Catalysing community-led local nature recovery with opportunity mapping: lessons from the Oxfordshire Treescape Project

Authors

Martha Crockatt*[1], Victoria Macnamara, Caitlin Hafferty[2], Jamie Hartzell, Marcus Simmons[3], Alison Smith[2, 4]

*Corresponding author; Martha.crockatt@ouce.ox.ac.uk

[1]Leverhulme Centre for Nature Recovery, School of Geography and the Environment, University of Oxford, South Parks Road, Oxford, OX1 3QY, United Kingdom

[2]Environmental Change Institute, School of Geography and the Environment, University of Oxford, South Parks Road, Oxford, OX1 3QY, United Kingdom

[3]Community Action Groups Oxfordshire, 1 Aristotle Lane, Oxford, OX2 6TP, United Kingdom

[4]Oxford Martin School, 34 Broad Street, Oxford, OX1 3BD, United Kingdom

Abstract

1. *Background.* The UK has ambitious nature recovery targets. Local communities and land managers have knowledge, expertise, and capacity to support place-based nature recovery, making them well-placed to help deliver these goals. We explore how these groups can be supported in nature recovery plans combining their local knowledge with complex ecological data, using Oxfordshire Treescape Project (OTP) as a case study.
2. *Methods.* OTP provided free reports to interested Oxfordshire communities (focusing on parishes, the lowest tier of local government) and land managers. These contained maps showing: existing nature assets; locations where nature recovery options, e.g. woodland, agroforestry or species-rich grassland, could be suitable according to simple rules; and the resulting expected changes in ecosystem service provision, generating wider benefits and avoiding trade-offs (including food production). Further resources were developed by OTP in response to demand. A survey of community report recipients explored nature recovery challenges and opportunities they faced and which of OTP's resources were most impactful.
3. *Findings.* In just four years, a small, agile team with limited funding developed the mapping and delivered 76 parish and 40 land manager reports, catalysing the development of several formal nature recovery plans. A survey of parish report recipients found that this audience highly valued the combination of opportunity maps, personalised support from the OTP team, and resulting collaborations between community groups, NGOs and local experts. Land manager reports typically acted as conversation starters, prompting consideration of alternative land management options that could deliver multiple ecosystem services. Communities highly valued existing nature recovery partnerships with land managers, but were often unsure how to establish new relationships.
4. *Synthesis and applications.* Complex ecological knowledge shared through the reports accompanied by local knowledge, personalised support and introductions to relevant partners helped communities apply their own knowledge and enthusiasm to develop local plans that supported broader nature recovery efforts. Lessons learnt can help scale up the approach. Lower land manager take-up was attributed to rapidly changing economic and policy conditions, including uncertainty over the availability of future

nature-friendly farming subsidies (ELMS). More resources are needed to support mutually beneficial community–land manager relationships.

Key words (3-8)

Nature recovery; Community-led conservation; Land manager; Farmer; Land use; Ecosystem services; Knowledge exchange

Author contributions

Victoria Macnamara, Jamie Hartzell, Martha Crockatt, Marcus Simmons and Alison Smith conceived the ideas and designed methodology; Martha Crockatt, Victoria Macnamara, Jamie Hartzell and Marcus Simmons collected the data; Martha Crockatt analysed the data; Martha Crockatt and Alison Smith led the writing of the manuscript, with substantial contributions from Victoria Macnamara and Caitlin Hafferty. All authors contributed critically to the drafts and gave final approval for publication.

Statement on inclusion: This study is based on a project that took place in Oxfordshire, England. The authors include not only academic researchers based within the area, but also non-academic collaborators who ran the project. The study presents the learnings from a project on stakeholder-led nature recovery, and as such intrinsically incorporates the opinions, knowledge and experience of local community groups and individuals. The project continues in an alternative form, led by one of the co-authors (MS); this study will be shared across that project, with an accessible summary, so that findings are shared with interested local parties.

Acknowledgements

The authors would like to thank those who requested Treescape Opportunity Reports, spent time talking to Oxfordshire Treescape Project (OTP), which hugely shaped the direction of the project, and those who contributed to the parish survey. They would also like to thank OTP's Management Group for their support, especially in the early stages of the project: Tim Stevenson, Neil Nicholson, Mark Charter, Nick Mottram, Ian Curtis, Karen Woolley, Sam

78 Clarke, Dom Hare and Martin Hugi. In addition, the Land App team were generous with their
79 time, knowledge and resources when integrating OTP mapping into Land App.
80 The Oxfordshire Treescape Project was supported by HERO (University of Oxford),
81 OxLEP (Oxfordshire Local Enterprise Partnership), Woodland Trust, Network for Social
82 Change, Oxfordshire and District and County Councils, Blenheim Estate, National Lottery
83 Community Fund, Oxford Friends of the Earth, Low Carbon Hub, CAG Oxfordshire and the
84 Pye Charitable Trust. MC, CH and AS were funded by the Leverhulme Trust as part of its
85 funding for the Leverhulme Centre for Nature Recovery at University of Oxford; AS is also
86 supported by the Natural Environment Research Council (NERC) [grant number
87 NE/W004976/1] as part of the Agile Initiative at the Oxford Martin School.
88 Thanks to Constance McDermott and Mark Hirons (Environmental Change Institute,
89 University of Oxford) for support with survey design and valuable thoughts on manuscript
90 drafts.
91

1 Introduction

The UK government has committed to reach net zero carbon emissions by 2050 and to meet the Global Biodiversity Framework's targets, including protecting 30% of land and sea for nature by 2030 (Department for the Environment, Food and Rural Affairs (Defra), 2023a; Dinerstein et al., 2019). The 2020 Agriculture Act and the 2021 Environment Act supply legislation for schemes that are intended to support delivery of these targets. In England, these include mandatory Biodiversity Net Gain for built development from 2024 (Defra, 2024a), the production of Local Nature Recovery Strategies (LNRS) to create a national Nature Recovery Network (Defra, 2024b) and the Environmental Land Management Scheme, supporting farmers in nature-friendly farming (Defra, 2025a). Ambitious tree planting targets under the England Tree Action Plan are also key tools for delivering climate and nature goals (Defra, 2021a). These policies work alongside funding schemes such as the England Woodland Creation Offer (Forestry Commission, 2025) and Farming in Protected Landscapes (Defra, 2025b).

However, delivering national policies relies ultimately on decisions made by individuals or groups which influence land-use at the local level. With 67 % of England being classified as agricultural land (Defra, 2024c), farmers and land managers (hereafter "land managers") are key in delivering nature recovery, as recognised through an increasing emphasis on farming subsidies that support nature (Defra, 2025c). This creates potential for conflict and trade-offs between the inter-related interests of food production, other ecosystem service provision, nature recovery and land managers' economic imperatives (Cordingley et al., 2016). While land managers have decision-making powers over large areas, it is important that adjacent local communities of place (i.e., those who live close to potential sites of nature recovery; hereafter referred to as 'communities') play an active role in governance of land and local natural resources (Newig et al., 2023; Reed, 2008); this is likely to be primarily land that is publicly accessible, such as village greens, sports fields, cemeteries, but could also include communities collaborating with land managers on particular projects. It is recognised that land managers are often important and active members of their local community, but they are considered separately for the purposes of this publication because having management decisions over a large area of private land distinguishes this demographic from the wider community.

Both land managers and surrounding communities hold important local (or 'place-based') knowledge that can feed into effective nature recovery (Raymond et al., 2010; Raymond et al., 2016; Šūmane et al., 2018). They have personal connections and relationships within their community and local landscape, as well as being the recipients of locally-provided ecosystem services, such as recreation, food provision and air quality (Broitman, 2020), giving them vested interests in protecting and enhancing their local area. They can therefore provide longevity and maintain momentum in gaps between short-term funding options, which is important given the long timescales needed to rebuild ecosystems.

With this in mind, we explore how local community groups and land managers can be supported in nature recovery planning that combines their local knowledge with complex ecological data in the form of nature recovery opportunity maps, using the Oxfordshire Treescape Project (OTP) as a case study. OTP's initial aim when established in 2019 was to support a substantial increase in tree cover in Oxfordshire (England), with the expectation that this would deliver multiple policy objectives including nature recovery, climate mitigation, climate adaptation, and increased human health and wellbeing, but the project rapidly evolved to include non-tree habitats, e.g. species-rich grasslands.

The project was initiated by two individuals working on a voluntary basis. In 2020 they formed a collaboration with University of Oxford's HERO (Healthy Ecosystem Restoration in Oxfordshire) project, an open forum of academics, community members, NGOs and local government set up to facilitate knowledge exchange and research partnerships**.** Nature recovery opportunities were identified using scientific knowledge (sensu Raymond et al., 2010), generated with support from the University of Oxford, to identify locations which would maximise ecosystem service provision while avoiding damaging trade-offs for biodiversity, food production, cultural heritage and carbon sequestration (Seddon et al., 2021, Warner et al., 2022). It was posited that this scientific knowledge could be operationalised by providing maps identifying these nature recovery opportunities to community groups and land managers, to support them in developing their own nature recovery plans using local knowledge. OTP became a learning journey akin to 'action research' in which researchers work closely with practitioners in an iterative process to co-develop, test and refine solutions to societal challenges (Croeser et al., 2024).

A substantial body of interdisciplinary literature demonstrates the benefits of community engagement for improving environmental outcomes**,** increasing project

sustainability, building trust and transparency in collaborative decision-making, building people-nature connectedness, and promoting pro-environmental behaviour, among other benefits (e.g., see Ferreira et al., 2020; Newig et al., 2023; Pocock et al., 2023). While there are numerous interpretations of engagement across disciplines and areas of practice, we define it as a process by which individuals, groups, and organisations can choose to take an active role in decisions which affect their lives (Hafferty et al., 2023; Reed, 2008). Engagement encompasses diverse approaches from top-down (e.g., providing information, educating or consulting communities in pre-defined nature recovery projects) to bottom-up (where environmental action is entirely community-led, e.g. grassroots and community ownership and wealth building initiatives) (see Chilvers et al., 2024; e.g. Lawrence et al., 2009; Marango et al., 2020).

Maps can contain a huge variety of information, e.g. physical geography, land use, political boundaries, social values, or species distributions. They can be created by professional cartographers, using national datasets and formal knowledge, but it is recognised that communities also hold extensive local knowledge, including detailed objective information about the physical environment as well as more subjective knowledge such as cultural values. The interplay between these pools of knowledge is important and makes maps and mapping processes potentially powerful tools for community engagement, as individuals and communities have opinions on how their local area is represented (Brown and Raymond, 2014). Participatory mapping aims to make the relationship between community and place visible through cartography (Cochrane and Corbett, 2020). This is associated with increased democracy in local decision making (Denwood et al., 2022), and has been used widely in relation to nature recovery, for example through mapping ecosystem service provision in coastal environments (Burdon et al., 2019), navigating trade-offs in marine conservation (Calado et al, 2025), designing Natural Flood Management schemes (Lavers & Charlesworth, 2018) or exploring community values within a landscape (Ernoul et al., 2018).

