Berwickshire's disappearing scarce plants

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ABSTRACT

As part of a larger project to repeat-record the v.c. of Berwickshire as a whole, a sample of 162 populations of locally rare and scarce species recorded between 1987 and 1995 were re-surveyed between 2007 and 2009. Of these 120 have probably survived and 42 appear to have been lost. This equates to a loss of 16% a decade. The sample excludes certain mobile species as no valid method was available to match losses against recent colonisation. The causes of the losses is analysed and change in the flora is discussed more generally by broad habitat. Comparison is made with other studies and conclusions are drawn regarding future recording.

KEYWORDS: British flora, rare species, extinctions, colonisation, change over time

INTRODUCTION

The flora of v.c. 81 Berwickshire was recorded systematically hectad by hectad on a sample basis between 1987 and 1999, noting 6-figure GRs for most records of the scarcer species, whether native or alien. A Rare Plant Register was published in 2004 (Braithwaite 2004) listing about 1,000 extant populations for around 200 native species. In 2007 a new cycle of recording was commenced following approximately the same hectad by hectad sequence as the 1987–1999 survey. One module of the recording plan is to re-find as many of the populations of rare and scarce (R&S) species as practical and to record fine-scale detail of their populations. This programme provides an opportunity to review the R&S populations believed to have been lost over a period of 15–20 years and any new colonisation observed. By 2009 six hectads had been repeat-recorded in this way and a consistent pattern of severe losses of R&S populations has emerged which is the subject of this paper.

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THE STUDY AREA

V.c. 81 Berwickshire lies near the centre of Britain, taken north to south. Its lowlands are agricultural and its uplands grassland, moorland and forestry. It has a fine coast, though much of it is cliff, a varied river system and diverse wetlands. It thus has elements representative of many of the habitats found in Britain, though there are no truly montane areas while ancient woodland, still open water and urban habitats are under-represented. Indeed the largest town, Eyemouth, has a population of only 3,400. Berwickshire has an area close to that of twelve hectads. The six whole and part hectads re-surveyed have a total area close to five hectads, or about 40% of the v.c., and all major habitats are sampled.

SPECIES SELECTION

The species considered are those listed in the Berwickshire Rare Plant Register 2004 as at least locally scarce, being believed present at ten or fewer localities in the v.c. (or thought likely to decline below this number in the near future). All were believed to be natives or archaeophytes in v.c. 81. A few species are now known to be slightly more widespread than was believed in 2004 and would not now qualify as locally scarce. No changes to the species selection have been made for this or other reasons except that the microspecies of *Hieracium*, *Rubus* and *Taraxacum* are excluded.

The wellbeing of populations of R&S species is not representative of the average of the range of species present at a particular site, as more widespread species are usually more resilient to change. Nevertheless the presence of R&S species tends to be strongly indicative of 'good' examples of a particular habitat, 'good' habitat being partly measurable by its species richness in relation to the range of species characteristic of the habitat. The loss of R&S species may thus be strongly indicative of degradation of habitat.

Berwickshire R&S species include many that are widespread nationally, as judged from the *New Atlas* (Preston *et al.* 2002). They are often scarce locally because they are near the limits of their geographic range. There is thus a degree to which the wellbeing of R&S species is related to climate change. One would expect there to be winners as well as losers, and indeed there are some species that appear to have spread, such as *Polystichum setiferum* (all Latin names follow Stace 1991). So there is a need to balance the review of losses with a review of new colonisation.

METHODS AND THEIR LIMITATIONS

At the beginning of each season lists of the R&S populations for the hectads to be repeat-recorded are extracted from the v.c. 81 MapMate database. These lists are sorted by site and annotated. Many sites fit within a single 'floating' 1 km square (not bounded by fixed gridlines) but the more linear sites may be 2 km or so long. Large blocks of similar habitat are subdivided into two or more sites. A plant population that extends into two such subdivisions is treated as two populations. Priorities are set for the sites to be visited. High priority may be given to sites poorly recorded, if at all, in previous surveys and low priority is given to sites revisited between 2000 and 2006, but in general the best sites are given the highest priority with a selection of others chosen to give as complete a sample of habitats as possible.

Taking these site lists, with so much 6-figure GR data, out into the field has enabled the localities of a high proportion of R&S populations to be visited. Nevertheless many populations have not been refound and much thought has been given to whether they have been lost or merely overlooked.

The review of potential losses to separate real losses from populations overlooked has been unashamedly subjective, though the review has been approached as systematically as possible. A scoring system has been used to limit the impact of subjective judgement: 1 for a refind, 0 for clear evidence of loss and ¾, ½ and ¼ for cases where it was considered more or less likely that a population had been overlooked. There is the further problem that the plants in a population cannot be assumed to be distributed within a site just as they were twenty years previously. Not only may numbers vary from year to year in response to the weather but the habitat gaps they exploit may close in some places and open in others. This is a particular problem for species which exploit mud beside ponds, lochs, burns and rivers such as *Rumex conglomeratus* and *R. maritimus*. Even if a 1 km stretch of habitat has been thoroughly searched at a suitable season without success, I may have been reluctant to score less than ½ recognising some probability that the species will reappear in future. Often it is all too obvious that the habitat has changed and that the failure to refind a population represents a real loss, score 0.

