BSS News

The Newsletter of the Botanical Society of Scotland

No. 118 March 2022

1

2

3

The Botanical Society of Scotland is a Scottish Charitable Incorporated Organisation (SCIO) (No. SC016283)

Front cover pictures:

Outside: *Astragalus danicus* (Purple Milk-vetch) at Nigg ferry car park. See **Are There Wild Plants On Car Parks?** Page 25. Photo: Brian Ballinger

Inside: **1.** *Daphne pontica* (Twin Flowered Daphne) **2.** *Lathraea squamaria* (Toothwort) **3.** *Rodgersia* leaves. See **A Botanical Walk Along The River South Esk, Midlothian** Page 9. Photos: Richard Milne

BOTANICAL SOCIETY OF SCOTLAND

c/o Royal Botanic Garden Edinburgh
20A Inverleith Row, Edinburgh, EH3 5LR
Website: http://www.botanical-society-scotland.org.uk
You can follow the BSS on Facebook and Twitter.

Founded in 1836 as the Botanical Society of Edinburgh, the Society became the Botanical Society of Scotland in 1991. Meetings and lectures are held in Edinburgh, and occasionally at the invitation of local societies in Aberdeen, Dundee, Glasgow, Inverness, Perth and St. Andrews. The Society encourages the study of flowering and non-flowering plants. Activities of the Society include lectures, field meetings, symposia, surveys, and an annual Scottish Botanists' Conference held jointly with the BSBI for the exchange of information on all aspects of Scottish botany.

All botanical enthusiasts are welcome to be members of the Society, including gardeners, professional plant scientists, amateur field botanists and students. All members receive information about the events of the Society, including programmes of lectures and field meetings, as well as a twice-yearly newsletter, *BSS News*. Standard membership also includes the scientific journal: *Plant Ecology & Diversity*, published by Taylor & Francis on behalf of the Botanical Society of Scotland. Standard members can also go online and download all of the Society's journals, from papers which have just been accepted for publication in Plant Ecology & Diversity, all the way back to the first issue of Transactions of the Botanical Society of Edinburgh published in 1844 (instructions can be found on our website).

Applications for membership and subscription payment are best made online via WebCollect through the BSS website at https://www.botanical-society-scotland.org.uk/content/bss-membership where we accept payment by bank transfer and direct debit. If you prefer to pay by cheque please send it to the Treasurer, using the address at the top of this page.

Subscription renewals due 1st October each year. Deadline 25th December	
Standard rate (with the Journal Plant Ecology & Diversity)	£40.00
Standard rate for undergraduate students (with the journal)	£30.00
Basic rate (without the journal)	£20.00
Basic undergraduate student rate (without the journal)	£5.00

CONTENTS

EDITORIAL

Thank you to all contributors to this edition of the BSS News, and to everyone who has continued to attend lectures online. We hope to have some lectures in person at the RBGE in 2022, but at the time of writing, we are not certain when these will start. We will email you, and post the news on our web site, when we have further information. Having BSS lectures over Zoom has had advantages, however, such as in January we were grateful to have an interesting lecture about bamboo and pandas given by Linda Neaves (at 5 am from Australia), and BSS members living throughout the world have been able to attend them virtually. There are ongoing discussions about the possibility of hybrid lectures, with an audience at RBGE and on Zoom at the same time, but we are unable to tell you when or if this might be possible.

We hope that people successfully used the online WebCollect system, to pay their subscriptions and update their details. This should make managing the membership and subscriptions easier, save a lot of time and reduce complications in the future. If you had any problems with WebCollect please contact our membership secretary for help.

The notice for our AGM is contained in this News. Please do get in touch with Jill if you would like to be involved in any way with running the BSS or have recommendations for people that you would like to take on BSS Council roles in the future. We need help with many aspects of running the BSS.

Also in this News is information about funding for students to support field work projects and training and also prizes for the best botanical dissertation. Last years' dissertation submissions can be found on pages 27 - 30, and reports of some of last year's student projects can be found on pages 43 – 58.

We wish you the best for 2022 and hope that you find more opportunities to enjoy field activities this year. We do have a programme of field visits planned (see the enclosed programme), and our Urban Flora of Scotland project is continuing. The pin and thrum for cowslips advertised in BSS News no. 116 is also active again this year https://cowslip.science/ so please join in.

We welcome botanical themed articles for publication in the BSS News. Please see the article formatting guidance on our web site.

Jill Thompson and Cameron Diekonigin

ANNUAL GENERAL MEETING

7pm Thursday 19th May 2022

The BSS Annual General Meeting will be held on Thursday 19th May 2022 at 7 pm, immediately after the final spring lecture. We hope to be able to have in person meetings at the RBGE by then but check the BSS web site for updates nearer the time and look out for email details in case we are able to meet in person at the RBGE.

Further information about the AGM will be sent out by email by 5th May 2022. If you have an email address, but are not currently receiving emails from the BSS then please log into WebCollect and update your details, or contact the membership secretary (see below). If you do not use email and wish to receive further information by post, please contact us in writing at Botanical Society of Scotland, c/o Royal Botanic Garden Edinburgh, 20A Inverleith Row, Edinburgh EH3 5LR, UK by 5th May 2022, marking your envelope 'AGM'.

At the AGM we will report on our activities over the last 12 months, present our draft financial accounts, elect members to our governing body (BSS Council) and answer your questions about the BSS. If you have any other business that you would like to add to the agenda then please inform the BSS general secretary (see below).

The provisional agenda for the AGM is as follows:

1. Chair's welcome, apologies for absence, opening remarks.
2. Draft minutes of the AGM 2021 for approval (they are available in the members' area of our website, and will be circulated in advance of the meeting).
3. President's Annual Report.
4. Treasurer's Annual Report.
5. Election / re-election of Council Members.
6. Any other Business.

Can you help us to run the BSS?

The BSS is run by volunteers, and we have some vacancies on our Council. We arrange the lecture and field programmes, keep financial accounts, manage membership, publish the BSS News, Plant Ecology & Diversity and our blog 'Botany in Scotland', run a website, organise projects, award student prizes and grants, and sometimes comment on relevant national strategy and planning issues (e.g. Coul Links).

You do not need to be a 'qualified botanist'; an interest in plants and a willingness to help are all that is required. Our varied activities require a wide range of skills to support them. You will also help to keep the Society relevant to Scottish botany and to our membership. We hold about five Council meetings per year that currently are virtual meetings by Zoom. If you would like further information, please contact Jill at the email address below. Applicants to our Council should provide a brief (one paragraph) résumé of their interests and experience, and details of two members of the BSS (a proposer and seconder) who agree to nominate them. If you do not know any other BSS members, please contact us and we will help you to arrange this. Nominations must be received by the General Secretary no later than 22nd April 2022.

Jill Thompson, President BSS
president@botanical-society-scotland.org.uk

Liz Lavery, General Secretary BSS
general.secretary@botanical-society-scotland.org.uk

Kevin Gaffney, Membership Secretary BSS
membership@botanical-society-scotland.org.uk

STUDENT AWARDS: FIELDWORK PROJECTS, TRAINING COURSES AND STUDENT DISSERTATION PRIZES

At the time of writing this (February 2022), we are unable to predict if there will be any Covid restrictions this summer but ask students and academic staff to read this and think about projects that it might be possible to carry out, or training courses to attend. The usual deadline of April 30th 2022 for project and training applications will apply, but given the uncertainties, we may be able to be flexible about deadlines for proposal submission. If you have an idea, but are not sure if it fits with BSS objectives, please get in touch – we would like to hear from you (see details and eligibility below).

Student dissertation prize nominations from supervisors, are requested as usual by July 1st 2022. Any changes to the deadlines or other aspects of the awards will be advertised on our website so check before submission. Last year the standard was so good we awarded two equal first prizes (see more details below).

Support for Student Fieldwork Projects

Fieldwork projects should not form part of a university or college course, but we encourage students to discuss project ideas with tutors, who may be able to make helpful suggestions. Also, talk to local volunteer groups and see if you could do a small project in line with their work.

The main features of these grants are given below, but please check further details on our website:

- We favour botanical projects conducted in Scotland, or from students attending Scottish Universities, but we do not exclude projects based elsewhere.
- Awards are for undergraduate students, and those in the first year following the date of graduation.
- The maximum grant available for fieldwork is £700.
- There is no limit on the number of applications from a particular university or college, and a small group of students may work together on the same project and each request an individual award of up to £700. To find out which fieldwork expenses may be covered see the BSS website.
- Up to 50% of the award may be used as a daily allowance at a rate of £50 per day.

- Include a fieldwork risk assessment with your proposal.

Support for Student Fieldwork Training

These grants are intended to enable students to attend a residential or local short training course to improve their botanical skills.

- Awards are for undergraduate students, and those in their first year after the date of undergraduate degree graduation.
- The value of these awards is £500.

Student Dissertation Prizes

The BSS awards an annual dissertation prize of £200 to a final year student of a Scottish University who produces the best dissertation on a botanical investigation. The award nomination must be submitted by the student's supervisor or department head (not the student themselves), and only one nomination is allowed per degree course. A panel at the BSS will decide the winner.

Further details of all awards, and how to apply for them, are on our website (follow the tabs in the left-hand green panel).

Jill Thompson, President BSS
president@botanical-society-scotland.org.uk

A BOTANICAL WALK ALONG THE RIVER SOUTH ESK, MIDLOTHIAN

During 2021 I discovered a fascinating new walk full of interesting plants. The walk takes in the sides of the river South Esk, running a mile south of the Dalhousie Castle Hotel, but it wiggles and hence ends up being much longer; also parts of it are not for the fainthearted. Still, hopefully, everyone will be able to enjoy my account of the incredible range of interesting plants to be found here.

I usually start the walk from southeast side of Bonnyrigg where the 31 bus can take you to a handy spot on the B704 road (~NT317645), but there is also space for a few cars a bit closer by, near the Cockpen Bridge, at NT31996396. Starting from the latter, one passes through a little gap in the wall and through woods to a path between woods and trees. Beyond the trees a steep, unstable slope rises up to an industrial estate, which sometimes makes the area a bit smelly. Only a crazy fool would attempt to ascend that slope, so I only did it a few times, but one of the ascents produced a massive plant of *Cannabis sativa*, which a friendly local worker claimed not to recognise!

Further along the path, several *Berberis* species and other exotics persist from old plantings. Anyone who likes hunting weird aliens may wish to divert here, climbing over the bank to the left, where all sorts of things can be found established from dumped soil, on a slightly raised bank by the path, or the far higher bank beyond it. Several established bulbs appear here, such as tulips and *Muscari*, and under the trees I found a purple form of *Euphorbia dulcis*. If you are willing to climb the much higher bank, you will come to the top of an artificial levee surrounding a hidden car park, which has *Helleborus foetidus* and large amounts of white-flowered *Galega officinalis*, and in 2020 there was a plant of *Marrubium vulgare,* plus a few *Euphorbia oblongata* plants lower down.

The path itself continues to where it joins a beautiful woodland path and valley. There are two ways to proceed here, and heading south with the valley on your left brings you to where a delightful stone bridge (NT32096317) clad with *Allium ursinum,* crosses the stream within the wooded valley. Cross this bridge and bear left and you will come in time to the river. Alternately, on reaching these woods head northeast with the valley on your right, and you'll soon see the impressive Dalhousie Castle

Hotel. They seem not to mind people passing through their grounds, so simply drop to the riverside and then head south (upstream). Both of these will get you to the same place.

The river here bends, forming a half circle around an area of woodland. Among the woodland plants here are *Adoxa moschatellina* (sporadically common in some woods south of the Edinburgh bypass) and *Stellaria nemorum*. The path follows the riverside, rising up on a shady bank, and a few plants of *Ribes alpinum* are scattered along it, probably relicts of planting, as exotic trees and shrubs do appear in a few places along this stretch. Remarkably, a total of five *Ribes* species may be seen on this walk, the others being *R. rubrum, R. nigrum, R. uva-crispa* and *R. sanguineum.*

The path now leaves the wood and passes along an open stretch by a grassy field, overlooking the river, with an ancient knarly oak and younger elms. Then the path reaches a pine plantation and seems to vanish, so from here the walker must become steadily more adventurous in order to proceed. This plantation has masses of *Allium ursinum,* but also offers the first encounters with *Lathraea squamaria* on this walk, a few near the river and more on the banks of a thin but steep stream gulley that cuts through the wood from a field above. The walker will need to ascend along this little gulley in order to continue. Any attempt to proceed at a lower level will be thwarted by a huge, steep and dramatic landslide running from the field edge down to the river that has obliterated all vegetation. However, one can pass easily enough above it, along the field edge. Eventually there is a chance to descend from the corner of a field to where a small stream meets the river, over a sort of stile and down a path on a little ridge within the wood, passing plants of an attractive microspecies of *Ranunculus auricomus* that has all its petals intact. However, it is worth briefly bearing right at the top of this path, along the upper slope of the valley of this tributary because the mass of native bluebells on its north bank includes a few naturally occurring white and pink morphs. Such morphs occur naturally though rather rarely in blue *Hyacinthoides* and *Scilla* species, but are made more common in gardens by human selection (see the BSS blog “Plant of The Week”, about Bluebells).

Near the confluence there are two cables drawn tight across the river, which allows brave souls to cross it. But one can continue southwards on the west side, as a narrow path cuts among the vegetation under thin tree cover. Soon the terrain flattens out to a platform some way above the river, but well below the field, with thick grass attesting to rich soil. Here, a massive sycamore tree plays host to a mass of *Lathraea squamaria*, which had around 100 flowering spikes on this tree alone, with several satellite colonies nearby. I have heard that 2021 was an unusually good year for toothworts generally, so there might not be as many in subsequent years, but I will certainly be going back.

Beyond the toothworts, another small stream joins the river, this one cutting across the path well above the stream, and one has to step over or walk around a tiny ravine. Then the walker has to struggle up diagonally to the boundary of an oddly shaped field, which recalled for me the oxen-ploughed fields of a remote scenic area in China. Here, again, one has to track along the field edge before descending to the river where the slope becomes shallow enough, and it is only just enough, the angle is about 45 degrees but there are plenty of young trees to hold onto. At the bottom, woodland plants abound, with a thick mass of *Ranunculus auricomus*. Picnicking here in April with my wife Nenya and son, it was Nenya, the gardener, who first caught sight of some very out of place purple leaves sticking out of the ground in one spot just above the river. Climbing down for a look, we identified it as a *Rodgersia*, fully established and spreading over a patch a few metres across. I returned repeatedly throughout the season, but it did not flower. However, I successfully dug up a few little pieces of it, 'recapturing' this particular escape back into cultivation. Hopefully, under Nenya's TLC, it will flower this coming year and we will know better which species it is. I do not think it was planted here – the spot is too wild and steep to be of any interest for cultivation, and it has no other exotic species. Instead, I think it arrived here via a piece of rhizome washed downstream.

Just downstream of the *Rodgersia* is a natural bridge, formed by a tree that fell several years ago (NT32556214). Masses of flotsam, both natural and manmade, have gathered on the upstream side, and anyone who is reasonably agile can make it across. Plants of various species, including some tree saplings that are growing on it, attest to the age of this bridge. Most of these species are fairly unremarkable, but there was a magnificent specimen of *Scrophularia umbrosa* standing proud halfway across. Both my family and three groups of students all dutifully followed me across this rather exciting river crossing. On the other side is a large floodplain with tussocky rough grass, but a line of trees separates it from the river. By July, however, this and other parts of this walk were becoming more difficult due to the thick vegetation. But north of the floodplain, following the river back now along its east side, a track soon appears, which clearly used to carry vehicles of some sort, and walking along it one must be wary of the short but precipitous drop to the river on the left. Further along, one passes below a mass of *Petasites hybridus* on a damp slope, then encounters a large fully naturalised patch of *Aruncus dioicus* right by the riverside. This, unlike the *Rodgersia*, looks like it could have originally been planted here, because there are several exotic evergreen shrubs in the vicinity, and a striking purple rose rises in lanky fashion to three metres high just a little further on. The spot with both these plants is marked by a semi-island in the river, separated from the east bank by a channel that floods when the river is in spate.

From here, it is best to climb a path to the top of the slope, where a clear path now runs parallel to the stream, with wooded slope below it and grassy, scrubby slope above. The slope above rewards an enterprising botanist with an odd assemblage of garden outcasts, attesting I suspect to the artificial origin of this particular hill. The Broom (*Sarothamnus*) plants include ‘Red Wing’ cultivars or similar, which cross with the normal yellow forms, and there are patches of *Centaurea montana* and a double white rose.

Whether you climb the slope or not, continued northward progress brings you to a flat area where the substrate seems to be eroded concrete, hence generating an artificial patch of basic grassland. Special plants here include *Pilosella caespitosa* and a creamy white form of *Vicia sativa*, which looks superficially very like *V. lutea*, but I knew it was not, having encountered *V. lutea* itself near Musselburgh earlier in the season.

Continuing along the path here, one is taken by a rising track back to the main road. However, on my first visit here, I did not know this and continued through the woods nearer the river. These were open at first, but then I became embroiled in a thick mass of *Rhododendron ponticum*. Thankfully, I have long experience of this plant (both physically and scientifically), and was able to thrash my way on through. It was worth it, because I encountered a large, well-hidden patch of a very strange evergreen with paired green buds, which eventually I identified as *Daphne pontica*, a first record for Scotland. Perhaps it had been planted here, but then long forgotten. The woods and Rhododendrons have been subjected to a major program of felling in the months since I visited, and I hope the *Daphne* survives. There is a lovely footpath through these woods back to the hotel grounds, but the footpath and the whole wood will be closed until these operations are complete, meaning you may need to walk back to the start along the roadside.

For any adventurous souls who would like to join me on this walk, I plan to repeat it as a BSS excursion on April 9th (see BSS field programme) to see at least the toothworts in flower.

Richard Milne, Edinburgh University

THE FLORA OF SOME SCOTTISH CEMETERIES

Cemeteries are oases of green space in urban areas and some English surveys have produced long lists of vascular plants found in them (Ferris 2000). They can also be important sites for lichens (Gilbert 2000), although this may be more so in rural churchyards. Cemeteries may be of historical interest, which may sometimes conflict with natural history issues. They are also very important places for families, where loved relatives are remembered, perhaps especially in more recent graveyards. Visits by families has often been associated with fairly intensive grounds cemetery management.

