

High-montane habitats: the sharp end

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Bryophytes, Fungi and Lichens Adviser



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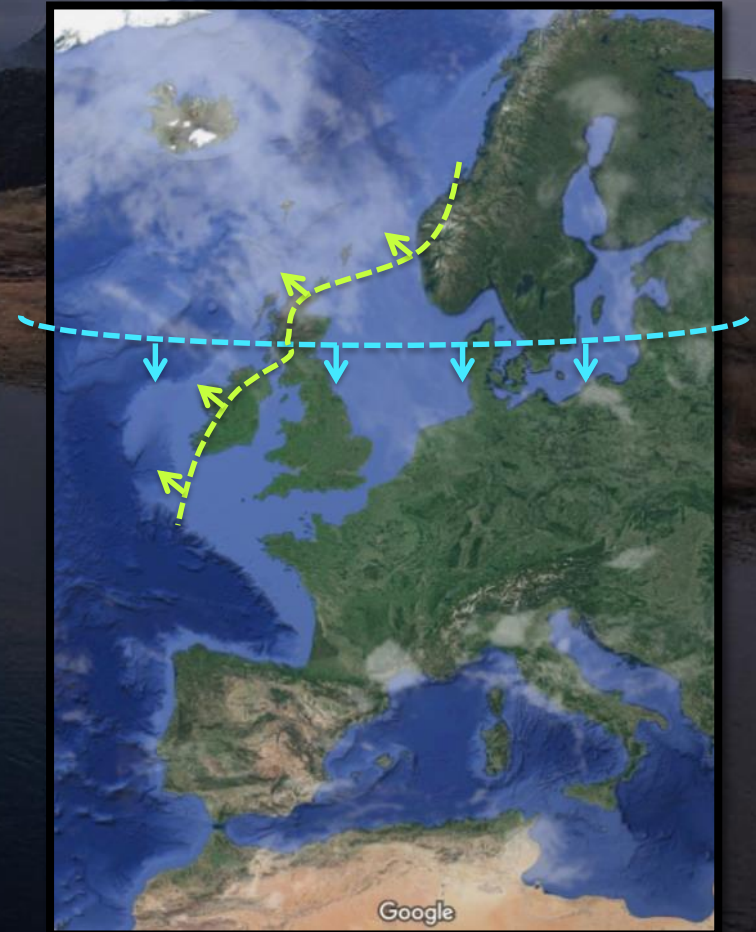
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Scottish mountains

- At the front-line of climate change impacts
- Southern extent of arctic species
- Western/altitudinal extent of alpine species
- Decreasing snow-cover UKCP09 scenarios project decline in snowfall of 65-80% by the 2080s



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A focus on bryophytes and lichens

- A large component of Scotland's biodiversity
- Strongly regulated by climate
- Respond to small-scale/micro-climatic variation
- Occupy a diverse range of niches
- Immobile – poor adaptation capacity?



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Some key questions

- How do we monitor climate change impacts?
- Are there any management options to help species adapt?

Scottish Snowbed
Vegetation Monitoring
Network

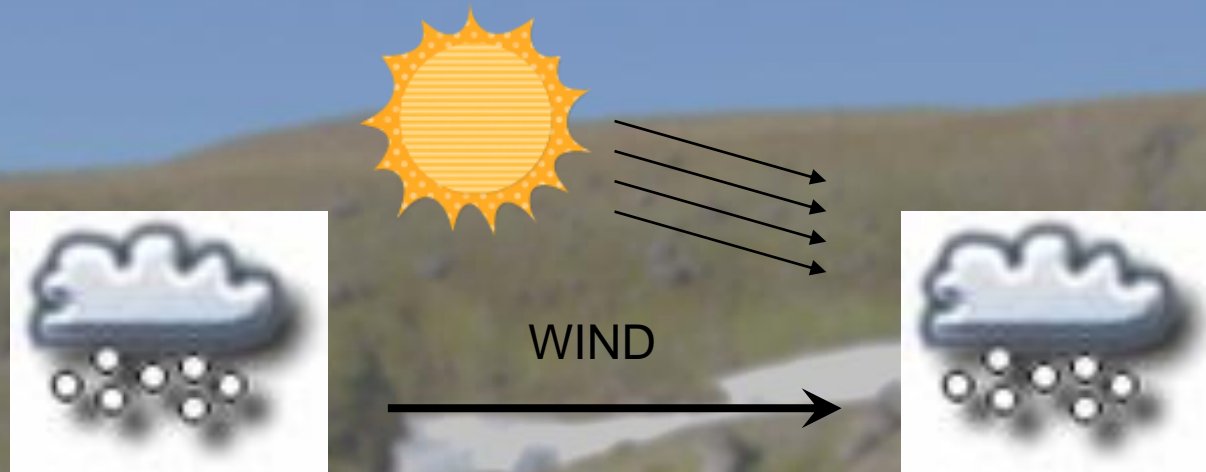
Assisted Colonisation of
immobile species



