Loch Lomond Symposium

Advances in Research in the Loch Lomond Catchment

27th and 28th October 2026



Loch Lomond Symposium: Advances in Research in the Loch Lomond Catchment

27th and 28th October 2026

Loch Lomond and The Trossachs National Park Headquarters, Balloch, G83 8EG

Programme

Tuesday 27th October

09:00		**Registration & Coffee**
10:00	Chris Harrod	Welcome and Introduction
10:15	**Colin Adams**	**Plenary 1: Contributions to science from the Loch Lomond catchment: The legacy of past research and prospects for the future**
10:45	Zihan Zhu	Reconstructing recent water-storage variability in major Scottish lochs using Sentinel-1 SAR and in-situ water-level observations
11:00	Francesco Baldini	Long-term monitoring of avian haemosporidian parasites in the Loch Lomond catchment: insights into host-vector-parasite interactions in a changing environment
11:15		**Coffee**
11:45	Owen Bramwell	Changing Priorities, Unchanged Rules: Adaptive Management of the Loch Lomond Water Supply Scheme Since 1971
12:00	Charlotte Slaymark	Biomarker records of climate and environmental change at Loch Lomond over the last 4,500 years
12:15	Jan Krokowski	Ecological status of Loch Lomond using phytoplankton
12:30	Jacob King	The names of the islands in Loch Lomond
12:45		Poster speed talks
13:15		**Lunch and poster session**
14:15	**Adrian Palmer**	**Plenary 2: Reconstructing Late Quaternary Environmental Change: Lessons from Loch Lomond**
14:45	Andrew Finlayson	Mapping Loch Lomond's underwater landslides
15:00	Jodie A.S. Geldard	Investigating the maximum extent, dynamics and retreat timing of the palaeo Lomond Glacier, an outlet of the West Highland Icefield.
15:15	Megan L. Baker	First assessment of the stocks and vulnerability of organic carbon buried in Loch Lomond
15:30		**Coffee**
16:00	**Kirsty Park**	**Plenary 3: Habitats, restoration and ecosystems**
16:30	Alan Law	Beavers: a 20 year journey of destruction and discovery
16:45	Rory Abernethy	Sitka spruce colonisation of montane habitats in Scotland
TBC		Evening drink/meal in local venue

Wednesday 28th October

09:30	**Colin Bean**	**Plenary 4: Conserving the Biodiversity of Loch Lomond: Past, Present and Future**
10:00	Ruaidhri Forrester	Relative read counts from eDNA metabarcoding accurately locate known spawning grounds of high conservation value Coregonus fishes
10:15	Hannele Honkanen	Navigating the catchment: Tracking Loch Lomond Atlantic salmon on their seaward migration
10:30	Jessica Rodger	Within species genetic and phenotype structuring amongst the salmonids over small spatial scales in the Loch Lomond catchment.
10:45	J. Peter Koene	A critical role for brain nutrition in the cognitive performance and life-history decisions of a partially migratory fish
11:00		**Coffee**
11:30	Lindis Kipp	From the Ground Up: how Structural Complexity and Microhabitat Availability Influence Rodent Abundance in Scottish Woodlands
11:45	Chris Harrod	Stable isotope analysis provides a rapid insight into ecological function, connectivity and unexpected variation across the SCENE catchment
12:00	Jemma Guthrie	The changing dynamics of moth pollination networks in Loch Lomond's temperate rainforest
12:15	Jennifer Dodd	Long-term change in macroinvertebrate distribution in the River Endrick
12:30		**Lunch and poster session**
13:30	**Cameron Easton**	**Plenary 5: More than just Tan Bark: An ecological history of the Loch Lomond Oak Woods**
14:00	Davide M. Dominoni	Ecology of small passerine birds along an urban-forest gradient between Glasgow and Loch Lomond
14:15	Katy Anderson	Water Voles and Beavers in the Trossachs - a story of restoration
14:30	Erin M. Phillips	Assessing the distribution of Loch Lomond's mammals using open data: species richness, knowledge gaps, and recording priorities
14:45		**Coffee**
15:15	Ashley Le Vin	The importance of field teaching for current students and in developing future ecologists
15:30	**Gordon Watson**	**Plenary 6: Loch Lomond and the Trossachs National Park: a nature positive, carbon negative, thriving place and the role which research partnerships play**
16:00	Chris Harrod	Final remarks

Talk Abstracts

Day 1

Session 1

Plenary

Contributions to science from the Loch Lomond catchment: The legacy of past research and prospects for the future.
Colin Adams

The Loch Lomond catchment has been batting well above its weight as a study site that has resulted in scientific discovery. Many discoveries have been of truly international importance. In this talk I will present a number of these; describe the importance of Loch Lomondside in the study and how the study findings have changed the way we understand the natural world. There are a number of reasons why Lomondside has played an important role in some kinds of scientific endeavour. I will also consider how and why Lomond will continue to provide a platform for filling gaps in our knowledge into the future.

Reconstructing recent water-storage variability in major Scottish lochs using Sentinel-1 SAR and in-situ water-level observations
Zihan Zhu, Adrian M. Bass, and Wenxin Zhang

Lake water storage is a key component of the regional water balance and reflects hydrological variability through time. In Scotland, rivers and lochs support water supply, industry and freshwater ecosystems, making water availability critical, particularly as our hydrological climate changes. Although satellite products have expanded lake-storage monitoring, quantifying seasonal-to-interannual variability and long-term trends requires sufficiently frequent estimates of both water-surface area and water level.
Scotland has an established hydrometric network that provides frequent and relatively long water-level records, however, temporally consistent observations of lake-surface areas remain limited. Optical satellite observations are frequently affected by cloud cover, creating substantial data gaps in Scotland's Atlantic maritime climate. Sentinel-1 synthetic aperture radar (SAR), by contrast, provides day-and-night observations largely unaffected by cloud conditions and therefore offers a consistent basis for monitoring changes in lake extent.
Here, we combine Sentinel-1-derived water-surface areas with in-situ water-level records to reconstruct relative storage changes in four contrasting Scottish lakes: Loch Lomond, Loch Leven, Loch Ness and Loch Katrine. These lakes differ substantially in surface area, depth, shoreline complexity, catchment characteristics and water-resource functions. Loch Lomond provides a particularly informative test case because its long, narrow and deep northern basin contrasts strongly with its broad, shallow and island-rich southern basin.
We establish lake-specific relationships among surface area, water level and relative storage, quantify associated uncertainties, and evaluate how lake morphology influences retrieval performance. The resulting storage series are used to characterize seasonal cycles, hydrological anomalies, interannual variability and trends during the Sentinel-1 observation period. This framework provides an observational basis for reconstructing storage variability beyond the satellite era using meteorological reanalysis, allowing recent fluctuations and hydrological extremes to be placed within a longer-term historical context.