The surveys described here are of Scottish cemeteries in Easter Ross and the city of Dundee. This was part of the BSS Urban Flora Project and more information will be reported later.

Easter Ross**,**

This survey included 20 cemeteries in Easter Ross, these being most of those in the vice-county, but excluding the Black Isle. Twelve cemeteries were in rural areas and eight were in towns. They were visited on two occasions, once in the spring and once in the summer of 2020-2021, and all vascular plants, that did not appear to have been planted, were recorded. The same route round the main paths was followed during each survey. A similar study was carried out in 2012 (Ballinger 2014) when 18 of the same cemeteries were included.

Results for Easter Ross**.**

I recorded 153 species, 103 in urban cemeteries and 133 in rural cemeteries. Of these species, 85 were present in both urban and rural locations. The mean species count for each cemetery was 38.7, with a mean of 39.0 for rural, and 38.4 for urban cemeteries. There were 15 neophyte (alien) species, representing 9.9% of the total, with 12 neophyte taxa in rural sites and eight in urban.

The commonest species overall in Easter Ross were: *Taraxacum, Urtica dioica, Bellis perennis, Trifolium repens, Luzula campestris, Chamerion angustifolium, Galium aparine*, *Hedera helix* and *Ranunculus repens* (Table 1).

Table 1. Summary of species found in Urban and Rural cemeteries in Easter Ross and Dundee

	Urban Easter Ross	Rural Easter Ross	Dundee
Number of cemeteries	8	12	7
Number of species	103	133	175
Mean species per site	38.4	39.0	63
Neophytes	8 (7.7%)	12 (9.0%)	22 (12.6%)
Commonest species	*Taraxacum, Bellis perennis, Anthoxanthum odoratum*	*Taraxacum, Urtica dioica, Trifolium repens*	*Bellis perennis, Epilobium montanum*

Species of note in Easter Ross included *Crassula tillaea* (Mossy Stonecrop), which has been increasing on gravel in Easter Ross. *Viola tricolor* (Wild Pansy) was noted in one cemetery.

Saxifraga granulata (Meadow Saxifrage) was present in quantity in two urban graveyards. *Luzula campestris* (Field Woodrush) was remarkably widespread (16 cemeteries) and often present in quantity. *Montia fontana* (Blinks) was present in 11 sites; often on paths.Dundee Cemeteries**.**

Seven cemeteries in Dundee were visited twice, once in the spring and once in the summer of 2020-2021.The cemeteries varied greatly in size, from a small churchyard of approximately 100 sq metres to a site of approximately 25 hectares. On each occasion, the same circular route around the main path was followed, noting all vascular plants that did not appear to have been planted.

Result for Dundee**.**

A total of 175 species were recorded. The average was 63 species per site, varying from 25 in the smallest cemetery to 118 in one large cemetery. The commonest species, found in all seven Dundee cemeteries were *Bellis perennis, Epilobium montanum, Holcus lanatus, Ranunculus repens, Senecio vulgaris*, *Taraxacum*, and *Trifolium repens.*

Species of note included *Saxifraga granulata*, which was present in two urban cemetery sites where it had not been recorded before, although I suspect it had been there for many years. *Dactylorhiza fuchsii* (Common Spotted Orchid) was recorded in two locations, in some quantity in one. *Luzula campestris* was found in three cemeteries, with a count of many plants.

One hilly cemetery (Balgay) had some patches of *Potentilla erecta* (Tormentil) and *Galium saxatile* (Heath Bedstraw), suggesting a heath origin. Elsewhere there were good displays of *Leucanthemum vulgare* (Ox-eye Daisy) and *Lotus corniculatus* (Bird's-foot Trefoil).

Discussion**.**

The flora of these cemetery sites in Easter Ross and Dundee was limited compared with some English reports (Ferris 2000), although no doubt more would have been found with more extensive searches, and more frequent visits. Generally, the cemeteries appeared to be heavily managed, with frequent grass cutting and a liberal use of herbicides. There were few relatively wild corners, although Dundee cemeteries did have a few less intensively managed places than those in Easter Ross. In spite of this management, *Saxifraga granulata* was doing well in some urban cemeteries, probably helped by its early flowering time, low growth form and bulbil production. It is not at all common in the surrounding areas.

Luzula campestris was present in many cemeteries, often being frequent. Low growth and early flowering may be to its advantage and again it was not at all that frequent in nearby places outside the cemetery.

The lack of marked differences between urban and rural cemeteries in Easter Ross, may be related to heavy and similar management and, unlike most other urban rural comparisons, there was no preponderance of neophytes (aliens) in the urban cemeteries.

The situation in Dundee was slightly more favourable with a higher species count and some less intensively managed parts. In one cemetery (Birkhill) an area has been set aside for woodland burial and here there were flowery areas with *Dactylorhiza fuchsii*. The hill part of Balgay cemetery was also less closely mown. The greater diversity of the Dundee city cemeteries would fit with the suggestion that larger towns have higher species counts than smaller urban places (Grace 2021).

Elsewhere in Britain, areas in urban cemeteries have been set aside for conservation, and an example is Newington Cemetery in Edinburgh. The Glasgow necropolis is noted for its flora (Dickson 1991). Some English graveyards have been designated as local nature reserves (Goode 2014).

Some cemeteries are reported to hold important lichen and bryophyte populations in places, but I did not record these in this project. Unfortunately, tombstone cleaning takes place at times in Dundee, and historical studies may at times conflict with cryptogam preservation.

The main function of cemeteries is to preserve the memory of the deceased and this is very important for many families, especially with more recent burials. Many members of the public would not like to see burial sites overwhelmed with “weeds” and Councils bear this very much in mind with their management of these sites. However, there has probably been some change in public attitudes and a greater appreciation of the natural world. Although some “tidying up” will always be required, more attention to conservation and sensitive grass cutting would be helpful (Leaney and Walmesley 2013).

Brian Ballinger

Names of Cemeteries Studied.

Easter Ross: Alness, Balintore, Chapelhill, Croick, Dingwall Mitchell Hill, Dingwall St Clements, Edderton, Fearn Abbey, Fodderty, Kilmuir, Kiltearn, Kincardine, Logie Easter, Nigg, Tore, Portmahomack, Roskeen, Strathpeffer, Tain new, Tain old.

Dundee: Birkhill, Balgay, Barnhill, Eastern, Howff, St Peter’s, Western.

References.

Ballinger B. (2014) Some Man-made Habitats in Easter Ross. BSBI news 126 11-12.

Dickson (1991) Wild Plants of Glasgow. Aberdeen University Press, Aberdeen.

Ferris (2000) The Flora of the City of London Cemetery. Wanstead Wildlife. Report.

Gilbert O. (2000) Lichens, New Naturalist Library HarperCollins, London.

Goode D. (2014) Nature in Towns and Cities. New Naturalist Library HarperCollins, London.

Grace J. (2021) Personal communication.

Leaney B. Walmesley A. (2013) Lowland Churchyard Wildflower Conservation. British Wildlife 25 151.

VENTURING INTO THE FIRE ZONE OF CALIFORNIA'S CZU LIGHTNING COMPLEX FIRE:

The Destruction and Rebirth of Nature

In August 2020 a storm off the Pacific Ocean broke loose along the central California coast. No rain fell, but more than 11,000 lightning strikes materialised over the sea and the Santa Cruz Mountains south of San Francisco. Because the 2020 storm occurred in the summer months of California's notoriously dry Mediterranean climate, the landward lightning strikes started hundreds of fires throughout the Santa Cruz Mountains. Individual fires were soon burning out of control, rapidly coalescing into the CZU Lightning Complex Fire, the 12th largest wildfire in the state's history. Despite firefighters' efforts to extinguish the flames, the fire burned for 37 days over 86,509 acres (35,009 ha), destroying 1490 homes and structures, and damaging the forests and infrastructure of California's first state park, Big Basin, originally created to preserve stands of old growth coast redwoods some of them over 300 ft (91m) tall and over 2000 years old. In early September, as the fires continued to burn, temperatures soared as high as 111°F (43.89°C) exacerbating efforts to fight the fire. The flames were finally declared contained on 22 September, but over the winter and spring months small fires continued to erupt within smouldering stumps making the fire zone too hazardous to enter.

Although central California shares a similar average annual rainfall with Scotland, the state has a Mediterranean climate in which most rain falls from November through March, leaving the remaining months dry. As a result, fires are a natural part of an ecosystem with fire adapted species (what Californians call "fire-followers) that depend on periodic fires to release seeds or activate epicormic buds. The increase in ferocity of the disastrous fires over the past few years has been attributed to several factors. Firstly, decades of fire suppression have allowed fuels to build up, heightening the intensity of wildfire flames that burn into forest canopies instead of merely creeping along the forest floor. Before the 1849 Gold Rush, California's forests contained approximately 50 to 70 trees per acre, but today that number has increased to 400 trees per acre allowing the recent mega-fires to burn through thick, normally resistant bark on trees such as redwoods, and to kill dormant seeds within the soil.[1]

Another reason for recent conflagrations is the change in regional climate. Each year the west is experiencing less rain and longer heat waves with higher temperatures. These combined with fire suppression and a freak lightning storm created the "perfect conditions" for a disaster, as some fires now burn through the coast redwoods' fire-resistant bark, and climb the trunks and crown-out, igniting forest canopies and dropping more fuel on the forest floor.

A third reason for the increase in California wildfires is the encroachment of people and homes into the wildland-urban interface (WUI). In California, 95% of wildfires are deliberately or accidentally set by humans. Even with a defensible space of 30-100 ft around a house, fires can still spread to a structure via flying embers. Houses in these areas put pressure on firefighters to save homes rather than stopping fast-spreading fires.[2]

My own house, built on land bought by my grandparents in 1921, is two miles southeast of the CZU Lightning Complex Fire zone in a mixed woodland of coast redwood, coast live oak, madrone, ponderosa pine, and chaparral. Four miles to the south along the San Lorenzo River is the location where Archibald Menzies collected the holotype of *Sequoia sempervirens* in 1793. During the 2020 fire the neighbouring town of Scotts Valley was a staging ground and evacuation centre, the parking lots filled with cars and campers of people evacuated from the fire zone. As the fires continued to expand and coalesce, the smoke became so thick that it was dangerous to go outside without a mask and the entire town was on evacuation alert. The sky glowed orange and ash rained down accompanied by burned leaves of tan oak, madrone, coast redwood, and Douglas fir. Fortunately, none of the smouldering leaves that landed on our house caused a fire. A hive of honeybees that has lived in a ponderosa pine downhill from the house, for as long as I can remember, retreated into their hive, not emerging until well after the fire stopped.

While on evacuation alert we kept the house and yard watered down to prevent the occasional wind-driven spark from igniting the roof and the trees. At the height of the fire, we were told to leave and so drove south to my brother's house in East Garrison. However, getting there was like jumping from the frying pan into the fire, as the nearby Camel Valley River Fire was also raging with many fire trucks and helitack choppers dumping water on the fire. Fortunately for us, the River Fire shifted course and we stayed for two weeks until the all-clear to return home.

Although this experience was stressful it was nothing compared to the experiences of my friends who lost their houses, or to the plight of birds and mammals (mountain lions, deer, bobcats, fox, and coyotes), that fled or perished in the fires, and are now living near our neighbourhoods (much to the cautious delight of the local people). Some people that lost their homes have left the county while others are starting to rebuild their homes after removing post-fire hazards of falling trees and toxins within burned construction materials. Curious to see how the forest had fared I drove up the coast from Santa Cruz to the newly reopened Swanton Road loop. This road passes through one of only five native *Pinus radiata* (Monterey pine) forests, as it works its way inland through the west slope of the Santa Cruz Mountains and the edge of the CZU Lightning Complex Fire zone. The damage was heart-breaking – but at the same time encouraging. The fog was thick along the coast, which added to the mood. Burned trees and occasional burned houses lined the road, with the hazard trees actively being cleared and stacked by recovery crews. The first rains of the season had only just begun, and I was heartened to see that surviving coast redwoods, willows, madrones, and oaks were already summoning what strength they had to send up new shoots.

The following April I was able to venture into the fire zone itself and drove to Ben Lomond and up Alba Road (several towns and geographical features in this area were named after places in Scotland by the early settlers: Rowardennan, Ben Lomond, Bonny Doon, Alba Road, St Andrews, Bracken Brae, and Highland Park to name a few). The road climbs up from the San Lorenzo Valley into the Santa Cruz Mountains twisting and turning through forests of coast redwood, tan oak, madrone, and Douglas fir. I had driven up this road many times over the years to reach a trailhead or to go for a leisurely Sunday afternoon jaunt, but I did not recognize a thing. The entire forest was burned; with standing and fallen blackened trees and black and brown madrone and tan oak leaves carpeting the forest floor. Tree-cutting crews with heavy machinery were clearing hazardous deadwood reducing the road to one lane. About halfway up Alba Road, I passed the spot where the little red Alba Schoolhouse, the last remaining one-room school in Santa Cruz County built in 1895, once stood. I drove right past without recognizing the location within all the stacked logs and trucks on site. Proceeding up to Empire Grade I passed hundreds upon hundreds of burned trees and places where houses once stood, burned redwood water tanks, burned cars – simply overwhelming.

Turning north on Empire Grade, I drove past the local Christmas tree ranch. Its openings were filled with tiny, burned trees and piles of shredded wood from those that were being chipped. I continued driving north to the old Locatelli Ranch and winery, its buildings entirely gone. Towering to the east Eagle Rock at 2488 feet (758m), the location of a former pre-satellite fire lookout station, was visible, the knobcone pines and manzanita on its flanks burned to skeletal outlines of their former selves.

But then, looking down I noticed that the meadows below Eagle Rock were green with newly sprouted annual grasses, orange California poppies and sky-blue lupine. The rocky outcrops of the road cuts were covered with *Dichelostemma capitatum ssp capitatum* (bluedicks), which had dried back to their underground corms before the fires hit, and patiently waited for the winter rains to come.

Plant species in California have adapted over millennia to recurring fires. Some species such as the coast redwood have epicormic buds embedded in their bark with a "strand" connection to the pith that increases in length as the tree's diameter grows. When conditions are right, such as after a fire, drought or logging, the buds sprout at the tree's base, along its trunk and on the branches. Few of us who live near 2020's fires realised how rapidly these sprouts would help the redwood forest to heal. Some of the trees, thoroughly blackened after the fire, almost immediately began to sprout at the base as had so many of the old growth (ancient woodland) coast redwoods that were harvested in the 19th and 20th centuries. In these old stands you can still see huge 100-year-old redwood stumps encircled by clones that are now hundreds of feet tall.

I returned to the fire zone six more times throughout the summer and autumn of 2021. The year 2020-2021 would turn out to be another drought year in California, but despite the severe lack of water, the forest continued to recuperate. During these summer forays, I observed our native *Cirsium occidentale* (red thistle) a thistle I had never observed before!) in full bloom, as well as blooming *Asyneuma prenanthoides* (California harebell). In the autumn the red blossoms of *Epilobium canum* (California fuchsia) appeared along west-facing road cuts attracting hordes of pollinators and hummingbirds. Meanwhile the blackened coast live oak, tan oak and madrones throughout the zone continued to base sprout to more than 6 feet (1.8 m) in a matter of months. At the site of the old Alba schoolhouse, I recorded one specific coast redwood that had sent up a base sprout next to its burned stump within a month after the fire. In the first photo of the shoot taken on 17 April 2021, the sprout was 6 inches. In June it had grown to 30 inches, and by October it measured 60 inches! Although I was able to observe the survival of so many of our California native plants through sprouting, seeding, or the presence of underground corms and bulbs that escaped the heat of the fire, I was curious as to how the non-native "invasive" plants, had fared after the fire, many of them being generalists able to outcompete native plants. One of these generalists was *Lathyrus latifolius*, (everlasting pea) that appeared to be doing well in sunny locations, having sprouted from its rhizomes among the native *Eriodictyon californicum* (yerba santa) and *Solidago elongata* (west coast Canada goldenrod). Also appearing after the fire were *Cirsium vulgare* (spear or "bull" thistle); *Brassica nigra* (black mustard), native to Scotland; *Rhaphanus sativus* (wild radish), casual in Scotland; *Amanita muscaria* (fly agaric); *Avena fatua* (wild oat) an archaeophyte in Scotland; and *Hedera helix* (English ivy).

In addition to the plants, native birds and wildlife are returning to the mountains. Badly burned forestlands cleared of their overstories now allow sunlight onto the forest floor encouraging growth of herbs, grasses, and regenerating chaparral that provide food for the returning fauna. Reptiles and amphibians such as lizards, skinks and salamanders have gradually emerged from the deep organic matter where they had buried themselves while the fire passed. Over the next ten years, herbivores and their predators are expected to increase in number. However, as the fire's dead trees fall and the shrubs grow higher, the fire cycle will begin anew.[3]

<u>Tree species affected by the fire include</u>:

Sequoia sempervirens (Coast redwood) Coast redwoods are fire resistant. Many of the older trees of the redwood region are cloaked with burned bark and scars dating back hundreds of years and have hollowed out caverns and tunnels in their trunks. The name *sempervirens* is apt, the trees can live through several fires and live to tell the tale with their scars and charcoal bark. The last fire to pass through our property occurred in 1929 singeing the redwood trunks that are still blackened to a height of 15 feet (4.9 m).

The fear for California's redwoods is that climate change, drought and fires may cause the loss of southern populations of coast and Sierra redwoods. A ray of hope for these species lies in ex-situ populations, holding pockets of living genetic material from California groves. In Scotland alone, the Scottish Redwood Trust has documented over 3400 Sierra redwoods and over 900 coast redwoods, many of them located on 19th century estates.[4]

Pinus attenuata (knobcone pine): Knobcone pine stands are scattered in chaparral and ridgetops throughout the Santa Cruz Mountains. The trees have adapted to fire and their serotinous cones are so well insulated that the charred cones protect the seeds inside. After high temperatures the cones open releasing their seeds to fall into mineral and ash permeated soil. Although the 2020 fire missed the knobcone pines that grow on the ridge above my family's property, the 1929 fire did kill the trees. Today I can see the 98-year-old conifers, which sprouted after that fire, still waiting for the next fire to open their cones and scatter their seeds.

