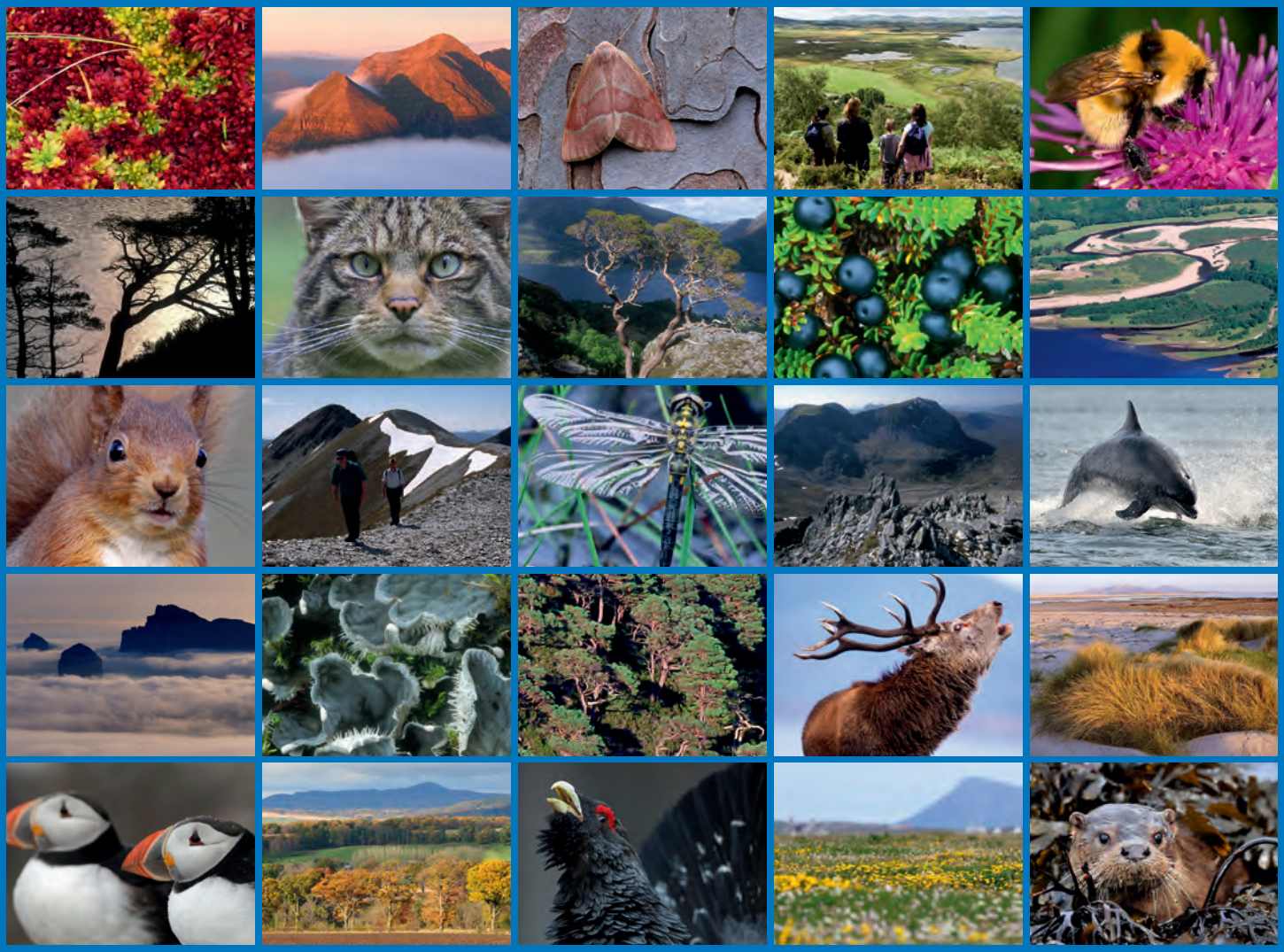
Scottish Natural Heritage
Commissioned Report No. 880

A resource for the study of Scottish upland vegetation: habitat and species data from "Plant Communities of the Scottish Highlands" and repeat surveys