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Factors contributing to snowbed formation



S/SW

Plateau

E/NE



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SENTINEL Hub

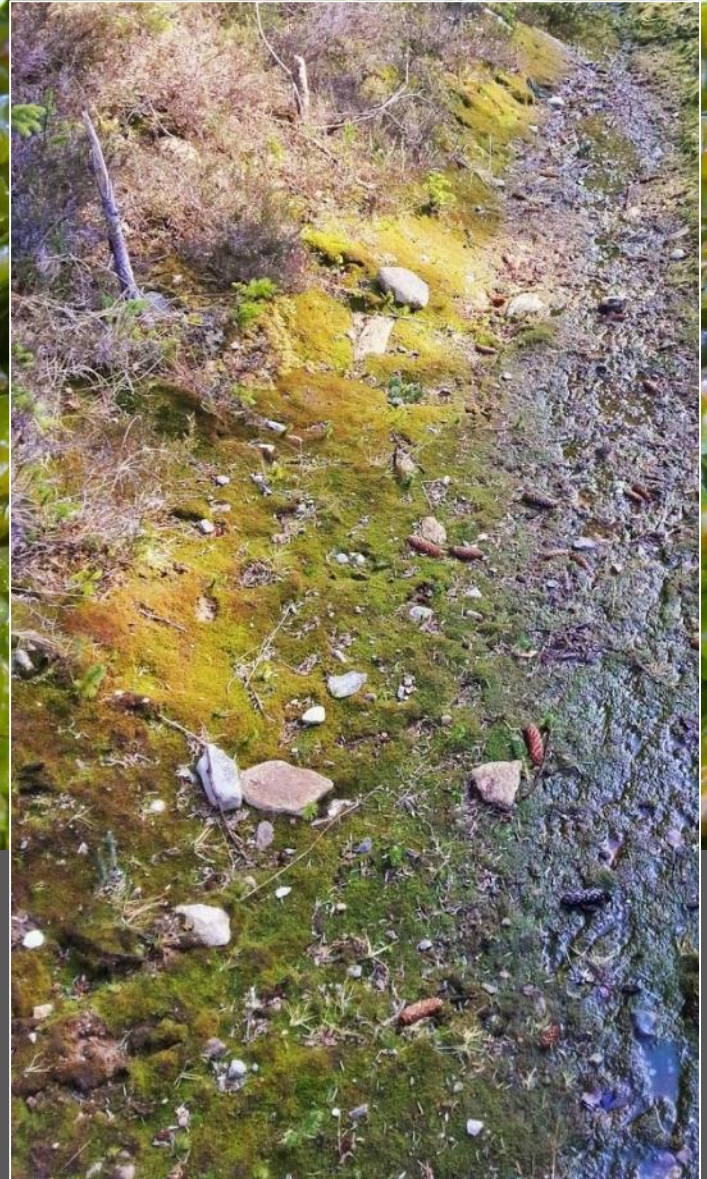
5th July



Nardia scalaris (Ladder Flapwort)



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Conostomum tetragonum
(Helmet-moss)



Polytrichum sexangulare (Northern Haircap)



Marsupella brevissima (Snow Rustwort)



Pohlia ludwigii (Ludwig's Thread-moss)

Scottish Snowbed Vegetation Monitoring Network

1989/90 first snowbed survey (58 sites)

c. 18 years

2007/8 second snowbed survey
(22 sites, 115 plots)



