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To cite this article: Antonia Eastwood, Altea Lorenzo-Arribas, Anke Fischer, Laura MacLean, Alice Hague, Alba Juarez-Bourke, Scott Herrett, Anja Byg, Keith Marshall, Robin Pakeman, Gillian Donaldson-Selby & Alison Hester (2024) Exploring the impacts of woodland management on ecosystem services – a deliberative method, *Ecosystems and People*, 20:1, 2322638, DOI: [10.1080/26395916.2024.2322638](https://doi.org/10.1080/26395916.2024.2322638)

To link to this article: <https://doi.org/10.1080/26395916.2024.2322638>



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RESEARCH



Exploring the impacts of woodland management on ecosystem services – a deliberative method

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ABSTRACT

There is a need for operational decision-making methodologies applicable at local management scales which are inclusive and enable the integration of plural values, knowledges and perspectives of co-produced ecosystem services. Here we describe a deliberative scenario analysis method using ‘management intervention bundles’ as distinct scenarios to assess the perceived impact of changing management on woodland ecosystem services. We used three hypothetical future management scenarios, Biodiversity Conservation, People Engagement and Austerity, alongside scenarios of the Past, Present and an existing Management Plan. We assessed the perceived impacts of these scenarios on 11 ecosystem services using local expert workshops in six sites across Scotland. The experts were chosen to represent a range of different perspectives, from biodiversity to the local economy, community concerns and recreation. Overall, Management Plan, Biodiversity Conservation and People Engagement scenarios performed significantly better than Past, Present and Austerity scenarios. Further quantitative and in-depth qualitative analysis revealed trade-offs and noteworthy patterns. We explore some of these key trade-offs and patterns and argue that our methodology has potential to be an effective tool for local managers to support local decision-making at management scales for co-produced ecosystem services. Our methodology enabled a diverse group of local experts to express and deliberate a range of values, experiences and viewpoints. This knowledge sharing and collective learning allowed the development of shared values and perspectives, which are thought to be critical in more equitable and inclusive decision-making.

ARTICLE HISTORY

Received 30 November 2022
Accepted 17 February 2024

EDITED BY

Davide Geneletti

KEYWORDS

Cultural ecosystem services; environmental justice; participatory methods; scenario planning; Scotland

Introduction

The importance of ecosystems and biodiversity to human wellbeing is now well established due to several seminal endeavours (MEA 2005; NEA 2011; IPBES 2019). Ecosystems are multi-functional; the same system gives rise to multiple, material as well as non-material, ecosystem services (IPBES 2019). It is also now widely accepted that ecosystem services are best conceptualised as being co-produced by people and place (Fisher et al. 2009; Chan et al. 2012; Fischer and Eastwood 2016).

As ecosystem services are co-produced through human-nature interactions, the governance of land and associated management choices will impact on which groups of people benefit from ecosystem services or disservices and in which way (Fischer and Eastwood

2016; Fish et al. 2016). Complex, interacting factors make it difficult to anticipate or predict the impacts of different management approaches on even a small number of ecosystem services. However, this is precisely the task that many land managers are facing. Land managers must understand and consider potential synergies and trade-offs in ecosystem services and take into account the diversity of potential human-nature interactions as well as the plurality of values, identities and capabilities of different beneficiaries (Fischer and Eastwood 2016).

Recognising and respecting plural values, catering for different capabilities and understanding the distributive aspects of ecosystem service co-production and associated burdens are key principles of achieving greater environmental justice (Schlosberg 2007; Walker 2012). Another important consideration for land managers is how decisions are made, known as procedural justice.

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 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/26395916.2024.2322638>

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Ways to address injustices in distribution and recognition include decision-making structures and procedures such as participation, deliberation, and communicative democracy (Schlosberg 2007). To achieve greater inclusivity, the Convention on Biological Diversity's Ecosystem Approach (CBD 2010) recommends decisions be made at an appropriate scale, decentralised to the lowest level, whilst IPBES (2019) advocates greater integration of local and indigenous knowledge. However, whilst there are multiple ecosystem service assessment and valuation approaches for different ecosystems and scales, few have explored the effect of different management approaches on ecosystem benefits beyond gross land use change or management intensity (NEA 2011; Dick et al. 2014; Sing et al. 2018; Harrison et al. 2019). As many ecosystem services are co-produced through interconnected, relational processes in environmental spaces (Church et al. 2011; Fish et al. 2016) it is therefore important to holistically assess the spectrum of benefits systematically, to fully understand the potential effects and implied trade-offs of management interventions on the ground.

In addition, many ecosystem service assessments are based on existing quantifiable metrics, which for cultural services are often indirect proxies for that service (Dick et al. 2014; Olander et al. 2018; Torralba et al. 2018). Whilst the use of existing indicators and scenario archetypes enables cross-site and multi-scale comparisons to be made at national, regional and global levels, their relevance to inform and assist local decision-making is questionable. Consequently, methods to explore and understand the impact of management on co-produced ecosystem services at a local level are necessary.

So how do land managers make decisions about the management of ecosystems in a way that is inclusive of different knowledges, recognises plural values and is more equitable in the distribution of benefits? Recent developments on participatory and deliberative methods such as participatory scenario planning, citizen juries and deliberative multicriteria analysis provide methodological inspiration to explore the impacts of management interventions on co-produced ecosystem services, as well as illuminating the challenges (Oteros-Rozas et al. 2015; Kenter et al. 2016a, 2016b; Mavrommati et al. 2017; Nyongesa and Vacik 2019; Saarikoski and Mustajoki 2021). For example, due to its time-consuming nature, participatory scenario analysis was found not to provide practical, operational solutions to site managers or communities (Waylen et al. 2015; Eastwood et al. 2017). As Waylen et al. (2015) concluded, there is a risk that more time is spent developing scenarios than using them. However, scenario planning purports to facilitate imaginative thinking, and encourages people to step outside of conventional ways of understanding issues (Shearer 2005), which

could be advantageous when exploring complex socio-ecological systems. Scenarios are plausible representations of possible futures, often using alternative drivers of change to explore a system, or alternative policies or management options (IPBES 2016). It has been argued that deliberative methods allow plural values, knowledges and perspectives associated with complex socio-ecological systems to be articulated and explored, this enabling social learning, the elicitation of shared values, and ultimately, integrated, shared decision-making (Kenter et al. 2016a, 2016b; Mavrommati et al. 2021).

In this paper, we take inspiration from, and build upon, the range of participatory and deliberative decision-making methods available to describe the application of a novel deliberative scenario analysis method using 'management intervention bundles' as distinct scenario archetypes to assess the perceived impact of changing management on woodland ecosystem services. Our focus was to develop an inclusive method that is appropriate for managing co-produced ecosystem services in a practical but holistic and systematic way. In this paper, we define deliberation as a group-based process of participation, social exchange, reflection, learning and meaningful debate (Kenter et al. 2016b).

