

Indicator name			Version
NB16a: Abundance and frequency of specialist and generalist species: snow-bed species			21/03/16
Indicator type:	Risk/opportunity	Impact	Action
		X	
SCCAP Theme	SCCAP Objective	CCRA risk/opportunity	
Natural Environment	N2	BD11: Generalist species more able to adapt than specialists	

At a glance
<ul style="list-style-type: none"> • Generalist species are likely to be less at risk from climate change than specialist species that require specific 'niche' habitat • Snow-bed bryophytes are specialist montane species that are threatened with a loss of climate space as they are already at the edge of their range in Scotland • Projected long-term reduction in snow-lie is likely to see these species being replaced by more generalist montane vegetation • Consistent trends have not been identified across snow-bed bryophytes • An analysis of vegetation structure indicated a decline in snow-bed bryophytes in western areas but an increase in the east (Cairngorms), suggesting that structural change is occurring in snow-bed vegetation

Latest Figure			Trend
	Snow-bed specialist bryophytes	All bryophytes	No significant trend
Western Scotland	10% decline	18% decline	
Eastern Scotland	4% increase	18% increase	

Why is this indicator important?
<p>Vegetation found in the Scottish mountains includes species of mosses and liverworts (bryophytes) which are snow-bed specialists dependent upon the late-lying snow which occurs in these areas. These 'snowbed bryophytes' include species of conservation priority such as <i>Andreaea nivalis</i>, <i>Marsupella arctica</i>, and <i>Gymnotrium apiculatum</i>.</p> <p>Information on the status of snow-bed bryophytes can be used to understand the risk that generalist species may be more able to cope with climate change than specialist species. This is because snow-</p>

bed bryophytes occur at the edge of their range in Scotland, capturing a situation in which species are unable to track changing climate space, e.g. via inter-connected habitat.

It is expected that a long-term trend towards a reduction in the size and length of snow-lie will cause changes in the composition of snow-bed vegetation; with conservation-priority snow-bed vegetation communities expected to shift towards a widespread 'generalist' vegetation type typical of more open montane conditions.

Related indicator:

NB16b Abundance and frequency of specialist and generalist species: butterflies

What is happening now?

A comprehensive survey of snow-bed vegetation was carried out in 1989-1990, for 58 areas of late-lying snow across Scotland. Scottish Natural Heritage commissioned a repeat survey of 22 of the original 58 snow-beds during 2007-2008 (Fig. 1, Table 1); these were located across western and central mountain ranges, and within the eastern and relatively more continental Cairngorm Mountains. Analysis of the composition of bryophyte assemblages and the frequency with which species occur has demonstrated only very tentative evidence for change in snow-bed communities. This included a statistically significant 13% decline in the frequency of the snow-bed specialist liverwort *Moerckia blytii*. However, trends in frequency of occurrence were not consistent across the snow-bed bryophytes, with some species showing a decrease (e.g. *Kiaeria starkei*: -4%) and some an increase (*Polytrichum sexangulare*: +11 %).

A separate analysis for this indicator focussed on broad measures of vegetation structure: vascular plants, with grasses as a specific example, and bryophytes generally, with National Vegetation Classification (NVC) snow-bed bryophyte species as indicators. The analysis (see Fig. 2) demonstrated a decline in the frequency of NVC snow-bed bryophyte indicator species and bryophytes generally for the snow-beds in western areas, implying structural change in the vegetation. In contrast, snow-bed bryophytes and all bryophytes increased across the snow-beds in eastern Scotland. There is therefore preliminary evidence for a change in the snow-bed vegetation, which may show regional variation.

