring colonies occupied a middle-ground between these two slightly differing ecological niches (Ní Dhúill, 2014). Relative humidity and temperature were found to be relatively uniform throughout study sites, regardless of habitat type, with constant high levels of relative humidity (on average above 90%) recorded at all populations visited (Ní Dhúill, 2014).

Ratcliffe *et al.* (1993) found the absence of the species from many apparently suitable habitats in its range to be puzzling. A lack of suitable continuous habitat and the effects of historic depredation of the sporophyte generation during the "Victorian Fern Craze", also known as "Pteridomania", which was at its height in the 1850s – 1890s (Allen, 1969; Whittingham, 2009), may explain the distribution of this species in Ireland. A study of 27 Irish populations reported that populations which occurred in open upland habitats tended to support single colonies whereas, in woodland habitats which provided a more continuous habitat, 61.5% of populations observed supported multiple colonies (Ní Dhúill, 2014). There are a number of factors that may explain the absence of this species from seemingly ideal habitats, such as a lack of suitable substrate, inadequate shading and inadequate relative humidity levels, i.e. high relative humidity levels may only be intermittent rather than constant.

Conservation obligations

The Irish Red Data Book on vascular plants lists *T. speciosum* as being rare and vulnerable (Curtis & McGough, 1988) and it is listed as rare in the checklist of protected and rare species in Ireland (Kingston, 2012). This category equates to the current category of 'endangered' (EN) as per the latest (version 3.1) International Union for the Conservation of Nature (IUCN) Red List categories (IUCN, 2001; 2012), which are used for classifying species that are at high risk of global extinction (Krupnick,

2005; IUCN, 2001; 2012). A taxon is considered threatened if it has an IUCN listing of 'critically endangered' (CR), 'endangered' (EN) or 'vulnerable' (VU) (Krupnick, 2005; IUCN, 2014).

The EU Habitats Directive aims to maintain or restore at a favourable conservation status the habitats and species that are of Community importance (European Commission, 1992; Evans & Arvela, 2011). This is one of the most important pieces of legislation for the conservation of biodiversity in Europe and was transposed into Irish law in the European Communities (Natural Habitats) Regulations (S.I. 94 of 1997). The Directive lists threatened habitats in Annex I and species in Annexes II, IV and V. Article 17 of the Habitats Directive requires that each member state must report to the European Commission every 6 years on the conservation status of listed habitats and species (European Commission, 1992; Evans & Arvela, 2011). Guidelines for assessing the conservation status of habitats and species were updated in 2011 (Evans & Arvela, 2011).

Trichomanes speciosum is listed in Annex II and IV of the Habitats Directive. For species listed in Annex II of the EU Habitats Directive, member states are required to designate Special Areas of Conservation (SACs). To date, Ireland has designated a total of 24 SACs which contain populations of *T. speciosum*, in 18 of which it is listed as a qualifying interest. Of the 6 SACs where *T. speciosum* is not listed as a qualifying interest, each of which contains a single population, 4 contain gametophyte-only populations and two contain sporophyte populations. Of those *T. speciosum* populations not within the SAC network, only two contain sporophytes; one, a Co. Cork population, was only discovered in 2012, the other, a Co. Kerry population, is included within a proposed Natural Heritage Area (NHA). *T. speciosum* colonies that are listed as qualifying features in SACs are protected by the Habitat Regulations (S.I. No. 477/2011), which regulates any plans or projects that may negatively impact on the species. NPWS provide a list of Activities Requiring Consent (ARCs) that are only granted if they do not negatively impact on the qualifying features within a SAC. Although there are currently 6 SACs that contain *T. speciosum* where it is not listed as a qualifying interest, it is however also protected by other directives and legal instruments. Specifically, *Trichomanes speciosum* is afforded protection by the Environmental Liability Directive (2004/35/EC, transposed into Irish law in the European Communities (Environmental Liability) Regulations 2008 (S.I. 547 of 2008), which prevents and remedies environmental damage to natural habitats and protected species. *T. speciosum* and its habitats are protected under the Flora Protection Order (FPO), 1999 (S.I. No. 94 of 1999). It illegal to cut, uproot or damage any species listed under the FPO and it is illegal to damage or interfere with the habitats of listed species.

Monitoring of *T. speciosum* in Ireland

With widespread loss of biodiversity occurring at an increasing rate, the necessity for conservation and monitoring of threatened species (flora and fauna) is extremely important (Sutherland, 2000). In order to effectively conserve rare and threatened species, in-depth knowledge of the target species and of the habitat where it occurs are equally important (Synge, 1981; Evans, 2005; Krupnick, 2005; Motiekaityté, 2006).

As a result of historic depredation of *T. speciosum* in Ireland, there is a great deal of secrecy surrounding the location of populations. Currently *T. speciosum* is considered to comprise 64 populations, encompassing 177 colonies. This population figure was derived from field estimates (Ní Dhúill & Smyth, 2013 and NPWS surveys, files, correspondence and submissions) and is considered to represent the population baseline (Ní Dhúill & Smyth, 2013). For *T. speciosum* the most suitable unit for measuring population size was considered to be the colony, which was simply defined as a discrete, i.e. unconnected, "patch" or "plant" (Ratcliffe *et al*., 1993; Rumsey, 1997). This unit was the most useful and accurate measure of population size for *T. speciosum*, on account of the rhizomatous nature of the sporophyte and the filamentous nature of the gametophyte, both of which make identification in the field of what precisely constitutes an individual difficult. Both sporophyte and gametophyte colonies may comprise one or many individuals. Frond numbers can fluctuate on an annual basis, therefore, presence or absence of a colony is a more reliable unit than frond counts for estimating population size of *T. speciosum* in Ireland.

A *T. speciosum* population is considered to encompass all colonies within a given locality (the locality being a distinct area, e.g. woodland, cliff face, ravine, boulder field). In many cases, a population comprises a single colony. The extent of a population is assessed visually by observing the number of colonies, which can range from single to multiple colonies in a given population.

Based on NPWS records, the 64 known *T. speciosum* populations comprise 25 that contain both sporophyte and gametophyte co-occurring, 18 sporophyte-only and 21 gametophyte-only populations. It is likely that many of the sporophyte-only populations do in fact have gametophytes occurring within or in close association with the sporophyte colonies. Twenty seven populations were visited between 2009 and 2011 comprising 77 observed colonies of which 75 were monitored (Ní Dhúill, 2014). At 12 populations that were previously recorded by NPWS as sporophyte-only, 9 (75%) of these were found to be co-occurring with gametophytes (Ní Dhúill, 2014). The 27 populations visited and monitored between 2009 and 2011 are outlined in Appendix 1 which also provides details of the life-stage (sporophyte or gametophyte) at each colony, the number of colonies at each

population, the number of fertile sporophyte colonies, grid references for each population (10 km x 10 km) and summary results for the Site Assessment for each individual population. The Site Assessment comprises a Population Assessment, Habitat for the Species Assessment, Future Prospects Assessment and Overall Conservation Condition Assessment (see Section A - D). Locations where a further 4 populations were reported to occur (two sites in Co. Kerry, one each in Cos Cork and Mayo) were also visited but the populations were not located. A more intensive search of these locations is recommended, especially at a mountain site in Co. Kerry, where adverse weather conditions prevented a thorough search and at the Co. Cork site, where the population was considered inaccessible and unsafe for survey at the time. The *T. speciosum* colony at the Co. Cork site is reported to occur in a deep crevice on a steep mountain slope where ropes would be required for safe access to the location.

The 27 populations that were selected for monitoring between 2009 and 2011 encompassed the geographic range of the species in Ireland and also the occurrence of the different generations – sporophyte, gametophyte and co-occurring generation populations (Ní Dhúill, 2014). Of these populations, 20 were sporophyte and gametophyte co-occurring, 3 were sporophyte-only and 4 were gametophyte-only. The range of habitats was also represented in the population selection which included woodland and open upland habitats, as was the range of population sizes, from single to multiple colonies.

For Article 17 reporting, the conservation status of a species is defined as the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory of the member states. The conservation status of a species will be taken as favourable when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The national assessment for species brings together information on Range, Population, Habitat for the Species and Future Prospects

Favourable Reference Values are set for Range and Population; these are targets against which current values are judged. These reference values should be at least equal to the value when the

Directive came into force, unless this value is not deemed to be enough to ensure the long term survival of the species being assessed.

Favourable Reference Value for *Range* is the total geographical area within which all significant ecological variations of the habitat or species are included and which is sufficiently large to allow the long-term survival of the species. Favourable Reference Values for *Population* are the minimum required for the long-term survival of the species in question.

The extent and quality of suitable habitat is assessed to determine whether the long-term survival of the species is assured. The major pressures and threats are also listed for each assessment. The impacts of these pressures and threats are used to determine the *Future Prospects*.

The rate of loss or the distance away from Favourable Reference Values are used to determine whether a parameter is "*favourable*", "*unfavourable – inadequate*", "*unfavourable – bad*" or "*unknown*" following a rules-based approach (Evans & Arvela, 2011). For a "*favourable*" Overall Assessment all parameters must be assessed as "*favourable*" (with one "unknown" acceptable); if any one of the parameters is assessed as "bad", the Overall Assessment is also "bad"; any other combination would result in an "inadequate" Overall Assessment.

The Article 17 Species Conservation Assessment for *T. speciosum*, 2007 – 2012, may be accessed at http://www.npws.ie/publications/article17assessments/ (NPWS, 2013).

Elements of this national assessment approach can be scaled down to assess the status at a population level by assessing Population, Habitat for the Species and Future Prospects. The results are combined to provide an overall assessment for each population.

- "Population" assesses the number of colonies of each generation at each population (sporophyte and gametophyte co-occurring, sporophyte-only or gametophyte-only), frond counts for colonies where sporophytes occur (actual or estimated) and whether a population is reproductively viable by observation of fertile fronds or juvenile sporophytes emerging from gametophytes.
- "Habitat for the Species" assesses the area and quality of the habitat in which the species occurs.
- "Future Prospects" are assessed by examining whether any activities are affecting the other attributes (i.e. population and habitat for the species) and what their impact would be if they continue unchecked. Future prospects should balance any positive and negative activities to determine whether the species will survive at each population for the foreseeable future.

Monitoring of 27 populations visited during 2009 - 2011 provided baseline data against which future monitoring at these locations can be compared (Ní Dhúill, 2014). Recommendations for 6 yearly

monitoring at populations is considered sufficient for assessing health and productivity at populations of both generations of *T. speciosum* in Ireland (Ní Dhúill, 2014). This would feed into the 6 yearly reporting on the national conservation status of this Annex II species as required by the EU Habitats Directive (European Commission, 1992; Evans & Arvela, 2011).

The future prospects of *T. speciosum* are considered to be stable at present and into the foreseeable future. Although there has been no loss of colonies/populations in recent times, 2 colonies are reported to be at risk of loss (Ní Dhúill, 2014); these occur in 2 multiple-colony woodland populations in Cos Cork and Limerick (Appendix 1, Populations 22 and 20). The risk of loss of one colony at the Co. Cork population was attributed to trampling, with a reduction in frond numbers from 16 to 2 during the survey period 2009 to 2011. The location on the bank where this colony occurs appeared to be used as a track down to the river. The colony from the Co. Limerick population had a frond loss from 28 to 2 between 2009 and 2011 which was attributed to removal of canopy cover provided by the invasive non-native shrub *Rhododendron ponticum* (Rhododendron) that had been cut back, resulting in the colony being completely exposed.

In addition to the two colonies above, pressures (or impacting activities) were recorded at 10 of the monitored populations visited between 2009 and 2011 (Ní Dhúill & Smyth, 2013; Ní Dhúill, 2014). Fire caused significant damage at a site in Co. Limerick (Appendix 1, Population 16) where 2 m of visible fronds were lost to fire in 2008. This population has since recovered and new fronds have emerged, therefore the negative impact of fire at this population is considered to be low. Evidence of possible sheep grazing was observed at one population but was considered to be having a low impact. Outdoor sports and leisure activities were also considered to be having a low impact at the two populations where these activities occur (Appendix 1, Populations 19 and 1). Invasive non-native shrubby species, *R. ponticum* and *Prunus laurocerasus* (Cherry Laurel), were observed as currently having a low impact at three populations in Cos Cork, Limerick and Waterford (Appendix 1, Populations 22, 20 and 26). *Rubus fruticosus* agg. (Bramble) is currently having a low-medium impact on a Co. Cork population (Appendix 1, Population 25) and future monitoring of this problematic native species is recommended.

