Cateran Ecomuseum

Review of landscape and land-use history in the catchment of the River Ericht

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Introduction

Rivers are dynamic landforms and do not form or function in isolation: they receive water and nutrients from the wider catchment, are a resource for human populations settled in the surrounding hills and valleys, and for mobile animals, from deer and sheep to migratory salmon. This is reflected in the River Ericht, which covers around 10 miles with a catchment that spans upland and low-lying terrain, from 349 m OD at Hill of Cally, above the confluence of the Blackwater and Ardle, south to the flatter reaches through Blairgowrie and Rattray, and its entry into the River Isla, at less than 40 m OD. As a result, the catchment provides a range of growing conditions – for plants and farmers. To recognise these connections, this review summarises what is known about the palaeoecology - or environmental history - of the Ericht and its surrounding catchment.

Palaeoecology (palaeo = old) includes a range of scientific methods with a common goal: to understand the composition and drivers of change in ecology over long time periods, where 'long' can refer to decades, centuries or millennia[1]. Whereas historians use written archives, palaeoecologists rely on natural archives, that is, sediments like peat and lake mud that build up over time and store signals from the environment in that process. Waterlogging in these natural archives reduces decay, so indicators from the environment – in the form of pollen grains, charcoal fragments, plant, fungal and insect remains, minerals, heavy metals and chemical pollutants – do not decompose and are preserved in layers of peat and mud that accumulate over time. These indicators are often referred to as 'proxies' because they allow us to reconstruct conditions that we cannot directly observe. Sediment cores are extracted from natural archives using specialised equipment (and a strong and well-organised coring team) and analysed in the laboratory to retrieve these microscopic records of terrestrial and atmospheric change and reconstruct the history of the environment.

Environmental proxies complement and extend archaeological and historical evidence by providing the environmental and natural resource context within which past settlements and economies functioned. Palaeoecology can also contribute to broader topics, like climate history, and can be used in conservation and environmental management to test that the baselines underpinning current conservation are accurate, rather than based on supposition about what is 'normal' or 'natural', or about events and processes that predate monitoring systems and human memory[2].

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[1] It is a separate field from **palaeontology**, which studies completely fossilised (mineralised) material – most obviously, from dinosaurs or extinct humans. Palaeoecology uses 'sub-fossils': materials that retain much of their original chemical composition.

[2] Regrettably, there are few examples in the public domain: many academic papers focus on potential (written by palaeoecologists) rather than applied benefits (the domain of conservationists and policy-makers) of taking a longer-term view. However, the ongoing push for peatland restoration provides a good example of how cultural heritage (including palaeoecological and archaeological records preserved in peat) can contribute to a

‘Reading’ pollen records requires expertise in ecology and sedimentary processes, so palaeoecological studies are often rather inaccessible to non-specialists. The aims of this review are to help make the palimpsest – the layers of human and environmental history - that shape contemporary landscapes more visible to local communities and visitors, to help tell the story of the living and dynamic landscape around the River Ericht, and become a more accessible source of information for ecological restoration. It is also intended stimulate interdisciplinary conversation (involving researchers, community, local and national organisations) about the potential for further work that takes a long-term view of ‘naturalness’ and change in ecosystems along the course of the Ericht, centred on topics like managing and restoring biodiversity and planning for climate change.

The review addresses two questions:

1. *How has the landscape of the Ericht changed over the last c.10000 years?* Existing palaeoecological evidence from around the River Ericht is used to outline how vegetation (land cover) and land-use have changed from the end of the last ice age to the present.
2. *What is the potential for recovering new palaeoecological records from the course of the Ericht and its catchment?* Land cover and soil maps are used to assess whether additional sediments suitable for palaeoecological study may survive along the course of the Ericht. This is considered in the context of areas of current conservation interest to evaluate the potential to connect visible and buried heritage.

Some suggested readings or resources are provided at the end for more information on Scottish archaeology and landscape dynamics, and for a broad introduction to palaeoecology and environmental archaeology.

How has the landscape of the Ericht changed over the last c.10000 years?