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COMMISSIONED REPORT

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A resource for the study of Scottish upland vegetation: habitat and species data from "Plant Communities of the Scottish Highlands" and repeat surveys

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This report should be quoted as:

Ross, L.C. & Flagmeier, M. 2015. A resource for the study of Scottish upland vegetation: habitat and species data from "Plant Communities of the Scottish Highlands" and repeat surveys. *Scottish Natural Heritage Commissioned Report No. 880.*

COMMISSIONED REPORT

Summary

A resource for the study of Scottish upland vegetation: habitat and species data from "Plant Communities of the Scottish Highlands" and repeat surveys

Commissioned Report No. 880
Project No: 14918
Contractor: Louise Ross (Ilex Ecological Services)
Year of publication: 2015

Keywords

McVean and Ratcliffe; upland vegetation; Scottish vegetation; plant species data; plant community data; re-visitation studies.

Background

The 1962 publication of "Plant Communities of the Scottish Highlands", by Donald McVean and Derek Ratcliffe, was a landmark in the study of upland ecology. Based on field survey, and using the methods of phytosociology, it systematically described and classified the vegetation of this region, and greatly improved our understanding of the diversity and ecology of plant communities in the uplands. It also provided a wealth of data giving a snapshot of Scottish upland vegetation in the 1950s. Relocating and re-surveying plots from this original survey can provide important insights into the magnitude and nature of vegetation change since that time, with particular relevance to climate change and management impacts. Several such studies have recently been undertaken.

Main findings

- This report accompanies a data archive in Excel that has been compiled to include the original and re-survey species data, as well as information on plot location, community type, and vegetation measurements.
- The data have been stored in a useful, accessible form, ensuring that they are both retained as an historic record and made available for future studies.
- Data can be extracted according to a range of criteria, including region, survey, species, plant functional group and vegetation type.
- Possible approaches to using the data are suggested.
- Guidance on relocating plots and analysing species data is given.