Because of the specific nature of its habitat and its specialised ecology, *T. speciosum* is potentially threatened by a wide variety of activities and impacts including road schemes, buildings and other developments, hydro-electric schemes, modification of watercourses, pollution, land reclamation, grazing, woodland management activities, fire, encroachment by non-native or problematic native plant species, sample collecting, recreational activities, amongst others. These can affect populations directly (e.g. the unwitting loss of plants through land clearance for developments, or removal by

collection of samples) or indirectly by alteration of habitat conditions (e.g. removal of woodland, alteration of watercourses, etc. leading to a reduction in relative humidity and subsequent desiccation of plants). However, the great majority of populations are not presently under threat, with many being recorded during monitoring from 2009 - 2011 as having no perceived current pressures or threats (Ní Dhúill, 2014).

The main threats are loss of habitat, exposure and encroachment of invasive species (such as *R. ponticum* and *P. laurocerasus)* and vigorous native species (such as *Rubus fruticosus* agg.). *T. speciosum* grows in deeply shaded habitats, however, the sporophyte can occur in higher light conditions where competition from other higher plants may be problematic. *R. ponticum* and *P. laurocerasus* did not occur in any of the vegetation plots in a recent study of 27 Irish populations (the largest plot size being 2 m x 2 m), however, they did provide canopy cover at a number of colonies in Cos Limerick and Waterford (Appendix 1, Populations 20 [Colony 4] and 26 [Colony B]) (Ní Dhúill, 2014). Although no *T. speciosum* colonies observed at the Co. Waterford population have been lost during the monitoring period 2009 to 2011, the presence of the invasive *P. laurocerasus* here is of concern (Ní Dhúill, 2014); its continued spread here would pose a threat to the species and to the quality of the habitat which occurs.

Although gametophytes typically occur in deeply shaded habitats where there is little competition from higher plants, encroachment by bryophytes or algae may pose a threat, although there was no current evidence of this reported in a recent study of Irish populations (Ní Dhúill, 2014). However, changes in light level and reduced shading may facilitate encroachment of bryophytes at gametophyte colonies. Such encroachment of gametophytes would be a difficult attribute to assess in a quantifiable manner and any negative impact would be difficult to immediately determine with this slow growing generation. If, however, any impact is observed in the future that is quantifiable, this attribute should be re-visited and considered for inclusion in the Habitat for the Species Assessment.

Grazing is considered to be a threat to sporophyte populations that are accessible to grazing livestock. It does not pose so much of a threat to gametophyte colonies, which are not usually within the reach of grazing livestock. Herbivory by invertebrates of the gametophyte generation, although not a current pressure, may pose a threat to this generation, however observation of this activity has not been reported to date based on the monitoring of 24 Irish populations where gametophytes occur between 2009 - 2011 (Ní Dhúill, 2014). If such impacting activity is observed in the future, it should be recorded in the Future Prospects Assessment (Table 1.8).

Changes in canopy cover or tree-felling can affect relative humidity, reduce shading and increase the amount of light reaching colonies. Such changes in canopy cover can occur through woodland

management to remove invasive species, as at a Co. Limerick site (Appendix 1, Population 20), and, unless undertaken sensitively and with the requirements of the species in mind, this activity can pose a threat (Ní Dhúill, 2014). Outdoor sports/leisure/recreational activities pose a threat of damage to some populations, for example, the sporophyte colony situated close to a popular, well-used path in Co. Kerry (Appendix 1, Population 19), and that occurring close to a docking area used by kayakers in a Co. Tipperary site (Appendix 1, Population 1). However, these are generally localised issues and overall there is no evidence to indicate that outdoor sports and leisure activities pose a significant threat to the species across the wider landscape (Ní Dhúill & Smyth, 2013; Ní Dhúill, 2014).

Although the threat of deliberate collection of the species is much reduced from levels during the "Victorian Fern Craze", it is considered that there is still a low level of threat to some colonies from this activity. For this reason the precise locations of colonies of the species are not made generally available.

Full field methodologies and assessment methodologies for ongoing monitoring are detailed in the following sections.

Pre-survey

Historical and restricted information on *T. speciosum* populations held by NPWS should be gathered and studied prior to commencement of field work and contact should be made with landowners where possible. A thorough familiarisation with previous surveys of the populations under investigation should highlight any changes in status or threats since previous visits. This would include perusal of Site Assessment Sheets along with Site Survey Cards and Killarney Fern Monitoring Sheets from the survey period 2009 – 2011, held by and available on request from NPWS, as appropriate.

Prior to the survey being carried out, the surveyors must ensure they have a licence from NPWS that allows visits to *T. speciosum* populations and for collection of gametophyte material for identification proposes. The surveyor should also ensure that they have the necessary skills to identify *T. speciosum* sporophyte and gametophyte generations. In relation to the sporophyte generation, it is important to be able to identify fertile and sterile mature fronds, young fronds, juvenile fronds emerging from gametophytes and unfurling fronds arising from rhizomes. Gametophyte generation colonies monitored between 2009 and 2011 should be identifiable in most cases without removal of material. Where gametophyte material has to be removed for identification, ensure that minimal amounts are extracted, i.e. < 0.5 cm^2 should be sufficient to identify gametophyte filaments under a hand lens or portable field microscope.

Some historical NPWS records provide Irish National Grid references for the *T. speciosum* populations which are mostly based on estimates from maps. These are not as accurate as a GPS position, but are very useful for getting to the locality where the colonies/populations occur. For the 27 populations monitored between 2009 and 2011, where possible, GPS positions were taken at each colony using a Garmin E-Trek handheld GPS based on the Irish National Grid co-ordinate system. It is not always possible to obtain accurate GPS positions at every colony within a population due to the types of habitats where *T. speciosum* occurs, in particular in deeply shaded woodland habitats, though there should be little difficulty obtaining accurate readings at the more open habitats. In all cases for the 27 populations monitored, GPS positions were also taken from the access points to the site and a full written description with directions to the population recorded and, where necessary, a sketched description of the site, populations and colonies. This standardised site visit protocol with full description for site access should be followed for any additional populations that are visited in the future.

Field survey equipment should include:

- Maps showing location of populations (Aerial photographs and Ordnance Survey Maps (Discovery Series)).
- A waterproof field notebook.
- Pencils.
- Adequate number of Site Survey Cards and Killarney Fern Monitoring Sheets (Appendix 2). Data from these are used to complete the Site Assessment Sheet (Appendix 3).
- Plant identification guides (i.e. Parnell & Curtis, 2012; Atherton *et al*., 2010; Cope & Gray, 2009).
- A handheld GPS receiver accurate to 50 cm or less with post processing, e.g. Trimble GeoExplorer range. Alternatively, a Garmin E-Trek or equivalent receiver can be used, although readings are not as accurate as a Trimble.
- Torch – a head torch is ideal for work in close confines.
- Handheld hygrometer.
- Compass.
- Measuring tape (20 m tape and graduated calipers).
- Hand lens or portable field microscope, e.g. Trekker (GX Optical) field microscope.
- Forceps (for removal of small amounts of gametophyte filaments if necessary for identification).
- Waterproof bag to carry folder and equipment.

- 25 cm x 25 cm quadrats (for frond number estimates).
- 1 m x 1 m quadrat (for assessing encroachment of invasive/vigorous species).
- Waders or thigh-high boots (for some populations).
- Wellington boots/hiking boots and waterproof clothing.
- Walking pole.

Note: Care should be taken during all visits to minimise impact on these populations.

Methodology

At each population visit a Site Survey Card is completed (Appendix 2). A Killarney Fern Monitoring Sheet is also completed for each colony (Appendix 2). The data from these are used to complete the Site Assessment Sheet (Appendix 3) with comprises the Population Assessment, Habitat for the species Assessment and Future Prospects Assessment, full details of which are set out in Section A – C below. The combined data allows for the Conservation Condition of each population to be determined, i.e. *Favourable*, *Unfavourable – inadequate* or *Unfavourable - bad* (Section D).

Section A – Population Assessment

For each population, the target is no loss of sporophyte or gametophyte colonies within each population. Some gametophyte-only colonies may become co-occurring generations if sexual reproduction occurs; in this case the gametophyte would still be expected to persist. Continued presence of monitored colonies should be confirmed and any changes from baseline data noted, including decline in frond numbers, observation of newly fertile fronds, absence of fertile fronds in previously fertile colonies, presence of gametophytes in previously sporophyte-only colonies, presence of juvenile fronds emerging from gametophytes.

Gametophyte Generation

The gametophyte generation is acting as a potential 'genetic-bank' and as such is of conservation importance (Ní Dhúill, 2014). The gametophyte generation is extremely slow growing and monitoring would only be recommended at most on a 6 yearly basis in order to confirm the continued presence of colonies, to measure extent of each colony and area of occupancy in each colony. The extent of each colony should be measured with a measuring tape or graduated calipers. As the colonies (both gametophytes and sporophytes) are irregular in shape, they should be measured as a rectangle, one measurement across the maximum dimension and another perpendicular to this. A 20 m measuring tape is generally suitable, though for small gametophyte colonies a graduated calipers may be more

suitable. These measurements of extent define a rectangle which encompasses the colony, the area of colony occupancy within this rectangle was then estimated, i.e. the greatest extent of the area within the rectangle occupied by *T. speciosum*.

During monitoring visits, investigation by an expert for the presence of gametangia and also emergence of juvenile sporophytes is recommended if this can be achieved with minimal disturbance; this will require a hand lens or portable field microscope. Niche availability in terms of available bare rock in the vicinity should be investigated for the presence of adjacent unrecorded gametophytes. Proximity to the nearest mature sporophyte should be recorded. If there are no sporophytes in the vicinity, proximity can be calculated using GPS points.

In the Population Assessment for populations where sporophytes occur (with or without gametophytes) as set out in Table 1.1, one of the attributes is the presence of associated gametophytes if observed in previous surveys. A thorough search should be conducted in the immediate vicinity of rocky substrate, crevices, overhangs and boulders in order to assess this attribute even if the population was previously recorded as sporophyte-only. If there are no gametophytes observed after a thorough search at sporophyte-only populations, then the result is 'NA'. If, however gametophytes are not observed at previously sporophyte and gametophyte co-occurring populations then the result is 'absent' and a fail for this attribute.

In the Population Assessment of gametophyte-only populations in Table 1.2, one of the attributes is the emergence of juvenile sporophytes from gametophytes. This is to allow for the recording of such growths at gametophyte-only populations. During the survey period 2009 – 2011 there were no juvenile sporophytes recorded at any of the 4 gametophyte-only populations surveyed (Ní Dhúill, 2014). If there are no juvenile sporophytes observed emerging from gametophytes at gametophyte-only populations then the result is 'NA'. In the event of juvenile sporophytes being observed at any population that was previously reported as being gametophyte-only, the result would be 'present' and the status would then be changed to a sporophyte and gametophyte co-occurring population and the Site Assessment (Population, Habitat for the Species and Future Prospects Assessments) would be carried out based on the new status.

The target for the population assessment of the gametophyte generation, whether in a co-occurring or single generation colony/population is that it is present and that the area of occupancy has not declined below 10% of the baseline figure to allow for human error and recording variability in estimated areas of occupancy. It should be noted that the gametophyte colony numbers and areas are conservative. It is highly likely that there are more colonies awaiting discovery.

Sporophyte generation

Population structure

At each population and colony where sporophytes occur, the population structure should be observed and recorded to include investigation of presence of gametophytes occurring intimately or in close association with the sporophyte generation, presence of fertile fronds, presence of juvenile sporophytes emerging from gametophytes and presence of young or unfurling fronds.

