Glasdrum Wood
National Nature Reserve

Exploring the perceived impacts of different management interventions on woodland benefits

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The James Hutton Institute

Glasdrum Wood
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Exploring the perceived impacts of different management interventions on woodland benefits

This is the second in a short series of reports written by researchers at the James Hutton Institute investigating people's perceptions of management interventions on different woodlands around Scotland.

Background

Forests and woodlands are an important part of Scotland's natural heritage. Woodlands provide a range of 'benefits': they are home to a variety of flora and fauna, they store water and carbon, and provide a space for recreation and relaxation. The way a forest or woodland is managed and used affects the benefits from a forest. A forest that is managed for timber production, for example, might have direct benefits such as timber and creating employment opportunities, and might additionally be used as a place of recreation and for mental restoration, as well as preventing water run-off and providing natural flood management. People will have different understandings about the range of benefits a woodland can offer, and some people might prefer one type of benefit over another. To understand how these factors are interconnected, researchers from the James Hutton Institute are conducting research about woodlands in different parts of Scotland: in the Central Belt (North Lanarkshire), on the west coast (Argyll), and in the Cairngorms (Highlands).

Glasdrum Wood

This report presents the results of research undertaken about Glasdrum Wood National Nature Reserve (NNR), a woodland located on the banks of Loch Creran, Argyll. This is the second report from this study area: the report of

the scenario-planning workshop for the nearby Glen Creran Wood, managed by Forestry and Land Scotland (FLS) which lies just to the east of Glasdrum Wood, is available from the James Hutton Institute. Glasdrum Wood is a Site of Special Scientific Interest (SSSI) designated for its oak woodlands and unique collections of lichens and bryophytes (i.e. mosses, liverworts and hornworts) as well as for rare butterfly species, particularly the Chequered Skipper and Pearl-Bordered Fritillary. Glasdrum's mixed woodlands and rocky slopes also mark it out as a Special Area of Conservation (SAC). The wood is managed by Scottish Natural Heritage (SNH).

Consulting local experts

To explore different perspectives about woodland management and about the impacts of management interventions on the perceived benefits from forests, we adopted a research methodology called *scenario workshops*. This entails describing a range of management scenarios for the woodland, which then form the basis of in-depth discussions with a small group of people with local knowledge and expertise about the woodland.

Scenario development

Researchers at the James Hutton Institute developed narratives depicting six management approaches for discussion (appendix 1), building on documents such as management plans, site surveys, and future climate predictions, and with input from Stuart Shaw and Heather Watkin of SNH. One of the scenarios was based on the past management of the site ("The Early 1980s"), one on the site's present management plan ("The Present (2019)"), and then four hypothetical future scenarios set in the year 2035, which focus on possible management interventions and practices on the site: i) "Rainforest Beginnings" which was based on the continued implementation of the current management plan for the site; ii) "A Diverse Hotspot", with a strong emphasis on biodiversity and conservation; iii) "Living History and Biodiversity for All" (hereafter 'Living History'), giving prominence to community engagement activities; and iv) "Successful Exotics", a scenario based on reduced budgets and resources, whereby only minimal management interventions necessary to fulfil statutory requirements are undertaken.

Local Expert Panel Methodology: "Woodland Workshop"

Nine participants attended a workshop in January 2019. Attendees included people with different backgrounds, professions and perspectives, but all with knowledge and interest in the woodland at Glasdrum. Participants included environmentally-engaged stakeholders such as locally-based forestry experts, local volunteers (interested in butterfly and lichen populations), site managers, and environmental educators. Two national-level experts (on woodlands, and lichens and bryophytes) also participated. The six scenarios were sent to participants in advance, and were distributed again on the day. Following a short introductory session, participants were individually asked to score (on a scale of 1-10, where 1 is low and 10 is high) how well they thought each scenario performed against eleven different woodland benefits (ecosystem service indicators). The full description of the eleven indicators is listed in appendix 2. Participants were also asked to indicate how confident they felt about their scores (low, medium, high).

The scores given by participants in relation to each indicator, and for each of the scenarios, were displayed visually around the room. These scores formed the basis of facilitated discussions to explore patterns and differences across the scenarios, and to identify the reasons behind participants' choices. Following these discussions, participants were given an opportunity to revise any individual scores. Finally, workshop participants were invited to identify their preferred future management scenario, and what an ideal future management approach would look like, explaining the rationale for their choice.

We analysed the scores given for each of the woodland benefits across the scenarios. We also analysed comments made by participants about their decisions to gather additional insight about perspectives of management interventions and their impact on the benefits from the woodland. These findings are discussed in the next section.

Ecosystem benefits across the scenarios: results from the scoring exercise

The median values for each of the eleven ecosystem service indicators, assessed for each scenario, are illustrated in table 1. These values show that four scenarios (The Present, Rainforest Beginnings, A Diverse Hotspot and Living History) were perceived overall as performing reasonably well across the range of indicators. Living History had the highest scores for employment and learning opportunities (9) due to the range of activities being undertaken on the site. In contrast, The Present, Rainforest Beginnings and A Diverse Hotspot performed poorly for timber extraction, with participants identifying that Glasdrum Wood is not geographically suitable for the commercial production of timber and that fallen timber is often left as deadwood on the site, which in turn supports the unique biodiversity of

the forest.

The scenarios that received the lowest scores across most indicators were The Past (1980s) and Successful Exotics, the scenario based on a significantly reduced management budget and subsequent operation. These scenarios did score reasonably well for carbon storage (6 and 7) and for natural flood management (6 and 7), primarily due to perceived undisturbed nature of the site.

Table 1: Median scores attributed to each ecosystem indicator for each scenario (where 1 is low and 10 is high). The 'median of medians' indicates the preferred scenario(s) overall, based on scores given by participants. A full description of each indicator is included in appendix 2.