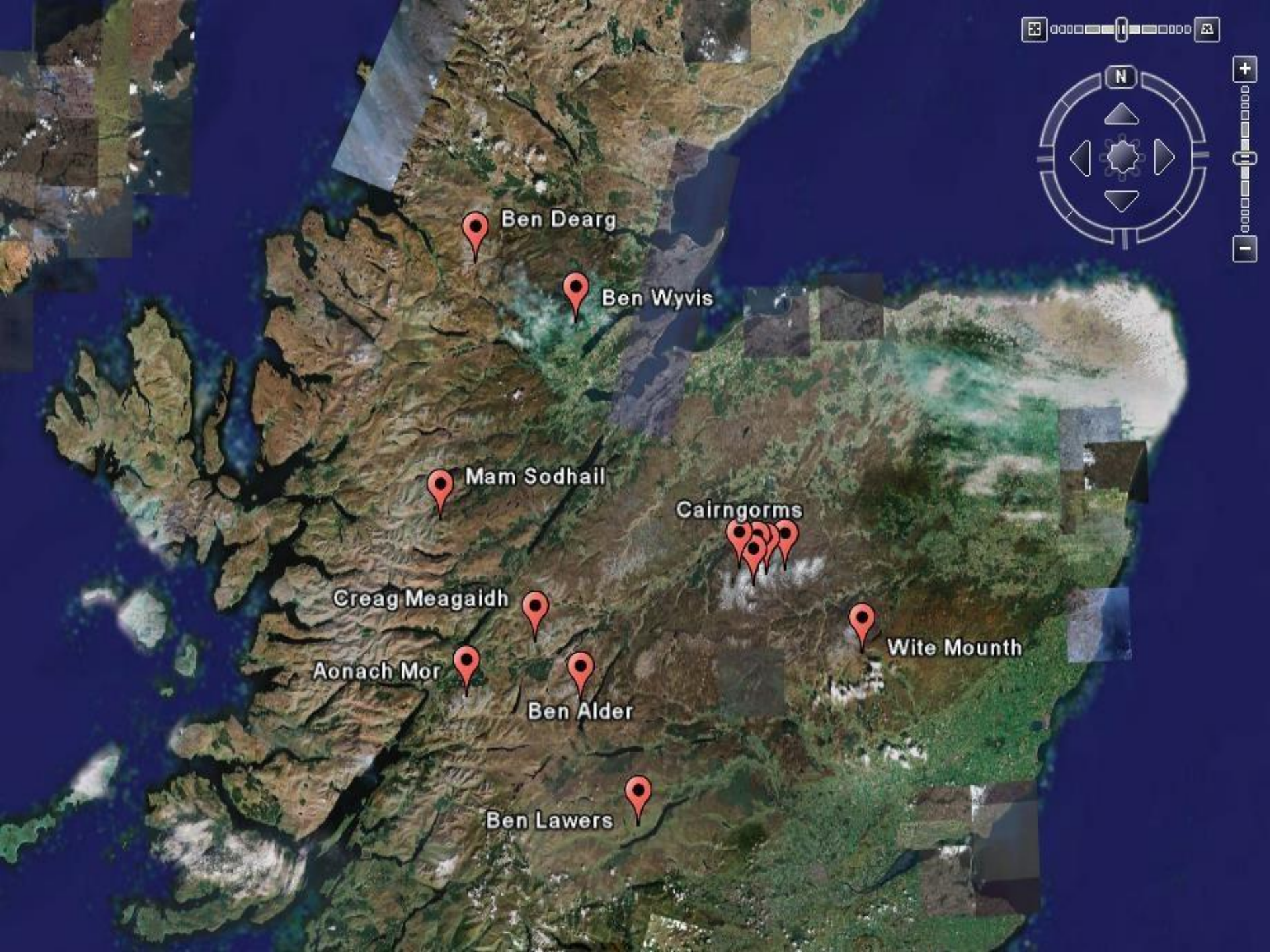
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Ben Dearg

Ben Wyvis

Mam Sodhail

Cairngorms

Creag Meagaidh

Wite Mounth

Aonach Mor

Ben Alder

Ben Lawers

Species	Difference in frequency	p-value	Difference in \bar{x} abundance	p-value
Oligotrichum hercynicum	25	0.001	1.80	0.003
Pohlia nutans	23	0.002	0.36	0.092
Ditrichum zonatum	18	0.004	0.71	<0.001
Juncus trifidus #	17	0.002	0.69	0.008
Kiaeria falcata	17	0.008	1.34	0.118
Saxifraga stellaris #	16	0.002	0.15	0.054
Racomitrium lanuginosum	15	0.016	0.29	0.092
Lophozia sudetica	11	0.111	1.30	0.036
Scapania uliginosa	10	0.006	0.74	0.016



Diplophyllum albicans
Pleurocladula albescens
 Polytrichum alpinum



Huperzia selago #
Gnaphalium supinum #
Marsupella condensata
Pohlia ludwigii
 Salix herbacea #
Marsupella stableri
 Gymnomitrium concinnatum