Long-term monitoring of avian haemosporidian parasites in the Loch Lomond catchment: insights into host-vector-parasite interactions in a changing environment

Georgia Kirby, Bedur Ali Albalawi, Meshach Lee, Magdalena Mladenova, Barbara Helm, Heather M. Ferguson, Davide M Dominoni and Francesco Baldini

Since 2015, we have established a long-term monitoring programme of avian haemosporidian parasites in the Loch Lomond catchment, providing a unique opportunity to investigate host-vector-parasite interactions in a temperate ecosystem undergoing environmental change. Our study combines sampling of passerine bird communities with surveillance of their insect vectors, including biting midges (*Culicoides* spp.), blackflies (*Simulium* spp.), and mosquitoes, which transmit Haemoproteus, Leucocytozoon, and Plasmodium parasites, respectively. By integrating data from hosts, vectors and environmental conditions across multiple years, this system enables the investigation of ecological drivers of parasite transmission dynamics.

One finding from this long-term programme comes from our investigation of Leucocytozoon infections in blue tit (*Cyanistes caeruleus*) nestlings and their *Simulium* vectors. Infection risk in nestlings was strongly associated with reproductive phenology, with earlier broods experiencing lower prevalence. Heavily infected nestlings also exhibited reduced body mass, suggesting potential fitness consequences of infection. Screening of 399 blackflies revealed high Leucocytozoon prevalence (48%) across eight *Simulium* species. Environmental conditions influenced vector infection patterns, with prevalence increasing with rainfall and temperature. In contrast, the presence of *Wolbachia* endosymbionts in infected blackflies showed no detectable relationship with parasite infection status. These findings demonstrate how host phenology, vector ecology and environmental variability jointly shape parasite transmission. The Loch Lomond monitoring programme provides a valuable natural laboratory for understanding the ecological mechanisms underlying host-vector-parasite interactions and for predicting how disease dynamics may respond to ongoing environmental and climatic change.

Changing Priorities, Unchanged Rules: Adaptive Management of the Loch Lomond Water Supply Scheme Since 1971

Owen Bramwell

The Loch Lomond water supply scheme was commissioned in 1971 and remains a key component of the public water supply network across central Scotland. The Water Order of 1966 allowed construction of a barrage, a pumping station and two water treatment works. The barrage regulates releases from Loch Lomond, compensating for abstraction while maintaining sufficient storage to sustain summer flows.

Operation of the scheme has altered the natural hydrological regime, increasing mean summer water levels and introducing a distinct flow pattern driven by Water Order requirements. During the first three decades of operation, barrage control closely followed the original operating rules, with minimum compensation releases during the week, higher releases at weekends, and unrestricted flow whenever loch levels exceeded the upper control threshold.

Since 2000, several operational modifications have been introduced without breaching the Water Order conditions. These include a seasonal reduction in the upper control level to increase flood storage and extend periods of higher downstream flow, increased spring releases to protect spawning habitat, and more gradual transitions between controlled and uncontrolled releases.

Changes in regional water supply infrastructure have also reduced abstraction pressures. The scheme must balance the competing requirements of public water supply, river ecology, flood management and recreation. Higher loch levels benefit navigation and tourism, while enhanced downstream releases support river habitats. The history of the scheme demonstrates how a fixed regulatory framework can accommodate changing priorities through adaptive

management, while highlighting the need for continual reassessment of the balance between these competing objectives.

Biomarker records of climate and environmental change at Loch Lomond over the last 4,500 years

Slaymark, C., García-Alix, A., Beaddie, C. and Toney., J

Understanding long-term climate controls on the environmental response of Loch Lomond's catchment can aid in preparing the area for future climatic and potential environmental variability. The West of Scotland's average climate is becoming increasingly warmer and wetter; it is projected to warm by 1.1- 2.0°C and experience a reduction of 12- 16% in summer rainfall and an increase of 7 - 13% in winter rainfall by the 2080s, from a 1981-2000 baseline. Over the last 4,500 years there have been both long term (millennial scale) and short term (centennial scale) fluctuations in Europe where warming, cooling, wetter and drier episodes have occurred. This period serves as a useful 'natural laboratory' to understand both long- and short-term environmental responses at the catchment scale to climate change. Here, we present an organic geochemical and compound-specific isotope perspective of palaeo-environmental change at Loch Lomond. Specifically, we reconstruct hydroclimate, proportion of aquatic plants, catchment plant functional types, and lake productivity constrained with a radiocarbon carbon chronology. We statistically identify periods of environmental change and present preliminary results of the identified subdivisions of lake and catchment changes over the last 4,500 years.

Ecological status of Loch Lomond using phytoplankton

Jan Krokowski

Freshwater phytoplankton are a key biological quality element used in the assessment of ecological status in lochs under the Water Framework Directive and provide sensitive indicators of nutrient enrichment, and broader environmental change in freshwater ecosystems. This presentation describes the Scottish Environment Protection Agency's approach to assessing the ecological status of Scottish freshwater lochs and Loch Lomond in particular, using phytoplankton data and highlights recent developments in monitoring and assessment. Monitoring and assessments are based on the Phytoplankton Classification Tool (PLUTO), which integrates three metrics, chlorophyll-a concentration, phytoplankton taxonomic composition (Phytoplankton Trophic Index), and cyanobacterial bloom intensity. Together these provide a robust evaluation of ecological condition across a diverse range of Scottish lochs.

The names of the islands in Loch Lomond

Jacob King

The names of the islands in Loch Lomond show a dynamic linguistic landscape. There is little Brittonic or Norse influence on the names of the area, but Gaelic was likely spoken here for many centuries until the early twentieth Century, with Scots and English taking over in the early modern period.

The names of the larger islands such as Inchcailloch belong to an early Gaelic stratum. Smaller islands were mainly coined in Gaelic, and some of them were translated into Scots (eg Eilean nam Boc, now Bucinch). Early modern maps and other documentary sources show not just how these names have evolved, often changing from one language to another, but also show the names of several islands which no longer exist. The speaker has written a monograph on this subject, which will be published in the near future, and this short presentation will be based on that work.

Session 2

Plenary

Reconstructing Late Quaternary Environmental Change: Lessons from Loch Lomond
Adrian Palmer

For over 150 years, the Loch Lomond basin has played an internationally important role in developing our understanding of Late Quaternary environmental change. In the nineteenth century, early scientists noted the peculiarity of discovering marine shells within glacial deposits. This finding led to a new interpretation involving a renewed expansion of glaciers into the Scottish Lowlands, subsequently termed the Loch Lomond Readvance after its type locality.

