NATIONAL PARKS AND WILDLIFE SERVICE

RESULTS OF A MONITORING SURVEY OF THE ANNEX II SPECIES *SAXIFRAGA HIRCULUS* (MARSH SAXIFRAGE) IN IRELAND 2015–2018

Fionnuala O'Neill, Rory Hodd and Maria Long

An Roinn Cultúir, Oidhreachta agus Gaeltachta
Department of Culture, Heritage and the Gaeltacht

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Main photograph:

Marsh Saxifrage *Saxifraga hirculus*, Maria Long

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Fionnuala O'Neill, Rory Hodd and Maria Long
BEC Consultants Ltd., 43 Herbert Lane, Dublin 2, D02 TE86

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The NPWS Project Officer for this report was: Deirdre Lynn; Deirdre.Lynn@chg.gov.ie

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Department of Culture, Heritage and the Gaeltacht, 90 North King Street, Smithfield, Dublin 7, D07 N7CV

Contents

Executive Summary

This report presents details of a monitoring survey conducted between 2015 and 2018 to assess the conservation status of the Annex II species *Saxifraga hirculus* (Marsh Saxifrage) (EU code 1528). The aims of the survey were to assess the species in terms of three parameters: Population, Habitat for the Species and Future prospects.

Nineteen sites were surveyed, comprising 16 in Co. Mayo and three in Co. Sligo. A review of the previous baseline and monitoring surveys was undertaken as part of the project remit. The assessment criteria were generally found to be suitable. However, following population surveys a number of points were noted: absence of *Sagina nodosa* did not necessarily signify unfavourable habitat condition, so expert judgement was applied on a site-by-site basis; the general target for vegetation height had been set too low at ≤15 cm and was adjusted upwards to ≤20 cm; and for water level, or hydrology, to pass, a pass rate of 40% of stops was applied in the current survey, with expert judgement the final decider of whether the site's overall hydrology was suitable or not.

Population extents were determined by extensive walkover surveys and recording GPS waypoints at the outer limits of the population. These points were used to map polygon envelopes in GIS.

Assessment data were recorded within monitoring plots measuring 1 m^2, which were placed at several locations throughout the population. Count data from monitoring plots were extrapolated up to the population level by multiplying the values in the 1 m^2 plots by the area in square metres of occupied habitat mapped in GIS.

Population was assessed at each site by three criteria: total number of rosettes estimated for the population, density of rosettes (average of counts from 1 m^2 monitoring plots), and estimated number of flowering heads in the population.

Habitat for the Species was assessed by seven criteria: area of *S. hirculus* (target to match or exceed that measured in the baseline survey), water level, cover of *Sagina nodosa* (positive indicator species), cover of *Molinia caerulea* (negative indicator species), cover of *Holcus lanatus* (negative indicator species), vegetation height, and grazing (recorded on a four-category scale).

Positive and negative activities were recorded at sites where they occurred. Grazing was usually seen as a positive where it occurred, although grazing by cattle was regarded as negative and sheep grazing is generally preferable for fragile *S. hirculus* habitat. Most of the negative pressures recorded were of a low intensity or affected less than half of the habitat at a site. However, undergrazing was regarded as a serious pressure at three sites. Drainage was a direct problem at four sites, although the effect was recorded as low intensity. Water levels at two sites were regarded as too low for *S. hirculus*, with vegetation tolerant of drier conditions becoming tall and rank as a consequence and out-competing *S. hirculus*.

Climate change may become an important negative impact in the future but its intensity is currently unknown and the length of time over which a measurable impact will be seen is likewise unknown.

The Population, Habitat for the Species and Future prospects assessment results were combined to produce a single overall site-level assessment for each site. Thirteen sites received a Favourable assessment, four sites were assessed as Unfavourable-Inadequate, and two sites were Unfavourable-Bad.

The report concludes with a discussion of the results and recommendations for monitoring the species in the future and improving the conservation status of less favourably scored sites.

Acknowledgements

The authors would like to thank everyone who contributed to this project, especially Orla Daly and Christina Campbell for assistance on site surveys. We thank Deirdre Lynn for her project support and Neil Lockhart for helpful comments on the draft of this report and for historical site data. Mike Wyse Jackson also provided additional information on sites. The assistance of other NPWS staff, including field staff, who helped us in various ways throughout the project is gratefully acknowledged, especially Leonard Floyd for assistance with site access at Sheskin. John Conaghan provided useful information on the Bellacorick site, and Ed Fitzgerald and Brian Egan of ESB gave on-site assistance at Bellacorick. We thank all BEC staff members for helping in various ways throughout the course of this project. Special thanks are due to the family of the late Caoimhe Muldoon, especially Damhnait Muldoon, for their assistance in locating additional data from the baseline survey.

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1 Introduction

1.1 *Saxifraga hirculus*

Saxifraga hirculus (Marsh Saxifrage) is a perennial herbaceous plant which has a mainly circumpolar distribution in the northern hemisphere. The species was once relatively widespread in Europe, but now, outside the Northern Polar regions, the distribution of *S. hirculus* is highly fragmented and has experienced a sharp decline in the nineteenth century due to a variety of reasons, including habitat degradation and fragmentation, afforestation, drainage and overgrazing (Muldoon *et al*., 2015). *S. hirculus* was formerly more widespread in Ireland, with sites in a number of midland counties including Tipperary, Westmeath, Offaly, Laois and Meath, as well as being found in five sites in Northern Ireland in Counties Derry and Antrim (Muldoon *et al*., 2015). The midlands sites have been lost due to drainage and peat removal, and *S. hirculus* is currently one of the rarest flowering plants in Ireland (Lockhart, 1989). It is listed on the Flora (Protection) Order, 2015 (S.I. No. 356/2015), and the all-Ireland population of the species was assessed as Near Threatened, based on a decline in its area of occupancy and extent of occurrence between the two assessment periods 1930–1969 and 1987–1999 (Wyse Jackson *et al*., 2016). Its lowland habitats having been lost, it is now considered to be a primarily upland species here and in most of northern Europe (JNCC, 2018). Further declines and extinctions in a number of countries in the EU led to it being listed on Annex II of the Habitats Directive, reserved for species most at risk of further decline or extinction within the EU.

The ecology of the species was described by Muldoon (2011) and the key points are summarised here, with additional information referenced where relevant.

The surviving habitat of the species in Ireland is exclusively mineral flushes within upland blanket bogs in the northwest of the country (Mayo and Sligo). There is also one extant *Saxifraga hirculus* site in Northern Ireland (Garron Plateau, Co. Antrim) where the context is similar, although differences exist in the underlying bedrock and associated species. Flushes are areas of rising groundwater seepage found in bogs, generally on sloping ground. The species' preference for flushes is likely to be due to the higher concentration of certain minerals compared to the surrounding bog. The presence of groundwater close to the surface is an important requirement for *S. hirculus*, but the species will not tolerate long periods of flooding and the water should be moving or flowing to some extent. This water circulation maintains a good oxygen supply, and the relatively low temperature of the water (typically around 12–14°C) also maintains a higher level of dissolved oxygen (Vittoz *et al*., 2006).

Saxifraga hirculus can reproduce both clonally (asexually), via runners, and sexually, by seed production mediated by insect pollination. The runners remain attached to the parent plant for at least one growing season before becoming an independent shoot that can form new rhizomes (Hedley & Walker, 2015). These shoots are thus genetically identical to the parent plant but are functionally independent (Ohlson, 1986). Ohlson (1986) found differences in reproductive strategies between groups of *S. hirculus* plants depending on environmental conditions, with plants growing in a spring area being shorter and producing fewer seed capsules compared to plants growing in a rich fen, but producing significantly more and longer runners per shoot. Groundwater temperature in the spring area was warmer in the early part of the growing season compared to the rich fen area, but this situation reversed later in the growing season, resulting in phenological differences that may have influenced the balance between seed production and growth of runners in the two areas. Ohlson (1988) also found that flowering frequency and the number of seeds produced both varied depending on the size of the shoots, with larger shoots flowering more frequently over a number of years but producing fewer seeds annually than smaller shoots. Significant inter-annual variation in seed production (Ohlson, 1988) and in runner production (Meškauskaitė, 2010; Ohlson, 1989) has also been noted, with Meškauskaitė (2010) noting that high production of runners by *S. hirculus* appears to be associated with population regeneration after a period of ecological stress in the previous year.

The flowering stem can range in height between 4 and 24 cm, usually with two or three flowers, although up to seven flowers may be found. The gravity-dispersed seed travels no more than a metre, and clonal spread of the species by runners is restricted to within its flush; therefore *S. hirculus* is unlikely to extend its range unless its propagules are carried from one flush to another by animals or humans. During flowering, the plants are readily identified by the bright yellow flowers, but in the vegetative state the rosettes of leaves can easily be overlooked. Therefore, surveys for the plant should be conducted during the plant's flowering season, usually between July and August.

The species requires sunny conditions for growth, and seed germination is also favoured by high light intensity (Vittoz *et al*., 2006). One of the pressures on the species is shading out by woody species (Welch, 1996, 2006) and taller grasses and sedges, which can proliferate in the aftermath of the cessation of grazing or mowing (Vittoz *et al*., 2006). *S. hirculus* is a weak competitor, and there is general agreement that appropriate light grazing is an important tool in its conservation by reducing shading and competition from more vigorous plants (Welch, 1970; Hedley & Walker, 2015). Arguably, undergrazing may be more damaging than overgrazing, having been known to cause local extinctions of the plant (Vittoz *et al*., 2006; Hedley & Walker, 2015), unlike heavy sheep grazing which, according to Welch (2006), populations can quickly recover from once grazing pressure has been released. Indeed, Hedley & Walker (2015) suggest that the production of runners by *S. hirculus* may be an adaptation to survive in a habitat that is readily poached by herbivores; Welch (1970) makes a similar point. However, *S. hirculus* competes better in nitrogen-limited conditions, therefore increases in nitrogen from grazing animals, as well as mechanical damage caused by trampling and removal of flowering shoots, may be counter-productive if levels are too high; it is therefore important that an appropriate balance is struck (Vittoz *et al*., 2006).

The work of Muldoon (2011) highlighted a negative correlation between *Saxifraga hirculus* and the abundance of *Molinia caerulea* and *Holcus lanatus*; there was also a negative correlation with tall vegetation. However, a positive relationship was found between *S. hirculus* and *Sagina nodosa*, and light grazing was also found to have a beneficial effect. Sheep grazing is common in or adjacent to *S. hirculus* sites in both Ireland and Northern Ireland.

1.2 Rationale for this survey

1.2.1 Article 17 of the EU Habitats Directive

Under Article 17 of the EU Habitats Directive (92/43/EEC), all EU Member States have a legal obligation to report on the conservation status of species listed on the Directive. Species listed on Annex II require the designation of Special Areas of Conservation (SAC) for their conservation. These national conservation status assessment reports are produced every six years. The report covering the period 2013–2018 was submitted in 2019. This is the third round of reporting carried out under Article 17 where the conservation status is assessed.

The National Parks and Wildlife Service (NPWS) of the Department of Culture, Heritage and the Gaeltacht commissioned BEC Consultants Ltd to carry out the Rare Plants Monitoring Survey (RPMS), a three-year survey conducted in 2015–2018 to monitor and assess eight species listed on Annexes of the EU Habitats Directive (92/43/EEC). Four of the survey's target species are Annex II species: *Hamatocaulis vernicosus* (Slender Green feather-moss), *Petalophyllum ralfsii* (Petalwort), *Saxifraga hirculus* and *Vandenboschia speciosa* (Killarney Fern); and four are Annex V species: *Diphasiastrum alpinum* (Alpine Clubmoss), *Huperzia selago* (Fir Clubmoss), *Lycopodiella inundata* (Marsh Clubmoss) and *Lycopodium clavatum* (Stag's-horn Clubmoss), collectively listed as "*Lycopodium* spp." on the Annex.

The results of this survey contributed to Ireland's 2019 Article 17 report.

1.2.2 Assessment of Annex II and Annex V species

Guidance on the assessment of annexed species is provided by the EU (DG Environment, 2017). Evaluation of the national conservation status of a species requires the separate assessment of four parameters: Range, Population, Habitat for the Species, and Future prospects. Range is only assessed at a national level. The other three parameters can be assessed at a more local level, for example, at the site or population level.

Range of a species is defined as "the outer limits of the overall area in which a species is found at present" and it can be considered as an envelope within which areas actually occupied by the species occur (DG Environment, 2017). The range is based on the actual distribution of the species and in general the surface area of the range is provided at 10 km x 10 km resolution, with a minimum value of 100 km^2 (DG Environment, 2017).

Population size is expressed in terms of a particular reporting unit, e.g. individuals. For *Saxifraga hirculus*, the most suitable population measure is the number of rosettes, as the species can propagate clonally, making counting of genetically distinct plants difficult. The number of flowers is also a key metric of the population assessment, to assess the ability of the population to produce seed.

The reporting guidelines (DG Environment, 2017) describe Habitat for the Species as referring to the "resources necessary at all stages in the life cycle of the species", with a species needing a "sufficiently large area of habitat of suitable quality and spatial distribution" to survive and flourish. This is assessed by means of criteria that define certain aspects of habitat in good condition, such as niche availability, competition from other species and suitable hydrology. In this monitoring survey, as in other species monitoring projects (e.g. Daly & Barron, 2015; Long & Brophy, 2019), such criteria are assessed at monitoring stops. A monitoring stop is usually a plot of fixed size delimited on the ground using a measuring tape or quadrat square. The dimensions of the plot and the number of monitoring stops recorded vary depending on the type and extent of the species and habitat being assessed.

The Future prospects assessment at each site requires an examination of the continued stability of the species in terms of its population and supporting habitat, in the context of the impacts and activities taking place where the species occurs across the site. The balance between positive management and negative impacts is weighed up and the prospects of the species at the site over the next two reporting periods (12 years) are evaluated.

Each parameter can receive an assessment of Favourable (green), Unfavourable-Inadequate (amber) or Unfavourable-Bad (red). The individual parameter assessments are then combined, with the aid of an evaluation matrix (Table 1), to give an overall assessment of conservation status for the species.

1.2.3 Previous *Saxifraga hirculus* surveys in Ireland

Saxifraga hirculus has been the focus of a number of surveys in the past several decades; it has also been discovered while carrying out surveys for other purposes, such as blanket bog surveys (Douglas *et al*., 1989) and upland habitat mapping surveys. Lockhart (1989) listed the historical records of the species, dating from 1866 by Moore and More (recorded from Tipperary, Westmeath, Offaly and Antrim), to 1901 by Praeger (with records from an additional two vice-counties, Laois and west Mayo), and up to the (then) latest known record in Bellacorick Iron Flush recorded by Scannell in 1958. Lockhart (1989, 1991) described the vegetation communities containing *S. hirculus* at Bellacorick Iron Flush, and described three further, hitherto unknown *S. hirculus* populations: two at Sheean and one at south-east of Lough Nambrackkeagh in Mayo (the latter since destroyed by afforestation). Lockhart (1999) also reported further populations of *S. hirculus* in Mayo at Formoyle, and subsequent finds at Uggool (in 1998), Sheskin (in 2000), Barroosky (in 2003) and Aghoo (in 2006) as part of NPWS rare plant surveys (NPWS unpublished data). Further discoveries were made by ecologists over the following years; an additional population at Sheskin was found in 2007, a new population at Largan Mor was recorded in 2012, and the first record in Co. Sligo was discovered in the Ox Mountains during the National Survey

of Upland Habitats in 2012 (NPWS unpublished data; M. Wyse Jackson, pers. comm.; Muldoon *et al.*, 2014.).

Table 1 General evaluation matrix for assessment of Conservation Status (CS) of Annex II species (adapted from DG Environment, 2017).