NEW DISCOVERIES AND RECENT COLONISATION

In the sample hectads 267 R&S populations (excluding introductions) were known in 1999, 221 most recently recorded in the period 1987–1999 and 46 most recently in 1979–1986. However a further 210 R&S populations are now known, 67 discovered in the period 2000–2004 and 143 in 2005–2009. Thus the sample hectads have been explored progressively over the thirty-year period for which I have been vice-county recorder with each recording phase being more intensive and better informed than the last. So it is no surprise that in 2009, after allowing for probable losses, the number of recorded R&S populations extant far exceeds those known in 1999. In the majority of cases it is reasonable to assume that the new discoveries have been overlooked in the past, indeed many of the sites have had no previous recording visit. In other cases new colonisation is at least a possibility.

This uneven recording history leads to major problems in comparing new colonisation between the 1987–1995 and 2007–2009 surveys with the probable losses. My approach has been to eliminate those species that appear to be mobile before attempting a quantitative analysis of the probable losses and to discuss colonisation in relation to the species and processes involved but not numerically. So there has been a need to identify mobile R&S species for exclusion.

SPECIES EXCLUDED FROM THE NUMERICAL ANALYSIS

Annual arable weeds have all been excluded as their appearance in a field in a particular year is so dependent on the cropping regime.

The clubmosses, *Lycopodium clavatum* and *Diphasiastrum alpinum*, appear to be very vulnerable to muirburn and grazing on the open moorland of Berwickshire and all their populations there seem to be impermanent.

They have colonised newly-constructed forestry tracks extensively in the last twenty years but here too their populations are expected to be impermanent. In the circumstances all clubmoss records have been excluded.

Some aquatic species appear to be mobile. *Catabrosa aquatica* and *Potamogeton pusillus* have appeared in new ponds where they are unlikely to have been introduced. *Potamogeton alpinus* flourishing in a new upland pond could well have been introduced. Such species have been excluded.

There have been changes too on the coast. Single specimens of several 'new' native species have been found, such as *Beta vulgaris subsp. maritima*, and others have appeared for a single season on beaches where they had not been seen before. Others that were known as just a few specimens have disappeared. It is not possible to balance the gains and losses in a numerically valid manner, so all mobile coastal species have been excluded.

It is the custom in BSBI to treat the inland roadside populations of halophytes as aliens on the grounds that their spread has been enabled by vehicles. Whatever their status, such populations have been excluded as mobile. The same argument is applied to the spread of *Spergularia rubra* and a few other locally-scarce species along forestry tracks. A related issue is that a few R&S annuals, such as *Geranium pusillum*, are found both in natural habitats and in more ruderal ones. The ruderal populations often prove to be impermanent or do not produce mature plants every year, like arable weeds, so all such ruderal populations of annuals have been excluded. Plantings and deliberate sowings, which may be thought of as casuals, have also been excluded.

Sedum villosum is quite well represented in the areas re-surveyed and I have been particularly interested to discover how its populations are faring. As it happens some of the visits were inconclusive and I plan repeat visits in the hope of resolving the matter. But an interesting point emerges. It seems that a proportion of the small colonies lower down a burn system have been lost while those at higher altitude remain. There is a possibility that some of the lower colonies were impermanent: established but temporarily in marginally suitable habitat on the floodplain from seed washed down from above. I have resisted this argument for *Sedum villosum* as there does not happen to be evidence that populations in whole sites, as opposed to small groups of plants within a site, were just casuals. However this could be a significant issue when seeking to record change in our montane flora in other areas.

Of the 127 species considered, 21 have been wholly excluded as mobile. The exclusions have the advantage of helping to focus this paper on change in semi-natural habitats. This is convenient as rural Berwickshire is not the county for a study of the role of brownfield sites and the like in the future of the British flora.

REPEAT SURVEY RESULTS TO DATE

The results of the repeat survey are summarised in Table 1:

TABLE 1. LOSSES OF R&S POPULATIONS RE-SURVEYED, BY HECTAD

Hectad	Interval	Sample Population	Losses Population	Losses %	95% Confidence	Loss decade
NT55	17 yrs	18	3·50	19%	±16%	12%
NT64	20 yrs	47	13·50	29%	±12%	16%
NT65	19 yrs	20	6·75	34%	±19%	20%
NT75	17 yrs	19	5·50	29%	±17%	18%
NT77	14 yrs	30	6·00	20%	±13%	15%
NT84	16 yrs	28	6·75	24%	±13%	16%
Total	17 yrs	162	42·00	26%	± 6%	16%

As the outcome for each population is essentially on a presence or absence basis, rather than a report on individual plant numbers within populations, quite a large sample size is required to narrow down the confidence limits of the losses observed. Within these limitations the rate of loss is the same for each hectad.