Research during the late twentieth century substantially refined this history. Sedimentological evidence demonstrated marine inundation in the southern Loch Lomond and Clyde catchments, indicating higher relative sea levels for a period before the ice readvanced. Developments in geomorphological mapping and glacial sedimentology established the extent and behaviour of the readvancing ice and identified glaciolacustrine systems formed by ice-dammed drainage. Palynological records revealed the sequence of climatic oscillations at the end of the last glaciation, including the return to cold conditions during the Loch Lomond Stadial, which drove this renewed glacier expansion. Radiocarbon dating subsequently constrained this cold phase to *c.* 12,900 to 11,700 years ago.

More recently, tephrochronology, annually laminated lake sediments, and cosmogenic radionuclide dating have further refined the timing and dynamics of glacier advance and retreat. This talk reviews the major scientific milestones that have made the Loch Lomond basin a key reference area for understanding climatic and environmental change during the Late Quaternary in north-west Europe.

Mapping Loch Lomond's underwater landslides
Andrew Finlayson, Nicola Dakin and Rhys Cooper

Loch Lomond is one of Scotland's most iconic landscapes, surrounded by landforms that reveal the region's glacial past. However, much less is known about the sediments and landforms hidden beneath its waters.
This talk explores underwater landslides that have affected the loch floor, using evidence from high-resolution multibeam bathymetry and shallow seismic imaging. The data reveal widespread subaqueous landslide activity shortly after deglaciation, around 11700 yrs ago. Although much of the loch bed is now largely stable, these relict landslides provide valuable insights into the long-term geomorphological evolution of Loch Lomond's underwater landscape and help identify potential locations that may be susceptible in the future.
We will also examine more recent underwater slope failures, some of which appear to be linked to construction work associated with A82 road improvement in the 1980s. These examples demonstrate how loading of the loch bed near steep shorelines can trigger underwater slope instability. Understanding these processes is important when planning future developments, such as transport and energy infrastructure, around steep loch shorelines.

Investigating the maximum extent, dynamics and retreat timing of the palaeo Lomond Glacier, an outlet of the West Highland Icefield.

Geldard, J.A.S.; Bradwell, T.; Benn, D.I. and Tisdall, E.

During the Loch Lomond Stadial (12.9 – 11.7 ka BP), a large ice cap formed over the West Highlands of Scotland. The Lomond Glacier was an anomalously large, low-gradient outlet, draining ice toward the south. The glacier forms the type-site of the Loch Lomond Stadial in Scotland, yet despite its significance, questions remain regarding its size, dynamics and retreat timing. Recent advances in high-resolution data availability and dating methods now permit a detailed reappraisal of the glacial record. This PhD re-examines the landform and sediment record of the Lomond Glacier, utilising field walkover surveys and analysis of high-resolution data, including LiDAR, multibeam swath bathymetry and sub-bottom seismic data. This multi-proxy approach enables the almost seamless mapping of landforms between the lacustrine and terrestrial records. Importantly, the high-resolution elevation data (≤2 metre pixel resolution) reveal subtle landforms previously unidentifiable from the more widely used RADAR data (5 metre pixel resolution). The new geomorphological mapping includes lateral limits, terminal moraines up to 50 metres in relief on the bed of Loch Lomond, and a field of subglacial bedforms extending over 100 km^2. These results enable the reconstruction of the palaeo Lomond Glacier, provide new evidence on former glacier dynamics, and highlight the asynchronous retreat between neighbouring catchments. Interdisciplinary value from this research includes insights on the former migration pathways of species, palaeo environmental reconstruction and post-glacial environmental development.

First assessment of the stocks and vulnerability of organic carbon buried in Loch Lomond

Megan L. Baker, Tom Bradwell, Jodie Geldard, Christopher Vane, Andrew Finlayson, Nicola Dakin and Jack Lacey

Burial of organic carbon in lake sediments is a significant long-term carbon sink. In Scotland, freshwater lochs are a major feature of the landscape, yet the amount and vulnerability of the organic carbon buried within these systems is poorly understood. Here, we use two sediment cores to characterise organic carbon burial in Loch Lomond.

Sediment cores were collected from the central basin at 54 m water depth (1.2 m long) and the southern basin at 20 m water depth (0.96 m long). From each core, sediment samples were analysed for dry bulk density, grain size, total organic carbon (TOC), total nitrogen (TN) and carbon isotopes (δ13C). Rock-Eval pyrolysis was undertaken to assess the organic carbon sources and degradation.

Results show that both cores are dominated by silt-sized sediments. Spatial variability in organic carbon burial was observed, with average TOC (>10 cm depth) of 3.8 ± 1.7% in the central basin and 2.7 ± 0.5% in the southern basin. Rock-Eval shows that the organic carbon is relatively stable, suggesting resistance to remineralisation if the loch bed is disturbed. The organic carbon is predominantly derived from terrestrial plant material, with contributions from lacustrine algae in the top ~5 cm of the sediment bed. A preliminary radiocarbon date indicates a long-term organic carbon accumulation rate of 3.2 g C m-2 yr-1, approximately half the rate reported for Scottish marine lochs. This work demonstrates that Loch Lomond sediments contain substantial, spatially variable organic carbon stocks that are resistant to degradation.

Session 3

Plenary

Using historical woodland creation sites as test landscapes to inform future conservation actions
Kirsty Park

Large-scale habitat creation is now widely recognised as essential in combating the global biodiversity crisis, yet evidence for its effectiveness remains limited due to short study timeframes, restricted spatial scales, and narrow taxonomic focus. Since 2013, the WrEN project has used a 'space-for-time' natural experiment to address these limitations, surveying 107 historical woodland creation sites across the UK, ranging in age from 10 to 160 years, to assess how past woodland creation has shaped current biodiversity. To date, we have documented more than 1,400 species across 10 taxonomic groups.
Responses to local and landscape attributes varied among taxa, but woodland age consistently had a positive effect on species richness and abundance. This relationship was indirect, mediated through the development of structural heterogeneity and decreasing tree density as woodlands mature, underscoring the critical role of ongoing management. Structurally complex woodlands, with a diverse range of tree sizes and ages, supported the greatest abundance and diversity of species. Even very small woodlands provided benefits, but larger sites supported substantially more plant and bird species, and proximity to existing high-quality woodland improved connectivity for slower-dispersing taxa such as plants.
Critically, ancient woodlands could not be replicated by new planting: it took more than 80 years for new woodlands to begin acquiring old growth structural features, and even then, ancient sites retained substantially more specialist woodland plants. Together, these findings point to three priorities for future woodland creation: designing for structural complexity from the outset, creating woodland at scale, and targeting new planting to maximise landscape connectivity.