As well as describing the application of our methodology across six woodland sites in three case study areas in Scotland (Table 1), we present our mixed-methods findings from a cross-site analysis asking: i) how different management approaches impact on perceived ecosystem services, ii) what similarities and differences in the impacts of management on ecosystem services occur across sites, and (iii) if deliberative workshops, designed to aid assessment of such impacts and bring together diverse, local perspectives, might be a helpful tool for local decision-makers. We discuss the potential of our novel deliberative scenario method to enable the inclusion of different knowledge systems, values and beliefs to inform the decision-making of complex sites and its relation to facilitating environmental justice.

Methodology

We used an iterative, co-creative process that involved both researchers and local site managers and stretched over several years, to: (i) select sites, (ii) develop an overall approach as well as scenarios representing different management approaches (archetypes), (iii) design the workshop format including a rationale for the selection of participants, (iv) formulate indicators to assess the scenarios, and (v) develop an approach to data analysis, including an assessment of the usefulness

of the method. These different elements are described in the following sections.

Selection of sites and scenario development

For our study, we selected woodland sites with similar management objectives, i.e. sites with primary objectives of biodiversity conservation and public engagement, albeit to varying degrees. Our study incorporated three case studies in Scotland, each with two woodland sites (Table 1).

Overall, our method can be characterised as a strategic, exploratory scenario approach (Börjeson et al. 2006) where ‘management intervention bundles’ representing alternative management options are assessed and then deliberated to explore perceived impacts on ecosystem services. Strategic

scenarios focus on factors that managers can affect, whilst taking external factors into account. We co-constructed such scenarios for each site together with the respective site managers ahead of participatory deliberative workshops, to enable participants’ time to be focused on the scenario assessment and ensuing deliberation.

We started by identifying six scenario archetypes (Table 2), which included three future, hypothetical ‘management intervention bundles’ (biodiversity conservation, people engagement and austerity) alongside scenarios of the past, present and each site’s 10-year management plan for comparison. The hypothetical scenarios were set in the short-term future, to coincide with the end of each site’s management plan (10–15 years). The Austerity scenario was included following feedback from a site manager during a pilot workshop.

Table 1. Description of the six woodland sites and summary of workshops.

| Case study area | Site | Site description | Governance: Owned and managed by ... | Workshop date | No. of participants |
|--------------------------------|---|--|---|---------------|---------------------|
| Cumbernauld, North Lanarkshire | Cumbernauld Glen 55°57'46"N, 3°57'42"W | Valley woodland in an urban area. Predominantly mature, non-native woodland. However, 65% designated as Ancient semi-natural woodland; includes smaller areas of heath and grassland. No official protected area status. Approx. 118.6 ha. | Scottish Wildlife Trust, a membership-based wildlife and conservation charity | June 2019 | 5 |
| | Forest Wood 55°57'01"N, 3°56'38"W | Peri-urban woodland. Mostly oak, beech, birch, underplanted with conifers (larch, Sitka spruce, Scots pine, lodgepole pine, western hemlock) in the 1960s. Small areas of lowland peat bog, heath and grassland. Approx. 30% recorded on Ancient Woodland Inventory. Approx. 90 ha. | Scottish Wildlife Trust | June 2019 | 6 |
| Glen Creran, Argyll and Bute | Glasdrum Wood 56°33'37"N, 5°15'40"W | Rural area. Upland sessile oak and ash woodland, part of a larger area designated as a Site of Special Scientific Interest (SSSI). Designated for upland oak woodland, bryophyte and lichen assemblages, Chequered Skipper and Pearl-bordered Fritillary butterflies). Special Area of Conservation (SAC) for mixed woodland on base-rich soils associated with rocky slopes and western acidic oak woodland. Mild, wet Atlantic rainforest. National Nature Reserve. Approx. 169 ha. | NatureScot, Scotland’s Nature Agency | January 2019 | 9 |
| | Glen Creran Woods 56°35'27"N, 5°11'49"W | Rural area. Two areas designated as part of the Glen Creran Woods SSSI & SAC (approx. 368 ha). Mixed woodland, mostly native broadleaf. Some exotic conifer plantation (Sitka and Norway spruce). The areas designated as SSSI are notified for upland oak woodland, bryophyte and lichen assemblages, and Chequered Skipper and Pearl-bordered Fritillary butterflies. The SAC is designated for mixed woodland on base-rich soils and western acidic oak woodland. Glen Creran area is owned by Forestry and Land Scotland. Approx. 2482 ha. | Forestry and Land Scotland, a Scottish Government agency | April 2018 | 7 |
| Loch Arkaig, Highlands | Clunes and Tom an Eireannaich woodland (56°57'10" N, 4°57'27" W) | Rural area. Ancient, mixed broad-leaved woodland containing patches of upland oakwood, upland birchwood and wet woodland. Small but good example of wet Atlantic rainforest. Approx. 6 ha. | Arkaig Community Forest, managed and owned by the local community since 2014 | August 2021 | 9 |
| | Loch Arkaig Pine Forest 56°57'12"N, 5°05'23"W | Rural area. Semi-natural Caledonian pinewood comprising mature Scots pine, upland birchwood and wet woodland. No formal conservation designations, but part of the Caledonian Pinewood Inventory woodlands. 1027 ha across two large woodland areas, with approx. 40% mature non-native conifers (Sitka spruce and lodgepole pine). Designated as Planted Ancient Woodland Site. | Woodland Trust Scotland, woodland conservation charity, (majority landowner) and Arkaig Community Forest (owns approx. 53 ha) | August 2021 | 8 |

Using the six archetype scenarios (Table 2) the research team developed site-specific scenario descriptions for each woodland site with input from local site managers. We used past and present management plans, site visits, ecological surveys, socio-economic studies and archival documents to develop scenario narratives. This resulted in 36 scenario narratives, six for each site, based on the six archetype scenarios. While writing these, the research team referred to a checklist of selected criteria to ensure the narratives were comparable in thematic content and style across sites and represented the respective scenario archetype in an effective way. Criteria on the checklist included aspects of the natural environment (structure, character and feel, species, management) and human use (infrastructure, use, challenges, relevant activities and access). An example of the site descriptions and the six scenarios developed for one of the sites can be found in Appendix 1. The site-specific scenarios (representing the six archetypes) for the each of the six sites can be viewed in the individual workshop reports accessible from Eastwood et al. (2022).

Using benefit indicators to assess management impact on ecosystem services: local expert workshops

To assess the impact of the different scenarios on perceived ecosystem services we conducted a deliberative scenario workshop at each site. Whilst recognising there is a diversity of ecosystem service definitions and terminology, we focused our study on ecosystem benefits – benefits understood as something of value to people – following the ecosystem cascade after Haines-Young and Potschin (2010) and Maes et al. (2012). In line with this, the term ecosystem benefits was also the concept that seemed easiest and least ambiguous to use with participants in our workshops. As such, we use the term ecosystem benefits in the remainder of this paper.