The same data has been analysed by a simplified set of broad habitats in Table 2:

TABLE 2. LOSSES OF R&S POPULATIONS RE-SURVEYED, BY BROAD HABITAT

Broad Habitat	Sample Population	Losses Population	Losses %	95% Confidence	Loss decade
Aquatic	18	6·00	33%	±17%	21%
Coastal	18	1·75	10%	±13%	6%
Grassland	30	9·75	32%	±15%	20%
Inland Rock	5	1·00	20%	±39%	12%
Moorland	17	6·50	38%	±23%	25%
Wetland	47	14·00	30%	±11%	19%
Woodland	27	3·00	11%	±10%	7%
Total	162	42·00	26%	± 6%	16%

Notes: The grassland sample includes 18 populations of annuals and only 12 of perennials; grassland is mainly neutral grassland; moorland includes bog; the wetland sample includes 26 populations of moorland flush species and only 21 of taller vegetation.

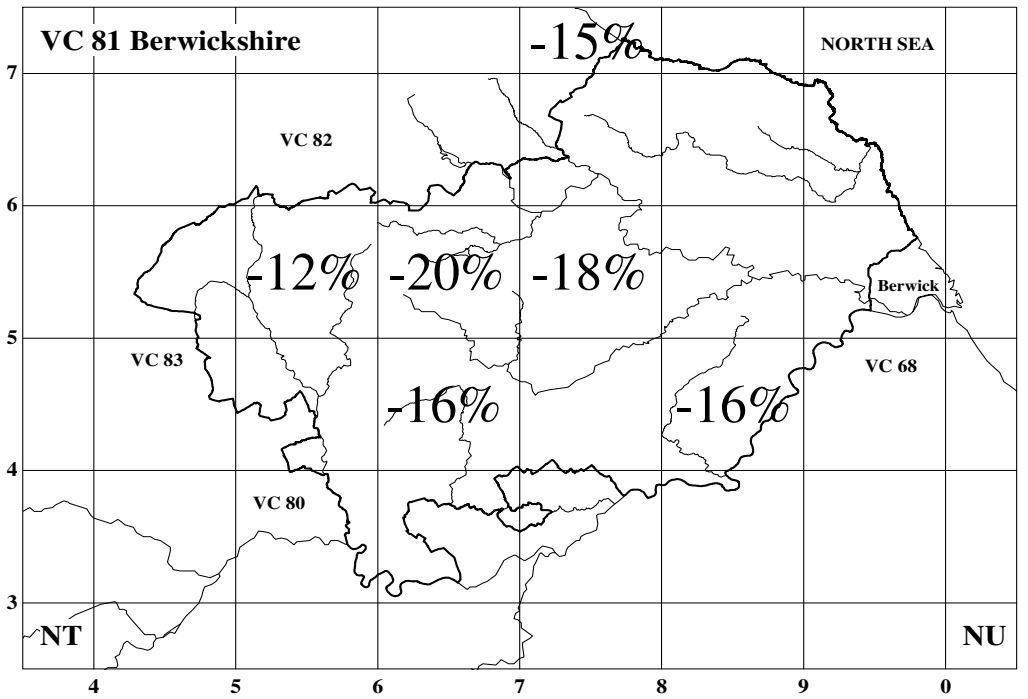

FIGURE 1. Rare and scarce populations: average probable loss per decade per hectad.

Two broad habitats have losses significantly lower than the average, coastal and woodland. There has apparently been an increase in diversity in the coastal habitats once colonisation is allowed for, as discussed below, while there really does appear to have been rather little change in the few woodlands surveyed.

The average probable loss per decade at hectad (10 km) scale is mapped in Figure 1, as is the change at monad (1 km) scale in Figure 2.

Monads with only species-poor habitats have often had but a single R&S species which may or may not have survived, if so they are mapped as 'all survive' or 'all lost'. Monads with the most species-rich habitats have often had several R&S species of which one or more may have been lost, if so they are mapped as 'some lost'. This accounts for the concentration of 'some lost' dots in a few species-rich areas, such as the one at the coast in NT77. This aside, R&S species are relatively evenly