Beavers: a 20 year journey of destruction and discovery
Alan Law and Nigel Willby

As ecosystem engineers, beavers are second only to humans in their capacity to change landscapes; their damming of streams creating heterogenous wetlands. This talk will summarise our work on beavers over 20 years, documenting expected and unexpected changes, and what to expect as they move into new catchments across Scotland.

Sitka spruce colonisation of montane habitats in Scotland
Rory Abernethy, Sarah Greenwood and Dan Chapman

Sitka spruce (*Picea sitchensis*), a non-native species in Scotland important for the forestry sector, now accounts for 43% of national woodland cover. It is increasingly colonising montane environments, raising concerns for native biodiversity across upland environments in Scotland - particularly in the Loch Lomond region, where extensive areas of Sitka spruce plantations border large areas of vulnerable upland habitat.
This talk presents findings from a national-scale observational analysis of the spatial patterns and habitat associations of colonisation alongside preliminary findings from a recently

established microclimate monitoring programme. This analysis reveals that colonisation is recorded above 1000m - approximately 500m above the highest plantation - with 2.5% (n = 124) of observation clusters situated above 600m, the broad elevation where a native treeline would be expected to form. Median dispersal distance increased almost tenfold between the 300-400m and 600m+ bands, from 181m to 1619m. Using the EUNIS habitat map of Scotland (HabMoS), habitat associations were broadly neutral, with cliffs and rocks showing a slight preference, which may point to this habitat's role as an establishment refugia, as browsing is usually reduced. Initial results from the microclimate experiment suggest a significant thermal buffering effect of Sitka canopies on air temperatures, with under-canopy loggers showing a significantly more compressed diurnal temperature range compared with open controls. Additionally, in response to periods of no precipitation, under-canopy soil dried more slowly than open controls, suggesting reduced evaporative demand beneath the canopy outweighs interception losses.

Day 2

Session 1

Plenary

Conserving the biodiversity of Loch Lomond: Past, Present and Future
Colin Bean

This talk explores the changing landscape of biodiversity conservation within Loch Lomond. It will examine how human activities have the potential to impact species of conservation concern, and explore how new approaches to both monitoring and conservation policy will help to protect this vital environment in future years.

Relative read counts from eDNA metabarcoding accurately locate known spawning grounds of high conservation value *Coregonus* fishes
Ruaidhri Forrester, Hannele M. Honkanen, Colin W. Bean, Melanie Fletcher, Nathan P. Griffiths, Jemma Guthrie, Chris Harrod, Phoebe Kaiser-Wilks, James A. Macarthur, Dave Ottewell, Philip Ramsden, Dasha Svobodova, Bernd Hänfling and Colin E. Adams

The identification of key spawning locations is an important component of the monitoring of freshwater fish, but existing approaches are often invasive or labour intensive. This study investigates the effectiveness of eDNA metabarcoding as a non-invasive method of locating the lacustrine spawning grounds of two species of salmonid fish, *Coregonus albula* and *Coregonus lavaretus*. In each of four study lakes, namely Bassenthwaite Lake, Derwent Water, Loch Eck and Loch Lomond, 20 spatially distributed two litre water samples were collected near the shoreline during the spawning period of the target species. Among-sample variation in the proportion of reads assigned to *Coregonus* was then compared with the locations of known *Coregonus* spawning grounds. In three of the four study lakes the eDNA signal was sufficiently strong to infer that evidence of spawning had been captured. In all three of these lakes, spatial variation in the *Coregonus* relative read counts qualitatively corresponded with the locations of known spawning grounds. In the two lakes with a spatially clustered distribution of known spawning grounds, the eDNA sampling site with the highest relative read count was significantly closer to those spawning grounds than would be expected by chance. Comparisons with eDNA data collected outside the *Coregonus* spawning season indicated spawning activity was likely to have been the cause of the observed correlations. These results suggest that the lacustrine spawning grounds

of *Coregonus* fishes can be located by evaluating the strength and spatial heterogeneity of an eDNA metabarcoding signal.

Navigating the catchment: Tracking Loch Lomond Atlantic salmon on their seaward migration

Hannele Honkanen, Jessie Lilly, Jessica Rodger, Louise Chavarie, Ruaidhri Forrester and Colin Adams

The smolt migration to sea is a critical stage in the life cycle of Atlantic salmon, often associated with high rates of mortality. Salmon in the Loch Lomond catchment have to migrate through a range of different habitats before reaching the open ocean. In particular, they face an additional challenge of migrating through a large area of standing water where water flow cues are not clear. This talk will synthesise acoustic telemetry studies from the Loch Lomond catchment and Clyde system that examine salmon movement from the River Endrick, through Loch Lomond and the River Leven, and into the estuary and the open ocean. Together, these studies demonstrate that salmon migration success is shaped by habitat-specific challenges, with particularly high losses in freshwater, mainly due to predation. Migration through Loch Lomond is characterised by slow and random movement, and no consistent differences can be found between successful and unsuccessful fish. Migration through the Clyde estuary is fast and with relatively low loss rates. The studies also illustrate how combining telemetry approaches with behavioural and mechanistic modelling can identify where and when migration bottlenecks occur, providing a basis for targeted monitoring and conservation.

Within species genetic and phenotype structuring amongst the salmonids over small spatial scales in the Loch Lomond catchment.

Jessica Rodger

We tend to think of species as comprising a group of very similar individuals, more or less randomly breeding and thus sharing genes and looking similar in terms of phenotype (for example in body shape, size, colour etc). When we find patterns that differ from this it can tell us an enormous amount about the processes that are shaping evolutionary pathways. In recent work we have shown very marked structuring in both the genotype and phenotype amongst brown trout in the Lomond area and something similar amongst the Atlantic salmon has been found. In this talk I will describe the intraspecific patterns of genetic and phenotype structuring and how it might have formed and is being maintained, and the consequences of these patterns for wildlife management.

