Trees, Forests and People 21 (2025) 100915

Contents lists available at ScienceDirect

Trees, Forests and People

journal homepage: www.sciencedirect.com/journal/trees-forests-and-people

Ash trees in Great Britain: How might land-managers respond to a new threat?

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ARTICLE INFO

Keywords:
Ash trees
Emerald ash borer
Ash dieback
Decision making
Trees pests
Tree diseases
Land-managers

ABSTRACT

Ash trees across Great Britain are under increasing threat from pests and diseases as ash dieback (ADB) continues to spread and intensify in impact. Meanwhile, concerns grow throughout Europe about the westward spread of emerald ash borer (EAB). Should EAB be discovered in Great Britain, decisions taken by managers of ash trees will be crucial to their survival, given the threat they already face from ADB. This study has investigated the likely responses of land-managers to EAB, their willingness to implement surveillance for EAB, their knowledge of EAB, and the importance of ash trees to them. An online questionnaire was conducted in 2021 with diverse land-managers across Great Britain. Analysis of 368 completed questionnaires revealed some of the potential influences on decisions that land-managers might make concerning surveillance and management for EAB. These include: the personal importance of ash trees to land-managers, their perceptions of EAB risk, previous experience with ADB, self-reported knowledge of EAB, and management aims for the trees. Overall, the results demonstrate a range of likely responses to EAB. Understanding likely responses will help policymakers better plan for the potential arrival of EAB by highlighting where and how interventions and support might be most effective. Findings have practical value for land-managers and decision-makers, policy relevance for governance, and also add to the evidence about land-manager decision-making when faced with dual environmental threats.

1. Introduction

Growth in the global movement of commodities and people, and climatic change, have had significant negative impacts on trees worldwide (Brasier, 2008; Santini et al., 2013; Green et al., 2021). In the UK, trees are threatened by a growing number of pests and diseases (P&Ds). Since Dutch Elm disease in 1971, 23 new P&D outbreaks have been recorded, 19 of them since 2000 (Defra 2023), and many have evaded eradication efforts. In many cases the social, economic and environmental impacts have been immense (Green et al. 2021). For example, *Phytophthora ramorum* impacting Japanese Larch, and *Dothistroma Needle Blight* affecting Pinus sp. have caused losses to the forestry sector (Green et al. 2021; Haugh 2022; Brasier and Webber 2010; Brown and Webber 2008). Disease impact in these cases is economically measurable but the full cost of tree mortality is far greater, particularly when broadleaf species are lost, affecting wider ecosystem services, including biodiversity and human well-being. Ash trees in Great Britain (GB) are severely impacted by ash dieback (ADB), a fungal disease first identified in GB in 2012 estimated to have caused £15billion losses to the economy, and to have changed the landscape through widescale tree mortality (Hill et al., 2019). Twelve percent of broadleaf woodland in GB is estimated to be ash woodland (Defra, 2019), and there are

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https://doi.org/10.1016/j.tfp.2025.100915

Available online 28 June 2025
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approximately 60 million ash trees outside of woodlands, pointing to their significance across the landscape. There are 955 species associated with ash trees (for example, invertebrates such as the caterpillars of many species of moth, birds including bullfinches and woodpeckers, and flora in the form of lichens and moss), showing their importance to biodiversity (Defra, 2019). Ash trees are also important for diverse social and cultural reasons, including landscape aesthetics and connecting people to seasonal change (Hall et al. 2021; Rackham 2014).

Preventing the introduction and spread of P&Ds is challenging but *a priori* surveillance, early identification, and prompt responses are crucial. Surveillance that can lead to early detection is important for eradication and prevention of establishment (Gupta et al., 2022). Land-managers have a critical role in surveillance, however, there is limited evidence on whether they are willing to adopt P&D-specific surveillance and management actions. Lack of awareness, incomplete knowledge, and limited resources are some of the reasons for limited action (Coyle et al., 2016), but there are other factors likely to influence decisions and actions, including risk perceptions (McFarlane et al. 2012; Ambrose et al. 2019), values associated with trees (Marzano et al. 2020), management objectives, perceived public acceptability (Urquhart et al. 2017; Gutsch et al., 2019) and previous experiences with P&Ds (Marzano et al. 2017).

ADB is a current threat, present in most parts of GB. Ash trees in GB may, in future years, face an additional threat from the emerald ash borer beetle (EAB; *Agrilus planipennis*) (Orlova-Bienkowskaja et al., 2018). Native to Asia, EAB has been reported in Russia and Ukraine (EPPO EAB Newsletter 2024; Orlova-Bienkowskaja et al. 2022). Much of what is known about EAB impacts is from North American experiences (McCullough 2019), and while there is evidence that some ash trees have some tolerance to ADB (Stocks et al. 2019), EAB is generally thought to be fatal (Forest Research, 2025). Effective surveillance and early detection of EAB is therefore essential. Various surveillance methods are available for land-managers looking for signs of EAB, including traps baited with chemical attractants, planting of sentinel trees (species that are particularly attractive to the beetle), tree girdling (to kill the tree and make it a more attractive target for the beetle), and branch sampling (cutting a branch to look for signs of infestation beneath the bark) (Ryall 2013; Schrader et al. 2020; Mercader et al. 2012, 2013; Evans et al. 2020). Should EAB be found there are options for its management, including pre-emptive felling to create a buffer zone, biological control using parasitic wasps, trunk injection with insecticide, and felling of infected trees (Evans et al. 2020; McCullough 2019; Duan et al., 2023).