	Past (1980s)	Present (2019)	Rainforest beginnings	A Diverse Hotspot	Living History	Successful Exotics
Employment	4	6	7	6	9	2
Target Species: Spring Flowers	3	6	7	7	6	2
Target Species: Bracken	2	7	8	8	6	2
Timber Extraction	4	4	3	4	7	2
Carbon Storage	7	6	5.5	6	6	6
Mental Restoration	4	8	8	7	7.5	3
Spirituality	4	7	7	7	7	4
Learning, Knowledge & Skills	3	7	8	8	9	2
Landscape Quality	5	8	8	7	7	3
Place Attachment	2	7	8	6	8	2
Natural Flood Management	7	7	7	6	6	6
Median of Medians	4	7	7	7	7	2

Scoring the scenarios

Figure 1 (on pages 6–7) shows a summary of the scores as boxplots for each of the indicators. The boxplots enable us to see the variation between participants' responses in more detail, and help to identify areas of commonality and agreement, as well as disagreement.

A number of key points stand out:

- both **The Past (1980s)** and **Successful Exotics** received low scores for most indicators, except for carbon storage and natural flood management. These two scenarios included limited management interventions. Participants felt that the root density and soil structure of an unmanaged woodland would help prevent water runoff, and that allowing unmanaged tree growth (and not removing dead/fallen trees) would mean good carbon storage within the woodland.
- The **Living History** scenario received a range of scores. This scenario was based on high levels of public engagement activity designed to attract visitors. Participants agreed that visitors would experience a strong sense of attachment to the site ('place attachment') as they would create fond memories of activities. Most of the participants felt this scenario would increase opportunities for learning. However, for indicators such as 'mental restoration' and 'spirituality', some participants gave higher scores because of increased accessibility of the site, while others were concerned about potential overcrowding that might *"reduce the get-away, sanctuary feel"* of the site. Increasing visitor numbers was also identified as a challenge for natural flood management: creating new paths and increasing visitor numbers could negatively impact drainage and increase runoff, through greater soil compaction.
- Participants did not feel confident about scoring for carbon sequestration or, to a lesser extent, natural flood management in the

scenarios. Both indicators were understood to be quite complex, with participants expressing uncertainty about how different aspects of the scenarios might enhance or reduce carbon sequestration and/or natural flood management.

- Participants engaged in considerable discussion about the indicators themselves, highlighting for example that 'Target species: spring flowers' should be considered a proxy for woodland species' diversity in the context of Glasdrum, and that the indicator 'Target species: brambles, bracken and rhododendron' was not necessarily wholly negative: low to moderate levels of bracken is beneficial for pearl-bordered fritillary butterflies at Glasdrum, for example, and bramble and some bracken is a natural part of the woodland understory. That said, there was agreement that rhododendron is always a negative indicator.
- Overall, except for the low scores for timber extraction (which, as noted earlier, is due to the steep gradient and unsuitable geography of the woodland, and its conservation value), both **Rainforest Beginnings** and **A Diverse Hotspot** scored highly for most indicators across all scenarios. **Living History** scored best for learning opportunities and a sense of attachment to place.

Figure 1: Boxplots summarising the scores for each ecosystem benefit across the six scenarios. The horizontal line in the middle of each box is the median, or middle, score. The top line of the box represents the 75th percentile (upper quartile) and the bottom line the 25th percentile (lower quartile). The lines emerging from the boxes represent the maximum and minimum scores given by participants. Points outside the lines are 'outliers' – scores that are numerically distant from the rest of the data. See Appendix 2 for a full description of the indicators.