We describe approaches, results and learnings from OTP's establishment phase and first two years of providing opportunity mapping, including results from a survey gauging the effectiveness of OTP's resources for supporting community-led nature recovery, allowing us to explore the question of how local community groups and land managers can be supported in nature recovery planning that combines their local knowledge with complex

ecological data. Learnings are presented as an objective narrative with the aim of helping inform similar initiatives globally. We discuss the challenges and successes of sharing mapped data to support nature recovery efforts by land managers and community groups, promoting communication and collaboration between these demographics, and the potential for local nature recovery planning to feed into larger scale plans, such as county-scale Local Nature Recovery Strategies in England. It provides a case study for how a small team with minimal resources can integrate scientific and local knowledge to catalyse community-led conservation, working at the parish scale (the lowest tier of local government).

2 Methods

OTP was run by a small team with limited funding. The founders (authors VM and JH) worked in an unpaid capacity with oversight from a Management Committee of local stakeholders with relevant expertise (see Acknowledgements) in the first two years. They were then joined by a part-time staff member (MC), as Reports were made available to communities and landowners, and a further part-time staff member the following year (MS).

2.1 Opportunity mapping

The mapping used by OTP was a simplified version of an existing system for generating natural capital maps (Smith, 2021), developed in collaboration with HERO and with input from Thames Valley Environmental Records Centre (TVERC). The opportunity maps showed existing natural assets (e.g. woodland, species-rich grassland and high-grade agricultural land), nature recovery opportunities, i.e. where new assets such as woodland, species-rich grassland or hedgerows could be situated, and the uplift in biodiversity and ecosystem services that new assets could provide (for full details see Oxfordshire Treescape Project, 2021a).

The mapping system was informed and tested through workshops and informal trials with land managers and parish councils, with specialist input from local expert practitioners.

2.2 Treescape Opportunity Reports

The Treescape Opportunity Reports (hereafter 'Reports') brought together a large body of knowledge relevant to nature recovery, primarily based on the maps of existing natural assets, nature recovery opportunities (Fig. 1), and potential uplift in ecosystem service provision (e.g. Oxfordshire Treescape Project, 2021b). Reports were generated through an automated process developed and delivered in partnership with TVERC, designed to be accessible to non-specialists while containing sufficient data to inform nature recovery activities and plans.

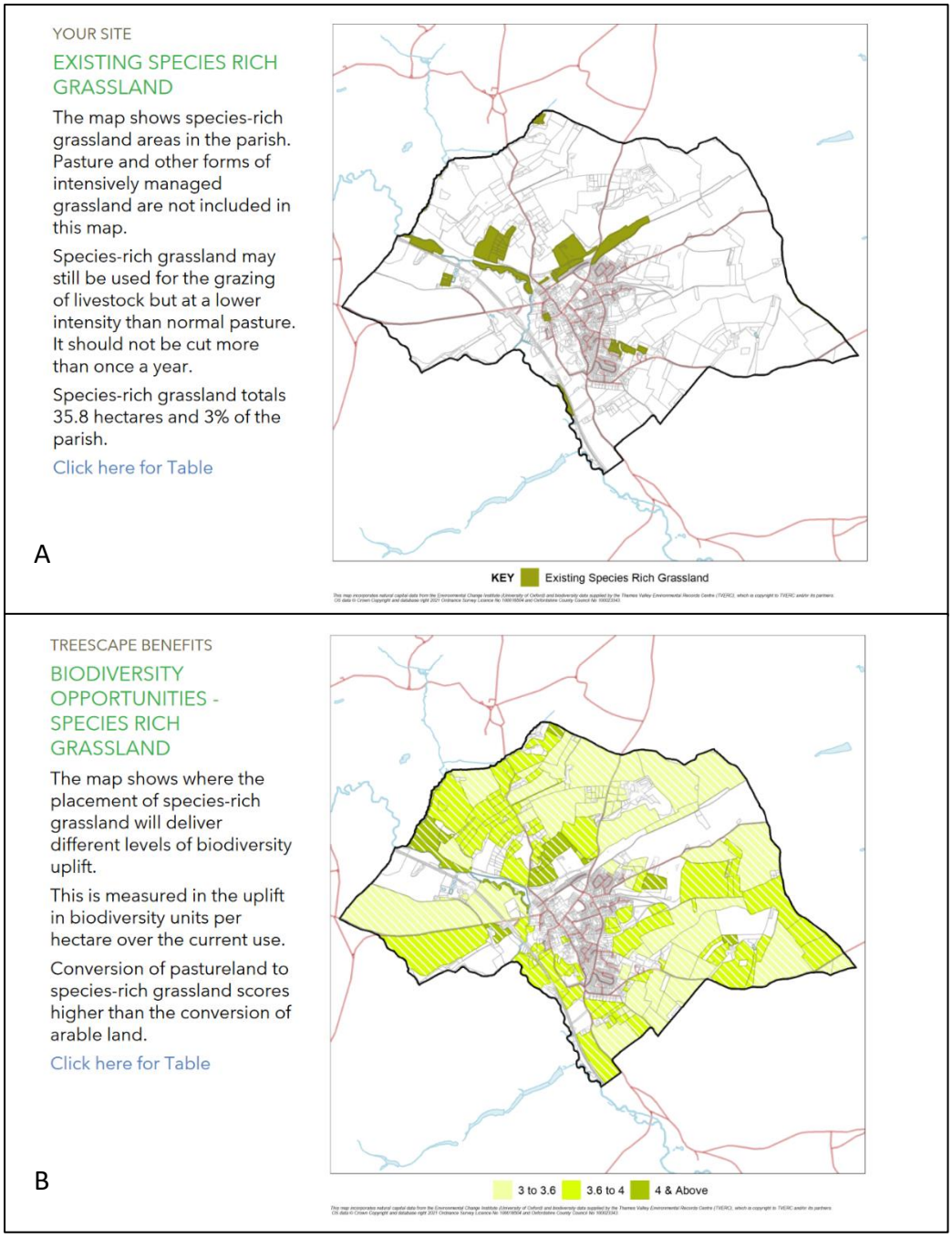


***Figure 1 Example maps from Treescape Opportunity Report (OTP, 2021b)**. A: Existing species-rich grassland within the parish. B: ecosystem service provision ("treescape benefits") - biodiversity uplift in potential locations for species rich grassland.*

225

226 Reports were initially created for land managers, but interest from community groups led to
227 development of a slightly adapted version for parishes (see rationale below). Both the Land
228 Manager and Parish Reports were provided free of charge, thanks to funding from a partner
229 (Woodland Trust, a charity focusing on tree and woodland creation, restoration and
230 protection in the UK).

Reports were the starting point for delivering OTP's aims, but methods of engaging with and supporting recipients developed over time as the OTP team dynamically and responsively explored different approaches. Below, we describe how Reports were used in conjunction with other tailored approaches and resources to engage both land managers and communities.

2.3 Supporting land managers

Land Manager Reports were offered to those with holdings over ca. 100 ha, as the level of detail on the maps was less appropriate for smaller holdings. Partnering with land agents and other advisers failed to gain traction, so potential recipients were identified through personal connections, farmer clusters (collaborative place-based groups of farmers; Warrener, 2017), word of mouth and attendance at relevant local events.

Feedback from land managers on first iterations of Land Manager Reports substantially influenced the format of the Reports. Reports were primarily intended as prompts, suggesting alternative ways of using land to provide multiple ecosystem services to complement a land manager's detailed knowledge of their land and farming system and other expert advice. They were delivered alongside a brief summary of key opportunities, and an invitation to a follow-up meeting. Approaches to interacting with land managers evolved in response to interactions with both those who received Reports and those who declined. Farmers were also offered the ability to view layers from the Opportunity Reports in LandApp (section 2.4.2.3), when that resource had been developed.

Responses to the OTP resources were not formally assessed, but key themes that emerged from informal conversations with land managers are presented in the Results.

2.4 Supporting communities

2.4.1 Identifying recipients

OTP worked with communities at the parish scale for multiple reasons:

- parish councils are the most local form of elected government, with statutory responsibilities and powers related to nature recovery, including powers to create a Neighbourhood Plan (NP), which sets out a shared vision for development and

growth, including protection and enhancement of local assets and character such as natural features and greenspace;

- parishes are an approachable scale for nature recovery planning (typically 400 - 800 ha (Office for National Statistics, 2024)), and typically have historical significance and longevity;
- parish councils often have both official and personal relationships with a wide range of local individuals and organisations;
- parish councils often have relationships with neighbouring parishes, which can form the foundations for "parish clusters", addressing nature recovery and connectivity across administrative boundaries.

Contacts were made with interested parishes through OTP presentations at public events and by working with relevant local organisations. Additionally, the ten parishes with the highest proportion of high-value nature sites in Oxfordshire were proactively approached. Parish Reports could be requested by any community member, but individuals or groups were encouraged to collaborate with their parish council.

2.4.2 Providing resources for communities

Parish Reports were accompanied by initial resources (a guide, story map and website) designed to support interpretation (Box 1), together with a brief assessment of key ecological points of interest or opportunities within the Report and an invitation to meet for further discussion. Ongoing personal support was offered in the form of meetings, introductions and training sessions, tailored to their specific needs. Topics included interpreting Reports, discussing nature recovery ideas and sharing approaches taken by other groups. OTP also introduced recipients to key potential partners and advisors such as local conservation organisations, other parish groups who could act as collaborators or mentors, statutory bodies such as the Forestry Commission, local councillors, funding bodies and local farmers, according to the needs of each group.

Early conversations with Report recipients identified that many lacked confidence and skills to action their nature recovery ambitions. Further resources were therefore developed to support next steps (Box 1).

Box 1: OTP Resources

Initial Resources

- **Opportunity Report** containing parish-scale maps of existing natural assets, potential nature recovery opportunities and the resulting benefits for biodiversity and ecosystem services.
- **Story Map**, an online, interactive nature recovery map of Oxfordshire.
- **Treescape Guide** providing background information to aid use of Reports.
- **OTP website**: online resource with case studies, links to funding opportunities and articles from the OTP newsletter (please note that the OTP website is no longer available; resources produced are available here.

Further resources (developed in response to experiences with Parish Report recipients)

- **Land ownership maps** pdf maps of land ownership and management at parish-scale.
- **Getting Started with Nature Recovery**, a guide on how to develop a parish nature recovery plan (Oxfordshire Treescape Project, 2021c).
- **LandApp maps** free online, interactive maps pre-populated with OTP Treescape Opportunity layers.
- **Guidance on collaborating with land managers** delivered through presentations and informal communication with Report recipients.

Personal support

- **OTP team** meetings, emails, phone calls to support parish groups.
- **Introductions** made by the OTP team to relevant individuals, groups or organisations to support parish groups with nature recovery.
- **LandApp sessions**, online, to support parish groups using LandApp for nature recovery planning and mapping.

2.4.2.1 Land ownership maps

Land ownership and land management maps were developed from publicly available data, covering ca 80% of Oxfordshire, to aid Parish Report recipients in understanding who they might need to approach to discuss potential nature recovery projects on private land.