There are no pollen records from within the course of the River Ericht because it has a bed of bedrock or glaciofluvial gravel, sand and silt, with no marshy backwaters or oxbows that would be suitable for lake formation or the accumulation of peat. But there are palaeoecological sequences from upland and low-lying areas either in or just beyond the catchment of the Ericht (fig. 1). Evidence comes from one loch and five peat bogs above Strathardle, and in the lowlands, from two lochs that formed in the fluvioglacial sediment that filled the Strathmore valley as the last glaciers melted. The sediments from Corrydon in the uplands and Stormont Loch in the lowland valley are remarkable in this region in that they take us back to the end of the last glaciation, a period of rapid climate oscillations. Many of the records from the catchment cover most of the last 10000 years, that is to say, the period since the melting of the last glaciers around 11700 years ago, once conditions had become suitable for plant growth (also providing the organic matter that is essential for lake mud and peat to accumulate). As a result, they allow us to track the establishment, changing composition and subsequent fragmentation of woodland cover, understand how farming altered the landscape and the origins of current features, like woods and fields. The quality of these records varies: several are undated which limits our ability to make comparisons between sites or to understand the rate of change in land cover or land-use. Several records are also fragmentary. For instance, the records from both Carn Dubh and Lair are incomplete, probably due to peat-cutting.

richer understanding of the value of peatlands: https://www.iucn-uk-peatlandprogramme.org/about-peatlands/peatland-benefits/culture-history. Natural England also commissioned an examination of how palaeoecology can be combined with ecological modelling to help assess and mitigate the impacts of climate change in ecological restoration: http://publications.naturalengland.org.uk/publication/5106575047917568

We are fortunate that Rae and Stormont Lochs escaped 18th and 19th century drainage and marl extraction, which was part of the 'agricultural improvements' that fed the industrial revolution. The outline presented here therefore describes the main trends in vegetation cover and land-use, and what is known about spatial patterns and altitudinal variability.

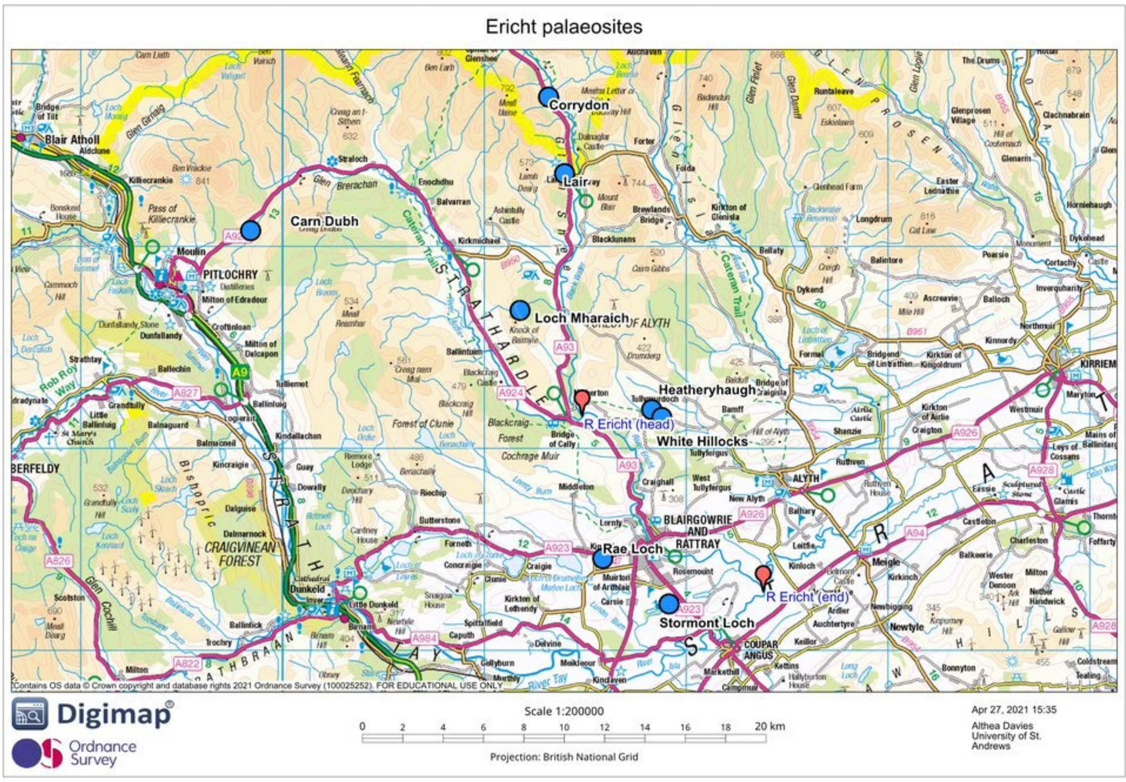

Figure 1. Palaeoecological sites around the River Ericht come from the higher ground to the north and low-lying valley floor around Blairgowrie and Rattray.