	Conservation Status			
Parameter	**Favourable ('green')**	**Unfavourable – Inadequate ('amber')**	**Unfavourable - Bad ('red')**	**Unknown**
Range	Stable (loss and expansion in balance) or increasing AND not smaller than the 'favourable reference range'	Any other combination	Large decline: equivalent to a loss of more than 1% per year within period specified by Member State OR more than 10% below 'favourable reference range'	No or insufficient reliable information available
Population	Population(s) not lower than 'favourable reference population' AND reproduction, mortality and age structure not deviating from normal (if data available)	Any other combination	Large decline: equivalent to a loss of more than 1% per year (indicative value Member State may deviate from if duly justified) within period specified by Member State AND below 'favourable reference population' OR more than 25% below 'favourable reference population' OR reproduction, mortality and age structure strongly deviating from normal (if data available)	No or insufficient reliable information available
Habitat for the species	Area of habitat is sufficiently large (and stable or increasing) AND habitat quality is suitable for the long-term survival of the species	Any other combination	Area of habitat is clearly not sufficiently large to ensure the long-term survival of the species OR habitat quality is bad, clearly not allowing long-term survival of the species	No or insufficient reliable information available
Future prospects (with regard to population, range and habitat availability)	Main pressures and threats to the species not significant; species will remain viable on the long-term	Any other combination	Severe influence of pressures and threats to the species; very bad prospects for its future, long-term viability at risk.	No or insufficient reliable information available
Overall assessment of Conservation Status	All 'green' OR three 'green' and one 'unknown'	One or more 'amber' but no 'red'	One or more 'red'	Two or more 'unknown' combined with green or all 'unknown'

A comprehensive survey of the ecology of *Saxifraga hirculus* was carried out by Muldoon (2011) as part of a PhD study on the species, with the stated aims of contributing to an improved understanding of the current status, ecology, breeding biology and genetic diversity of the species, and to develop

monitoring methods for the species in Ireland. Based on this work, a set of monitoring guidelines was subsequently produced (Muldoon *et al*., 2015) as a guide to surveyors on how best to monitor the conservation status of this rare species.

Thirteen *Saxifraga hirculus* sites were surveyed by Muldoon (2011) and six new *S. hirculus* populations were subsequently discovered (NPWS unpublished data; M. Wyse Jackson, pers. comm.). This survey, therefore, covers all of the 19 known locations of *S. hirculus* in the Republic of Ireland. Survey of the additional site in Northern Ireland was not within the remit of this project.

1.2.4 The 2015–2018 survey

NPWS commissioned BEC Consultants to carry out the study detailed in this report. The aims of the study that relate to this report, as set out by NPWS, are as follows:

- Review and revise where necessary the monitoring methods developed by Muldoon *et al*. (2015);
- Undertake the monitoring of the conservation status of all known populations of *S. hirculus* in Ireland;
- Complete a National Conservation Status Assessment (NCA) and audit trail for the species using the latest available Commission and NPWS guidance.

The study was required to collate all relevant data on *S. hirculus* in Ireland and to record data to assess the conservation status of the species. The requisite licence was obtained from NPWS's Wildlife Licensing Unit to survey this rare plant. Each of the 19 populations surveyed between 2015 and 2018 were assessed on an individual site basis. The results of the site-by-site assessments were collated to evaluate the conservation status of the species on a national basis. These results are presented in a separate National Conservation Assessment report (NPWS, 2019).

1.3 Scope and format of this report

1.3.1 Scope of this report

This report details the monitoring methodology and site assessment results for the Annex II species *Saxifraga hirculus,* surveyed as part of the RPMS. Individual site reports have been produced and are included as an appendix at the end of this report (Appendix 3). This report does not include the national assessment results; as noted above, these are detailed in a separate publication.

1.3.2 Conventions used throughout this report

The terms Range, Population, Habitat for the Species and Future prospects are capitalised when they refer directly to the four parameters being assessed. The assessment result terms Favourable, Unfavourable-Inadequate and Unfavourable-Bad are capitalised when they refer directly to assessment results achieved by parameters.

Note that the term "site" simply refers to a location where there is a single population of *Saxifraga hirculus* present. Only one population is assessed at each site. Therefore, the terms "site" and "population" are generally interchangeable in this report.

"Rosette", the leafy terminal shoot of the vegetative runner, is the term given to the unit of population measurement and is analogous to "ramet". A rosette is therefore genetically identical to the parent plant from which it arose but becomes an independently functioning unit after about a year when the stoloniferous link between the rosette and its parent plant breaks down.

2 Methodology

2.1 Review of survey methodology and assessment criteria

The baseline methodology for the survey and assessment of *S. hirculus* (Muldoon *et al*., 2015) was reviewed before and after the populations were surveyed.

The survey methodology was generally considered to be suitable. However, statistically random placement of plots was not carried out as this could have resulted in some plots not having *S. hirculus* present. Extrapolation of counts up from monitoring plots to population estimates are therefore skewed as there is an inherent assumption that the frequency of *S. hirculus* per square metre throughout the mapped population is 100%. Thus, estimates are likely to be higher than the actual value.

Muldoon *et al*. (2015) assessed the Population parameter by three criteria: number of rosettes, density of rosettes, and number of flowering heads (including flower buds). These criteria were found to be suitable. Flowering head numbers were estimated as an order of magnitude (e.g. 10s, 100s) visually across the population as a whole, with counts of flowers within plots being used to assist the population estimates. For example, at the four Sheean populations SH08, SH09, SH10 and SH11, which were surveyed in July 2016, many flowers were in bud but only a few had begun to open. As buds are less conspicuous than open flowers, it was difficult to estimate bud and flower numbers solely by viewing the population, so bud and flower counts from monitoring plots were utilised in these cases to estimate flowering head numbers across the entire population.

Muldoon *et al*. (2015) assessed the Habitat for the Species parameter by seven criteria: area of *S. hirculus*, water level, cover of *Sagina nodosa* (positive indicator species), cover of *Molinia caerulea* (negative indicator species), cover of *Holcus lanatus* (negative indicator species), vegetation height, and grazing (recorded on a four-category scale). These criteria were found to be generally suitable and assessment data were collected during surveys. However, following population surveys a number of points were noted:

- *Sagina nodosa*, while co-occurring with *S. hirculus* at many sites, was not present at all sites even when the habitat was suitable for *S. hirculus*. This absence was not attributed to habitat degradation but rather to natural species variability – *S. nodosa* did not appear ever to have been at these locations. Therefore, specific local conditions were taken into account when assessing the population by this criterion.
- In the previous monitoring period, general targets were set for Habitat for the Species criteria based on analysis of data from baseline surveys (Muldoon, 2011). For sward height, the target of ≤15 cm was set at a time when sites were undergoing a period of adjustment of grazing level due to destocking required under the Commonage Framework Plans (Muldoon, 2011). During the current survey it was apparent to surveyors that grazing had been relaxed at many of these sites and sward heights had increased accordingly. In many cases, surveyors were of the opinion that the existing sward height, even though it was above the 15 cm threshold set during the baseline survey, was still suitable for *S. hirculus* and numbers of rosettes were as high as, if not higher than, the baseline survey. Based on data recorded during the current survey, such as grazing levels and impacts of grazing on both habitat and population criteria, the general target for vegetation height has been adjusted upwards from ≤15 cm to ≤20 cm as this is the upper limit of stem height for *S. hirculus* described by Stace (2010). It also accords well with the mean sward height (20–25 cm) noted in healthy *S. hirculus* populations in Scotland (Welch, 2006). Some exercise of expert judgement is allowed if sward height is too tall but all other criteria have been met.
- Water level, or hydrology, is a criterion that requires water to cover the hand if pressed lightly onto vegetation. However, no stipulation was made in the monitoring methods as to what percentage of monitoring stops should pass this criterion, whether a single pass is sufficient, or

whether all stops should pass. A pass rate of 40% of stops was applied in the current survey. Out of five stops this would mean a requirement for two stops to pass. Also, the result can depend to some degree on weather conditions, whether very wet or very dry. Expert judgement should be the final arbiter of whether the site's overall hydrology is suitable or not.

2.2 Site selection

All known *Saxifraga hirculus* sites were selected by NPWS for survey. Table 2 lists the sites and Figure 1 shows their location, overlaid with the range and distribution maps reported in NPWS (2013). All except three are located in Co. Mayo, the other three being found in Co. Sligo. All are within SACs. Of the 19 *S. hirculus* populations surveyed for the current project, six had not been surveyed in detail before and required baseline surveys.

Table 2 *Saxifraga hirculus* sites surveyed for the Rare Plants Monitoring Survey 2015–2018.

Site ID	Site name	County	Survey type	SAC code	SAC name
SH01	Aghoo	Mayo	Monitoring	000500	Glenamoy Bog Complex
SH02	Barroosky	Mayo	Monitoring	000500	Glenamoy Bog Complex
SH03	Bellacorick	Mayo	Monitoring	000466	Bellacorick Iron Flush
SH04	Formoyle	Mayo	Monitoring	001922	Bellacorick Bog Complex
SH05	Largan Mor A	Mayo	Monitoring	000476	Carrowmore Lake Complex
SH06	Largan Mor B	Mayo	Monitoring	000476	Carrowmore Lake Complex
SH07	Largan Mor C	Mayo	Baseline	000476	Carrowmore Lake Complex
SH08	Sheean A	Mayo	Monitoring	000534	Owenduff/Nephin Complex
SH09	Sheean B	Mayo	Monitoring	000534	Owenduff/Nephin Complex
SH10	Sheean C	Mayo	Monitoring	000534	Owenduff/Nephin Complex
SH11	Sheean D	Mayo	Monitoring	000534	Owenduff/Nephin Complex
SH12	Sheskin A	Mayo	Monitoring	001922	Bellacorick Bog Complex
SH13	Sheskin B	Mayo	Monitoring	001922	Bellacorick Bog Complex
SH14	Sheskin C	Mayo	Baseline	001922	Bellacorick Bog Complex
SH15	Uggool	Mayo	Monitoring	000534	Owenduff/Nephin Complex
SH16	Croaghaun East	Mayo	Baseline	001922	Bellacorick Bog Complex
SH17	Ox Mountains A	Sligo	Baseline	002006	Ox Mountains Bog
SH18	Ox Mountains B	Sligo	Baseline	002006	Ox Mountains Bog
SH19	Ox Mountains C	Sligo	Baseline	002006	Ox Mountains Bog

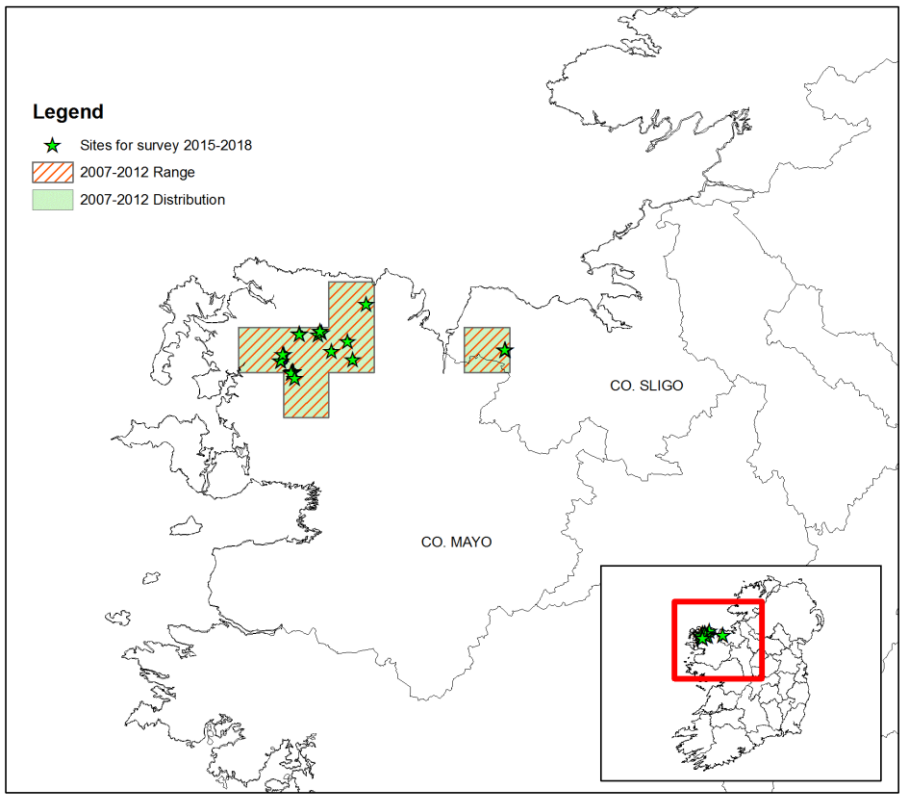

Figure 1 Location of *Saxifraga hirculus* sites to be surveyed during the Rare Plants Monitoring Survey 2015–2018, overlain with the 10 km range and distribution maps from the 2007–2012 Article 17 report (NPWS, 2013).

2.3 Survey preparation

2.3.1 Site packs

A site pack was set up for each site, containing information from the baseline survey by Muldoon (2011) or, if this was not available, any information on previous records for the species at the site. Also included was an aerial photograph with the location of the species indicated. A blank site summary data sheet was included in the pack, to be completed by the ecologists at the end of the site survey (see Appendix 1).

2.3.2 Trimble Nomads

Hand-held Trimble Nomads were set up to record GPS waypoints in ArcPad (ESRI, USA) and to record monitoring stop and vegetation data in Turboveg CE (Alterra, The Netherlands). The shapefiles created during the baseline survey were uploaded onto the Trimbles to enable the surveyors to navigate directly to the monitoring stops. Additional points recorded on other surveys were also uploaded as a shapefile.

2.4 Site surveys

Sites were surveyed between 19 July and 18 August in 2016, between 8 August and 5 September in 2017 and on 8 August 2018. Survey teams consisted of two ecologists. During all stages of the survey, surveyors recorded any information of interest or relevance, including features or species of interest,

botanical or otherwise. Where possible, these were photographed. Photographs of site features (e.g. impacts, management) were taken as appropriate for inclusion in the project's Image Databank.

The survey methodology can be broadly divided into three main tasks:

- Establish and map the extent of the population;
- Record monitoring stop data; and
- Complete the site summary data sheet including impact recording.

2.4.1 Population extent

This is the area occupied by the species. One of two methods was used to map and measure this, depending on the density and distribution of *Saxifraga hirculus* on site:

(a) Method 1 (for most sites, where rosettes carpet the ground):

GPS waypoints were recorded to map the outer limits of the area where the species occurred. These points were downloaded in the office and used as a guide to digitise polygons using ArcGIS 9.3 (ESRI, USA). The area occupied by these polygons was calculated using ArcGIS.

OR

(b) Method 2 (for sites where colonies are clumped and scattered rather than continuous)

GPS waypoints were recorded at each individual plant/group of plants to help delimit the population envelope. To account for the fact that much of the envelope was not occupied by *Saxifraga hirculus*, the percentage cover of *S. hirculus* within the population envelope was estimated. A GIS polygon was later digitised in the office to encompass all points, after which an accurate area of the population envelope was calculated. The percentage cover of *S. hirculus* within the population envelope was applied to this to calculate the actual area occupied by *S. hirculus* in the site.

2.4.2 Monitoring stop recording

Data to assess Population and Habitat for the Species were recorded within monitoring stops. Up to five monitoring stops were recorded at each site. Monitoring stops consisted of plots measuring 1 m x 1 m, delineated on the ground using a measured rope and tent pegs. A GPS waypoint was recorded on the Trimble at every monitoring stop and photographs were taken, including at least one close-up of the plot and another more general view of the plot in the context of the landscape. As no previous location data were available for the baseline plots, and in any case the guidelines of Muldoon *et al*. (2015) recommended that monitoring plots be placed randomly, a stratified random system of plot placement was followed, with monitoring stops positioned in areas that represented the variability in the population but with some *Saxifraga hirculus* present in every plot.

To augment current data on the ecology of *Saxifraga hirculus*, some full relevés (plant species list, together with species abundances as percent cover) were recorded. Relevé data were recorded at an average of two out of every five monitoring plots[1]. When full relevés were recorded, additional structural data, such as cover of graminoids and presence of leaf litter, were also recorded for information purposes but were not used in the assessment. Appendix 2 gives the full list of data items recorded in Turboveg at each monitoring stop.

The following Population assessment data were recorded at each stop:

- Number of rosettes in plot – obtained by direct counts or by sub-sampling if more than 100.

[1] This ratio is across all monitoring stops rather than at a site level. At some sites only monitoring data were recorded, while at other sites relevé data were recorded at some or all monitoring stops.

- Number of flowering heads in plot. (Number of flowering heads across the whole site was also estimated by eye to an order of magnitude – 10s, 100s, 1000s, etc.).

The following Habitat for the Species assessment data were recorded at each stop:

- Suitable water level: "Y" was recorded if water from the soil or peat substrate covered the fingers under light pressure from the hand/fingertips.
- Percent cover of *Sagina nodosa* (positive indicator).
- Percent cover of *Molinia caerulea* (negative indicator).
- Percent cover of *Holcus lanatus* (negative indicator).
- Vegetation height (cm): Four measurements of vegetation height were taken with a steel measuring tape at 25 cm intervals across the 1 m^2 quadrat and the mean calculated. In each case, the highest vegetation at each point was measured.
- Category of grazing level: Each plot was assigned to one of four categories based on visual examination of the vegetation in each quadrat and an estimation of the percentage vegetation grazed, as follows:
    - 0–25%: the vegetation is rank and little or no grazing is evident.
    - 26–50%: this is optimal where the vegetation is under moderate levels of grazing, some small open areas may be present and an examination of the vegetation would show evidence of grazing. However, flowering should occur.
    - 51–75%: the vegetation is cropped extremely short with very little or no flowering occurring, areas of bare peat more pronounced.
    - 76–100%: very little vegetation present due to heavy overgrazing.