Arbutus menziesii (Madrone): A member of the heath family, *Ericaceae*, and named after Archibald Menzies, these magnificent, red-barked trees are found throughout the fire zone. Hundreds of madrones were burned so badly in 2020 that they did not survive above the soil line, but since then many have sprouted from the base, as have the tan oaks (*Notholithocarpus densiflorus*) and the coast live oaks (*Quercus agrifolia*).

Pseudotsuga menziesii (Douglas fir): Another tree named after Archibald Menzies and David Douglas, Douglas fir is a component of the mixed conifer forests of the Santa Cruz Mountains. Many more fir trees died in the fire, than did coast redwoods. Fir bark is covered with a sticky sap that ignites easily causing flames to race up the tree crackling and sparking into the canopy.[5]

Pinus ponderosa (ponderosa pine): Ponderosa pines are residents of the area's inland marine sandhills. After visiting the sandhills, Dr. Peter Raven, President of the Missouri Botanical Garden said, "From a global perspective, the Sandhills are important because of their remarkable concentration of biodiversity. Because of the patchy nature of the habitat, which resembles an archipelago, I once called it the Galapagos Island of Santa Cruz County, which, if anything, understates its global significance." Ponderosa pine is the predominant tree here and historically the sandhills experience ground fires on average every 25 years.

Cupressus abramsiana (Santa Cruz Cypress): This endangered tree is also a resident of the inland marine sandhills. Requiring fire to open its cones, the species flourishes with fires occurring 50-100 years apart. The question is what impact will more frequent, longer, and more intense fire seasons have on this tree's future?

Looking back on the fire, despite the forest's resilience I feel a great sense of sadness. The mountains I grew up knowing so intimately will never be the same in my lifetime. Forty or fifty years from now when the new seedlings grow taller and the foliage of the redwoods that survived fills in again, they may begin to resemble what they once were, but I will not be here to witness it. Hopefully Californians can face the fires of the future with more wisdom and better management than we have in the past. Since the fire, work cleaning up the fire zone and Big Basin State Park's destroyed facilities has continued. It will be some time before the public are allowed into the park.[8]

Sam Hodder, president of Save the Redwoods League, has said, "The trees themselves will tell about resilience and recovery and the broader California landscape … While this is a difficult and heartbreaking situation to be in, it does give us an opportunity to think about doing things differently, that takes into consideration climate resilience and acknowledges that fire is an inevitable inhabitant of this landscape".[9]

Peggy Edwards
BS Environmental Studies, University of California, Berkeley
Graduate Certificate Natural Science Illustration, University of California, Santa Cruz
California Teaching Credential, University of San Francisco
Former USFS Field Botanist and Naturalist
pegedwards@sierranatureprints.com

References.

[1]Dicus, Christopher Ph.D (2009). *Fire on the Landscape, current policies and a changing climate lead toward higher costs, more severe wildfire,* California Forests, Volume 13 Number 2, pp 16-17

[2]Kelly, Hazel, *Understanding Fire*. The California State University. calstate.edu/csu-system/news/Pages/understanding-fire.aspx

[3]*Fire Safe - Inside and Out*, booklet & video available from the California Department of Forestry and Fire Protection, P.O. Box 944246, Sacramento, CA 94244 (916) 653-5123

[4]The Scottish Redwood Trust. scottishredwoodtrust.com/

[5]Hayes, Grey (2021) *Post Fire Early Winter Mixed Conifer Forest*, A Community for Nature greyhayes.net/a-community-for-nature/

[7]Raven, Peter (2013) *Endemic, rare and unique species of the Santa Cruz Sandhills Land.* Land Trust of Santa Cruz County, Santa Cruz, California. landtrustsantacruz.org/downloads/sandhills_species.pdf

[8]Rogers, Paul (2021). *Big Basin Redwoods: One year after devastating fire,* The Mercury News. mercurynews.com/2021/08/12/big-basin-redwoods-one-year-after-devastating-fire-burned-wreckage-cleared-rebuilding-planning-just-starting/

[9]Mendoza, Martha (2021). *Resilient redwood forest a beacon of hope for California.* APNews apnews.com/article/wildfires-forests-trees-coronaviru-pandemic-fires-eb9af87f8e802031c22fc4a7b651071a

ARE THERE WILD PLANTS ON CAR PARKS?

Car parks are everywhere in this era of the automobile, and most botanists use them regularly. They are not usually regarded as wildlife sites but may perhaps be seen as arising from a cross between pavements and roads. I have often felt that many of the plants we are looking for are within 100 metres of the carpark and this project sought to see what could be found even closer to the tarmac. A secondary aim was to compare urban and rural car parks.

Car parks present a challenging habitat for plants, as they are subject to management in the form of herbicides and cutting, as well as crushing, trampling by vehicles and feet, and pollution.

Methods.

Two visits were made to each of 10 urban car parks in small towns in the Tain and Invergordon area of Easter Ross, and 10 rural car parks in the surrounding countryside. One visit was to each car park in summer 2021 and one in winter 2021 and, on each occasion, I walked around the edge of the car park and any central reservations, noting any plants growing on the hard surface or within one metre of the parking area. All vascular plants that were identifiable and appeared not been planted were recorded.

Results.

The urban car parks yielded an average of 14.5 (range 10-22) species in winter, rising to 19.9 in summer (range 6-36). The rural car parks recorded an average of 15.2 (Range 5-24) species in winter, rising to a mean of 21.3 (range 9-40) in summer. There was evidence of active summer management on some car parks, especially in the towns.

A total of 151 species was recorded in all, 99 in urban car parks and 117 in rural, with 65 of the same species seen in both urban and rural settings (Table 1). The commonest urban species were *Bellis perennis* (Daisy), *Dactylis glomerata* (Cocksfoot), *Poa annua* (Annual Meadow Grass), *Senecio vulgaris* (Groundsel) and *Taraxacum sp.* (Dandelion). The commonest rural species were *Dactylis glomerata, Holcus lanatus* (Yorkshire Fog), *Poa annua, Plantago major* (Greater Plantain) and *Urtica dioica* (Common Nettle). As in other studies, alien species (neophytes) were commoner in urban sites, where 14 different species were found, as opposed to six in urban car parks.

Table 1. Comparison between the number of species in rural and urban car parks in winter and summer.

	Winter	Summer	% increase from winter to summer
Urban mean species per site	14.5	19.9	37%
Rural mean species per site	15.2	21.3	40%

'Notable' species (nationally or locally scarce or Red Data Book) recorded only in the rural car parks, included *Astragalus danicus* (Purple Milk-vetch*), Blackstonia perfoliata* (Yellow-wort*), Crassula tillaea* (Mossy Stonecrop*), Sagina maritima* (Sea Pearlwort) and *Spergula arvensis* (Corn Spurrey*)*.

Conclusion.

This study shows that some wild plants manage to survive in the challenging habitats of car parks, which may provide a refuge for notable species. As in other settings, the species lists differed considerably between urban and rural sites, reflecting habitat and management differences. Some of the rural sites were on the edge of wild land and this was reflected in the species lists. The urban lists were similar to the species lists from surrounding pavements and roads. A survey in urban Dundee is yielding similar results.

I conclude that there is some botanical interest to be found particularly in rural car parks, although it is usually best to also look at the surrounding area. This is reassuring to those of us who may be becoming less agile with the passing of the years!

Brian Ballinger

ABSTRACTS OF BSS STUDENT DISSERTATION SUBMISSIONS

The standard of theses submitted in 2021 by university supervisors for the BSS prize was very high again this year and we were very pleased to receive five nominations. Two theses were awarded equal first prize as it was not possible to decide between them. The winners were **Francisco Navarro Rosales** from University of Edinburgh and **Holly-Anne Turner,** also from the University of Edinburgh. In addition to the summary given here with the other abstracts, Francisco also very kindly sent us a longer report on his study (see page 31).

VEGETATION PATCHES IN SEMI-ABANDONED OLIVE GROVES ARE IMPORTANT RESERVOIRS OF WOODY PLANT SPECIES RICHNESS

Francisco Navarro Rosales. Awarded equal first prize
Degree Course: *Honours in Ecological and Environmental Sciences with Management*
Submitted by Caroline Nichol University of Edinburgh, *Chair of the Board of Examiners.*

Many mountain olive groves in Spain have experienced some degree of neglect in recent years, yet research into the ecology of these semi-abandoned, patch-like systems remains scarce. I studied the woody vegetation at three semi-abandoned olive groves in Sierra Morena de Córdoba, focusing on the effect of patch area on woody plant species richness and composition. I sampled a total of 154 vegetation patches in the summer of 2020, recording a total of 15,863 woody plants belonging to 50 species and 22 botanical families. I then examined the relationship between patch size and species richness and turnover in species composition among patches. I found that surrounding habitat quality and vegetation history impacted the nature of the species-area relationship. I also found there was significant species turnover across sites and with patch area, and that the probability of finding all sampled species increased with area. I then related the observed patterns to differences in commonness, life form and dispersal mechanisms, as well as differences in species-specific abundances across patch area. This study provides insight into the potential impacts of grove abandonment on landscape management and conservation.

DID THE LEAVES OF *ASTEROXYLON MACKIEI* DEVELOP IN A REGULAR PHYLLOTAXIS?

Holly-Anne Turner. Awarded equal first prize *Honours in Plant Sciences*
Submitted by Sandy Hetherington, University of Edinburgh

The early Devonian Rhynie chert fossil collection is known to contain the greatest diversity of freshwater and terrestrial plants and animals of its age anywhere in the world, and is invaluable in discerning the evolution and ecology of early life on land. The first ever digital 3D reconstruction of a leafy side-branch from Rhynie lycopsid *Asteroxylon mackiei* completes the full *Asteroxylon* body-plan reconstruction and allows for the collection of quantitative data on leaf arrangement (phyllotaxis). The reconstruction reveals a shoot meristem, a secondary bud, an unstalked sporangium and a regular arrangement of leaves organised into orthostichies. This investigation cements *Asteroxylon's* place as a stem lycopsid within the Drepanophycales and pushes the timeline of phyllotactic evolution in microphylls further back in the evolution and establishment of Embryophyta as a terrestrial presence.

REGENERATION OF NATIVE TREE SPECIES ON A SITKA SPRUCE CLEAR-FELLED SITE IN WESTERN SCOTLAND

Agathe Stoffel *Honours in Environmental and Forest Management*
Submitted by Sarah Woodin, University of Aberdeen

There is increasing focus on transforming exotic conifer monocultures into more natural woodlands of higher conservation value. This study investigated the use of natural regeneration to transform a clear-felled Sitka spruce plantation into a semi-natural woodland, at Whinnyhill Wood, Renfrewshire. The aims were to investigate the effects of environmental factors on seedling distribution across the site and to predict what National Vegetation Classification woodland community would establish. Field survey showed birch to be dominant across the site, with a high seedling density which was positively correlated to soil moisture. Sitka spruce and birch seedling densities were both negatively correlated to the distance from the remaining plantation woodland. The ground vegetation and soil predicted W11 and W17 woodland communities, known as

Atlantic oakwoods. This was confirmed by Forest Research's Ecological Site Classification tool. Atlantic oakwoods are a protected habitat with a highly fragmented distribution; their restoration is a priority. Whinnyhill Wood has good potential to regenerate into an Atlantic oakwood as the climate, soil and vegetation are characteristic of these habitats. This study helped improve Whinnyhill Wood’s management plan by suggesting required actions, including the planting of Sessile oaks, as they were absent from the site, and the removal of rhododendron.

MULTIPLE VALUES OF ARABLE WEEDS WITH REFERENCE TO ECOSYSTEM SERVICES

Ellie Guillonneau *Honours in Conservation Biology*
Submitted by Louise Ross, University of Aberdeen

The intensification of farming is causing severe global biodiversity loss, with arable plant species being among the worst affected. The conservation and management of such landscapes is complicated due to the overlapping niches that each species fills, meaning that policy-makers must be able to implement a fully inclusive framework that protects and optimises the functioning of ecosystems that also considers the economic, conservational and cultural implications.

In this investigation, I quantify the contributions of 61 arable weed species to provisioning (edibility and medicinal), cultural, (presence in poetry), supporting (presence in bird diet and links with invertebrates), and conservational (rarity and population change index) services. Overall, I find that some ecosystem services are underpinned by a few dominant species and other services are supported by many of the species equally. In addition, some species are dominant in multiple ecosystem services whereas others may only contribute to a single ecosystem service. This investigation demonstrates the importance of the multi-level measurement of ecosystem services, explores how this framework can be implemented, and the possible challenges associated with the trade-offs and synergies between the services.

A CASE STUDY ON THE IMPORTANCE OF INFORMING MANAGEMENT STRATEGIES BY INVESTIGATING FORMER BIODIVERSITY OFFSETS

Lilian Wadle *Honours in Conservation Biology*
Submitted by Jennifer Dodd, Napier University

Whilst new energy developments secure the delivery of sustainable energy, ecosystems must be destroyed to accommodate the growing energy-grid. Mitigation strategies such as offsets, aim to lower the environmental impact of construction projects and determine appropriate measures to compensate for any ecosystem damages, although many mitigation strategies are neither supported by science nor properly monitored with eminent uncertainties about their success rates. This study investigated if mitigation measures successfully compensated for the permanent habitat loss caused by a new power line corridor in the north of Scotland. Multiple aerial Phase 1 Habitat Surveys were performed of the development/offset sites before and five years after the construction. Furthermore, Biodiversity Units (BU) were calculated to see if there was a net-loss in biodiversity followed by non-parametric statistical analyses. The mitigation measures could not mitigate the biodiversity loss due to insufficiently sized offset areas. Moreover, only 13.51% of woodland has been compensated and overall, there was a total net BU loss. This supports the consensus that modern mitigation strategies are limited by theoretical knowledge and practical capabilities. The uncertainty of offsets could be improved by more long-term monitoring to inform management strategies combined with better stakeholder communication and enforced regulatory frameworks.

VEGETATION PATCHES IN SEMI-ABANDONED OLIVE GROVES: THE EFFECT OF AREA ON RICHNESS AND COMMUNITY COMPOSITION OF WOODY PLANTS.

Thesis awarded joint first prize 2021

Supervisor: Dr Matthew Bell, The University of Edinburgh

Here I have presented a summary of my bachelor's dissertation project, which I completed over my last year and a half at The University of Edinburgh. I would like to thank the BSS for awarding the prize, and for inviting me to write this article for publishing in the newsletter. I would also like to encourage the readers to contact me, using the details provided below, if there are any doubts or questions about my work. I will happily provide more information upon request.

<u>Introduction.</u>

Since the mid 20th century, European countries have become urbanised (Blasi et al., 2000). Demographic change has been particularly evident in olive-producing regions of Southern Spain, where the rural population is aging and traditional olive cultivation has almost disappeared (Rallo, 2007). As olive groves are abandoned, they become indistinguishable from the surrounding shrubland (Blasi et al., 2000). These recently forested areas provide ecosystem services such as increased carbon sequestration and habitat provision for wildlife, but they can also become less accessible and more fire prone (Allen et al., 2006).

To avoid complete land abandonment, some landholders in the Sierra Morena de Córdoba (Southern Spain) have been actively maintaining an open vegetation structure in marginal mountain olive groves. Here, the open habitat structure is maintained by ploughing the spaces between the olive trees and by introducing grazers. Since ploughing and grazing pressure has been moderate, patches of vegetation have developed around the olive trees.

The existence of distinct vegetation patches within partially abandoned olive groves provided a unique chance to study the plant community within these landscapes, as well as an opportunity to examine key ecological relationships. Therefore, in my dissertation, I investigated the relationship of area with richness and composition of woody species, focusing on three semi-abandoned groves in Sierra Morena de Córdoba, Southern Spain. I hypothesised that richness of woody plants should increase with patch size, since larger patches receive more incoming dispersal from adjacent areas and can sustain a wider range of microhabitats, being more likely to support more species than smaller patches (Hart & Horwitz, 1991). I also expected there to be turnover – changes in community composition – across area, as larger patches represent forest-like environments that should support more woodland-adapted plants (Andivia, 2017).

Methods.

I studied three traditional mountain olive groves (*La Soledad, Las Niñas and Piquín*) at Sierra Morena de Córdoba, Spain. Until the 1990s, the groves were dedicated to olive oil production. The sites have then been intermittently ploughed and grazed by sheep and cattle, so vegetation patches have developed around the olive trees. The three study sites are relatively flat, and have limestone rock and Mediterranean climate.

I sampled the woody vegetation within the three groves in July 2020. I selected about 50 patches within each grove following a random stratified approach based on work by Hong et al. (2007). Patch area ranged from about 0.25 to about 250 m^2. I identified all individual woody plants and recorded the abundance of species within each of the sampled vegetation patches using the guide "Flora Vascular del Término Municipal de Córdoba" (López Tirado, 2018). Finally, I interviewed site managers and reviewed the database of historical aerial photographs (CNIG, 2021) to understand the sites' management history.

I analysed my data using R Statistical Software (R Core Team, 2020). I examined the relationship between area and species richness by building exponential (Gleason, 1922) and power (Arrhenius, 1921) models. Building exponential models involves log-transforming area, whilst creating power models requires logging both area and species richness. I studied changes in community composition across area using generalised linear mixed models with presence-absence data. This is a new approach developed by Shutt et al. (2020) which allows us to investigate changes in the presence of many species along a gradient.

Results.

In the sampled 154 vegetation patches across the three groves, I recorded a total of 15,863 individual woody plants and identified a total of 50 species belonging to 22 families (Table 1). Overall, the four most common and abundant species were *Rubus ulmifolius* Schott, *Viburnum* *tinus* L., *Smilax aspera* L. and *Asparagus acutifolius* L.. The three least abundant and common species were *Castanea sativa* Mill., *Crataegus monogyna* Jacq. and *Prunus dulcis* (Mill.) Webb.