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Table of Contents **Page**

Acknowledgements

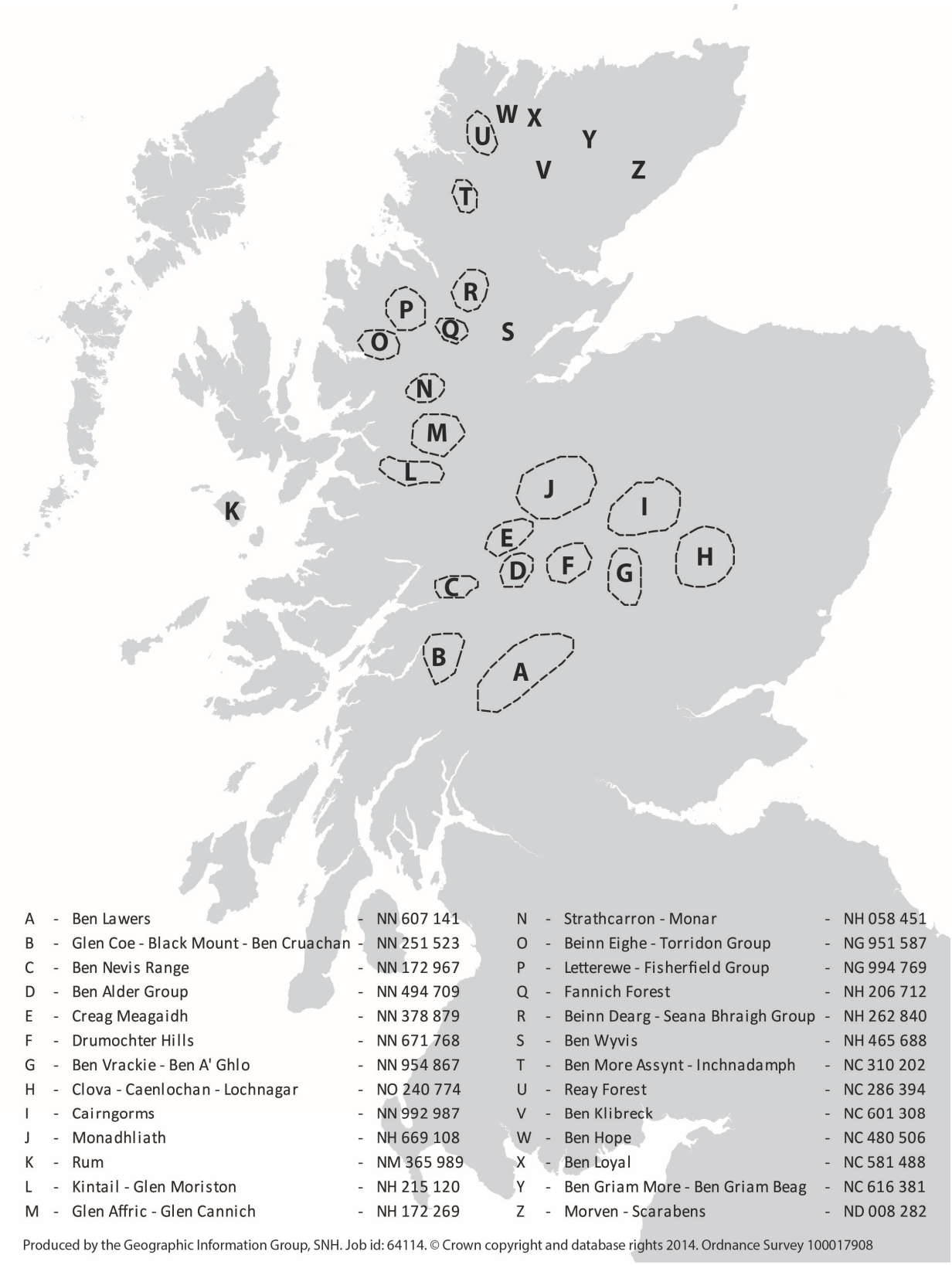
We would like to thank Graham Sullivan of SNH for letting and administering the contract, and for comments on an earlier version of this report. We also thank Colin McLeod, again of SNH, for discussions and information on data formats and mapping systems, and the Geographic Information Group at SNH for production of the map of the original survey areas. Richard Hewison of the James Hutton Institute provided technical advice on using TABLEFIT, which was created by Mark Hill of the Centre for Ecology and Hydrology.

1. INTRODUCTION

Re-survey studies based on phytosociological survey data have become increasingly common in recent years (e.g. Bennie *et al.* 2006, Britton *et al.* 2009, Keith *et al.* 2009, Ross *et al.* 2012, Flagmeier *et al.* 2013) and allow vegetation change to be analysed over a longer timeframe than is possible with most monitoring studies (Bakker *et al.* 1996).The ground-breaking book "Plant Communities of the Scottish Highlands", compiled by two of the founding fathers of modern British upland ecology, Donald McVean and Derek Ratcliffe and published in 1962, has been and continues to be a seminal text on the vegetation of the Scottish uplands. Their phytosociological survey of plant communities across the major mountain ranges of the Scottish Highlands was the first attempt to systematically describe and classify the vegetation of this region, and greatly improved our understanding of the diversity of plant communities in the uplands. The high quality of McVean and Ratcliffe's records provides a robust foundation on which to confidently quantify and characterise changes in species abundance. They represent a unique resource of immense importance and potential use in studies related to long-term vegetation change, with particular application to climate change and management impacts. Existing re-survey work had highlighted the homogenisation of upland vegetation, the greater degree of change in drier compared with wetter habitat types, the shift towards graminoid-dominated communities, the loss of dwarf-shrubs, lichens and forbs, the impact of climate change on upland vegetation (Ross *et al.* 2012, Ross 2015) and the vulnerability of liverwort heath to environmental change (Flagmeier *et al.* 2013). By making available all of the original and re-survey data in an accessible form, further studies on changes in habitats, species, regions and plant functional groups, and how vegetation change relates to environmental change, will be facilitated.