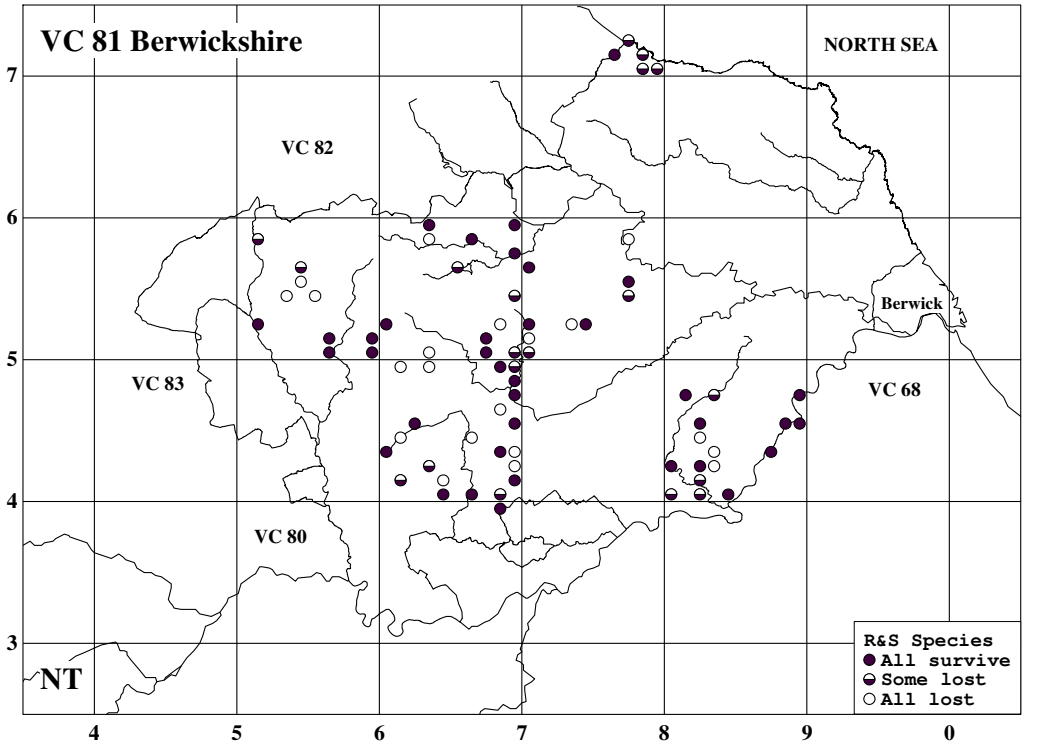

FIGURE 2. Rare and scarce populations: probable losses 1987–1995 to 2007–2009.

distributed across the v.c. and losses are fairly randomly distributed, though some local concentrations are evident.

COMPARISON WITH OTHER STUDIES

The estimate of a 16% loss per decade for R&S populations in Berwickshire may usefully be compared with other studies.

Bradshaw (2009) reports on the decline of the scarcer *Alchemilla spp.* in Northern England over a period of almost fifty years. Of 756 populations recorded at field-scale around 1952 only 210 could be refound in 2000. This equates to a loss of 23% per decade. A similar study reported in the same paper showed *Trollius europaeus* losing 20% of its populations per decade between 1967 and 2004.

Change in the British Flora 1987–2004 (Braithwaite *et al.* 2006) reported on the *BSBI Local Change* project, the repeat-recording of a sample of tetrads across Britain. It was found that the repeat survey had been more intensive than the first survey so that analysis of apparent gains and losses would not give measures of absolute change. Instead change was analysed relative to an average for representative native species. While only relatively widespread species yielded enough records for analysis they include many that are scarce at the fringes of their geographical range, including some Berwickshire R&S species. As a broad generalisation, the species that had declined most had declined by something of the order of 10% in the 16 year period between surveys, significantly less than the average of 26% in a 17 year period for the Berwickshire R&S species. However, if one studies the data one can infer that the rate of change at the fringes of a species range might be around three times the average as losses are high at the fringes and low in the core area of the range where the species is relatively frequent. This brings the rate of loss at the fringes to the same order of magnitude as the Berwickshire results even without adding something for the likely difference between relative and absolute change and ignoring the difference in scale, 1 km for Berwickshire, 2 km for *BSBI Local Change* (note that a higher rate of loss is to be expected at finer scale, as a tetrad may contain up to four 1 km-scale populations and all must be lost to register change at tetrad scale). So, while the comparison is imprecise, there is no evidence of inconsistency.

TABLE 3. HISTORICAL LOSSES OF R&S POPULATIONS

Basis period	Resurvey period	Sample Population	Losses Population	Losses %	Loss Decade	Comment
1740–1853	1987–2008	401	273	68%	7%	Many of best populations, focus on coastal strip
1854–1902	1987–2008	363	262	72%	10%	304 supplementary to 1740–1853, 59 refinds
1903–1944	1987–2008	143	73	51%	9%	Mostly revisits to best populations
1945–1969	1987–2008	337	176	52%	16%	Representative sample
1970–1986	1987–2008	280	72	25%	15%	Bias to best populations

Repeat-recording projects of all tetrads in several English v.cc. have recently been completed and their results are currently awaited with interest. The analysis of change is likely to be subject to the same problem of more intensive recording in the second survey so absolute measures of change are not expected, at least for the majority of species. More detailed statistics may be possible for some R&S species, but these are by definition the species with rather few populations so there is little opportunity for species by species measures of change. Even for R&S species, the problem of how to allow equitably for recent colonisation of the more mobile species will arise, and this appears to be intractable.