Table 1, list of sampled species and their taxonomic families, according to López-Tirado (2018)

Family	Species	Family	Species
Pinaceae	*Pinus pinea* L.	Fabaceae	*Ononis spinosa* L.
Lauraceae	*Laurus nobilis* L.		*Retama sphaerocarpa* Boiss
Fagaceae	*Castanea sativa* Mill.	Thymelaceae	*Daphne gnidium* L.
	Quercus coccifera L.	Santalaceae	*Osyris alba* L.
	Quercus ilex L.	Rhamnaceae	*Rhamnus alaternus* L.
	Quercus suber L.		*Rhamnus oleoides* L.
Ulmaceae	*Celtis australis* L.	Anacardiaceae	*Pistacia lentiscus* L.
	Ulmus minor Mill.		*Pistacia terebinthus* L.
Moraceae	*Ficus carica* L.	Rutaceae	*Ruta montana* L.
Cistaceae	*Cistus albidus* L.	Meliaceae	*Melia azedarach* L.
	Cistus crispus L.	Lamiaceae	*Calamintha nepeta* (L.) Kuntze
	Cistus ladanifer L.		*Lavandula stoechas* L.
	Cistus salviifolius L.		*Marrubium vulgare* L.
	Halimium umbellatum Spach		*Origanum vulgare* L.
Capparaceae	*Capparis spinosa* L.		*Phlomis purpurea* L.
Ericaceae	*Arbutus unedo* L.		*Teucrium fruticans* L.
	Erica arborea L.		*Thymus mastichina* L.
Rosaceae	*Crataegus monogyna* Jacq.	Caprifoliaceae	*Lonicera implexa* Aiton
	Prunus domestica L.	Adoxaceae	*Viburnum tinus* L.
	Prunus dulcis (Mill.) Webb	Asteraceae	*Dittrichia viscosa* (L.) Greuter
	Rubus ulmifolius Schott		*Helichrysum stoechas* (L.) DC.
Fabaceae	*Adenocarpus telonensis* DC.		*Phagnalon saxatile* L.
	Coronilla juncea L.	Smilacaceae	*Smilax aspera* L.
	Cytisus scoparius (L.) Link	Liliaceae	*Asparagus albus* L.
	Genista hirsuta Vahl		*Asparagus acutifolius* L.

I found that richness of woody plants had a strong positive relationship with patch area, and that the nature of this relationship at each of the three groves could be adequately modelled by log-transforming both area and species richness (Figure 1). This means the species-area curves at the three groves can be approximated to the power model, which was proposed by Arrhenius in 1921.

However, the species area-curve at one of the groves (*La Soledad*) could also be assigned to the exponential model proposed by Gleason in

1922, and this suggests site-related factors are affecting the dynamics between patch area and species richness.

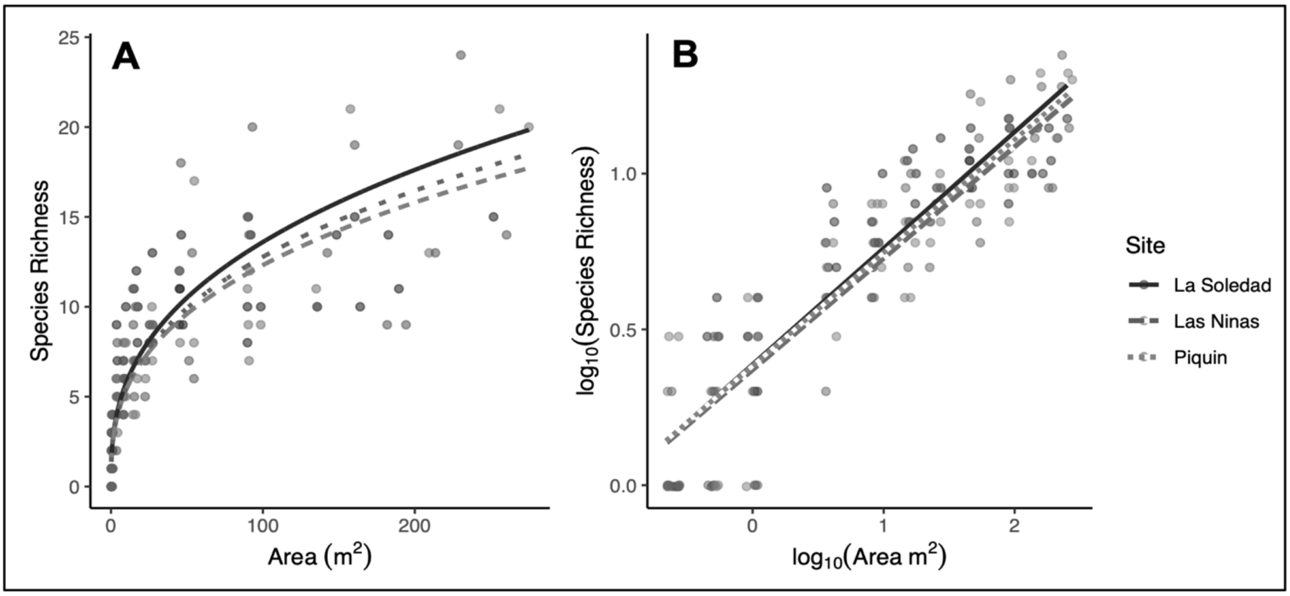


Figure 1, representation of the power species-area curves for the woody patch vegetation within the olive groves. **A**) power species-area relationships on the raw scale. **B**) relationship between log-transformed species richness and log-transformed area at all three groves. There were no significant statistical differences between the three curves.

(Continued on page 39)

Captions to photos on pages 35 & 36: All photos: Peggy Edwards. See **Venturing Into The Fire Zone Of California's Czu Lightning Complex Fire** page 17.

Page 35, 1. *Arbutus menziesii* (Madrone) Burned Tree & Sprouts.

Page 35, 2. *Sequoia sempervirens* (Coast Redwoods) SESE Base Sprouts Alba Road

Page 36, 3. *Cirsium vulgare* (Spear Thistle) & *Cirsium occidentale* var. *venustum* (Red thistle).

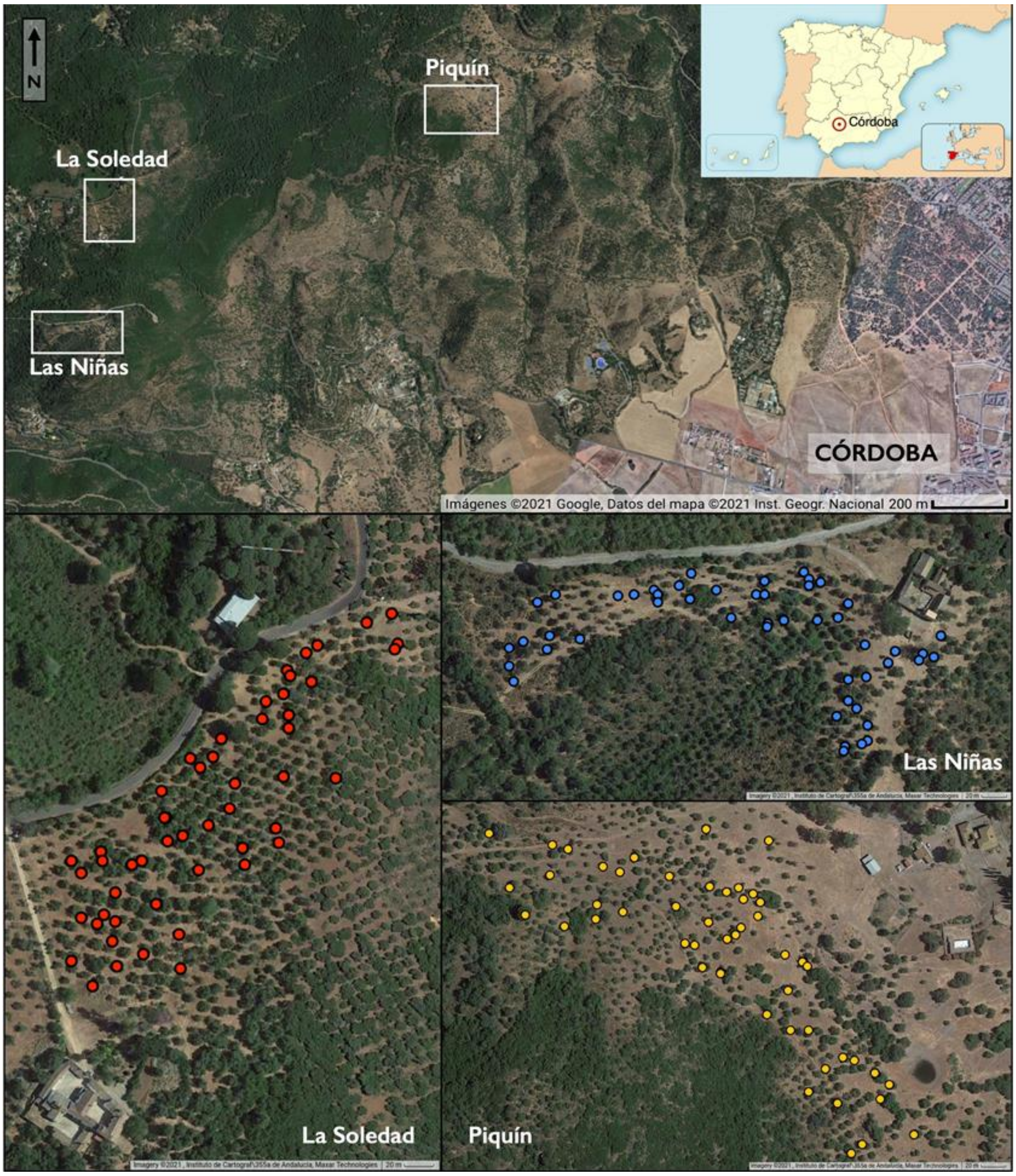
Page 36, 4. *Amanita muscaria* (Fly Agaric).


1


2

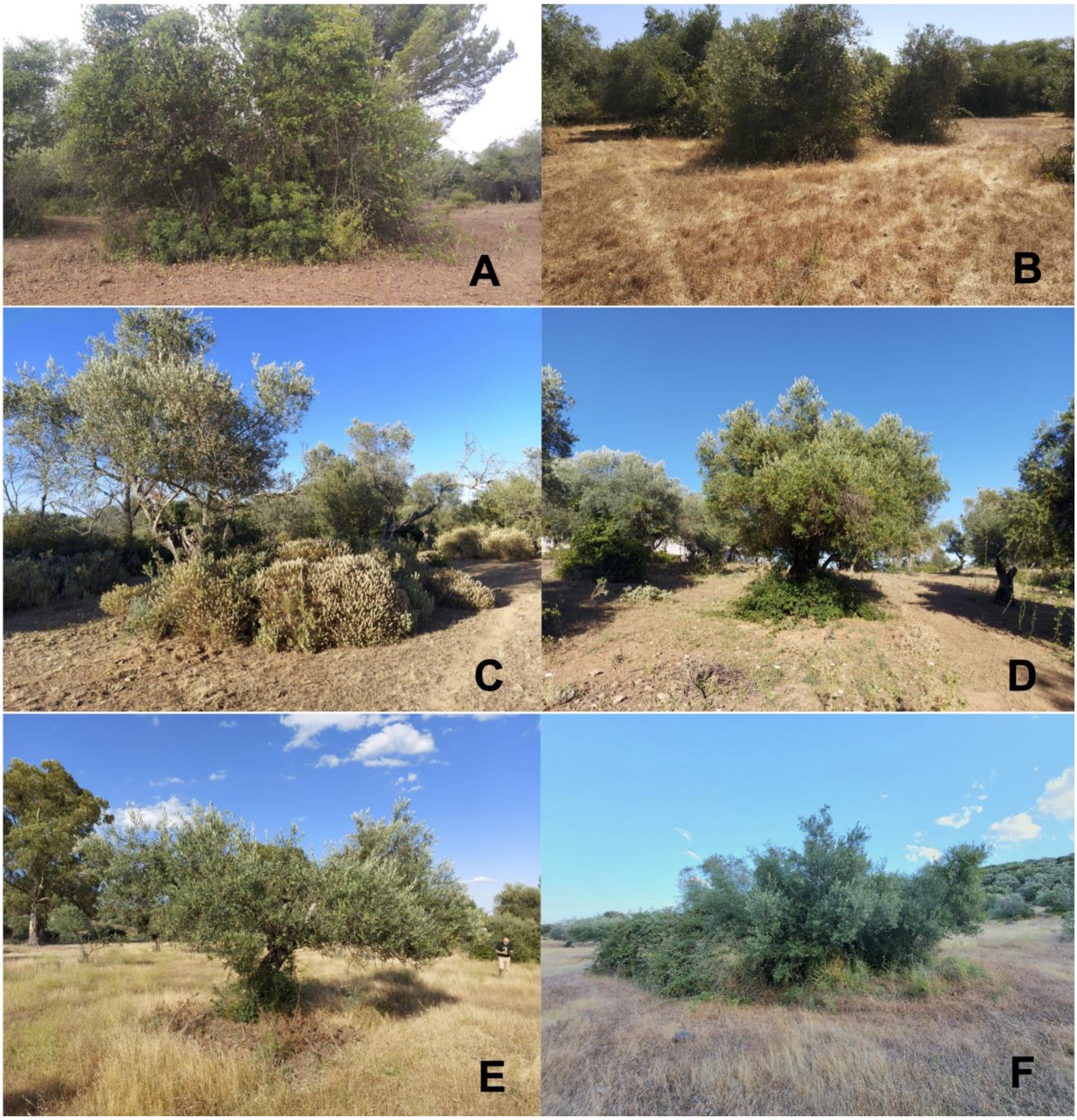

3


4



Sampling map. Location of the study sites with respect to the city of Córdoba in Southern Spain (top) and distribution of the sampled vegetation patches within each of the groves (bottom). The map images were obtained from Google Maps (2021), and Wikimedia Commons (2010). Aerial images and coordinate locations for each grove were obtained using Maps.co (2021).

See **Vegetation Patches in Semi-Abandoned Olive Groves** page 31.



Patches example. Example images of vegetation patches surrounding olive trees at partially abandoned groves in Sierra Morena de Córdoba, Spain (July 2021). A-B) La Soledad. C-D) Las Niñas. E-F) Piquín.

See **Vegetation Patches in Semi-Abandoned Olive Groves** page 31.

There appeared to be a difference in woody species composition from one site to another (Figure 2), and there was significant turnover of woody species as patch area increased. Area-related changes in composition were characterised by the gain of species with area (Figure 3), and this was observed both as a general and site-specific trend.

Discussion.

I found that log-transformed species richness varied linearly with log-transformed area, following the function proposed by Arrhenius (1921). According to these functions, patches of 250 m^2 supported about 5.5 times more richness than patches of 2.5 m^2. Curves were also statistically similar across all three sites. This means the influence of alternative factors on richness is likely minimised by all three groves having similar climate, geology, soil type and management history. The results are also consistent with species-area patterns observed within other agricultural and Mediterranean ecosystems (Pausas et al., 1999; Keeley, 2003; Pardo et al. 2003; Cristaudo et al., 2015).

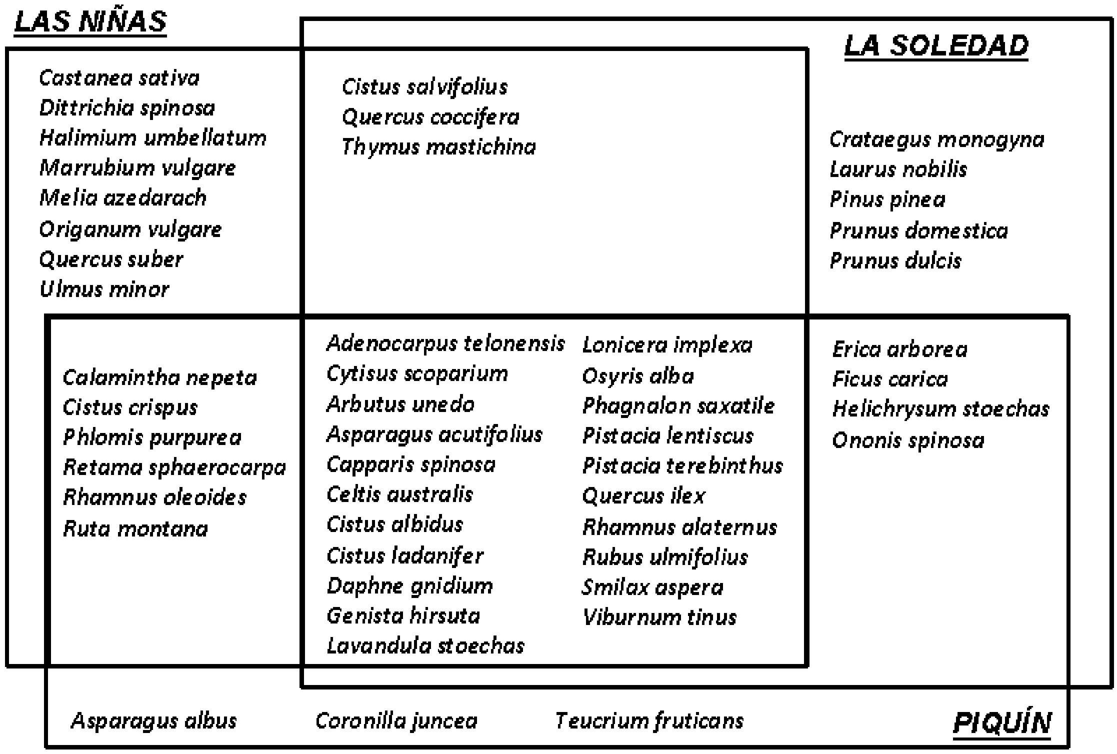


Figure 2, Venn diagram indicating the distribution of sampled species across the three groves. Please note differences in composition between sites could not be studied statistically due to excessive model complexity.

The species-area relationship at *La Soledad* followed the exponential function, meaning species richness levelled-off more quickly in larger patch sizes. This eventual reduction in the rate of increase of richness could be explained by factors relating to seed dispersal and land use history. *La Soledad* is surrounded by fewer areas of forest and scrub. Richness of plants that disperse into vegetation patches at the grove could be smaller because the site is father away from seed sources.