The original survey comprised fine-scale plot data (usually 2m x 2m in size) collected from all terrestrial upland vegetation types: dwarf-shrub heaths, grasslands, mires, woodlands, wetlands, tall herb communities, and moss and lichen heaths (McVean & Ratcliffe 1962). All plant species, including bryophytes and terricolous macrolichens were recorded using the Domin scale of cover abundance (see Section 3). These data were mostly collected between 1955 and 1959, with records from the Breadalbane area collected in 1952 by Duncan Poore (1955a, b & c). To date, re-surveys of these data have been undertaken for dwarf-shrub heaths, mires, flushes, grasslands and summit heaths in the North-West Highlands (Ross *et al.* 2012), liverwort-rich heaths (Flagmeier *et al.* 2013), dwarf-shrub heaths, mires, flushes and grasslands in the East Central Highlands (Ross 2011) and grasslands, flushes and summit heaths on Ben Lawers and surrounding hills (Ross 2015). The original plot location information was used to relocate the original survey plot as accurately as possible, and the re-survey plot data were recorded using the same protocol as the original survey. This method has been shown to be suitable for quantifying vegetation change with confidence (Ross *et al.* 2010).

The importance of these data is such that they must be stored in a useful form, ensuring that they are both retained as an historic record and made available for future studies. The original data are therefore required in a format that can be easily extracted for a subset of plots defined by, for example, vegetation type or region. In this report we provide a user's guide to a data archive in the form of an Excel spreadsheet, available as a download from the SNH website, which has been compiled to include the original and re-survey species data, as well as information on plot location, community type, and vegetation measurements.



A	-	Ben Lawers	- NN 607 141	N	-	Strathcarron - Monar	- NH 058 451
B	-	Glen Coe - Black Mount - Ben Cruachan	- NN 251 523	O	-	Beinn Eighe - Torridon Group	- NG 951 587
C	-	Ben Nevis Range	- NN 172 967	P	-	Letterewe - Fisherfield Group	- NG 994 769
D	-	Ben Alder Group	- NN 494 709	Q	-	Fannich Forest	- NH 206 712
E	-	Creag Meagaidh	- NN 378 879	R	-	Beinn Dearg - Seana Bhraigh Group	- NH 262 840
F	-	Drumochter Hills	- NN 671 768	S	-	Ben Wyvis	- NH 465 688
G	-	Ben Vrackie - Ben A' Ghlo	- NN 954 867	T	-	Ben More Assynt - Inchnadamph	- NC 310 202
H	-	Clova - Caenlochan - Lochnagar	- NO 240 774	U	-	Reay Forest	- NC 286 394
I	-	Cairngorms	- NN 992 987	V	-	Ben Klibreck	- NC 601 308
J	-	Monadhliath	- NH 669 108	W	-	Ben Hope	- NC 480 506
K	-	Rum	- NM 365 989	X	-	Ben Loyal	- NC 581 488
L	-	Kintail - Glen Moriston	- NH 215 120	Y	-	Ben Griam More - Ben Griam Beag	- NC 616 381
M	-	Glen Affric - Glen Cannich	- NH 172 269	Z	-	Morven - Scarabens	- ND 008 282

Figure 1. Map of Scotland showing the areas covered in the original survey. Re-drawn from McVean & Ratcliffe (1962).

2. DATA SOURCES AND METHODS

All the original species data (1952-1959) and the re-survey species data (2007-2013), as well as site information and vegetation measurements for each plot, have been compiled into a single Excel 2010 file. Nomenclature follows Stace (2010) for vascular plants, Hill *et al.* (2008) for bryophytes and Smith *et al.* (2009) for lichens. Species names which have changed since the original survey are listed on the synonyms tab in the archive, with their modern equivalent used in the archive.

The original species data were extracted from a Microsoft Access database that had previously been compiled by SNH from "Plant Communities of the Scottish Highlands" (McVean & Ratcliffe, 1962) and formatted and re-organised to be suitable for our purposes. Cross-checks were made to ensure that the data has been entered accurately. The re-survey species data were collected by Louise Ross and Maren Flagmeier between 2007 and 2013 (Ross 2011, Ross *et al*. 2012, Flagmeier *et al*. 2013, Ross 2015), and were entered into the archive from the field record sheets.