In discussion with the site managers, we developed our indicators to reflect ecosystem benefits that were context-specific, relatable, and relevant at the local

scale, whilst being generalisable across the sites (Table 3). We attempted to cover benefits arising from a range of woodland ecosystem services, including regulating, provisioning and cultural services, without intending to use these categories for analytical purposes. While many of the benefits directly matched conventional interpretations of ecosystem services – e.g. mental restoration and spirituality reflecting benefits connected to cultural ecosystem services – others, such as timber, which represented a provisioning service but also alluded to cultural services, were less straightforward to categorise. Two of the 11 indicators related to biodiversity associated with Scottish woodlands that are well managed (target species: spring flowers e.g. wood anemones, violets and bluebells) and poorly managed (target species: bracken, brambles and rhododendron, higher scores for suppression). These biodiversity indicators also hold significant cultural values and would therefore be classified as indicators of cultural (dis-)services in many ecosystem services classifications including CICES (Haines-Young and Potschin 2018) and the UKNEA (Mace et al. 2011).

The use of benefit-relevant ecosystem indicators for decision-making has been recommended by researchers such as Olander et al. (2018). Our method used individual and shared expert knowledge to score and deliberate scenario performance based on participants' interpretations of the perceived causal links between variables in the scenario narratives (e.g. ecological conditions, access, interventions, types of beneficiaries etc.) and ecosystem benefits, rather than quantitative calculations as suggested in Olander et al. (2018).

Participants were invited for their knowledge of the site and local area, and included education professionals, land managers, business owners, staff from government agencies, researchers, environmental NGOs and local residents. We deliberately sought a small number of 'local experts' (5–9 people) with differing knowledges, views and experiences of, and about, the site. For example, participants attending one workshop included local residents and managers

Table 2. The six scenario archetypes used as a basis for site-specific scenarios in the six sites.

| Scenario name | Description of scenario | Source |
|---------------------------|---|--|
| Past | Past state of the site reconstructed from existing data | Based on existing data, images, maps and other documents from 1980–1990s, with feedback from site managers |
| Present | Present state of the site | Based on existing data, with feedback from site managers |
| Management plan | Result of the current management approach | Based on existing management plans, set 10–15 years into the future, with feedback from site managers |
| Biodiversity Conservation | Focus on enhancing and restoring native species and habitats, including removing non-natives and reintroducing species if plausible | Hypothetical, set 10–15 years into the future, with feedback from site managers |
| People Engagement | Focus on public engagement and education, community development and improving access for a range of actors | Hypothetical, set 10–15 years into the future, with feedback from site managers |
| Austerity | Only activities to fulfil legal requirements, health and safety regulations and, if possible, income generation | Hypothetical, set 10–15 years into the future, with feedback from site managers |

Table 3. Indicators of ecosystem benefits used in the local expert workshops to assess the impact of the 6 management scenarios.

| Indicator | Question to participants |
|--|---|
| 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? |
| 2. Target species – spring flowers | Overall, how well do you think the scenario encourages woodland spring flowers (bluebell, wood anemone, violets etc.)? |
| 3. Target species – brambles, bracken and rhododendron | Overall, how well do you think the scenario suppresses species such as bramble, bracken and rhododendron? |
| 4. Timber | 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? |
| 5. Carbon sequestration | Overall, how do you think each scenario will affect the amount of carbon stored at the site? |
| 6. Mental restoration | Overall, to what extent does each scenario promote people's feelings of being relaxed and restored? |
| 7. Spirituality | Overall, how well do you think each scenario delivers on opportunities for spiritual experiences? |
| 8. Knowledge, education, skills and training | Overall, how well do you think each scenario delivers on opportunities for training, education and learning? |
| 9. Landscape quality and character | Overall, how well do you think the scenario delivers on perceived landscape quality and character? |
| 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? |
| 11. Natural flood management | Overall, how well do you think each scenario provides protection from flooding, e.g. through natural flood management? |

of a holiday rental property, a local café owner and walker, a lichenologist, a resident and community development expert, a native woodland expert and the local wildlife ranger.

Four of the workshops (Glen Creran, Glasdrum, Cumbernauld Glen and Forest Wood) were held face-to-face whilst those at the Loch Arkaig and Clunes were conducted on-line using a virtual whiteboard (Miro). To allow familiarisation with scenario narratives participants were sent copies one week before the workshop. Following an information session, participants were asked to subjectively score, on a scale from 1 to 10 (1 - not at all; 10 - very much), how well they perceived each scenario's performance against the 11 ecosystem benefit indicators (Table 3, see also Appendix 2).

Our methodology used Likert scoring, often used in questionnaires in the social sciences, to subjectively rate statements using an interval – or as we do here, an ordinal scale (Joshi et al. 2015). On completion of the scoring, the individual scores for each participant across the six scenarios and 11 indicators were represented graphically, using a different colour for each participant (Figure 1). These 11 charts, depicting the 11 indicators across the six scenarios, formed the basis of the first deliberative discussion amongst participants, facilitated by the researchers (30 mins). The purpose of the discussion was to explore and understand the rationale behind any immediately visible patterns in scoring (either across scenarios or indicators), and any divergences or similarities. Following the first deliberation, participants were given an opportunity to revise their scores and discuss their reasons for any changes. Another deliberation session followed, allowing participants to discuss the scenarios and potential impacts of different management approaches on different groups of people, thus exploring justice implications of the scenarios (45 mins). Following the second deliberation session,

participants were asked to identify their preferred scenario (30 mins), noting their reasons and how they would improve it. This session ended with a short third deliberation on what a preferred future scenario would look like.

The workshops were audio-recorded and transcribed with the informed consent of the participants. Ethics approval (reference 126/2018) for the research was obtained from the James Hutton Institute's Research Ethics Committee.

Site and cross-site analysis

After each workshop, the individual numerical scores were analysed using R 4.1.3 (R Core Team 2021) to produce summary descriptive statistics and corresponding data visualisations for the 11 benefit indicators across the six scenarios. The transcripts of the workshop discussions were analysed using NVivo 12 software. The qualitative analysis explored concepts, links, and relationships between different scenarios (management interventions), benefits, different stakeholder groups, site context, as well as different perspectives on benefits, trade-offs and temporality. Methodological themes were also coded and included discussions and comments on the narratives, scoring, preferred scenario and confidence. Descriptive statistics and boxplots with key discussion points from each workshop were written up into reports and shared with participants and site managers, to allow further feedback and clarification (Eastwood et al. 2022).

Subsequently, the quantitative and qualitative data from all six sites were combined and analysed using a sequential mixed methods design (Creswell 2003) where key findings from the cross-site quantitative analysis were followed by a combined analysis of the qualitative data. Statistical tests were used to determine whether there were significant differences (at



Figure 1. Participants (local experts) deliberating the perceived impact of management on ecosystem benefits.