A critical role for brain nutrition in the cognitive performance and life-history decisions of a partially migratory fish

J. Peter Koene, Arne Jacobs, Libor Závorka, Matthias Pilecky, Hannele Honkanen, Martin Kainz, Kathryn Elmer and Colin Adams

Partial migration, in which migratory and non-migratory individuals coexist within a single population, is widespread among salmonids, yet its proximate causes remain unresolved. This study tested whether access to n-3 long-chain polyunsaturated fatty acids (LC-PUFA), particularly DHA, shapes cognitive performance and migratory tendency in brown trout (*Salmo trutta*). In a controlled feeding experiment, juveniles reared on LC-PUFA-enriched diets developed larger brains and outperformed diet-restricted conspecifics on cognitive assays. Wild riverine, potamodromous, and anadromous trout sampled from the Loch Lomond catchment

showed ecotype-specific fatty acid and hepatic transcriptomic profiles, with riverine residents showing elevated LC-PUFA biosynthesis gene expression and greater endogenous DHA bioconversion. These findings indicate that the principal axis of divergence is migratory versus non-migratory life history, with residents physiologically adapted to compensate for nutrient-poor natal streams.

Session 2

From the Ground Up: How Structural Complexity and Microhabitat Availability Influence Rodent Abundance in Scottish Woodlands
Lindis Kipp

Climate change and land use change have driven a major decline in forest cover worldwide, leading to a decrease in structural heterogeneity and associated habitat availability. However, the impacts of these changes on forests and their inhabitants have been primarily investigated at landscape scale, with forests as patches. For many animal species within a forest, this is too coarse as they rely heavily on microhabitat availability. This study investigated the influences of variation in fine-scale ground-based microhabitat availability on the abundance of wood mouse (Apodemus sylvaticus) and bank vole (*Myodes glareolus*) in three woodlands in and around the Loch Lomond catchment, which differed in age and connectivity. Vegetation surveys were paired with rodent trapping data to analyse influences at both the fine-scale trap level and site-level. Site was the strongest predictor of rodent abundance at trap level. Microhabitat effects were scale-dependent: at the trap level, soil moisture and vegetation height positively predicted abundance, whereas at site level leaf litter depth was a significant positive predictor and understorey canopy cover was a significant negative predictor. Site-level abundance matched the surrounding landscape forest cover gradient; sites surrounded by more woodland had greater rodent abundance. These findings show that microhabitat availability has a measurable effect on rodent abundance, with the relevant vegetation parameters depending on scale. This has implications for woodland restoration, where herbaceous understorey restoration is rarely prioritised despite its slow recovery post-disturbance. The results suggest re-establishing connectivity may have to be combined with active understorey restoration to improve biodiversity outcomes.

Stable isotope analysis provides a rapid insight into ecological function, connectivity and unexpected variation across the SCENE catchment
Chris Harrod, Davide Dominoni, Claire Branston, Calum Johnstone, Kanishk Walavalkar, Jason Newton, Rona McGill, Ana Beatriz Navarro, Seth Nisbet and Darren Gröke

Stable isotopes have become a standard tool in the ecologist's toolbox, helping to reveal information from physiology and behaviour of individual and groups of organisms, energy and nutrient flow from different primary production pathways thorough consumers at different trophic levels and across ecosystem boundaries. Here, using data collected by researchers at SCENE from terrestrial and aquatic systems and taxa, I will show how stable isotope analysis has provided a rapid insight into ecological function, connectivity and (unexpected) heterogeneity across the SCENE catchment.

The changing dynamics of moth pollination networks in Loch Lomond's temperate rainforest

Jemma Guthrie, Dan Haydon, Barbara Mable, Jan Lindstrom, Adam Kleczkowski, Jim Jeffrey and Brigid Primrose

Moths are crucial but poorly understood pollinators, with much remaining to be discovered about the structure and dynamics of their pollination networks. To predict the future stability of these systems and continued provision of vital ecosystem processes, it is essential to study how these networks function over time and in response to environmental change. Identifying pollen carried by moths captured in the Loch Lomond oak woods has enabled us to model their pollination network in this ecosystem, revealing which moths are the most important pollinators and which plants are most reliant on moths for pollination. We will combine this with analysis of a 58-year data set of moth catches at SCENE to understand how this vital ecosystem process has changed over time, incorporating seasonal patterns and long-term dynamics. This will enable us to predict how these services might respond to climate change or conservation interventions. From two years of data collected so far on moth pollen transport, we have identified key pollinating species such as the brown silver-line (*Petrophora chlorosata*). We also found that moths contribute to much more complex pollination networks in spring than in summer. Preliminary analysis of long-term moth data reveals substantial levels of species turnover, with many new species arriving in the community, including several identified as pollinators. By synthesising these, we will address knowledge gaps surrounding the importance of different moth species as pollinators in temperate woodlands, and the resilience of moth pollination networks under environmental change.

Long-term change in macroinvertebrate distribution in the River Endrick

Jennifer Dodd and Colin Adams

Macroinvertebrates are the backbone of freshwater health assessment; community composition integrates the prevailing conditions within a system. But much of what we treat as the expected distribution of species rests upon work carried out in the early to mid-20th Century; expectations set under a different climate and a different biodiversity baseline. Where distributions have shifted in response to global change drivers, assessments tied to historical expectations risk attributing changes in species presence solely to local pressures. Disentangling global from local signals is thus crucial to set targets that are achievable.

The challenge of meeting this need is compounded by changes in how descriptive science is funded and published. Fieldwork-based studies have fallen as a share of the conservation literature since the 1980s and tend to appear in lower-profile journals, while funding has moved towards work framed around an attributable stressor or a novel technique. Science asking what lives where now, and how that differs from before, satisfy neither criterion, despite generating the baselines on which stressor attribution depends.

This talk describes changes in macroinvertebrate species presence along the River Endrick in 1960 and 2010 and compares with observations from other river systems. The results showed that cold adapted species distributions have contracted while pollution tolerant and non-native species have expanded their distribution. The results highlight the importance and need for observational studies.

Session 3

Plenary

More than just Tan Bark: An ecological history of the Loch Lomond Oak Woods
Cameron Easton

The oak woods round SCENE are an integral part of the "Bonny Banks of Loch Lomond". There are various ecological definitions of the woods, but crucially they are both Ancient Woodlands and Atlantic Rain Forest. As such, the woods provide a perfect system for researchers to study natural ecological processes.
And yet. These woods are not natural. Indeed, people were present on Loch Lomondside long before the oak woods even developed.
For nearly 7,000 years people had only a slight impact on the woodlands. Then, over the next 2000 years, agricultural communities altered the nature of the woods significantly. The 18th century re-invented the woods as an industrial scale source of tan bark and pyroligneous acid for the dyeing industry. While this phase lasted for only 200 years, it changed the woodlands completely. Despite this, for the last 70 years the woods have been protected by a series of nature conservation mechanisms. This has not always been a smooth process, and along the way there was state-sponsored coniferisation and skullduggery in the corridors of power over ownership of the woods.
However, even with the highest levels of protection, the future of the woods is not secure. Action is required to mitigate ongoing threats. But we lack basic information to understand the scale of the problems. Nowhere are these threats more visible than in the woods round SCENE. And nowhere is there a better opportunity to study both threats and solutions!