There was also a significant change in community composition of woody species as patch area increased, and this was characterised by increases in the presence probability of all woody species. Larger patches can support additional woody species whilst maintaining species that were already present at smaller areas, suggesting larger patches are providing increased forest-like conditions in the centre but maintaining edge-like conditions at the outside (Andivia *et al*., 2017). This explains why I was able find woodland plants such as *Viburnum tinus* L. in patches that also supported sun-loving species like *Helichrysum stoechas* (L.) DC.

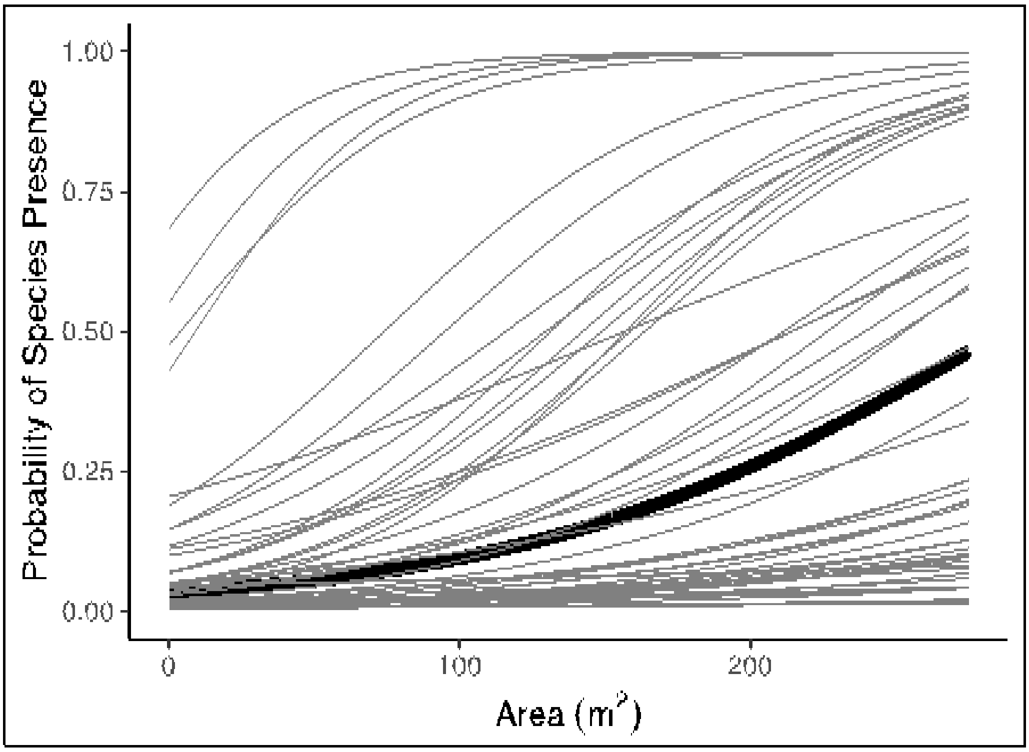


Figure 3, the probability of woody species being present at vegetation patches of different areas, using data from all sites. The thick black line represents change in the average species presence probability across area, while the thin grey lines represent individual species responses.

My analyses revealed that patches of larger areas will support higher species richness without incurring an ecological loss. Therefore, I suggested that landholders could enhance woody plant diversity within their groves by enlarging the size of the current patches. Patch-mediated restoration could allow landholders to increase the presence of natural vegetation around olive trees, whilst simultaneously managing patch areas and maintaining an open landscape. These practices could reduce reforestation costs, while maximising woody plant diversity and enhancing ecosystem services derived from both open and closed habitats. Patch-mediated restoration could enhance biomass production, pollination, water retention, reduction of erosion, reduction of fire risks and recreational value (Blasi et al., 2000; Allen et al., 2006; Rallo, 2007; Duarte et al., 2008).

To conclude, I would like to highlight the importance of studying vegetation dynamics within patch-like and heterogeneous landscapes. I encourage experts, some of whom might be readers of this journal, to replicate this investigation at other sites, and to use novel statistical techniques to investigate the factors influencing richness and community composition within vulnerable ecosystems.

Francisco Navarro Rosales
francisco.navarrorosales@wolfson.ox.ac.uk
Wolfson College, Linton Road,
Oxford, OX2 6UD

References.

Allen, H.D., Randall, R.E., Amable, G.S. and Devereux, B.J. (2006). The impact of changing olive cultivation practices on the ground flora of olive groves in the Messara and Psiloritis regions, Crete, Greece. *Land Degradation & Development*, 17, 249-273.

Andivia, E., Villar-Salvador, P., Tovar, L., Rabasa, S. and Rey Benayas, J.M. (2017). Multiscale assessment of woody species recruitment in Mediterranean shrublands: facilitation and beyond. *Journal of Vegetation Science*, 28, 639-648.

Arrhenius, O. (1921). Species and area. *Journal of Ecology*, 9, 95-99.

Blasi, C., Di Pietro, R. and Fortini, P. (2000). A phytosociological analysis of abandoned terraced olive grove shrublands in the Tyrrhenian district of Central Italy. *Plant Biosystems*, 134, 305-331.

Cristaudo, A., Restuccia, A., Onofri, A., Lo Giudice, V. and Gresta, F. (2015). Species–area relationships and minimum area in citrus grove weed communities*. Plant Biosystems*. 149, 337-345.

Duarte, F., Jones, N. and Fleskens, L. (2008). Traditional olive orchards on sloping land: sustainability or abandonment? *Journal of Environmental Management*, 89, 86-98.

Gleason, H.A. (1922). On the relation between species and area. *Ecology*, 3, 158-162.

GNIG (2021). Fotografía aérea histórica, Fototeca Digital del Centro Nacional de Información Geográfica. Available from: http://fototeca.cnig.es [Accessed 21/04/2021].

Hart, D.D. and Horwitz, R.J. (1991). Habitat diversity and the species-area relationship: alternative models and tests in Bell, McCoy & Mushinsky *Habitat Structure*. Springer, Dordrecht.

Hong, C., Yanqiong, L., Shaowei, Z., Ling, W., Fei, H., Jun, L. and Changlong, M. (2007). Determination of species-area relationships and minimum sampling area for the shrub communities in the arid valley in the upper reach of the Minjiang River, China. *Acta Ecologica Sinica*, 27, 1818-25.

Keeley, J.E. (2003). Relating species abundance distributions to species-area curves in two Mediterranean-type shrublands. *Diversity and Distributions*, 9, 253-259.

López Tirado, J. (2018). *Flora vascular del término municipal de Córdoba. Catálogo florístico y claves de identificación*. Monografías de Botánica Ibérica, 22. Jolube Consultor Botánico y Editor, Jaca (Huesca).

Pardo, M.T., Calvo, J.F., Caballero, J.M. and Selma, M.Á.E. (2003). Relaciones especies-área en los saladares del Guadalentín (SE Ibérico, España) e implicaciones para la conservación, restauración y gestión. *Anales de Biología*, 25, 91-102.

Pausas, J. G., Carbó, E., Caturla, R. N., Gil, J. M. and Vallejo, R. (1999). Post-fire regeneration patterns in the eastern Iberian Peninsula. *Acta Oecologica*, 20(5), 499-508.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available from: https://www.R-project.org/ [Accessed: 21/04/2021].

Rallo, L. (2007). La olivicultura en un cambio de época. in Cortés & Pozuelo, *Agricultura Familiar en España*, Unión de Pequeños Agricultores y Ganaderos, Madrid.

Shutt, J.D., Nicholls, J.A., Trivedi, U.H., Burgess, M.D., Stone, G.N., Hadfield, J.D. and Phillimore, A.B. (2020). Gradients in richness and turnover of a forest passerine's diet prior to breeding: A mixed model approach applied to faecal metabarcoding data. *Molecular Ecology*, 29, 1199-1213.

STUDENT PROJECT REPORT

THE EFFECTS OF THE BELTIE BURN RESTORATION PROJECT ON RIVERSIDE VEGETATION IN DEESIDE.

A restoration project has recently taken place at the Easter Beltie Burn in Deeside, Scotland. The burn, which was artificially straightened and deepened in the 18th century to create space for the Deeside Railway line, has been restored to its natural state as a meandering stream (Dee Catchment Partnership, 2021). The restoration began in September 2020 and the groundworks were completed in November 2020, making it almost a year between the start of the restoration and this study in July-August 2021. This is the very first restoration project of its kind to occur in the North East of Scotland and so it is essential to evaluate how these structural changes will impact wildlife within and surrounding Beltie Burn.

Human activities have hugely negative impacts on natural ecosystems worldwide (Ledgig, 1992). The straightening and deepening of streams is particularly damaging to the biodiversity of these sensitive ecosystems as it removes natural structures such as oxbows and meanders, which drastically changes the stream as a habitat for wildlife (Heller, 1978). Streams form a habitat for a variety of aquatic and terrestrial species (Brown, 1991), riverside vegetation is of particular importance due to its role in stabilizing the riverbanks, intercepting runoff nutrients from farms, and providing shelter for wildlife (Pattison et al, 2017).

The aim was to show the effects the Beltie Burn restoration is having on riverside vegetation. To do this, the vegetation in quadrats was recorded on the banks of a section of the burn that remains unrestored and then a section of the burn that has been restored, so that the diversity of riverside vegetation at each site could be directly compared. Although a restoration project of this kind has never been carried out in the North East of Scotland before, it was expected that the restoration site would show an increase in riverside vegetation diversity when compared to the unrestored section of the burn. This research could demonstrate how restoration projects like the Beltie Burn can make a positive impact on local wildlife, specifically riverside vegetation. The invasive species *Impatiens glandulifera* (Himalayan Balsam) was previously found in abundance on the banks of the now restored section of the Beltie Burn.

The absence of Himalayan Balsam would also be a positive indicator of how the restoration project will benefit vegetation diversity.

Methods.

Study site.

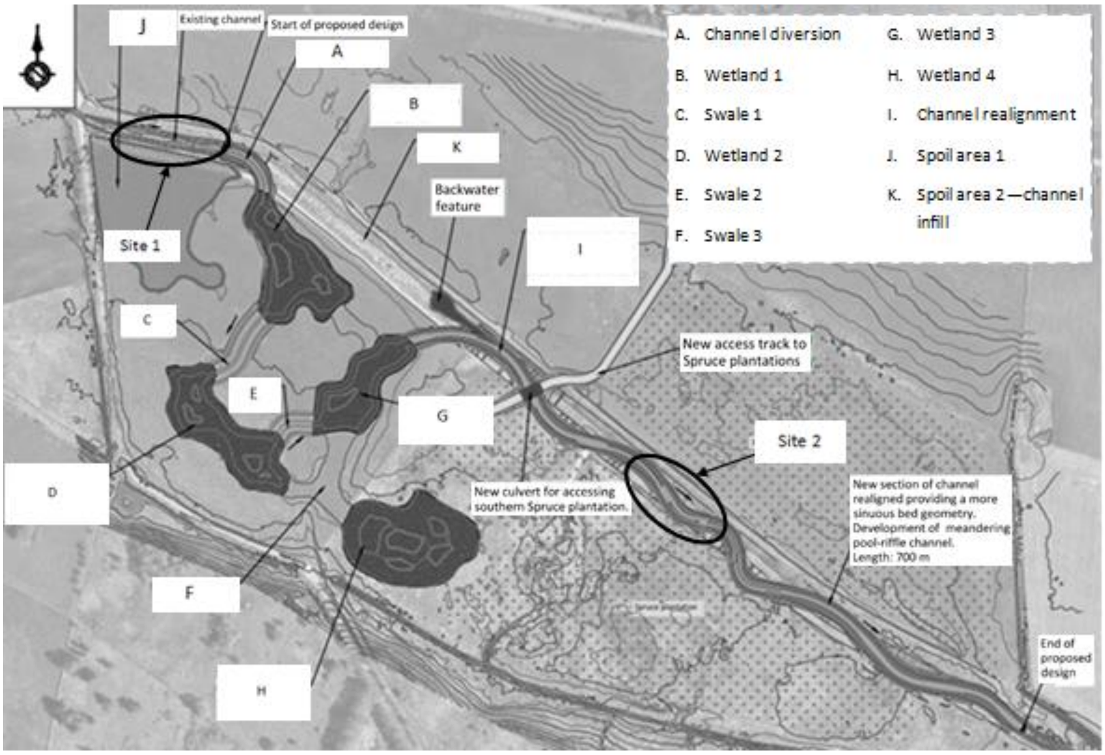


Image 1 showing a map of the restoration site at Beltie burn in Aberdeenshire, Scotland (Dee Catchment Partnership, 2021).

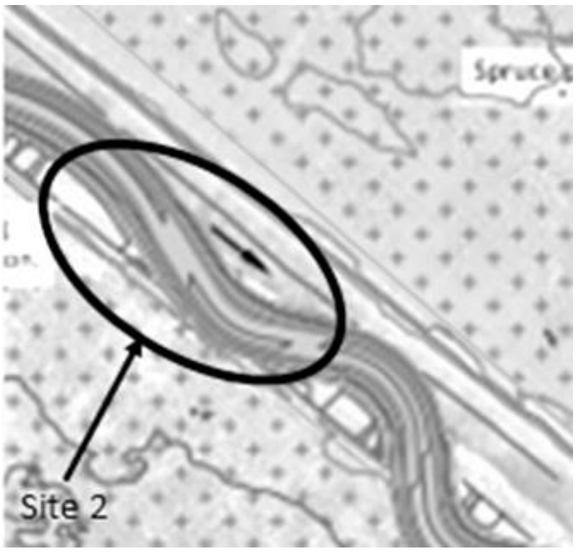


Image 2 and Image 3 showing location of sampling sites. (Site 1 & Site 2).

Data Collection.

To assess how the restoration project has affected the diversity of plant species surrounding Beltie Burn, I conducted a stream habitat assessment using quadrat sampling on two structurally different sections of the burn (Site 1 which is unrestored, and Site 2 which is restored). I was then able to compare the different sites for species diversity. Data collection started on the 18^{th} July and was finished by 24^{th} August.

I spent the first day at Site 2 recording measurements for bank length and width, and stream depth and velocity. For bank length and width, using a tape measure I took measurements on both sides of the stream. For length, I measured 50m along the stream bank and placed a flag at each end to mark out the study site. For stream bank width I measured from the stream to the edge of the riverside vegetation. To measure stream depth, I waded into the middle of the stream and measured its depth with a measuring stick, I repeated this depth measurement at three different points then calculated the averages. For stream velocity I measured 10m within the 50m study site, placing flags at each end. Then dropped an orange upstream and timed how long it took to travel between the flags. I repeated this five times then calculated the average velocity. This process was then repeated at Site 1.

Quadrat sampling.

The first day was also spent trying different methods for quantifying riverside vegetation diversity and abundance. I chose quadrat sampling as such as walking transects. I began the quadrat sampling on the 19^{th} July and it took 6 days to complete. Using a $4m^2$ (2 x 2 m) quadrat I recorded 15 quadrat samples from the 50 m testing zone. For each sample I randomly threw the quadrat and then identified and counted the plant my main method as it seemed to be more efficient than other trialled methods, species that were inside the quadrat. I repeated the method on each side of the stream, recording data from 30 quadrats at each site.

Habitat assessment.

To determine how successful the restoration was in transforming the Beltie burn into a better habitat for wildlife I completed a simple habitat assessment at both sites. The parameters were as follows; attachment sites for macro invertebrates, bank vegetation protection, riparian vegetation diversity and zone width, and channel alteration. Each parameter was scored as either; poor (0-5), marginal (6-10), suboptimal (11-15), or optimal (16-20).

Table 1 showing the habitat assessment parameters for optimal and poor sites.

Parameter	Optimal	Poor
Attachment sites for macro invertebrates	More cobble, wider and longer riffle/run sections.	More gravel or sand and small riffle/run sections.
Bank vegetative protection	Almost all of the bank covered in vegetation and/or boulders etc.	Little vegetation, little or no resistance to erosion.
Riparian vegetation diversity and zone width	Diverse vegetation, wider vegetation zone, less human activity.	No diversity, small vegetative zone, human activity such as mowed areas or crops.
Channel alteration	Natural state, restorative alterations.	Direct human activity, altering of channel e.g., straightening and deepening.

Himalayan Balsam Survey.

To estimate the abundance of Himalayan Balsam in the restored section of the burn I walked transects along Site 2 and kept a tally of the number of patches found. To accurately determine whether this invasive species has re-established itself I surveyed the restoration site near the end of June, when Himalayan Balsam comes into flower.

Analysis.

The data collected from the various sampling methods was then collated on an excel spreadsheet where calculations to determine the difference in abundance and diversity of riverside vegetation between Site 1 and Site 2 could be made.

Results.

The total of different plant species found at Site 1 (unrestored), which can be seen in Table 2, was 5 whereas the total of different plant species found at Site 2 (restored) was 20. Table 2 reveals that the average flow rate at Site 1 is 41.3 whereas the average flow rate at Site 2 is 22.3, giving a significant difference of 18.948 seconds. Table 2 also shows that depth and bank width was different between Site 1 and Site 2. Site 1 had an average depth of 123cm, whereas Site 2 had an average depth of 43cm. Site 1 also had an average bank width of 11.3m whereas Site 2 had an average bank width of 9.6m.

Table 2 showing the total number of plant species found on the riverbanks and average measurements taken from both sites. Site 1 (unrestored) and Site 2 (restored).