The original plot i.d. number, original surveyor name, locality, county, year of original survey, McVean and Ratcliffe plot name, McVean and Ratcliffe table number (from Plant Communities of the Scottish Highlands), original McVean and Ratcliffe community name, and the original six-figure grid reference, altitude, plot size, vegetation height, aspect and slope of plot, were entered manually from the information in the original book. The re-survey i.d. number, re-survey surveyor number, month and year of re-survey, and the re-survey altitude, ten-figure grid reference, GPS error, vegetation height, moss height, dung counts, abundance of hoof prints, signs of grazing on dwarf-shrubs, graminoids and herbs and any other remarks on plot location etc. were entered manually from the field record sheets. The method for recording abundance of hoof prints and signs of grazing was taken from MacDonald *et al.* (1998).

The original and re-survey NVC communities were derived from the TABLEFIT software (Hill 1996), and the Annex 1 habitat types were derived using a draft version of NVC to Annex 1 correspondence tables subsequently published in Strachan (2015).

There are up to five photos available for each re-survey plot, showing the plot from different angles in order to provide landscape context and aid future relocation. These are numbered using the format 478 1, 478 2 etc., where 478 is the plot number. The photos may be obtained from SNH if required.

3. DISCUSSION

As few monitoring schemes were implemented in the 1950s, these original data serve as an important baseline for quantifying and characterising vegetation change since that time. We would encourage anyone contemplating using the data presented here in any re-survey study to discuss this with SNH, with a view to using the same format, and submitting any new data for inclusion in the archive. In this way the value and future usefulness of any new data will be enhanced.

There are various possibilities for using this data. Some ideas for analysis are listed below:

- Regional studies of change within a defined geographical area
- Change within a vegetation type or NVC community
- Change in the frequency/abundance of a plant functional group, e.g. dwarf-shrubs, lichens
- Change in the frequency/abundance of individual species
- Changes in the altitudinal distribution of species and communities
- Differences between areas that have received protected area status and the wider countryside
- Generating indicator species of climate change, nitrogen deposition, carbon sequestration potential etc.

Although the percentage cover of species was recorded in the re-survey, this was not the case in the original survey, so the Domin scores must be used to compare species composition between the two surveys. This could be problematic, as Domin scores cannot be used in statistical tests due to the non-linear relationship between cover values and Domin scores. A solution, as used here, is to back-transform both original and re-survey datasets to percentage cover using the midpoint of each Domin category in the "Domin 2.6" transformation (Currall 1987), where

$$\% \text{ cover} = (\text{Domin value})^{2.6}/4$$

The transformation provides a convenient and robust transformation of Domin ordinal values to quasi-continuous variables that are directly comparable for use in numerical analysis (Rothero *et al.* 2007). In some cases, the same percentage cover can be recorded as a different Domin score, depending on the size of the plants. For example, a larger plant could have a percentage cover score of 3 and a Domin score of 2 (a few individuals). A smaller plant could also have a percentage cover score of 3 but a Domin score of 3 (frequent, low cover).

While care has been taken to transcribe all information accurately, human error and multiple steps in the data entry process, including that from the original record cards, may have resulted in some errors in the archive. If a further re-survey is planned, we recommend that the plot locations are plotted out on an OS map, and the altitude in the original information is cross referred with that shown on the map, as this can reveal errors in the grid reference. It should also be noted that the original information on altitude may not correspond entirely with the original grid reference, particularly in areas where there is considerable topographic variation, as the technology to accurately record grid reference and altitude was not available at the time of the original survey. In such cases, information on slope and aspect is helpful in relocating the plots accurately, although occasionally some may not be able to be relocated satisfactorily, if the discrepancy is too large. For further guidance on relocating unmarked plots, see Ross *et al.* (2010).

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ANNEX 1: USER'S GUIDE TO *A RESOURCE FOR THE STUDY OF SCOTTISH UPLAND VEGETATION: HABITAT AND SPECIES DATA FROM "PLANT COMMUNITIES OF THE SCOTTISH HIGHLANDS" AND REPEAT SURVEYS*

1. Overall structure

The archive consists of an Excel spreadsheet with four tabs.

The first is "file information" and contains an explanation of the columns in the main tab (site_species_vegetation data). This is also presented in tabular form in Annex 2.