Ecology of small passerine birds along an urban-forest gradient between Glasgow and Loch Lomond
Davide M Dominoni, Paul J Baker, Claire J Branston, Barbara Helm and Stewart White

Urban areas are altered from natural landscapes in several ways that can impact wildlife. Birds are widespread in urban areas, and it is well documented that there are phenotypic differences between urban and non-urban conspecifics. However, little is known about which characteristics of the urban environment are driving differences. We have established the Glasgow Urban Gradient since 2014, installing nest boxes for passerine birds at 20 sites along a 40-km urban–non-urban gradient between Glasgow and Loch Lomond. We have used this system to test which environmental characteristics along the urban gradient influenced We have obtained detailed measurements of environmental characteristics in the area around each nest box, including vegetation (native and non-native foliage availability, temperature, light and noise pollution and human population density) and used these to explain differences in phenology and reproductive success in blue tits (*Cyanistes caeruleus*). We found that urban blue tits do not breed earlier than forest ones, but they suffer from reduced reproductive success, mostly due to high mortality of chicks after one week of age. Higher non-native foliage availability at both a site and territory level was negatively related to clutch size. The number of fledglings produced was reduced at sites with higher levels of non-native foliage and increased at sites with greater amounts of native oak foliage present. We also found territories with a higher human population density had reduced fledging success. Moreover, the number of Lepidopteran larvae, blue tits' preferred prey, that were collected over the breeding season was positively related to native oak foliage availability. Our results strongly indicate that the presence of native trees, such as oak, are beneficial to breeding insectivores by increasing the number of fledglings they can successfully raise, likely due to the increased availability of invertebrate prey. We suggest that

urban planting regimes should be carefully considered, selecting tree species that are native or non-native congeneric species, and most importantly that will host Lepidoptera larvae. This will not only help to support complete food chains, but also to maximize biodiversity and ecosystem services of urban green spaces.

Water Voles and Beavers in the Trossachs - a story of restoration
Katy Anderson

A brief account of The Trossachs Water Vole Reintroduction Project, which started in 2006, aiming to return water voles to restored wetlands on forestry sites. This was the first WV reintroduction in Scotland and has been a tremendous success. 20 years later, water voles are thriving throughout the Trossachs and surrounding landscape. In 2024 the first Beaver translocations in the Trossachs took place at some of the same sites where water voles were released. Beavers are now spreading throughout the Trossachs, transforming the landscape and creating diverse new habitats.

Assessing the distribution of Loch Lomond's mammals using open data: species richness, knowledge gaps, and recording priorities
Erin M. Phillips and Dominic J. McCafferty

Terrestrial and aquatic mammals play important roles in the ecology and functioning of the Loch Lomond catchment area. However, except for a few species of conservation concern, the overall distribution of species throughout the catchment is not well documented. We make use of open and citizen science data to 1) explore the richness and occupancy of native and invasive mammals within the Loch Lomond region, and 2) assess gaps in recording their distribution. We find that distribution for most species reflects bias in both systematic surveys and citizen scientist observer effort. This analysis provides important insight into current data availability and coverage that can inform future biodiversity surveys in the region, and highlights priorities for citizen science recording to further develop our understanding of mammal ecology in Loch Lomond and the Trossachs National Park.

The importance of field teaching for current students and in developing future ecologists
Ashley Le Vin, Anna McGregor, Victoria Paterson and Stewart White

Many generations of students have had the pleasure of gaining their first experience of fieldwork at SCENE, and some have taught later generations as members of University staff. As educators and ecologists we recognise the importance of such experiences, but with increasing pressures on our ability to deliver them, with climbing student numbers and decreasing budgets. The importance of equality, diversity and inclusion and supporting all who wish to take courses is another pressure.
In this presentation we will give a brief history of University of Glasgow undergraduate field courses at SCENE and discover what past students have done with the experience in their later careers. More importantly we will summarise some of the transferrable skills developed on the field courses, as these are hugely important for students post-graduation. We will also address the opportunities for community building and social networking between the students and creating stronger connections between students and staff that are a unique aspect of field courses. We will utilise a range of sources, from formal student feedback to the University, NSS comments and informal discussion with staff. To recognise the changing shape of the university experience, we will share how fieldwork teaching progresses to reflect national priorities within higher education, both in terms of interdisciplinary experience and work-based learning. By the end of the presentation we will have illustrated why SCENE in particular and field courses in

general are an irreplaceable part of student education across disciplines and argued why universities should continue to support them.

Plenary

Loch Lomond and the Trossachs National Park: a nature positive, carbon negative, thriving place and the role which research partnerships play

Gordon Watson

Gordon Watson will present a strategic and operational perspective on the National Park vision to deliver a nature positive, carbon negative, thriving place and the role which research partnerships can play in helping achieve that aim. The plenary session will describe the overall National Park Partnership Plan including the modelling work completed by Small World Consulting which drives the National Park's net zero goals and the State of Nature reviews and ecological indicators which guide the Nature restoration plans. A Greenhouse Gas (GHG) Assessment carried out for each of the UK's National Parks has provided a detailed carbon footprint and a proposed pathway for each Park to become a Net Zero place. The GHG assessment for Loch Lomond & The Trossachs shows that the National Park has the capacity to go from being an emitter, as it currently is, to being a significant source of sequestration, or a 'carbon sink', helping Scotland achieve its ambition to be a Net Zero Nation by 2045. There remain many operational challenges and research questions to inform this 'glide path' to being a carbon sink ranging from monitoring the impact of current peatland restoration work to understanding and designing a range of programmes to reduce emissions from transport and food and drink. In terms of nature restoration the Future Nature Route Map works towards an ambitious vision that "Loch Lomond & The Trossachs National Park is a resilient nature-rich National Park, where abundant wildlife and a healthy natural environment provide a wealth of benefits through an extensive, well-connected living network." A State of Nature review carried out in 2023 showed that "although the park may be performing relatively well compared to some benchmarks, it still falls significantly short of the ambitious goals set for a National Park". Scaling up peatland restoration and woodland expansion in recent years demonstrates a growing delivery programme but major research questions on the connectivity and resilience of our habitat networks remain. In terms of the water habitat in particular the National Park Authority has this year completed a full strategic review of its water delivery plan in response to the overlying SEPA water quality data which continues to show approximately 50% of water bodies in the National Park may not be in good ecological condition. A key point of this review was the remaining significant data gaps in our understanding of the water habitat. Across the work of the National Park there are opportunities for the scientific community to work alongside the operational teams in the National Park to implement truly ambitious programmes for carbon reduction, nature restoration and thriving communities.