5% significance level) between scores: one-way ANOVA was used to assess overall differences between the scores across indicators and Bonferroni post-hoc tests were used to determine which specific indicators drove these differences. Overall and specific differences between sites and scenarios were assessed using the corresponding nonparametric versions of the aforementioned tests, i.e. Kruskal-Wallis and Dunn post-hoc tests, to account for the associated data breaking the equal variance assumption.

In addition, we used the qualitative data (including a feedback session) to reflect on the suitability of the scenario approach for site managers. For example, during the workshop discussions, our participants commented on the credibility and usefulness of the scenarios and the scoring method. Such comments and reflections were integrated into the qualitative coding (see methodological themes above) and formed the basis of our assessment of the potential and limitations of the deliberative scenario approach.

Results

The impact of management on ecosystem benefits – overview

Median scores across the sites and indicators for the six scenarios ranged from 3.0 (Austerity) to 7.0 (Management Plan, Biodiversity Conservation and People Engagement). Austerity was thus seen to lead to the lowest level of ecosystem benefits (Table 4), whereas the other three future scenarios were assessed in more positive terms. Past (median = 5.0) and Present (median = 6.0) were evaluated as lying somewhere in between. There were statistically significant differences between the three highest scoring scenarios (Management Plan, Biodiversity Conservation, People Engagement) and the lowest scoring (Past, Present and Austerity).

Across all sites, Past (Table 4) co-produced low to medium levels of perceived ecosystem benefits, with low levels of bramble, bracken and rhododendron suppression (median = 3.0) to a medium level of natural

Table 4. Median scores for the six scenarios across the 11 benefit indicators (darker shades denote higher scores).

| | Past | Present | Management Plan | Biodiversity Conservation | People Engagement | Austerity |
|--|------|---------|-----------------|---------------------------|-------------------|-----------|
| (1) Employment & Income | 5.0 | 5.0 | 6.0 | 5.0 | 8.0 | 2.0 |
| (2) Spring flowers | 4.0 | 6.0 | 7.0 | 8.0 | 6.0 | 3.0 |
| (3) Brambles, bracken & rhododendron (suppression) | 3.0 | 6.0 | 7.0 | 8.0 | 7.0 | 2.0 |
| (4) Timber extraction | 5.0 | 5.0 | 4.0 | 4.0 | 6.0 | 2.0 |
| (5) Carbon sequestration | 5.0 | 6.0 | 6.5 | 7.0 | 6.0 | 4.0 |
| (6) Mental restoration | 5.0 | 7.0 | 8.0 | 7.0 | 7.0 | 3.0 |
| (7) Spirituality | 4.0 | 6.0 | 7.0 | 7.0 | 6.0 | 3.0 |
| (8) Knowledge, education & skills | 4.0 | 6.0 | 8.0 | 6.0 | 9.0 | 2.0 |
| (9) Landscape quality & character | 5.0 | 7.0 | 8.0 | 8.0 | 7.0 | 3.0 |
| (10) Place attachment | 4.0 | 7.0 | 8.0 | 7.0 | 8.0 | 3.0 |
| (11) Natural flood management | 5.5 | 6.0 | 7.0 | 7.0 | 6.0 | 4.0 |
| <i>Median of medians</i> | 5.0 | 6.0 | 7.0 | 7.0 | 7.0 | 3.0 |

flood management (median = 5.5). Overall, ecosystem benefits were perceived by our workshop participants to be on an upward trajectory over time, as management under Present and Management Plan were regarded as delivering increasing levels of benefits. Overall, future management plans were perceived to deliver better than present-day management in 10 of the 11 indicators, with timber extraction being the only exception, decreasing from a median of 5.0 to 4.0. Interestingly, Loch Arkaig (highest median = 8.5) performed significantly better than other sites under the Management Plan scenario, whilst Clunes (a small adjacent site, median = 6.0) performed poorly compared to other sites (Appendix 3, Table S1). In fact, Clunes performed significantly worse than Cumbernauld Forest Wood, Glasdrum and Loch Arkaig across all scenarios (Appendix 3, Table S2).

Compared to ecosystem benefits under management plans, future management interventions that focused on biodiversity conservation or people engagement enhanced some perceived benefits, whilst reducing others, indicating trade-offs (Table 4). For example, when compared to the Management Plan (median = 8.0), knowledge, education and skills benefits were lower in the Biodiversity Conservation scenario (median = 6.0) but increased under People Engagement (median = 9.0).

However, the patterns observed in the cross-site analysis did not manifest themselves equally in all sites. Cumbernauld Glen and Forest Wood both scored significantly better than the other four sites in the Past (Appendix 3, Table S3), with Cumbernauld Glen showing better scores overall for the Past than the Present and Biodiversity Conservation scenarios. This was possibly because its management prior to 1995 was remembered positively, with many more people being employed to manage the site than after 1995, when the reserve changed ownership.

As outlined above, the three scenarios Management Plan, Biodiversity Conservation and People Engagement scored the same overall (Table 4). Further testing and comparisons between sites, as well as an in-depth analysis of the qualitative data, revealed noteworthy and significant patterns related to the impacts of different management interventions on ecosystem benefits.

Comparing future scenarios

Managing for biodiversity conservation

Compared to the Present, management under Biodiversity Conservation was perceived as delivering better for six of the eleven indicators (Table 4). Landscape quality and the two biodiversity indicators scored high (median = 8.0). In contrast, Biodiversity Conservation was seen to contribute relatively little to timber extraction (median = 4.0). In fact, across all

sites, both timber extraction and employment scored lower than most of the other benefit indicators under the Biodiversity Conservation scenario.

The performance of the other benefit indicators (Table 4) in the Biodiversity Conservation scenario across sites was more variable. For example, in Cumbernauld Glen, the only indicators that scored better under the Biodiversity Conservation scenario compared to the Past were the two biodiversity indicators, spring flowers and suppression of bracken etc. Knowledge, education and skills, place attachment and mental restoration were all perceived to perform better under the Present than under the Biodiversity Conservation scenario – in Cumbernauld Glen, but also in Glasdrum and Glen Creran.

Managing for Biodiversity Conservation was perceived to have overall unequal effects across sites, with Loch Arkaig scoring significantly better (Appendix 3, Table S4) under this scenario (median = 8.5) than Cumbernauld Glen, Forest Wood and Glasdrum. Loch Arkaig scored very high (median = 9.0) for suppression of bracken etc., carbon stored and landscape quality.

The quantitative analysis thus indicated perceived trade-offs arising from a shift to management for biodiversity conservation, beyond the trade-offs in timber extraction and employment. The qualitative analysis of workshop discussions offers possible reasons. For example, the shift towards managing for native wildlife and habitats in Cumbernauld Glen had caused consternation amongst some residents:

A lot of people think this is just messy and it's untidy and it's not what they remember. I do remember comments being made and complaints being made to [the forest manager] saying you know the place is dreadful, it's going to wrack and ruin.