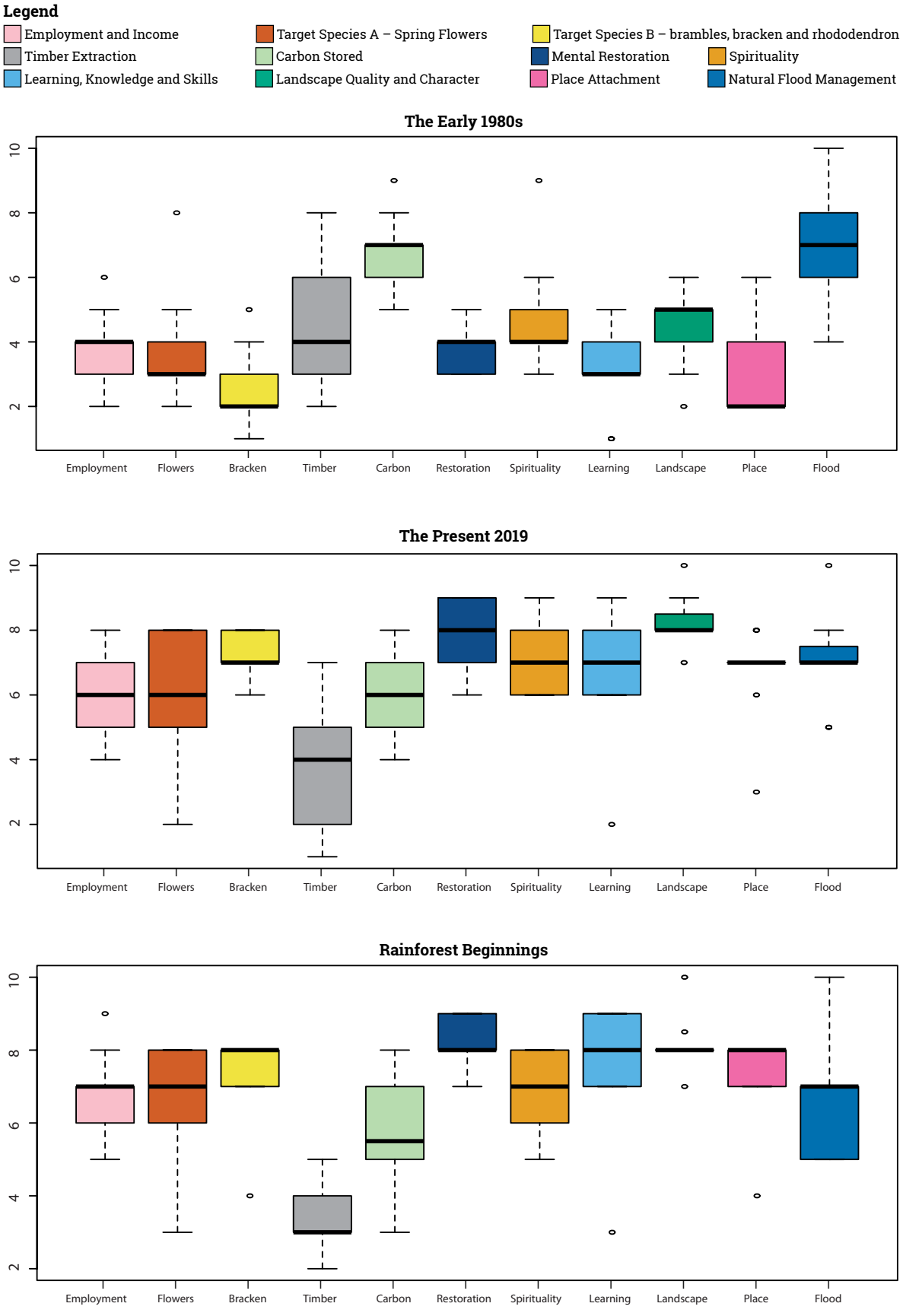
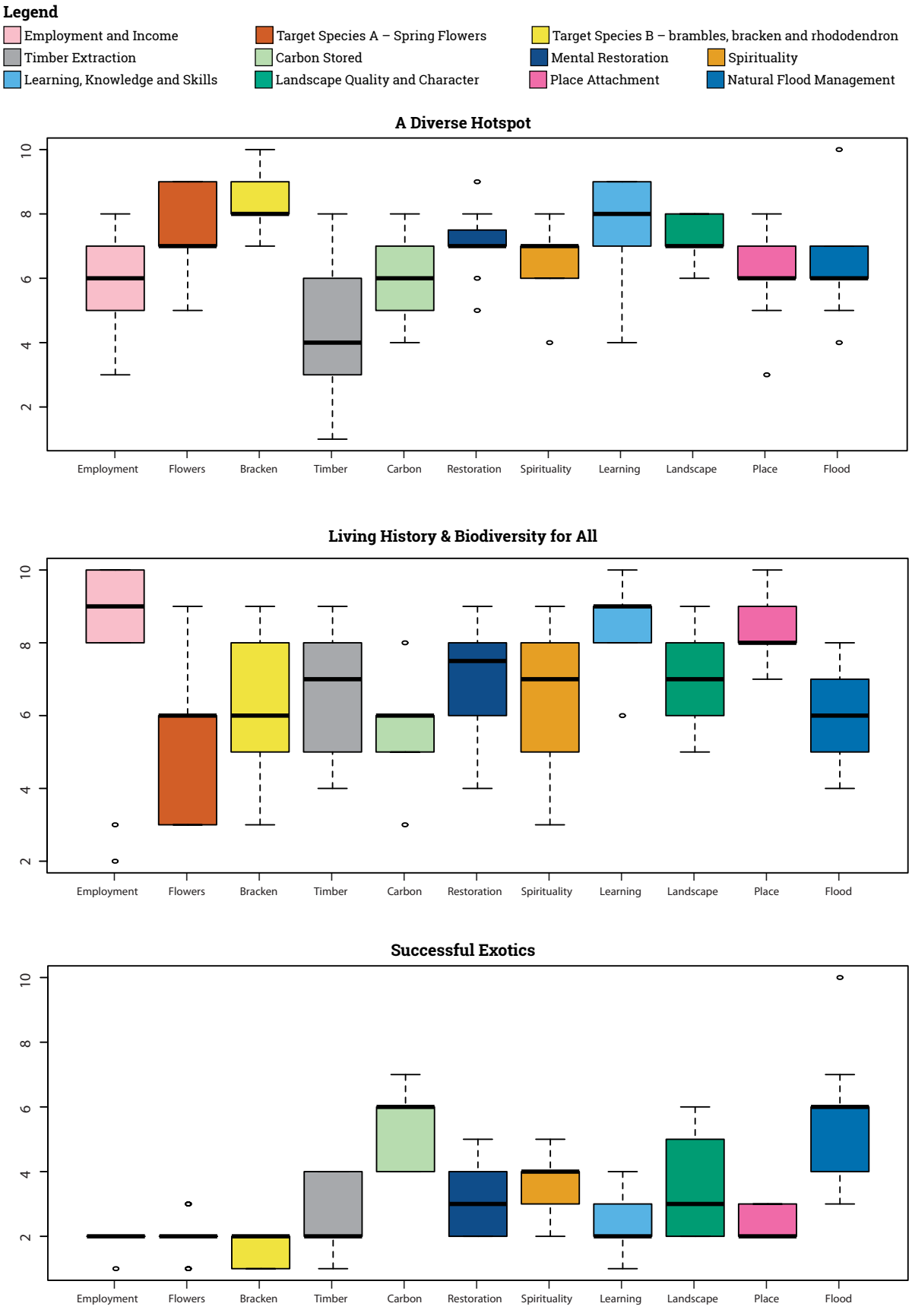


Figure 1. Continued.



Key discussion points

Public engagement and access

Participants were keen to enhance peoples' engagement with the woodland. Suggestions included developing activities for schools and families; creating opportunities for community walks and foraging; and ensuring that people can access the woods to enjoy a walk and help enhance their health and wellbeing. Participants also emphasised promoting engagement to increase knowledge and understanding of the natural environment, rather than focusing exclusively on cultural activities. One participant explained this clearly in light of current education activities hosted in the woodland: *"the way we're teaching children at the moment is to be part of the forest, to learn those ecosystems..."* whereas focusing more explicitly on the culture and history of the site could be *"taking away from that wildness."*

Questions were raised about whether managing the woodland to attract a larger number of visitors might reduce the 'benefits' available to those visitors. As one participant reflected: *"One thing I've heard come out quite a bit and something that affected my thinking a lot is... that it all depends on scale and whether you reach a threshold. So having a few people go into a woodland, fantastic. Having thousands of people going into a woodland, not fantastic."* Others outlined how simply focusing on increasing public engagement on the site might have possible disbenefits: *"I think... it's the impact, potential impact of activity and on the sense of spirituality of the woodland and it's a really conflicted thing. It could go too far and that could impact people's enjoyment of the woodland, but it is giving people a sense of connection."*

In terms of creating a greater sense of attachment with the woods, one participant emphasised the potential for community engagement in the decision-making processes around management interventions. Others highlighted that experiencing a sense of attachment does not rely on living nearby, but does imply accessibility and an opportunity for people to visit. Glasdrum Wood is known as a habitat for the chequered skipper butterfly which can drive a sense of "a special place" for butterfly enthusiasts from afar, while another participant added *"I feel attached to a place when I have memories associated with it..."* In fact, participants wondered whether visitors from further afield might be more closely attached to the biodiversity and conservation aspects of the site, while local visitors simply enjoy the footpaths without necessarily knowing or understanding its conservation value.