The second tab is named "site_species_vegetation data", and contains site, plot, species and vegetation data in columns, with plot records in rows. This format will be most useful where vegetation types or plot records are of most interest.

The third tab is named "species data_rows" and contains the same species data as the previous tab, but they have been transposed into rows with a column identifying plant functional group. The plot i.d. number, year of survey and grid reference are included for each row, for ease of reference. This format will be more useful where individual species or plant functional groups are of most interest.

The fourth tab is a list of synonyms: species names that have changed since the original survey, with their 2013 equivalent as used in this study.

2. Main data tab: "Site_species_vegetation data"

There is a single record for plots that have not been re-surveyed, and three records for plots that have been re-surveyed. The first is the original record, with cover values expressed in the Domin scale of cover abundance used in the original survey (Table 1). These scores are slightly different to those used in the National Vegetation Classification surveys (Rodwell 1991 *et seq*.). The second record gives the Domin scores recorded at the re-survey. The third record gives the actual percentage cover value recorded at the re-survey. There are 952 original records, of which 218 have been re-surveyed.

Table 1. Range of percentage cover values in each Domin category, as used by McVean and Ratcliffe (1962)

Domin score	Range of percentage cover values
<1	Species occurs just outside the plot
1	One or two individuals (<5%)
2	Sparsely distributed (<5%)
3	Frequent, low cover (<5%)
4	5-19%
5	20-25%
6	26-33%
7	34-50%
8	51-75%
9	76-90%
10	91-100%

3. Example

An example of how to use the archive to extract a particular set of records is given here:

Q. How do I display percentage cover values for *Erica tetralix* in wet heath samples from below 300 m in re-surveyed plots?

A. In the site_species_vegetation data tab, filter column R, “re-survey NVC community” by selecting records for “M15 *Trichophorum cespitosum-Erica tetralix* wet heath”. From these records, filter column Y, “re-survey altitude”, choosing the option “less than or equal to” and type “300”. From these results, filter on column D “Type of species data” and select “percentage cover”. Then scroll across to *Erica tetralix* (column BV) to see cover values.

ANNEX 2: INFORMATION CONTAINED IN THE COLUMNS OF THE SITE_SPECIES_VEGETATION DATA TAB

Column	Column name	Description
A	Original plot id	The four-figure i.d. number for the original plot record (the same number in the SNH Access database (1- c.950)), final 0 denotes original survey, e.g. 0010, 0020 etc
B	Re-survey plot id	The four-figure i.d. number for the re-survey plot record, if applicable, using original plot i.d. number but with final digit (1) denoting re-survey, e.g.0011, 0021 etc. n/a = not re-surveyed.
C	Survey number	0 = original survey (1952-59), 1 = re-survey (2007-13)
D	Type of species data	Domin scores, percentage cover (re-survey only)
E	Original surveyor name	(Donald) McVean, (Derek) Ratcliffe, (Duncan) Poore, (Terry) Elkington, n/a = not available
F	Re-survey surveyor name	(Louise) Ross, (Maren) Flagmeier
G	Locality	Site name (usually estate, mountain or glen)
H	County	Region, e.g. Perthshire, Ardnamurchan etc, as used in original survey
I	Year of original survey	1952-1959
J	Year of re-survey	2007-2013
K	Month of re-survey	May-September
L	McVean & Ratcliffe plot name	From the tables in the original book, e.g. R57017 = Ratcliffe, 1957, reference number 017)
M	McVean & Ratcliffe table	Relevant table number from the original book, which shows the plot and species information for each community, 4-64
N	Original McVean & Ratcliffe community	Each table in the original book shows the data for up to three (closely-related) communities, e.g. *Callunetum, Saxifragetum aizoidis*
O	Original NVC community_closest	Derived from TABLEFIT, using the National Vegetation Classification Vols 1-4 (Rodwell 1991 *et seq*.).
P	Original NVC community_second closest	If applicable, derived from TABLEFIT, using the National Vegetation Classification Vols 1-4 (Rodwell 1991 *et seq*.).
Q	Original NVC sub-community	If applicable, derived from TABLEFIT, using the National Vegetation Classification Vols 1-4 (Rodwell 1991 *et seq*.).
R	Re-survey NVC community	Derived from TABLEFIT, using the National Vegetation Classification Vols 1-4 (Rodwell 1991 *et seq*.).
S	Re-survey NVC sub-community	If applicable, derived from TABLEFIT, using the National Vegetation Classification Vols 1-4 (Rodwell 1991 *et seq*.).
T	Annex 1 habitat	Derived using a draft version of NVC to Annex 1 correspondence tables subsequently published in Strachan (2015)
U	Aspect (cardinal)	Cardinal and sub-cardinal points of the compass, for both original and re-survey plot