	Site 1	Site 2
Total species found	5	20
Velocity (m s-1)	41.3	22.3
Depth (cm)	123	43
Bank width (m)	11.3	9.6
Total Himalayan Balsam found	N/A	61

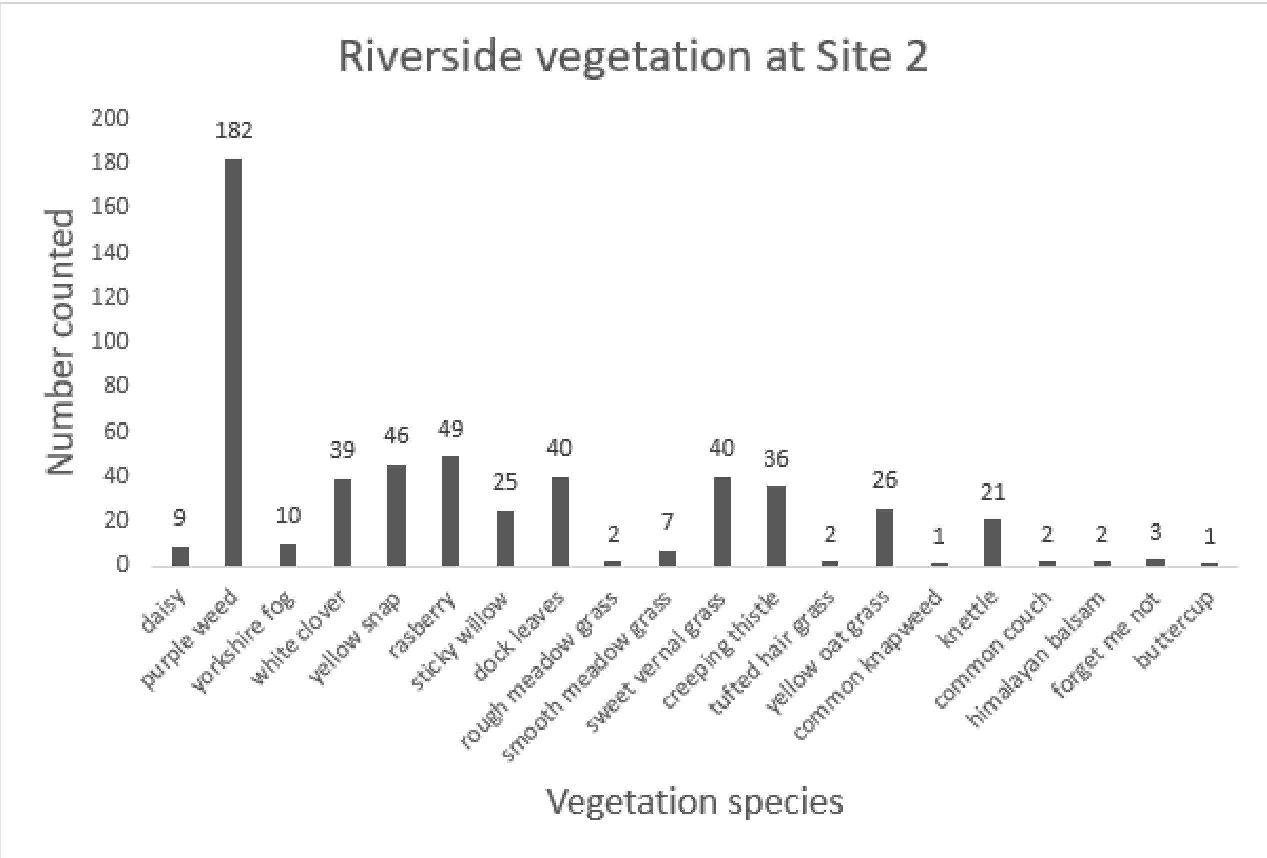
The total number of plant species found (as seen in Table 2) at Site 2 was 20, which is considerably higher than the number of different species found at Site 1, which was 5. This clearly shows that the Beltie Burn Restoration has increased riverside vegetation diversity. Himalayan Balsam (Table 2) was found at Site 2 a total of 61 times on the 100m walked transect. Showing the restoration project has not been able to prevent the spread of this species

Table 3 showing the results from the Habitat assessment (see Table 1).

Habitat assessment	Score	
	Site 1	Site 2
Attachment sites for macro invertebrates	10	15
Bank vegetative protection (stream cover)	12	10
Riparian vegetation type and zone width	2	20
Channel alteration	0	18
Total score (out of 80)	**24**	**63**

As seen in Table 3, Site 1 scored 24 out of a possible 80 whereas Site 2 scored 63. The biggest differences between sites being Riparian plant species diversity and zone width, and Channel alteration, with Site 2 scoring considerably higher for both factors.

Figure 1 showing the number of each plant species counted during quadrat sampling.



As seen in Figure 1, quadrat sampling also revealed that the most abundant plant species was purple weed, later identified as *Geranium robertianum*, with a total of 182 plants being counted. An abundance of other species such as *Persicaria maculosa* (rasberry), *Mimulus luteus* (yellow snap), and a variety of grasses were also found.

Discussion.

The quadrat sampling revealed that there is a greater number of different plant species at the restored section of the burn, some of which are in high abundance, when compared to the unrestored section, which is primarily dominated by a single species of grass. This shows how the restoration has improved the Beltie Burn as a habitat for different species of riverside vegetation. Alongside this, both velocity and water depth are lower at Site 2, which reflects the differences in channel alteration between Site 1 (unrestored) and Site 2 (restored). This shows how the restoration has created a more suitable habitat for wildlife, as aquatic species will be better suited to these conditions (Macura et al, 2016). The Beltie Burn Restoration has also connected the burn with the surrounding land by transforming it into a wetland, and the vegetation on the bank of Site 2 naturally merges into the wetland area. At Site 1 the riverside vegetation is mostly fenced off from the surrounding land. This connectivity between the wetland and the burn at Site 2 shows that the restoration will increase the land's resilience to changing climatic conditions. The wetland surrounding the burn will be able to retain more water, preventing extreme flooding, which is expected to increase due to climate change (Seavy et al, 2009). Although Himalayan Balsam was found at the restoration site, there is still time to control the spread of it before it becomes damaging to wildlife by outcompeting other species.

Overall, data collected by quadrat sampling and the habitat survey revealed that the Beltie Burn Restoration has increased riverside vegetation diversity and transformed the area into a habitat where a range of different species can now thrive. This study took place almost one year after the restoration of the burn and surrounding area, showing how much the area has developed in a short space of time. With the correct management and control of invasive species, particularly Himalayan Balsam, I expect that biodiversity will increase further as more species establish themselves over time.

This research was made possible due to funding from the BSS and with assistance from Susan Cooksley from the James Hutton Institute, who are the leading researchers at the Beltie Burn.

Erin Fraser
Ecological and Environmental Sciences student,
The University of Edinburgh

References**.**

Brown, T.C., Taylor, J.G. and Shelby, B., (1991). ASSESSING THE DIRECT EFFECTS OF STREAMFLOW ON RECREATION: A LITERATURE REVIEW 1. JAWRA Journal of the American Water Resources Association, 27(6), pp.979-989. Dee Catchment Partnership. (2021) Easter Beltie Restoration. Available at: https://www.deepartnership.org/project/easter-beltie-restoration/ (Accessed:25 April 2021)

Heller, V.J., 1978. Effects of Stream Alteration and Associated Land Use Changes on Riparian Avifauna in Southcentral Oklahoma (Doctoral dissertation, Oklahoma State University).

Ledig, F.T., (1992). *Human impacts on genetic diversity in forest ecosystems.* Oikos, pp.87-108.

Macura, V., Štefunková, Z. and Škrinár, A., (2016). Determination of the effect of water depth and flow velocity on the quality of an in-stream habitat in terms of climate change. Advances in Meteorology, 2016.

McLaughlin, J.E., McLaughlin, G.W., McLaughlin, J.S. and White, C.Y., 2016. Using Simpson's diversity index to examine multidimensional models of diversity in health professions education. International journal of medical education, 7, p.1.

Pattison, Z., Minderman, J., Boon, P.J. and Willby, N., (2017). *Twenty years of change in riverside vegetation: what role have invasive alien plants played?.* Applied Vegetation Science, 20(3), pp.422-434.

Seavy, N.E., Gardali, T., Golet, G.H., Griggs, F.T., Howell, C.A., Kelsey, R., Small, S.L., Viers, J.H. and Weigand, J.F., (2009). Why climate change makes riparian restoration more important than ever: recommendations for practice and research. Ecological Restoration, 27(3), pp.330-338.

STUDENT PROJECT REPORT

LOCAL ADAPTATION OF *ARABIDOPSIS THALIANA* IN EDINBURGH

Understanding Local Adaptation on a Small Scale

Arabidopsis thaliana (mouse-ear cress) has been used in many studies of local adaptation as it is distributed globally, over many different environmental conditions (Pico, 2012). For example, these studies have revealed genetic mechanisms for local adaptation of seed yield to climate across Europe (Fournier-Level *et al*., 2011), local adaptation of flowering time in the Yangtze River basin (Zou *et al*., 2017), and local adaptation in seedling traits in Sweden compared to Italy (Postma and Ågren, 2016). However, few studies have looked at local adaptation on a smaller scale.

A previous study had demonstrated high levels of genetic variation in *A. thaliana* around Edinburgh and found that this likely reflected post-glaciation migration of different genotypes from the rest of the UK and accumulation of new mutations (Lim, 2013). The level of genetic variation was surprising compared to other studies. Our study aimed to investigate whether genetic variation relates to phenotypic variation in the Edinburgh population and whether it could be maintained by local adaptation.

Methods.

In February 2006 *A. thaliana* plants, within a 2.5 km radius around Edinburgh, had been collected by a BSc student. Experiments were then performed on their offspring to understand phenotype distribution among these sub-populations. My internship involved analysing the data from this experiment.

Under controlled conditions growth rate (rosette area 24 days after germinating in mm^2), fitness (seed yield in mg), and flowering time (number of days between germination and flowering) were measured, and the relationships among them plotted (Figure 1). Plants grown in controlled conditions were also compared with plants in their natural environment.

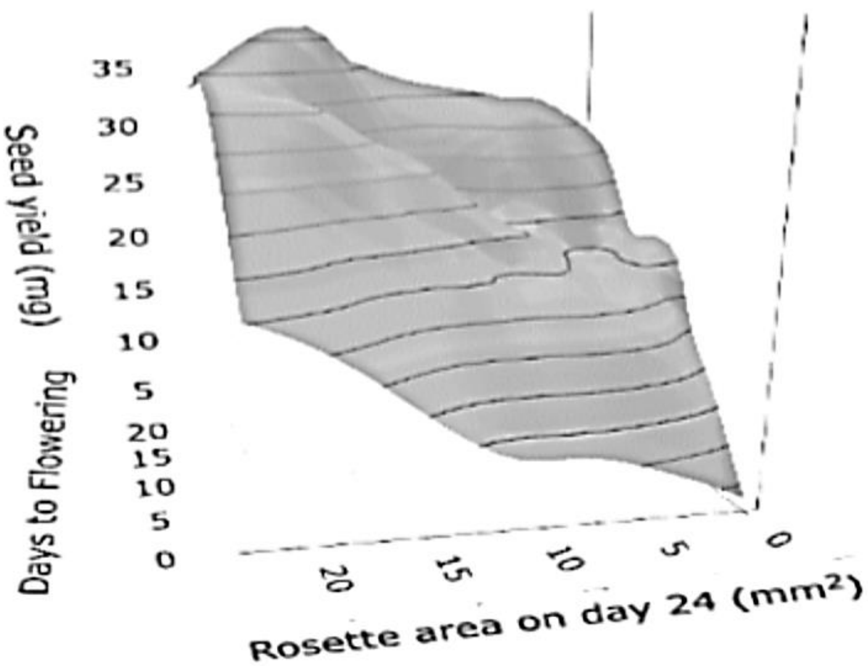


Figure 1. A 3D graph of the relationship between growth rate, flowering time, and seed yield.

Results.

Both flowering time and growth rate were found to affect seed yield, which is a measure of fitness (respectively: $p=6.156\times10^{-11}$; $p=5.565\times10^{-8}$) and together they explained 35% of the variation in seed yield. This suggests that vegetative biomass is correlated with seed yield, as there is more vegetative biomass after a longer vegetative growth period (more days to flowering) or with a faster growth rate (larger rosette area), increasing seed yield. However, the interaction between flowering time and growth rate was not significant, suggesting different genes are involved in their variation.

We also found that phenotypic variation mirrored genotype variation. Heritability calculations demonstrated that a significant proportion of the variation in phenotypes occurs between genotypes, compared to within genotypes, and so is genetically determined (Table 1).

Table 1. Heritability of traits (proportion of variance that can be explained by genetic differences). Growth room values are greater due to less variation in the growing conditions compared to the field.

Trait	**Field**	**Growth room**
Growth rate (mm^2)	0.4616	0.6788
Flowering time (no. leaves)	0.7952	0.8594
Seed yield (mg)	0.2460	0.6487
Fresh weight (g)	-	0.5632
Dry weight (g)	0.26	0.5699

We then wanted to see whether variation might reflect local adaptation. *A. thaliana* is either a winter or summer annual, germinating in autumn or spring respectively (Pico, 2012; Montesinos *et al*., 2009). We therefore examined whether the growth rate of genotypes responded differently to season, using plants grown in a common garden in spring or autumn. The genotypes had been collected at different elevations, so we also tested growth rate at high (290 m) and low (75 m) elevation.

There was a significant correlation for growth rate at low and high elevation in both spring ($r_{(32)}=0.594$; $p=0.0002113$; Figure 2A) and autumn ($r_{(32)}=0.6298$; $p=6.571\times10^{-5}$; Figure 2B). This suggests the genotypes are not locally adapted to elevation, as the same genotypes, which have a higher growth rate at high elevations, also tend to have a higher growth rate under low elevation conditions.

However, there was no significant correlation between growth rate of each genotype grown in autumn compared to spring at the same elevation (Figure 2C and 2D). This suggests that the *A. thaliana* genotypes could be locally adapted to seasonal conditions, as some genotypes grew better in autumn and some in spring.

Two-way ANOVA on each combination of conditions (elevation and season), supported the idea of local adaptation to season: interaction of season and genotype had a significant effect on growth rate (Table 2), explaining about 88% of growth rate. A significant but lower effect of an interaction between genotype and elevation was also identified, suggesting some adaptation to elevation.

Table 2. Two-way ANOVA results of the effect of the interaction between genotype and either elevation or season on growth rate.

Interaction	**Constant Condition**	**df**	**F**	**P** ($\alpha \leq 0.05$)
genotype*elevation	Spring	33	1.7375	0.007843
genotype*elevation	Autumn	33	4.0143	2.79×10^{-11}
genotype*season	High	32	6.4436	$<2.2 \times 10^{-16}$
genotype*season	Low	32	10.7675	$<2.2 \times 10^{-16}$

The growth rate of genotypes relative to others under the same conditions were compared over three years (Figure 3). We can begin to see that in some genotypes the growth rate in spring is slower compared to during autumn, such as 11B2 and 11A2. Whereas the growth rate of some genotypes is greater when grown in spring compared to autumn, such as 1B5 and 4A4. However, further work is needed to assess if these patterns are significant.

Analyses were performed to test the effect of separate seasonal factors (temperature, daylength and light intensity) on the growth rate of each genotype. Further analyses were performed to test if seasons have predictable effects on growth rate depending on the genotype.

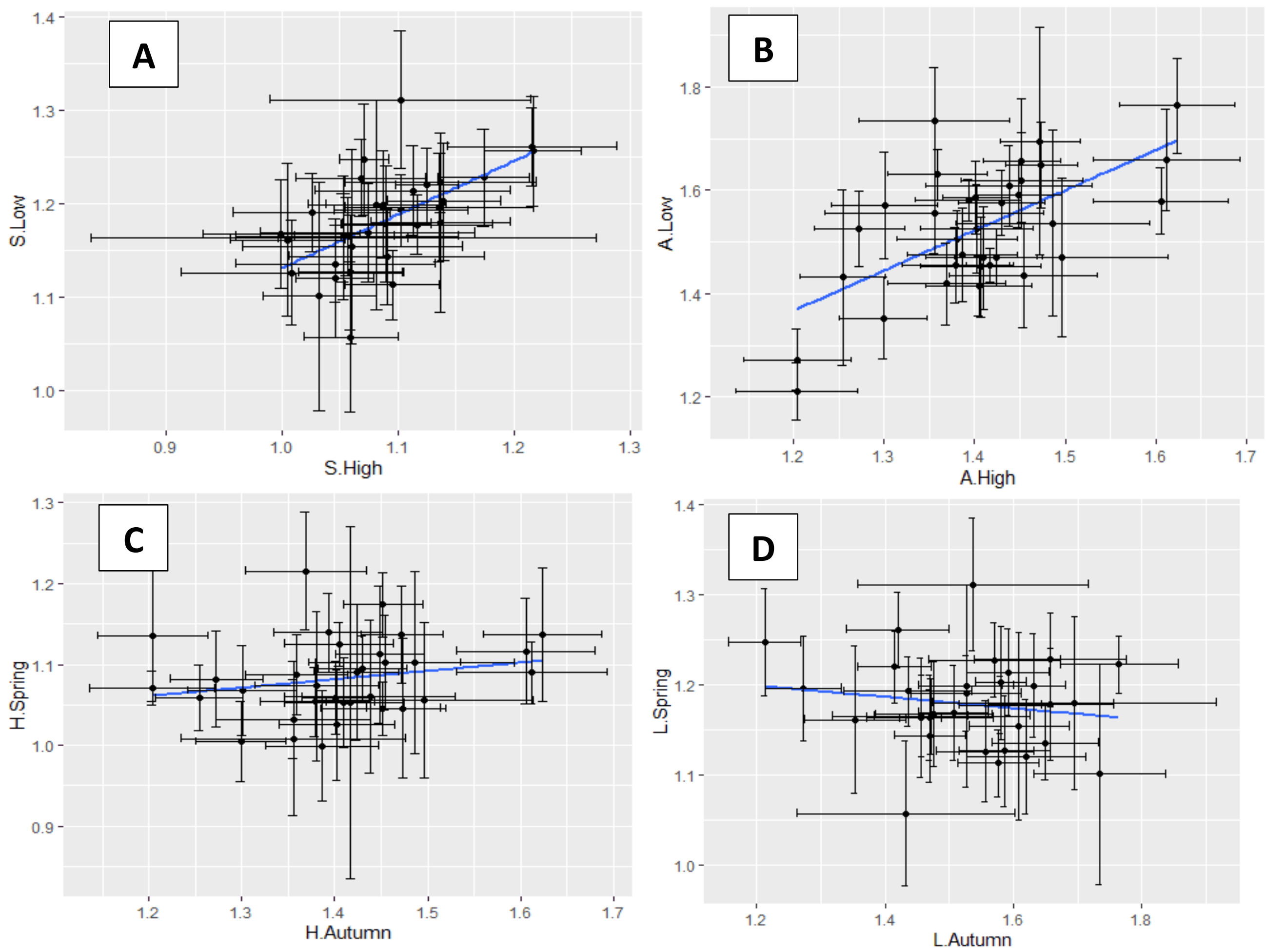


Figure 2**.** Correlation between growth rate (±SD; mm^3 at day 24) under high elevation conditions compared to under low elevation conditions, either under spring conditions (A) or autumn conditions (B). Correlation between subpopulation growth rate (±SD; mm^3 at day 21) under autumn conditions compared to spring conditions, either at a high elevation (C) or low elevation (D).