At populations that were historically recorded as sporophyte-only based on NPWS records, it is important to search for gametophytes within any sporophyte colonies, and any surrounding rocky substrate, crevices, overhangs and beneath any nearby boulders. Based on results from the survey period 2009 – 2011, gametophyte were observed at 9 of the 12 populations that were historically recorded as being sporophyte-only (75%) making it likely that gametophytes may be observed in the vicinity of sporophytes (Ní Dhúill, 2014). In the Population Assessment for populations where sporophytes occur (with or without gametophytes) set out in Table 1.1, one of the attributes is the presence of associated gametophytes, if previously observed, with the target being that they are present. As outlined in the previous section, if gametophytes are not observed at previously sporophyte and gametophyte co-occurring populations then the result is 'absent' and a fail for this attribute. If there are no gametophytes present in populations previously recorded as sporophyte-only, having conducted a thorough search in the immediate vicinity, the result is 'NA'. However, all subsequent visits of sporophyte-only populations must still include a thorough search for gametophytes in the immediate vicinity.

Colony area

The rectangle defining the extent of each colony should be measured with a measuring tape, and the area of occupancy of *T. speciosum* within this rectangle estimated and recorded as outlined in the previous section. The target is no decline in area of occupancy below 10% of the baseline reference value for each colony to allow for human error and recording variability. Sporophytes and gametophytes should be measured as separate entities, even when the gametophyte is occurring intermingled with the sporophytes.

Frond numbers

Full frond counts should be carried out where possible at each colony, and estimates be calculated where counts are impractical. Frond numbers are recorded on the Killarney Fern Monitoring Sheet for each colony (Appendix 2). In the case of actual frond counts, these can be carried out on easily accessible colonies that are usually < 1 m^2. Numbers of the following frond types should be recorded:

- Mature sterile fronds (>50% green, fully expanded)
- Mature Fertile fronds (>50% green, fully expanded)
- Young fronds (still unfurling, not fully expanded)
- Unfurling fronds (Croziers)
- Juvenile fronds (emerging from gametophyte)
- Dying fronds (<50% green)
- Dead fronds (blade ± intact but frond all brown)

In the case of larger colonies, estimates should be carried out based on counts using 25 cm x 25 cm quadrats (1 - 3 quadrats used depending on colony size). These quadrats are placed at different sections of the colony to ensure an accurate reflection of density of a colony, and the number of fronds in each quadrat counted based on the frond types outlined above. The density of fronds per 1 m^2 and the estimated area of occupancy of each colony are used to estimate total colony frond number. For populations that comprise multiple sporophyte colonies, frond counts for each colony are added together to give the full frond count for the population.

It has been reported that fertile fronds begin to brown and wither after complete spore discharge (Ratcliffe *et al*., 1993; Page, 1997). This may occur over a number of years and may show a significant reduction in fertile frond numbers compared to the baseline. Percentage fertility of colonies should be calculated based on living frond counts. Analysis of colony frond counts during 2009 - 2011 suggested that fertile fronds had a shorter life span than sterile fronds as they tended to brown and die after all sporangia have been released (Ní Dhúill, 2014). This may have implication on future monitoring of frond numbers as fluctuations in counts may reflect natural mortality of fertile fronds rather than any other factor impacting the colony. Baseline data for frond counts recorded between 2009 and 2011 at the 23 populations where sporophytes occurred comprising 55 colonies where full counts were carried out can be used to assess whether fluctuation in frond numbers reflect an increase or reduction in colony size.

The target is not less than a 10% reduction in frond number for each colony, where the reduction is due to an obvious pressure. Note that where a reduction cannot be attributed to an obvious pressure, the indicator should be recorded as passed, but this should trigger an immediate investigation to determine the cause of the decline and to determine whether this is part of a natural fluctuation or represents the start of a continued and perhaps unexplained decline. This may require more frequent monitoring of any such colonies (initially annually), AND should trigger action to improve the conservation status of the colony. Any colony which shows declines in frond numbers over two

successive reporting cycles, even if the pressure is undetermined, should be deemed to have failed the frond number indicator.

For the Population Assessment, the target is the presence of fertile fronds and/or young fronds and/or unfurling fronds at colonies where sporophytes occur. Fertile fronds have been included with young and unfurling fronds as an indication of colony health, productivity and viability. Fertile fronds have the potential to produce gametophytes which in turn have the potential to produce juveniles, which may increase the population size. Young and unfurling fronds also indicate growth by continued production of fronds. For the purpose of assessing this attribute as an indicator of a healthy viable population any frond type or combination would be a pass. A reduction in frond counts from the baseline may be due to natural fluctuation in frond numbers and as such is considered a pass if there is no obvious pressure attributable to the frond loss. In the case of juvenile sporophytes emerging from gametophytes, their presence or absence should be noted. The target is that their continued presence is observed, or that they are observed to show growth towards becoming mature fronds by the presence of pinnae pairs; however, a reduction in their numbers is only considered a fail if attributed to an obvious pressure, such as canopy loss or reduced relative humidity levels for extended periods. If juvenile sporophytes emerging from gametophytes were not observed during the monitoring period 2009 – 2011, then NA will be input in the target box, however if juveniles are observed during future monitoring, the numbers should be counted or estimated and recorded.

Population level evaluation

Tables 1.1 & 1.2 show examples of complete Population Assessments for populations where sporophytes occur (including those with both generations) and for gametophyte-only populations. The baseline target figures for population size and the total living fronds for the example below represents the baseline data from the monitoring period ending 2011 for that population and is therefore equivalent to the results column as it relates to the same survey period. Due to natural fluctuations in frond numbers at sporophyte colonies, the target frond count is only considered a fail if there is an obvious pressure attributable to any frond loss. Likewise, any reduction in numbers of juvenile sporophytes emerging from gametophytes are only considered a fail if attributed to an obvious pressure. The data for completion of the Population Assessment is derived from the Killarney Fern Monitoring Sheet (Appendix 2) which is completed for each colony. For populations with multiple colonies, the Population Assessment is based on the combined colony data from each Killarney Fern Monitoring Sheet for a given population. For multiple colony populations, the result column for the indicator 'Frond Types' states which colonies the frond types refer to, as not all colonies in a population may have fertile fronds. This would follow for the indicators 'Associated

gametophytes' and 'Juveniles emerging from gametophytes'. See the example given below in Table 1.1.

The individual population condition is considered *favourable* for populations containing sporophytes (including co-occurring generation populations) if four or more indicators are passed. It is considered *unfavourable - inadequate* if only 2 or 3 indicators are passed, and *unfavourable - bad* if no more than one indicator is passed (Table 1.1). In cases where the indicator cannot be assessed, a value of NA should be returned, i.e. at colonies where gametophytes and/or juveniles were historically absent and continue to be absent. If gametophytes and/or juvenile sporophytes are observed at such colonies during future monitoring, they should be recorded, and in the case of juveniles, frond numbers should be counted or estimated.

Table 1.1. Population Assessment indicators and targets for populations where **sporophytes** occur, with or without gametophytes. Example data from a site in Co. Kerry (Appendix 1, Population 14).

Indicator	**Target**	**Baseline target for Population 14**	**Result for Population 14**	**Pass/Fail**
Total number of colonies	No loss of colonies	≥ 2	2	Pass
Population size (combined area of occupancy of all colonies)	No reduction in population size	3.4 m^2	3.4 m^2	Pass
Frond types	Fertile and/or Young and/or unfurling fronds present	Fertile/Young /unfurling fronds present	Fertile at Main Colony and young fronds present at both colonies	Pass
Associated gametophytes	No loss of associated gametophyte colonies, if previously observed	≥ 2 colonies	2	Pass
Juveniles emerging from gametophytes	No loss of previously observed juveniles. If there is a reduction of juveniles with no obvious pressure attributable to loss, the result is a pass	Juveniles present	Juveniles present at Up-stream colony	Pass
Total no. living fronds (Estimate)	No reduction. If there is a reduction in frond numbers with no obvious pressure attributable to loss, the result is a pass,	≥ 850	850	Pass
Individual Population Condition (sporophytes)	*Favourable (Green):* 4 - 6 passes *Unfavourable-inadequate (Amber):* 2 or 3 passes *Unfavourable-bad (Red):* 0 or 1 pass		6 passes	**Favourable**

The individual population condition is considered *favourable* for populations containing gametophyte-only if at least two indicators are passed. It is considered *unfavourable - inadequate* if only 1 indicator is passed, and *unfavourable - bad* if zero indicators are passed (Table 1.2).

Table 1.2. Population Assessment indicators and targets for populations where gametophytes occur in the absence of mature sporophytes (gametophyte-only populations). Example data from a site in Co. Wicklow (Appendix 1, Population 4)

Indicator	**Target**	**Baseline for Population 4**	**Result for Population 4**	**Pass/Fail**
Total number of colonies	No loss in colonies	≥ 2	2	Pass
Population size (combined area of occupancy of colonies)	No reduction in population size	≥ 0.37 m^2	0.37 m^2	Pass
Juveniles emerging from gametophytes	No loss of juveniles, if previously observed, unless not attributed to an obvious pressure	NA*	NA	NA
Individual Population Condition (gametophyte-only)	*Favourable(Green):* *Unfavourable-inadequate (Amber):* *Unfavourable-bad (Red):*	at least 2 passes 1 pass 0 passes	2 passes	**Favourable**

*NA (not applicable) means that juveniles were not observed during the monitoring period 2009 – 2011. If juveniles emerging from gametophytes are observed during future monitoring, the numbers should be counted or estimated and recorded and the baseline adjusted accordingly.

Section B – Habitat for the Species Assessment

The suitable area of habitat would correspond to the area where populations occur, such as a ravine, an area of woodland, cliff-face or crevice.

Domin scores and a Shade Index are used in the Habitat Assessment and are set out in Tables 1.3 and 1.4 below.

Table 1.3. Domin scale used to assess canopy cover at *T. speciosum* colonies/populations

Domin Scale	**Percentage DOMIN cover***
10	91-100%
9	76-90%
8	51-75%
7	34-50%
6	26-33%
5	11-25%
4	5-10%
3	1-4%
2	<1% with several individuals
1	<1% 1-2 individuals, no measurable cover
+	<1% 1 individual with no measurable cover

*Adapted from Kent (2012).

Table 1.4. Shade Index values recorded at each *T. speciosum* colony monitored

Shade Index Scale	**Details**
1	Fully exposed to sunlight all day
2	Sunlit for > half the day
3	Significant sunlight, but for < half the day
4	Moderate shade, e.g. light-medium deciduous canopy with sun flecks
5	Permanently shaded from direct sunlight but otherwise open to sky
6	Deep woodland (e.g. coniferous or in ravine) shade, no sun flecks
7	Perpetual deep shade, e.g. cave entrance, beneath boulder

Habitat Assessment for gametophyte-only populations

For the Habitat Assessment where *T. speciosum* gametophyte-only populations occur, there are 2 attributes that need to be assessed:

Adequate shading

The 4 gametophyte-only populations monitored between 2009 and 2011 occurred in deeply shaded microhabitats such as crevices, ravine walls, cliff overhangs, beneath boulders and cave entrances, which are typical habitats for this generation (Ní Dhúill, 2014). These populations were assigned the highest shade index scores of 6 and 7 which reflected the perpetually deeply shaded microhabitats where these colonies occurred, i.e. crevices, beneath boulders, cave entrances, ravines (Table 1.4). The target for this attribute is a Shade Index score of 6 or greater. A Shade Index score lower than this at a gametophyte-only population would be a fail for this attribute.

Relative humidity

Gametophyte-only populations can occur at drier locations than where the sporophyte generation typically occurs. A water source is not always visible at gametophyte-only populations. At these drier locations, running water would not always be expected to be observed, however, relative humidity levels should still be comparable with that found at the sporophyte colonies in wetter habitats. At these drier locations, high relative humidity is maintained within the crevices or beneath the overhangs or boulders where colonies occur. There would be little air movement at such sheltered locations. Relative humidity at gametophyte-only populations is typically above 90% and not usually less than 80% (Ní Dhúill, 2014). The target for relative humidity in the Habitat Assessment for gametophyte-only populations is that relative humidity is greater than or equal to 80%. This is measured with a handheld hygrometer by placing the sensor probe into the crevice to the location where the gametophyte colony occurs. It is recommended to allow instrument to acclimatise to the ambient relative humidity at the colony before recording the result, i.e. when a stable reading is given. A score lower than 80% would be a fail for this attribute.