  The median of each category was calculated and averaged among all stops to reassign the grazing level to one of the four categories.

2.4.3 Site summary data

Surveyors completed a site summary data sheet (see Appendix 1) at the end of each site's survey. This allowed them to give general descriptive information about the site, including their overall impression of the site, and any impacts or management taking place that might affect the species or its habitat. Impacts and activities were recorded with the impact code (Ssymank, 2011), magnitude, influence, and percentage of *Saxifraga hirculus* habitat affected. The population extent was calculated by GIS after field waypoints were downloaded and polygons had been digitised in the office. Data from the site summary data sheets are presented in Appendix 3 as brief site reports.

2.5 Assessments

2.5.1 Population **parameter**

Population was assessed by three criteria: total number of rosettes in the population, density of rosettes (if applicable), and the number of flowering heads in the population (see Table 3). The values recorded in the current survey were compared with the targets set in the baseline survey (Muldoon, 2011). Targets were specific to each site. A monitoring stop passed a criterion if the recorded value met the criterion's target for that site.

For the six sites being surveyed for the first time, the values recorded in the current survey formed the basis of the site-specific targets for criteria that would be used in future monitoring surveys. The target for the density of rosettes and the total number of rosettes at these new sites was set at 80% of the values estimated in the current survey, the same procedure followed by Muldoon (2011) to allow a margin of error for plant estimates.

Table 3 Criteria and targets for assessment of Population for *Saxifraga hirculus*.

	Criterion	Scale of assessment	Target
1	Total number of rosettes	Population	No decrease from previous monitoring period
2	Density of rosettes	Average over all monitoring stops	No decrease from previous monitoring period
3	No. of flowering heads	Population	No decrease from previous monitoring period
	Population assessment	Favourable (Green): 2 passes	
		Unfavourable-Inadequate (Amber): 1 pass	
		Unfavourable-Bad (Red): 0 passes	

For sites where rosettes formed a continuous carpet (Figure 2), the average density of rosettes, as rosettes per square metre, was calculated from the counts in the monitoring stops. The number of rosettes in the site was estimated by multiplying this average density by the area in square metres of the occupied habitat, derived from the GIS after digitisation.

Figure 2 Swathe of *Saxifraga hirculus* rosettes at SH02 Barroosky, Co. Mayo. Photo by Maria Long.

Density of rosettes was not required for SH03 Bellacorick or SH13 Sheskin B as the species occurs there as isolated clumps rather than as a swathe and full counts could therefore be conducted.

The total number of flowering heads was estimated across the population as a whole as an order of magnitude, e.g. 10s, 100s. The number of flowers counted in plots was used to help in the estimation, particularly if flowering heads were less obvious, e.g. a high proportion of flowers in bud or gone to seed.

2.5.2 Habitat for the Species parameter

Habitat for the Species was assessed at each site by means of seven criteria:

Area of *Saxifraga hirculus* habitat: This criterion assesses whether or not the extent of the species is being maintained. This was determined by recording GPS points to delimit the extent of the occupied habitat, followed by digitisation of polygons using these points in the office.

Hydrology: Muldoon (2011) noted that *Saxifraga hirculus* requires a stable, moving water table close to the soil surface, hence its preference for flushes. The test for adequate water supply in the assessment protocol is to press the hand lightly onto the vegetation. If the fingers of the hand are covered by water, hydrology is suitable; if not, it is too dry. For this round of monitoring a threshold was set which requires at least 40% of stops in a site (e.g. two out of five) to pass in order to pass the criterion at the site level.

Frequency of *Sagina nodosa* in stops: Muldoon (2011) found that *Saxifraga hirculus* is positively correlated with the occurrence of *Sagina nodosa*. The guidelines of Muldoon *et al*. (2015) state that at least two of every five monitoring stops at a site should contain *Sagina nodosa*. As not all populations may be large enough for five stops to be recorded, this target has been reworded to state that at least 40% of stops should contain *Sagina nodosa*.

Percent cover of *Molinia caerulea*: *Molinia caerulea* was identified as a negative indicator within *Saxifraga hirculus* habitat. Muldoon (2011) set an upper limit of 5% on the abundance of *M. caerulea* on average across all plots at a site. Zero values were included in the calculation of the average.

Percent cover of *Holcus lanatus*: Muldoon (2011) noted that, while *Holcus lanatus* was present in most plots with *Saxifraga hirculus*, the latter was negatively correlated with higher cover of *H. lanatus*. Therefore an upper limit of 15% was set for the average abundance of *H. lanatus* across all plots at a site. Zero values were included in the calculation of the average.

Grazing level: Both undergrazing and overgrazing are damaging to *Saxifraga hirculus*; the former because the resulting rank vegetation may out-compete *S. hirculus* and even cause drying out of the substrate, and the latter because overgrazing can reduce rates of flower production and fruit survival (Muldoon, 2011). Therefore a certain level of light grazing, determined by Muldoon (2011) as 26–50%, is optimal to reduce competition and open up areas suitable for colonisation by *S. hirculus* (see section 2.4.2).

Vegetation height: This is allied to grazing level; taller vegetation was found to be negatively correlated with the abundance of *Saxifraga hirculus* by Muldoon (2011). Following the review of criteria (see section 2.1) the upper threshold for vegetation height has been set at 20 cm.

Table 4 shows the Habitat for the Species criteria and their targets. Targets for the Habitat for the Species criteria are not population-specific, apart from the area occupied by *Saxifraga hirculus*, which is based on the area recorded in the baseline survey (Muldoon, 2011). For the six sites being surveyed for the first time, the area recorded in the current survey was used as a basis to set the target to be met in future monitoring surveys. The target for the area of *S. hirculus* was set at 90% of the current area to allow a margin of error for area measurement, the same procedure followed by Muldoon (2011). The assessment results for each of the other six criteria were obtained initially at the monitoring stop level; frequency or average values were then calculated as appropriate across all stops to obtain a result for the population.

Table 4 Criteria and targets for assessment of Habitat for the Species for *Saxifraga hirculus*.

	Criterion	Scale of assessment	Target
1	Area of *Saxifraga hirculus* habitat	Population	Population-specific, set at 90% of baseline area
2	Hydrology	Monitoring stop	Water covers fingers of hand pressed onto substrate; at least 40% of stops to meet target
3	Frequency of *Sagina nodosa*	Monitoring stop	Present in at least 40% of stops
4	%cover *Molinia caerulea*	Monitoring stop	Mean % cover across all stops ≤5%
5	%cover *Holcus lanatus*	Monitoring stop	Mean % cover across all stops ≤15%
6	Grazing	Monitoring stop	Grazing levels 26–50% in all stops
7	Vegetation height	Monitoring stop	Mean vegetation height across all stops ≤20 cm
Habitat for the Species assessment			Favourable (Green): 7 passes
			Unfavourable-Inadequate (Amber): 4–6 passes
			Unfavourable-Bad (Red): 0–3 passes

2.5.3 Future prospects parameter

EU guidance states that the Future prospects parameter "should be evaluated by individually assessing the expected future trends and subsequently future prospects of each of the other three parameters [Range, Population and Habitat for the Species], taking primarily into account the current conservation status of the parameter, threats (related to the parameter assessed) and the conservation measures being taken or planned for the future. Once the future prospects of each of the other three parameters have been evaluated, they should be combined to give the overall assessment of Future prospects" (DG Environment, 2017).

Future prospects were assessed at the site level by evaluating the future prospects and future expected trend of Population and Habitat for the Species at each site, and examining the current pressures, future threats and beneficial management practices operating on the species' habitat. Guidance provided by the EU (DG Environment, 2017) was followed to determine the future trends and future prospects of each parameter. The evaluation matrices from the guidance document were used and are shown in Tables 5 and 6.

It is important to note that these activities are recorded in the context of the effect on the species rather than on its habitat *per se*, although in the case of *S. hirculus* the two are usually synonymous.

For a species to be assessed as having Favourable Future prospects, its prospects had to be judged as good, with no severe impacts expected from threats, and the population and its habitat expected to be stable or improving in the long term. For it to be assessed with Unfavourable-Bad Future prospects, its prospects were judged to be bad, with severe impacts expected from threats and the species and/or its habitat expected to decline or disappear in the long term. A Future prospects assessment of Unfavourable-Inadequate was between these two extremes.

To help evaluate Future prospects according to the above guidance, the pressures, threats and positive activities occurring on each *Saxifraga hirculus* site were recorded according to the impact codes of Ssymank (2011) (the 2017 impact codes were not available at the commencement of the project). The magnitude of the impact (high, medium or low), influence (positive, negative or neutral) and percentage area of occupied habitat affected were also noted.

Table 5 Assessing the future prospects of a parameter (Steps 1 and 2) (Reproduced from DG Environment, 2017).

Step 1 Future trends of parameters			Step 2 Future prospects of a parameter	
Balance between threats and measures	Predicted future trend reflects balance between threats and measures	Current conservation status of parameter	Resulting future prospects of parameter (over next 12 years)	
Balance between threats acting on the parameter (mostly threats with insignificant impact and/or Medium impact threats) and conservation measures; no real change in status of the parameter expected	overall stable	Favourable	good	
		Unfavourable-Inadequate	poor	
		Unfavourable-Bad	bad	
		Unknown	unknown	
Threats expected to have negative influence on the status of the parameter (mostly High or Medium impact threats), irrespective of measures taken	negative / very negative	Favourable	poor (negative)	bad (very negative)
		Unfavourable-Inadequate	poor (negative)	bad (very negative)
		Unfavourable-Bad	bad	
		Unknown	poor (negative)	bad (very negative)
None (or only threats with insignificant impact) and/or effective measures taken: positive influence on the status of the parameter expected	positive / very positive	Favourable	good	
		Unfavourable-Inadequate	poor (positive)	good (very positive)
		Unfavourable-Bad	poor (positive)	good (very positive)
		Unknown	poor (positive)	good (very positive)
Threats and/or measures taken unknown or interaction not possible to predict	unknown	Favourable	unknown	
		Unfavourable-Inadequate		
		Unfavourable-Bad		
		Unknown		

Table 6 Combining the evaluation of the three parameters to give Future prospects for a species (Reproduced from DG Environment, 2017).

Assessment of Future prospects	Favourable	Unfavourable-inadequate	Unfavourable-bad	Unknown
Prospects of parameter: Range, Population and Habitat for the Species	All parameters have 'good' prospects OR prospects of one parameter 'unknown', the other prospects' good'	Other combination	One or more parameters have 'bad' prospects	Two or more 'unknown' and no parameter with 'bad' prospects

2.5.4 Site-level conservation status assessment

The overall conservation status assessment for *Saxifraga hirculus* at each site was evaluated based on the results of all three parameters – Population, Habitat for the Species and Future prospects, according to the evaluation matrix in Table 1 and using the guidance provided by the EU (DG Environment, 2017).

3 Results

3.1 Population assessment

Table 7 shows the results of the Population assessment for *Saxifraga hirculus* in the current monitoring survey. All except two sites met or exceeded the targets for the total number of rosettes and density of rosettes for the site set in the baseline surveys, so most of the populations appear to be holding their population numbers steady, or even increasing. The two sites that failed the Population assessment, SH03 Bellacorick and SH12 Sheskin A, appear to have suffered declines in number since the baseline, with Bellacorick decreasing from an estimated 700 rosettes in the baseline survey (Muldoon, 2011) to just 23 in 2018, a decline of 97%, and Sheskin A decreasing from an estimated 360 rosettes in (Muldoon, 2011) to 73 rosettes in 2018, an 80% decline. Both of these sites are undergrazed, with tall, rank vegetation a feature of the habitat. In both sites, plant distribution is patchy, so full rosette counts were conducted, rather than estimates extrapolated from plot data as in the other 17 sites.

It should be noted, however, that differences in survey intensity and weather conditions may have played a role in the magnitude of the differences observed between the results of the baseline and current surveys. The Bellacorick site in particular is one of the best known *Saxifraga hirculus* sites in the country and the population has been visited many times since it was first recorded by Scannell (1958), with numbers fluctuating somewhat; for example, a count of 27–30 flowering stalks plus many vegetative rosettes was recorded in 1995 (MhicDaeid, Byrne & O'Sullivan, unpublished data from NPWS), an estimate of 300 individuals was made in 1999 based on extrapolation up from a 2 m x 2 m relevé (McKee, unpublished data from NPWS), and 40 flowering heads (no individual rosette counts made) were recorded in 2012 (BES, 2012). Overall, however, the population may have reached an equilibrium with the conditions prevailing at the site (Lockhart, pers. comm.). For the current survey, the Bellacorick site was visited in August 2018 after a prolonged period of dry, hot weather, which may have adversely affected the production of rosettes that year. The unusually high counts recorded by Muldoon in the baseline may have been the result of greater sampling intensity: the Bellacorick site was visited ten times for that study over the course of two flowering seasons, 2005–2006 (Muldoon, 2011), greatly increasing the chances of finding all rosettes in the population. The Sheskin A population was visited just once by Muldoon (2011), but the physical characteristics of the habitat are similar, with the tall vegetation making it more difficult to spot the small rosettes. It may be that the target rosette numbers for Bellacorick and Sheskin A are unreasonably high, given the circumstances in which they were set, and a lower benchmark may be more appropriate. This is discussed further in section 4.

The target for the number of flowering heads was not reached by four populations but in at least some instances was thought to have been due to a later flowering season.

Table 7 Results of the Population assessment for *Saxifraga hirculus* in the Rare Plants Monitoring Survey 2015–2018. Fav=Favourable; U-B=Unfavourable-Bad. n/a=Not assessed. * Full count of all *Saxifraga hirculus* plants present carried out at SH03 and SH12.

Site ID	Total no. of rosettes	Density of rosettes	No. of flowering heads	No. of passes	Population estimated	Population Assessment
SH01	Pass	Pass	Pass	3	58,600	Fav
SH02	Pass	Pass	Pass	3	755,000	Fav
SH03	Fail	n/a	Fail	0	23*	U-B
SH04	Pass	Pass	Pass	3	1,900	Fav
SH05	Pass	Pass	Fail	2	15,700	Fav
SH06	Pass	Pass	n/a	2	700	Fav
SH07	Pass	Pass	Pass	3	6,400	Fav
SH08	Pass	Pass	Pass	3	170,400	Fav
SH09	Pass	Pass	Fail (time of year)	2	98,000	Fav
SH10	Pass	Pass	Pass	3	1,300,800	Fav
SH11	Pass	Pass	Pass	3	118,700	Fav
SH12	Fail	Fail	Fail	0	73*	U-B
SH13	Pass	n/a	Pass	2	750	Fav
SH14	Pass	Pass	Pass	3	3,000	Fav
SH15	Pass	Pass	Pass	3	122,100	Fav
SH16	Pass	Pass	Pass	3	103,500	Fav
SH17	Pass	Pass	Pass	3	300,000	Fav
SH18	Pass	Pass	Pass	3	46,400	Fav
SH19	Pass	Pass	Pass	3	20,600	Fav

3.2 Habitat for the Species assessment

The assessment of Habitat for the Species was conducted by comparing the data measured at monitoring stops to the criteria targets. Table 8 shows the results.

Thirteen sites (68%) passed all criteria and received a Favourable assessment. Four sites (21%) failed one to three criteria and received an Unfavourable-Inadequate assessment. The remaining two sites (10.5%) failed more than three criteria and received an Unfavourable-Bad assessment.

Table 9 shows the failure rates of the individual criteria. Most sites maintained their area of occupancy since the previous monitoring period. The exceptions were SH03 Bellacorick, where the area occupied by *S. hirculus* had decreased from 950 m² in the previous monitoring period to 155.6 m² in 2018; and SH10 Sheean C, which decreased slightly from 790 m² in the baseline survey to 767 m² in the current survey. The latter was regarded as a marginal fail which could be due to differences in GPS accuracy; the population here was the most dense of all the sites, so it was passed on expert judgement and the population received a Favourable assessment.

Table 8 Results of Habitat for the Species (HfS) assessment of *Saxifraga hirculus*. Fav=Favourable, U-I=Unfavourable-Inadequate, U-B=Unfavourable-Bad. n/a=not assessed.