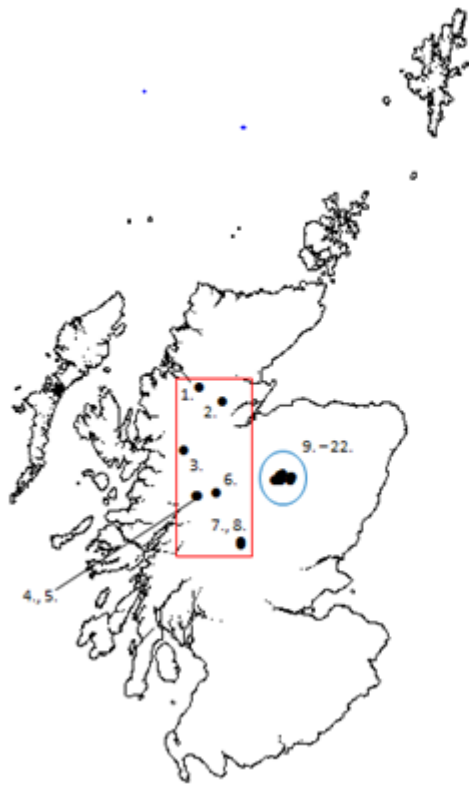


Figure 1: The location of 22 repeat-survey snow-beds for which data was made available by Scottish Natural Heritage. Snow-beds were grouped into two regions for analysis: Region 1 (red box), with snow-beds 1.-8., representing more western and central mountain ranges, and Region 2 (blue circle), with snow-beds 9.-22., representing the eastern and relatively more continental Cairngorm snow-beds. The data collected from these sites in 1989-1990 and 2007-2008 was analysed to calculate changes in the frequency of snow-bed vegetation (see indicators of impact).

Region	Site Code	Site Name
Western	S1	Beinn Dearg
	S2	Ben Wyvis, North Coire
	S3	Mam Sodhail, Lochan Uaine
	S4	White Mounth, Coire Boidheach
	S5	White Mounth, Glas Allt
	S6	Creag Meagaidh, West Coire
	S7	Ben Lawers, An stuc
	S8	Ben Lawers, NE Face
Eastern	S9	Cairngorm, Ciste Mhearad
	S10	Carn Lochan, Coire Domhain
	S11	Carn Lochan, Coire Domhain
	S12	Ben Macdui, Lower Garbh Uisge Beag
	S13	Ben Macdui, Upper Garbh Uisge Beag
	S14	Ben Macdui, North Slope
	S15	Ben Macdui, Upper Garbh Uisge Mor
	S16	Ben Macdui, Bealach 1232m
	S17	Braeriach, Garbh Coire Mor
	S18	Braeriach, Garbh Coire Mor E Gully
	S19	Beinn a Bhuird, Coire an

		t'Snaechda
	S20	Beinn a Bhuird, Dubh Lochan
	S21	Beinn a Bhuird, North Top
	S22	Beinn a Bhuird, Garbh Coire

Table 1: Names of snow-bed sites used in the repeat survey (illustrated in Figure 1).