Table 1.5 gives an example of a completed Habitat Assessment for gametophyte-only populations. The indicators used are relative humidity and shading, described above. The individual habitat assessment is considered *favourable* for populations containing gametophyte-only if both indicators are passed. It is considered *unfavourable - inadequate* if only 1 indicator is passed, and *unfavourable - bad* if zero indicators are passed.

Table 1.5. Habitat Assessment indicators and targets for the **gametophyte-only** population. Example data from a site in Co. Wicklow (Appendix 1, Population 4)

HABITAT TYPE = WOODLAND/OPEN UPLAND

Indicator	Target	Baseline for Population 4	Result for Population 4	Pass/Fail
Shade (shade index)	≥ 6	7	7	Pass
Relative Humidity	Relative Humidity > 80%	97%	97%	Pass
Individual Habitat condition (Gametophyte-only populations)	*Favourable (Green):* 2 passes *Unfavourable-Inadequate (Amber):* 1 pass *Unfavourable-bad (Red):* 0 passes		2	**Favourable**

Populations containing sporophytes

In a study of the ecology of *T. speciosum* in Ireland, using multivariate analysis, the 27 monitored populations were grouped into two general habitat types: 1) Woodland habitats; 2) Open upland habitats (Ní Dhúill, 2014). Within these habitats, *T. speciosum* sporophytes and gametophytes occupy specific microhabitats that provide constant high relative humidity and shade. For the Habitat Assessment where *T. speciosum* sporophytes occur, with or without the gametophyte generation, there are a number of attributes that need to be assessed:

Humidity and substrate moisture (Visible water source and substrate damp/wet to touch)

A water source is usually clearly visible at populations where sporophytes occur and include rivers, streams, waterfalls, cascades, dripping rock-faces or dripping banks. These water sources are very important in terms of maintaining high relative humidity where *T. speciosum* colonies occur. At colonies that occur on river/stream banks, the main source of water for the colonies is typically seepage. These banks are permanently wet which also aids maintenance of high relative humidity. As mentioned in the previous section, gametophyte-only colonies can sometimes occur at drier locations with no obvious water source. Sporophytes have been also been observed growing in such locations in Cos Donegal, Kerry (2 sites) and Limerick (Appendix 1, Populations 21, 12, 19 and 16). Rock seepage is typically the main source of water for these colonies. At these drier locations, depending on the time of year and weather conditions, running water would not be expected to be observed, however, relative humidity levels would still be comparable with that found at the colonies in wetter habitats. In these cases the substrate upon which *T. speciosum* sporophytes occurs should be wet/damp to touch. The target for humidity and substrate moisture in the Habitat Assessment for

woodland populations and open upland populations where sporophyte occur is that there is a visible water source and/or the substrate is damp/wet to touch. Unlike at gametophyte-only populations, it is not necessary to measure relative humidity using a hygrometer as this attribute can be assessed by the observation of a visible water source and/or substrate moisture at populations where sporophytes occur (with or without gametophytes) which would imply adequately high relative humidity.

Adequate shading

Shading at woodland colonies where sporophytes occur is mainly provided by canopy cover. Gametophytes at co-occurring generation populations in woodland habitats typically occur in crevices, except in more deeply shaded ravines where gametophytes have been observed growing in large mats on ravine walls (Ní Dhúill, 2014). Canopy cover score (Domin), which is estimated based on the proportion of the colony area covered by the vertical projection of the tree canopy, and Shade Index scores as per Tables 1.3 and 1.4 would be expected to remain relatively stable when compared to baseline data for the period 2009 to 2011. For the populations monitored between 2009 and 2011, canopy cover values for woodland habitats where sporophyte colonies occurred was typically assigned a Domin score of 6 – 7 (25-33% and 34-50% canopy cover). Shade at woodland colonies where sporophytes occurred was typically assigned a shade index score of 4 (light-medium deciduous canopy with sun flecks), with those occurring in ravines having a shade index score of 6 reflecting the deeper shade at these populations. The target Domin score for canopy cover at sporophyte colonies that occur in woodland habitats is ≥ 6 (this equates to greater than 26 – 33%) and the target shade index value is ≥ 4. A score lower than these would be a fail for these attributes.

For the sporophyte generation at open upland habitats, shade is typically provided by rocky outcrops, cliff over-hangs, crevices, boulders and aspect. Gametophytes at co-occurring generation populations in open upland habitats typically occur in crevices or beneath boulders. At these open locations, Shade Index scores are either 5 (permanently shaded from direct sunlight, but otherwise open to the sky) or 7 (perpetual deep shade). Shade Index values generally reflect the microhabitat where a colony occurs and would typically be expected to remain the same in each subsequent assessment (see Table 1.4). The target for this attribute for the Habitat Assessment for open upland habitats is set at ≥ 5 as anything less than 5 based on this Shade Index would indicate a major change. Any value less than this would be considered a fail for this attribute.

Encroachment

T. speciosum grows in deeply shaded habitats, however, the sporophyte can occur in higher light conditions where competition from other higher plants may be problematic. Encroachment of *T. speciosum* sporophyte colonies by vigorous native species or by invasive non-native species could negatively impact these colonies. *R. fruticosus* agg. was the only vigorous native species observed in the quadrats that was negatively impacting a colony within a population (Ní Dhúill, 2014). Encroachment by vigorous native species or by invasive non-native species should be investigated at all populations. If any such species are evident within a *T. speciosum* sporophyte colony that occupies an area greater than 1 m x 1 m, then a Domin score of 4 (5 – 10%) or less for such species in a 1 m x 1 m quadrat containing *T. speciosum* sporophytes would be a pass for this indicator. For colonies that occupy an area less than 1 m x 1 m, the indicator is the same (Domin score less than 4 for any vigorous native or invasive non-native species), however this is based on encroachment of such species within the area of occupancy of the *T. speciosum* colony. For populations with multiple colonies containing sporophytes, if any colony in the population has a Domin score greater 4 for encroachment, this is a fail for the whole population for this indicator.

Table 1.6 gives an example of a completed Habitat Assessment for Woodlands where the sporophyte generation occurs (with or without the gametophytes). The indicators used are humidity and soil moisture (visible water source and/or substrate damp/wet to touch), canopy cover, shading, and encroachment of vigorous native species or invasive non-native species. Table 1.7 gives an example of a completed Habitat Assessment for Open Uplands. The indicators used are humidity and soil moisture, and shading, described above. This Habitat Assessment would be applicable for any exposed habitat where *T. speciosum* occurs such as exposed rock and open lowlands.

The individual habitat assessment is considered *favourable* for woodland populations containing sporophytes (with or without gametophytes) only if at least four indicators are passed. It is considered *unfavourable – inadequate* if only 2 - 3 indicators are passed, and *unfavourable - bad* if zero to one indicator is passed (Table 1.6).

Table 1.6. Habitat Assessment indicators and targets for **<u>woodland</u>** populations where sporophytes occur, with or without gametophytes. Example from a site in Co. Cork (Appendix 1, Population 8)

HABITAT TYPE = WOODLAND

Indicator	Target	Baseline for Population 8	Result for Population 8	Pass/Fail
Canopy cover (Domin)	≥ 6	7	7	Pass
Shade (shade index)	≥ 4	4	4	Pass
Humidity and substrate moisture	Visible water source and/or substrate damp/wet to touch	Visible water source and substrate damp/wet to touch	Visible water source and substrate damp/wet to touch	Pass
Occurrence of vigorous native species or invasive non-native species within sporophyte colonies at *T. speciosum* populations *	Domin score ≤ 4 (1 – 10%) Species:	0	0	Pass
Habitat condition (woodland)	*Favourable (Green):* 4 passes *Unfavourable-Inadequate (Amber):* 2 - 3 passes *Unfavourable-bad (Red):* 0 passes		4 passes	**Favourable**

* For sporophyte colonies ≥ 1 m x 1 m, a Domin score ≤ 4 for such species in a 1 m x 1 m quadrat containing *T. speciosum* sporophytes is a pass. For colonies that are < 1 m x 1 m, a Domin score of ≤ 4 for such species is based on their presence within the area of occupancy of *T. speciosum* sporophytes. If any colony within a population fails for this indicator, then the whole population fails for this indicator.

The individual habitat assessment is considered *favourable* for <u>open upland</u> populations containing sporophytes (with or without gametophytes) only if at least two indicators are passed. It is considered *unfavourable - inadequate* if only 1 indicator is passed, and *unfavourable - bad* if zero indicators are passed (Table 1.7).

Table 1.7. Habitat Assessment indicators and targets for **open upland** populations where sporophytes occur, with or without gametophytes. Example from a site in Co. Kerry (Appendix 1, Population 5)

HABITAT TYPE = OPEN UPLAND

Indicator	Target	Baseline for Population 5	Result for Population 5	Pass/Fail
Shade (shade index)	≥ 5	5	5	Pass
Humidity and substrate moisture	Visible water source and/or substrate damp/wet to touch	Visible water source and substrate damp/wet to touch	Visible water source and substrate damp/wet to touch	Pass
Habitat condition (open upland)	*Favourable(Green):* 2 passes *Unfavourable-Inadequate (Amber):* 1 pass *Unfavourable-bad (Red):* 0 passes		2 passes	**Favourable**

Section C – Future prospects

The Site Assessment Sheet contains sections to record impacting activities. Such impacting activities are considered pressures if they are currently negatively impacting the species and they are considered threats if it is considered that they are likely to impact the species or its habitat in the foreseeable future. Not all impacting activities are negative and there can be activities that may have a positive impact on a species. Continued and standardised assessment of the local threat status will be important in monitoring trends over time, and will ultimately help inform management decisions and strategies.

Impacting activities should be recorded using the standardised EU-devised list of impact codes including their location, influence, intensity and area affected (Ssymank, 2010). These standardised activity categories are assessed based on a visual examination of colonies within a population ("within") and the surrounding habitat ("outside"). The "surrounding habitat" is difficult to define as the sphere of influence that may impact *T. speciosum* colonies/populations is not easily determined. It can loosely be defined as the vicinity around the population where activities may have an impact on the colony(s) within the population, i.e. tree felling and canopy loss in a woodland where *T. speciosum* colonies occur may affect relative humidity; landslides or bank collapses may dislodge or even destroy colonies within populations. Expert judgement is to be used to determine the "surrounding habitat" and the approximate area of this should be recorded. The intensity of the activity is graded low, medium or high. Additional activities should be recorded and included as observed. The Future Prospects Assessment (Table 1.8) should be completed to record current pressures and future threats at populations where *T. speciosum* occurs. This allows for flagging of potential impacting activities.

The column for 'area affected' is to be completed if there is a measurable impact from a pressure. If the impact cannot be measured or if there is no current impact, then the 'unknown' category can be assigned. If the influence and intensity of a potential impacting activity is unknown then 'unknown' should be completed in the relevant column. Again, this flags potential issues that may arise based on the impacting activity and allows for such pressures and threats to be monitored at future visits to the population. An example of a Future Prospects Assessment section set out in Table 1.8.

The Future Prospects Assessment for individual populations is more subjective. If there is no significant impact from the activities the Future Prospects should be assessed as *favourable* (green), moderate impact should be assessed as *unfavourable - inadequate* (amber) and severe impact as *unfavourable - bad* (red). For populations where there are more than one impacting activity recorded, if any of the impacting activities are having a moderate impact, the overall future prospects assessment is amber for that population. Likewise, if any of the impacting activities are having a severe impact in an individual population, the overall future prospects assessment is red for that population.