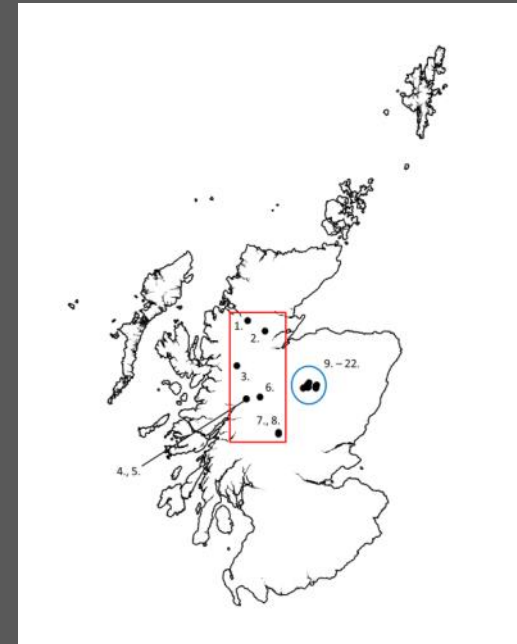
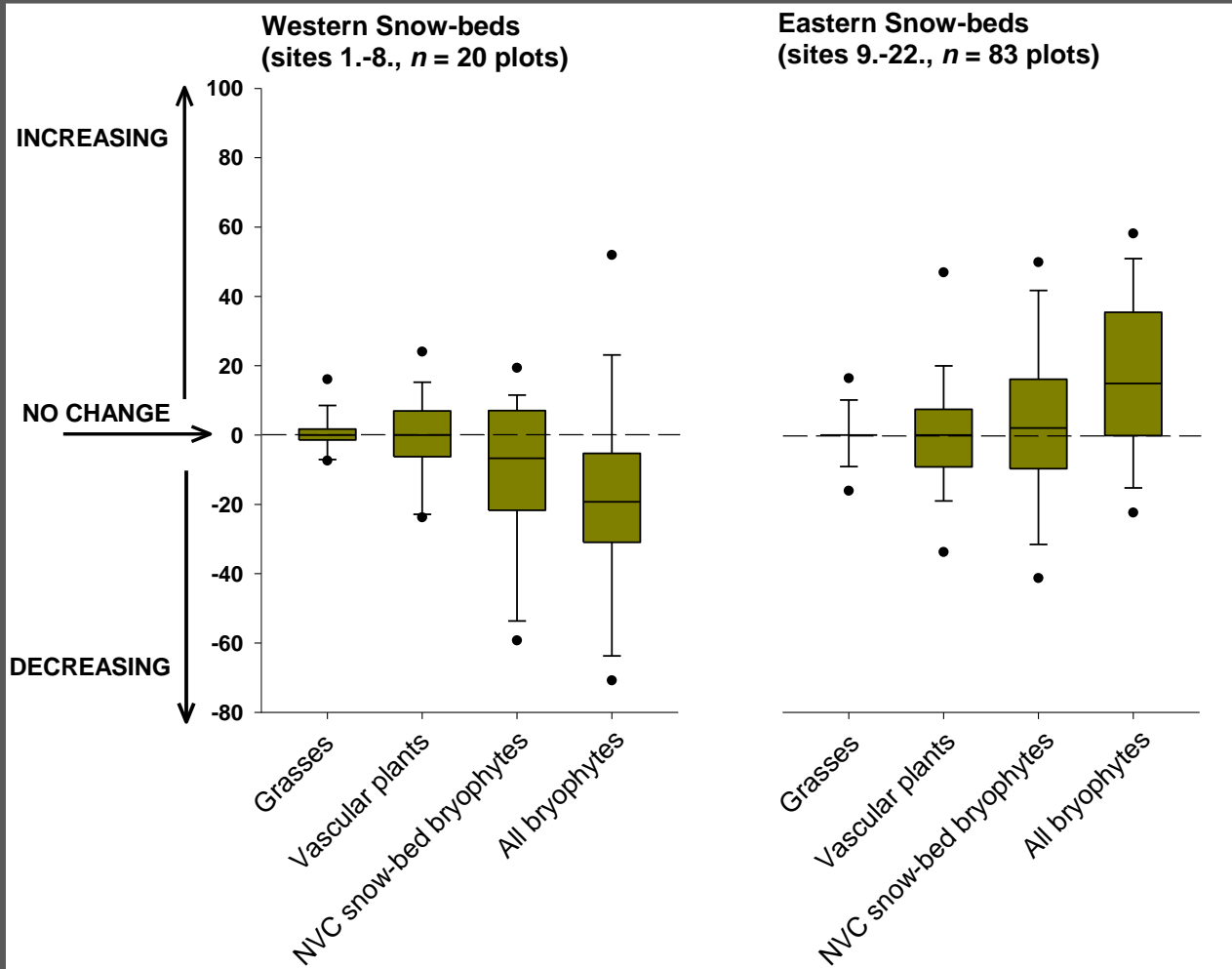
-4 0.578 0.03 0.815
 -5 0.425 0.33 0.619
 -5 0.483 0.97 0.438
 -7 0.147 0.10 0.497
 -8 0.055 -0.06 0.610