2.4.2.2 Guide to creating Parish Nature Recovery Plans

To support action based on the Reports, OTP created a guide for developing a Parish Nature Recovery Plan. Such a plan would provide structure for nature recovery ambitions and activities, and act as a formal document to inform local policy such as Neighbourhood Plans (NP), Local Plans and the Local Nature Recovery Strategy at the parish, district and county scale, respectively. NPs were given particular focus as there is a remit for them to identify, map and safeguard wildlife-rich habitats, and to promote the conservation, restoration and enhancement of priority habitats and ecological networks (Ministry of Housing, Community and Local Government, 2012). The guide ("Getting Started with Parish Nature Recovery"; Oxfordshire Treescape Project, 2021c) was developed iteratively and was not finalised in time to share with all Parish Report recipients.

2.4.2.3 Interactive mapping with LandApp

In response to feedback, free interactive versions of the maps were made available in partnership with LandApp (https://thelandapp.com), a company providing online mapping used widely by the farming industry. Report recipients were able to view nature recovery opportunities identified in Reports overlaid on data already available within LandApp (e.g. footpaths, habitat types, designations, etc). They could then correct any errors in the maps, add local information such as existing nature recovery activities, or add plans for future nature recovery projects. Training materials and online sessions on using LandApp were developed by OTP in collaboration with LandApp.

2.4.2.4 Guidance on collaborating with land managers

In response to informal feedback, resources were created and training sessions offered at relevant public events to support parish groups in approaching land managers. These helped community actors understand concerns and pressures typically faced by land managers, including economic and policy changes at the time, and suggested ways to open conversations with land managers such as finding out what they are already doing for nature, and how they are affected by changes in agricultural subsidies. Efforts were also made to focus on this area in correspondence and conversations with parish report recipients; introductions between parish groups and local land managers were made where possible, using existing local knowledge and connections of the OTP team.

2.4.3 Survey of Parish Report recipients

An online survey was sent to Parish Report recipients 14 months after Reports were first made available. As nature recovery planning and implementation takes a long time, parishes were typically at a very early stage of their nature recovery journey. The survey therefore investigated what resources and support provided by OTP and others were most valued and useful in nature recovery efforts, rather than what nature recovery impacts had been achieved. The survey was conducted in accordance with guidelines from University of Oxford's Central University Research Ethics Committee (CUREC; reference number SOGE1A2021-247); survey questions are available in the Supplementary Information.

3 Results

We report levels of demand for OTP resources and feedback gathered on resource usefulness, from land managers and communities. We then describe relationships and collaborations between these groups, and how OTP is being taken forward.

3.1 Land Managers

3.1.1 Demand for resources

Land Manager Reports were requested by forty holdings representing a range of farming types from smallholders to large estates, including horticulture, arable, livestock and woodland. No Land Managers accessed the interactive mapping layers within LandApp.

3.1.2 Informal observations of land manager responses to OTP resources

Informal conversations with recipients showed that Reports, as intended, acted as conversation starters, allowing land managers to see their holdings from a different perspective and consider potential nature recovery actions. A minority of Land Manager Report recipients accepted the offer of an in-person meeting to discuss their Report; some also took up offers of introductions to relevant local experts (e.g. agroforestry specialists), to peers with relevant initiatives or experience on their own land, or to local community or parish groups where it was deemed to be mutually beneficial.

Responses to Reports were generally positive, although many thought they were too long. Nature recovery opportunity maps within Reports were of particular interest, especially when multiple land use options were indicated. However, inaccuracies in Reports sometimes caused frustration, e.g. where recent tree planting was not shown. A consistent theme was the ongoing uncertainty over details of the new agricultural subsidy scheme (the Environmental Land Management Scheme, ELMS), combined with economic volatility in fuel and grain prices caused by the conflict in Ukraine. Together, these factors deterred land managers from engaging in new nature recovery efforts before it was clear whether they might be funded in the future by ELMS.

3.2 Communities

3.2.1 Demand for OTP resources

Requests were received for 76 Parish Reports, including one for a cluster of 12 parishes, covering 85 (27%) of Oxfordshire's parishes. None of the ten parishes with the greatest proportion of high-value nature sites responded to emailed invitations to receive a Report. Of the parish groups that received a Report, ca 85% had an initial meeting with OTP to discuss their Report, and 45% then sought further support from OTP. Forty groups requested their mapping to be available within LandApp, although the majority of these did not appear to be regularly using the facility.

3.2.2 Survey of Parish Report recipients

There was a 20% response rate to the survey (18 responses; Crockatt et al., 2023). Although this is a small dataset, common themes were discernible.

Of OTP resources, those rated as having greatest influence on nature recovery efforts were discussions with OTP (93% of respondents who used the resource rated it 4 or 5 out of 5), maps provided in LandApp (86%) and introductions to relevant people or organisations (85%) (Fig. 2). Although LandApp maps were rated as one of the most influential resources, comments included both "LandApp… is awesome" and "LandApp is a potentially very useful resource but at every turn I have found it frustrating to use." Reports ranked fifth out of the ten resources listed, but still had a high proportion of scores of 4 or 5 (71%). The least influential resources were the OTP website (29%), LandApp workshops (46%) and the Getting Started with Nature Recovery guide (56%) (Fig. 2).

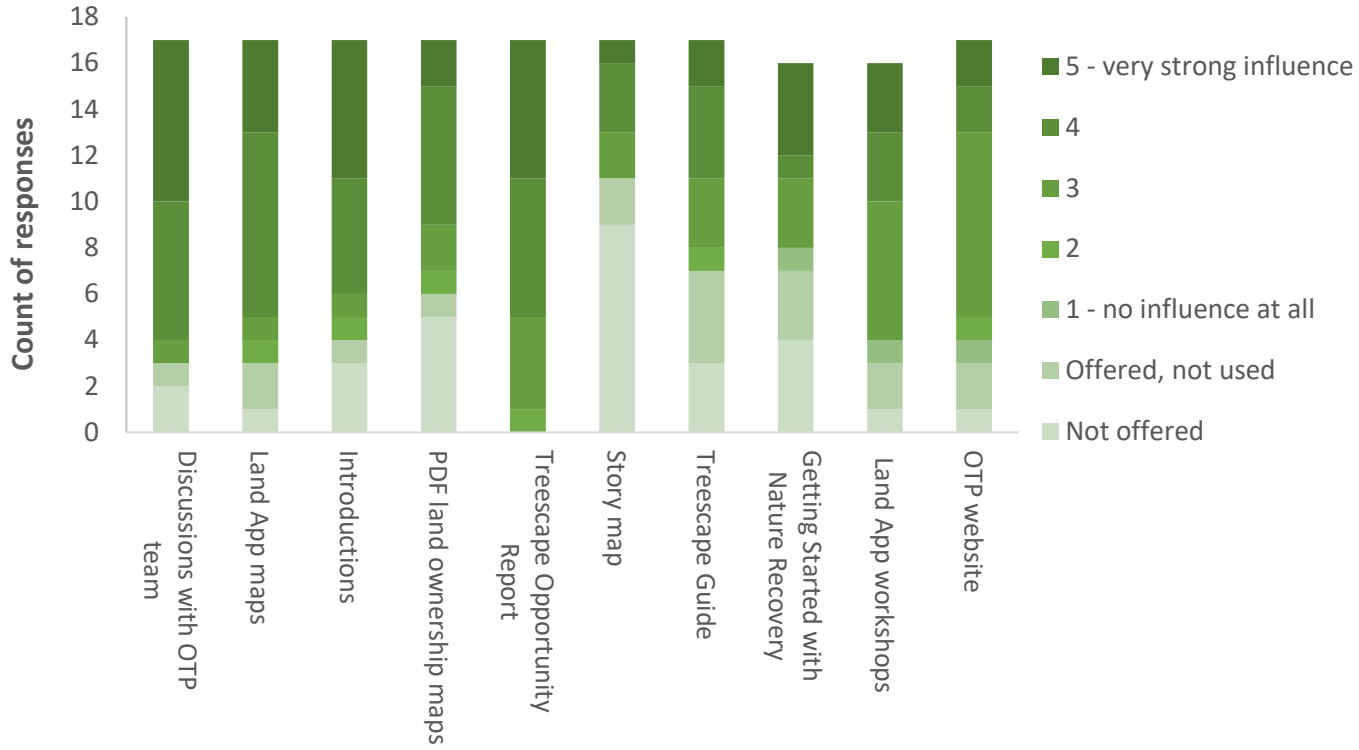


Figure 2 Influence of OTP resources on nature recovery efforts. In response to the survey question: *Please rate the extent to which the following OTP resources influence your nature recovery efforts*.

Within Reports the most useful sections were maps of existing natural assets (93% scored 4 or 5 out of 5), opportunities (89%) and ecosystem services (81%) (Supplementary Information (SI) Fig. S1).

Reports were most frequently used for identifying and planning nature recovery opportunities, but were also used for further communication within recipients' communities, including parish councils, community groups, local land managers and neighbouring parishes (SI Fig. S2). For example, parish councillors often used Reports as a communication tool with the rest of the parish council. When asked what made resources particularly helpful or unhelpful, two of the 11 responses referred to maps not being accurate or detailed enough, two said that maps were not spatially targeted enough, and one thought Reports were too long and complicated.

When asked to rate support for nature recovery from various groups, those rated highest were community groups (88% scored 4 or 5 out of 5), parish council (65%), and local

district or county councillors (65%) (SI Fig. S3). Local businesses (10%) and local farmers / land managers (14%) had lowest ratings.

Respondents found it hardest to access information and support, from any source, about working with private land managers / farmers (no scores of 4 or 5 out of 5) and accessing funding (28%) (SI Fig. S4). It was easiest to gain information and support for information about their parish (61%), how to get started on nature recovery (56%) and ecological knowledge (56%).

Thirteen respondents stated that they had or were considering a Neighbourhood Plan (NP); nine of these felt their NP was likely or very likely to support parish nature recovery. Conversations with recipients showed that Reports were seen as a valuable resource for parishes developing or reviewing NPs; at the time of writing we are aware of at least one NP (covering a cluster of 12 parishes) and two parish Nature Recovery Plans (one of which is a cluster of three parishes) which include OTP maps as data sources. This includes the parish of East Hagbourne, whose NP was used as an example of how Reports could feed into NPs by South Oxfordshire District Council (East Hagbourne, 2023).

While nature recovery outcomes had not been realised at the time of the survey, comments included “Progress has been slow starting… [but] we’re gathering momentum”, and “Just sorry that we cannot move quicker”.

3.2.3 Informal observations of responses to OTP resources

During meetings with recipients it was clear that Report maps were powerful communication and engagement tools, providing a spatially explicit medium through which to discuss nature recovery opportunities, as well as general nature recovery concepts. Recipients were enthusiastic and curious when presented with their Reports, orienting themselves by mapped features, such as roads or rivers, or by local information not included within Reports, e.g. a privately owned field that was commonly used by local dog walkers with the owner’s informal consent. Recipients frequently noted missing features and discussed how maps related to existing local nature recovery efforts. Small errors, inherent in any desk-based mapping exercise, while noted as an issue of concern by some recipients, typically increased engagement as recipients displayed strong knowledge of their local area. The land ownership maps also generated much discussion.