Table 1.8. Future Prospects Assessment of impacting activities (with EU code) including location, influence, intensity and area affected for *T. speciosum* colonies/populations. Example from a site in Co. Kerry (Appendix 1, Population 19)

Activity	Pressure (P) or threat (T)*	Location "Within" or "Outside"	Influence Positive/Negative/ Neutral	Intensity High/Medium/ Low	Area affected (m^2)
A04 Grazing	T	Within & Outside	Negative	Medium	Unknown
B02.03 Removal of forest undergrowth					
B02.04 Removal of dead and dying trees					
B02.06 Thinning of tree layer					
F04 Taking & removal of terrestrial plants					
G01 Outdoor sports & Leisure activities, recreational	T	Within and outside	Unknown	Low	Unknown
I01 Invasive non-native species	P	Outside	Unknown	Unknown	Unknown
I02 Problematic native species					
J01.01 Fire (burning down)					
K01.01 Natural erosion					
K04.01 Species composition change					
L09 Fire (natural)					
M01.01 Temperature changes (e.g. rise of temperature & extremes)					
M01.02 Droughts and less precipitations					
M01.03 Flooding and rising precipitations					
Other					
Future prospects condition	*Favourable (Green):*		No significant impact		***Unfavourable – inadequate* (Amber)**
	Unfavourable-inadequate (Amber):		Any moderate impact		
	Unfavourable-bad (Red):		Any severe impact		

* Pressure (P) – activity currently impacting the species or habitat. Threat (T) – activity likely to impact the species or habitat.

The above list in Table 1.8 should be updated if any additional potential impacting activities are noted that were not considered during the survey period 2009 – 2011.

Section D – Assessing Overall Conservation Condition for Individual populations

The Overall Conservation Condition of each individual population is derived by combining the results from each of the assessments (Population, Habitat for the Species and Future Prospects) using the following criteria:

- All assessments green = *Favourable* (green)
- 1 – 3 amber assessments = *Unfavourable - inadequate* (amber)
- Any red assessments = *Unfavourable - bad* (red)

An example of an Overall Conservation Condition Assessment for individual populations is given in Table 1.9.

Table 1.9. Overall Conservation Condition for an individual population. Example a from site in Co. Carlow (Appendix 1, Population 7)

Attribute	**Assessment**
Population Assessment	*Favourable*
Habitat for the Species Assessment	*Favourable*
Future Prospects Assessment	*Favourable*
Overall Individual Population Condition	**Favourable**

Section E – Assessing Overall Conservation Status for the species in Ireland

The proposed framework for assessing the condition at a population level allows for the amalgamation of results to assess conservation status at a national level, as required under Article 17 of the Habitats Directive. Evans & Arvela (2011) detail the approach that should be undertaken to assess status at the national level.

The *T. speciosum* populations under the current study are a representative sample across the natural range of the species in the Republic of Ireland. As detailed below in the recommendations, all 64 known populations should be visited to ensure accurate values for Range and Population are being reported. Any population or colony within a population that is lost since the Directive came into force

will result in a downgrading of the *Population* attribute to Amber or Red following the rules-based approach in Evans & Arvela (2011). For the populations not covered by the study, expert judgment should to be used if a population, or colony within a population, has been lost to determine the timing of the loss. As this species is well represented across its Range, any losses that occurred before the Directive came into force will not be assessed negatively.

Any significant reduction in the number of colonies with fertile fronds or juvenile sporophytes reported through ongoing monitoring should also be taken into account when assessing the *Population* attribute. Over half of populations monitored (57%) had fertile fronds recorded, although not all colonies in a population were necessarily fertile, nor were all fronds in a colony fertile. Lack of fertility at populations does not mean a population is in poor conservation condition, however, should fertile fronds be lost without replacement by young or unfurling fronds, it may be indicative of an unseen pressure. Therefore, after two reporting cycles, if fertile fronds are not observed in previously fertile populations AND if there is no evidence of new frond production based on frond counts (mature fertile or mature sterile fronds) and/or observation of young and/or unfurling fronds, then the status would be considered *unfavourable – inadequate* (amber) for this attribute. If however, frond numbers remain stable or increase at the colony(s) within populations, regardless of evidence of fertility, then the status remains *favourable* (green). If any fertile colonies are lost, with no evidence of production of new fronds (sterile, young or unfurling), then the population attribute would be considered *unfavourable – bad* (red), i.e. the loss of all fronds and future production of fronds (sterile or fertile) considered unlikely.

Range may also be affected by any losses, however, this will depend on where the population is located. Any new discoveries of *T. speciosum* colonies or populations may result in an adjustment of Favourable Reference Values. New discoveries are likely to be populations or colonies that were overlooked rather than an expansion in the Range of the species, this is particularly true of the gametophyte.

There is likely to be adequate habitat of sufficient quality for *T. speciosum* in Ireland, However, *T. speciosum* is habitat specific and is restricted to damp shady microhabitats. Based on the monitoring carried out between 2009 and 2011, encroachment by a vigorous native species was considered a problem at 1 of the known populations, representing 4% of the 27 populations visited. If the area of a colony within a population declines by 11% - 20% with no obvious reason, i.e. natural frond turnover OR if the cumulative decline of colony areas in populations with multiple colonies totals between 11% - 20% OR if the negative impact of encroachment occurs at any colonies within 2 – 4 populations then this attribute will be downgraded to Amber. If the area of colonies within populations declines by

more than 20% with no obvious reason, i.e. natural frond turnover, OR if the cumulative decline of colony areas in populations with multiple colonies is greater than 20% OR if the negative impact of encroachment occurs at any colonies at 5 or more populations, this attribute will be downgraded to red (unfavourable – *bad*).

The list of pressures reported for each population should be amalgamated to determine whether there are any pressures that are being repeatedly observed and at an intensity that is resulting in a decline in *Population* or *Habitat for the Species*. The severity of the impact will determine whether to assess as *unfavourable – inadequate* (amber) or *unfavourable – bad* (red).

Although *T. speciosum* is very ecologically niche specific, it is important to note that based on the monitoring of 27 populations between 2009 and 2011, there is no evidence of any major pressures operating at present,

The Overall Conservation Status for Ireland is derived by combining the results from each of the assessments and extracting details on the area of colonies within populations, frond loss and/or lack of frond production and/or impact by invasive non-native species and vigorous native species using the criteria set out below. However, expert judgment should be used when assessing these attributes, i.e. where there is a localised issue that is not considered a threat at the national level, this threat should be highlighted for that population, but may not necessarily reflect a negative impact on the national conservation status.

Table 1.10. Assessing Overall Conservation Status for the species in Ireland

Favourable (green)	=	All populations and colonies within populations remain stable OR decline in area of no more that 10% at any colonies (unless reduction attributable to natural frond turnover) OR that the cumulative decline in colony areas in populations with multiple colonies is not greater than 10% OR frond numbers remain stable or increase (any reduction in frond numbers attributable to natural frond turnover is acceptable).
Unfavourable – inadequate (amber)	=	Decline in colony area by 11% - 20% at a colony in a population, (unless reduction in area attributed to natural frond turnover) OR if the cumulative decline of colony areas in populations with multiple colonies totals between 11% - 20% (unless reduction in area attributed to natural frond turnover) OR frond number reduction with no production of new fronds (regardless of fertility) at any colony in a population OR encroachment by non-native invasive species or vigorous native species at any colonies at 2 – 4 populations.
Unfavourable – bad (red)	=	Decline in colony area by greater than 20% at a colony in a population (unless reduction attributed to natural frond turnover) OR if the cumulative decline of colony areas in populations with multiple colonies is greater than 20% (unless reduction in area attributed to natural frond turnover) OR total frond loss with no production of new fronds (i.e. all fronds lost at any colony in any population) OR encroachment by non-native invasive species or vigorous native species at any colonies at 5 or more populations.

Based on the survey period ending 2011, five populations had an *unfavourable - inadequate* conservation condition (amber) (see Appendix 1). These were based on localised issues, i.e. pressure from *R. fruticosus* agg. encroachment at Population 25, threat from grazing animals at Population 19, impact from removal of canopy cover at one colony in Population 20, impact on one colony in Population 22, attributed to trampling, and threat from *P. laurocerasus* invasion at Population 26, and are unlikely to become a national issue for the species. Therefore, the overall national assessment is that of a Favourable Conservation Status (green).

Recommendations for ongoing monitoring

Field Assessment

All questions on the Site Survey Card, Killarney Fern Monitoring Sheet (Appendix 2) and Site Assessment Sheet (Appendix 3) should be filled in at the population level to the best ability of the surveyor. For populations comprising multiple colonies, the Site Assessment Sheet (Appendix 3) can be filled in after the site visit as this requires collation of the data from each colony. The aim is to record the extent of the plant and any pressures or threats at each colony/population. It is recommended that the sheet containing the previous monitoring results be used in the field and the current monitoring results added. This will enable the surveyor to ascertain if any changes have taken place between surveys.

Timing

Monitoring of *T. speciosum* should be carried out between June and October. For woodland populations where sporophytes occur this would allow for observation of changes in canopy cover and encroachment by the vigorous native species *R. fruticosus* agg., or by any invasive non-native species that may negatively impact a colony/population. It is also during this period that spores are reported to mature (Page, 1997). For open upland populations where sporophytes occur, monitoring during this period would increase the chances of observing mature fertile fronds. For populations monitored during 2009 - 2011, future monitoring should be carried out at the same time of year as previous visits in order to attain comparable data. Newly monitored populations should be visited at the same period in subsequent years. Newly monitored gametophyte-only populations can be monitored at any time of year as the attributes for the purpose of the Habitat Assessment at these populations should not be unduly affected by seasonality, i.e. target relative humidity and shading index values.

Monitoring recommendations

Recommendations for ongoing monitoring are based on observations at the 27 *T. speciosum* populations visited during the period 2009 - 2011 which incorporates the requirements set out in the All-Ireland Species Action Plan for *T. speciosum* in Ireland (Anonymous, 2008), along with monitoring guidelines outlined by Rumsey (1997) and the JNCC (2004). Monitoring of populations visited during

the period 2009 to 2011 provide baseline data against which future monitoring at these locations can be compared.

It is recommended that monitoring of *T. speciosum* gametophyte-only populations be carried out at most every 6 years and monitoring of populations where sporophytes occur be carried out every 6 years, with the exception of more frequent visits to a number of populations that contain colonies that are considered to be at risk of loss (Colony 4, Population 20; Colony 7, Population 22 (see Appendix 1)) and colonies that suffered severe frond loss during the monitoring period 2009 to 2011 but were not considered at risk of being lost (Population 19 and the smaller of the two co-occurring sporophyte/gametophyte colonies in Population 1). In addition to this, more frequent visits to populations where juvenile sporophytes were observed is recommended to assess their survival at these locations (Colonies B, C, E and 3, Population 26; Colonies 1 and 4, Population 22; Upstream Colony, Population 14; Populations 7 and 24). The necessity for more frequent visits to monitor these colonies should be reassessed after the next EU Habitats Directive Article 17 reporting submission due in 2018. The Site Survey Card and Killarney Fern Monitoring Sheet (Appendix 2) should be completed at each site visit.

Presence of invasive non-native species or vigorous native species should be recorded if observed in the vicinity of the colonies, particularly in relation to colonies or populations where the presence of such species have previously been recorded, i.e. *R. fruticosus* agg. at Population 25, *R. ponticum* at Population 20 and *P. laurocerasus* at Populations 22 and 26.

On average, based on spot readings and extended environmental recordings of relative humidity during the monitoring period 2009 - 2011, average relative humidity generally exceeded 90% and was typically > 80% (Ní Dhúill, 2014). Taking into account weather conditions and the use of different hand-held devices, an acceptable relative humidity value should not be below 80% at *T. speciosum* colonies regardless of generation.

Photographs of the colony should be taken at each visit, including close-up images of fronds and general images of the colony.

The overall target is that there is no reduction in *T. speciosum* population or colony numbers in Ireland. Based on the historic presence of populations visited during the monitoring project period 2009 to 2011, it is very likely that the majority of the remaining populations that were not subject to recent survey are still present in their locations, however, it is recommended that all remaining populations be visited and baseline data recorded in line with that recorded during monitoring from 2009 – 2011. It is recommended that the oldest recorded populations be prioritised for survey in order to confirm their continued existence at those locations.