Marsupella sphacelata	-9	0.099	-0.11	0.762
Moerckia blyttii	-13	0.002	-2.40	0.020



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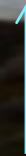


Scottish Snowbed Vegetation Monitoring Network

1989/90 first snowbed survey (58 sites)



2007/8 second snowbed survey
(22 sites)
(10 permanent transects set up)



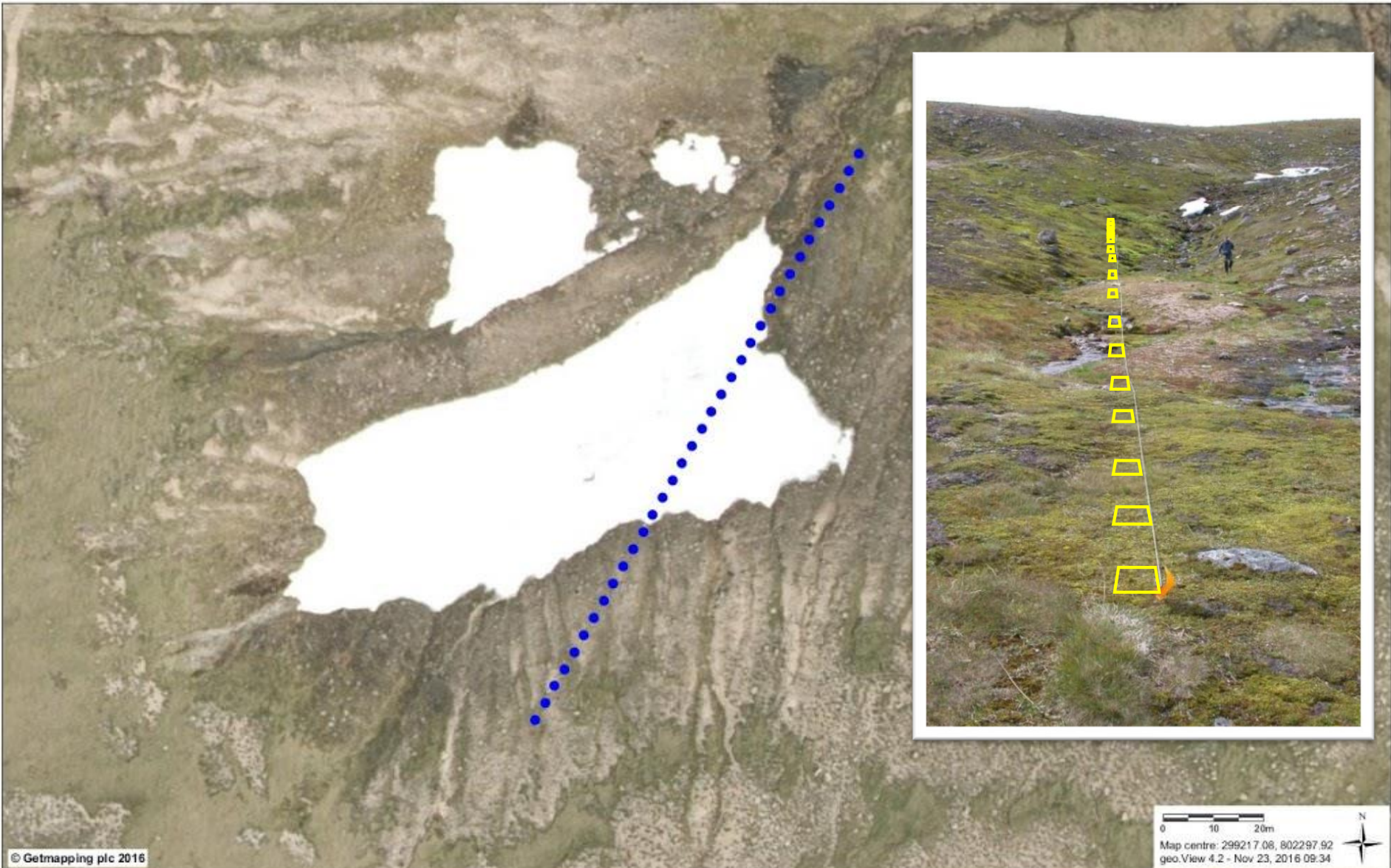
2014/15/16
Second transect survey
(training apprentices)