Recipients were encouraged to undertake engagement with the wider community. Engagement methods varied, but were often creative; e.g. one parish held an open evening in a pub where the local community were invited to view, comment on and mark-up large printouts of the Report maps; this formed the start of a community engagement programme to develop a parish-scale nature recovery plan, run by interested community members.

Parish groups frequently collaborated, some as a result of OTP introductions. Typical collaborations included providing advice or support, or planning joint nature recovery programmes in adjoining parishes. As an example of the former, OTP introduced a number of parish groups to the individual responsible for successfully integrating nature recovery into East Hagbourne's NP (East Hagbourne, 2023), enabling other parishes to also use their Reports to inform their NPs. Joint nature recovery programmes ranged from two adjacent parishes planning a joint hedge recovery programme to a cluster of 12 parishes using Reports to propose the inclusion of nature recovery in their joint NP (Mid Cherwell Neighbourhood Plan, 2025).

3.3 Collaboration between land managers and community groups

The Parish Survey found that land managers were rated seventh out of eight stakeholder types for supporting community nature recovery efforts, with only local business receiving lower ratings (SI Fig. S3). Respondents also felt they had poor guidance for working with private land managers (SI Fig. S4). However, four respondents included supportive land managers as one of their parish's greatest strengths (SI Fig. S5) while ten cited "landowner engagement" as one of their greatest challenges (SI Fig. S6), e.g. "The resources have been really helpful. The hard part is to get the engagement of local landowners". Informal feedback from Report recipients reinforced these findings.

During conversations with land managers, it emerged that some were being approached by multiple groups, creating a feeling of frustration and a drain on their time. OTP aimed to reduce this pressure by encouraging a considered, co-ordinated approach by one body, e.g. a parish council.

Parish groups also considered approaches for engaging the wider community, including land managers. These included the pub event mentioned above, where OTP maps could be marked up with local connections, existing nature recovery activities and ideas for

nature recovery, and plans for an event to celebrate a parish's existing natural resources and benefits, including food production.

3.4 Continuation of Oxfordshire Treescape Project

In summer 2023 OTP was integrated into Community Action Groups Oxfordshire, as the Oxfordshire Nature Project. Embedding the project within an established local organisation was intended to increase its long-term stability. Lessons learned and resources developed by OTP continue to inform the project's direction.

The approach developed by OTP was subsequently incorporated into a broader nature-recovery and nature-based solutions opportunity mapping system; the mapping methodology is available for use across England using open-source software (Smith, 2024).

4 Discussion

4.1 Summary of key findings

This study explored how land managers and local community groups can be supported in nature recovery planning that integrates their local knowledge with complex ecological data, using OTP as a case study. In four years, a small team with very limited funding succeeded in engaging 27% of parish communities in Oxfordshire, as well as 40 land managers, contributing to several formal nature recovery plans being developed as a result. Given that none of the parishes approached proactively responded, there appears to be more value in supporting community groups where there is existing enthusiasm for nature recovery, rather than trying to generate interest where there is little present. We found that communities highly valued the provision of ecological data in accessible formats, but that additional tailored support was vital to catalyse community-led nature recovery initiatives inspired by Reports. The findings represent an important addition to community-led nature recovery research (e.g. Hinson et al., 2022; Sterling et al., 2017; Lawrence et al, 2009; Reed, 2008), and are intended to help increase the potential for supporting local communities in nature recovery over longer timescales and across larger areas.

Below we discuss challenges in engaging with land managers, the importance of personal support and introductions, the need for more focus on community-land manager relations, the role of community-led nature recovery in delivering national policy, and the

value of integrating different knowledge systems in nature recovery planning. Finally, we discuss limitations of this study and how the approach could be scaled out more widely.

4.2 Challenges in engaging with land managers

Low uptake of OTP resources by land managers was attributed to complex and rapidly changing economic and policy conditions in 2021 and 2022: gradual replacement of the main farming subsidy (Basic Payment Scheme) with an uncertain new system (ELMS), together with economic impacts of war in Ukraine and frequent changes in national government leadership. Reluctance to investigate nature recovery opportunities with OTP when potential funding for such activities was uncertain, especially with the concern that early adopters might not be eligible to receive funding retrospectively, echoes a 2021 survey of over 15,000 farmers in England and Wales which found that phasing out of BPS was perceived as a major challenge by 47% of respondents and a minor challenge by 22% (RABI, 2021). Further, as a new project with no track record in this area beyond personal experience and contacts of one team member, OTP had not achieved the status of a trusted advisor in this complex sector, where multiple organisations offer sometimes widely varying advice on similar topics (Immel-Parkinson & Vrain, 2024), and where uptake of agri-environmental practises relies on complex social and attitudinal considerations and, in particular, economic considerations (Brown et al., 2021; Mills et al., 2016). Finally, farming is a stressful occupation, with higher levels of stress and anxiety than in the wider UK population (Wheeler & Lobley, 2022). Land managers may therefore have been be focussed on immediate operational and/or business concerns, rather than being available to exploring new approaches. This provides a contrast to community groups whose motivations for working voluntarily on local nature recovery projects are more likely to include personal factors such as health and well-being (Takase et al., 2018), developing a sense of belonging, caretaking the environment and personal learning (Bramston et al., 2010).

4.3 Importance of personalised place-based support for community groups

Survey responses showed that personal support and introductions were highly valued, helping to build relationships that may not have happened organically. Parish groups also

supported each other by sharing information and experiences, or planning nature recovery activities across adjacent parish borders. This illustrates that data alone (in this case, opportunity maps) is insufficient to catalyse action, and how organisations such as OTP, with a strong knowledge of the local area and community, can play a key role in connecting people and resources in self-organizing nature recovery initiatives (Ruiz-Mallén and Corbera, 2013). A key element of organizational success in nature recovery is resilience (Galatowitsch, 2022); the small, responsive, mission-driven OTP team was able to adapt approaches swiftly according to feedback from communities and landowners, which may have contributed to the success of the project.

4.4 Land manager-community relationships need support

Relationships between community groups and land managers are complex but important, as parish groups and the wider community typically have direct influence over small areas of land. Parish Report recipients recognised the importance of engaging with land managers but most were unsure how to do this, an example of "decoupling" of farmers from rural communities (Smithers et al., 2005). Strong relationships between local actors, described as "networks of deep learning", are important to the success of placed-based interventions (Borén and Schmitt, 2022). Despite this, self-organized land manager – community collaborations for nature recovery have received little or no coverage in published literature; perhaps because these projects primarily involve non-academic participants (Sterling et al., 2017). We suggest that facilitating farmer-community relationships is a priority for the success of local nature recovery efforts in England. OTP supported community groups by suggesting how to approach land managers and making introductions where relevant, but further research and resources are needed.

While communities were keen to engage with land managers, land managers saw less value in engaging with community or parish groups. In future, such relationships may emerge through funding criteria for Defra's Landscape Recovery Scheme, the top tier of ELMS, which include "social impact" based on physical access, participation of diverse demographics and community engagement in the project's natural heritage (Defra, 2025a). However, there is a lack of guidance on how to do this, and a need for evidence on which approaches work in practice and how they can be implemented and monitored.

4.5 Maps as a tool for integrating local and academic knowledge

OTP Reports proved a valuable tool for communicating complex data to non-experts and eliciting local knowledge. The maps were excellent for starting conversations about nature recovery opportunities with both communities and farmers, especially at the parish or farm scale as opposed to individual sites. OTP's approach aligned closely with Raymond et al.'s (2010) principles for integrating different knowledge types for environmental management through a reflexive and cyclic problem-focussed process.

A key learning point was that it is important to manage expectations by emphasising that the Reports and maps are generated through desk-based study using national or regional datasets, and are a starting point for incorporation of local knowledge rather than a final plan. This ensures that recipients' confidence in maps is not undermined when errors or omissions are identified. OTP addressed frustrations with mapping inaccuracies by collaborating with LandApp, which allowed users to integrate their local knowledge into the maps. This option was taken up by many community groups, but not by land managers, even though it is widely used in the farming community. This may be because land managers were already using their own mapping systems and did not see the immediate relevance of this new information to their businesses.

OTP's approach was akin to participatory mapping, in which local communities co-create maps with "experts" or a convening organisation (e.g. Burdon et al., 2019) but, unlike the majority of such projects (Hinson et al., 2022), OTP handed the mapping over to communities for use in their own decision-making, with ongoing support as required. Combining local knowledge with maps based on existing datasets has multiple benefits, such as more accurate base-maps for decision making, inclusion of information and cultural values that are known only to local communities (Jones et al., 2020), greater community engagement, and better communication between stakeholders, ultimately leading to increased ownership of local decisions (Cochrane & Corbett 2020) and thus better conservation outcomes (Newig et al., 2023).

4.6 The value of community-led nature recovery in delivering environmental policies

It is now widely recognised that community involvement in nature recovery decision-making results in more equitable and effective outcomes for both biodiversity and human well-

being, by increasing the legitimacy and acceptance of projects and facilitating better ecosystem stewardship (Dawson et al., 2021, Newig et al., 2023). International guidelines therefore state that nature-based solutions should be implemented with the full engagement and consent of local communities (IUCN, 2020; Seddon et al., 2021). In the UK, even though much of the land needed to deliver policies related to nature recovery (such as BNG, LNRS and ELMS) will be privately owned farmland or large estates, community involvement could help to improve project design and incorporate local knowledge, views and values, thus leading to more sustainable outcomes with multiple benefits (Dawson et al., 2021; Marango et al., 2020). In England, there is a statutory requirement for LNRS to be developed and delivered in partnership with local communities (Defra, 2023b), with recommendations from the LNRS pilot scheme that "presentation of data needs to be accessible enough to empower non-specialists to make informed suggestions about what their priorities are", and "early engagement of a wide range of people and organisations is crucial to secure genuine engagement" (Defra, 2021b). OTP's approaches meet these recommendations, supporting community engagement and empowerment in nature recovery, and priming communities for involvement with LNRS planning and implementation.

The high demand for Parish Reports shows a strong appetite for community-led nature recovery in Oxfordshire. OTP found that parish groups were often keen to feed into local policy and planning by enshrining nature recovery within formal NPs or developing informal parish nature recovery plans. Once adopted, NPs are part of the statutory Local Plan for the wider area, so could contribute to addressing nature recovery at a larger scale and supporting implementation of LNRSs. Several parish groups have also used their Local Nature Recovery Plans to suggest refinements to the Oxfordshire LNRS opportunity maps, incorporating local knowledge into county-scale mapping (Smith et al., 2025). This chimes with the long-term success of the Parish Maps project (Crouch and Matless, 1996), an art-based mapping project established in 1987 promoting "positive parochialism", recognised as an approach that has continued relevance to contemporary parish-scale ecological concerns (Devine-Wright et al., 2018). Success of these projects indicates a potential source of local nature recovery enthusiasm, knowledge and effort that could play a key role in complementing the work of the relatively small number of professional staff engaged in delivering national nature and regional recovery policies. As well as identifying suitable

locations for nature recovery activities based on local knowledge, community groups can help with project design, implementation, maintenance and monitoring, e.g. through citizen science (van Noordwijk et al., 2021).