Site ID	No. of stops	Area of occ.	Hydro-logy	Freq. of *Sagina*	%cover *Molinia*	%cover *Holcus*	Veg. height	Grazing level	No. passes	Expert judgm't	HfS result
SH01	5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	7	7	Fav
SH02	5	Pass	Pass	Pass	Pass	Pass	Fail*	Pass	6	7	Fav
SH03	5	Fail	Fail	Fail	Pass	Pass	Fail	Pass	3	3	U-B
SH04	3	Pass	Pass	n/a**	Pass	Pass	Pass	Fail	5	5	U-I
SH05	5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	7	7	Fav
SH06	1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	7	7	Fav
SH07	5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	7	7	Fav
SH08	5	Pass	Pass	Pass	Pass	Pass	Fail*	Pass	6	7	Fav
SH09	5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	7	7	Fav
SH10	5	Fail*	Pass	Pass	Pass	Pass	Pass	Pass	6	7	Fav
SH11	5	Pass	Fail*	Pass	Pass	Pass	Pass	Pass	6	7	Fav
SH12	5	Pass	Fail	Fail	Pass	Pass	Fail	Fail	3	3	U-B
SH13	3	Pass	Pass	Fail	Pass	Pass	Fail	Fail	4	4	U-I
SH14	5	Pass	Pass	Fail	Pass	Pass	Pass	Fail	5	5	U-I
SH15	5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	7	7	Fav
SH16	5	Pass	Pass	Pass	Pass	Pass	Pass	Fail*	6	7	Fav
SH17	5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	7	7	Fav
SH18	5	Pass	Pass	Pass	Pass	Pass	Fail*	Pass	6	7	Fav
SH19	2	Pass	Fail	Pass	Pass	Pass	Pass	Fail	5	5	U-I

* Marginal failure; site was assessed as Favourable on expert judgement as all other criteria were passed.
** Absence of *Sagina nodosa* from this site not considered to be due to unsuitability of habitat but rather due to natural variation in species distribution; criterion was not assessed.

Table 9 Failure rates of individual Habitat for the Species criteria. Failure rates shown here apply to results before expert judgement was applied.

Criterion	No. of sites assessed	No. of sites that failed	Failure rate (%)
Area of occupancy	19	2	10.6
Hydrology	19	4	21.1
Freq. of *Sagina nodosa*	18	4	21.1
%cover *Molinia*	19	0	0.0
%cover *Holcus*	19	0	0.0
Grazing level	19	6	31.6
Vegetation height	19	6	31.6

Unsuitable hydrology was an issue at four sites, but particularly at SH03 Bellacorick and SH19 Ox Mountains C, where none of the stops passed the hydrology criterion. The hydrology at SH19 is provided by a large domed springhead, in contrast to most of the other sites which tend to be level flushes, and different hydrological processes may be at work. The population here is small but dense, so hydrology – if it is an issue – does not yet appear to be affecting plant numbers. At SH11 Sheean D

and SH12 Sheskin A, one stop out of five passed the criterion. Because the population numbers at SH11 were high, vegetation was not rank and all other criteria were passed, hydrology was judged not to be a serious issue here and the population received a Favourable assessment overall.

Sagina nodosa was absent from all stops at four sites – SH03 Bellacorick, SH04 Formoyle, SH12 Sheskin A and SH13 Sheskin B, and present in only one of the five stops at SH14 Sheskin C. This is a possible indication of unsuitable habitat for *S. hirculus*, as a positive correlation between this species and *Saxifraga hirculus* was established by Muldoon (2011). However, surveyors at SH04 were of the opinion that, while the habitat was generally of good quality, it is unlikely ever to support *Sagina nodosa* and thus could never attain Favourable condition if this criterion were to continue to be tested here. Therefore for this site the criterion was not assessed.

Covers of the negative species *Molinia caerulea* and *Holcus lanatus* were found to be within acceptable limits at all sites.

Grazing levels were deemed to be unsatisfactory at six sites. SH04 Formoyle and SH19 Ox Mountains C were found to be overgrazed. In SH04, the flush with *S. hirculus* was preferentially grazed, and grazed heavily, by cattle. However, this was thought to be a once-off occurrence and unlikely to remain a serious issue into the future as the greater flush/fen complex in which the *S. hirculus* habitat was located was itself hardly grazed. All of the SH04 stops were classed as overgrazed, within category 51–75% (see section 2.4.2 for description). SH19 was a small site, with two stops recorded, and did pass the criterion in one of the two stops. The failure could therefore be regarded as marginal, although this site was also found to be slightly drier than optimal, so a discretionary pass was not awarded. The three Sheskin sites A, B and C (SH12, SH13 and SH14) and SH16 Croaghaun East were undergrazed, with all 18 stops across the four sites ranked within the grazing category 0–25%. In the case of SH16, a discretionary pass was awarded for the grazing criterion on the basis that sward height is being maintained by the wet hydrology and in all other respects the habitat condition and population numbers are favourable.

A related criterion, vegetation height, was also used to assess grazing pressure. As explained in section 2.1, following a review of criteria used in the baseline survey, a higher vegetation height threshold was employed for the current survey to allow for the fact that many of the sites were recovering from overgrazing since the baseline survey. Based on the new threshold, thirteen sites passed the criterion outright, while an additional three sites passed on expert judgement due to healthy population statistics and because all other criteria were passed.

3.3 Future prospects assessment

3.3.1 Pressures, threats and other activities

Prior to evaluating the Future prospects parameter, the activities, both positive and negative, recorded in the *Saxifraga hirculus* habitat were examined. Table 10 shows the negative impacts, Table 11 shows the positive measures, and Table 12 shows other impacts that were not impacting on the habitat either way.

Many of the negative pressures recorded were of a low intensity and/or affected less than 50% of the habitat at a site. Undergrazing (A04.03), while recorded as a negative impact at just 3 of the 19 sites, was significant in that it occurred with a medium or high intensity across the entire habitat. Insufficient grazing allows more competitive plants, such as tussocky grasses, to grow taller and overtop the less competitive *S. hirculus* plants. Overgrazing (A04.02) was also a problem, with cattle grazing considered to be too high at two sites, and sheep grazing too high at a third. Again, in all cases, 100% of the habitat was affected.

Drainage (J02.07.01) was a direct problem at four sites, affecting all of the habitat where it occurred, although the effect was recorded as low intensity at two sites. At SH03 Bellacorick, hydrological data

recorded recently for a nearby windfarm project show that water levels have not dropped since 2012 (David Broderick, pers. comm.). Therefore active drainage is not currently an issue at this site. However, water levels were deemed to be lower than optimal for *S. hirculus*. Significant drainage of the site for peat extraction had occurred in the 1960s, well before the EU Habitats Directive came into force in 1994 (N. Lockhart, pers. comm.), and water levels at the site have not recovered.

Table 10 Frequency of negative impacts, by intensity and % habitat affected, recorded in the 19 *Saxifraga hirculus* sites.

Impact code	Impact description	Intensity				% habitat affected			
		High	Medium	Low	Unknown	≤25%	26–75%	>75%	Freq.
A04.02.01	Non-intensive cattle grazing	1		1				2	2
A04.02.02	Non-intensive sheep grazing		1					1	1
A04.03	Undergrazing	2	1					3	3
G01.03.02	Quad bike tracks		2			2			2
G05.01	Trampling by surveyors			19		19			19
J02.07.01	Drainage		1	3				4	4
K01.01	Erosion	1					1		1
M	Climate change				19			19	19
Frequency		*4*	*5*	*23*	*19*	*21*	*1*	*29*	*51*

Table 11 Frequency of positive impacts, by intensity and % habitat affected, recorded in the 19 *Saxifraga hirculus* sites.

Impact code	Impact description	Intensity			% habitat affected			
		High	Medium	Low	≤25%	26–75%	>75%	Freq.
A04.02.02	Non-intensive sheep grazing		7	2	1		8	9
A04.02.05	Non-intensive mixed grazing			2			2	2
K04.05	Deer grazing		1	1			2	2
Frequency			*8*	*5*	*1*		*12*	*13*

Table 12 Frequency of neutral impacts, by intensity and % habitat affected, recorded in the 19 *Saxifraga hirculus* sites.

Impact code	Impact description	Intensity			% habitat affected			
		High	Medium	Low	≤25%	26–75%	>75%	Freq.
A04.02.01	Non-intensive cattle grazing			2			2	2
A04.02.05	Non-intensive mixed grazing			1			1	1
C01.03.02	Peat extraction	1					1	1
Frequency		*1*		*3*			*4*	*4*

Signs of quad bike tracks (G01.03.02) were noted at two sites. This practice damages the fragile *S. hirculus* habitat. While the percentage of habitat affected was relatively low, less than 25%, it was recorded as medium intensity in both cases.

Trampling (G05.01) by ecologists was an unavoidable consequence of carrying out the monitoring, and every effort was made by the surveyors to minimise the extent of the damage caused.

Climate change (M) has been included as an impact at all sites on the assumption that it will negatively affect this upland species. However, the intensity of the impact on the species, and the timeframe over which measurable changes will occur, is unknown.

Beneficial management practices all involved some form of grazing. While grazing by cattle (A04.02.01) was seen as negative, or neutral if in combination with sheep (A04.02.05), grazing by sheep alone (A04.02.02) or with horses (A04.02.05) was deemed to have a positive effect by keeping the habitat open for *S. hirculus*. Deer grazing (K04.05) was also seen as beneficial to *S. hirculus* habitat.

3.3.2 Site-level assessment of Future prospects

The future prospects of the Population and Habitat for the Species parameters were examined for each of the 19 *Saxifraga hirculus* sites surveyed during the current project in the context of the pressures, threats and conservation measures occurring in each. Table 13 shows the results.

Table 13 Future prospects (FP) assessment for the 19 *Saxifraga hirculus* sites surveyed during the Rare Plants Monitoring Survey 2015–18. Pop=Population, HfS=Habitat for the Species; Fav=Favourable, U-I=Unfavourable-Inadequate, U-B= Unfavourable-Bad.

Site ID	FP of Pop	FP of HfS	Pressures	Current mgmt	FP of *S. hirculus*	Rationale
SH01	Fav	Fav	None	Sheep and horse grazing	**Fav**	Population numbers and density have increased since baseline and HfS passed the *Sagina nodosa* criterion this time, unlike in baseline. Hydrology and sward height are adequate. Grazing levels have been increased since baseline survey and this seems to have improved the situation for *S. hirculus*.
SH02	Fav	Fav	None	Sheep grazing	**Fav**	Population numbers and density have increased since baseline. HfS passed the *Sagina nodosa* criterion this time, unlike in baseline. Sward height is above threshold set but surveyors noted that habitat appeared in good condition, not rank, and with sheep moving through the habitat. Therefore Future prospects of HfS deemed to be favourable.
SH03	U-B	U-B	Undergrazed; too dry	Sheep grazing, though level thought to be insufficient	**U-B**	Population numbers have declined since the baseline survey. HfS failed several criteria: hydrology (too dry; note: assessed during prolonged dry spell), *Sagina nodosa* (absent), vegetation height (too tall). Insufficient grazing is the main problem; fewer sheep probably graze now that windfarm construction under way. Water level probably too low also; higher level would prevent sward from getting too rank. Population is small and vulnerable.

Site ID	FP of Pop	FP of HfS	Pressures	Current mgmt	FP of *S. hirculus*	Rationale
SH04	Fav	U-I	Cattle grazing, unsuitable for such a wet site	Cattle grazing	**U-I**	Population numbers and density have increased since baseline. Absence of *Sagina nodosa* not deemed to be problem as there is no indication that it was ever present here. Grazing slightly higher than optimal (poaching and dung evident), but this may be an isolated grazing incident, as surrounding areas are not overgrazed, and therefore not a future threat. However, because HfS is currently unfavourable, FP of HfS must also be unfavourable.
SH05	Fav	Fav	Possibly slightly undergrazed	Sheep and horse grazing, though levels may be too low	**Fav**	Population numbers and density have increased since baseline. Signs that habitat is improving here. *Sagina nodosa* present, unlike in baseline. Site passed the grazing level criterion this time, unlike baseline, and vegetation height is suitable.
SH06	Fav	Fav	Cattle grazing causing poaching	Sheep grazing	**Fav**	Population numbers have increased since baseline and *Sagina nodosa* criterion passes this time. Grazing appears to be optimal, though some poaching and dung were noted.
SH07	Fav	Fav	None, though cattle could damage if level increases	Sheep grazing	**Fav**	Population numbers are healthy. All HfS criteria were passed.
SH08	Fav	Fav	Small area damaged by quad bike	Sheep grazing	**Fav**	Population numbers are stable since the baseline. Vegetation height is slightly above the 20 cm threshold, despite sheep grazing, but HfS passed all other criteria including grazing level, so vegetation height deemed to pass also.
SH09	Fav	Fav	Small area damaged by quad bike	Sheep grazing	**Fav**	Population numbers and density higher than baseline. HfS passed all criteria.
SH10	Fav	Fav	None	Sheep grazing	**Fav**	Population numbers and density higher than baseline. HfS passed all criteria.
SH11	Fav	Fav	None	Sheep grazing	**Fav**	Population numbers and density higher than baseline but a marginal fail on hydrology (passed in 1 out of 5 plots). As all other criteria were passed and population numbers are increasing, Future prospects of both parameters are Favourable.
SH12	U-B	U-B	Undergrazed/ abandoned	None, but the area is lightly grazed by deer	**U-B**	Population numbers and density have declined since the baseline survey. Several HfS criteria failed: hydrology too dry, vegetation too tall and rank, level of grazing too low.
SH13	Fav	U-I	Undergrazed/ abandoned	None	**U-I**	Population numbers are higher than recorded in baseline but the vegetation height remains too tall and grazing levels too low, the same situation as during the baseline survey.

Site ID	FP of Pop	FP of HfS	Pressures	Current mgmt	FP of *S. hirculus*	Rationale
SH14	Fav	U-I	None, though small bushes of Rhododendron noted nearby	None, but the area is grazed by deer	**U-I**	Population numbers are healthy and flowering is occurring. *Sagina nodosa* is present in only 1 of 5 plots and grazing levels are below threshold, although vegetation height meets target. The site is extremely wet so introducing grazing is not recommended.
SH15	Fav	Fav	None, though some natural erosion occurring	Sheep grazing	**Fav**	Population numbers are higher than baseline and all HfS criteria were passed.
SH16	Fav	Fav	None	Sheep grazing	**Fav**	Population numbers are very healthy. Grazing levels below the threshold for a pass, but flush kept open due to hydrology (extremely wet), so undergrazing may not be a problem and increased grazing could be damaging.
SH17	Fav	Fav	Drainage; active turf cutting nearby	Sheep grazing	**Fav**	Population numbers are very healthy. No evident impacts from drainage or active turf cutting. However these should be monitored closely for changes.
SH18	Fav	Fav	Drainage; active turf cutting nearby	Sheep grazing	**Fav**	Population numbers are very healthy. HfS passes all criteria (vegetation height 0.4 cm above threshold; passed on expert judgement). No evident impacts from drainage or active turf cutting. However these should be monitored closely for changes.
SH19	Fav	U-I	Drainage; active turf cutting nearby; slightly overgrazed	Sheep grazing	**U-I**	Population numbers are very healthy. HfS fails due to hydrology (fails in both plots) and grazing level, which passes in one plot but is too high in the other. No obvious impacts from drainage or active turf cutting. However these should be monitored closely for changes.

Thirteen of the nineteen sites were assessed as having Favourable Future prospects, four sites received an Unfavourable-Inadequate assessment, and two sites received an Unfavourable-Bad assessment.

3.4 Site-level conservation status assessment

The Population, Habitat for the Species and Future prospects assessment results were combined to produce a single overall site-level assessment for each site. Thirteen sites received a Favourable assessment, four sites were assessed as Unfavourable-Inadequate, and two sites were Unfavourable-Bad. These results are shown in Table 14.

Table 14 Results of the site-level assessments of *Saxifraga hirculus* at all known sites for the species based on the RPMS 2015–18. Fav=Favourable, U-I=Unfavourable-Inadequate, U-B=Unfavourable-Bad.