Managing woodlands for multiple benefits

Participants recognised some of the challenges inherent in managing the site with the aim of realising multiple benefits from the woodland: while there is little pressure for timber production given the unsuitability of the landscape, participants drew attention to places where different woodland benefits might come into conflict. For example, increasing public engagement might impact negatively on the potential for natural flood management due to the creation of footpaths leading to greater levels of erosion. Increasing visitor numbers might pose challenges in trying to manage herbivore populations. Concern was expressed that developing a more open landscape to benefit butterflies and wildflowers through the occasional use of cattle grazing could damage the landscape if the livestock are not well-managed. It could also reduce people's use of the site due to public concern about entering an area where cattle are present, and about increased tick populations. Different perspectives about some management interventions were also expressed: a few participants indicated that they quite enjoyed an *"unmanaged feel"* to the woodland, for example, but were concerned that other people, and particularly members of the public, would value the woodland less as it might feel *"obviously not cared for"* or have a *"sense of abandonment."* Yet the sense of wildness was seen as beneficial: even in discussions about increasing public engagement activities, suggestions included concentrating events in an accessible area near the car park to maintain a *"wild landscape"* or *"a wild space for biodiversity"* further up the slopes of the woodland. Finally, within the group, those with a professional interest in forest and land management also indicated the challenges of making any decisions about management interventions given the backdrop of legislative objectives and responsibilities: *"it's an SSSI [so] we've got to meet certain objectives... that's what we go by..."*

Managing on a landscape scale

While the focus for this workshop was Glasdrum Wood, participants stressed the importance of considering the broader landscape and *"seeing the big picture"*. Glasdrum Wood is a broad-leaved woodland, and one of the UK's best examples of a cool-temperate rainforest with national and international conservation value. The SSSI includes Glasdrum Wood and the neighbouring Glen Creran Wood, currently managed by Forest and Land Scotland (FLS), with both SNH and

FLS seeking to manage the land to support the conservation requirements of the SSSI designation. Managing a woodland within the context of the larger, landscape scale also brings challenges: conflicting priorities about managing herbivores such as deer at a landscape scale was one example given by participants; another was the removal of non-native invasive species such as rhododendron where it is important to reduce seed stock across the whole landscape. As one workshop participant summarised: *"At the landscape scale you've got your winners and losers locally, but you try and achieve winners at a bigger scale."* One participant highlighted the importance of recognising spatial and temporal aspects of landscapes in the decision-making process, calling for better tools within conservation research to help communicate the challenges of managing sites at a landscape scale. Another participant highlighted the challenge of managing at a landscape scale when discussing their preferred scenario, Rainforest Beginnings: *"this encapsulates the difference in view between species specialists and habitat specialists... what interests me about this scenario [Rainforest Beginnings] is that they were managing it as an ecosystem at a low grazing pressure. And then [an] intervention to create these areas where you would deliver the species requirements, rather than the whole thing being managed for the species."*

Preferences for future management

While the numerical scoring of the management scenarios suggested that the **Living History** scenario would provide the most benefits overall, during the discussions, participants indicated preferences for **Rainforest Beginnings, A Diverse Hotspot** and **Living History** as their favourite scenarios. The least popular management scenario was the one with the lowest level of active management, Successful Exotics. This was understood to deliver a low level of woodland benefits across the board, except for carbon storage and natural flood management.

The scenarios for **Rainforest Beginnings** and **A Diverse Hotspot** focused on management interventions that **support the conversation of biodiversity** and managing the woodland to support the populations of rare butterfly and lichen species that the site sustains. Living History had higher levels of public engagement. In identifying their 'preferred scenario', participants found themselves trying to integrate positive aspects of each of these scenarios to find a middle-ground that allows the site to continue to develop somewhat naturally, yet also focuses on increased management for conservation of rare species, as well as enabling greater community engagement with the woodlands. Each of those who preferred 'Rainforest Beginnings' suggested it could be adapted to include more education and community engagement, while other participants highlighted that the woodland is large and diverse enough to allow for the mutual and complementary benefits of the different scenarios to be gained. The **Living History** scenario, with a strong focus on management for public engagement, received the highest scores in the quantitative analysis for woodland benefits it might provide, and was also a popular choice for participants' 'preferred scenario'. People appreciated the community outreach and links to the historical use of the site, although one participant expressed concern that this scenario focused too much on humans' use of the woodland, and overlooking the environmental and natural heritage of the site: *"the way we're teaching children at the moment is to be part of the forest, to learn [about] those ecosystems..."* adding that the focus on cultural education included in 'Living History' would not address the value of *"the ecology, the lichens, all the species that are there..."* Those participants who identified 'Living History' as their preferred option did so with ideas for improvement, suggesting a designated and accessible area near the current car park where engagement activities could be focused, thereby maintaining much of the woodland as *"a wild space for biodiversity."* This might mean compromising accessibility elsewhere on the site, to maintain a greater sense of wilderness: *"What I'm suggesting is that the rest of the space is a wild space for biodiversity, but it's also a space for young people to go on immersive, connective programmes, where, to generate a connection to rural place, wild place, and to learn skills which can enable employment in the rural environment so that they can go away to university or college but they've actually still got employability to come back to."*

Overall, participants supported enhanced public engagement for facilitating public support

for nature reserves: *"I like the idea of people back in the landscape, using the woods again. I think if you don't get people on board and get people supporting the importance of these sites then there's a danger that they do get forgotten about... they might fall off the radar and you could tip over into Successful Exotics without people on board. If people don't care enough about them and they don't have that sense of attachment, I think there's a danger that...if people aren't visiting then they can sort of fall off the list."*

Next steps

We have now concluded two workshops in Glen Creran, Argyll: this one carried out on Glasdrum Wood NNR and one in April 2018 on Glen Creran Woodlands, FLS. In 2019 we will be conducting additional woodland workshops in the other study areas: North Lanarkshire, and the Cairngorms. In addition to producing reports for each workshop, we will analyse the data gathered across all three sites to gain an in-depth understanding of perspectives about how different management interventions can impact the benefits and services gained from woodlands.