4.7 Limitations

These findings are from just four years of OTP's activities in one county of England; it is important to adopt a place-based approach to translate this to other locations. This is especially true for working with land managers, given the smaller number of participants and unique policy and economic conditions prevalent when the project was running. This paper explores how to support community groups and land managers in *starting* nature recovery planning and efforts; impacts on nature recovery, which are typically realised over many years (Watts et al., 2020), are not guaranteed to follow.

OTP worked at parish scale for multiple reasons (see Methods). However, low election turnouts and regular co-option mean that parish councils are actually the least democratic tier of elected government (Willett & Cruxon, 2019). This emphasises the need for wider engagement to give all sectors of society the opportunity to be part of community nature recovery efforts.

Reports were provided as static snapshots, but land use, land ownership and ecosystems change over time. It would be valuable to explore options for providing the information in a more dynamic format that could be regularly updated.

4.8 Scaling out

Parish-scale local nature recovery planning is a form of local environmental stewardship, empowering individuals and communities to contribute to global issues of climate change and biodiversity loss through using their own expertise and knowledge to make positive changes in their local area (Bennett et al., 2018). This can be aligned with existing policies and governance mechanisms, such as LNRS and NPs, for maximum impact.

OTP's mapping approach has now been incorporated into the Agile opportunity maps (Smith, 2024) which can be applied across England, and are being used to develop LNRS in several counties. However, based on OTP's experience and in line with other studies (e.g. James & Gittins, 2007), well-resourced and experienced local partners are needed to

deliver the people-centric resources that were highly valued by Report recipients, including the ability to make introductions to relevant local individuals, landowners, statutory bodies. As well as scaling-out across the country, there are benefits to scaling-out and collaboration within an area. These include sharing knowledge and resources (e.g. volunteers, tools, insurance); and developing a co-ordinated landscape-scale approach to support habitats, species or features that cross boundaries. OTP supported several types of parish collaborations (see section 3.2.3). The creation of such partnerships and networks should be of value to Responsible Authorities developing and delivering LNRSs.

Drawing on lessons learned from OTP, it might be possible to increase landowner and stakeholder engagement by linking Reports to a specific 'big picture' theme, such as improving water quality (associated with a catchment partnership) or creating a habitat network (in line with the LNRS). Reports and maps could show how local farmer clusters, NGO and community groups can work together for a specific outcome, with actions being linked to specific existing nature recovery funding opportunities. However, this requires a committed person or group to "join the dots" and maintain momentum.

5 Conclusions

National nature recovery policies and targets ultimately rely largely on local communities and land managers to deliver action on the ground, but there are knowledge gaps around how best to achieve this in practice. OTP provided an opportunity to explore the operationalisation of complex ecological data through providing nature recovery opportunity maps to local communities and land managers. Crucially, the data, i.e. maps, were delivered in informative reports and combined with personal support, training resources, and introductions to relevant groups and individuals. In four years, a small team with limited funding succeeded in engaging 40 land managers and over a quarter of Oxfordshire's parishes, leading to development of several local nature recovery plans and ongoing use of the project resources.

Key lessons include the importance of building relationships between and within communities, managing expectations regarding map accuracy, supporting provision of maps with training and follow-up discussions, and ultimately enabling communities to take control of updating and improving their own maps, bringing in their own local knowledge. OTP

694 focussed on supporting groups with enthusiasm for nature recovery and let the approach
695 evolve over time, being agile enough to learn from mistakes. Just as with a 'rewilding'
696 approach to nature recovery, not all outcomes were as planned, but the elements that
697 flourished were supported. Following this approach has led to the continuation of OTP's
698 work to focus on community groups rather than land managers, who are now more
699 supported in nature recovery efforts through government funding mechanisms. The
700 approaches and resources developed by OTP could be scaled out to support communities
701 elsewhere in their nature recovery ambitions including through LNRS and NPs.

References

Agriculture Act 2020. https://www.legislation.gov.uk/ukpga/2020/21/contents/enacted. Accessed 5 June 2025

Bennett, N., Whitty, T., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., Allison, E. (2018). Environmental Stewardship: A conceptual review and analytical framework. *Environmental Management, 61*, 597-614. https://doi.org/ 10.1007/S00267-017-0993-2

Borén, T., & Schmitt, P. (2021). Knowledge and place-based development – towards networks of deep learning. *European Planning Studies*, *30*, 825–842. https://doi.org/10.1080/09654313.2021.1928042

Broitman, D. (2020). Locally-Provided and Globally-Relevant Ecosystem Services: A Needed Distinction for Quantification. *Lecture Notes in Computer Science*, *12253*, 394–404. https://doi.org/10.1007/978-3-030-58814-4_28/TABLES/3

Brown, G. and Raymond, C.M. (2014). Methods for identifying land use conflict potential using participatory mapping. *Landscape and Urban Planning*, 122, 196-208. https://doi.org/10.1016/j.landurbplan.2013.11.007

Brown, C., Kovács, E., Herzon, I., Villamayor-Tomas, S., Albizua, A., Galanaki, A., Grammatikopoulou, I., McCracken, D., Olsson, J.A., Zinngrebe. Y. (2015). Simplistic understandings of farmer motivations could undermine the environmental potential of the common agricultural policy. *Land Use Policy*, 101, https://doi.org/10.1016/j.landusepol.2020.105136

Burdon, D., Potts, T., McKinley, E., Lew, S., Shilland, R., Gormley, K., Thomson, S., & Forster, R. (2019). Expanding the role of participatory mapping to assess ecosystem service provision in local coastal environments. *Ecosystem Services*, *39*, 101009. https://doi.org/10.1016/J.ECOSER.2019.101009

Calado, H., Gutierrez, D. & De Bruyn, A. (2025). Navigating trade-offs on conservation: the use of participatory mapping in maritime spatial planning. *npj Ocean Sustain, 4*, 8. https://doi.org/10.1038/s44183-025-00109-6

Chilvers, J. (2024). Remaking public engagement with climate change. *Dialogues on Climate Change*, *1*, 49-55. https://doi.org/10.1177/29768659241293224

Cochrane, L., Corbett, J. (2020). Participatory Mapping. In: Servaes, J. (eds) Handbook of Communication for Development and Social Change. Springer. https://doi.org/10.1007/978-981-15-2014-3_6

Cordingley, J. E., Newton, A. C., Rose, R. J., Clarke, R. T., & Bullock, J. M. (2016). Can landscape-scale approaches to conservation management resolve biodiversity–ecosystem service trade-offs? *Journal of Applied Ecology*, *53*, 96–105. https://doi.org/10.1111/1365-2664.12545

Crockatt, M., Macnamara, V., Simmons, M. 2023. Parish nature recovery survey report. https://naturerecovery.ox.ac.uk/projects/oxfordshire-treescape-project/. Accessed 16th July 2025

Croeser, T., Clement, S., Fernandez, M., Garrard, G. E., Mell, I., Bekessy, S.A. (2024). Action research for transformative change. *Sustainability Science, 19*, 665–670 . https://doi.org/10.1007/s11625-023-01458-2

Crouch, D., & Matless, D. (1996). Refiguring Geography: Parish Maps of Common Ground. *Transactions of the Institute of British Geographers*, *21*, 236–255. https://doi.org/10.2307/622935

Dawson, N., Coolsaet, B., Sterling, E., Loveridge, R., Gross-Camp, N., Wongbusarakum, S., … Rosado-May, F. (2021). The role of Indigenous peoples and local communities in effective and equitable conservation. *Ecology and Society*, *26*. https://doi.org/10.5751/ES-12625-260319

Defra (2021a). *The England Trees Action Plan 2021-2024*. https://assets.publishing.service.gov.uk/media/60a3ddd1d3bf7f2886e2a05d/england-trees-action-plan.pdf

Defra (2021b). *Local Nature Recovery Strategy pilots: lessons learned - GOV.UK*. https://www.gov.uk/government/publications/local-nature-recovery-strategy-pilots-lessons-learned/local-nature-recovery-strategy-pilots-lessons-learned

Defra (2023a). *Delivering 30by30 on land in England*, Version 1. https://assets.publishing.service.gov.uk/media/65807a5e23b70a000d234b5d/Delivering_30by30_on_land_in_England.pdf

Defra (2023b). Local nature recovery strategy statutory guidance: What a local nature recovery strategy should contain.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1146160/Local_nature_recovery_strategy_statutory_guidance.pdf

Defra (2024a). *Biodiversity net gain*. https://www.gov.uk/government/collections/biodiversity-net-gain Accessed 6 June 2025

Defra (2024b). *The Nature Recovery Network*. https://www.gov.uk/government/publications/nature-recovery-network/nature-recovery-network Accessed 6 June 2025

Defra (2024c) *Agricultural land use in England at 1 June 2024; Accredited official statistics*. https://www.gov.uk/government/statistics/agricultural-land-use-in-england/agricultural-land-use-in-england-at-1-june-2024. Accessed 3 July 2025

Defra (2025a). *Future of farming in England*. https://www.gov.uk/government/collections/future-of-farming-in-england

Defra (2025b). Get funding for farming in protected landscapes. https://www.gov.uk/guidance/funding-for-farmers-in-protected-landscapes#full-publication-update-history. Accessed 6 June 2025

Defra (2025c). Spending review 2025: a commitment to farming. https://defrafarming.blog.gov.uk/2025/06/16/spending-review-2025-a-commitment-to-farming/. Accessed 18 June 2025

Denwood, T., Huck, J. J., & Lindley, S. (2022). Participatory Mapping: A Systematic Review and Open Science Framework for Future Research. *Annals of the American Association of Geographers*, *112*, 2324–2343. https://doi.org/10.1080/24694452.2022.2065964

Devine-Wright, P., Smith, J., Batel., S. (2018) "Positive parochialism", local belonging and ecological concerns: Revisiting Common Ground's Parish Maps project, Transactions of the Institute of British Geographers, 44, 407-421. https://doi.org/10.1111/tran.12282

Dinerstein, E., Vynne, C., Sala, E., Joshi, A. R., Fernando, S., Lovejoy, T. E., Mayorga, J., Olson, D., Asner, G. P., Baillie, J. E. M., Burgess, N. D., Burkart, K., Noss, R. F., Zhang, Y. P., Baccini, A., Birch, T., Hahn, N., Joppa, L. N., & Wikramanayake, E. (2019). A Global Deal for Nature: Guiding principles, milestones, and targets. *Science Advances*, *5*. https://doi.org/10.1126/sciadv.aaw2869