Poster Abstracts

Integrating DNA metagenomics and biotelemetry to link diet and movement ecology of tawny owls (*Strix aluco*) along an urban gradient

Eugenio Carlon, Giuseppe Orlando, Paul Baker, Arianna Passarotto, Luca Nelli, Alma Liss Sanchez Quinones, Andreanna J Welch and Davide M Dominoni

In nocturnal predators, anthropogenic light and noise pollution affect foraging by interfering with sensory perception, but also likely by altering prey accessibility through changes in prey behaviour. Sensory pollutants may reduce access to natural prey while creating novel opportunities to exploit alternative species. Albeit nocturnal predators occupy key roles in ecosystem health, to date most research on the effects of sensory pollutants has focused on diurnal species at low or intermediate trophic levels.

Here, we combine diet DNA metabarcoding techniques and biotelemetry to investigate how urbanisation and sensory pollutants influence movements and diet of Tawny owls (*Strix aluco*). Specifically, we aim to (1) use pellets and buccal swabs to evaluate dietary shifts across an urban and sensory pollution gradient, also optimizing a metabarcoding framework for dietary analysis of a generalist meso- or apex predator predator. Also, we (2) use GPS tags with accelerometers to study Tawny owl movement ecology in relation to sensory pollutants; and (3) contrast foraging strategies assessed using a machine learning classification approach.

We hypothesise that the modified sensorial landscape leads to a more varied diet in urban Tawny owls, with a shift towards more avivorous diets relative to their typical preference for small mammal prey. Moreover, we expect this dietary change to be associated with reduced sit-and-wait foraging strategy and landing strikes, and increased movement in search of foraging opportunities at illuminated sites under noisy conditions.

This study will provide the first evidence for effects of combined anthropogenic light and noise on nocturnal predators' diets, generating novel insights into the potential cascade effects on the ecosystem community at broad.

Webs of reciprocity: an investigation of the drivers of aquatic subsidy use by web-building spiders in a lacustrine island system

Calum Johnstone

Aquatic ecosystem subsidies, and emergent amphibiotic insects in particular, constitute a significant source of energy and nutrients to lacustrine island systems, which are often otherwise limited in terms of autochthonous resources. Whilst the effects of island geometric characteristics, such as area and shape, upon aquatic subsidy influx have been partially described, subsequent effects upon the proportional dietary contributions of aquatic resources to generalist terrestrial predators have not been explored. In this study, I aimed to provide the first estimates of the overall proportional contribution of emergent aquatic insects to the diets of insular spiders in a lacustrine island system. Furthermore, I aimed to characterise the effects of spider family, and island area and shape upon the proportional use of aquatic-derived prey. Through carbon and nitrogen stable isotope analysis of insular web-building spiders (Tetragnathidae and Theridiidae) and their prey, sampled from eight islands in Loch Lomond, I estimate aquatic-derived insects to constitute 36% of insular spider diets. Significant variation in dietary contribution estimates was observed between spider families, as tetragnathids derived 50% of their assimilated C and N from aquatic-derived sources, whilst this fell to 18% for Theridiidae. GLMM analysis did not suggest island geometry to significantly affect the proportional use of aquatic-derived prey, but general trends within the data indicate that both island area and shape regularity may be negatively correlated with consumption of this prey

resource. This study therefore lays the groundwork for future research to fully characterise the drivers of the observed variation in aquatic-subsidy use by generalist arthropod predators in lacustrine island systems and contributes to the understanding of the trophic ecology of the Loch Lomond catchment.

Exploring the role of littoral macrophytes in supporting food-web processes in a dystrophic lake in Western Scotland

Kanishk Walavalkar, Chris Harrod and Darren Gröcke

Littoral habitats are often overlooked in assessments of carbon cycling in lakes, despite their potential to support higher trophic levels. Dystrophic lakes, with variable contributions from autochthonous and allochthonous production, provide a useful model for resolving these pathways. We investigated carbon flow through the food web of Dubh Lochan, a small (0.07 km^2) dystrophic lake in western Scotland, using carbon and nitrogen stable isotope analysis.

We quantified the contribution of littoral production to consumer biomass using *Perca fluviatilis* as a focal consumer and Bayesian mixing models. Littoral macrophytes were the largest individual primary carbon source (28.2%), while allochthonous sources collectively dominated overall carbon inputs (58.1%). Despite contributing only 41.9% of total inputs, autochthonous production accounted for 50.4% of perch biomass, indicating disproportionate transfer of locally produced carbon to higher trophic levels. Terrestrial sources, including leaf litter, contributed a further 32.1%.

Our results demonstrate that carbon availability and carbon transfer through the food web are not equivalent, highlighting the disproportionate role of littoral production in supporting higher trophic levels. These findings underscore the functional importance of littoral habitats in carbon cycling within dystrophic lake ecosystems.

Impact of light pollution on macro-moth morphology and community structure

Eiryn Milligan

Macro-moths are known to exhibit positive phototactic behaviour, but recent research has revealed that this behaviour may be reduced in response to long term light pollution. Behavioural shifts may be underpinned by morphological changes, but little is known about how light pollution affects macro-moth morphology. This study aimed to provide the first insights into the effects of light pollution on macro-moth morphology in Scotland. Estimated eye surface area and forewing length of common marble carpet (*Dysstroma truncata*) individuals were compared from an urbanised (Glasgow) and rural (Scottish Centre for Ecology and the Natural Environment) location to represent two ends of a light pollution gradient. All other macro-moth species caught in traps were identified and counted, and published average body size values of the collected specimens were used to calculate community-weighted mean body mass. Moths were captured using a paired bait and light trap method. This study found no significant relationship between estimated eye surface area and light pollution, as well as between forewing length and light pollution. Estimated eye surface area when corrected for body size was also not significantly affected by light pollution. There was however a significant reduction in community-weighted mean body size with increasing radiance. These results suggest that while light pollution may cause changes in morphological trait composition in a community, this may not be applicable to all species.