Glasdrum Wood National Nature Reserve

Site description

Glasdrum Wood is found just off the busy A828, the main road linking Oban and Fort William. Glasdrum Wood National Nature Reserve is a 169 ha upland sessile oak and ash woodland on the lower southeast slopes of Beinn Churalian, a mountain which rises steeply from Loch Creran, a sea loch. The reserve is part of a designated national Site of Special Scientific Interest (SSSI) (703 ha) and forms a large part of the Glen Creran Woods Special Area of Conservation (SAC) (535 ha).

Glasdrum is a broad-leaved woodland. Its mild, wet Atlantic climate provides ideal conditions for lichens, mosses, liverworts and ferns. It provides habitat for four globally vulnerable and nineteen globally near-threatened species of lichen. It is one of the UK's best examples of a cool-temperate rainforest. The southeast-facing slopes and the shelter provided by the trees favour a variety of insects, including rare butterflies such as chequered skipper and pearl-bordered fritillary. The rock types within the reserve are mainly black slates and phyllites but also calcareous on the lower slopes, limestone, and intrusions of igneous rocks on the higher slopes. This variety of rock types determines the woodland's diverse vegetation.

Historically, Glasdrum Wood was managed for charcoal production (to supply the iron furnace at Bonawe) and for wood pasture. These uses have influenced the structure and composition of the wood. For instance, some areas are dominated by previously coppiced trees, while the past grazing practices promoted areas of open glades, which are good for butterfly populations. Some parts of the woods were cleared of the deciduous woodland and planted with conifers in the 1960s. An area of the wood was declared a National Nature Reserve in 1967 and this area was extended in 1977. It is now owned by Scottish Natural Heritage.

The following scenarios were presented to workshop participants for discussion. The first two describe the past and present (2019) site condition; the four future scenarios describe what the Glasdrum Wood NNR might look like in the future (2035) if different hypothetical management approaches are followed.

The Early 1980s

The area predominantly consisted of dense thickets of mature oak and ash, with birch found on the higher elevations and an area of hazel occupying a patch of ground on lower elevations. The woodland had a diverse structure, both spatially and aesthetically. This was due to the patches of different tree species, such as the dense thicket of hazel that neighboured the mature oak and ash stands, and also from the contorted structure of individual trees, especially those that had been previously coppiced, such as ash and oak. There was one block of spruce of about 5.5 ha left with the trees around 10m high. These had been enclosed with a fence which appeared not to have been maintained very well.

There were a few areas of open glades which showed signs of becoming more closed due to the onset of scrub, indeed there were areas of dense scrub and bracken. Access into the wood was very difficult as previous access routes and tracks were overgrown with bracken, bramble and some exotic species such as Japanese knotweed and rhododendron. Red and roe deer were residents of the reserve, and some trees showed signs of browsing, with stripped bark, but livestock grazing had been reduced by the completion of a stock fence to the west towards Creagan Farm in 1983. The wood harboured butterfly species such as chequered skipper which were mostly found in the glades and open scrub areas, feeding on spring flowers like bugle and the non-native Japanese knotweed, rhododendron and violets. Pearl-bordered fritillary and mountain ringlet butterflies were found in the more elevated areas of the reserve.

The site also had a rich diversity of oceanic lichen and bryophytes. Rare lichen assemblages were found in the open patches of woodlands and glades. Apart from researchers and people with particular interests in lichens, mosses, butterflies or Atlantic woodlands, the reserve received hardly any visitors. There were no visitor facilities.

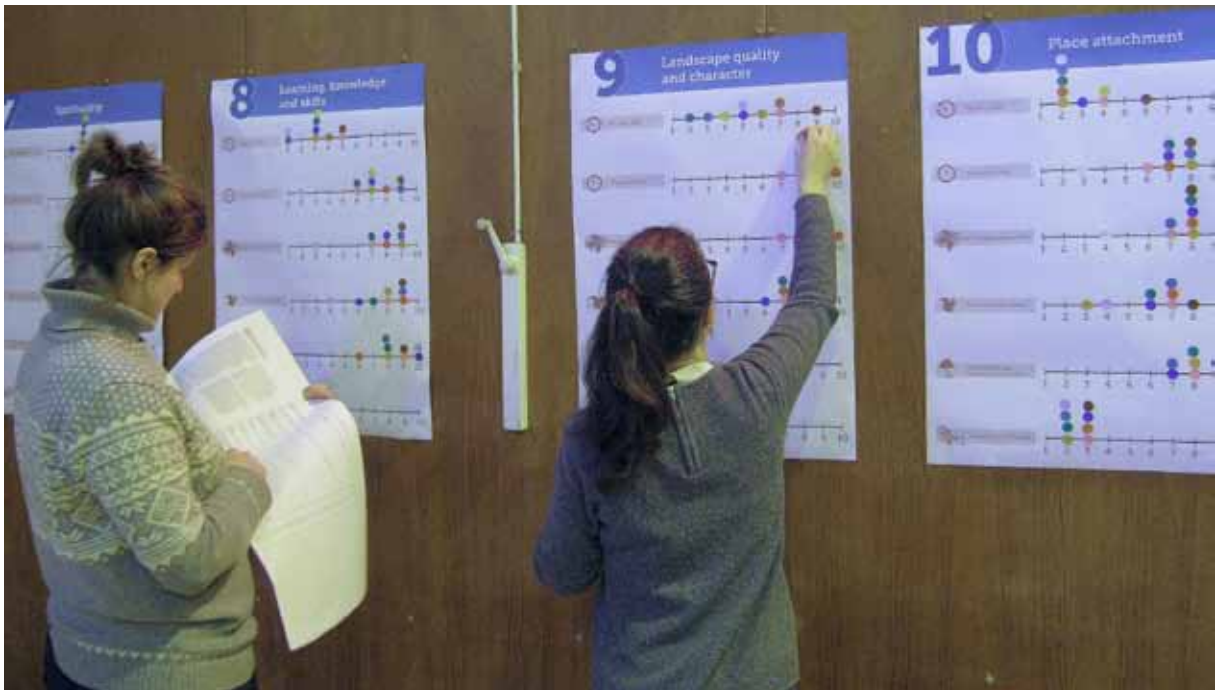
The Present (2019)