East Hagbourne Parish Council (2023). *East Hagbourne Neighbourhood Development Plan 2018-2033*. https://www.southoxon.gov.uk/wp-content/uploads/sites/2/2021/01/EHNP-Made-version.pdf

Environment Act 2021. https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted Accessed 6 June 2025

Ernoul, L., Wardell-Johnson, A., Willm, L., Béchet, A., Boutron, O., Mathevet, R., Arnassant, S., Sandoz, A. (2018). Participatory mapping: Exploring landscape values associated with an iconic species. *Applied Geography, 95*, 71-78, https://doi.org/10.1016/j.apgeog.2018.04.013

Ferreira, V., Barreira, A. P., Loures, L., Antunes, D., & Panagopoulos, T. (2020). Stakeholders' Engagement on Nature-Based Solutions: A Systematic Literature Review. *Sustainability, 12,* 640. https://doi.org/10.3390/SU12020640

Forestry Commission (2025). Guidance: England Woodland Creation Offer. https://www.gov.uk/guidance/england-woodland-creation-offer Accessed 9 June 2025

Galatowitsch, S. (2023) Organizational capacity and ecological restoration. *Restoration Ecology, 31*: e13757. https://doi.org/10.1111/rec.13757

Hafferty, C., Hirons, M., Tomude, E. S., & McDermott, C. (2023). *A Recipe for Engagement in Nature-based Solutions and Nature Recovery*. https://www.naturerecovery.ox.ac.uk/wp-content/uploads/2023/12/Recipe-for-Engagement-compressed.pdf

Hinson, C., O'Keeffe, J., Mijic, A., Bryden, J., Van Grootveld, J., & Collins, A. M. (2022). Using natural capital and ecosystem services to facilitate participatory environmental decision making: Results from a systematic map. *People and Nature*, *4*, 652–668. https://doi.org/10.1002/pan3.10317

Immel-Parkinson, L., & Vrain, E. (2024). *The Niche Mapper Analytical Framework. Technical Report*. Leverhulme Centre for Nature Recovery, University of Oxford. https://www.naturerecovery.ox.ac.uk/wp-content/uploads/2024/05/The-Niche-Mapper-Analytical-Framework.pdf

IUCN. (2020). *Guidance for using the IUCN global standard for nature-based solutions* (1st ed.) https://doi.org/10.2305/IUCN.CH.2020.09.en

James, P., & Gittins, J. W. (2007). Local landscape character assessment: An evaluation of community-led schemes in Cheshire. *Landscape Research, 32*, 423–442. https://doi.org/10.1080/01426390701449794

Jones, L., Holland, R. A., Ball, J., Sykes, T., Taylor, G., Ingwall-King, L., Snaddon, J. L., & S.-H. Peh, K. (2020). A place-based participatory mapping approach for assessing cultural ecosystem services in urban green space. *People and Nature, 2*, 123–137. https://doi.org/10.1002/pan3.10057

Lavers, T., & Charlesworth, S. (2018). Opportunity mapping of natural flood management measures: a case study from the headwaters of the Warwickshire-Avon. *Environmental Science and Pollution Research*, *25*, 19313–19322. https://doi.org/10.1007/S11356-017-0418-Z

Lawrence, A., Molteno, S., Butterworth, T. (2009). Community wildlife sites in Oxfordshire: an exploration of ecological and social meanings for green spaces. *International Journal of the Commons, 4*, 122-141. https://doi.org/10.18352/ijc.160

Marango, S., Bosworth, G., Curry, N. (2020). Applying Neo-Endogenous Development Theory to Delivering Sustainable Local Nature Conservation. *Sociologa Ruralis, 61*, 116-140. https://doi.org/10.1111/soru.12315

Mid Cherwell Neighbourhood Plan (2025). *Mid-Cherwell Neighbourhood Plan 2024-2042 pre-submission consultation; revised version: April 2025.* https://heyzine.com/flip-book/ea236eae1d.html Accessed 18 June 2025

Mills, J., Gaskell, P., Ingram, J. Dwyer, J., Reed, M., Short, C. (2017). Engaging farmers in environmental management through a better understanding of behaviour. *Agriculture and Human Values 34*, 283–299. https://doi.org/10.1007/s10460-016-9705-4

Ministry of Housing, Community and Local Government (2012). National Planning Policy Framework. https://www.gov.uk/guidance/national-planning-policy-framework Accessed 4/6/2025

Newig, J., Jager, N. W., Challies, E., & Kochskämper, E. (2023). Does stakeholder participation improve environmental governance? Evidence from a meta-analysis of 305 case studies. *Global Environmental Change, 82*, 102705. https://doi.org/10.1016/j.gloenvcha.2023.102705

North East Cotswold Farmer Cluster. (2025) *QR Codes Project* https://www.cotswoldfarmers.org/qr-codes Accessed 11 June 2025

Office for National Statistics (ONS) (2024). Dataset: Standard Area Measurements for Parishes. https://open-geography-portalx-ons.hub.arcgis.com/datasets/ons::standard-area-measurements-for-parishes-december-2021-in-ew/about. Accessed 23/10/2024

Oxfordshire Treescape Project (2021a). Mapping methodology and technical report. https://naturerecovery.ox.ac.uk/projects/oxfordshire-treescape-project/

Oxfordshire Treescape Project (2021b). Opportunity Report for Charlbury Parish https://naturerecovery.ox.ac.uk/projects/oxfordshire-treescape-project/

Oxfordshire Treescape Project (2021c). Getting Started with Parish Nature Recovery. https://naturerecovery.ox.ac.uk/projects/oxfordshire-treescape-project/

Pocock, M.J., Hamlin, I., Christelow, J., Passmore, H.A. and Richardson, M. (2023). The benefits of citizen science and nature-noticing activities for well-being, nature connectedness and pro-nature conservation behaviours. *People and Nature*, *5*(2), pp.591-606. https://doi.org/10.1002/pan3.10432

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation*, *141*, 2417–2431. https://doi.org/10.1016/J.BIOCON.2008.07.014

RABI (2021). The big farming survey: the health and wellbeing of the farming community in England and Wales in the 2000s. Royal Agricultural Benevolent Society (RABI). https://rabi.org.uk/wp-content/uploads/2024/03/RABI-Big-Farming-Survey-FINAL-single-pages-No-embargo-APP-min.pdf

Raymond, C.M., Bieling, C., Fagerholm, N., Martin-Lopez, B. Plieninger, T. (2016). The farmer as a landscape steward: Comparing local understandings of landscape stewardship, landscape values, and land management actions. *Ambio 45*, 173–184. https://doi.org/10.1007/s13280-015-0694-0

Raymond, C. M., Fazey, I., Reed, M. S., Stringer, L. C., Robinson, G. M., Evely, A. C. (2010). Integrating local and scientific knowledge for environmental management, *Journal of Environmental Management,*91, 1766-1777, https://doi.org/10.1016/j.jenvman.2010.03.023

Ruiz-Mallén, I., & Corbera, E. (2013). Community-Based Conservation and Traditional Ecological Knowledge: Implications for Social-Ecological Resilience. *Ecology and Society*, *18*. http://dx.doi.org/10.5751/ES-05867-180412

Seddon, N., Smith, A., Smith, P., Key, I., Chausson, A., Girardin, C., House, J., Srivastava, S., Turner, B. (2021). Getting the message right on nature-based solutions to climate change. *Global Change Biology*, *27*, 1518–1546. https://doi.org/10.1111/gcb.15513

Smith, A. (2021). *Natural Capital in Oxfordshire | Short report*. https://www.biodiversity.ox.ac.uk/wp-content/uploads/2023/08/Natural-capital-mapping-in-Oxfordshire.pdf

Smith, A. (2024). *Agile nature recovery and Nature-Based Solutions opportunity maps: description*. https://nbshub.naturebasedsolutionsinitiative.org/mapping-nbs-opportunities/

Smith, A., Crockatt, M. and Kaleb, K. (2025). Oxfordshire Local Nature Recovery Strategy Phase 3 consultation: Analysis of responses. Leverhulme Centre for Nature Recovery. 25 March 2025. Report prepared for the LNRS team at Oxfordshire County Council. https://www.oxfordshire.gov.uk/residents/environment-and-planning/local-nature-recovery-strategy

Smithers, J., Joseph, A. E., Armstrong, M. (2005). Across the divide (?): Reconciling farm and town views of agriculture–community linkages, Journal of Rural Studies, 21, 281-295. https://doi.org/10.1016/j.jrurstud.2005.03.003

Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., Malone, C., Pekor, A., Arengo, F., Blair, M., Filardi, C., Landrigan, K., & Porzecanski, A. L. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. *Biological Conservation, 209*, 159-171, https://doi.org/10.1016/j.biocon.2017.02.008

Šūmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., Rios, I.D.I., Rivera, M., Chebach, T., Ashkenazy, A. (2018). Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. *Journal of Rural Studies*, *59*, 232-241, https://doi.org/10.1016/j.jrurstud.2017.01.020

van Noordwijk, T., Bishop, I., Staunton-Lamb, S., Oldfield, A., Loiselle, S., Geoghegan, H., Ceccaroni, L., van Noordwijk, T., Bishop, I., Staunton-Lamb, S., Ceccaroni, L., Oldfield, A., Loiselle, S., & Geoghegan, H. (2021). Creating Positive Environmental Impact Through Citizen Science in Vohland, K., Land-Zandstra, A., Ceccaroni, L, Lemmens, R., Perelló, J., Ponti, M., Samson, R., Wagenknecht K. (Eds.), *The Science of Citizen Science*, (pp373–395). Springer. https://doi.org/10.1007/978-3-030-58278-4_19

Warner, E., Lewis, O. T., Brown, N., Green, R., McDonnell, A., Gilbert, D., & Hector, A. (2022). Does restoring native forest restore ecosystem functioning? Evidence from a large-scale reforestation project in the Scottish Highlands. *Restoration Ecology*, *30*, e13530. https://doi.org/10.1111/REC.13530

Warrener, S. (2017). Farmer Clusters – working together to achieve more. Natural England. https://naturalengland.blog.gov.uk/2017/03/21/farmer-clusters-working-together-to-achieve-more/ Accessed 7 July 2025

Watts, K., Whytock, R.C., Park, K.J., Fuentes-Montemayor, E., Macgregor, N. A., Duffield, S., McGowan, P. J. K. (2020). Ecological time lags and the journey towards conservation success. *Nature Ecology & Evolution, 4*, 304–311. https://doi.org/10.1038/s41559-019-1087-8

Willett, J., & Cruxon, J. (2019). Towards a participatory representative democracy? UK Parish councils and community engagement. *British Politics*, *14*, 311–327. https://doi.org/10.1057/S41293-018-00090-4/METRICS

Supplementary Information

Text of parish survey questionnaire

---

1. Participant Consent Form

We require an answer to each statement. Your data will not be used in our study unless you select "yes" for questions 1 - 8. Agreeing to statements 9 - 11 is optional.

1.1 I confirm that I have read and understand the information for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. -

1.2 I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without any adverse consequences or penalty.

1.3 I understand that research data collected during the study may be looked at by authorised people outside the research team. I give permission for these individuals to access my data.