Conclusion

The completion of the life cycle of *T. speciosum* is important in terms of genetic diversity of this species, however, the ability of both generations to perpetuate vegetatively is important for continued survival at its current locations. Climatic control of juvenile sporophyte production and survival has been suggested (Rumsey & Sheffield, 1996) and it was further noted that climate change, which may result in warmer wetter climates, may provide more favourable conditions for *T. speciosum* to complete its life-cycle (Krukowski & Świerkosz, 2004).

Overall the future prospects of the monitored Irish colonies at 27 populations between 2009 and 2011 looks positive with colony numbers remaining stable, with the exception of the possible loss of 2 small colonies described earlier.

T. speciosum sporophyte range distribution is more a reflection of the current climatic conditions (Ratcliffe *et al.,* 1993) and a relictual distribution (Jermy, 1994). It thus could be considered that the current range of *T. speciosum* sporophyte more or less reflects its potential range. However, it is likely that many more gametophyte colonies occur in both upland and woodland habitats yet to be recorded and it is also likely that there are further sporophyte colonies awaiting discovery.

T. speciosum has a long life history in Ireland and future survival at its current locations is expected.

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Appendix 1

Lists of 27 populations surveyed between 2009 – 2011 and details of the life-stage (sporophyte or gametophyte) at each colony, the number of colonies at each population, the number of fertile sporophyte colonies, grid references for each population (10 km x 10 km) and summary results for the Site Assessment (Population Assessment, Habitat Assessment and Overall Assessment).

Appendix 1. List of 27 populations surveyed between 2009 – 2011 with details of observed colony numbers, number of fertile sporophyte colonies, grid references (10km x 10km) and results of site assessment (population assessment, habitat assessment, future prospects and overall assessment). Population details held by National Parks and Wildlife Service. Green = favourable; Amber = unfavourable inadequate; Red = unfavourable bad.

Population No.	County	Grid ref. (10 km²)	Sporophyte/ Gametophyte	Total No. Gametophyte-only colonies	Total No. Colonies with Sporophyte	No. Colonies with fertile fronds	Population Assessment	Habitat Assessment	Future Prospects	Overall Assessment (Conservation Condition)
1	Tipperary/ Limerick	R75	S&G	2	2	*0	Favourable	Favourable	Favourable	Favourable
2	Mayo	G20	G	1	0	na	Favourable	Favourable	Favourable	Favourable
3	Wicklow	O11	G	1	0	na	Favourable	Favourable	Favourable	Favourable
4	Wicklow	T29	G	2	0	na	Favourable	Favourable	Favourable	Favourable
5	Kerry	Q40	S	0	1	1	Favourable	Favourable	Favourable	Favourable
6	Kerry	Q40	S&G	0	1	0	Favourable	Favourable	Favourable	Favourable
7 **	Carlow	S74	S&G	1	1	0	Favourable	Favourable	Favourable	Favourable
8	Cork	V65	S&G	0	2	2	Favourable	Favourable	Favourable	Favourable
9	Kerry	V77	S&G	1	1	0	Favourable	Favourable	Favourable	Favourable
10	Kerry	V77	S	0	1	0	Favourable	Favourable	Favourable	Favourable
11	Kerry	V88	S&G	0	1	1	Favourable	Favourable	Favourable	Favourable
12	Kerry	V98	S&G	1	1	0	Favourable	Favourable	Favourable	Favourable
14 **	Kerry	Q70	S&G	0	2	1	Favourable	Favourable	Favourable	Favourable
15	Kerry	Q50	S	0	1	1	Favourable	Favourable	Favourable	Favourable
16	Limerick	R61	S&G	1	1	1	Favourable	Favourable	Favourable	Favourable
17	Sligo	G52	S&G	1	1	0	Favourable	Favourable	Favourable	Favourable
18	Kerry	Q41	S&G	0	1	1	Favourable	Favourable	Favourable	Favourable

Population No.	County	Grid ref. (10 km²)	Sporophyte/ Gametophyte	Total No. Gametophyte-only colonies	Total No. Colonies with Sporophyte	No. Colonies with fertile fronds	Population Assessment	Habitat Assessment	Future Prospects	Overall Assessment (Conservation Condition)
19	Kerry	V98	S&G	0	1	1	Favourable	Favourable	Unfavourable (inadequate)	Unfavourable (inadequate)
20	Limerick	R75	S&G	0	5	3	Favourable	Favourable	Unfavourable (inadequate)	Unfavourable (inadequate)
21	Donegal	G98	S&G	0	1	0	Favourable	Favourable	Favourable	Favourable
22	Cork	W23	S&G	0	7	3	Favourable	Favourable	Unfavourable (inadequate)	Unfavourable (inadequate)
23	Donegal	B91	S&G	0	1	0	Favourable	Favourable	Favourable	Favourable
24 **	Kerry	V98	S&G	0	***4	0	Favourable	Favourable	Favourable	Favourable
25	Cork	W14	S&G	2	2	2	Favourable	Unfavourable (inadequate)	Unfavourable (inadequate)	Unfavourable (inadequate)
26 **	Waterford	X29	S&G	4	18	3	Favourable	Favourable	Unfavourable (inadequate)	Unfavourable (inadequate)
27	Waterford	S00	S&G	1	1	0	Favourable	Favourable	Favourable	Favourable
28 **	Kilkenny	S63	G	2	0	na	Favourable	Favourable	Favourable	Favourable

* 1 colony was fertile in 2009-2010 but severely burned with loss of majority of mature fertile and sterile fronds. New fronds emerging. Fertility to be reassessed.

** Gametangia observed. *** Frond counts not carried out at 2 colonies observed in 2011 that comprised many tiny juvenile sporophytes emerging from gametophytes.

Appendix 2

(1) Blank Site Survey Card for *Trichomanes speciosum* to be completed for the overall populations and (2) Blank Killarney Fern (*T. speciosum*) Monitoring Sheet to be completed for each colony.

SITE SURVEY CARD – *Trichomanes speciosum*

(population may include 1 or more colonies)

Surveyor:	**Date:**

Location:	**Population Name:**	**No. Colonies:**
Discovery Series OS Map No.:	**Aerial Photo ID and year:**	**Land Tenure:** (SAC, NHA, private, unknown)
Historic grid reference:	**GPS at access point:**	**GPS at population:**

Habitat type: (Woodland/Open Upland/Exposed Rock, etc)	**Fossitt classification:**	**EU classification:**

Generation: (Sporophyte/gametophyte or both)	**Brief Vegetation description:**
Approximate extent of suitable habitat (m^2):	

Extent of population (m^2) for multiple colony population OR single colony population.	
For **multiple colony populations**, this is the area (m^2) from 1st colony to furthest colony.	For **single colony populations**, this is the area (m^2) of the colony.
Seasonal flooding (y/n):	**Weather condition:**
Mapped digitally (✓): (on Trimble or other handheld GPS device)	**Other Notes:**
Time spent on site:	

Photographs	**Photo ID**	**Notes**
General		
Colony(s)		
Sporophytes		
Gametophytes		
North		
South		
East		
West		

ADDITIONAL PHOTOS

Photo ID:	**Notes:**	**Photo ID:**	**Notes:**

SITE SKETCH (if necessary)

Indicate North

Killarney Fern (*Trichomanes speciosum)* Monitoring Sheet

For populations with **multiple colonies**, this sheet is to be completed for **each colony**.

Surveyor:	**Date:**

Population Name:	**Colony Name:**
Generation: Sporophyte-only; gametophyte-only or sporophyte & gametophyte co-occurring	

SECTION A – Monitoring of <u>sporophyte</u> direct attributes	
Sporophyte present (Y/N):	**Grid reference** (if possible)**:**
Colony Area (m²): (Measured as a rectangle, one measurement across the maximum dimension of the colony and another perpendicular to this)	**Area of occupancy (%):** (the greatest extent of the area of the colony within the rectangle occupied by *T. speciosum)*

Count or **Estimate**		**Count**	**Estimate**		
			Patch No. (25 x 25cm)	Patch No (25 x 25cm)	Patch No (25 x 25cm)
Frond Numbers Notes:	**No. mature sterile fronds** (>50% green, fully expanded)				
	No. fertile fronds (>50% green, fully expanded)				
	Young (still unfurling, not fully expanded)				
	Croziers (beginning to unfurl)				
	Juvenile fronds (emerging from gametophytes)				
	No. dying fronds (<50% green)				
	No. dead fronds (blade ± intact but frond all brown)				

SECTION B – Monitoring of <u>gametophyte</u> direct attributes	
Gametophyte present (Y/N):	**Grid reference** (if possible)**:**
Colony Area (m²): (Measured as a rectangle, one measurement across the maximum dimension of the colony and another perpendicular to this)	**Area of occupancy (%):** (the greatest extent of the area of the colony within the rectangle occupied by *T. speciosum)*
Distance to nearest sporophyte: (measured from the extremity of gametophyte colony to nearest sporophyte colony)	
Describe gametophyte colony: Dense colony Patchy colony Sparse colony	

SECTION C – Monitoring of colony direct attributes	
Aspect:	**Altitude:**
Seasonal flooding at colony (y/n):	**Rock type:**

Relative humidity and substrate moisture:	**Visible water source (Y/N):**
	***Water source:**
	Substrate damp/wet to touch (at sporophyte colony)**:**
	Relative humidity: Target RH ≥ 80% (at gametophyte colony)
*__**WATER SOURCE**__: **1** = Stream; **2** = River; **3** = Dripping Cave; **4** = Splash; **5** = Waterfall; **6** = Ground seepage; **7** = Rock seepage; **8** = Other	
Shading:	**Adequate shading (Y/N):** (if no, give reason)
	Woodland shading: (Target **shade index ≥ 4)
	Open upland shading: (Target shade index ≥ 5)
__SHADE INDEX :__ 1, Fully exposed to sunlight all day. **2**, Sunlit for > half the day. **3**, Significant sunlight, but for < half the day. **4**, Moderate shade, e.g. light-medium deciduous canopy with sun flecks. **5**, Permanently shaded from direct sunlight but otherwise open to sky. **6**, Deep woodland (e.g. coniferous or in ravine) shade, no sun flecks. **7,** Perpetual deep shade, e.g. cave entrance, beneath boulder	
Canopy Cover: (Woodland habitats only)	**Adequate canopy cover (Y/N):** (if no, give reason)
	Canopy cover (Domin*):** (Target Domin score ≥ 6)
***__DOMIN SCALE__: + =** < 1% with no measurable cover; **1** = < 1% 1 – 2 individuals, no measurable cover; **2** = < 1% with several individuals; **3** = 1 – 4%; **4** = 5 – 10%; **5** = 11 – 25%; **6** = 26 – 33%**; 7** = 34 – 50%**; 8** = 51 – 75%**; 9** = 76 – 90% **10** = 91 – 100%	
Encroachment**	**Vigorous native species in colonies where sporophytes occur:** Target Domin ≤ 4
List species name(s) and give Domin score and area of colony affected (m²).	**Non-native invasive species in colonies where sporophytes occur:** Target Domin ≤ 4
	Encroachment of bryophyte species in colonies where gametophytes occur: (No Domin target score set)
**** ENCROACHMENT: For sporophyte colonies ≥ 1 m x 1 m, a Domin score ≤ 4 for such species in a 1 m x 1 m quadrat containing *T. speciosum* sporophytes is acceptable. For sporophyte colonies that are < 1 m x 1 m, a Domin score of ≤ 4 for such species is based on their presence within the area of occupancy of *T. speciosum* sporophytes.	
Observation of vigorous native species or non-native invasive species in the vicinity of the colony: **(**List any such species occurring in the immediate vicinity i.e. *Rubus fruticosus* agg., *Rhododendron ponticum*, *Prunus laurocerasus*)	Vigorous native species**:** Invasive non-native species:
Other impacting activities: (i.e. grazing, collecting, trampling, removal of forest undergrowth, thinning of tree layer, etc.)	**Extent of damage:** Give details on number fronds damaged and/or area of colony affected (m²)
Recommendations for management of colony:	

Appendix 3

Blank Site Assessment Sheets for gametophyte-only populations and for populations containing sporophytes (with or without gametophytes). Site Assessment Sheets to be completed based on collated data from the Site Survey Card (Appendix 2) and the Killarney Fern Monitoring Sheet (Appendix 2).