From tundra to woodland

The cold, arid conditions at the end of the last glaciation meant that only low-growing, drought-tolerant species could survive on unstable, ice-free ground. However, the complex interconnections between ice, ocean, land and the Earth's orbit that determined climate cycles resulted in rapid warming around 117000 years ago. This allowed soils to develop and stimulated a process of species migration in response to the northward expansion of growing conditions suitable for more warmth-demanding species. This generated a dynamic landscape, when viewed over centuries, with rather open juniper, dwarf birch and cowberry scrub gradually outcompeted by birch and hazel as they migrated north and became established, before the arrival of longer-lived trees like oak, elm, pine and alder between around 10000 and 7000 years ago. In general terms, the Ericht lies in the region of Scotland that was colonised by mixed deciduous woodland, mainly dominated by oak with hazel and elm, but species composition varied depending on altitude and soil type. For instance, pine is thought to have colonised some upland areas to the north of Strathardle, such as Carn Dubh, but it did not become established in lowland catchments, like Rae or Stormont Lochs, where it could not compete with oak and elm on the better soils. Conversely, oak and alder were less abundant in the uplands, where pine and birch woodland reached its maximum extent around 5800 years ago. Tree cover was by no means continuous. Peat began to form in water-collecting basins and valley floors as early as 10500-9800 years ago. Exposed summits and ridges and active floodplains would also have remained relatively open, so the landscape consisted of a mosaic of woods, peat and grass or heath.

It is unclear from the palaeoecological evidence whether Mesolithic hunter-gatherers were active in this area. The scale of their impacts on vegetation may have differed little from disturbances such as windthrow, animal browsing or gap-replacement dynamics, where the death of mature or diseased trees created openings in the canopy for other trees to replace them. As a result, any deliberate or incidental disturbance by people may be indistinguishable from 'natural' factors. For instance, at Carn Dubh, the valley peat records soil erosion from the adjacent hillslopes before 6000 years ago. This is thought to have been caused by periods of more intense rainfall, rather than as a result of human disturbance. Often the abundance of charcoal fragments in peat or lake sediments is used to suggest deliberate fire-setting, either to drive animals or create openings, rather than wildfire. However, fires can also occur naturally and, as indicated above, the landscape contained open ground which could have provided sightlines within and above the treeline for hunters without a need to manipulate vegetation cover.

From woodland to farmland

The first farming communities became established in a generally well-wooded landscape, but the age, distribution and extent of Neolithic settlement is difficult to detect in the pollen record because trees (having a large canopy) produce an abundance of 'pollen rain' compared with lower-growing plants. For instance, cereal pollen, from crops like barley and oats, is very poorly dispersed from the parent plant, so small fields may be invisible unless located near to a pollen sampling site. Virtually all pollen diagrams from NW Europe show a feature called the 'elm decline' around 6000-5000 years ago: a marked and permanent decline (or series of declines) in the abundance of elm pollen. This was once thought to be a synchronous event, synonymous with the establishment of the first farming communities. We now recognise that this feature reflects a prolonged transition, spanning hundreds of years, and it was probably caused by a combination of climate change, human impact (e.g. felling, grazing, harvesting 'leaf fodder') and disease (like the fungus responsible for the Dutch elm disease in the 1970s). However, the elm decline remains a useful approximate starting point for thinking about human interaction with the landscape, not least because woodland was a major component of the landscape and the elm decline (whatever the cause) created a permanent shift in the composition of the woods. At sites in both Strathmore and the uplands to the north, elm declines coincided with reductions in the abundance of other tree species, suggesting woodland opening, possibly through felling (an arduous task with stone axes), burning or through persistent grazing, which could have suppressed regeneration.

Looking in more detail at two well-dated sites, around 6000-5800 years ago, elm declined abruptly at Rae Loch and Carn Dubh. In both cases, pollen from grazing-tolerant plants is recorded – most likely from livestock rather than an increase in wild herbivores. This was severe enough to cause soil erosion into Loch Rae. Both areas show gradual opening of the canopy and expansion of grassland over the following 2000 years or more. It is not until around 3100 years ago that arable farming is recorded at Rae Loch. In contrast, cereal pollen remains absent from the higher ground at Carn Dubh, where grazing was the main land-use. Since the Neolithic era began around 6000 years ago and was followed by the Bronze Age around 4500 years ago, this could indicate that crop-growing was a rather late adoption in the area. The story may, however, be more complex.