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Transect 3 - Coire Domhain

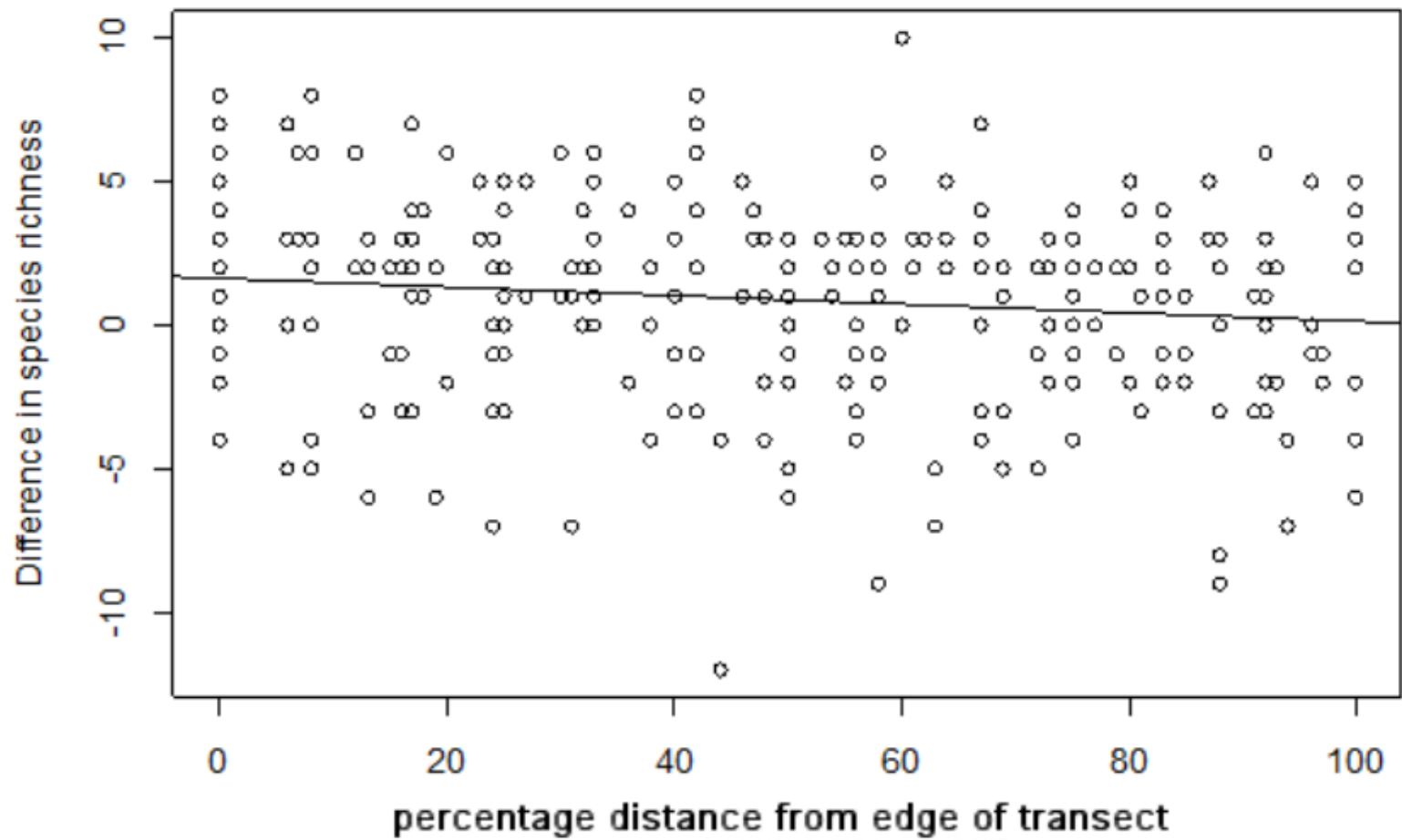


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0 10 20m

Map centre: 299217.08, 802297.92
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Practical challenges

- Unpredictable weather
- Long-term funding
- Continuity of EXPERTS!



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Can we help species adapt to climate change?

Management options:

1. In-situ conservation
2. Allow/enable species range shifts
3. Active translocation

Increasing intervention
and controversy

- Ethical debate
- Is it even possible, especially for mountain species?