Site Assessment Sheet for gametophyte-only populations

Population Name: **County** **(SAC no.)** **Date:**

Total No. Colonies	Colony	Colony Generation	Total area Sporophyte (m^2)	Total area Gametophyte (m^2)	Grid Reference	Alt (m)
			Na			
			Na			
			Na			
TOTAL			Na		NA	NA

Ownership: Private/public/unknown. If private, supply owner contact details if available

Timing for monitoring of this population should be around _____ for comparative purposes.

Brief description of population and habitat where it occurs

Overall Conservation Condition for *T. speciosum* at _____

Attribute	Assessment
Population Assessment	
Habitat for the Species Assessment	
Future Prospects Assessment	
Overall Individual Population Condition	

(A) POPULATION ASSESSMENT

The individual population condition is considered favourable for populations containing **gametophyte-only** if at least two indicators are passed. It is considered unfavourable-inadequate if only 1 indicator is passed, and unfavourable bad if zero indicators are passed.

Population Assessment indicators and targets for the *T. speciosum* population at _____.

Indicator	**Target**	**Baseline for**	**Result for**	**Pass/Fail**
Total No. colonies	No loss in colonies			
Population size (combined area of occupancy of colonies)	No reduction in population size			
Juveniles emerging from gametophytes	No loss of juveniles, if previously observed, unless not attributed to an obvious pressure			
Individual Population Condition (gametophyte-only)	*Favourable(Green):* *Unfavourable-Inadequate (Amber):* *Unfavourable-bad (Red):*	at least 2 passes 1 pass 0 passes		

*NA (not applicable) means that juveniles were not observed during the monitoring period 2009 – 2011. If juveniles emerging from gametophytes are observed during future monitoring, the numbers should be counted or estimated and recorded.

(B) HABITAT FOR THE SPECIES ASSESSMENT (Gametophyte-only)

The individual habitat assessment is considered favourable for populations containing gametophyte-only if at least two indicators are passed. It is considered unfavourable-inadequate if only 1 indicator is passed, and unfavourable bad if zero indicators are passed.

Habitat Assessment indicators and targets for the **gametophyte-only** population at _____.

HABITAT TYPE = WOODLAND/OPEN UPLAND

Indicator	Target	Baseline for	Result for	Pass/Fail
Shade (shade index)	≥ 6			
Relative Humidity	Relative Humidity > 80%			
Individual Habitat condition (Gametophyte-only populations)	*Favourable (Green):* 2 passes *Unfavourable-Inadequate (Amber):* 1 pass *Unfavourable-bad (Red):* 0 passes			

SHADE INDEX : **1.** Fully exposed to sunlight all day. **2.** Sunlit for > half the day. **3.** Significant sunlight, but for < half the day. **4.** Moderate shade, e.g. light-medium deciduous canopy with sun flecks. **5.** Permanently shaded from direct sunlight but otherwise open to sky. **6.** Deep woodland (e.g. coniferous or in ravine) shade, no sun flecks. **7.** Perpetual deep shade, e.g. cave entrance, beneath boulder

(C) FUTURE PROSPECTS

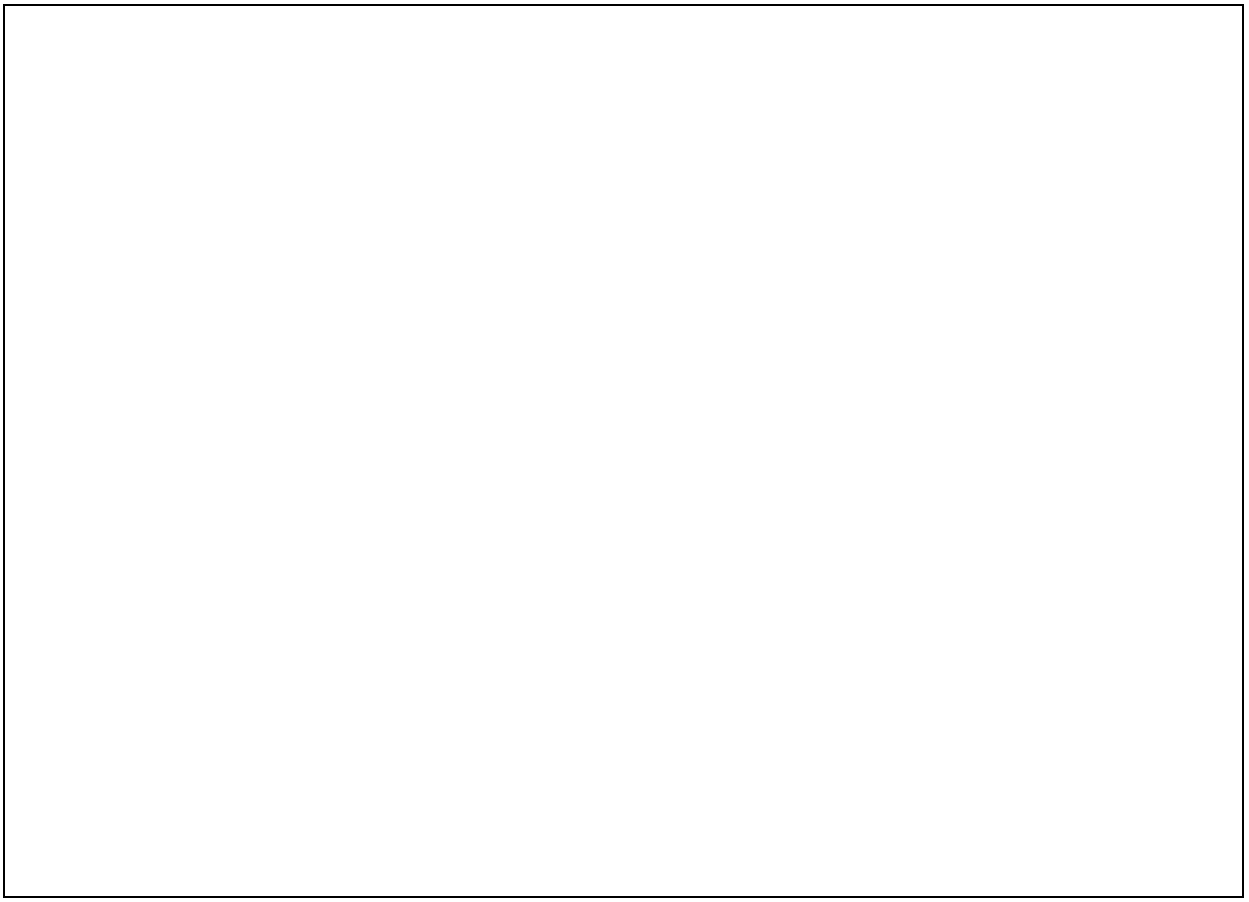
If there is no significant impact from the activities Future Prospects should be assessed as *favourable* (green), moderate impact should be assessed as *unfavourable - inadequate* (amber) and severe impact as *unfavourable - bad* (red). For populations where there are more than one impacting activity recorded, if any of the impacting activities are having a moderate impact, the overall future prospects assessment is amber for that population. Likewise, if any of the impacting activities are having a severe impact in an individual population, the overall future prospects assessment is red for that population.

Future Prospects Assessment of potential impacting activities (with EU code) including location, influence, intensity and area affected for the *T. speciosum* population _____

Activity	**Location "Within" or "Outside"**	**Influence Positive/Negative/ Neutral**	**Intensity High/Medium/ Low**	**Area affected (m^2)**
A04 Grazing				
B02.03 Removal of forest undergrowth				
B02.04 Removal of dead and dying trees				
B02.06 Thinning of tree layer				
F04 Taking & removal of terrestrial plants				
G01 Outdoor sports & Leisure activities, recreational				
I01 Invasive non-native species				
I02 Problematic native species				
J01.01 Fire (burning down)				
K01.01 Natural erosion				
K04.01 Species composition change				
L09 Fire (natural)				
M01.01 Temperature changes (e.g. rise of temperature & extremes)				
M01.02 Droughts and less precipitations				
M01.03 Flooding and rising precipitations				
Other				
Future prospects condition	*Favourable(Green):* Not significant *Unfavourable-Inadequate (Amber):* Any moderate *Unfavourable-bad (Red):* Any severe			

LOCATION DETAILS

See ordnance survey map and aerial map below in Map 1 and 2 showing the S&G/S-only/G-only population at _____



Map 1. Ordnance Survey Map showing S&G/S-only/G-only population at _____ and also showing access point to the site (red X).

Map 2. Aerial Map showing S&G/S-only/G-only population at _____ and also showing access point to the site.

ACCESS DETAILS

Detailed description of access to population and colonies within, including photographs. Sketches to be included if necessary. Photographs of each colony (sporophytes and gametophytes) to be included.

Site Assessment Sheet for populations containing sporophytes

Population Name: **County** **(SAC no.)** **Date:**

Total No. Colonies	Colony	Colony Generation	Total area Sporophyte (m^2)	Total area Gametophyte (m^2)	Grid Reference	Alt (m)
TOTAL		NA			NA	NA

Ownership: *Private/public/unknown. If private, supply owner contact details if available*

Timing for monitoring of this population should be around _____ for comparative purposes.

Brief description of population and habitat where it occurs

Overall Conservation Condition for *T. speciosum* at _____

Attribute	Assessment
Population Assessment	
Habitat for the Species Assessment	
Future Prospects Assessment	
Overall Individual Population Condition	

(A) POPULATION ASSESSMENT

The individual population condition is considered favourable for populations containing sporophytes (including co-occurring generation populations) if four or more indicators are passed. It is considered unfavourable-inadequate if only 2 or 3 indicators are passed, and unfavourable bad if no more than one indicator is passed.

Population Assessment indicators and targets for _____.

Indicator	**Target**	**Baseline target for**	**Result for**	**Pass/Fail**
Total number of colonies	No loss of colonies			
Population size (combined area of occupancy of all colonies)	No reduction in population size			
Frond types	Fertile and/or Young and/or unfurling fronds present			
Associated gametophytes	No loss of associated gametophyte colonies, if previously observed			
Juveniles emerging from gametophytes	No loss of previously observed juveniles. If there is a reduction of juveniles with no obvious pressure attributable to loss, the result is a pass			
Total no. living fronds (Estimate)	No reduction. If there is a reduction in frond numbers with no obvious pressure attributable to loss, the result is a pass,			
Individual Population Condition (sporophytes)	*Favourable (Green):* 4 - 6 passes *Unfavourable-Inadequate (Amber):* 2 or 3 passes *Unfavourable-bad (Red):* 0 or 1 pass			

*NA (not applicable) means that the indicator was not observed during the monitoring period 2009 – 2011. NA would only be applicable to the indicators 'Associated gametophytes' and 'Juveniles emerging from gametophytes'. If these indicators are observed during future monitoring, they should be recorded, and in the case of juveniles, frond numbers should be counted or estimated.

(B) HABITAT FOR THE SPECIES ASSESSMENT (WOODLAND)

The individual habitat assessment is considered favourable for **woodland populations** containing sporophytes (with or without gametophytes) only if at least four indicators are passed. It is considered unfavourable-inadequate if only 2 - 3 indicators are passed, and unfavourable bad if zero to one indicator is passed.

Habitat Assessment indicators and targets for *T. speciosum* at _____.

HABITAT TYPE = WOODLAND

Indicator	Target	Baseline for	Result for	Pass/Fail
Canopy cover (Domin)	≥ 6			
Shade (shade index)	≥ 4			
Humidity and substrate moisture	Visible water source and/or substrate damp/wet to touch			
Occurrence of vigorous native species or invasive non-native species within sporophyte colonies at *T. speciosum* populations *	Domin score ≤ 4 (1 – 10%) Species:			
Habitat condition (woodland)	*Favourable (Green):* 4 passes *Unfavourable-Inadequate (Amber):* 2 - 3 passes *Unfavourable-bad (Red):* 0 passes			

* For sporophyte colonies ≥ 1 m², a Domin score ≤ 4 for such species in a 1 m x 1 m quadrat containing *T. speciosum* sporophytes is a pass. For colonies that are < 1 m², a Domin score of ≤ 4 for such species is based on their presence within the area of occupancy of *T. speciosum* sporophytes. If any colony within a population fails for this indicator, then the whole population fails for this indicator.