Pollen recovered from soil horizons buried beneath Cleaven Dyke, south of Blairgowrie, suggest that this Neolithic ceremonial monument was constructed (sometime around 5500 years ago) in a mosaic of grazed grass-heath and trees, not in a woodland. Soils are biologically active, which is not ideal for preserving pollen, but cautious comparison of the woodland-dominated pollen record from Rae Loch and the imperfect pollen snapshot from soils below the monument could suggest that openings were present but are too small to be visible in the tree-dominated 'pollen rain' landing in the loch, some 4 km to the north. This has led some authors to suggest that small-scale 'forest farming' might have taken place during the Neolithic, largely hidden from our palaeoecological view. This is certainly the case if we look further north, to Crathes in Aberdeenshire, where a Neolithic timber hall was constructed within a clearing and surrounded by cereal crops and hazel, all of which was invisible in the nearest lake pollen record.

Many narratives of woodland cover, especially in the Scottish uplands, revolve around negative stories of human clearance and mismanagement. The evidence from around the Ericht shows that this is far too simplistic and misrepresents a complex history. While the long-term trend in tree cover was generally downward, this took place over millennia, i.e. very many human generations, and occurred in fits and starts. For example, at Carn Dubh there were multiple phases of woodland reduction and recovery between 5700 and 4200 years ago, each lasting several centuries and most probably driven by variations in grazing intensity. Tree composition also changed over time, creating a shifting landscape mosaic, and we should not imagine widespread, synchronous waves of woodland coming and going, with axe-wielding humans or hungry livestock in hot pursuit, wantonly mismanaging their natural resources.

The intermittently increasing open ground was covered in a mix of grass and heath, with heather more common in the hills and grassland more extensive in the low-lying valleys. Both were used for grazing livestock. Curiously, the agricultural expansion that is recorded across central Scotland during the Iron Age (around 2800-1500 years ago) – which stimulated much debate about whether the Romans caused widespread woodland clearance - did not occur in lowland Perthshire until relatively late. Larger-scale mixed agriculture was not established around Rae Loch, in the fertile lowland Strathmore valley, until the early first millennium AD. There are too few well-dated pollen records to judge whether this comparatively late date is representative of the wider area or reflects a very local picture, where woodland continued to dominate the loch catchment. Roman legionary forces were billeted at Inchtuthil, some 5.5 km SW of Rae Loch, and the demand for wood and produce to build and feed the fortress, respectively, may have contributed to soil erosion and reductions in oak pollen around 2000 years ago.

From prehistory to modernity

Although our understanding of agricultural history during the Roman and then medieval and later periods is document-aided, most surviving written sources relate to higher status (e.g. ecclesiastical) lives and concerns, so archaeology and palaeoecology remain key to understanding 'everyday' lives. The identification of distinctive turf and stone 'byre-houses' (known as Pitcarmick-type buildings) in NE Perthshire has helped fill an important gap between (somewhat ubiquitous) hut circles (dating to Bronze and Iron Ages) and the medieval period. Although Lair, in Glen Shee, lies to the north of the Ericht catchment, the combined archaeological and palaeoecological study conducted there offers an important window into the period often known as the 'Dark Ages' and provides a useful upland comparison with the best-dated record from the area, at Rae Loch. The pollen record from the acidic hillslopes at Lair suggests that cultivation was as central to the upland economy from the seventh to tenth centuries AD as it was in the adjacent Strathmore lowlands around Rae Loch. Cultivation at 350-400 m OD may have been facilitated by a period of relative climatic warmth. The close correspondence between the pollen record of cultivation and radiocarbon dates from the archaeological structures raise the possibility that Pitcarmick buildings, with a dwelling area at one end and byre at the other, were used to concentrate manure to fertilise arable fields. In contrast, other parts of the uplands, such as Carn Dubh, over towards Pitlochry, were used only for grazing. This shows that a patchwork of trees and open, grazed and, in places, cultivated, open ground continued through the Pictish and early medieval periods.