Column	Column name	Description
V	Aspect (degrees)	Aspect of plot recorded in the original survey, for both original and re-survey plot
W	Slope (degrees)	Slope of plot recorded in the original survey, for both original and re-survey plot
X	Original altitude (m)	Altitude recorded in original survey
Y	Re-survey altitude (m)	Altitude recorded in the re-survey (using GPS)
Z	Original grid reference (OS)	6-figure grid reference recorded in the original survey and used to relocate re-survey plot
AA	Re-survey grid-reference (OS)	10-figure grid reference recorded for re-survey plot by GPS
AB	Re-survey grid reference (eastings)	Re-survey OS grid reference converted to eastings format
AC	Re-survey grid reference (northings)	Re-survey OS grid reference converted to northings format
AD	GPS error (m)	Recorded at plots during re-survey
AE	Plot size (m^2)	Dimension of plot in square metres, usually 4, sometimes 1, 2, 16 etc
AF	Photo reference numbers	Photo reference numbers for the re-survey plots, using the format 478 1, 478 2 etc., where 478 is the plot number. n/a = not available
AG-BP	Tree and shrub species (A-Z)	Abundance scores
BQ-CF	Dwarf-shrub species (A-Z)	Abundance scores
CG-DO	Pteridophyte species (A-Z)	Abundance scores
DP-GV	Graminoid (grass, sedge & rush) species (A-Z)	Abundance scores
GW-OH	Forb species (A-Z)	Abundance scores
OI-AAC	Bryophyte species (A-Z)	Abundance scores
AAD-ADG	Lichen species (A-Z)	Abundance scores
ADH	Bare Ground	% cover of bare ground in the re-survey plot
ADI	Rock	% cover of rock in the re-survey plot
ADJ	Original vegetation cover (%)	% cover of vegetation in the original plot
ADK	Original vegetation height (cm)	Height of vegetation in the original plot (cm)
ADL	Re-survey vegetation cover (%)	% cover of vegetation in the re-survey plot
ADM	Re-survey	Mean height (of five measurements) of vegetation in the re-

Column	Column name	Description
	vegetation height (cm)	survey plot
AND	Re-survey moss height (cm)	Height of moss in the re-survey plot (cm)
ADO	No. sheep dung	Number of groups of sheep dung along four 1 x 10m transects walked outwards from the corners of each re-survey plot
ADP	No. deer dung	Number of groups of deer dung along four 1 x 10m transects walked outwards from the corners of each re-survey plot
ADQ	No. other dung	Number of groups of other dung along four 1 x 10m transects walked outwards from the corners of each re-survey plot
ADR	Abundance of hoof prints	Within 10 m by 10 m areas around the plot: absent; inconspicuous; patchy; extensive
ADS	Signs of grazing on dwarf-shrubs	1 = limited, probably patchy; 2 = frequent, easily found, patchy; 3 = extensive to ubiquitous
ADT	Signs of grazing on graminoids	1 = limited, probably patchy; 2 = frequent, easily found, patchy; 3 = extensive to ubiquitous
ADU	Signs of grazing on herbs	1 = limited, probably patchy; 2 = frequent, easily found, patchy; 3 = extensive to ubiquitous
ADV	Height and cover of dwarf-shrubs relative to graminoids	For heath plots ONLY: DS<G = dwarf-shrubs shorter than graminoids, sparse; DS>G = dwarf-shrubs frequent, equal to or taller than graminoids
ADW	Remarks	Comments on location of plot etc.

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ISBN: 978-1-78391-340-4

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