In addition, the removal of non-native species at some sites was considered a waste of money by some participants:

I honestly don't think for the vast majority of people it matters whether it is conifers, or native species, or non-native species ... We get tied up in knots about it [...]. I think if you're just walking in a woodland, for the general public – it's just trees.

Where it affected individual, mature trees their removal '*for purist reasons*' was regarded as '*crazy*' and '*a sacrilege*' by some participants in Glen Creran.

It was felt that due to limited community engagement in Biodiversity Conservation, benefits such as place attachment and knowledge, education and skills scored lower. Participants at Cumbernauld Glen and Forest Wood suggested that children and their families would benefit from organised activities to connect them with woodlands, as parents' concerns about crime and safety had reduced opportunities for independent outdoor play and adventure seeking.

Managing for people engagement

Comparing the different sites there were no statistically significant differences in the scoring of the People Engagement scenario, which across the sites received particularly high scores on knowledge, education and skills (median = 9.0). Employment, place attachment as well as knowledge, education and skills were all perceived as performing significantly better than the other benefit indicators.

The qualitative analysis revealed that participants often associated interventions such as nature engagement programmes, employment, and volunteering opportunities with not only learning but also place attachment. One participant recalled the wildflower planting they had done with their primary school:

It would be about 2007 we started doing wildflower planting up in the Glen, that's the first time I'd been there and every time we'd go for a walk, I'd be like let's go to the Glen, let's see if the wildflowers are there.

They later elaborated saying that the more deeply people were involved in projects the more people were likely to say:

I'm part of this, I'm a small part of this bigger picture, . . . This is my home and I helped with this'.

The connection between active involvement in woodland management and place attachment was also mentioned by a participant from the Clunes workshop:

If you work in a place, if you're involved in a group that's making a difference and changing it, if you're going to be there on a repeat basis, those are the things that build up place attachment.

Participants acknowledged that opportunities to access a woodland for visual and sensory experiences contributed to spirituality and mental restoration. Several deliberations centred around the notion of the 'quality' over 'quantity' of experiences, with the notion that sites that encouraged people engagement would have higher footfall and therefore provide benefits to more people, including a potential boost to direct and indirect employment for rural areas. However, some participants argued the importance of solitude for spirituality and mental restoration benefits. For one participant at the Loch Arkaig workshop enabling greater access was a matter of social equity, stating that it was '*anti-democratic and elitist*' not to actively encourage people's engagement with woodlands.

Managing under austerity

Participants consistently scored the Austerity scenario low (median of medians = 3.0, Table 4). Statistically significant differences were found

between Austerity and all other scenarios, with participants viewing this scenario as performing poorly across all 11 benefit indicators.

However, carbon storage and natural flood management (Table 4) were perceived to perform significantly better than several other indicators such as employment and income, spring flowers, and the suppression of bramble etc., scoring reasonably well across all sites (Table 4).

Across all sites, participants discussed the lack of accessibility associated with this scenario, referring to physical obstructions (such as overgrown paths) as well as emotional barriers, such as litter and fly-tipping. The lack of access was thought to impact people's ability to gain place attachment or mental restoration benefits from the woodland. This feeling was echoed across all sites, where participants commented that the scenario felt '*claustrophobic*', and the place '*inaccessible*' and a '*battle*' to get through.

However, a divergent viewpoint became apparent at the workshop at Loch Arkaig, where some participants saw positive aspects of the Austerity scenario. They felt that it had spiritual value because the site's inaccessibility would attract fewer visitors, thus providing some solitude in the wilderness:

I probably scored the not very restored forest quite high on that because I was like well, it'll be quiet and if you do get out there it'll be really nice, whereas the busy people's forest has lots going for it but perhaps not so much in terms of retreat for personal space.

These debates highlight the importance of personal experience. Whilst many perceived inaccessibility as negative, others saw it as positive for their own personal mental restoration, spirituality, and overall enjoyment. The trade-off between spiritual and restorative benefits and the perceived safety was reported in both urban and peri-urban sites, with one participant at Cumbernauld stating that as a trail runner, they '*like it when the site is overgrown*' and '*out of control*' and that their running group used the fallen trees as obstacles to jump over.

A deliberative scenario methodology for site managers?

In total, 41 local experts participated in six deliberative scenario workshops to explore and better understand the potential impacts of diverse management approaches on woodland benefits. The workshops were approximately seven hours long, including one hour of preparation at home. The workshops allowed participants to share and learn collectively about their different perspectives, knowledges and values. They were also able to deliberate the

complexity and nuances of how different management approaches could impact benefits for different beneficiaries, discussing trade-offs and synergies between ecosystem benefits and beneficiaries. It revealed the complex task of getting the ‘*balance right*’: by maximising benefits, minimising trade-offs (particularly with wildlife), and enhancing inclusivity.

The initial scoring of the narratives (approximately 1½ hours), whilst considered challenging by participants in the allotted time, enabled individual scores to be displayed visually and compared quickly. As one participant wrote on the feedback board:

‘a very effective way of rapid generation of opinions/data – interesting to see the range of views’.

The visual display of scores gave participants the opportunity to identify patterns and ranges in scores across and between scenarios, indicators and scorers. Participants readily engaged with the visual displays and self-initiated conversations that were relevant and of interest to them. Written participant feedback on the methodology included:

‘works well to let individuals have their own thoughts and then bring together for discussion’.

Workshop deliberations were detailed, nuanced, complex, personal and wide-ranging. That participants perceived narratives differently, as well as having their own perspectives and understandings on interventions and relative impacts, appeared to facilitate and not hinder deliberation. Individual expert knowledge about complex ecosystem processes such as carbon sequestration and natural flood management was shared, enabling social learning between participants. One butterfly expert critiqued the suppression of bracken as an ecosystem benefit indicator for the Glasdrum site, noting that a rare butterfly, the Pearl-bordered Fritillary, needed some bracken to suppress grass and encourage violets as a food source for its caterpillars. This only demonstrated the importance of local expertise and knowledge of specific sites for determining management impacts.

One participant commented how the process made them realise the challenges of decision-making for multiple benefits, especially when having to consider a full suite of indicators, include their own and others’ values, priorities and preferences, and then combine these with bigger sustainability issues such as carbon sequestration. The opportunity to listen to other points of view during deliberations allowed participants to think about their own perspectives and values, and reflect, with more understanding, on how management may affect different groups of people. As one participant responded to a fellow workshop participant:

It’s just a fascinating perspective that I’ve not considered. ... I don’t come from that same level of community, my perspective on it is slightly different. It’s just a really interesting contrast to how I interpreted that question.