Site ID	Site name	Population	Habitat for Species	Future prospects	Overall conservation status
SH01	Aghoo	Fav	Fav	Fav	Fav
SH02	Barroosky	Fav	Fav	Fav	Fav
SH03	Bellacorick	U-B	U-B	U-B	U-B
SH04	Formoyle	Fav	U-I	U-I	U-I
SH05	Largan Mor A	Fav	Fav	Fav	Fav
SH06	Largan Mor B	Fav	Fav	Fav	Fav
SH07	Largan Mor C	Fav	Fav	Fav	Fav
SH08	Sheean A	Fav	Fav	Fav	Fav
SH09	Sheean B	Fav	Fav	Fav	Fav
SH10	Sheean C	Fav	Fav	Fav	Fav
SH11	Sheean D	Fav	Fav	Fav	Fav
SH12	Sheskin A	U-B	U-B	U-B	U-B
SH13	Sheskin B	Fav	U-I	U-I	U-I
SH14	Sheskin C	Fav	U-I	U-I	U-I
SH15	Uggool	Fav	Fav	Fav	Fav
SH16	Croaghaun East	Fav	Fav	Fav-	Fav
SH17	Ox Mountains A	Fav	Fav	Fav	Fav
SH18	Ox Mountains B	Fav	Fav	Fav	Fav
SH19	Ox Mountains C	Fav	U-I	U-I	U-I

3.5 *Saxifraga hirculus* inside and outside of the SAC network

In Ireland, any population of an Annex II species that lies outside an SAC, or that occurs within an SAC but is not listed as a Qualifying Interest (QI) for that SAC, does not have the same level of legal protection as a population that occurs within an SAC for which the species is listed as a QI.

All 19 known populations of *S. hirculus* are situated inside an SAC and the species is listed as a QI in each of the SACs within which it occurs (see Table 2).

4 Discussion

The recommendations for monitoring *Saxifraga hirculus* in Ireland were based on the PhD research of Muldoon (2011) and the subsequent monitoring guidelines that arose out of this work (Muldoon *et al.*, 2015). The *S. hirculus* component of the RPMS 2015–18 resurveyed Muldoon's sites and also for the first time surveyed and assessed populations of the species discovered after her PhD fieldwork had concluded.

Between 2016 and 2018 all of the populations for which baseline information was available were found and resurveyed, and populations first recorded (but not assessed) between 2010 and 2014 were also visited and assessed. All were found to be still extant. Thus the range of *Saxifraga hirculus* was maintained since the previous monitoring period. As Muldoon (2011) noted, species such as *Saxifraga hirculus* with fragmented and declining populations can suffer from inbreeding and loss of viability unless gene flow with other populations can occur, so the conservation of all known *Saxifraga hirculus* sites is important for the maintenance of genetic diversity within and between populations. Loss of an entire population, even a small one such as Bellacorick, may be more damaging to the species nationally than a significant decline in the number of individuals within a single population. The concurrent maintenance of mechanisms for gene flow between populations, such as retaining suitable habitat that supports pollinating insects, is also critical to functionally linking up such populations.

Population numbers in sites for which baseline data were available were, in most cases, broadly similar to those recorded in the previous monitoring period by Muldoon (2011), or even significantly higher. There were two exceptions: SH03 Bellacorick and SH12 Sheskin A. At both sites, population losses were linked to poor habitat quality caused by undergrazing and insufficient groundwater supply, although the magnitude of the losses was unexpected. Appropriate grazing levels and suitably wet hydrological conditions both serve to keep vegetation from becoming rank and tussocky, providing more open conditions in which *S. hirculus* is better able to compete. Undergrazing becomes a problem when the vegetation surrounding *S. hirculus* becomes tall and rank, out-competing it and potentially also providing a physical barrier to the establishment of new vegetative clones (Muldoon, 2011). Too dry a hydrological regime can have a similar effect, and there is a further issue with this as *S. hirculus* requires a constant flow of well-oxygenated groundwater close to the surface to thrive (Vittoz *et al.*, 2006).

In comparing the results between the baseline survey and the current survey, however, it should be noted that the survey intensity and resolution was much higher in the former, which, being part of a PhD study, involved several visits and repeated counts at Bellacorrick, Barroosky and Sheean A. In the current survey, counts were generally conducted in a single day. Differences in sampling intensity do not appear to have been of significance at Barroosky and Sheean A, as rosette numbers recorded in the current survey were higher than the baseline, and the average sward height of 20–25 cm was short enough to make rosettes easy enough to find; however, it could well have been an issue at Bellacorick, where mean sward height was 42 cm and rosettes were concealed among tall, rank vegetation. The core location and extent of the habitat occupied by *S. hirculus* at Bellacorick appears to have remained relatively constant, having been described as 15 m x 10 m in 1995 and 20 m x 10 m in 1999 (NPWS, unpublished data), and mapped as 550 m^2 in 2012 (BES, 2012) and as 300 m^2 in 2018. The larger area of 950 m^2 mapped by Muldoon (2011) was due to the greater spread of plants found, particularly one outlier to the south of the core area (Figure 3). Despite diligent searching in 2018, no plants were located at this southern point.

The number of rosettes counted in the baseline survey was particularly high for Bellacorick, where surveys have been on-going since the late 1980s and little fluctuation has been noted over most of that time (N. Lockhart, pers. comm.; NPWS unpublished data). The high numbers recorded during the baseline survey may thus be anomalous as they were collected by more prolonged and intensive sampling, and the population threshold for this site may therefore be set too high. It is also possible that conditions during the baseline survey may have been particularly good for the plant, in terms of both vegetative runner and flowering stem production. It should also be noted that the summer of 2018,

when Bellacorick was visited for the current survey, was one of the driest on record in Ireland, and this may have negatively impacted on the number of rosettes. It would be of some interest to see if rosette numbers at Bellacorick were to undergo a spike in 2019 in response to the extremely dry conditions experienced in 2018.

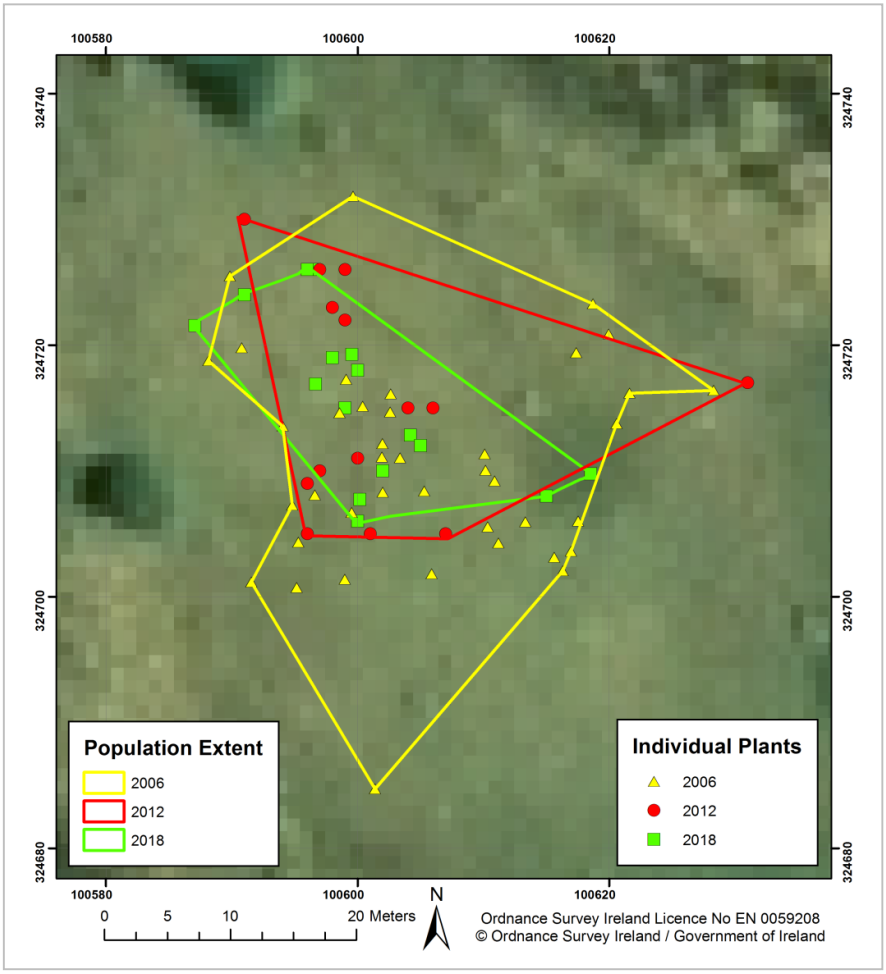

Figure 3 *Saxifraga hirculus* population at Bellacorick mapped in three separate years: 2006 (Muldoon, 2011), 2012 (BES, 2012) and 2018 (current survey). Lines indicate population extent; Symbols indicate individual plant records.

Sheskin A, while less well documented, is a similar type of site to Bellacorick (tall, rank vegetation) which likewise appears to have remained more or less unchanged since its discovery about 20 years ago (N. Lockhart, pers. comm.). This site was only visited once by Muldoon (2011) so there is less reason to posit sampling intensity as a reason for population number differences. There was some evidence during the current survey, in the form of skeleton gorse bushes, that burning had taken place here in the past, so the decline here may be due to other factors. A follow-up survey may be indicated to see if there are signs of recovery in rosette numbers.

Having regard to the above caveats regarding interpretation of results between the two monitoring period, and while the counts recorded in the current survey may not represent the catastrophic decline suggested by the comparison between the numbers recorded in the two surveys, the populations are undoubtedly smaller than before and there is no doubt that the habitat for the species at both of these sites is less than optimal for *S. hirculus.* At Bellacorick, falling water levels are not a recent problem but have been occurring since the 1950s as the site was extensively drained for peat extraction (N. Lockhart, pers. comm.). Hydrological data recorded for the Oweninny windfarm indicate that water levels have remained steady there since 2012 (D. Broderick, pers. comm.), but water levels do not appear to have recovered sufficiently for *S. hirculus* since the site was drained, and conditions here are not optimal for

S. hirculus. On the basis of habitat condition alone, the Unfavourable-Bad assessments for Bellacorick and Sheskin A are justified.

While the windfarm does not appear to be having any direct impacts on the *S. hirculus* population, there may be indirect negative impacts, such as reducing the number of sheep accessing the site. The site has always been undergrazed, however, with grazing only carried out by small numbers of sheep that make their way onto the site through the broken fence from adjacent fields. Some level of grazing is beneficial to *S. hirculus* habitat by keeping the vegetation open and preventing more competitive species such as *Molinia caerulea* and *Holcus lanatus* from becoming dominant. The type of animal can also be an important factor, with most grazing of Irish *S. hirculus* sites carried out by sheep rather than cattle. Vittoz *et al*. (2006) note that cattle grazing has traditionally been practised in areas of *S. hirculus* habitat in Switzerland, so optimal levels of grazing and type of grazer may vary from site to site. While prolonged grazing by cattle may be too much for fragile flush habitats, short periods of cattle grazing may benefit the habitat by opening up vegetation and laying soil bare for seed germination, and there is evidence that the plant's vegetative runners help it to recover from some level of trampling (Hedley & Walker, 2015). Given the fact that suitable *S. hirculus* habitat is usually extremely wet, cattle may be naturally unsuitable and a combination of grazers may therefore prove more suitable. It is important to strike the correct balance between under- and overgrazing as too many grazers could damage the habitat by poaching or by removing too many flowering stems, thus reducing seed set, while too few would be inadequate to control competing vegetation. Flush systems are self-maintaining to an extent, in that vegetation will often be kept open if the site is sufficiently wet. Sites that start to dry out often have associated problems with vegetation becoming progressively more rank. The carrying capacity of a wet habitat is lower than a drier one, so this needs to be taken into account if grazing is to be used to manage a *S. hirculus* site.

Vegetation heights recorded during the current survey were frequently higher than in the baseline survey but rosette numbers did not appear to be adversely affected; the vegetation height assessment threshold was therefore increased from the baseline. Muldoon (2011) noted that the number of sheep on the west Mayo bogs had been reduced under the Commonage Framework Plans and the Ireland CAP Rural Development Programme of 2010. Thus it is likely that the baseline targets were set at a time when grazing levels were undergoing a period of adjustment. Stock numbers before and after destocking were not sought, however, so this is inferred rather than confirmed, but relaxation of grazing pressure could account for the higher numbers of rosettes recorded in the current survey compared to the baseline survey. Of the 12 sites where rosette density had been calculated during the baseline survey, 11 had higher density in the current survey, in several cases by an order of magnitude. While many of these rosettes will not survive to adulthood and flowering, it nevertheless bodes well for the continued survival of *S. hirculus* at these sites. This finding also demonstrates the critical role played by appropriate grazing in managing the habitat for the species.

Possible threats noted during the survey include that posed by turf cutting expansion, especially in the Ox Mountains sites (SH17, SH18 and SH19). Here, active cutting is taking place within 150–200 m of the *S. hirculus* populations. Any expansion of the area being cut, or increases in drainage to facilitate cutting in other adjacent areas, will likely prove highly damaging.

At all flushes at Sheean (SH08, SH09, SH10 and SH11), tall *Calluna vulgaris* plants and *Molinia caerulea* tussocks were noted in the vicinity of the *S. hirculus* populations. While this is not a problem in itself, these species are highly flammable, so burning the hillside in the vicinity could impact on the *S. hirculus* habitat, particularly during a dry spell. Burning was not noted at any of the sites during the current survey, with the possible exception of Sheskin A. Here, burning – indicated mainly by the presence of dead gorse bushes – was suspected to have taken place in the past, and was considered to be a possible cause of the reduction in rosette numbers, although it was not known how long ago this occurred. Burning is frequently practised in blanket bogs and heaths (NPWS, 2013), which often form part of the greater landscape mosaic in which *S. hirculus* flushes are situated.

Given the northern distribution of the species globally, there is a real concern that higher temperatures due to climate change will have a serious impact on the distribution of this species, particularly at its southern limits, pushing the species further northwards or to higher altitudes, where suitable habitat may not occur, thus leading to extinction. Reference has already been made to the dry, hot summer of 2018, in which several new temperature and drought records were set (www.met.ie). Muldoon (2011) noted that other climate-related changes, such as altered rain/groundwater levels or a change to the composition and diversity of the flush communities, could also occur, presenting further challenges to the species. Vittoz *et al*. (2006) further note that nitrogen atmospheric pollution may increase competition from existing species surrounding *S. hirculus* or facilitate the establishment of new species.

5 Recommendations

- Site SH03 Bellacorick should be targeted for remedial conservation work at the earliest opportunity as its population shows a significant decline since the intensive surveys of the previous monitoring period, although the core area of the population has remained largely unchanged since its discovery in the 1950s. Unsuitable hydrology and undergrazing at the site need to be addressed. Survey timing should be carefully planned as the population here flowers late (J. Conaghan, pers. comm.) and past surveys have indicated flowering even in October (Scannell, 1958). Regular *S. hirculus* surveys are being carried out at Bellacorick (John Conaghan, pers. comm.), as are on-going hydrological investigations as part of the ecological obligations for the Oweninny windfarm. However, other more targeted remedial actions should also be taken. Micro-management may be beneficial, such as strimming taller vegetation and removing the cut material, or mimicking the effects of grazing in some other way to create small patches of bare ground. Any activities should be carried out on a very local scale initially, perhaps targeting areas of the site where the plant was formerly recorded but has not recently been found to see if plants will reappear there. If measures meet with success at Bellacorick they could be extended to Sheskin A.

- Optimal levels of grazing should be determined for sites and due consideration should be given to the ability of the habitat to physically support the grazers when deciding on appropriate grazing regimes. Sheep, horses or cattle may be suitable, although cattle may be too heavy for the wetter flushes. However, short periods of cattle grazing may be suitable in some cases to open up vegetation and lay soil bare for seed germination, and there is some evidence that the plant's runners help it to overcome the effects of trampling. Grazing should only be carried out if it is clearly needed (e.g. rank sward) and may not be needed if the habitat is being kept open adequately by hydrology alone.

- Ecosystem-level protection of *S. hirculus* flush habitats, rather than simply protection of the flushes themselves, should be carried out where possible. This means that the flush and the wider landscape in which it is situated should be protected with equal diligence. Measures such as drain blocking could be implemented on sites where sub-optimal hydrology has been shown to be an issue. The success of such measures will depend on available resources and landowner agreement.

- Consider reducing the thresholds of rosette counts in Bellacorick and Sheskin A if they seem to be unattainably high. This may require further visits and counts to set a more reasonable target. Alternatively, or in addition, a target could be set for the number of flowers rather than the number of rosettes. This measure might be easier to count and less subject to wide fluctuations. Rosette numbers have been seen in some studies to vary greatly between years.

- Future monitoring surveys need only record the specific data required to assess the species and its habitat. There should be no further need to record full relevé data at each monitoring stop. This will speed up the monitoring process without any loss of relevant data and will also minimise damage to the habitat caused by surveys.