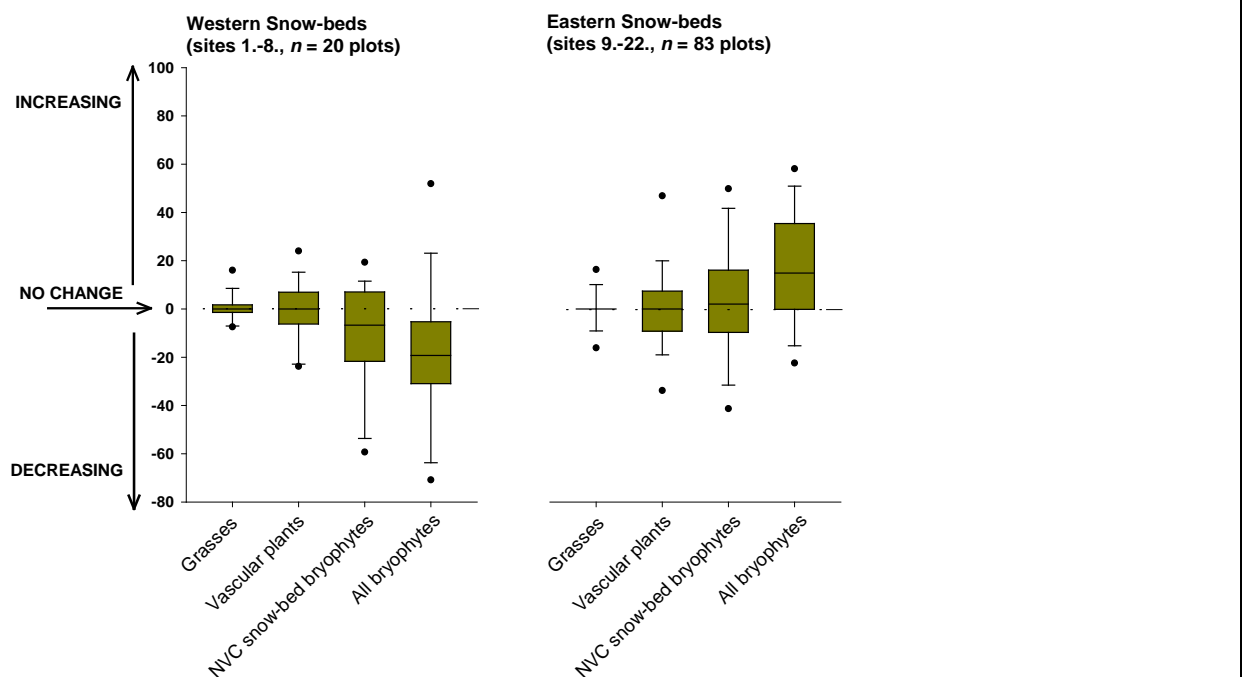


Figure 2: Change in the frequency of snow-bed vegetation. Time-series comparison (1989/90-2007) in the percent cover of four vegetation parameters: (i) grasses, (ii) all vascular plants (including ferns), (iii) NVC snow-bed dominant bryophytes (*Kiaeria starkei*, *Polytrichum alpinum*, *Polytrichum sexangulare* and *Racomitrium heterostichum*), and (iv) all bryophytes.

What has happened in the past?

N/A

What is projected to happen in the future?

N/A

Patterns of change

See above

Interpretation of indicator trends

There are as yet no clear trends in the frequency of occurrence for snow-bed bryophytes, compared to more generalist species found in snow-bed vegetation communities. However there is some tentative evidence that suggests a reorganisation of snow-bed vegetation structure may be occurring

but that this differs across regions in Scotland. On the other-hand, the evidence may reflect the fact that the repeat sampled plots were not strictly replicates.

Limitations

As noted above, the sampled plots in 2007/8 were not strict replicates of those used in 1989/90. This limitation will not be relevant to future surveys and analyses of data, as formal sample plots have now been established.

References

Further information

Scottish Natural Heritage (SNH) Site Condition Monitoring: www.snh.gov.uk/protecting-scotlands-nature/protected-areas/site-condition-monitoring

Rothero, G.P., et al (2008) *Effects of climate change on bryophyte-dominated snowbed vegetation*. Scottish Natural Heritage, Inverness.

Acknowledgements

The analysis underpinning this indicator was carried out by Chris Ellis, Royal Botanic Garden Edinburgh using data provided by Rothero et al (2008).

Suzanne Martin (RBGE) contributed as a co-author.

Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	Abundance and frequency of specialist and generalist species: snow-bed species
Indicator contact: Organisation or individual/s responsible for the indicator	Ruth Monfries (Royal Botanic Garden Edinburgh/ClimateXChange)
Indicator data source	Chris Ellis (RBGE), using SNH snow-bed surveys (Rothero, G.P. et al., 2008)
Data link: URL for retrieving the indicator primary indicator data.	N/A

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	1989/1990 2007/2008
Frequency of updates: Planned or potential updates	A repeat survey is being carried out during 2014-2016, and probably every 5-10 years thereafter
Spatial coverage: Maximum area for which data is available	Scotland (scalable)
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	The plots were not strictly replicates but paired plots aimed to capture species composition for equivalent snow bed communities. Permanent sample plots have now been established within the snow-beds, and are being used in monitoring by SNH
Spatial resolution: Scale/unit for which data is collected	Site level resolution
Categorical resolution: Potential for disaggregation of data into categories	Possible, for example according to four vegetation community categories
Data accessibility: Restrictions on usage, relevant terms & conditions	SNH plan to upload a report containing details of the surveys within the coming months.

Table 3 Contributing data sources

Contributing data sources
Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
Snow bed survey site data, Scottish Natural Heritage (SNH).

Table 4 Indicator methodology

Indicator methodology
The methodology used to create the indicator data
114 plots with repeat survey across two time-periods (1989/90 and 2007) for 22 sites. Out of 114 plots, 11 were without at least one of the NVC snow-bed indicator species in 89/90 (<i>Kiaeria starkei</i> , <i>Polytrichum alpinum</i> , <i>Polytrichum sexangulare</i> , or <i>Racomitrium heterostichum</i>) and these were removed prior to analysis ($n = 103$).
Domin scores were converted to quasi-continuous variables, using the 'Domin 2.6 transformation': % cover = $[\text{Domin}^{2.6}] / 4$.
The percent cover was compared for the four vegetation parameters (grasses, all vascular plants, snow-bed indicator bryophytes and all bryophytes) between 1989/90 and 2007, for western and eastern sites separately, using a Wilcoxon paired-sample test in order to retain plot structure. Differences in percent cover were plotted as an increase or decrease between the two time-points, using normalised values.