Unfortunately, once we arrive at the historic period, when many more written and artefactual sources survive, the palaeoecological record for this area is disappointingly weak. In some places, this is because peat-cutting or drainage have destroyed the sediment, this in itself demonstrating the intensity of human impacts on natural resources. But in other locations, the pollen record has not been analysed in detail or been closely dated, making it difficult to compare the evidence from written and natural archives. All that can be glimpsed from the currently available palaeoecology, therefore, is a significant expansion of pastoral grassland – at the expense of tree cover – around Rae Loch, and the reinstatement of some tree cover, in the form of conifer plantations, from the late eighteenth to twentieth centuries in the Strathardle uplands around Loch Mharaich, 6 km north of the headwaters of the Ericht.

What is the potential for recovering palaeoecological records from the course of the Ericht and its catchment?

The Ericht is a relatively short river, spanning around 10 miles, but the catchment that feeds it covers some 432 km^2. As mentioned above, the hard substrates (bedrock and gravel, sand and silt) that form the course of the River Ericht means there are with no marshy backwaters or oxbows suitable for waterlogged sediments to accumulate. To offer a desk-based review of potential for identifying new palaeoecological sampling sites near the river course, this section focuses on wetter areas that are more likely to preserve palaeoecological evidence. In addition to the academic studies used above, the main sources used in this section are maps of superficial drift geology (sediments overlying bedrock), land cover models (1930-2019) and historic maps (1860-present) (all accessed via Digimap), along with the locations of sites with conservation designations (from NatureScot SiteLink). The emphasis is on filling gaps identified in the previous section, notably during the documentary period, where combining historical, archaeological and palaeoecological evidence with oral history has the potential to provide a rich narrative of a living landscape. Further back in time, the shortage of well-dated records limits our ability to map through time the changing patterns of land cover and land use, so revisiting and adding dates and detail to existing sites could also help understand the dynamics between communities and economies in the uplands and lowlands.

The drift and land cover maps suggest a predominance of rather well-drained or agriculturally modified soils. The drift map shows small peat deposits around Rae Loch and in the uplands, within a matrix of well-drained till (upland) and river terrace deposits, alluvial and glaciofluvial sediments (valley) (fig. 2a). This is reflected in the land cover map, which depicts the dominance of heather, acid grassland and forestry in the uplands and improved grassland and arable in the valley (fig. 2b). As a result ,there is limited potential to find new waterlogged sediment suitable for palaeoecological analysis beyond the sites already studied. The most likely areas to recover new sediment or new evidence are therefore the low-lying lochs and upland peats. Existing sites are used to gauge the likely quality and availability of these sediments.