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Appendix 1 Site summary data sheet

This data sheet was used as a front sheet for all site packs. Some information, such as the site number, name and grid reference, was printed on the sheet prior to survey. "Type of survey" was either "Monitoring" or "Baseline".

The Survey results and Survey notes sections, including positive and negative activities occurring on site, were filled out by surveyors after the survey had been completed.

bec CONSULTANTS

Rare Plants Monitoring 2015–18

Saxifraga hirculus

Site no:	[Autofilled prior to survey]	**Disco. map:**	[Autofilled prior to survey]
Site name:	[Autofilled prior to survey]	**AP no. (2005):**	[Autofilled prior to survey]
Grid ref:	[Autofilled prior to survey]	**Type of survey:**	[Autofilled prior to survey]
SAC:	[Autofilled prior to survey]		

Survey results: Site-level criteria

Total no. of rosettes: _____

Population extent (m^2): _____

No. of mon. plots recorded: _____

Survey notes:

Site description or changes since baseline:

Impact code / description e.g. A04.01 intensive grazing	**Location** inside / outside pop. extent	**Influence (+/-/0)**	**Intensity (H/M/L)**	**% pop. extent affected** (<1%; 1–25%; 26–50%; 51–75%; 76–99%; 100%)

Comments on condition/management:

Other remarks:

Data entry/checking:

GPS points downloaded: INITIALS _____ DATE _____
Turboveg checked: INITIALS _____ DATE _____
Photos labelled correctly: INITIALS _____ DATE _____
Data checked & complete: INITIALS _____ DATE _____

Appendix 2 Turboveg header data recorded at each monitoring stop

The following header information was recorded at each monitoring stop in the vegetation database recording program Turboveg (Compact Edition for use on hand-held devices; Alterra, The Netherlands):

	Field name	Description
1.	Cover abundance scale	Percentage (code 00) was always selected
2.	Date	Date the plot was recorded
3.	Releve area (m^2)	Relevé size: 1
4.	X-coordinate	X-coordinate of plot
5.	Y-coordinate	Y-coordinate of plot
6.	Site_no	Site number, e.g. SH04
7.	Plot_no	Monitoring plot number. 1, 2, etc.
8.	Plot_type	Two options: Full relevé (with species data) or assessment plot (monitoring data only, no species data)
9.	Surveyors	Initials of ecologist(s) recording the stop
10.	Foss_hab	Fossitt code of the habitat in which stop is recorded, e.g. PF1
11.	Water_levl	Does water level cover hand pressed into vegetation? Y or N
12.	Sag_nod_pc	Percent *Sagina nodosa* in the plot
13.	Mol_cae_pc	Percent *Molinia caerulea* in the plot
14.	Hol_lan_pc	Percent *Holcus lanatus* in the plot
15.	Avg_veg_ht	Average height of vegetation in cm
16.	Graz_categ	Assessed as one of four categories; see main report for details
17.	No_rosetts	Number of *S. hirculus* rosettes counted in the plot
18.	No_flowers	Number of *S. hirculus* flowers counted in the plot
19.	Aspect	Cardinal or ordinal compass point (N, NW, etc.) of stop's aspect if on a slope, otherwise "None"
20.	Slope	Slope in degrees determined by clinometer; 0 if flat
21.	Annex_code	Annex I habitat in which stop is recorded, e.g. 7230
22.	Topography	Description of topography where stop is recorded, e.g. mid-slope, flat
23.	Soil_type	Type of soil on which plot recorded, e.g. basin peat
24.	Bare_soil	Percent cover of bare soil/peat in the plot
25.	Bare_rock	Percent cover of bare rock in the plot
26.	Surf_water	Percent cover of surface water in the plot
27.	Leaf_littr	Percent cover of leaf litter in the plot
28.	Bryo_cover	Percent cover of bryophytes in the plot
29.	Forb_cover	Percent cover of forbs (broadleaf herbs) in the plot
30.	Gram_cover	Percent cover of graminoids in the plot
31.	Vasc_cover	Percent cover of vascular plants in the plot
32.	Remarks	Other pertinent data, e.g. grazer numbers

Appendix 3 Individual site reports

Individual site reports were compiled from the following:

- the summary paragraphs written by ecologists after each survey,
- the impacts recorded during the survey, and
- the results of the different components of the species assessment.

SH01	Aghoo
SH02	Barroosky
SH03	Bellacorick
SH04	Formoyle
SH05	Largan Mor A
SH06	Largan Mor B
SH07	Largan Mor C
SH08	Sheean A
SH09	Sheean B
SH10	Sheean C
SH11	Sheean D
SH12	Sheskin A
SH13	Sheskin B
SH14	Sheskin C
SH15	Uggool
SH16	Croaghaun East
SH17	Ox Mountains A
SH18	Ox Mountains B
SH19	Ox Mountains C

Site report - Rare Plant Monitoring Surveys

Marsh Saxifrage (Saxifraga hirculus)

SH01 Aghoo, Co. Mayo

Irish Grid ref.: 108304 335100; Altitude: 190m; SAC: 000500

Monitoring Period:	2013-2018	**Survey start date:**	14/08/2017	**No. of monitoring stops:**	5
Surveyed by:	OD/RH	**Survey end date:**	14/08/2017	**Survey type:**	Monitoring

Comments on site:

The extent of the colony is unchanged since the last monitoring period. However, population numbers and density have increased since the baseline survey. Habitat for the Species passed the Sagina nodosa criterion this time, unlike in the baseline. Grazing levels appear to have increased since the baseline survey.

Comments on condition/management:

During the survey there were signs of grazing by horses and sheep, which preferentially graze the flush. The surrounding bog is undergrazed but sward height was deemed to be adequate for the Saxifraga hirculus habitat, and the increase in grazing appears to have improved conditions for the species.
Water only covered the hand in two plots, but hydrology was not deemed to be an issue at the site.

Other notes:

The colony is located in a small iron-rich flush on a boggy hillside. The flush has Sphagnum around the edges with Carex rostrata throughout. Saxifraga hirculus occurs with Sphagnum contortum and Tomentypnum nitens and other brown moss species. Carex limosa is also present.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 01	Total no. of rosettes	>=960	58,590	Pass	
2013-2018	SH 01	Density of rosettes (mean across all stops)	>=5	310	Pass	
2013-2018	SH 01	No. of flowering heads	100s	100s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 01	Area covered by the population (m2)	>=170	189	Pass	
2013-2018	SH 01	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	Hydrology suitable in 2 out of 5 plots
2013-2018	SH 01	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 5 out of 5 plots	Pass	
2013-2018	SH 01	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 01	Mean % cover of Holcus lanatus across all stops	<=15	6.6	Pass	
2013-2018	SH 01	Mean vegetation height (cm) across all stops	<=20	15.6	Pass	
2013-2018	SH 01	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 01	A04.02.05	Non-intensive mixed animal grazing	L	Positive	100	189	Sheep and horses
2013-2018	SH 01	G05.01	Trampling, overuse	L	Negative	1-25	2-47	Trampling by surveyors
2013-2018	SH 01	M	Climate change	XX	Negative	100	189	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 01	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH02 Barroosky, Co. Mayo

Irish Grid ref.: 93561 328520; Altitude: 200m; SAC: 000500

Monitoring Period:	2013-2018	**Survey start date:**	08/08/2017	**No. of monitoring stops:**	5
Surveyed by:	RH/ML	**Survey end date:**	08/08/2017	**Survey type:**	Monitoring

Comments on site:

Population numbers and density have increased since the baseline survey. Vegetation height seems to be higher than previously; however, it does not appear to be at all rank, sheep are moving through the habitat, so there does not appear to be a problem with undergrazing. Habitat for the Species passed the Sagina nodosa criterion this time, unlike in the baseline survey. All other attributes of the habitat are similar to the baseline.

Comments on condition/management:

Sheep grazing is probably at just about the right level, but no reduction in grazing should occur. Sward height is above the threshold set but surveyors noted that the habitat appeared in good condition, not rank, and with sheep moving through the habitat. Therefore Future prospects of Habitat for the Species are deemed to be favourable.

Other notes:

None

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 02	Total no. of rosettes	>=52,000	755,000	Pass	
2013-2018	SH 02	Density of rosettes (mean across all stops)	>=24	327	Pass	
2013-2018	SH 02	No. of flowering heads	10,000s	10,000s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 02	Area covered by the population (m2)	>=2,025	2309	Pass	
2013-2018	SH 02	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	All plots passed
2013-2018	SH 02	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 2 of 5 stops	Pass	
2013-2018	SH 02	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 02	Mean % cover of Holcus lanatus across all stops	<=15	1.1	Pass	
2013-2018	SH 02	Mean vegetation height (cm) across all stops	<=20	25.4	Pass	Passed all other criteria, sward height not deemed to be a problem in this site
2013-2018	SH 02	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 02	A04.02.02	Non-intensive sheep grazing	M	Positive	100	2309	
2013-2018	SH 02	G05.01	Trampling, overuse	L	Negative	1-25	23-577	Trampling by surveyors
2013-2018	SH 02	M	Climate change	XX	Negative	100	2309	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 02	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH03 Bellacorick, Co. Mayo

Irish Grid ref.: 100605 324711; Altitude: 100m; SAC: 000466

Monitoring Period:	2013-2018	**Survey start date:**	08/08/2018	**No. of monitoring stops:**	5
Surveyed by:	RH/ML	**Survey end date:**	08/08/2018	**Survey type:**	Monitoring

Comments on site:

Very few Saxifraga hirculus plants were found, either flowering or non-flowering. The population extent appears to have contracted and population numbers have declined since the baseline survey.
According to hydrology data collected for the nearby windfarm, hydrology has apparently not been affected since windfarm construction began. Water levels are low thoughout this year due to prolonged drought. Drainage for peat cutting is of long standing (1960s) and has not been entered as a current impact.

Comments on condition/management:

Vegetation is quite tall and relatively dense. During the survey the ground was quite dry underfoot, with no standing water or water visible on applying pressure. However, the prolonged heat wave in previous weeks may have been the cause. Higher water levels would prevent the sward from becoming too rank. There were indications of sheep grazing (dung and nibbled vegetation) and sheep were seen nearby, but grazing levels on site are moderate to low. Habitat for the Species failed several criteria: hydrology (too dry; note: assessed during prolonged dry spell), Sagina nodosa (absent), vegetation height (too tall). Insufficient grazing is the main problem; fewer sheep may graze now that windfarm construction is under way.

Other notes:

The main species occurring with Saxifraga hirculus include Carex rostrata, C. diandra, C. limosa, C. nigra, Potentilla palustris, Epilobium palustre and Lychnis flos-cuculi.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 03	Total no. of rosettes	>=560	23	Fail	Absolute count, not estimated
2013-2018	SH 03	Density of rosettes (mean across all stops)	N/R	N/R	N/A	
2013-2018	SH 03	No. of flowering heads	100s	10s	Fail	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 03	Area covered by the population (m2)	>=855	156	Fail	
2013-2018	SH 03	Wetness of substrate	Water level covers hand	No plot passed	Fail	No plot passed this test
2013-2018	SH 03	Presence of Sagina nodosa	Present in at least 2 of 5 stops	0	Fail	
2013-2018	SH 03	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 03	Mean % cover of Holcus lanatus across all stops	<=15	3	Pass	
2013-2018	SH 03	Mean vegetation height (cm) across all stops	<=20	42	Fail	
2013-2018	SH 03	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 03	A04.02.02	Non-intensive sheep grazing	L	Positive	100	156	Low level of sheep grazing, insufficient for S. hirculus
2013-2018	SH 03	A04.03	Abandonment of pastoral systems, lack of grazing	H	Negative	100	156	Abandonment; very occasional grazing occurs but site is still undergrazed
2013-2018	SH 03	G05.01	Trampling, overuse	L	Negative	1-25	2-39	Trampling by surveyors
2013-2018	SH 03	J02.07.01	Groundwater abstractions for agriculture	M	Negative	100	156	Drainage
2013-2018	SH 03	M	Climate change	XX	Negative	100	156	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 03	Unfavourable-Bad	Unfavourable-Bad	Unfavourable-Bad	Unfavourable-Bad
Trend (if known):		n/a	n/a		n/a

SH04 Formoyle, Co. Mayo

Irish Grid ref.: 105315 322817; Altitude: 70m; SAC: 001922

Monitoring Period:	2013-2018	**Survey start date:**	05/09/2017	**No. of monitoring stops:**	3
Surveyed by:	CC/RH/NL	**Survey end date:**	05/09/2017	**Survey type:**	Monitoring

Comments on site:

The site appears to be more intensively grazed than in the baseline survey. Poaching and dung was evident, with more disturbance than before. The vegetation was browsed fairly extensively. Towards the upper part of the population polygon, Saxifraga hirculus was more sporadic and sparsely occurring. Despite these issues, however, population numbers and density have increased considerably since the baseline survey.

Comments on condition/management:

The long-term impact of the current grazing level is not certain, whether positive or negative.
Grazing is slightly higher than the optimal threshold (poaching and dung are evident); however, this may be due to an isolated grazing incident, as the surrounding areas are not overgrazed. In addition, the Saxifraga hirculus population has increased since the baseline survey. Therefore, despite the unfavourable assessment of Habitat for the species, Future prospects are deemed to be Favourable.

Other notes:

None

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 04	Total no. of rosettes	>=136	1,898	Pass	
2013-2018	SH 04	Density of rosettes (mean across all stops)	>=2	26	Pass	
2013-2018	SH 04	No. of flowering heads	10s	10s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 04	Area covered by the population (m2)	>=65	73	Pass	
2013-2018	SH 04	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	All plots passed
2013-2018	SH 04	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Absent from all stops	N/A	Sagina nodosa not considered likely to occur here at any time
2013-2018	SH 04	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 04	Mean % cover of Holcus lanatus across all stops	<=15	0	Pass	
2013-2018	SH 04	Mean vegetation height (cm) across all stops	<=20	16	Pass	
2013-2018	SH 04	Grazing (Average across all stops)	26-50%	51-75%	Fail	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 04	A04.02.01	Non-intensive cattle grazing	H	Negative	100	73	Grazing judged to be higher than optimal (poaching, dung and disturbance evident) during the survey, but this may be an isolated grazing incident, as surrounding areas are not overgrazed.
2013-2018	SH 04	G05.01	Trampling, overuse	L	Negative	1-25	1-18	Trampling by surveyors
2013-2018	SH 04	M	Climate change	XX	Negative	100	73	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 04	Favourable	Unfavourable-Inadequate	Unfavourable-Inadequate	Unfavourable-Inadequate
Trend (if known):		n/a	n/a		n/a

SH05 Largan More A, Co. Mayo

Irish Grid ref.: 89381 322581; Altitude: 120m; SAC: 000476

Monitoring Period:	2013-2018	**Survey start date:**	17/08/2016	**No. of monitoring stops:**	5
Surveyed by:	CC/RH	**Survey end date:**	17/08/2016	**Survey type:**	Monitoring

Comments on site:

Population numbers and density have increased since the baseline survey. Saxifraga hirculus covers a greater area than previously recorded, as it was recorded outside the previous polygons. There are signs that the habitat is improving: Sagina nodosa is present, unlike in the previous survey, the grazing level criterion was met, and vegetation height is suitable. Fewer flowering heads were recorded compared to the baseline survey.

Comments on condition/management:

Horse and sheep grazing is occurring on site but surveyors considered that the grazing level was lower than optimal for Saxifraga hirculus. Despite this, population numbers and density have increased since the baseline and there are indications that overall conditions for the species are improving.

Other notes:

None

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 05	Total no. of rosettes	>=2,800	15,650	Pass	
2013-2018	SH 05	Density of rosettes (mean across all stops)	>=30	92	Pass	
2013-2018	SH 05	No. of flowering heads	1,000s	100s	Fail	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 05	Area covered by the population (m2)	>=83	171	Pass	
2013-2018	SH 05	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	All plots passed
2013-2018	SH 05	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 3 of 5 stops	Pass	
2013-2018	SH 05	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 05	Mean % cover of Holcus lanatus across all stops	<=15	0.7	Pass	
2013-2018	SH 05	Mean vegetation height (cm) across all stops	<=20	17	Pass	
2013-2018	SH 05	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 05	A04.02.05	Non-intensive mixed animal grazing	L	Positive	100	171	Low level of sheep and horse grazing occurs; may be slightly undergrazed
2013-2018	SH 05	G05.01	Trampling, overuse	L	Negative	1-25	2-43	Trampling by surveyors
2013-2018	SH 05	M	Climate change	XX	Negative	100	171	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 05	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH06 Largan More B, Co. Mayo

Irish Grid ref.: 89920 324049; Altitude: 160m; SAC: 000476

Monitoring Period:	2013-2018	**Survey start date:**	16/08/2016	**No. of monitoring stops:**	1
Surveyed by:	CC/RH	**Survey end date:**	16/08/2016	**Survey type:**	Monitoring

Comments on site:

Population numbers have increased since the baseline survey and the Sagina nodosa criterion was met this time.