The Impact of Urbanisation on Hibernation Physiology and Behaviour in European Hedgehogs (Erinaceus europaeus)

Isaac Westlake and Davina Hill

Hibernation is an extreme energy-saving strategy characterised by a depression in metabolic activity and body temperature, employed by species during periods of food scarcity and adverse ambient conditions. As an important life-history strategy, hibernation tightly constrains the hibernator's life cycle, limiting individuals to a short active period for growth and reproduction. Therefore, alterations in hibernation physiology and behaviour, particularly timing, can have negative impacts on survival and reproductive success. Urbanisation poses risks to hibernators, as sensory disturbance and altered habitats and microclimates may influence hibernation behaviour and physiology. However, as most studies rely on coarse survival metrics to monitor hibernation, there is a lack of fine-scale evidence linking sensory disturbance to hibernation physiology and behaviour, and consequently a lack of mechanistic understanding. This project aims to address this gap using the European hedgehog (*Erinaceus europaeus*) as a model species, given its abundance across urban and rural habitats and amenability to fine-scale biologging. Specifically, this project will examine the hibernation physiology and behaviour of hedgehogs across an urban-rural gradient between SCENE and the city of Glasgow. We will use continuous biologging of radio-tagged hedgehogs alongside nest-scale environmental monitoring to quantify associations between environmental conditions/disturbance and hedgehog hibernation patterns, physiological stress, and body condition. We will also experimentally manipulate noise disturbance in a subset of hibernation nests to gain causal understanding of the effects of artificial noise on hibernation physiology and behaviour. This poster will present the project's aims, background and study design ahead of the upcoming field seasons.

Impacts of Urbanisation and Land Management on the Peregrine Falcon (*Falco peregrinus*) Population of Scotland

Keir Hardy

The Peregrine falcon is globally distributed species of raptor found in a variety of habitats. In the UK the species is traditionally associated with upland areas and coastal cliffs. However, in recent years its distribution has shifted to become more lowland and urban, as upland population decline and peregrines colonise anthropogenic habitats. Despite this limited empirical research exists investigating the drivers of these shifts.

This study used a 20-year dataset of Peregrine monitoring across Scotland, including notable sampling within the Loch Lomond area, to determine how occupancy, breeding success and productivity were impacted by habitat, grouse moors and May rainfall.

We found that nests in urban sites were less likely to be successful than rural ones, but these sites were more productive when successful. Sites on grouse moors were less likely to be occupied and successful than unmanaged ones. And heavy May rainfall negatively impacted both breeding success and productivity. These results mark the first time urban environments have been shown to negatively impact Peregrine reproduction, potentially due to a lack of suitable nest sites in Scotland. Meanwhile the negative impacts of grouse moors and heavy rainfall present potential explanations for observed upland declines and could hold significance for future management decisions within the Loch Lomond and the Trossachs national park site.

Blue Tit Stable Isotopes

Ben Smith, Chris Harrod

Blue tits (Cyanistes caeruleus) are dietary generalists that breed across woodland and garden habitats along rural–urban gradients. During breeding, nestling diets consist predominantly of caterpillars and other arthropods, although this well-characterised feeding ecology may conceal variation among broods. This poster presents a reanalysis of nestling blood stable isotope data from Navarro et al. (2025), focusing on nest boxes within the long-term study at SCENE. Unexpectedly, nestlings from different nest boxes occupied distinct regions of carbon–nitrogen ($\delta^{13}C$–$\delta^{15}N$) isotope space, revealing pronounced isotopic differences among broods. Two processes may explain this pattern. Parental pairs may adopt distinct foraging strategies, selecting different prey or foraging locations and consequently provisioning nestlings with isotopically different diets. Alternatively, spatial variation in baseline isotope values across parental foraging ranges may produce differences among broods even where prey composition is similar. The observed variation may therefore reflect parental behaviour, environmental heterogeneity, or their combined influence. Future work should therefore assess the relative contributions of these processes, examine whether comparable patterns occur in other bird species, and investigate associations with breeding performance and success. These findings highlight the importance of considering variation among broods when interpreting population-level patterns in trophic ecology.

Urbanisation had no negative impact on the body condition and size of two bumblebee species when compared between urban and rural sites in Scotland.

Emma Plant, Dominic McCafferty and Jeanne Robinson

Urbanisation, the conversion of natural habitat to environments increasingly dominated by impervious surfaces, is rapidly increasing worldwide. Urban environmental conditions are associated with losses in pollinator diversity. Environmental stressors such as the urban heat island (UHI) effect may influence pollinator physiology and, consequently, individual fitness. For example, the UHI effect has been associated with smaller body sizes in *Bombus* species compared with their rural counterparts. Body condition is an important indicator of both individual and environmental health, yet it remains relatively understudied in urban environments for bumblebees. Loch Lomond and the Trossachs National Park provides an opportunity to compare bumblebee physiological traits from a rural ecosystem with those from an urban ecosystem in Glasgow. In this study, we compared body mass and body size between urban and rural populations of *Bombus lucorum agg.* and *Bombus hypnorum*. We also tested associations between bumblebee body size and mass and a range of environmental variables, including temperature, green space area, fragmentation and floral abundance. We found no differences in body mass or body size between urban and rural *Bombus* populations for either taxon. However, intertegular distance (ITD) in B. lucorum agg. was negatively associated with habitat fragmentation. Furthermore, we found no evidence of a UHI effect across the urban and rural sites sampled in Glasgow, with no difference in temperature between urban and rural sites. Floral abundance also did not differ between urban and rural sites. Overall, the absence of physiological differences between urban and rural populations of *B. lucorum agg.* and *B. hypnorum* suggests that urban green spaces within Glasgow may provide suitable habitat for these species, like those sampled in Loch Lomond. Nevertheless, maintaining well connected urban green spaces with sufficient floral resources will be important in supporting bumblebee populations.

Stable isotope characterisation shows unexpected levels of small-scale ecological variation in a small stream catchment (Ross Burn, Loch Lomond)

Seth Nisbet, Darren Gröcke, Chris Harrod

Local-scale food web research is vital in improving our understanding of the functioning, structural composition, energy flows and environmental controls within an ecosystem. This not only provides a strong foundation for ecosystem-based management but is key information for understanding biogeochemical cycling, e.g. of carbon. Stable isotope analysis has become an important tool for assessing how ecosystems function. This study set out to characterise the ecology of the low order Ross Burn stream system that drains the area immediately north and east of the Scottish Centre for Ecology and the Natural Environment (SCENE) and ultimately flows into Loch Lomond. Samples of primary producers, macroinvertebrates and brown trout were collected and analysed for $\delta^{13}C$ and $\delta^{15}N$. Low $\delta^{13}C$ and $\delta^{15}N$ values overall suggested a reliance on autochthonous, respired carbon; high mycorrhizal transfer and low nitrate levels within the food web. Trophic structure revealed isotopically distinct primary producers and predators and a continuum of macroinvertebrate predation in between, reflecting a high level of omnivory and opportunism. Stream sections draining two sub-catchments located less than 2 km apart were isotopically distinct, revealing unexpected variation in functional biodiversity, highlighting the importance of small-scale variability in understanding broad scale loch ecology assessment.