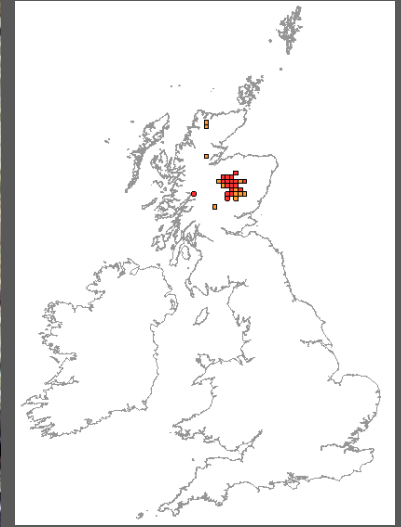
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Can we predict where to put species now?

Flavocetraria nivalis

- Easily identified
- Distinct altitudinal distribution
- Arctic/alpine species– (relatively) limited biotic interactions



The approach

- Large-scale field survey and modelling of current distribution
- Translocations to an independent site within current range
- Test ability of the model to predict translocation success



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Field survey



Recorded:

- Vegetation composition
- Vegetation height
- Aspect, slope

Added from extrapolated climate data:

- Altitude
- Climate parameters (e.g. max/min T; precipitation)

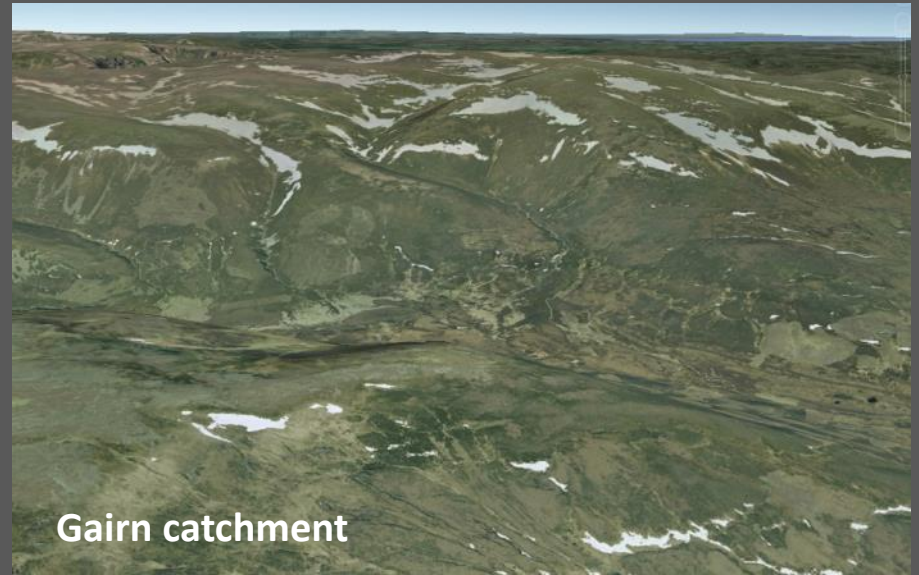
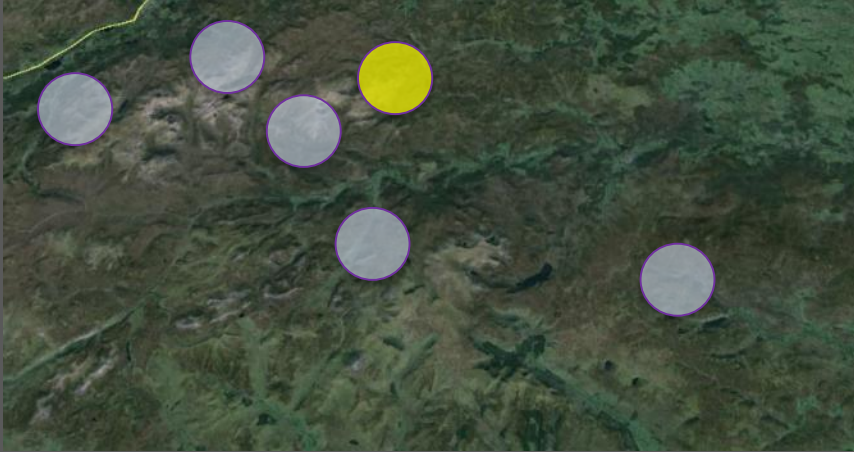
Training model based on field survey data

Parameter	Field survey data
Intercept	*
Minimum temperature, February	*
Minimum temperature, July	*
Minimum temperature, February*Minimum temperature, July	NS
Aspect	***
Altitude	**
Vegetation height	†
% of total deviance explained	27.2%

Reasonable fit of model to field survey distribution
(abiotic parameters are key)



Translocation trials



- Placed out from 650 m to 1100 m in range of vegetation types . 'Good' and 'bad' locations
- Recorded same data as per wider survey + **iButton loggers**
- Recorded survival 2011 and 2015