Comments on condition/management:

Grazing appears to be optimal, although some poaching (by cattle) and dung were noted. Sheep grazing does not seem to be having a negative effect.

Other notes:

None

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 06	Total no. of rosettes	>=440	715	Pass	
2013-2018	SH 06	Density of rosettes (mean across all stops)	>=88	143	Pass	
2013-2018	SH 06	No. of flowering heads	N/R	0	N/A	No flowering observed during baseline or current survey, so criterion not assessed

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 06	Area covered by the population (m2)	>=4.5	5	Pass	
2013-2018	SH 06	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	Passed in the one plot recorded
2013-2018	SH 06	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in stop	Pass	
2013-2018	SH 06	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 06	Mean % cover of Holcus lanatus across all stops	<=15	3	Pass	
2013-2018	SH 06	Mean vegetation height (cm) across all stops	<=20	10	Pass	
2013-2018	SH 06	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 06	A04.02.01	Non-intensive cattle grazing	L	Negative	100	5	
2013-2018	SH 06	A04.02.02	Non-intensive sheep grazing	L	Neutral	100	5	
2013-2018	SH 06	G05.01	Trampling, overuse	L	Negative	1-25	0-1	Trampling by surveyors
2013-2018	SH 06	M	Climate change	XX	Negative	100	5	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 06	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH07 Largan More C, Co. Mayo

Irish Grid ref.: 90154 324018; Altitude: 170m; SAC: 000476

Monitoring Period:	2013-2018	**Survey start date:**	16/08/2016	**No. of monitoring stops:**	5
Surveyed by:	CC/RH	**Survey end date:**	16/08/2016	**Survey type:**	Baseline

Comments on site:

Saxifraga hirculus occurs in three parallel flushes which are part of a larger flush system. Limited habitat is occupied by Saxifraga hirculus as most of the system is too acidic and/or too wet. However, population numbers are healthy.

Comments on condition/management:

Cattle and sheep grazing occurs on site. Too many cattle could potentially cause excessive damage through poaching, as has occurred in adjacent flushes. Sheep grazing is allowable to maintain open conditions.

Other notes:

Hamatocaulis vernicosus is frequent in 2 of the 3 flushes.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 07	Total no. of rosettes	>=5,000	6,288	Pass	
2013-2018	SH 07	Density of rosettes (mean across all stops)	>=64	81	Pass	
2013-2018	SH 07	No. of flowering heads	100s	100s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 07	Area covered by the population (m2)	>=70	79	Pass	
2013-2018	SH 07	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	Hydrology suitable in 2 out of 5 plots
2013-2018	SH 07	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 5 of 5 stops	Pass	
2013-2018	SH 07	Mean % cover of Molinia caerulea across all stops	<=5	0.02	Pass	
2013-2018	SH 07	Mean % cover of Holcus lanatus across all stops	<=15	1	Pass	
2013-2018	SH 07	Mean vegetation height (cm) across all stops	<=20	9.2	Pass	
2013-2018	SH 07	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 07	A04.02.05	Non-intensive mixed animal grazing	L	Neutral	100	79	Cattle and sheep
2013-2018	SH 07	G05.01	Trampling, overuse	L	Negative	1-25	1-20	Trampling by surveyors
2013-2018	SH 07	M	Climate change	XX	Negative	100	79	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 07	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH08 Sheean A, Co. Mayo

Irish Grid ref.: 91949 320077; Altitude: 145m; SAC: 000534

Monitoring Period:	2013-2018	**Survey start date:**	19/07/2016	**No. of monitoring stops:**	5
Surveyed by:	RH/ML	**Survey end date:**	20/07/2016	**Survey type:**	Monitoring

Comments on site:

Population numbers are stable since the baseline survey. The area of suitable habitat on this site is an elongated flush with Saxifraga hirculus present in places. It is not thought to have changed since the baseline survey, except perhaps that it may be less grazed than before, based on vegetation height.

Comments on condition/management:

Vegetation height is slightly above the 20cm threshold, despite sheep grazing, but all other Habitat for the Species criteria were met, including grazing level, so the vegetation height was allowed a discretionary pass also. Quad bike tracks are visible on site and judged to be having a negative effect on the habitat; however, the affected area is small and the activity is not considered to threaten the species's future prospects as long the area affected does not increase.

Other notes:

Calluna vulgaris and Molinia caerulea are tall and dense near all four Sheean flushes, so if fire were to occur, this could damage the flushes.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 08	Total no. of rosettes	>=150,000	170,100	Pass	
2013-2018	SH 08	Density of rosettes (mean across all stops)	>=84	102	Pass	
2013-2018	SH 08	No. of flowering heads	>10,000	10,000s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 08	Area covered by the population (m2)	>=1,620	1671	Pass	
2013-2018	SH 08	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	Hydrology suitable in 3 out of 5 plots
2013-2018	SH 08	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 4 of 5 stops	Pass	
2013-2018	SH 08	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 08	Mean % cover of Holcus lanatus across all stops	<=15	7.6	Pass	
2013-2018	SH 08	Mean vegetation height (cm) across all stops	<=20	22.8	Pass	Marginal fail but all other criteria were passed
2013-2018	SH 08	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 08	A04.02.02	Non-intensive sheep grazing	M	Positive	100	1671	
2013-2018	SH 08	G01.03.02	Off-road motorized driving	M	Negative	1-25	17-418	Quad bike tracks
2013-2018	SH 08	G05.01	Trampling, overuse	L	Negative	1-25	17-418	Trampling by surveyors
2013-2018	SH 08	M	Climate change	XX	Negative	100	1671	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 08	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH09 Sheean B, Co. Mayo

Irish Grid ref.: 91946 320024; Altitude: 150m; SAC: 000534

Monitoring Period:	2013-2018	**Survey start date:**	20/07/2016	**No. of monitoring stops:**	5
Surveyed by:	RH/ML	**Survey end date:**	21/07/2016	**Survey type:**	Monitoring

Comments on site:

Population numbers and density of Saxifraga hirculus are higher than recorded during the baseline survey, and all thresholds for Habitat for the Species criteria were met or exceeded.

Comments on condition/management:

The site is in good condition, with a variety of vegetation heights and types (e.g. some areas very mossy, some with fairly tall sedges, and some with grazed sedges). Sheep grazing levels appear to be suitable for the site.

Other notes:

The Saxifraga hirculus habitat is one large elongated flush, with a number of nearby and interlinked runnels/channels or mossy patches. Some areas have fairly tall sedges (e.g. Carex rostrata, C. paniculata, C. diandra), others have a low mossy sward.
Calluna vulgaris and Molinia caerulea are tall and dense near all four Sheean flushes, so if fire ever occurred, this could damage the flushes.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 09	Total no. of rosettes	>=36,000	98,000	Pass	
2013-2018	SH 09	Density of rosettes (mean across all stops)	>=70	172	Pass	
2013-2018	SH 09	No. of flowering heads	10,000s	100s	Fail	Early in season

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 09	Area covered by the population (m2)	>=430	570	Pass	
2013-2018	SH 09	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	Hydrology suitable in 2 out of 5 plots
2013-2018	SH 09	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 5 of 5 stops	Pass	
2013-2018	SH 09	Mean % cover of Molinia caerulea across all stops	<=5	0.2	Pass	
2013-2018	SH 09	Mean % cover of Holcus lanatus across all stops	<=15	2.9	Pass	
2013-2018	SH 09	Mean vegetation height (cm) across all stops	<=20	18.2	Pass	
2013-2018	SH 09	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 09	A04.02.02	Non-intensive sheep grazing	M	Positive	100	570	
2013-2018	SH 09	G01.03.02	Off-road motorized driving	M	Negative	1-25	6-143	Quad bike tracks
2013-2018	SH 09	G05.01	Trampling, overuse	L	Negative	1-25	6-143	Trampling by surveyors
2013-2018	SH 09	M	Climate change	XX	Negative	100	570	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 09	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH10 Sheean C, Co. Mayo

Irish Grid ref.: 91753 319925; Altitude: 155m; SAC: 000534

Monitoring Period:	2013-2018	**Survey start date:**	21/07/2016	**No. of monitoring stops:**	5
Surveyed by:	RH/ML	**Survey end date:**	21/07/2016	**Survey type:**	Monitoring

Comments on site:

Population numbers and density of Saxifraga hirculus are higher than recorded during the baseline survey, and all thresholds for Habitat for the Species criteria were met or exceeded.
The vegetation is perhaps taller than in the baseline survey but this is evidently not having a negative effect on the population.

Comments on condition/management:

Saxifraga hirculus occurs in a wet flush dominated by bryophytes and sedges. It is very abundant, forming carpets in many places, and occurs here in the highest density of all four Sheean sites. This is also the wettest site of the four.
The habitat is grazed by sheep and appears to be in good condition.

Other notes:

Calluna vulgaris and Molinia caerulea are tall and dense near all four Sheean flushes, so if there is fire this could damage the flushes.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 10	Total no. of rosettes	>=104,000	>500,000	Pass	
2013-2018	SH 10	Density of rosettes (mean across all stops)	>=120	1,700	Pass	Carpet-forming swathes of rosettes
2013-2018	SH 10	No. of flowering heads	10,000s	10,000s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 10	Area covered by the population (m2)	>=790	767	Pass	Only slightly smaller area than target but otherwise excellent condition and high plant density
2013-2018	SH 10	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	Hydrology suitable in 4 out of 5 plots
2013-2018	SH 10	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 5 of 5 stops	Pass	
2013-2018	SH 10	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 10	Mean % cover of Holcus lanatus across all stops	<=15	2.4	Pass	
2013-2018	SH 10	Mean vegetation height (cm) across all stops	<=20	17	Pass	
2013-2018	SH 10	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 10	A04.02.02	Non-intensive sheep grazing	M	Positive	100	767	
2013-2018	SH 10	G05.01	Trampling, overuse	L	Negative	1-25	8-192	Trampling by surveyors
2013-2018	SH 10	M	Climate change	XX	Negative	100	767	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 10	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH11 Sheean D, Co. Mayo

Irish Grid ref.: 92109 320180; Altitude: 135m; SAC: 000534

Monitoring Period:	2013-2018	**Survey start date:**	18/07/2016	**No. of monitoring stops:**	5
Surveyed by:	RH/ML	**Survey end date:**	19/07/2016	**Survey type:**	Monitoring

Comments on site:

Population numbers and density of Saxifraga hirculus are higher than recorded during the baseline survey. The population extent appears to be the same as the baseline, although it was difficult to get a consistent GPS reading during the current survey. There was a marginal fail on hydrology (passed by 1 out of 5 plots). Grazing levels appear to be slightly lower than during the baseline survey, but are still judged to be suitable.

Comments on condition/management:

The habitat appears suitable and grazing should be maintained at its current level. Sheep grazing levels are low, with some droppings noted.
Despite the fact that the hydrology assessment passed in only 1 of the 5 plots, all other criteria were met and population numbers are increasing, so hydrology does not appear to be an issue at this site at present.

Other notes:

The site comprises two iron-rich flushes in blanket bog separated by about 10 m. It is a sedge-rich and bryophyte-rich habitat.
Only 1 flower was open at the time of the survey, although some on tussock sides were in bud.
Calluna vulgaris and Molinia caerulea are tall and dense near all four Sheean flushes, so if fire were to occur this could damage the flushes.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 11	Total no. of rosettes	>=19,000	118,690	Pass	
2013-2018	SH 11	Density of rosettes (mean across all stops)	>=33	166	Pass	
2013-2018	SH 11	No. of flowering heads	1,000s	1	Pass	Early in season, thousands in bud

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 11	Area covered by the population (m2)	>=510	715	Pass	
2013-2018	SH 11	Wetness of substrate	Water level covers hand	No; water level covers hand in only 1 plot	Pass	All other criteria were passed, and hydrology suitable in 1 plot
2013-2018	SH 11	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 2 of 5 stops	Pass	
2013-2018	SH 11	Mean % cover of Molinia caerulea across all stops	<=5	1.5	Pass	
2013-2018	SH 11	Mean % cover of Holcus lanatus across all stops	<=15	2.1	Pass	
2013-2018	SH 11	Mean vegetation height (cm) across all stops	<=20	16	Pass	
2013-2018	SH 11	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 11	A04.02.02	Non-intensive sheep grazing	M	Positive	100	715	
2013-2018	SH 11	G05.01	Trampling, overuse	L	Negative	1-25	7-179	Trampling by surveyors
2013-2018	SH 11	M	Climate change	XX	Negative	100	715	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 11	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH12 Sheskin A, Co. Mayo

Irish Grid ref.: 98131 329170; Altitude: 150m; SAC: 001922

Monitoring Period:	2013-2018	**Survey start date:**	09/08/2017	**No. of monitoring stops:**	5
Surveyed by:	RH/ML	**Survey end date:**	09/08/2017	**Survey type:**	Monitoring

Comments on site:

Population numbers and density have declined since the baseline survey. Rosettes of Saxifraga hirculus are sparse and patchy, less than the previous count. Several Habit for the Species criteria were not met: hydrology is too dry, vegetation is too tall and rank, and the level of grazing is too low.

Comments on condition/management:

The site is only very lightly grazed by deer, and vegetation is becoming dense and rank as a consequence, with tall Eriophorum, Carex rostrata, C. nigra and Holcus lanatus. The whole area has been subjected to burning at some point in the past, with gorse skeletons abundant in the flush and surrounding bog, and this may have impacted on the population.The site is relatively dry. There is a large deer hollow just above the population, with a big area of bare mud.

Other notes:

None

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 12	Total no. of rosettes	>=288	73	Fail	Absolute count, not estimated
2013-2018	SH 12	Density of rosettes (mean across all stops)	>=18	3	Fail	
2013-2018	SH 12	No. of flowering heads	100s	10s	Fail	11 flowering heads counted

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 12	Area covered by the population (m2)	>=14	24	Pass	
2013-2018	SH 12	Wetness of substrate	Water level covers hand	No; water level covers hand in only 1 plot	Fail	
2013-2018	SH 12	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Absent from all stops	Fail	
2013-2018	SH 12	Mean % cover of Molinia caerulea across all stops	<=5	4.8	Pass	
2013-2018	SH 12	Mean % cover of Holcus lanatus across all stops	<=15	8	Pass	
2013-2018	SH 12	Mean vegetation height (cm) across all stops	<=20	35	Fail	
2013-2018	SH 12	Grazing (Average across all stops)	26-50%	0-25%	Fail	

Impacts and activities

Mon. period	Site	Activity code	Description	Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 12	A04.03	Abandonment of pastoral systems, lack of grazing	H	Negative	100	24	Severely undergrazed
2013-2018	SH 12	G05.01	Trampling, overuse	L	Negative	1-25	0-6	Trampling by surveyors
2013-2018	SH 12	K04.05	Damage by herbivores (including game species)	L	Positive	100	24	Deer grazing
2013-2018	SH 12	M	Climate change	XX	Negative	100	24	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 12	Unfavourable-Bad	Unfavourable-Bad	Unfavourable-Bad	Unfavourable-Bad
Trend (if known):		n/a	n/a		n/a

SH13 Sheskin B, Co. Mayo

Irish Grid ref.: 98471 328787; Altitude: 130m; SAC: 001922

Monitoring Period:	2013-2018	**Survey start date:**	09/08/2017	**No. of monitoring stops:**	3
Surveyed by:	RH/ML	**Survey end date:**	09/08/2017	**Survey type:**	Monitoring

Comments on site:

The vegetation height is above the upper threshold set by the assessment, and grazing levels are too low, unchanged since the baseline survey. Despite this, however, Saxifraga hirculus rosette numbers are significantly higher than recorded in the baseline survey, particularly at the very north of the population envelope, where many more plants than expected were recorded - the population would pass on the number of plants in this area alone.

Comments on condition/management:

The vegetation, particularly Carex rostrata, is quite tall but despite this, Saxifraga hirculus seems to be thriving. This is a very wet site and there is much open water, while other areas of the species's habitat are extremely fragile, being composed of floating vegetation.