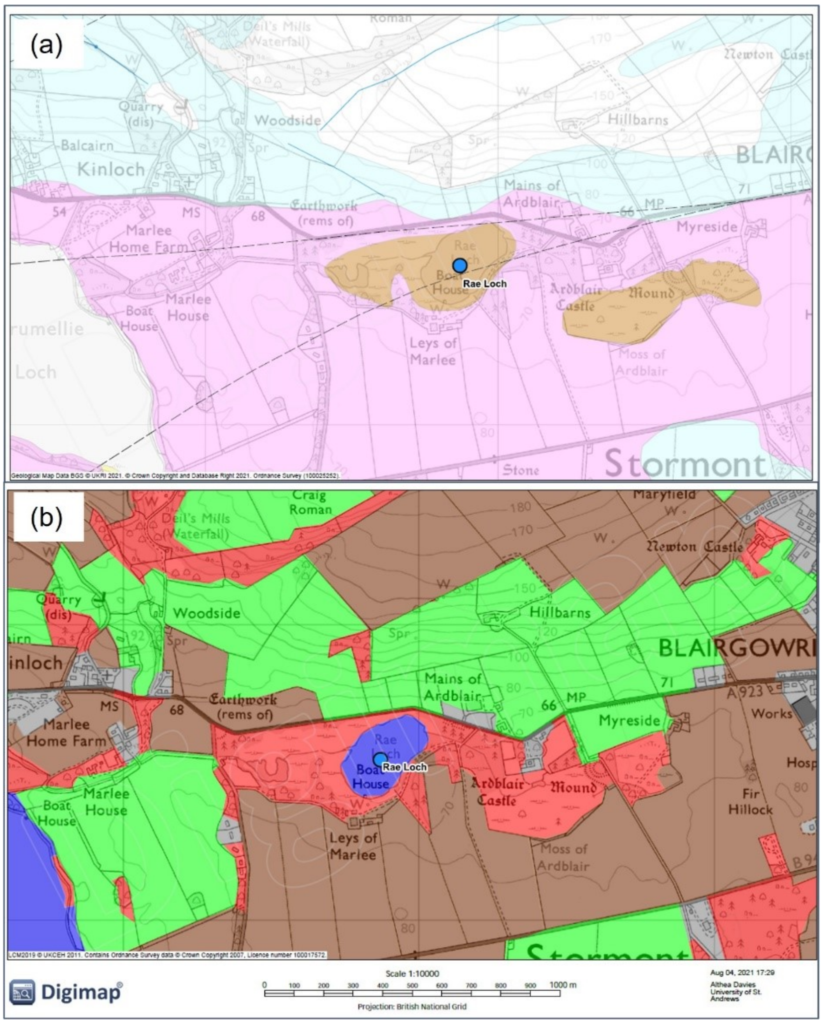

Figure 2. Examples of drift and land cover maps, showing (a) the peat-infilled lake basin at Rae Loch (brown), within glaciofluvial sand and gravel (purple), now surrounded by (b) broadleaved woodland (red) within arable (brown) and improved grassland (green).

In low-lying parts of the Ericht catchment, potential for waterlogged sediment is restricted to the lochs and the marshy areas around them. Hare Myre, Monk Myre and Stormont Loch are all kettlehole lochs, formed when glaciofluvial sands and gravels were deposited by glacial meltwater around relict blocks of ice, which then melted out to leave lake basins. They jointly constitute a Site of Special Scientific Interest (SSSI) for open water-fen communities. However, it appears most of these and other lochs in Strathmore have been modified to varying extents as part of historic land management to improve agricultural capacity. Indeed, it is possible that the lochs may in part be artificial. For instance, during fieldwork to locate suitable sediment for palaeoecology in the late 1970s, it was found that the relatively shallow Monk Myre lacks much in the way of sediment, likely because of eighteenth century drainage or trawling to recover marl that was deposited in mineral-rich early postglacial waters in order to fertilise agricultural ground. The loss of lochs in Strathmore through marl and peat extraction is mentioned in the 1796 Old Statistical Account. While this scale of geo-engineering may sound unexpected, it is far from unique. Kilconquhar Loch, in Fife, was shown through joint historical and palaeoecological analyses to have formed from a flooded medieval peat-cutting, while peat from the carse above Stirling was sluiced down the Forth River as part of late eighteenth and nineteenth century ‘agricultural improvements’, and can still be found mixed with the estuarine sediments downriver. The lack of sediments in itself, then, is an indicator of substantial anthropogenic change along the course of the Ericht.

As explained above, Stormont Loch contains a well-preserved record of postglacial vegetation succession. The uppermost 40 cm of sediment was not analysed in the original study, however, so it is possible that a historic record is present. Similarly, the pollen sequence from Rae Loch continues to the present day but the full results have not been published, so this site could also provide insight into historic land-use dynamics. This time period is rather poorly served in most lowland areas, precisely because of the management impacts outlined here, so this has the potential to provide evidence that is valuable on national and local scales. Both sites are well-placed to explore how the fertile farming landscape has changed (for comparison with historical descriptions of agriculture and livelihoods provided in the Old (1796) and New (1845) Statistical Accounts, for instance) and how the current high conservation-status wetlands fared through periods of agricultural intensification. As NatureScot note in their description of the Stormont Lochs SSSI, open water and fen habitats are sensitive to disturbance, including pollution and nutrient enrichment. This raises questions over whether these communities have a long history or formed after peak levels of agriculture. An historic record from Stormont Loch could also shed light on the ecological history of the adjacent Scots pine woodland. This was planted, but it is now over 150 years old and has developed a conservation-worthy understory at Stormont Loch and the adjacent Hare Myre.