There was a positive correlation of growth rate between individuals grown under a high light intensity compared to individuals under a low light intensity ($r_{(18)}=0.8353$, $p=4.572\times10^{-6}$; Figure 4). A two-way ANOVA demonstrated a significant interaction between genotype and light intensity affecting growth rate ($F_{(19,269)}=3.7786$, $p=4.887\times10^{-7}$). This suggests there is local adaption to light intensity among the genotypes of *A. thaliana* in Edinburgh.

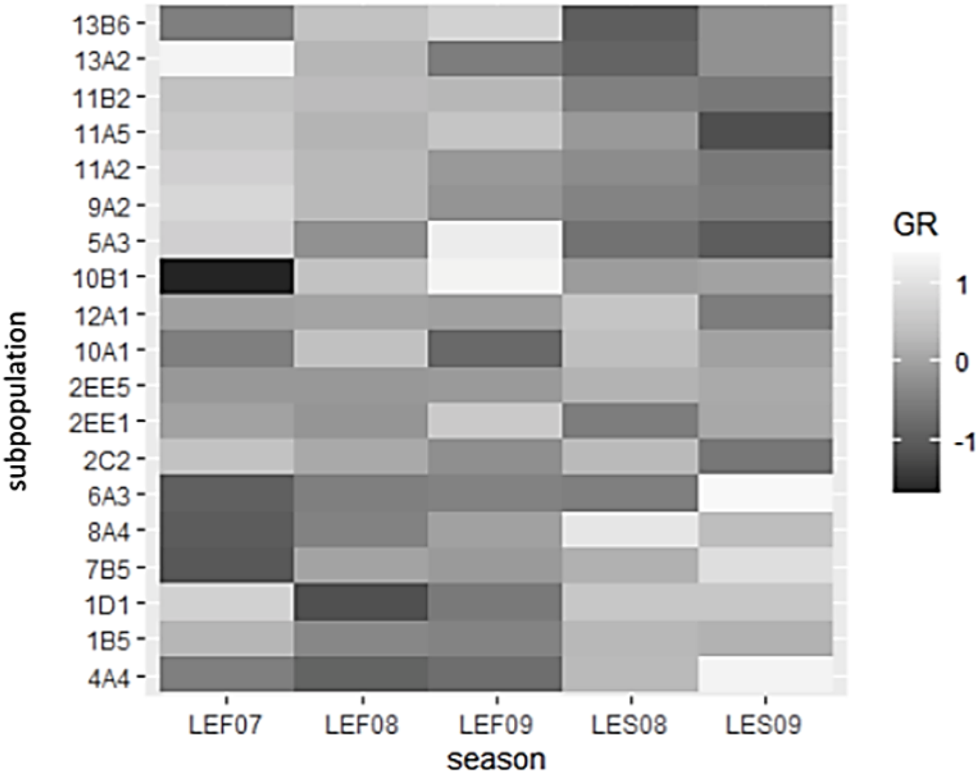


Figure 3. Heat map of the normalized mean growth rate of selected genotypes over five consecutive spring and autumn seasons (autumn 2007(LEF07), spring 2008 (LES08), autumn 2008 (LEF08), spring (LES09), autumn (LEF09)). The difference between the mean growth rate of each genotype and mean growth rate of all genotypes is calculated, and colour coded depending on the difference. Black represents the genotype with the slowest growth rate, the genotype with the negative greatest difference compared to the average of all genotypes, whereas white represents the genotype with the fastest growth rate.

The effects of day length and temperature were also investigated. *A. thaliana* genotypes were grown with either long-day or short-day conditions (8 hrs or 16 hrs light) at 5 ˚C, 10 ˚C, 16 ˚C or 20˚C. Correlations in growth rates were highest at similar temperatures at the same day length. For example, under short day conditions the correlation between 0˚C and 16˚C was 0.675, whereas the correlation between 5˚C and 20˚C was only 0.036 (Figure 5). This suggests local adaption to temperature.

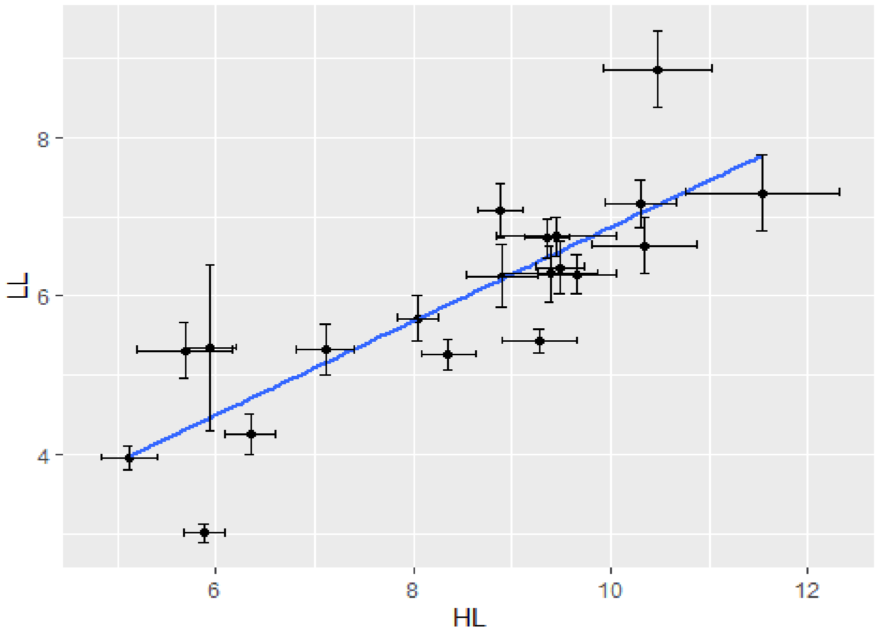


Figure 4. A correlation plot to show the mean growth rate (mm^3; ±SD) of each genotype when grown at a high (HL) or low light (LL) intensity.

Three way ANOVA demonstrated temperature, genotype and day length interact to significantly affect growth rate ($F_{(51,\ 581)}$=8.0990, p=<2x10^{-16}). As does genotype and day length ($F_{(19,\ 581)}$=9.67, p=<2x10^{-16}) and genotype and temperature ($F_{(56,\ 581)}$=6.53, p=<2x10^{-16}), suggesting local adaptation to both temperature and day length. The effect of day length is shown for two genotypes (Figure 6).

Conclusions.

Previous work suggested genetic variation in the *A. thaliana* population of Edinburgh is most likely from colonisation post-glaciation and that there has been relatively little gene flow between the subpopulations (Lim, 2013). Our findings suggest that local adaptation to seasonal variation, in particular temperature, light intensity, and day length, has a role in maintaining this variation.

These findings demonstrate local adaptation can be found on a small scale and could have important implications for understanding the effect of climate change on populations in Edinburgh and elsewhere. We have demonstrated that there is much genetic and phenotypic variation within the local population, potentially important for future adaptation, however as there is relatively little gene flow between genotypes, further adaptation from new genetic combinations may be limited (Lim, 2013).

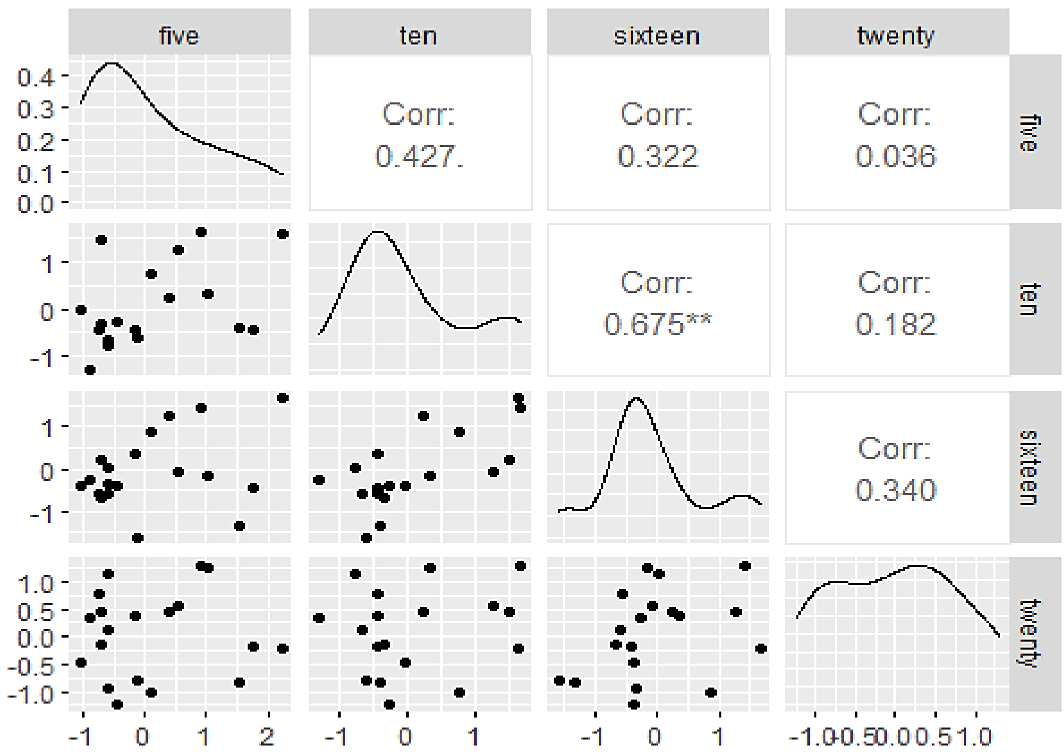


Figure 5. Scatter plots present the correlation between normalized growth rate under short day conditions between two temperature conditions, values in the upper right corner present the correlation value (r), and significance with asterisks, and the diagonal shows the densities of the mean growth rates.

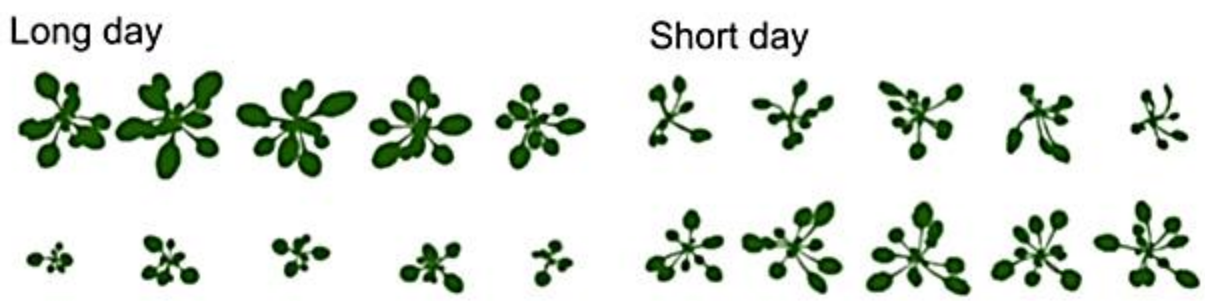


Figure 6. Rosette size of individuals from two different genotypes (top verses bottom row) grown either under short- or long-day conditions (provided by Andrew Hudson).

Beth Mitchell, s1807480@ed.ac.uk
Working with Dr. Andrew Hudson, and data collected by Sarah Witall

References.

Fournier-Level, A., *et al*. (2011). A Map of Local Adaptation in *Arabidopsis thaliana*. *Science*, 334, pp. 86-89.

Lim, P.N. (2013). An Investigation into Natural Variation and Adaptation of *Arabidopsis thaliana* in Edinburgh and the Lothians. PhD thesis, University of Edinburgh, Edinburgh.

Montesinos, A., *et al*. (2009). Demographic and Genetic Patterns of Variation among Populations of *Arabidopsis thaliana* from Contrasting Native Environments. *PLoS ONE*, 4(9).

Picó, F.X. (2012). Demographic fate of *Arabidopsis thaliana* cohorts of autumn- and spring-germinated plants along an altitudinal gradient. *Journal of Ecology*, 100, pp. 1009–1018.

Postma, F.M. and Ågren, J. (2016). Early life stages contribute strongly to local adaptation in *Arabidopsis thaliana*. *PNAS*, 113(27).

Zou, Y., *et al*. (2017). Adaptation of *Arabidopsis thaliana* to the Yangtze River basin. *Genome Biology*, 18(1).

STUDENT PROJECT REPORT

THE LOST BIODIVERSITY OF SUBMERGED LANDSCAPES.

Evidence from the eroding intertidal peat at Tuquoy, Westray, Orkney.

Approximately 0.5 metres of intertidal peat remains at the Bay of Tuquoy, Westray because of tidal scouring and erosion. Indicators of past biodiversity preserved within the peat represent a time sensitive opportunity to employ palaeoecological methods to reconstruct the now submerged landscape.

The funding received from BSS contributed towards the fieldwork portion of this project, which aims to reconstruct past vegetation from the floor upwards to provide a unique perspective into the past environment of Westray, using macro-fossils to recreate landscapes. The excursion to Westray to collect a peat monolith was undertaken from 5th-6th October. The group included myself, my supervisor and two other students. The weather was thankfully excellent, and a large tide window provided plenty of time for the fieldwork to take place.

As my supervisor, Dr Scott Timpany, had envisaged, the peat shelf lay exposed just below the cliff edge. An auger was used to test the depth of the exposed intertidal peat. Nothing deeper than 0.5 metres was discovered, which Dr Timpany observed was a decrease from that found in previous years, conveying the intensity of tidal erosion. At the deepest recorded section of the peat shelf, the edge was cut back to reveal the peat horizons. These were drawn and recorded before a monolith tin was hammered into the section of the peat shelf to take a monolith peat sample. Observations during the fieldwork found flecks of charcoal. This clearly implies the presence of burning in the landscape and therefore potential anthropogenic activity. The monolith sample contained a sandy, grainy horizon clearly imposing amongst horizons of brownish-red silt suggesting a substantial storm event. It will be interesting to assess the impact of these storm surges on the biodiversity of the area.

The monolith sample was taken back to the laboratory at Orkney College where it will be subsampled and analysed for plant macro-fossils, pollen, and non-pollen palynomorphs. The results of this analysis and the vegetation pattern conveyed will be contrasted with current biodiversity records for the island of Westray. This will provide a contrast between past and present vegetation patterns. Depending on the results of radiocarbon dating, the peat could well contain evidence of the impact of human habitation in and around the Bay of Tuquoy.

Orkney is a particularly rich in intertidal peat deposits, although this is the first study of an intertidal peat on the island of Westray. Multiple antiquarian studies have made use of the remains of submerged landscapes contained within intertidal peats (Watt 1820; Traill 1868; Traill Dennison 1893). The work of Martin Bell in the Severn Estuary is a testament to the archaeological potential concealed within these intertidal peats (Bell 2007, 2013). More attention is now being paid to the special capacity of peat deposits and inter-tidal zones, especially considering evidence coming from the now submerged Doggerland (Gaffney et al. 2007; Gearey et al. 2017; Krüger et al. 2017).

A study by Timpany *et al.* (2017) more recently analysed the intertidal peat at the Bay of Ireland, Orkney, yielding fascinating insight into the activity of Mesolithic communities on Mainland Orkney. The potential for the intertidal peat from Tuquoy yielding similar, or even contrasting results is a possibility. Consequently, the results of this fieldwork will contribute to our understand of the interaction of communities and their environment. However, the intertidal peat is a finite resource, and so the funding from the Botanical Society of Scotland has enabled a small monolith section to be preserved and analysed for posterity.

Amy Blank

University of the Highlands and Islands
19019557@uhi.ac.uk

References.

Bell, M. (2007). Prehistoric coastal communities: the Mesolithic in Western Britain (Research Report. 149). York: Council for British Archaeology.

Bell, M. (2013). The Bronze Age in the Severn Estuary (Research Report 172). York: Council for British Archaeology. Henderson, D.M. and Dickson, J.H. (1994). *A naturalist in the Highlands*. Scottish Academic Press, Edinburgh.

Gaffney, V.L., Thomson, K. & Fitch, S. (eds). (2007). Mapping Doggerland: the Mesolithic landscapes of the southern North Sea. Banbury: Archaeopress, p97-101.

Gearey, B.R., Hopla, E.-J., Boomer, I., Smith, D., Marshall, P., Fitch, S., Griffiths, S. & Tappin,D.R. (2017). Multi-proxy palaeoecological approaches to submerged landscapes: a case study from 'Doggerland', in the southern North Sea. In: M. Williams, T. Hill, I. Boomer & P. Wilkinson (eds.). The archaeological & forensic applications of microfossils: a deeper understanding of human history: p35–53. London: The Geological Society of London.

Krüger, S., Dörfler, W., Bennike, O. & Wolters, S. (2017). Life in Doggerland– palynological investigations of the environment of prehistoric hunter-gatherer societies in North Sea Basin. E&G Quaternary Science Journal 66, p3–13.

Traill, W. (1868). 'On submarine forest and remains of indigenous wood in Orkney'. Transactions of the Botanical Society of Edinburgh 9, p146-154

Traill Dennison, W. (1893). 'On the encroachment if the sea and the subsidence of the land, as seen in the Island of Sanday'. Saga Book of the Viking Club 1, p74-89

Timpany, S., Crone, A., Hamilton, D. & Sharpe, M., (2017). Revealed by waves: a stratigraphic, palaeoecological, and dendrochronological investigation of a prehistoric oak timber and intertidal peats, Bay of Ireland, West Mainland, Orkney. The Journal of Island and Coastal Archaeology 12, p515–539

Watt, W. G. (1820). 'Notice regarding the submarine remains of a grove of fir-trees in Orkney'. Proceedings of the Edinburgh Philosophical Journal 18(3), p100-102

URBAN AND RURAL FLORA IN EASTER ROSS

Part 3

When searching for wildflowers people often head straight for the countryside and wild plants in towns are often regarded as “weeds” to be uprooted or sprayed with herbicide. However, modern agriculture and forestry practises have often depleted the rural flora and many wild plants successfully inhabit urban sites.