Areas of relatively open glades with mature oak and ash neighbour more dense scrubby woodland. The dense, sometimes thicket-like woodland is a result of regrowth from oak and ash standards and natural infill regeneration of birch, hazel and alder. Ash regeneration is somewhat limited and is thought to be due to an increase in the deer population and hence browsing. Although the woodland features of the site have been considered unfavourable until recently, the reserve is one of the best sites in the Scotland for butterflies (with 21 of the 34 Scottish species recorded), including chequered skippers and pearl-bordered fritillaries, which use the open ground for basking, nectaring and for food for their developing larvae. The woodland is also renowned for its rich oceanic lichen and bryophyte diversity, including 15 lichen Red Data Book species. The lichen assemblages can be found in the smaller open patches in woodlands, or micro-glades where both humidity and sunlight are at relatively high levels. Pine marten, red squirrel, pipistrelle bat, red and roe deer are all residents of the reserve.

The site is predominantly managed for its conservation value, related to the woodland, its lichen and bryophyte assemblages, and to the butterflies. Regular monitoring and research (woodland condition and regeneration, butterflies and lichens), including by university students and volunteers from Butterfly Conservation, feed into the adaptive management of the reserve. The focus of management is for the woodland habitats to regenerate naturally, whilst maintaining enough open ground for butterflies and micro-glades for lichens. However, clearance of areas of regenerating scrub and bracken is still necessary to ensure there are enough open glades (15-25% of total cover) for butterflies and smaller, sheltered open spaces for the lichen assemblages. Non-native invasive species such as rhododendron and Japanese knotweed are removed and sprayed with herbicides. This is part of a wider campaign together with local landowners and the Forestry Commission (now Forest and Land Scotland), to eradicate rhododendron in the whole area.

Two members of staff based in Lochgilphead are responsible for all three SNH reserves in the wider Argyll area. Visitor numbers are at around 2800 per year. There is a small car park, picnic area and short, but relatively steep, circular 1km trail with a few location signs along the route around a small part of the reserve. Occasionally, guided walks are offered for schools and butterfly enthusiasts. Wooden footbridges lead over babbling streams and cascading waterfalls and there are a number of viewpoints across Loch Creran.

Researchers from the James Hutton Institute visually representing scores given for different indicators.



Rainforest Beginnings (2035)

Glasdrum Wood NNR is an oak and ash woodland where natural changes in the habitat are allowed to evolve while maintaining the NNR's most valuable species. Four key objectives underpin the management for natural heritage: (a) to maintain the woodland in favourable condition, (b) to maintain the diversity and distribution of lichen species, e.g. through ensuring that enough micro-glades are available, (c) to maintain at least 15% of the woodland area in a condition that supports key butterfly species and (d) to use monitoring to improve adaptive management of the reserve.

The area is seen as an integrated part of the wider Glen Creran native woodland so, where possible within a limited time budget, management actions are coordinated with neighbouring areas to achieve an integrated management at a landscape scale. Deer populations are managed by local stalkers and in collaboration with neighbouring estates, which has led to a stabilisation of browsing rates at a relatively low level. This, together with the removal of non-native invasive plants and the protection of sapling ash trees, has allowed for a natural regeneration of broadleaves, although ash trees have been hit by ash dieback and have therefore not regenerated as well as hoped, and oak regeneration has been limited over the last decades. Some of the older trees have died which means that the specific communities of lichens on old trees have become much more restricted.

Controlling the spread of invasives such as rhododendron is a constant challenge, as there are still a few remaining sources of plants in private gardens adjacent to the reserve, despite concerted efforts to eradicate the plant through the first ever landscape-scale attempt to remove rhododendron which started about 20 years ago. Likewise, bracken requires constant attention, as climate change has meant that there are fewer late frosts and bracken is therefore spreading more rapidly than before. Bracken control is mainly done using a horse to drag a weight across the bracken, and scrub encroachment is also kept in check, to maintain open areas that favour butterfly populations. Populations of chequered skipper and pearl-bordered fritillary have stayed more or less stable.

Regular monitoring and research is carried out to inform future management. This includes monitoring the structure and condition of the woodland, the impact of herbivores, changes in the distribution and population of lichens, and specific butterfly species and their habitats. There is continued cooperation with farming neighbours who let their cattle graze in some parts to help keep these open.

The area is especially popular with dog walkers and butterfly enthusiasts, and visitor numbers are about 3,000 per year. The reserve provides and updates information for visitors, and maintains the car park, picnic area and other facilities in good condition, although there is no concerted effort to attract more visitors. The reserve also engages local population by offering volunteering opportunities, utilising local contractors and engaging with local tourism service providers. On average, one school visit from local primary schools is supported each year.

A Diverse Hotspot (2035)

Glasdrum Wood is an oak and ash woodland and a biodiversity hotspot which holds rare species and assemblages of lichens, mosses, and butterflies, as well as red squirrels, pine martens, golden eagles and wildcats. White-tailed eagles are fishing on the loch and have just (in the last couple of years) been found breeding in the reserve. Invasive plants such as rhododendron, Japanese knotweed and American skunk cabbage have been eradicated, which involved removing rhododendron from home gardens in the neighbouring areas, and regrowth of rhododendron and Japanese knotweed and skunk cabbage is removed regularly, where necessary with herbicides.