The workshops culminated with the participants starting to describe and develop their preferred scenarios based on the six presented. Often these preferred scenarios were a combination of elements from the Management Plan, People Engagement and Biodiversity Conservation, with tweaks or caveats. This exercise enabled novel ideas to be imagined, shared and deliberated between participants. Specific ideas included a community woodland enterprise for Cumbernauld Glen and ambitious catchment-scale participatory budgeting at Glen Creran.

Discussion

Our mixed-methods analysis demonstrated the perceived impacts of different management approaches in three different woodland case studies (two sites per case study) on ecosystem benefits. As well as illuminating generic trade-offs and synergies between different management approaches across all sites, it also highlighted context-specific trade-offs and potential consequences of alternative types of management on different groups of people (see additional details in Eastwood et al. 2022). However, over and above this, our study also offers methodological insights. In the following sections, we therefore focus the discussion on our novel, deliberative methodology and the importance of incorporating local knowledge in decision-making on ecosystem services.

Using deliberative management scenarios to support local decision-making

Our deliberative, analytical scenario method allowed site managers from diverse sites to assess the impact of different management interventions on ecosystem benefits at a human-nature interaction scale, the scale at which many services are co-produced (Fischer and Eastwood 2016). Our methodology enabled very different types of co-produced ecosystem benefits to be assessed and deliberated systematically and holistically, in a relatively short time scale. This is something that has, to our knowledge, not been previously attempted by researchers investigating participatory scenario analysis or deliberative analytical processes for ecosystem services.

Our focus on incremental management interventions rooted in today’s management practice would not be suitable for longer term strategic planning or future horizon scanning (O’Neill et al. 2017). Our methodology did not facilitate creative imagination and co-creation of new, transformative futures, ones

that are thought to be needed to make the systemic paradigm shift for sustainable, long-term transformations (Kahane 2012; Lonsdale et al. 2015; Roy 2019). However, our methodology supports shorter term decision-making for site managers but where complex and plural knowledges, perspectives and aspects have to be considered simultaneously.

To enable greater participant engagement and facilitate procedural justice, we pre-prepared scenario narratives for each site, co-constructed with site managers, rather than including scenario development as part of the process. This proved to be a useful approach, with all six workshops concluding by drafting preferred management scenarios in the allotted time. Our methodology enabled participants to focus their time on assessing management interventions and deliberating trade-offs, synergies, possible compromises and solutions, rather than developing scenarios and criteria from scratch. We feel this is an important consideration often overlooked when trying to enable more democratic assessments of ecosystem services (Waylen et al. 2015; Eastwood et al. 2017; Jiren et al. 2021), and agree with Reed (2008) that participatory processes should be designed with the appropriate levels of engagement, based on careful consideration of people's availability and time. It is also important for site managers and participants to have tangible, meaningful outcomes from participatory processes, an important aspect of procedural, recognition as well as distributive justice.

By purposefully selecting a group of diverse participants with local knowledge, we hoped to facilitate recognition justice through the expression and deliberation of a range of values, experiences, and viewpoints (Kenter et al. 2016a). This was achieved in all sites although a more diverse group composition would have been desirable in Cumbernauld. Here we struggled to recruit residents not already connected to the Scottish Wildlife Trust through volunteering or professional links. This issue highlights the challenges of procedural justice, e.g. when participants are unable to attend full day workshops. In our case, the lack of representation of residents in Cumbernauld was compensated by the presence of community engagement officers. However, ensuring participants from different social groups and backgrounds can participate meaningfully in deliberative environmental decision-making remains a persistent challenge. Greater equity in local decision-making could be achieved by compensating participants for their time where appropriate (e.g. if self-employed), embedding a culture of civic duty with employers, and, where needed, ensuring the provision of child-care facilities.

What became evident was that although the scoring exercise was conducted individually initially, deliberation quickly shifted to considering, reflecting

on and debating the viewpoints and preferences of fellow participants, and other potential users and groups, as was also found by Mavrommati et al. (2021). Recognising and respecting others' perspectives and values is a fundamental principle of recognition justice (Schlosberg 2007). Our method proved very effective in enabling a range of values and preferences, from the individual to societal, to be expressed and discussed openly, shifting conversations from individual preferences to the common good. It is such shared or collective values (the values people hold for the communities where they live, rather than personal or individual preferences) that play an important role in more robust, more equitable and inclusive decision-making in complex systems (Kenter et al. 2016a, 2016b; Saarikoski and Mustajoki 2021).

The deliberative process enabled people from different areas of expertise to share knowledge and collectively learn from each other. Deliberation is increasingly seen as an important process when considering complex socio-ecological systems, especially when people's values and preferences may be further formed through social learning and deliberation, as in our study (Kenter et al. 2016a, 2016b; Mavrommati et al. 2021). Even though some participants did not feel they were 'experts' in the traditional sense, their local knowledge was evidently valued and reflected upon by other participants. This levelling of power dynamics was a conscious decision to facilitate procedural and recognition justice with explicit acknowledgement of local expertise. However, deliberation in our workshops was limited to one day, which may have impacted the participants' (and site managers') ability to reflect on new understandings and embed social learning into practice.

Local decision-making matters for ecosystem services

The intimate knowledge and expertise of the local experts of the sites enabled a discussion of bespoke decision-making and targeted interventions for specific groups (i.e. children and families) or specific areas (i.e. wilder or more managed areas), potentially enhancing ecosystem benefits and improving equity. This was, for example, apparent when participants from the urban/peri-urban sites (Cumbernauld) deliberated how changes in management from well-maintained amenity woodlands to more natural, wilder and native woodlands were viewed negatively by some residents, exacerbating fears around crime and safety. The local experts' recognition of residents' concerns echoed research on the effects of vegetation structure, site design and maintenance in urban woodland on personal safety perceptions (Jansson et al. 2013). Concerns over crime and safety, a social justice issue, have been identified as a significant

barrier to people using woodlands, or allowing children to do so, thus reducing opportunities for place attachment, creative play, nature connection and mental restoration (O'Brien 2005; Hand et al. 2018).

Many studies focus on landscape ecosystem services but have less consideration for assessing impacts of management interventions at the local level (Torralba et al. 2018). However, as our research illustrates, and others have concluded (Mullin et al. 2018), the equitable management of ecosystems at a local level is an important consideration to achieve greater environmental justice. Local context and knowledge were very important when considering potential impacts of different management interventions, something that is increasingly accepted for urban greenspace (Dobson and Dempsey 2019), but less so for rural sites. However, as we have seen, detailed local knowledge of the site and the local context, from different perspectives and users, can be just as important for rural sites.