Rae and Stormont Lochs are less than 1.5 miles from the Ericht, and the environmental histories of the lochs is closely linked to the agriculture and ways of life along the river, including the character of the settlements and way of life for their inhabitants (e.g. as a former centre for flax production). The historic past can also be connected to current ways of living, to prompt residents and visitors to think about how their lives might be coded into still-forming sediment records. For instance, should we begin to look for microplastics in the sediment to glimpse the legacy of our lifestyles? Although now retired, the authors of the original studies on Rae and Stormont Lochs could be contacted as a first step to assess the potential for obtaining more detailed records of the environmental history of these sites. With permission from land owner and NatureScot (essential for the SSSI), coring and exploratory lab analyses could then be considered, with a focus on the easier-access marshy sediments nearer the loch edges, rather than the more logistically complex process of coring lake sediments from a boat. Coring near-surface sediments causes minimal disturbance and could be assessed in the field using a small diameter gouge corer (a first check that the sediment is not too soggy to sample and looks fresh enough to offer a record of the more recent past), and, if it seems suitable, cored to obtain a larger sample of material (5-10 cm diameter cores) for exploratory labwork. Lab analyses could check for completeness at relatively low cost since soot particles from fossil fuel burning provide a good marker for the last c.150 years, as well as telling the story of pollutant deposition. Even if sediment is found to be missing or mixed (due to disturbance), this adds to our knowledge of the landscape because it helps 'ground-truth' the written records about changing economies and land-use.

In the upland areas, the greatest potential for new evidence lies in the peats, especially north of the Ericht headwaters. These are picked out in the drift map as discrete areas, rather than extensive blanket peats, so field- and lab-work are needed to provide a better assessment of how extensive or intact these are. Previous work shows that peat-cutting and erosion is widespread, leading to gaps in the records at Lair (Glen Shee), Heatheryhaugh and White Hillocks (east of Bridge of Cally). Similarly, the record from Loch Mharaich (in the hills between Glen Shee and Strathardle) is thought to be missing some of the last few centuries. Careful field examination will be needed to identify potentially intact sequences, supported by labwork to date sediments. If a historic record is sought, this labwork is relatively straightforward and cost-effective, as indicated above. Multiple radiocarbon dates and exploratory pollen analyses are required for older materials; this would be more costly since radiocarbon dates cost around £400 each. As a first step, a scoping study (focused on assessing the stratigraphy of the sediment in the field and potentially obtaining initial samples for radiocarbon dating) could be conducted to establish if the materials are available in locations where broader research questions could be identified suitable for applying for funding for a research project. Within the current funding, prioritising historic records is recommended as this is more cost-effective and has potential to leverage additional benefits around community engagement.

Conclusions: where next?

This report sets out the broad sweep of change over the last 10000 years along the course of the River Ericht. It highlights the diversity of landscapes through time and space where upland and lowland environments intersect. Both ecosystems and land-uses seem to have been relatively resilient: there is no evidence for abrupt, widespread deforestation or climatically-induced upland abandonment – the two narratives that are often presumed to have taken place in the past, especially in upland ecosystems which are more exposed to climate shifts and more difficult to farm. Indeed, human choices (and the political and economic factors that stimulate these) are the most evident drivers of change in this area. The slow attrition of woods in prehistory and into the last millennium contrasts markedly with the gaps in records that appear as a result of marl-dredging and peat-cutting as efforts to increase productivity accelerated in the last 200 years, a period now widely recognised as the Anthropocene.

Current gaps suitable for future research include a closer insight into how current biodiversity relates to the past, including the effects of past management since it is unlikely that modern areas with a distinctive or 'less disturbed' diversity are free of human influence (e.g. Stormont Lochs SSSI). As ecosystems will change in response to land management and climate, ecosystem managers need to anticipate and either direct or accept shifts in ecology. A long-term view on the range of variability in these communities can help think outside the familiar. The environmental history of the Ericht, that is, the landscape changes during the document-aided period, is poorly understood and has potential to reveal more about both designed and working landscapes (e.g. the history of ornamental tree planting or changing crops that characterised the arable ground, including flax). This in turn can be compared and combined with archaeological and written sources, and with resident memories to make the past part of the living landscape and part of conservations about choices for future restoration.

Resources

- If you would like to read more about the archaeological and palaeoecological history of Scotland, the Scottish Archaeological Research Framework (ScARF) provides a summary for each archaeological period: https://scarf.scot/national/. Regional frameworks are also being produced, including for Perth and Kinross: https://www.pkht.org.uk/projects/current-projects/pkarf/.
- For more detailed explanations of the principles and methods that are used in palaeoecology and environmental archaeology to reconstruct past human-environment interactions, this practical guide from Natural England explains good practice: https://historicengland.org.uk/images-books/publications/environmental-archaeology-2nd/