The management of the woodland focuses on the rare lichen communities and butterfly species for which the reserve is known. Dense, thicket-like areas have been thinned and coppiced to give the younger woodland areas more structure and permeability, with the prime aim being to enhance the habitat for the target butterfly and lichen species. Deer management takes place in close collaboration with neighbouring estates, who are working together in a newly set up, smaller Deer Management Group to coordinate their activities. However, grazing pressure from deer is not necessarily only seen as negative as grazing helps to keep the desired open woodland structure. Agreements have been set up with neighbouring farmers to let their cattle graze in the area, which also helps to maintain open areas among the trees.

The overall management of the nature reserve happens in close coordination with other land owners and managers in the wider area to achieve better overall results at the landscape scale. Many ash trees have died due to ash dieback and this has also created more openings in the woodland structure as well as more deadwood which is left to provide habitat for deadwood species. Some individual ash saplings are showing resistance to ash dieback and are beginning to regenerate. While the management aim is to maintain an open woodland structure, individual saplings of ash as well as other species such as oak are protected through deer guards and fences (where needed) to ensure that enough grow up into mature trees to replace the older ones as they die. This helps to ensure that there continues to be sufficient numbers of older trees to maintain the rare lichen species dependent on these trees. Some areas are kept clear of bracken and scrub encroachment through targeted cutting and herbicide application using drones to provide habitat for butterflies and rare lichen communities.

In collaboration with universities, research organisations and non-governmental organisations (NGOs), close monitoring and research is conducted on the structure and condition of the woodland, on lichen communities, and on specific butterfly species. This guides the management of the woodland in a way that balances the habitat needs of lichens and butterflies. While some of the older oak trees (with well-established but rare communities of lichens) have died, experimental research by the Royal Botanic Garden Edinburgh has developed approaches to translocate these communities, so they have found new host trees. Due to these novel approaches, the site has become a popular area for researchers.

The trail and footbridges are maintained to ensure the safety of visitors. There are signs explaining the work being done and its aims, but other than that, signage and facilities for visitors are kept at a minimum. The open woodland structure means that the site provides good views over Loch Creran and to the other side of the glen.

Living History and Biodiversity for All (2035)

It has been decided to focus more on community engagement, visitor education and outreach. This includes not only the biodiversity of the site, but also the cultural history, remnants of which are visible at Glasdrum. To make history come alive for visitors and local people, part of the site is now managed according to historical management techniques and, together with the local history association, a charcoal kiln and hearth has been reconstructed and regularly runs charcoal-making demonstration days. More footpaths have been established, some leading higher up the hillside, and another one linking Glasdrum to the rest of Glen Creran Woods SSSI to the east. The different routes have different lengths, as well as themes such as the Jacobites or the early Christians. Each path has online as well as paper and in situ sign-based information materials associated with it. The paths link up with longer distance paths to Ballachulish and the old iron furnaces at Bonawe. Virtual signposts at regular intervals along the paths provide interactive information material about the natural and cultural history of the site. Visitors can add their own pictures and stories from the site, as well as reporting sightings of animals and plants as they go along. Nest boxes have been erected and webcams have been installed in these, as well as in other parts of the site where wildlife is often seen, so people can follow the wildlife of the site online. Local businesses and visitors can adopt a nest box and camera through sponsorship. Most of these activities are run and maintained by volunteers, often students, who join the reserve team for several months at a time and stay in nearby Appin. This programme is organised through a local community organisation which successfully applied for Lottery funding to realise these projects. To avoid complaints by visitors, herbicides are no longer used on the reserve, which means that spreading invasives such as rhododendron, Japanese knotweed and American skunk cabbage have to be removed manually by specially trained volunteers. These are mainly local residents, who in turn have the right to harvest wood on a small scale (where trees have to be thinned) and use this for firewood. This more manual approach to the control of invasives means that it has not been possible to completely eradicate these invasives. Deer are managed by two locally-based stalkers, supported by students from the gamekeeping colleges in Thurso and Fife. Collaboration with local accommodation providers has helped make the reserve more widely known in the local tourism sector, which in turn has helped attract more visitors. A composting toilet facility has been built at the car park. The car park has been widened to double its size by cutting trees and levelling an adjacent area to the east. The original path has also been widened and redesigned so that it is step-free and less steep, allowing access for wheelchair users and buggies. The increased visitor numbers have created some problems with waste, and wild campers sometimes damage the vegetation or light fires.

In addition to recreational visitors, the site is used as an outdoor classroom by local schools for science projects. Most of the monitoring of animal, plant, lichen and bryophyte populations is done using remote sensing, and the large amount of data generated is analysed with the help of the pupils and volunteers in online citizen science projects. A local woodland management group has also been established. The members help to make decisions about the management and to implement agreed actions. Bracken control is implemented using a horse to drag a weight over the bracken. This has proven a popular tourist event in summer. Due to the great variety of potential activities – walks of different lengths traversing different landscape types, and the potential for different ways of engagement, ranging from nature discovery by kids, to wildlife watching, to learning about the ecology and cultural history of the place – visitor numbers have increased a lot, and many more people follow the wildlife on the site remotely through webcams.

Opposite: Glasdrum Wood

Succesful Exotics (2035)

Only the most necessary management interventions are carried out. The path is no longer maintained, and wind-thrown trees are left in place unless they pose immediate risks. The benches have been removed, and information materials are no longer being provided.