1.4 I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.

1.5 I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.

1.6 I understand how this research will be written up and published.

1.7 I understand how to raise a concern or make a complaint.

1.8 I agree to take part in the study

1.9 Optional: I agree to the use of anonymised quotes in research outputs

1.10 Optional: I agree for research data collected in this study to be given to researchers, including those working outside of the EU, to be used in other research studies. I understand that any data that leave the research group will be fully anonymised so that I cannot be identified

1.11 Optional: I agree that my personal contact details can be retained in a secure database so that the researchers can contact me about future studies.

2. Name:

3. Email address:

4. Which parish are you representing?

4.a. If you selected Other, please specify:

5. Which of the following best describes your role?

5.a. If you selected Other, please specify:

6. When did you first start engaging with Treescape Opportunity maps of your parish (in an Opportunity Report OR within the LandApp)?

7. Does your parish have a Neighbourhood Plan?

7.a. If you selected Other, please specify:

8. If you have or are considering a Neighbourhood Plan, how likely do you think it is that it will support nature recovery? (1= very unlikely; 5 = very likely)

9. How would you rate support for nature recovery in your parish from the following groups? (1 = very low, 5 = very high)

9.1.a. The parish council

9.2.a. Local councillors (district or county)

9.3.a. Community groups

9.4.a. General public

9.5.a. Local farmers / land managers

9.6.a. Local business

9.7.a. Neighbouring parishes

9.8.a. Other groups not mentioned above

9.a. If you have selected Other, please specify:

10. How easy do you find it to get support (from any sources) for the following issues related to nature recovery?

10.1.a. How to get started - 1=poor / difficult, 5 = good / easy

10.2.a. Accessing information about the parish, e.g. land ownership, designation of wildlife sites, etc. - 1=poor / difficult, 5 = good / easy

10.3.a. Working with private land managers / farmers - 1=poor / difficult, 5 = good / easy

10.4.a. Accessing funding - 1=poor / difficult, 5 = good / easy

10.5.a. Ecological knowledge to plan and assess nature recovery projects - 1=poor / difficult, 5 = good / easy

10.6.a. Organisational skills to put nature recovery plans into action - 1=poor / difficult, 5 = good / easy

10.7.a. Volunteer recruitment - 1=poor / difficult, 5 = good / easy

10.8.a. Other (please tell us more below) - 1=poor / difficult, 5 = good / easy

10.a. Other (please tell us about any other areas that you've received support in):

11. Please rate the extent to which the following Oxfordshire Treescape Project resources influence your nature recovery efforts.

11.1.a. Treescape Opportunity Report - 1 = no influence at all, 5 = strong influence

11.2.a. Story map - 1 = no influence at all, 5 = strong influence

11.3.a. PDF land ownership maps - 1 = no influence at all, 5 = strong influence

11.4.a. LandApp maps with Treescape Opportunity layers - 1 = no influence at all, 5 = strong influence

11.5.a. LandApp workshops or drop-in sessions - 1 = no influence at all, 5 = strong influence

11.6.a. Treescape Guide - 1 = no influence at all, 5 = strong influence

11.7.a. OTP website - 1 = no influence at all, 5 = strong influence

11.8.a. 10 Steps Guide to Nature Recovery (draft) - 1 = no influence at all, 5 = strong influence

11.9.a. Discussions with the Oxfordshire Treescape Project team - 1 = no influence at all, 5 = strong influence

11.10.a. Introductions to other individuals or organisations for support - 1 = no influence at all, 5 = strong influence

12. How have these resources supported you? Please tick all that apply.

12.1.a. Treescapes Opportunity Report

12.2.a. Story map

12.3.a. PDF land ownership maps

12.4.a. LandApp maps with parish Treescape Opportunity layers

12.5.a. LandApp workshops or drop-in sessions

12.6.a. Treescape Guide

12.7.a. OTP website resources

12.8.a. 10 Steps Guide to Nature Recovery (draft)

12.9.a. Discussions with the Oxfordshire Treescape Project team

12.10.a. Introductions to other individuals or organisations for support

12.a. Other: Please tell us any other ways in which resources have helped you.

13. How have these resources supported you in engaging with the following groups? Please tick all that apply.

13.1.a. Treescapes Opportunity Report

13.2.a. Story map

13.3.a. PDF land ownership maps

13.4.a. LandApp maps with parish Treescape Opportunity layers

13.5.a. LandApp workshops or drop-in sessions

13.6.a. Treescape Guide

13.7.a. OTP website resources

13.8.a. 10 Steps Guide to Nature Recovery (draft)

13.9.a. Discussions with the Oxfordshire Treescape Project team

13.10.a. Introductions to other individuals or organisations for support

13.a. Other: Please tell us any other ways in which resources have helped you.

14. How useful did you find the different parts of the Treescape Opportunity Report?

14.1.a. Overview of policy landscape - 1 = not useful at all; 5 = very useful. Please select "NA" if you haven't received a report.

14.2.a. Overview of funding options - 1 = not useful at all; 5 = very useful. Please select "NA" if you haven't received a report.

14.3.a. Maps showing what is already in the parish - 1 = not useful at all; 5 = very useful. Please select "NA" if you haven't received a report.

14.4.a. Maps of treescape opportunities - 1 = not useful at all; 5 = very useful. Please select "NA" if you haven't received a report.

14.5.a. Maps of natural benefits provided - 1 = not useful at all; 5 = very useful. Please select "NA" if you haven't received a report.

14.6.a. Recommendations on meeting Climate Change Committee targets - 1 = not useful at all; 5 = very useful. Please select "NA" if you haven't received a report.

15. Please tell us more about what made the resources particularly helpful or unhelpful.

16. How could we improve the resources provided?

17. What do you see as your parish's greatest strengths or opportunities for nature recovery? This could be anything from existing nature-rich sites to supportive volunteers.

18. What do you see as your parish's greatest challenges for nature recovery?

19. What other resources or support (provided by Oxfordshire Treescape Project or elsewhere) would help you and your parish move forwards in planning for nature recovery?

20. Is there anything else that you would like to tell us?

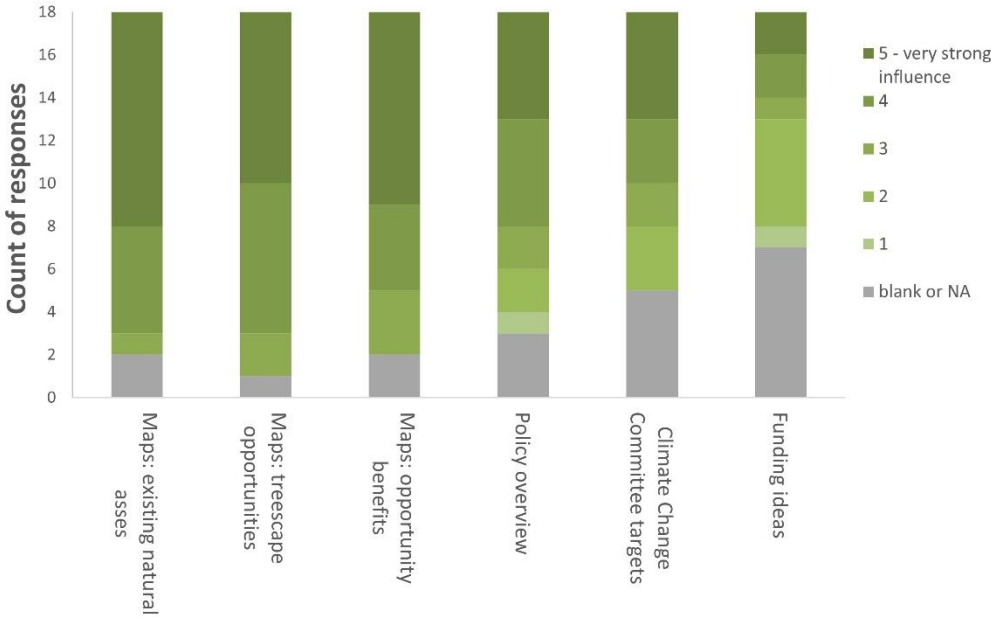
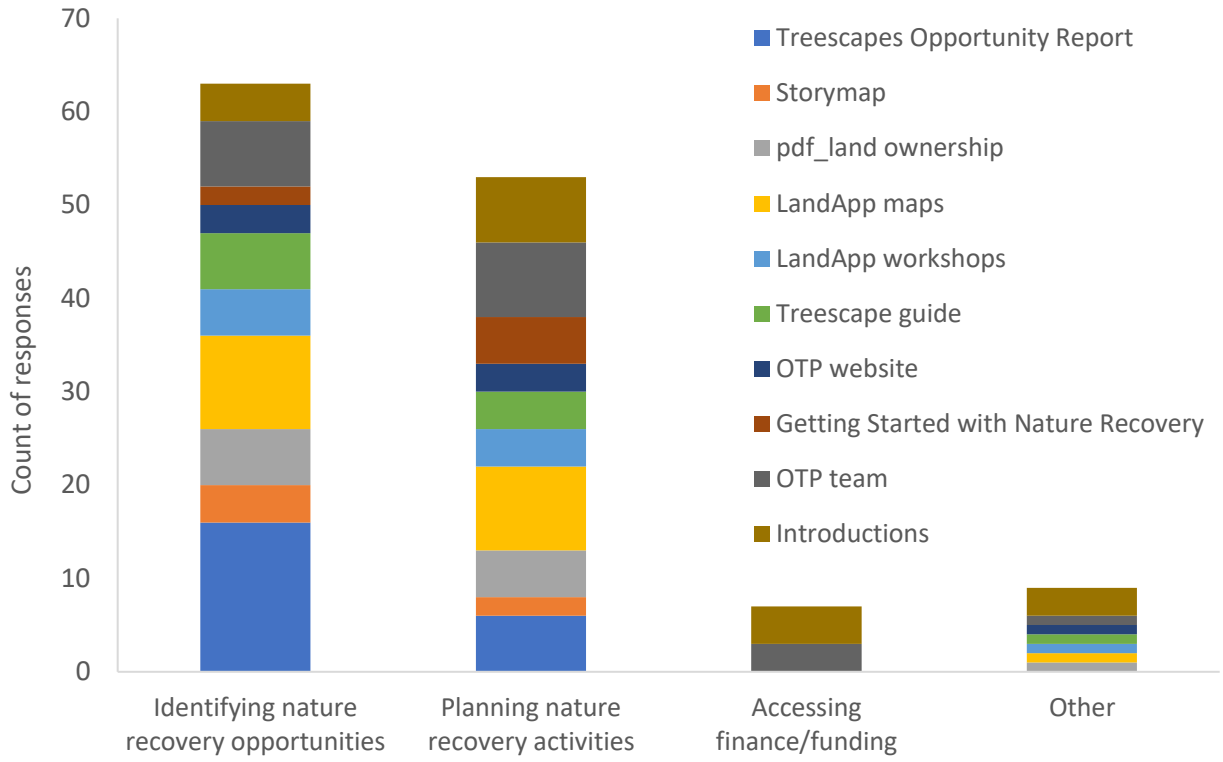


Figure S1 Usefulness of different sections of the Treescape Opportunity Report. Response to question: *How useful did you find the different parts of the Treescape Opportunity Report?* 1= not useful at all, 5 = very useful.