HISTORICAL LOSSES IN BERWICKSHIRE

In the Berwickshire Rare Plant Register 2004 I analysed the historical data for those species with a good historical record along rather similar lines to this paper. The average rate of loss for nineteenth century records had been 9% per decade from 1850 to 2000 and for twentieth century records 14% per decade from 1960 to 2000. Analysis by broad habitat showed that coastal species had declined less than those of other habitats.

Since 2004 Berwickshire's historical plant records have been fully computerised and the analysis has been repeated in greater detail, Table 3. Species of arable and ruderal habitats were not excluded. There is less difficulty in demonstrating the local extinction of arable and ruderal species over a long time-period as so often all sites in a particular hectad have been lost, not just the population at a particular site. This does, however, ignore the issue of casual occurences of arable weeds following introduction with crop seed.

All analysis is taken to the same resurvey date as there was no adequate repeat coverage until recently, so the scope for interpretation is limited. Nevertheless the analysis may be taken as evidence that the rate of losses before the Second World War was slower than more recently.

THE CAUSES OF LOSSES 1987–1995 TO 2007–2009

The cause of many of the losses between 1987–1995 and 2007–2009 can be deduced with reasonable certainty, though a residue remains where no cause is obvious. This is set below.

TABLE 4. CAUSES OF LOSSES

Probable cause of loss	Population
Agricultural/forestry operations	3·00
Alien invasion (*Centranthus*)	1·50
Bramble invasion (*Rubus*)	1·00
Development (housing/caravans)	3·00
Flush degraded (eutrophication/ climate change)	8·75
Grazing, too little	4·75
Habitat fragmentation/drainage	4·00
Muirburn	1·50
New pond (wetland converted)	2·50
Quarried	2·50
Unknown	9·50
Total probably lost	42·00
Probably surviving	120·00
Total sample	162·00

The drivers of change are similar to those identified in other recent studies. The overriding impression has been of an increase in tall rushes and coarse grasses with species-poor vegetation at the expense of shorter more species-rich vegetation.

DISCUSSION OF CHANGE BY BROAD HABITAT

None of the arable R&S species recorded in 1987–1999 have been refound where previously recorded but all have been discovered elsewhere in the survey area. Set-aside strips proved a productive habitat for such species up till 2007 and there was the feeling that arable weed diversity was increasing, but the grant system supporting them has been lost and the reverse was true in 2009 when most new discoveries of scarce arable weeds were made in ruderal situations. *Matricaria recutita*, a near locally-scarce species, has continued to spread.

Of the ruderal R&S species there are three who might be winners from climate change on the basis of the favoured habitats in which they occur. These are *Geranium pusillum*, *Hordeum murinum* and *Veronica polita*. While new discoveries of these species have been made, there have been losses too and no overall trend is evident. All finds of *Geranium lucidum* and *Malva moschata* were considered escapes from cultivation and, while *Mycelis muralis* has increased in natural woodland as well as ruderal habitats, it is a species that is probably a fairly recent accidental introduction (first record 1872).

Colonisation of forestry tracks by *Lycopodium clavatum*, *Diphasiastrum alpinum*, *Spergularia rubra*, *Montia fontana subsp. minor* and *Vicia sativa subsp. segetalis* has been one of the highlights of the re-survey. Many of these tracks have been constructed within the last twenty years.

While there have been losses of aquatic species, *Apium inundatum* and *Ranunculus circinatus* in particular, the overall position seems more positive. The information base has proved inadequate when it comes to considering whether discoveries of additional populations of *Catabrosa aquatica* and *Sparganium emersum* are new colonisation or not. Some change in these two species follows an established cycle of ditch clearance.

Only a few kilometres of coast fall in the survey area though they contain some of the richest coastal habitats in the v.c. The changes have been remarkable. *Aster tripolium*, *Atriplex littoralis* and *Beta vulgaris subsp. maritima* are new to the v.c. (though the *Atriplex* had been recorded recently as a roadside adventive). The populations of *Cakile maritima* and *Glaucium flavum* have increased greatly in numbers and *Atriplex laciniata* has become more frequent. However *Parapholis strigosa*, only recorded in 1984, has disappeared and both *Glaux maritima* and *Puccinellia maritima* may have lost colonies. It is perhaps premature to think of these changes as permanent, it seems more likely that they represent a response to unusually favourable conditions on a coast with small populations on beaches which are vulnerable to damage from winter storms.

In 1987 *Atriplex prostrata*, *Puccinellia distans* and *Spergularia marina* would have qualified as R&S species in Berwickshire. These species are now almost ubiquitous at the margin of main roads and widespread on minor roads. There they have been joined by *Armeria maritima*, *Atriplex littoralis*, *Cochlearia danica*, *Juncus ambiguus* and *Sagina maritima* in what has undoubtedly been the most spectacular change in the flora of the v.c. in the period.

A disproportionate number of Berwickshire's R&S grassland species are annuals. They are found on rocky knowes where their broad habitat could equally well be described as inland rock. Their populations vary from season to season. The losses recorded relate to small-scale quarrying and scrub encroachment. The only increasing species has been *Allium vineale*, which is spreading down the river Tweed in the manner of an alien.