Conclusions

Through our empirical study we have demonstrated the potential of incorporating local expertise and knowledge into decision-making at the local management scale, which we believe is essential for realising co-produced ecosystem services. As our results show, management choices can lead to trade-offs and consequences for ecosystem benefits that affect different groups of people in different ways. Deliberative approaches incorporating local knowledge allow such trade-offs and potential local consequences to be identified and discussed, management decisions to be adapted and potential challenges to be mitigated by site managers. Our methodology facilitated the deliberation of different values, knowledges and perspectives, enabling social learning to occur, and thus a greater understanding of complex systems for more informed decision-making. We recommend similar deliberative methodologies be tested with other ecosystems and governance structures, with the addition of longitudinal monitoring to assess whether such deliberative processes do indeed bring about social learning, improved site management for co-produced ecosystem services and more equitable distribution of benefits for local people.

Acknowledgements

We would like to thank all the participants, site managers and partner organisations for their invaluable input to this research project. Two anonymous reviewers and the editors of this journal provided helpful comments on earlier drafts of this paper.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This study was funded by the Scottish Government's Strategic Research Programme [2016-2022].

References

- Börjeson L, Höjer M, Dreborg K-H, Ekvall T, Finnveden G. 2006. Scenario types and techniques: towards a user's guide. *Futures*. 38(7):723–739. doi: [10.1016/j.futures.2005.12.002](https://doi.org/10.1016/j.futures.2005.12.002).
- CBD. 2010. Operational guidance for application of the ecosystem approach. [accessed 2022 Aug 1]. <https://www.cbd.int/ecosystem/operational.shtml>.
- Chan KMA, Satterfield T, Goldstein J. 2012. Rethinking ecosystem services to better address and navigate cultural values. *Ecol Econ*. 74:8–18. doi: [10.1016/j.ecolecon.2011.11.011](https://doi.org/10.1016/j.ecolecon.2011.11.011).
- Church A, Burgess J, Ravenscroft N. 2011. Cultural services. Cambridge: UNEP-WCMC, Cambridge. The UK National Ecosystem Assessment Technical Report, p. 633–692.
- Creswell JW. 2003. *Research design: qualitative, quantitative and mixed methods approaches*. 2nd ed. Thousand Oaks (California): Sage Publications, Inc.
- Dick J, Maes J, Smith RI, Paracchini ML, Zulian G. 2014. Cross-scale analysis of ecosystem services identified and assessed at local and European level. *Ecol Indic*. 38:20–30. doi: [10.1016/j.ecolind.2013.10.023](https://doi.org/10.1016/j.ecolind.2013.10.023).
- Dobson J, Dempsey N. 2019. Working out what works: the role of tacit knowledge where urban greenspace research, policy and practice intersect. *Sustainability*. 11(18). doi: [10.3390/su11185029](https://doi.org/10.3390/su11185029).
- Eastwood A, Fischer A, Byg A. 2017. The challenges of participatory and systemic environmental management: from aspiration to implementation. *J Environ Plann Manage*. 60(9):1683–1701. doi: [10.1080/09640568.2016.1249787](https://doi.org/10.1080/09640568.2016.1249787).
- Eastwood A, Lorenzo-Arribas A, Juarez-Bourke A, Hague A, MacLean L, Donaldson-Selby G, Marshall K, Pakeman R, Hester A. 2022. Assessing the impact of different management interventions on perceived woodland benefits. Web Resource. [accessed 2024 Feb 6]. <https://sefari.scot/research/assessing-the-impact-of-different-management-interventions-on-perceived-woodland-benefits>.
- Fischer A, Eastwood A. 2016. Coproduction of ecosystem services as human–nature interactions—an analytical framework. *Land Use Policy*. 52:41–50. doi: [10.1016/j.landusepol.2015.12.004](https://doi.org/10.1016/j.landusepol.2015.12.004).
- Fish R, Church A, Winter M. 2016. Conceptualising cultural ecosystem services: a novel framework for research and critical engagement. *Ecosyst Serv*. 21:208–217. doi: [10.1016/j.ecoser.2016.09.002](https://doi.org/10.1016/j.ecoser.2016.09.002).
- Fisher B, Turner RK, Morling P. 2009. Defining and classifying ecosystem services for decision-making. *Ecol Econ*. 68:643–653. doi: [10.1016/j.ecolecon.2008.09.014](https://doi.org/10.1016/j.ecolecon.2008.09.014).
- Haines-Young R, Potschin M. 2010. The links between biodiversity, ecosystem services and human well-being. In: Raffaelli DG, Frid CLJ, editors *Ecosystems ecology: a new synthesis*. Cambridge: Cambridge University Press; p. 110–139.