Other notes:

The population has been mapped as a number of small, disjunct polygons rather than as a continuous population envelope as the species occurs as isolated colonies at this site.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 13	Total no. of rosettes	>=92	744	Pass	
2013-2018	SH 13	Density of rosettes (mean across all stops)	N/R	N/R	N/A	
2013-2018	SH 13	No. of flowering heads	10s	100s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 13	Area covered by the population (m2)	>=14	61	Pass	
2013-2018	SH 13	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	All plots passed
2013-2018	SH 13	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Absent from all stops	Fail	
2013-2018	SH 13	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 13	Mean % cover of Holcus lanatus across all stops	<=15	2.3	Pass	
2013-2018	SH 13	Mean vegetation height (cm) across all stops	<=20	35	Fail	
2013-2018	SH 13	Grazing (Average across all stops)	26-50%	0-25%	Fail	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 13	A04.03	Abandonment of pastoral systems, lack of grazing	M	Negative	100	61	
2013-2018	SH 13	G05.01	Trampling, overuse	L	Negative	1-25	1-15	Trampling by surveyors
2013-2018	SH 13	M	Climate change	XX	Negative	100	61	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 13	Favourable	Unfavourable-Inadequate	Unfavourable-Inadequate	Unfavourable-Inadequate
Trend (if known):		n/a	n/a		n/a

SH14 Sheskin C, Co. Mayo

Irish Grid ref.: 97680 328397; Altitude: 125m; SAC: 001922

Monitoring Period:	2013-2018	**Survey start date:**	09/08/2017	**No. of monitoring stops:**	5
Surveyed by:	RH/ML	**Survey end date:**	09/08/2017	**Survey type:**	Baseline

Comments on site:

This site is on a moderate slope, in open blanket bog, approximately 100m from a large area of conifer forestry. The population occurs in a very wet flush, flanked on both sides by a dense Sphagnum carpet. Although a single population envelope was mapped, only an estimated 15% of the area supports S. hirculus, consisting as it does of very large areas of open muddy water with Saxifraga hirculus confined almost entirely to small hummocks rising above open water in a central channel. Population numbers are healthy and flowering is occurring.

Comments on condition/management:

This site is extremely wet and very difficult to survey - both due to difficulty in getting around the site and because of the potential for damaging the fragile habitat. It is considered that any trampling or increase in water levels would be detrimental to the population. Grazing levels are below the lower threshold, but vegetation height meets the target. Because of the hydrology of the site, introducing grazing is not recommended, and it is likely that the very wet conditions will be sufficient to keep the vegetation open.

Other notes:

Rhododendron ponticum is nearby - multiple small bushes were noted within 20m of the population.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 14	Total no. of rosettes	>=2,340	2,926	Pass	
2013-2018	SH 14	Density of rosettes (mean across all stops)	>=9	11	Pass	
2013-2018	SH 14	No. of flowering heads	100s	100s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 14	Area covered by the population (m2)	>=239	266	Pass	
2013-2018	SH 14	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	All plots passed
2013-2018	SH 14	Presence of Sagina nodosa	Present in at least 2 of 5 stops	No; present in only 1 stop of 5	Fail	
2013-2018	SH 14	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 14	Mean % cover of Holcus lanatus across all stops	<=15	1.4	Pass	
2013-2018	SH 14	Mean vegetation height (cm) across all stops	<=20	18.8	Pass	
2013-2018	SH 14	Grazing (Average across all stops)	26-50%	0-25%	Fail	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 14	G05.01	Trampling, overuse	L	Negative	1-25	3-67	Trampling by surveyors
2013-2018	SH 14	K04.05	Damage by herbivores (including game species)	M	Positive	100	266	Deer grazing
2013-2018	SH 14	M	Climate change	XX	Negative	100	266	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 14	Favourable	Unfavourable-Inadequate	Unfavourable-Inadequate	Unfavourable-Inadequate
Trend (if known):		n/a	n/a		n/a

SH15 Uggool, Co. Mayo

Irish Grid ref.: 92534 318749; Altitude: 120m; SAC: 000534

Monitoring Period:	2013-2018	**Survey start date:**	18/08/2016	**No. of monitoring stops:**	5
Surveyed by:	CC/RH	**Survey end date:**	18/08/2016	**Survey type:**	Monitoring

Comments on site:

Population numbers are higher than the baseline survey, and all Habitat for the Species targets were met.

Comments on condition/management:

Most of the site is managed by low-intensity sheep grazing. Natural erosion is also occurring but is not expected to threaten the long-term future prospects of the population.

Other notes:

Hamatocaulis vernicosus also occurs in association with Saxifraga hirculus at this site.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 15	Total no. of rosettes	>=24,000	122,000	Pass	
2013-2018	SH 15	Density of rosettes (mean across all stops)	>=84	357	Pass	
2013-2018	SH 15	No. of flowering heads	1,000s	1,000s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 15	Area covered by the population (m2)	>=283	342	Pass	
2013-2018	SH 15	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	Hydrology suitable in 4 out of 5 plots
2013-2018	SH 15	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 2 of 5 stops	Pass	
2013-2018	SH 15	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 15	Mean % cover of Holcus lanatus across all stops	<=15	9.9	Pass	
2013-2018	SH 15	Mean vegetation height (cm) across all stops	<=20	9.4	Pass	
2013-2018	SH 15	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 15	A04.02.02	Non-intensive sheep grazing	L	Neutral	76-99	260-339	
2013-2018	SH 15	G05.01	Trampling, overuse	L	Negative	1-25	3-86	Trampling by surveyors
2013-2018	SH 15	K01.01	Erosion	H	Negative	26-50	89-171	Natural erosion
2013-2018	SH 15	M	Climate change	XX	Negative	100	342	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 15	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH16 Croaghaun East, Co. Mayo

Irish Grid ref.: 104156 326906; Altitude: 120m; SAC: 001922

Monitoring Period:	2013-2018	**Survey start date:**	15/08/2017	**No. of monitoring stops:**	5
Surveyed by:	OD/RH	**Survey end date:**	15/08/2017	**Survey type:**	Baseline

Comments on site:

This site comprises a wet flush with Saxifraga hirculus surrounded by bog. Phragmites australis is found at the upper and lower parts of the flush. An open wet area is present towards the centre. Saxifraga hirculus grows in the wetter parts of the flush. Associated species include Carex diandra, Carex dioica, Carex rostrata, Holcus lanatus, Calliergonella cuspidata, Menyanthes trifoliata, Cardamine pratensis and Lychnis flos-cuculi.

Comments on condition/management:

Some sheep dung was noted at the edge of the flush during the survey, and there was disturbance of turf in the area from poaching. Grazing was low and below the target to meet the criterion, but the flush was kept open due to its very wet hydrology and additional grazing is not recommended.

Other notes:

The abundance of flowers here is extremely high (estimated 10,000+). For the current survey, the flush was walked from its source and followed for some distance below the existing population but no additional suitable habitat was found.

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 16	Total no. of rosettes	>=82,000	100,000	Pass	
2013-2018	SH 16	Density of rosettes (mean across all stops)	>=200	253	Pass	
2013-2018	SH 16	No. of flowering heads	1,000s	1,000s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 16	Area covered by the population (m2)	>=368	409	Pass	
2013-2018	SH 16	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	All plots passed
2013-2018	SH 16	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 2 of 5 stops	Pass	
2013-2018	SH 16	Mean % cover of Molinia caerulea across all stops	<=5	0.2	Pass	
2013-2018	SH 16	Mean % cover of Holcus lanatus across all stops	<=15	9.6	Pass	
2013-2018	SH 16	Mean vegetation height (cm) across all stops	<=20	19.8	Pass	
2013-2018	SH 16	Grazing (Average across all stops)	26-50%	0-25%	Pass	Very high flower density, flush kept open by hydrology; undergrazing not deemed to be an issue

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 16	A04.02.02	Non-intensive sheep grazing	L	Positive	20	81.8	
2013-2018	SH 16	G05.01	Trampling, overuse	L	Negative	1-25	4-102	Trampling by surveyors
2013-2018	SH 16	M	Climate change	XX	Negative	100	409	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 16	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH17 Ox Mountains A, Co. Sligo

Irish Grid ref.: 139142 325005; Altitude: 120m; SAC: 002006

Monitoring Period:	2013-2018	**Survey start date:**	16/08/2017	**No. of monitoring stops:**	5
Surveyed by:	OD/RH	**Survey end date:**	16/08/2017	**Survey type:**	Baseline

Comments on site:

This site comprises a broad flush in bog. Saxifraga hirculus occurs close to the head of the flush. The flush is dominated by tall sedges: Carex echinata, Carex diandra, Carex rostrata and Eriophorum angustifolium, with Hydrocotyle vulgaris, Menyanthes trifoliata and Epilobium palustre also present. The bryophyte layer is dominated by Calliergonella cuspidata and Cratoneuron filicinum, and Tomentypnum nitens is also present in the flush. Two other small Saxifraga hirculus populations are also present in the adjacent flush.

Comments on condition/management:

A drain is present along the top boundary of the flush, and a lower drain is also influencing hydrology. They are approximately 15-20 years old. Sheep preferentially graze the flush. Active sausage cutting is taking place approximately 100-150 m from this flush. While there are currently no evident impacts from either drainage or active turf cutting, there is a danger that the flush could be destroyed by future cutting/drainage, so this should be monitored for change. The drainage channel occurs on the perimeter of the monitoring polygon and is therefore deemed to be inside the area of occupancy of Saxifraga hirculus.

Other notes:

None

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 17	Total no. of rosettes	>=232,000	299,800	Pass	
2013-2018	SH 17	Density of rosettes (mean across all stops)	>=494	617	Pass	
2013-2018	SH 17	No. of flowering heads	1,000s	1,000s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 17	Area covered by the population (m2)	>=437	486	Pass	
2013-2018	SH 17	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	All plots passed
2013-2018	SH 17	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 4 of 5 stops	Pass	
2013-2018	SH 17	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 17	Mean % cover of Holcus lanatus across all stops	<=15	4.7	Pass	
2013-2018	SH 17	Mean vegetation height (cm) across all stops	<=20	18	Pass	
2013-2018	SH 17	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 17	A04.02.02	Non-intensive sheep grazing	M	Positive	100	486	
2013-2018	SH 17	C01.03	Peat extraction	H	Neutral	100	486	Sausage cutting occurs about 150m outside habitat for species
2013-2018	SH 17	G05.01	Trampling, overuse	L	Negative	1-25	5-122	Trampling by surveyors
2013-2018	SH 17	J02.07.01	Groundwater abstractions for agriculture	L	Negative	100	486	Drainage; inside habitat for species
2013-2018	SH 17	M	Climate change	XX	Negative	100	486	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 17	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH18 Ox Mountains B, Co. Sligo

Irish Grid ref.: 139004 324893; Altitude: 120m; SAC: 002006

Monitoring Period:	2013-2018	**Survey start date:**	16/08/2017	**No. of monitoring stops:**	5
Surveyed by:	OD/RH	**Survey end date:**	16/08/2017	**Survey type:**	Baseline

Comments on site:

This site is a broad flush spreading down from a spring head where the extremely rare bryophyte Meesia triquetra (previously thought to be extinct in Ireland) is present. The flush is dominated by tall sedges Carex diandra, Carex echinata, Eriophorum angustifolium, Carex nigra, Carex pulicaris and Carex dioica, with Hydrocotyle vulgaris, Menyanthes trifoliata and Cardamine pratense also present. Bryophytes include Calliergonella cuspidata, Philonotis calcarea, Brachythecium rivulare and Scorpidium cossonii. The habitat in which the smaller second population was recorded is drier and more grassy in character.
Population numbers are very healthy, and all Habitat for the Species criteria were passed (vegetation height was marginally above the threshold but was passed on expert judgement).

Comments on condition/management:

Sheep grazing occurs on site, and is considered to be beneficial to the species's habitat. A ditch occurs across the bottom end of the flush with signs that the vegetation is drying out adjacent to the ditch. While there are currently no evident impacts from drainage or active turf cutting, the site would be damaged if further turf cutting and drainage were to take place in the surrounding area, so this should be monitored for any change.

Other notes:

None

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 18	Total no. of rosettes	>=37,150	46,436	Pass	
2013-2018	SH 18	Density of rosettes (mean across all stops)	>=150	188	Pass	
2013-2018	SH 18	No. of flowering heads	1,000s	1,000s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 18	Area covered by the population (m2)	>=222	247	Pass	
2013-2018	SH 18	Wetness of substrate	Water level covers hand	Water level covers hand	Pass	Hydrology suitable in 3 of 5 plots
2013-2018	SH 18	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 5 of 5 stops	Pass	
2013-2018	SH 18	Mean % cover of Molinia caerulea across all stops	<=5	0.7	Pass	
2013-2018	SH 18	Mean % cover of Holcus lanatus across all stops	<=15	4.8	Pass	
2013-2018	SH 18	Mean vegetation height (cm) across all stops	<=20	20.4	Pass	Marginal fail but all other criteria were passed
2013-2018	SH 18	Grazing (Average across all stops)	26-50%	26-50%	Pass	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 18	A04.02.02	Non-intensive sheep grazing	M	Positive	100	247	
2013-2018	SH 18	G05.01	Trampling, overuse	L	Negative	1-25	2-62	Trampling by surveyors
2013-2018	SH 18	J02.07.01	Groundwater abstractions for agriculture	L	Negative	100	247	Drainage; inside habitat for species
2013-2018	SH 18	M	Climate change	XX	Negative	100	247	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 18	Favourable	Favourable	Favourable	Favourable
Trend (if known):		n/a	n/a		n/a

SH19 Ox Mountains C, Co. Sligo

Irish Grid ref.: 139012 325002; Altitude: 120m; SAC: 002006

Monitoring Period:	2013-2018	**Survey start date:**	16/08/2017	**No. of monitoring stops:**	2
Surveyed by:	OD/RH	**Survey end date:**	16/08/2017	**Survey type:**	Baseline

Comments on site:

This site consists of a large dome springhead surrounded by Juncus effusus. The sward is low due to grazing and the ground is relatively dry. Associated species include Carex echinata, Hydrocotyle vulgaris, Agrostis stolonifera, with the bryophyte layer dominated by Calliergonella cuspidata and Tomentypnum nitens.
Population numbers of Saxifraga hirculus are very healthy. Habitat for the Species criteria are not met for hydrology (fails in both plots) and grazing level, which passes in one plot but is too high in the other.

Comments on condition/management:

The site is slightly overgrazed by sheep. Drainage and active turf cutting occur nearby. While there are currently no obvious impacts on the habitat from drainage or active turf cutting, these should be monitored closely for changes as any increase in either could be damaging to the habitat.

Other notes:

None

Population assessment criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 19	Total no. of rosettes	>=16,450	20,570	Pass	
2013-2018	SH 19	Density of rosettes (mean across all stops)	>=484	605	Pass	
2013-2018	SH 19	No. of flowering heads	100s	100s	Pass	

Habitat for the species criteria

Mon. period	Site	Indicator description	Target	Result	Outcome	Notes
2013-2018	SH 19	Area covered by the population (m2)	>=30	34	Pass	
2013-2018	SH 19	Wetness of substrate	Water level covers hand	No plot passed	Fail	No plot passed
2013-2018	SH 19	Presence of Sagina nodosa	Present in at least 2 of 5 stops	Present in 2 of 2 stops	Pass	
2013-2018	SH 19	Mean % cover of Molinia caerulea across all stops	<=5	0	Pass	
2013-2018	SH 19	Mean % cover of Holcus lanatus across all stops	<=15	5	Pass	
2013-2018	SH 19	Mean vegetation height (cm) across all stops	<=20	10	Pass	
2013-2018	SH 19	Grazing (Average across all stops)	26-50%	51-75%	Fail	

Impacts and activities

Mon. period	Site	Activity code / Description		Intensity	Effect	Habitat affected %	Habitat affected sq. m	Notes
2013-2018	SH 19	A04.02.02	Non-intensive sheep grazing	M	Negative	100	34	Slightly overgrazed
2013-2018	SH 19	G05.01	Trampling, overuse	L	Negative	1-25	0-9	Trampling by surveyors
2013-2018	SH 19	J02.07.01	Groundwater abstractions for agriculture	L	Negative	100	34	Drainage; outside species' habitat
2013-2018	SH 19	M	Climate change	XX	Negative	100	34	

Parameter assessment results

Mon. period	Site	Population	Habitat for the species	Future prospects	Overall
2013-2018	SH 19	Favourable	Unfavourable-Inadequate	Unfavourable-Inadequate	Unfavourable-Inadequate
Trend (if known):		n/a	n/a		n/a