The one loss from inland rock is unusual. There was a surprising colony of *Cryptogramma crispa* on a drystane dyke by an old drove road. This section was demolished by forestry vehicles.

The moorland species with the most losses is *Genista anglica*. It seems to recover poorly from muirburn. *Antennaria dioica* is a moorland-edge species that also suffers. Nowadays, with honourable exceptions, keepers conduct muirburn on the grouse moors with military precision and no bank, burnside or rough corner is allowed to escape. *Empetrum nigrum* has become rather scarce and even *Vaccinium myrtilis* is often extraordinarily sparse. No R&S species are colonising moorland though juniper, *Juniperus communis subsp. communis*, may now be planted at the fringes.

The Lammermuirs have very little wetland but one of the delights of botanising there is to happen upon a small flush area with *Sedum villosum*, if it be relatively acid, or *Carex dioica*, *Eleocharis quinqueflora*, *Selaginella selaginoides* and *Parnassia palustris* if it be more base-rich. I am particularly interested in chronicling the fate of such communities. It is proving difficult. Twice I have been reduced to

revisiting a remote flush area where I have failed to refind the expected rarities. Twice I have been rewarded by refinding the species-rich flush just over a rise little more than a hundred metres from a more run-of-the-mill flushed area. Nevertheless it is clear that there have been losses with tall rushes invading small flushes. Then there have been subtle changes at the burnside itself where *Sedum villosum* was formerly found among moss carpets where *Epilobium brunnescens* is now frequent, though I am not suggesting it is as simple as the one displacing the other.

I am concerned about the riverside and pond species that depend on cattle plodging to keep patches of habitat open. There has been much fencing-off of the riverside to promote angling and water quality. Like muirburn the practice has been taken too far and there has been a marked decline in the populations of *Lythrum portula, Rumex conglomeratus* and *Veronica anagallis-aquatica agg*. These species are probably still present in the seed bank even where they appear to have been lost, so any change in management could reverse their fortunes.

Berwickshire lost most of its remaining woodlands over the centuries of Border warfare, so it is pleasing to report few recent species losses. The last known colony of *Goodyera repens* has finally gone: it had hung on for some years under the few remaining mature pines after the main plantation had been felled and has succumbed to brambles. Two R&S species that appear to be responding positively to climate change are *Carex pendula* and *Polystichum setiferum*. Their colonies in dean woodland by the coast have expanded up the slopes away from the burn and *Polystichum setiferum* appears to have colonised plantations well inland. *Viburnum opulus* had been reduced to less than ten bushes in the v.c. as a native but is now increasingly planted, sometimes in ancient woodland.

SUMMARY

While the discussion of change by broad habitat highlights colonisation as well as the losses summarised in the tables, the overall balance is discouraging. A limited number of species have shown spectacular gains in man-made habitats, particularly roadsides and forestry tracks, but not in more natural habitats. The unobtrusive spread of *Carex pendula* and *Polystichum setiferum* in natural habitats is scant compensation for the loss of so many populations of R&S species, especially those of grassland and wetland.

Nevertheless there is a fundamental asymmetry between decline and spread. Decline is by the gradual whittling-away over many years of populations that fragment and finally succumb. Many species may decline to a similar pattern. Colonisation may be rather rapid. Spread of 1·4 km/year is about the norm for rapidly spreading species (Braithwaite 2010), so a v.c. may be extensively colonised in a twenty-year period between two surveys. Rather few species may be spreading at a particular time so their impact may be underrated. It is easy to forget the now-familiar species that have colonised a v.c. over the last century or so. For Berwickshire these include the following riverside species: *Acorus calamus, Butomus umbellatus, Dipsacus fullonum, Glyceria maxima, Lysimachia vulgaris* and *Scrophularia umbrosa*. If the habitats were surviving climate change need not necessarily lead to a species-poor flora in the long-term.

But at present climate change is but one driver of change and the habitats are not surviving. Most have already been grievously fragmented. Eutrophication is ubiquitous and has been leading to a reduction in diversity. The demands of mankind through agriculture, forestry, sporting interests, the transport infrastructure and the built environment are remorseless. Yes, Berwickshire's scarce plants are disappearing.

CONCLUSION

Evidence is presented that the current rate of the loss of Berwickshire's rare and scarce plant populations is about 16% per decade. However the sample analysed excludes mobile species, especially annual arable weeds and species of ruderal habitats. New colonisation has also been excluded and, while it concerns only a minority of species, discussion indicates that it largely negates the results for aquatic and coastal habitats.

The comparisons have been made at 1 km scale on a presence or absence basis rather than on the basis of changes in the size of individual populations. This basis demands quite large sample sizes before statistically valid results can be expected and for this reason the analysis by broad habitat is very provisional. More detailed results should be possible in the future as all populations of rare or scarce plants are now being plotted out at 10 m scale (100 m for a few large populations) supplemented in some cases by counts of individual plants. No solution is in prospect to the problem of how to measure absolute change for mobile species.