- Haines-Young R, Potschin MB. 2018. Common international classification of ecosystem services (CICES) V5.1 and guidance on the application of the revised structure. <https://cices.eu/resources/>.
- Hand KL, Freeman C, Seddon PJ, Recio MR, Stein A, van Heezik Y. 2018. Restricted home ranges reduce children's opportunities to connect to nature: demographic, environmental and parental influences. *Landsc Urban Plan.* 172:69–77. doi: [10.1016/j.landurbplan.2017.12.004](https://doi.org/10.1016/j.landurbplan.2017.12.004).
- Harrison PA, Harmackova ZV, Karabulut AA, Brotons L, Cantele M, Claudet J, Dunford RW, Guisan A, Holman IP, Jacobs S, et al. 2019. Synthesizing plausible futures for biodiversity and ecosystem services in Europe and central Asia using scenario archetypes. *Ecol Soc.* 24 (2). doi: [10.5751/es-10818-240227](https://doi.org/10.5751/es-10818-240227).
- IPBES. 2016. The methodological assessment report on scenarios and models of biodiversity and ecosystem services: summary for policy makers. edited by S. Ferrier, ... and B. Wintle. Bonn (Germany): Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.
- IPBES. 2019. The global assessment report on biodiversity and ecosystem services. Summary for policy makers. Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES); Bonn (Germany).
- Jansson M, Fors H, Lindgren T, Wistrom B. 2013. Perceived personal safety in relation to urban woodland vegetation - a review. *Urban For Urban Greening.* 12 (2):127–133. doi: [10.1016/j.ufug.2013.01.005](https://doi.org/10.1016/j.ufug.2013.01.005).
- Jiren TS, Riechers M, Kansky R, Fischer J. 2021. Participatory scenario planning to facilitate human-wildlife coexistence. *Conserv Biol.* 35 (6):1957–1965. doi: [10.1111/cobi.13725](https://doi.org/10.1111/cobi.13725).
- Joshi A, Kale S, Chandel S, Pal DK. 2015. Likert Scale: Explored and Explained. *Br J Appl Sci Technol.* 7 (4):396–403. doi: [10.9734/BJAST/2015/14975](https://doi.org/10.9734/BJAST/2015/14975).
- Kahane A. 2012. Transformative scenario planning: changing the future by exploring alternatives. *Strategy Leadersh.* 40(5):19–23. doi: [10.1108/10878571211257140](https://doi.org/10.1108/10878571211257140).
- Kenter JO, Bryce R, Christie M, Cooper N, Hockley N, Irvine KN, Fazey I, O'Brien L, Orchard-Webb J, Ravenscroft N, et al. 2016a. Shared values and deliberative valuation: future directions. *Ecosyst. Serv.* 21:358–371. doi: [10.1016/j.ecoser.2016.10.006](https://doi.org/10.1016/j.ecoser.2016.10.006).
- Kenter JO, Reed MS, Fazey I. 2016b. The deliberative value formation model. *Ecosyst Serv.* 21:194–207. doi: [10.1016/j.ecoser.2016.09.015](https://doi.org/10.1016/j.ecoser.2016.09.015).
- Lonsdale K, Pringle P, Turner B. 2015. Transformative adaptation: what it is, why it matters & what is needed. UK climate impacts programme. Oxford (UK): University of Oxford.
- Mace GM, Bateman I, Albon S, Balmford A, Brown C, Church A, Haines-Young R, Pretty JN, Turner K, Vira B, et al. 2011. Conceptual framework and methodology. Cambridge: UK National Ecosystem Assessment, UNEP-WCMC. The UK National Ecosystem Assessment Technical Report.
- Maes J, Ego B, Willemsen L, Liqueste C, Vihervaara P, Schägner JP, Grizzetti B, Drakou EG, La Notte A, Zulian G, et al. 2012. Mapping ecosystem services for policy support and decision-making. *Ecosyst Serv.* 1:31–39. doi: [10.1016/j.ecoser.2012.06.004](https://doi.org/10.1016/j.ecoser.2012.06.004).
- Mavrommati G, Borsuk ME, Howarth RB. 2017. A novel deliberative multicriteria evaluation approach to ecosystem service valuation. *Ecol Soc.* 22(2). doi: [10.5751/es-09105-220239](https://doi.org/10.5751/es-09105-220239).
- Mavrommati G, Borsuk ME, Kreiley AI, Larosee C, Rogers S, Burford K, Howarth RB. 2021. A methodological framework for understanding shared social values in deliberative valuation. *Ecol Econ.* 190. doi: [10.1016/j.ecolecon.2021.107185](https://doi.org/10.1016/j.ecolecon.2021.107185).
- MEA. 2005. Ecosystems and human well-being: synthesis. Millennium ecosystem assessment. Washington (DC): Island Press.
- Mullin K, Mitchell G, Nawaz NR, Waters R. 2018. Natural capital and the poor in England: towards an environmental justice analysis of ecosystem services in a high income country. *Landsc Urban Plan.* 176:10–21. doi: [10.1016/j.landurbplan.2018.03.022](https://doi.org/10.1016/j.landurbplan.2018.03.022).
- NEA. 2011. The UK national ecosystem assessment: synthesis of key findings. Cambridge (UK): UNEP-WCMC.
- Nyongesa KW, Vacik H. 2019. Evaluating management strategies for Mount Kenya Forest Reserve and National Park to reduce fire danger and address interests of various stakeholders. *Forests.* 10(5). doi: [10.3390/f10050426](https://doi.org/10.3390/f10050426).
- O'Brien EA. 2005. Publics* and woodlands in England: well-being, local identity, social learning, conflict and management. *Forestry.* 78(4):321–336. doi: [10.1093/forestry/cpi042](https://doi.org/10.1093/forestry/cpi042).
- O'Neill BC, Kriegler E, Ebi KL, Kemp-Benedict E, Riahi K, Rothman DS, van Ruijven BJ, van Vuuren DP, Birkmann J, Kok K, et al. 2017. The roads ahead: narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global Environ Change.* 42:169–180. doi: [10.1016/j.gloenvcha.2015.01.004](https://doi.org/10.1016/j.gloenvcha.2015.01.004).
- Olander LP, Johnston RJ, Tallis H, Kagan J, Maguire LA, Polasky S, Urban D, Boyd J, Wainger L, Palmer M. 2018. Benefit relevant indicators: ecosystem services measures that link ecological and social outcomes. *Ecol Indic.* 85:1262–1272. doi: [10.1016/j.ecolind.2017.12.001](https://doi.org/10.1016/j.ecolind.2017.12.001).
- Oteros-Rozas E, Martin-Lopez B, Daw TM, Bohensky EL, Butler JRA, Hill R, Martin-Ortega J, Quinlan A, Ravera F, Ruiz-Mallen I, et al. 2015. Participatory scenario planning in place-based social-ecological research: insights and experiences from 23 case studies. *Ecol Soc.* 20(4). doi: [10.5751/es-07985-200432](https://doi.org/10.5751/es-07985-200432).
- R Core Team. 2021. R: a language and environment for statistical computing. Vienna (Austria): R Foundation for Statistical Computing. <https://www.R-project.org>. R version 4.1.3.
- Reed MS. 2008. Stakeholder participation for environmental management: a literature review. *Biol Conserv.* 141:2417–2431. doi: [10.1016/j.biocon.2008.07.014](https://doi.org/10.1016/j.biocon.2008.07.014).
- Roy R. 2019. Transformative scenario planning: unpacking theory and practice. *Indian J Sci Technol.* 12(6):1–18. doi: [10.17485/ijst/2019/v12i6/107741](https://doi.org/10.17485/ijst/2019/v12i6/107741).
- Saarikoski H, Mustajoki J. 2021. Valuation through deliberation- citizens' panels on peatland ecosystem services in Finland. *Ecol Econ.* 183. doi: [10.1016/j.ecolecon.2021.106955](https://doi.org/10.1016/j.ecolecon.2021.106955).
- Schlosberg D. 2007. Defining environmental justice – theories, movements and nature. Oxford (UK): Oxford University Press.
- Shearer AW. 2005. Approaching scenario-based studies: three perceptions about the future and considerations for landscape planning. *Environ Plann B Plann Des.* 32 (1):67–87. doi: [10.1068/b3116](https://doi.org/10.1068/b3116).
- Sing L, Metzger MJ, Paterson JS, Ray DC. 2018. A review of the effects of forest management intensity on ecosystem services for northern European temperate forests with a focus on the UK. *Forestry.* 91(2):151–164. doi: [10.1093/forestry/cpx042](https://doi.org/10.1093/forestry/cpx042).

- Torralba M, Fagerholm N, Hartel T, Moreno G, Plieninger T. 2018. A social-ecological analysis of ecosystem services supply and trade-offs in European wood-pastures. *Sci Adv.* 4(5). doi: [10.1126/sciadv.aar2176](https://doi.org/10.1126/sciadv.aar2176).
- Walker G. 2012. *Environmental justice – concepts, evidence and politics*. London: Routledge.
- Waylen KA, Martin-Ortega J, Blackstock KL, Brown I, Uribe BEA, Hernandez SB, Bertoni MB, Bustos ML, Bayer AXC, Semerena RIE, et al. 2015. Can scenario-planning support community-based natural resource management? Experiences from three countries in Latin America. *Ecol Soc.* 20(4). doi: [10.5751/es-07926-200428](https://doi.org/10.5751/es-07926-200428).