1078

1079 **Figure S2 How OTP resources have supported nature recovery activities,** in answer to the

1080 question: *How have these resources supported you?*

1081

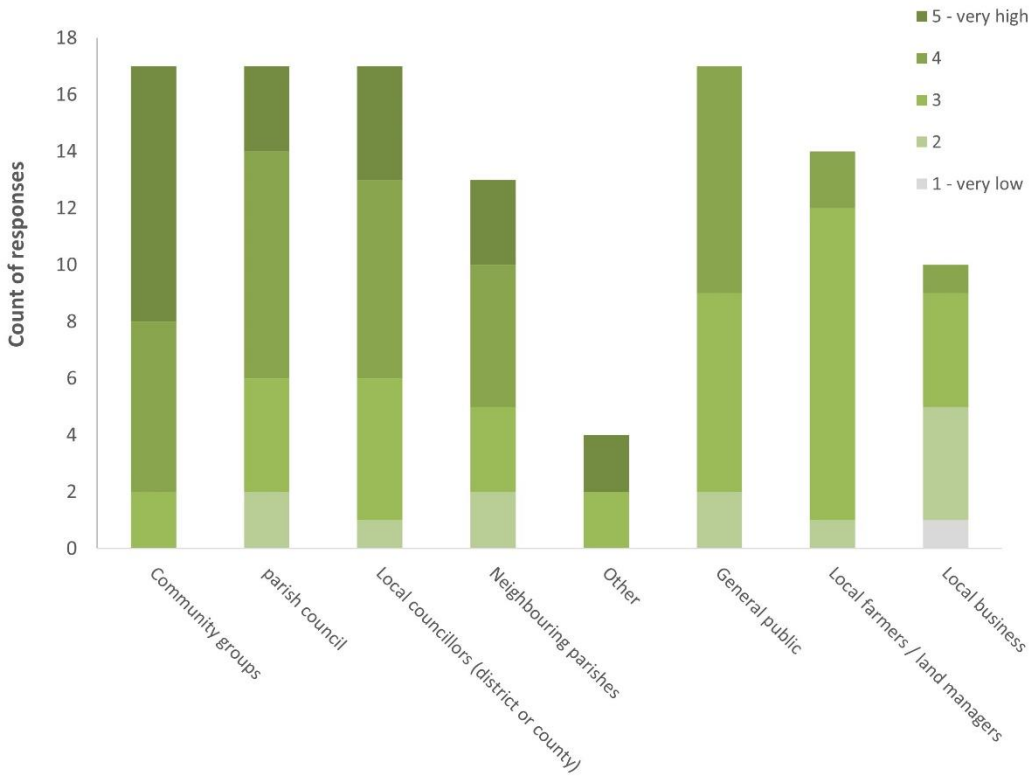


Figure S3 Support for nature recovery from different groups. In response to the question: *How would you rate support for nature recovery in your parish from the following groups?* Where there are less than 17 responses the respondent had not experience of working with that group.

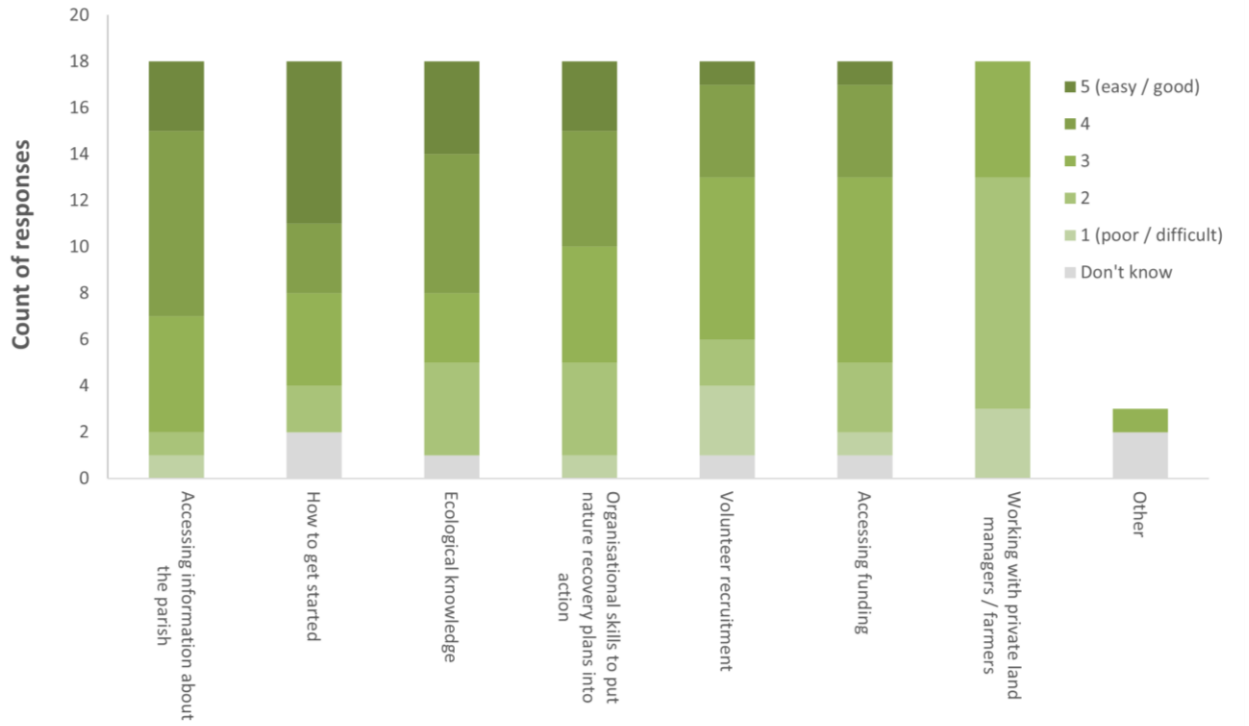


Figure S4 Ease of access to support for issues related to nature recovery. In response to the question: *How easy do you find it to get support (from any sources) for the following issues related to nature recovery?*

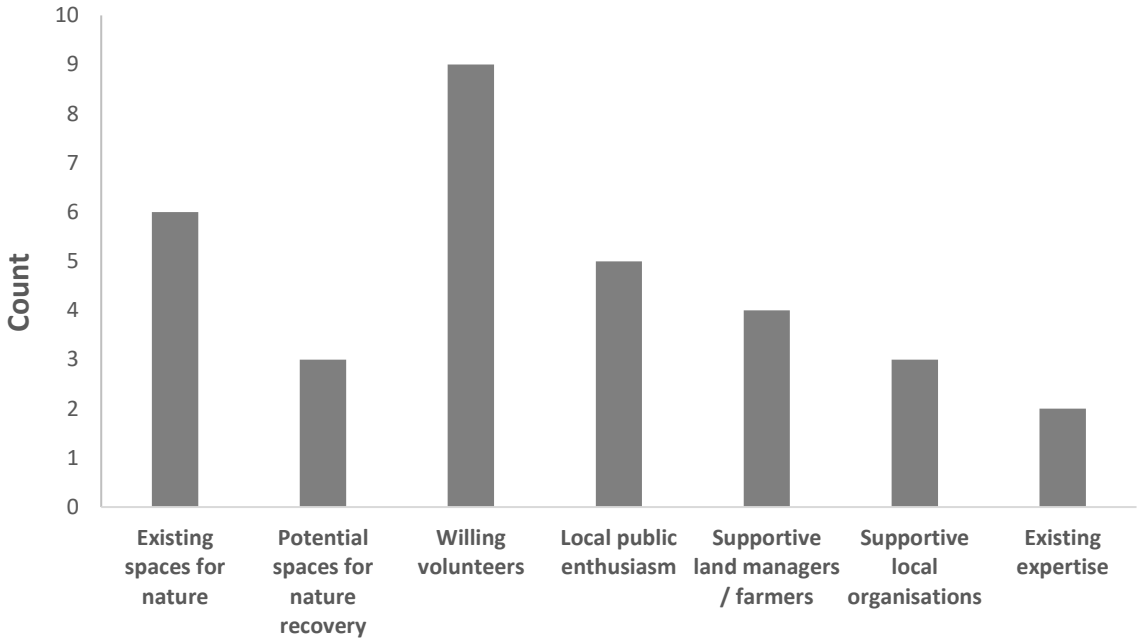


Figure S5 Parish's greatest strengths or nature recovery opportunities. In response to the free text question: *What do you see as your parish's greatest strengths or opportunities for nature recovery? This could be anything from existing nature-rich sites to supportive volunteers.* 16 respondents answered. Text was analysed for themes, and ideas in each response assigned to a theme.

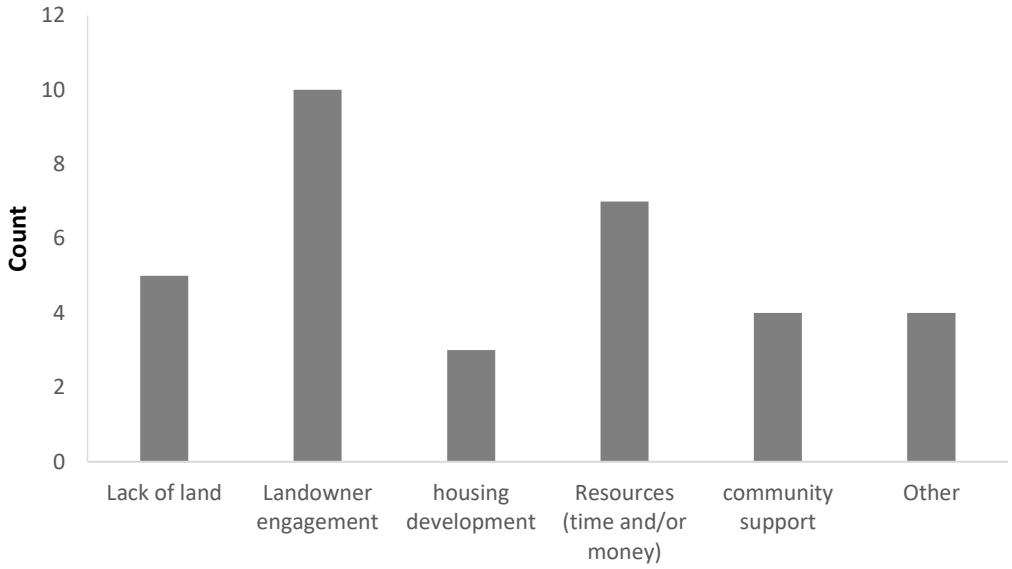


Figure S6 Greatest nature recovery challenges for parishes. In response to the free text question: *What do you see as your parish's greatest challenges for nature recovery?* 17 respondents answered. Text was analysed for themes and ideas in each response assigned to a theme.