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REFERENCES

BRADSHAW, M. E. (2009), The decline of Lady's-mantles (*Alchemilla vulgaris L. agg*.) and other hay meadow species in Northern England since the 1950s, *Watsonia* **27**: 315–321.

BRAITHWAITE, M. E. (2004), *Berwickshire Vice-county Rare Plant Register,* privately published.

BRAITHWAITE, M. E. (2010), How well has BSBI chronicled the spread of neophytes? *Watsonia* **28**: 21–31.

BRAITHWAITE, M. E., ELLIS, R. W. & PRESTON, C. D. (2006). *Change in the British Flora 1987–2004*, Botanical Society of the British Isles, London.

PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British and Irish flora*, Oxford University Press, Oxford.

STACE, C. A. (1991). *New Flora of the British Isles*, Cambridge University Press, Cambridge.

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APPENDIX: TABLE OF RARE AND SCARCE SPECIES POPULATIONS IN THE SURVEY SAMPLE

Broad Habitat	*Taxon*	Lost	Surviving	Total	Not analysed	Not Visited	Total
Wetland	*Anagallis tenella*		1·00	1			1
Moorland	*Antennaria dioica*	1·00		1			1
Grassland	*Anthriscus caucalis*	1·00		1			1
Aquatic	*Apium inundatum*	0·75	1·.25	2			2
Coast	*Astragalus danicus*	1·00		1			1
Coast	*Atriplex laciniata*		1·00	1			1
Grassland	*Ballota nigra*		1·00	1			1
Wetland	*Blysmus compressus*		1·00	1			1
Coast	*Blysmus rufus*		1·00	1			1
Grassland	*Botrychium lunaria*	1·00	2·00	3			3
Coast	*Cakile maritima*		1·00	1			1
Coast	*Carex arenaria*		1·00	1			1
Wetland	*Carex dioica*	0·75	3·25	4		1	5
Coast	*Carex distans*		1·00	1			1
Coast	*Carex extensa*		1·00	1			1
Woodland	*Carex laevigata*		1·00	1			1
Grassland/ Ruderal	*Carex muricata* subsp. *lamprocarpa*		1·00	1	1		2
Woodland	*Carex pallescens*	0·75	1·25	2			2
Woodland	*Carex pendula*		1·00	1			1
Woodland	*Carex remota*		1·00	1		1	2
Wetland	*Carex vesicaria*	1·75	0·25	2			2
Coast/ Grassland	*Centaurium erythraea*	0·50	2·50	3			3
Grassland	*Cerastium semidecandrum*	1·00	1·00	2			2
Wetland	*Cicuta virosa*		1·00	1			1
Wetland	*Cirsium heterophyllum*	2·00	3·00	5			5
Grassland	*Clinopodium vulgare*		1·00	1			1
Woodland	*Corallorhiza trifida*		1·00	1			1
Rock	*Cryptogramma crispa*	1·00		1			1
Wetland	*Dactylorhiza incarnata*	1·00	2·00	3			3
Grassland	*Dianthus deltoides*		1·00	1			1
Moorland	*Drosera rotundifolia*	2·00	4·00	6			6
Wetland	*Eleocharis quinqueflora*	1·50	3·50	5			5
Woodland	*Epilobium roseum*					1	1
Wetland	*Eriophorum latifolium*		1·00	1			1
Grassland/ Ruderal	*Erodium cicutarium*		2·00	2	2		4
Coast	*Erophila majuscula*	0·75	0·25	1			1
Wetland	*Euphrasia scottica*		1·00	1			1
Grassland	*Filago minima*	0·75	1·25	2			2
Wetland	*Galium boreale*		1·00	1			1
Grassland	*Galium mollugo*		1·00	1	1		2
Moorland	*Genista anglica*	1·50	2·50	4			4
Coast	*Glaucium flavum*		1·00	1			1
Coast	*Glaux maritima*		1·00	1	1		2
Woodland	*Goodyera repens*	1·00		1			1
Grassland	*Gymnadenia conopsea*		1·00	1			1
Wetland	*Hippuris vulgaris*	0·50	0·50	1			1
Coast	*Honckenya peploides*		2·00	2			2
Woodland	*Hypericum maculatum*		1·00	1			1

APPENDIX CONT...