Staffing levels in Lochgilphead for the three SNH reserves in the wider area have been reduced. There is still some management for the priority species for the site, mainly in the form of periodic clearing of small areas to encourage butterfly and lichen assemblages. As far as possible, this is being done with the aid of volunteers through partners such as Butterfly Conservation. There is no active deer management at the site, but deer stalking is still taking place at the nearby Forestry Commission (now Forest and Land Scotland) sites, so deer numbers have remained more or less constant. Ash dieback has led to the death of most of the ash trees, which has meant that gaps are opening in the forest. As the deer mainly browse on the young oak and other broadleaf seedlings and saplings and there is no money to put up fencing or rabbit and deer guards, this has meant that there are few young oak and other broadleaf trees that reach the woodland canopy height to replace the dead trees. Non-native conifers have seeded into some parts of the site from elsewhere in the glen and, as these are less palatable and more shade tolerant than other species, some have already grown to canopy height and are starting to change the tree species composition of the woodland back to a more conifer dominated woodland. As a consequence of climate change, there are fewer late frosts, bracken is spreading in many parts of the site, particularly where the mature trees have died, leaving open, non-wooded areas. The spread of invasives, such as rhododendron, azalea, Japanese knotweed and American skunk cabbage has been left unchecked and these are also benefitting from the open areas beneath the dead ash trees. The contract with a farmer who had let his cattle graze in the area to help thin out some of the vegetation has been terminated to save money. Altogether this has resulted in a decline of previous priority taxa such as lichens, bryophytes and butterflies, due to the dense understory scrub of rhododendron and other species which are not eaten by deer. However, a narrow strip still has to be kept open along the power line running through the area, and at least in this area some of the rare butterflies can still be found. The upper part of the site is still without tree cover as continued deer browsing prevents the native forest from spreading upward. Staff time is focused on management of the reserve, and there is little time for partnership working with other stakeholders. Monitoring is only carried out insofar as organisations such as universities do research in the area, but this has also declined as other organisations have been hit by funding cuts, and the ecological value of the site has also declined. Fewer people visit the site than before, as the path has become overgrown and less accessible, especially because many people are nervous about the risk of tick-transmitted diseases, which has increased with climate change.

Appendix Two - Ecosystem service indicators:

Potential benefits from Glasdrum Wood.

These indicators are common across the different research sites in this study. As such, some of the indicators (e.g. timber extraction; natural flood management) might be more applicable to the other woodland contexts than Glasdrum Woodland.

	Indicator	Explanation
1	**Employment and Income** Overall, how well do you think each scenario delivers with regards to employment, i.e. the number of jobs directly or indirectly linked to the site?	Consider for each scenario the impact on employment for the area. Think about the impact each scenario has on the diversity of jobs available in the local area and whether these are likely to be unskilled, skilled or professional jobs.
2	**Target species – spring flowers** Overall, how well do you think the scenario encourages woodland spring flowers (bluebell, wood anemone, violets etc.)?	Consider for each scenario to what extent the various management interventions lead to more open, woodlands, with moderate levels of disturbance and species rich ground flora.
3	**Target species – brambles, bracken and rhododendron** Overall, how well do you think the scenario suppresses species such as bramble, bracken and rhododendron?	For this indicator we are interested in the impact of the scenario on species that are considered 'bad for biodiversity' as they potentially exclude others, leading to reduced species diversity. In this case, a high score indicates that these species would be kept at bay in a given scenario.
4	**Timber Extraction** Overall, how do you think each scenario will affect the actual extraction of different types of wood materials (i.e. construction timber, wood fuel, wood for pulp, craft woods) from the site?	This indicator refers to wood/timber materials for different uses that are extracted from the site under the different scenarios. Please consider in your answers both the availability of such materials and the extent to which it is actually taken off site.
5	**Carbon stored** Overall, how do you think each scenario will affect the amount of carbon stored at the site?	Please consider in your answer that all of the components of the site potentially contribute to carbon uptake and storage, e.g. trees, understory shrubs and grasses, mosses, but also the carbon in the soil itself.
6	**Mental restoration** Overall, to what extent does each scenario promote people's feelings of being relaxed and restored?	This indicator relates to subjective experiences that contribute to mental wellbeing. In your answer please consider how each scenario would affect users' feelings of calmness and tranquillity, stress relief and escape from daily hassles/problems, and feeling refreshed and re-energised. This includes local residents, visitors and any other people using the site.

Workshop discussions.

	Indicator	Explanation
7	**Spirituality** Overall, how well do you think each scenario delivers on opportunities for spiritual experiences?	This indicator refers to how each scenario fosters a sense of encountering something sacred or bigger than oneself, and promotes a sense of wonder.
8	**Learning, Knowledge and Skills** Overall, how well do you think each scenario delivers on opportunities for training, education and learning?	Please consider the full range of potential knowledge, skills and training opportunities and all age groups – from traditional land management skills to handicrafts, to research and monitoring, to outdoor education and mountaineering skills.
9	**Landscape quality and character** Overall, how well do you think the scenario delivers on perceived landscape quality and character?	To which extent do you think people will appreciate the landscape, in terms of its visual aesthetics as well as its other features and its overall character? Consider how the different elements and features (natural and human made) make up the landscape in the scenario.
10	**Place Attachment** Overall, how well do you think each scenario supports local people/visitors in forming and/or maintaining a strong attachment to this place?	How might each scenario affect people's emotional connection to the site? Please consider how the changes described in the scenario would affect the emotional significance of the place for individuals, as well as extent to which users would experience feelings of belonging and being 'at home'.
11	**Natural Flood Management** Overall, how well do you think each scenario provides protection from flooding, e.g. through natural flood management?	Do any scenarios increase or decrease the risk of flooding either in the upper or lower catchment? Consider how the vegetation and soil structure in each scenario may affect the volume and speed of surface water run off or soil permeability.

Acknowledgements

We would like the thank the workshop participants for their time and expertise, Stuart Shaw and Heather Watkin (Scottish Natural Heritage) for their support and access to site data and information materials and Sally Eaton (Royal Botanic Garden Edinburgh) for sharing insights about lichen biodiversity. The research for this project is funded by the Rural Affairs, Food and the Environment Strategic Research Programme of the Scottish Government under the theme 'Natural Assets'. For further information about the project please contact antonia.eastwood@hutton.ac.uk.

Other resources

Halliday, John (2013): The Story of Glasdrum Wood National Nature Reserve (second edition) Scottish Natural Heritage.

The report for the workshop held in April 2018 regarding the nearby Glen Creran Wood is also available:

Eastwood, A., Juarez Bourke, A., Fischer, A., Herrett, S., Selby-Donaldson, G., Hague, A., Pakeman, R.J., Hester, A., and Artz, R. (2018). Glen Creran Woods: Exploring the perceived impacts of different management interventions on woodland benefits. Workshop Report. The James Hutton Institute.

Suggested citation:

Hague A., Eastwood, A., Lorenzo-Arribas, A., Juarez-Bourke, A., Herrett, S., Byg, A., Fischer, A. (2019). Glasdrum Wood: exploring the perceived impacts of different management interventions on woodland benefits. Workshop Report. The James Hutton Institute.