DOMIN SCALE: + = no measurable cover; **1** = < 1% 1 – 2 individuals, no measurable cover; **2** = < 1% with several individuals; **3** = 1 – 4%; **4** = 5 – 10%; **5** = 11 – 25%; **6 =** 26 – 33%**; 7 =** 34 – 50%**; 8 =** 51 – 75%**; 9** = 76 – 90% **10** = 91 – 100%

SHADE INDEX : 1. Fully exposed to sunlight all day. **2.** Sunlit for > half the day. **3.** Significant sunlight, but for < half the day. **4.** Moderate shade, e.g. light-medium deciduous canopy with sun flecks. **5.** Permanently shaded from direct sunlight but otherwise open to sky. **6.** Deep woodland (e.g. coniferous or in ravine) shade, no sun flecks. **7.** Perpetual deep shade, e.g. cave entrance, beneath boulder

(B) HABITAT FOR THE SPECIES ASSESSMENT (OPEN UPLAND)

The individual habitat assessment is considered favourable for **open upland populations** containing sporophytes (with or without gametophytes) only if at least two indicators are passed. It is considered unfavourable-inadequate if only 1 indicator is passed, and unfavourable bad if zero indicators are passed.

Habitat Assessment indicators and targets for the *T. speciosum* population at _____.

HABITAT TYPE = OPEN UPLAND

Indicator	Target	Baseline for	Result for	Pass/Fail
Shade (shade index)	≥ 5			
Humidity and substrate moisture	Visible water source and/or substrate damp/wet to touch			
Habitat condition (open upland)	*Favourable(Green):* 2 passes *Unfavourable-Inadequate (Amber):* 1 pass *Unfavourable-bad (Red):* 0 passes			

SHADE INDEX : **1.** Fully exposed to sunlight all day. **2.** Sunlit for > half the day. **3.** Significant sunlight, but for < half the day. **4.** Moderate shade, e.g. light-medium deciduous canopy with sun flecks. **5.** Permanently shaded from direct sunlight but otherwise open to sky. **6.** Deep woodland (e.g. coniferous or in ravine) shade, no sun flecks. **7.** Perpetual deep shade, e.g. cave entrance, beneath boulder

(C) FUTURE PROSPECTS

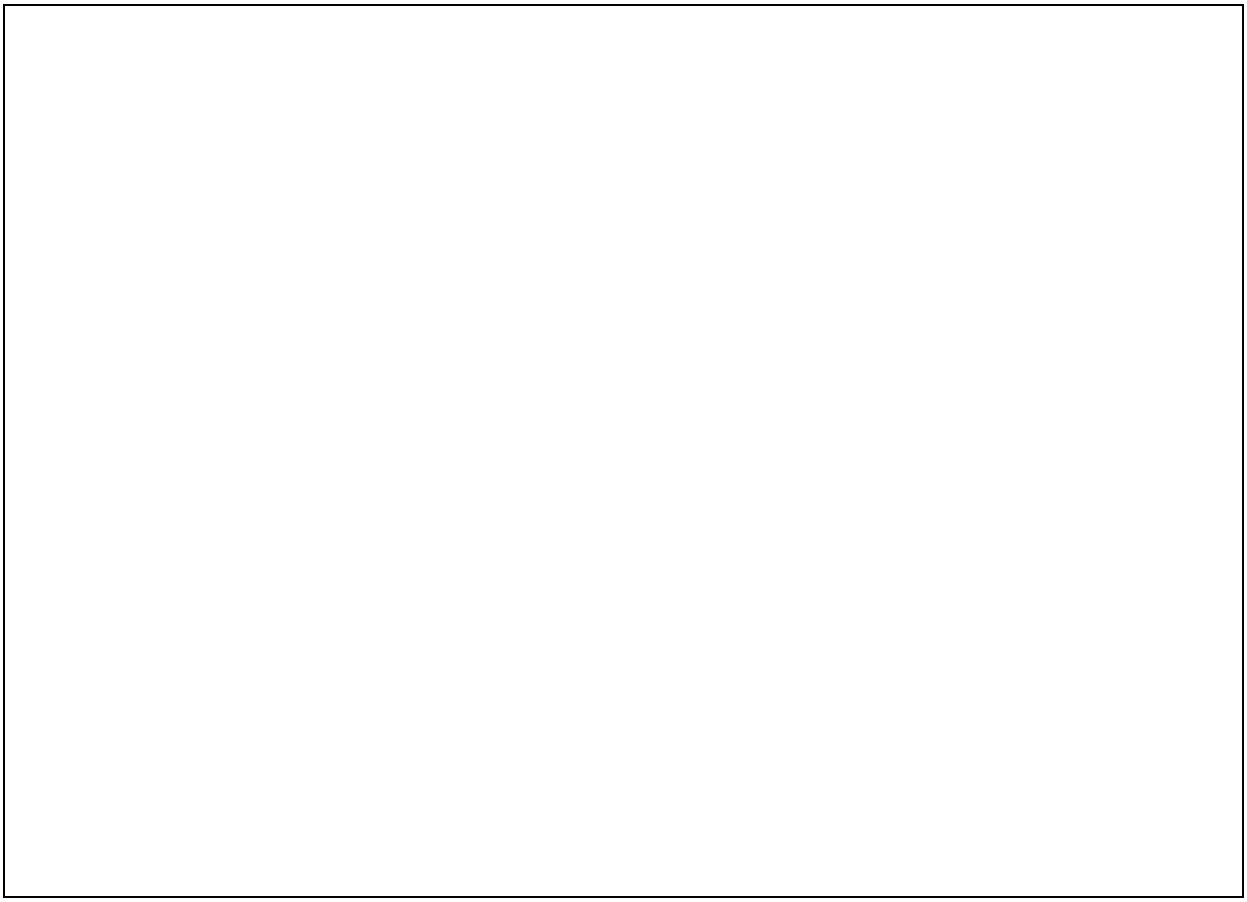
If there is no significant impact from the activities Future Prospects should be assessed as *favourable* (green), moderate impact should be assessed as *unfavourable - inadequate* (amber) and severe impact as *unfavourable - bad* (red). For populations where there are more than one impacting activity recorded, if any of the impacting activities are having a moderate impact, the overall future prospects assessment is amber for that population. Likewise, if any of the impacting activities are having a severe impact in an individual population, the overall future prospects assessment is red for that population.

Future Prospects Assessment of potential impacting activities (with EU code) including location, influence, intensity and area affected for the *T. speciosum* population _____

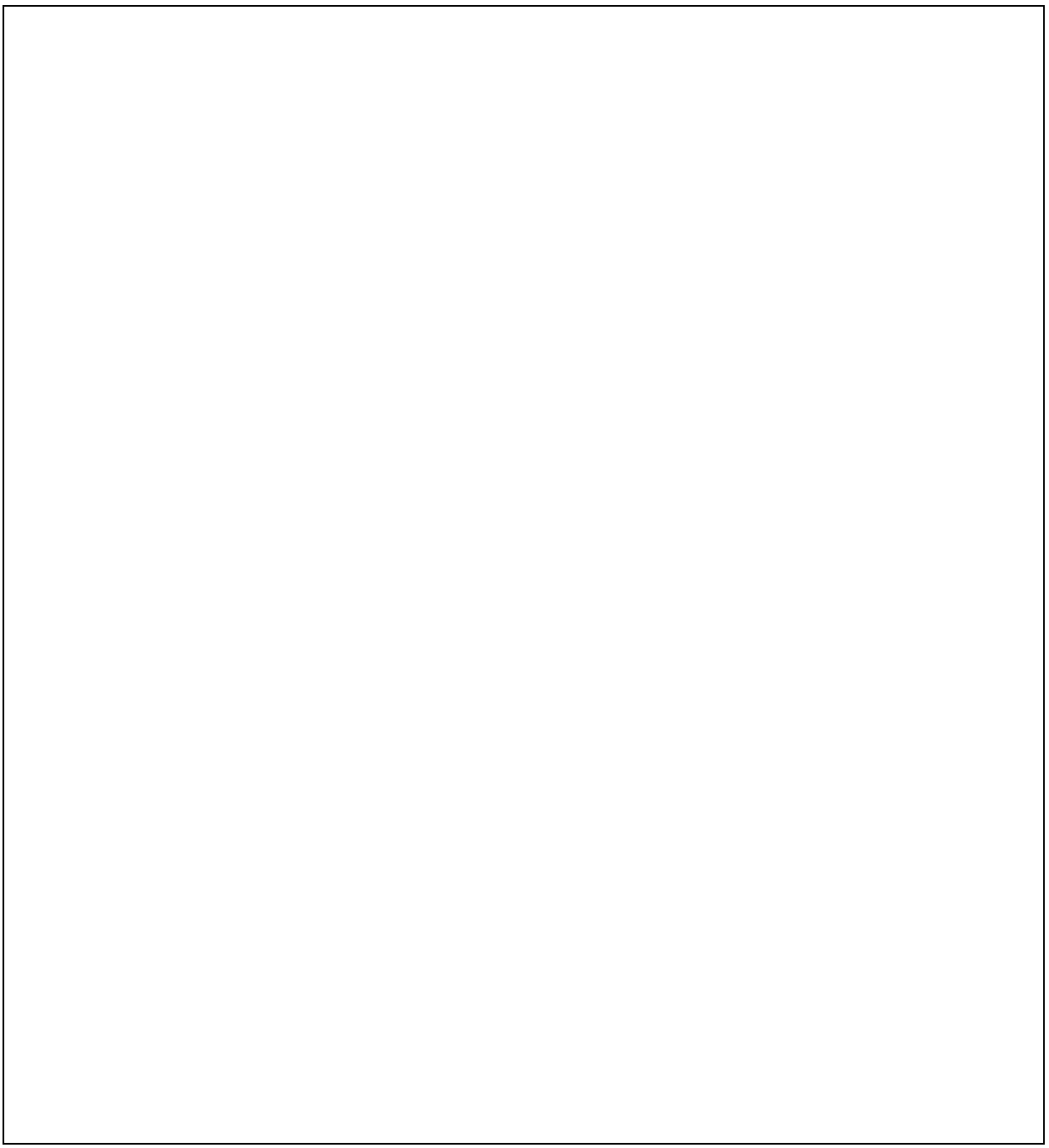
Activity	**Location "Within" or "Outside"**	**Influence Positive/Negative/ Neutral**	**Intensity High/Medium/ Low**	**Area affected (m^2)**
A04 Grazing				
B02.03 Removal of forest undergrowth				
B02.04 Removal of dead and dying trees				
B02.06 Thinning of tree layer				
F04 Taking & removal of terrestrial plants				
G01 Outdoor sports & Leisure activities, recreational				
I01 Invasive non-native species				
I02 Problematic native species				
J01.01 Fire (burning down)				
K01.01 Natural erosion				
K04.01 Species composition change				
L09 Fire (natural)				
M01.01 Temperature changes (e.g. rise of temperature & extremes)				
M01.02 Droughts and less precipitations				
M01.03 Flooding and rising precipitations				
Other				
Future prospects condition	*Favourable(Green):* Not significant *Unfavourable-Inadequate (Amber):* Any moderate *Unfavourable-bad (Red):* Any severe			

LOCATION DETAILS

See ordnance survey map and aerial map below in Map 1 and 2 showing the S&G/S-only/G-only population at _____



Map 1. Ordnance Survey Map showing S&G/S-only/G-only population at _____ and also showing access point to the site (red X).



Map 2. Aerial Map showing S&G/S-only/G-only population at _____ and also showing access point to the site.

ACCESS DETAILS

Detailed description of access to population and colonies within, including photographs. Sketches to be included if necessary. Photographs of each colony (sporophytes and gametophytes) to be included.