Broad Habitat	*Taxon*	Lost	Surviving	Total	Not analysed	Not Visited	Total
Coast	*Juncus gerardii*		1·00	1			1
Rock	*Lactuca virosa*		2·00	2			2
Aquatic	*Lemna trisulca*	0·75	1·25	2			2
Coast	*Leymus arenarius*		1·00	1		1	2
Woodland	*Linnaea borealis*		1·00	1			1
Woodland	*Listera ovata*		1·00	1		1	2
Aquatic	*Littorella uniflora*		1·00	1			1
Woodland	*Melica uniflora*	0·25	1·75	2			2
Woodland	*Mentha arvensis*		2·00	2			2
Woodland	*Milium effusum*		1·00	1			1
Wetland	*Molinia caerulea* subsp. *arundinacea*	0·25	0·75	1			1
Grassland	*Montia fontana* subsp. *minor*	0·25	0·75	1			1
Grassland	*Montia fontana* subsp. *variabilis*	0·50	0·50	1	1		2
Woodland	*Mycelis muralis*		2·00	2			2
Grassland	*Myosotis ramosissima*	1·50	0·50	2		1	3
Aquatic	*Nuphar lutea*		1·00	1			1
Grassland	*Ophioglossum vulgatum*		1·00	1			1
Woodland	*Platanthera bifolia*		1·00	1			1
Grassland	*Poa angustifolia*					1	1
Woodland	*Polypodium interjectum*					1	1
Woodland	*Polystichum setiferum*		1·00	1			1
Aquatic	*Potamogeton lucens*		1·00	1			1
Aquatic	*Potamogeton* × *salicifolius*		1·00	1		1	2
Coast	*Puccinellia maritima*		1·00	1		1	2
Woodland	*Pyrola minor*		4·00	4			4
Woodland	*Ranunculus auricomus*	0·75	1·25	2			2
Aquatic	*Ranunculus circinatus*	1·00		1			1
Aquatic	*Ranunculus lingua*		1·00	1			1
Aquatic	*Ranunculus peltatus*	0·75	0·25	1			1
Rock	*Rosa pimpinellifolia*		2·00	2			2
Woodland	*Rubus saxatilis*		1·00	1			1
Wetland	*Rumex conglomeratus*	0·50	0·50	1			1
Wetland	*Rumex maritimus*	0·75	0·25	1			1
Wetland	*Sagina nodosa*		2·00	2			2
Wetland	*Salix phylicifolia*		2·00	2			2
Wetland	*Schoenoplectus lacustris*		2·00	2			2
Wetland	*Schoenoplectus tabernaemontani*		1·00	1			1
Grassland	*Scleranthus annuus*	0·75	1·25	2			2
Wetland	*Scutellaria galericulata*	0·50	0·50	1			1
Wetland	*Sedum villosum*	2·75	1·25	4			4
Wetland	*Selaginella selaginoides*	0·75	3·25	4			4
Grassland	*Sherardia arvensis*	0·75	0·25	1			1
Grassland	*Silaum silaus*	1·00		1			1
Aquatic	*Sparganium emersum*	1·50	1·50	3			3
Coast	*Spergularia media*		1·00	1			1
Wetland	*Stellaria palustris*	1·00		1			1
Coast	*Triglochin maritimum*		1·00	1			1
Wetland	*Trollius europaeus*		1·00	1			1

APPENDIX CONT...

Broad Habitat	*Taxon*	Lost	Surviving	Total	Not analysed	Not Visited	Total
Moorland	*Ulex gallii*		1·00	1			1
Moorland	*Vaccinium oxycoccos*	2·00	3·00	5			5
Grassland	*Valerianella locusta*		1·00	1			1
Aquatic	*Veronica catenata*		1·00	1			1
Aquatic	*Veronica catenata / V.* × *lackschewitzii*	1·00	1·00	2		5	7
Aquatic	*Veronica* × *lackschewitzii*	0·25	0·75	1		2	3
Woodland	*Viburnum opulus*	0·25	0·75	1	1		2
Grassland	*Vicia lathyroides*	0·75	0·25	1			1
Grassland	*Vicia orobus*		1·00	1			1
Grassland	*Vicia sativa* subsp. *segetalis*					2	2
	Subtotal	42	120	162	7	19	188
	Excluded species						
Ruderal	*Aethusa cynapium*				2		2
Ruderal	*Arenaria serpyllifolia* subsp. *leptoclados*				1		1
Aquatic	*Catabrosa aquatica*				5		5
Ruderal	*Centaurea cyanus*				1		1
Ruderal	*Chelidonium majus*				1		1
Arable	*Chrysanthemum segetum*				1		1
Ruderal	*Convolvulus arvensis*					1	1
Ruderal	*Filago vulgaris*				1		1
Arable	*Fumaria officinalis* subsp. *wirtgenii*				1		1
Arable	*Fumaria purpurea*				1		1
Ruderal	*Geranium lucidum*				1		1
Ruderal	*Hordeum murinum*				1	1	2
Arable	*Hypericum humifusum*				1		1
Moorland	*Lycopodium clavatum*				4		4
Aquatic	*Lythrum portula*				1		1
Arable	*Persicaria lapathifolia*				2		2
Aquatic	*Potamogeton obtusifolius*					1	1
Aquatic	*Potamogeton pusillus*				2		2
Ruderal	*Spergularia rubra*				1		1
Ruderal	*Veronica polita*				5		5
Arable	*Viola tricolor*				2		2
	Total	42	120	162	41	22	225