Some studies have suggested that the urban flora is more diverse than the rural and that urban habitats may have considerable conservation value (Kowarik et al 2011).

I compared rural and urban sites in Easter Ross and have published these in two previous BSS reports, and they did not show a definite difference in plant diversity, although the species lists differed considerably (Ballinger 2019, 2020). There was a trend for the rural squares near towns to be more species rich than the more distant rural sites, although altitude may explain this difference. The site selection in those earlier studies was based on ease of access and not fully randomised. The present study described here attempted to use a more random site selection.

<u>Methods.</u>

Ten 100m x 100m squares were randomly selected in each of 10 different towns in Easter Ross. The towns had people populations in the range 1000 to 10,000. For each of the urban squares a corresponding rural site was selected in the same hectad (10km x 10km square). If access was impossible, an immediately adjacent square was used. These paired sites were all studied during the same week, and a maximum of 40 minutes was allowed for each plant recording visit. All vascular plants that did not appear to have been planted were recorded.

Two visits were made to each site, one in November-February 2019-2020 and the other in July-August 2021. It was only possible to access an average of approximately 25% of the area of the squares, in both rural and urban situations, because of buildings, gardens, growing crops, fences, rivers, dense vegetation etc. I followed all regulations concerning covid 19 at all times during my surveys.

Results.

In the autumn - winter visits there was a total of 237 records in the 10 urban sites, and 215 in the 10 rural sites, with 100 species in the urban and 97 in the rural locations. In the summer visits, there were a total of 286 records in the urban areas and 365 in the rural areas with 104 species in the urban areas and 136 species in the rural areas (Table 1).

The overall species totals from the four surveys were 143 urban and 159 rural. There were 91 species found in both the urban and rural samples, of which 24 species were neophytes (alien 16%) species in the urban list and 5 (3%) in the rural areas. In the urban areas the commonest species were *Bellis perennis, Taraxacum sp, Dactylis glomerata, Epilobium montanum, Poa annua, Plantago lanceolata and Rubus fruticosus*. In the rural areas the commonest species were *Ranunculus repens, Urtica dioica, Arrhenatherum elatius, Dactylis glomerata, Dryopteris filix-mas, Galium aparine,* and *Heracleum sphondylium*.

There was no significant difference (X^2 = 2 1.96, df1 NS) between urban and rural species totals, although the rural total was slightly higher.

Table 1. Number of plant records in Winter and Summer, and total number of species recorded during visits in the summer and winter 2019-2021

	Urban totals in 10 sites	Rural totals in 10 sites
Total Records winter	237	215
Total Records summer	286	365
Species winter	100	97
Species summer	104	136
Neophytes	24 (16%)	5 (3%)
Commonest species	*Bellis perennis Taraxacum*	*Ranunculus repens, Urtica dioica*

Discussion.

The relatively small increase of species numbers in the urban area in the summer, when compared to the winter is probably the result of the widespread use of herbicides in urban streets. Once again, as found in my previous studies (Ballinger 2019 and 2020), this 2019-2021 survey, which used more comparable methods in rural and urban areas, (ie the same recording time in paired urban rural areas), did not demonstrate an overall difference in species abundance between urban and rural areas in Easter Ross. There were differences in the identity of the species recorded in the urban and rural area in each year. In particular, there were more neophytes (aliens) in urban areas than in rural in 2019-2021.

The rural squares were in the same hectad as the urban and, therefore, relatively near the urban areas. My earlier reports (Ballinger 2019 and 2020) suggested that rural areas near towns may be more species rich than more distant ones. A study of other botanical records suggested that large towns may have more species than smaller towns (John Grace pers. comm.). My study of urban cemeteries also found more species in large town cemeteries than small town cemeteries, although with that study it was not possible to create matched pairs, and it was not easy to compare them (Ballinger 2022).

The relationship between urban and rural flora is very complex and a greater number of studies would be useful. If you wish to collect data using the same methods as I have, then please contact me to discuss them. I am grateful to Julia Wilson for helpful comments on this article.

Brian Ballinger

References.

Ballinger B. (2019) A Comparison of Urban and Rural Flora in Easter Ross. BSS News 113:34-36.

Ballinger B. (2020) Comparison of Urban and Rural Flora in Easter Ross – part 2. BSS News 114: 27-28

Ballinger B. (2022) The Flora of some Scottish Cemeteries. BSS News (this issue).

Grace J. (2021) Personal communication.

Kowarik, I., Fischer, L., Säumel I., von der Lippe M., Weber, f. and Westermann, J. (2011) Plants in Urban Settings: From Patterns to Mechanisms and Ecosystem Services. In W. Endlicher et Al. (eds) Perspectives in Urban Ecology Springer-Verlag Bertin Heidelberg.

THE BSBI ROUGH CREW LECTURE
23rd November 2021

Joint meeting of Dundee Naturalists' Society and Botanical Society of Scotland.

This talk was held on Zoom and we were pleased to welcome Jim McIntosh, the Botanical Society of Britain and Ireland's (BSBI) Scottish Officer, a post he has held for the last 17 years.

For the last few years Jim and a small hardy group of botanists have been going to remote and often under-recorded areas of the Scottish mountains, searching for rare plants and making records for the BSBI's database. For his talk, Jim concentrated on one of their trips in 2020, which took them to the area around Beinn Dearg and Seana Bhraigh in the north-west highlands. This is one of the most remote mountain areas in Scotland.

Four botanists and a dog ventured forth and camped in small tents, with a night in a bothy. They took a circular route visiting 30, 1 km squares, making more than 1000 botanical records, including 16 red list and 24 nationally rare or scarce species. The commonest notable species included *Salix lapponum* (Downy Willow), *Cerastium alpinum* (Alpine mouse-ear) and *Sibbaldia procumbens* (Sibbaldia), many in new locations.

The botanists were impressed by a large population of the scarce *Omalotheca norvegica* (previously named *Gnaphalium norvegicum;* (Highland Cudweed) on steep and rugged slopes above Loch a Choire Ghranda under Beinn Dearg. The scarce grass *Phleum alpinum* (Alpine Catstail) was found in flower, having escaped the attention of grazing animals so far.

There were some strikingly beautiful views on clear days. For much of the trip they were fortunate with the weather, so unpredictable in this place, but then the rain and mist arrived, fortunately only for a little while, before clear conditions returned.

The second campsite was high above the Cadha Dearg corrie and *Poa glauca* (Glaucous Meadow-grass) was prominent on the cliffs beside the tents. The attractive crucifer (Brassicaceae) *Arabidopsis petraea* (Northern Rockcress) was found in several places on cliffs in the Cadha Dearg, along with the beautiful *Sausserea alpina* (Alpine Saw-wort).

Trekking north again to the remote Seana Bhraigh, they made a pilgrimage to view the rare *Artemisia norvegica* (Norwegian Mugwort), in one of its three sites in Britain. It was past its flowering best in early August, but still attractive. They resisted moving on to visit its second site on nearby Corbett, given the time and distance needed.

Jim mentioned other mountain trips made by his crew in recent years. The one that followed the Beinn Dearg expedition was marred by misty and cold weather, but that is often a feature of these mountains. The rough crew have added many new sites and records for some of our special plants.

Many of the locations in the Beinn Dearg trip are in the Vice-County that I cover (Easter Ross) and I am very grateful for all of their work. I have paid brief visits to some of these places, but the rough crew have added so much more.

Brian Ballinger

FIELD HANDBOOK TO BRITISH AND IRISH DANDELIONS

Reviewed by Leslie Tucker

BSBI Handbook No. 23.
Author: A.J. Richards. Edited by T.C.G. Rich.
Published by BSBI, Durham, October 2021.
Pp. vi + 302, including 1,000+ coloured photographic illustrations.
Pbk £20.00

The Field Handbook to British and Irish Dandelions No. 23 (FHbk23), published in October 2021 by the Botanical Society of Britain and Ireland (BSBI), is distinguished by being profusely illustrated with colour photographs of exemplary, living, plant specimens. Many taraxacologists are acknowledged for contributing the original high quality digital photographs for these essential images; however, the author, Professor A.J. Richards (AJR), makes a particular point of thanking the editor, Dr. T.C.G. Rich, for his major contribution, in being “very often the first to photograph these species in the wild, and to document their ecology and status.”

In effect, FHbk23 is a thoroughly revised edition by the surviving author of the 1997 classic Dandelions of Great Britain and Ireland, BSBI Handbook No. 9 (Hbk9). That was written by A.A. Dudman and AJR at a time when it was only considered feasible to illustrate every species account with just one black and white silhouette each, showing a pressed and dried herbarium specimen, supplemented with line illustrations of involucres by Olga Stewart. Much of the new revision and re-formatting effectively underwent interim trials as BSBI's online Dandelion accounts in the Plant Crib 3 series.

Although large portions of Hbk9's text still reappear in FHbk23, its taxonomy and nomenclature has been thoroughly revised and updated, including several *Taraxacum species* (Dandelion sorts) which were only described during the last 24 years. AJR has also devised new keys, and provided updated distribution maps and identification notes to accompany the illustrations.

If this were a hardback book from a commercial publishing house there would most likely be a laudatory biographical note and portrait of the author on the dustjacket. Here, readers will have to make do with my gloss on the References at the back: there, appropriately following many Scandinavian authorities, RICHARDS, A.J., is represented by 20 entries leading to species accounts. Then, of the 240-odd species considered, 34 Latinate binomials indicate his original authorship.

Elsewhere, e.g. Alpine Garden Society (AGS) publications, AJR's efforts are also much appreciated: thus, the latest updates from AGS's Northumberland Diary inform us that he has lived in South Northumberland (BSBI VC67) for 50+ years. He gained a PhD from University College Durham in 1969 for his thesis, 'The biosystematics of Taraxacum', and is now Emeritus Professor of Botany at the University of Newcastle, where his research interests centre on the evolution and genetics of plant breeding systems. He is not only our authority on *Taraxacum* (Dandelions), but also *Primula* (Primroses), and their BSBI Referee. Being also a keen gardener, he is a regular flower show exhibitor and judge. That perhaps explains his occasional 'characterisations' of some dandelion species as being "ugly, untidy", etc.

Even though this monograph is titled as a field handbook, it also incorporates in the General Introduction (pp. 1 – 10), a brief but very authoritative review of the subject's development which is backed up by impressive References (pp. 297-300); so, it is effectively also a standard textbook.

Considering these References, it is evident that the founders and developers of taraxacology were professional academics based in Scandinavian universities, and they conducted their initial studies on plants native to their local regions around the Baltic Sea. However, their investigations and innovative general theories regarding plant reproduction and species evolution, which they developed to account for the rather extraordinary-seeming behaviour of their plant subjects, were always well integrated with the latest and most important controversies and theories circulating in the worldwide phytological community. Still today, the study of genomic processes operating in such allopolyploid apomicts is a vital research topic, which challenges the leading scientific researchers interested in understanding biodiversity and crop breeding.

It seems reasonable to assume that many of the likely purchasers of FHbk23 will be interested in carrying it around to help identify *Taraxacum species* (Dandelion sorts) as part of their regular plant recording activities; so, it is worth noting that its paper and binding materials appear durable. I also found the font type and size (Times New Roman 11pt ?) clear and easy to read, with few typographical errors. The price seems generally acceptable. Most routine botanical recording involves 'filling-in' some sort of A4 prompt sheet, like the BSBI recording cards, in an all-weather clipboard. Adding this larger (B5) and heavier (ca. 800g.) volume, compared (or even together) with the standard-sized (A5) and lighter (ca. 600g, or 400g reprint) Hbk9, it should still not prove too burdensome.

Of course, no review of a 'field' guide should ignore assessment of its effectiveness as such. However, writing this Review in the wintertime, immediately following publication, I have not yet had any appropriate opportunities to experience and observe its actual use during the recommended springtime flowering season best for dandelion identifications. So, I will limit myself for now to observing that its many coloured illustrations, which were selected to correspond with AJR's admittedly (p.1) "difficult to verbalise" characterisations, should prove most useful.

As always, though, there are Catch-22-like situations looming: AJR adds cautionary premonitions regarding the use of his dichotomous keys (p.150): "… which many will probably get wrong initially. With time and familiarity … provide a useful framework for narrowing down the choices."

In recent correspondence about taraxacology, I asked AJR if there was any particular advice that he would like to give BSS members, His reply was:

“I think they shouldn't fuss too much about the 'weeds' that surround them and concentrate instead on the splendid disjuncts and endemics that populate their islands, dunes and mountains! I think a living collection of some of the rarer and more spectacular Scottish species is a splendid idea, but it would take a lot of curation.

Best wishes, John.”

GATHERING MOSS by Robin Wall Kimmerer

Book review by Maria Chamberlain

Published: Penguin 01/07/2021
ISBN: 9780141997629
Length: 192 Pages
Dimensions: 198mm x 11mm x 129mm
Weight: 145g
RRP: £9.99

Robin Wall Kimmerer is a New York bryologist, decorated professor, mother, and citizen of the Potawatomi nation. In this engaging little book of essays, she interweaves science, her personal life, and the age-old wisdom of her tribe. She explains how mosses, with their elegant simplicity, their 400-million-year-old adaptive radiation in response to small scale differences in substrate and microclimate, can offer hidden insights and act as a vehicle for intimacy with the landscape. Sadly, in our modern pre-packaged world, it is an intimacy that we have now lost.

Being married to an obsessive 'mosser', I have always wondered how he and his fellow bryologists can 'read' the landscape to provide information on the pH of the substrate, the geology of the area and the major pollutants in the air or soil. I believe that they do this by observing the unique species composition of a given ecosystem. They examine each specimen in turn, admire its beauty, its leaf structure and arrangement, 'hair style', and capsule shape, and then turn to taxonomic keys to determine its name. Kimmerer's book is not an identification guide, but by pulling you into the magic world that mosses inhabit, it will encourage you to buy a lens, a field guide and look for yourself.

The essays describe and explain moss biology lyrically, but simply. One deals with the mosses' relationship with water; this is important, for without conducting tissues or roots mosses rely for readily water to photosynthesise, grow and reproduce. When water is not available, mosses can dry to a crisp, losing 98% of their water content. But, they can wait and wait – sometimes for 40 years in a herbarium packet – while 'dreaming of water', as she puts it. Then when you spray on the water, the moss comes back to life, its functions restored.

This is an adaptation called poikilohydry; most mosses do it, though some species are better at it than others.

Another essay addresses moss reproduction. Mosses along with most other plants, fungi and lichens have a choice when it comes to reproduction. They can do it sexually, producing gametes, which unite to form the sporophyte, the capsules of which bear meiotic spores. They can also do it asexually through gemmae or even plant fragments to produce identical progeny. The sexual strategy is best in a changing environment because it ensures genetic diversity and wide scale dispersal; in contrast the asexual strategy is best when the conditions stay the same and there is plenty of land to colonise, because after all, if life is good why would you want to alter a winning recipe? My own research on fungi provided ample evidence of this, and I was pleased to find that Kimmerer's data on *Tetraphis* reaffirmed it, showing that the choice between sex or gemmae depended on the density of the colony.

A chapter on City Mosses could be of interest to our own Urban Flora project. The city with its multitude of habitats provides a moss list of 'urban cliff' species similar to that of guano-covered natural cliffs. Other species pretend that the man-made high pH wall cement is really a limestone rock. Kimmerer argues that the modern-day habit of exterminating anything that is green and fuzzy is a terrible idea, that mosses add texture and that contrary to the common misconception, they do NOT kill lawn grasses – they merely outcompete them when the environment for moss growth is better than that for grass growth. Mosses should likewise not be scraped off roofs, where they add a cooling layer in the summer and insulation in the winter.

I have read this book twice, first when I bought it after its rave *Guardian newspaper* review[1], and then once more before writing this piece. I now plan to re-read her second book *Braiding Sweetgrass,* so watch this space!

Maria Chamberlain

Reference.

[1] https://www.theguardian.com/science/2021/jun/19/robin-wall-kimmerer-gathering-moss-climate-crisis-interview

BSS NEWS – GUIDELINES FOR CONTRIBUTORS

The Newsletter of the Botanical Society of Scotland ISSN 0967-5922

Receiving editor: Dr Jill Thompson:
Email news@botanical-society-scotland.org.uk

All contributions should be sent to the Receiving Editor

Coordinating editor: Cameron Diekonigin.

Aims and scope of BSS News
The aims of BSS News are to communicate with the membership, to keep members informed and to act as a vehicle for members' contributions on all things botanical. All contributions are welcome, for example:
- Reports of field excursions
- Descriptions and recommendations of botanical sites to visit
- Articles of current or historical interest
- Biographical profiles of botanists
- Botanical notes, poems, news, announcements, reports
- Citizen science projects to contribute to etc.
- Book reviews, crosswords and quizzes
- Illustrations, including paintings, photographs and line drawings

Guidelines for Contributors
Please follow the more detailed guidelines and use the template downloadable from
https://www.botanical-society-scotland.org.uk/content/bss-news-newsletter-botanical-society-scotland.
The space for colour images is limited to the cover and centre pages, please use black and white and greyscale for items within the text.
Contact the Receiving Editor for help and advice.

The deadlines are **15th January** and **15th July** each year.
Earlier submission is appreciated.

Back cover pictures

Inside: **1.** Rural v urban near Tain. See **Urban And Rural Flora In Easter Ross Part 3** Page 61.
2. *Amsinckia micrantha* (Common Fiddleneck) Balgay cemetery, Dundee. See **The Flora Of Some Scottish Cemeteries** Page 13. Photos: Brian Ballinger

Outside: 1 & 2. Beltie burn. See **The Effects Of The Beltie Burn Restoration Project On Riverside Vegetation In Deeside** Page 43. Photo: Erin Fraser

3. *Saxifraga granulata* (Meadow Saxifrage) Tain cemetery. See **The Flora Of Some Scottish Cemeteries** Page 13. Photo: Brian Ballinger

4. Monolith tin sample. See **The Lost Biodiversity Of Submerged Landscapes** Page 58. Photo: Amy Blank


1


2


1


2


3


4