Predicting transplant success

Parameter	2010-2011 interpolated
Altitude	0.008
Vegetation Height	0.005
Slope	NS
T Average 01/12	N.A.
T Average 04/12	N.A.
T Average 05/12	N.A.
T Average 06/12	N.A.
T Average 07/12	N.A.
% of total deviance explained	10.7%



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- Poor predictive power for first year survival of transplants
- Inclusion of microclimatic data did not improve model fit
- Model still poor after five years with interpolated climate
- Model greatly improved with microclimate data

Key results

- Survey data alone - poor initial fit
- Fit improves with time - lichens die slowly!
- Fit improves with introduction of microclimatic data
- There remains a substantial amount of unexplained variation



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Conclusions

The slow mortality of lichens emphasises the need for long-term monitoring when assessing the success of translocations.



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Conclusions

Location, location, location

Micro-climate can be extremely important with a few centimetres perhaps making the difference between survival and death.



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Options

Very detailed survey of a species' microclimate niche at recipient sites.

Very time-consuming and expensive.

Combine coarse-scale predictive models with expert-led judgement on the ground.

Another case for investing in specialist field-ecologists.

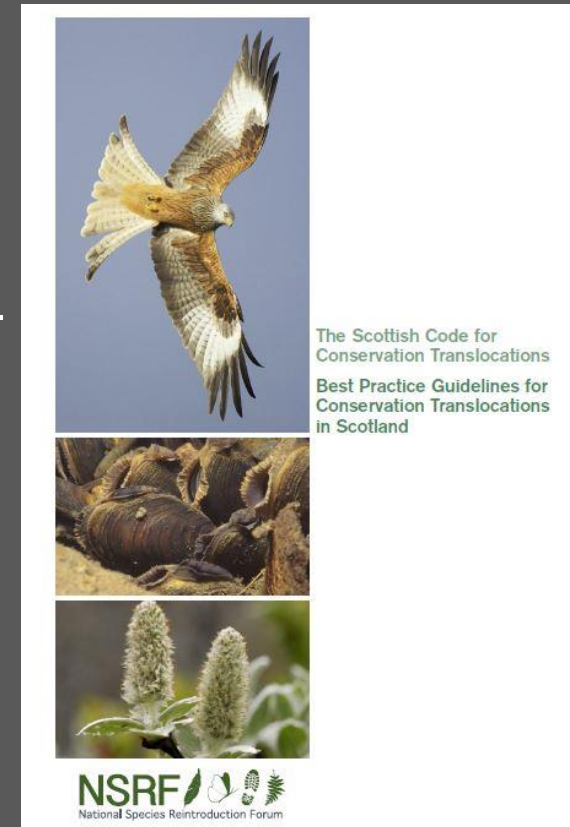
Accept a high-level of transplant mortality

The minimum number of transplants may be much higher than we currently expect – early intervention required.



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Scottish Code for
Conservation Translocations

Thank you

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www.climatechange.org.uk/adapting-to-climate-change/indicators-and-trends/generalist-species-more-able-to-cope

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RISK: Generalist species more able to cope than specialist species - snow-bed species

SCCAP themes/objectives:
N2: Support a healthy and diverse natural environment with capacity to adapt

Level of risk/opportunity:

	Risk			Opportunity		
2020s	High	Med	Low	Low	Med	High
2050s	High	Med	Low	Low	Med	High
2080s	High	Med	Low	Low	Med	High

Level of confidence:

Low
Medium
High

Key Understanding the indicator icons

Upward trend Downward trend No significant trend No trend possible trend

The colour of icon indicates whether the trend is positive (desirable), negative (undesirable) or neutral (neither desirable or undesirable) as follows:

Positive Negative Neutral

The level of need for improved data is shown as follows:

Low (L) Medium (M) High (H)

This table shows the estimated levels of risk/opportunity for the 2020s, 2050s and 2080s, and associated confidence in those assessments, according to the Climate Change Risk Assessment for Scotland 2012.

Adaptation at a glance:

Species of mosses and liverworts (bryophytes) which grow in areas with late-lying snow -snow beds - in Scottish mountains are a conservation priority. They are specialised for the kind of conditions found in these areas and, in Scotland, are found at the edge of their natural area of occurrence. This means they are not able to move to areas with more suitable conditions as the climate changes.

Downloads:

- Indicator Card Snow-bed species 713.03 KB pdf
- Method Statement snow-bed specialists

Ellis, C & Genney, D.R. **Climate change adaptation in Scotland Programme. Indicator Card 2014 - Generalist species more able to cope with climate change than specialist species**