Land-managers with ash trees will be crucial to GB's response, if EAB is found. Current evidence on ash management (in response to either EAB or ADB) suggests that multiple factors influence land-manager decision-making, which may not align with the actions needed. For example, personal values and emotional connections to ash trees may act as barriers to effective management if destruction or removal of trees is required. Landowners reacted against a rapid response programme implemented by the government when EAB was found in Ontario. Reactions were based on their emotional attachment to the trees, and their appreciation of the values of their forests (Mackenzie and Larson, 2010). Lack of knowledge, awareness or access to appropriate information about P&D management may limit responses to new incursions. In an example from Sweden (wrt ADB) some land-managers felled ash trees due to lack of information or because they believed that was the correct action to reduce the risk of spread, despite the need to leave ash trees if they show resistance to ADB (Bengtsson and Senstrom, 2017). ADB management recommendations are not always followed because some forest owners make decisions about felling damaged ash, based, for example, on economic yield, and therefore may fail to retain viable ash trees (Pliura et al., 2017).

The successful use of novel approaches to manage pests may depend on land-manager risk perceptions and belief systems. Dunens et al. (2012) held focus groups with stakeholders to understand perceptions of effectiveness and safety of chemical injection to control EAB in USA. A group including scientists and forest managers experienced in EAB management expressed high confidence regarding safety and a moderate level of confidence in the efficacy of chemical injections. Contrastingly, a group including aboriculturalists, gardeners, and environmental and neighbourhood organisations were moderately confident in the use of chemicals and their safety, and slightly more confident that it was effective. Public perceptions regarding safety, however, were low which may influence land-managers. All groups showed concern about unintended consequences of chemical use (Dunens et al., 2012).

Previous experiences with other P&Ds can influence decisions about management. This was found in a study about ADB whereby forest advisors and managers with past experiences of rapid (ineffective) responses adopted a cautious attitude (Marzano et al., 2019). When considering EAB in the USA, some stakeholders referred to previous pests (the gypsy moth) where control attempts had failed (Dunens et al., 2012). Stakeholders were disillusioned by efforts they considered were wasted, as they failed to eradicate the pest or control its impact (Dunens et al., 2012).

Given the diversity of GB land-managers and the limited understanding of how they might contribute to EAB surveillance and management, this paper addresses three questions: (i) Are ash trees valued by land-managers and does this impact likely tree health actions? (ii) Do knowledge and risk perceptions inform attitudes towards different surveillance and management measures? (iii) Has experience with ADB influenced potential responses to EAB?

2. Materials and methods

An online questionnaire targeted diverse GB land-managers with ash trees, or responsibility for decisions about ash management.

2.1. Structure of questionnaire

The questionnaire aimed to investigate the willingness of land-managers to apply surveillance and management relevant to EAB, and examine the factors linked to that willingness. It included 40 questions and was online between September and November 2021. The first section of the questionnaire asked about the respondent's ash trees, including where they are and the type of land ownership. Questions asked about the importance of different management aims. The second section included questions about the value and importance of ash trees. The third section asked about awareness and risk perceptions of ADB and EAB. The fourth section included questions about the management of ADB, while the fifth section asked about surveillance and management for EAB. This was followed by a section including questions about information sources and networks that respondents engage with, and the final section featured questions about the land holding(s) (location and size of area) and demographics (See Supplementary material for the questionnaire). (Note that not all responses to all questions are reported here but were used to contribute to other parts of the project, reported elsewhere).

The surveillance options investigated for EAB were: planting sentinel trees, branch sampling, sticky traps and tree girdling. The management options were: pre-emptive felling, chemical (trunk) injections, biological control and felling of infected trees (plus the option of taking no action).

Given the lack of a database of land-managers of interest, a purposive sampling approach was used. Fifty five relevant organisations (based on the categories in Fig. 1) were asked to distribute the questionnaire link to their members or staff. Fifty-one percent of organisations agreed to do so. The link was also shared via social media. Given this approach to sampling and recruitment the results reported cannot be treated as being representative of all GB land-managers with ash trees.

- Forestry and land agents/consultants
- Land managers from large land-based charities
- Local authority tree officers
- National Park authorities/rangers
- Farmers with ash trees on their land
- Grounds staff for sporting facilities such as golf courses
- Grounds staff for other private or public spaces with trees such as schools, hospitals, religious grounds, business parks
- Other private landowners such as transport companies, utility companies, estate owners
- Other owners of small and large woodlands
- Transport network companies

Fig. 1. Categories of land-managers targeted.

2.2. Statistical analysis

The R statistical software package (version 4.0.2) was used for data analysis and statistical modelling. Graphics were produced using 'ggplot2' (Wickham, 2016). Generalised mixed linear models (GLM) were used to test whether there were differences in the likelihood that participants would use the surveillance measures and management options for the control of EAB (Q29 and Q30 of the questionnaire). These questions used five-point Likert scales for responses, from 5 'highly likely' to 1 'highly unlikely'. Responses were converted to binary responses with `5: Highly likely' and '4' recoded to 1; and '3', '2' and '1: Highly unlikely' recoded to 0. Participants who stated 'Don't know enough to say' were excluded from the analysis.

The 'lme4' package (Bates et al., 2015) was used to fit the GLMs. The likelihood of using surveillance measures or management options was fit as an outcome variable and each of the question sub-options fit as a fixed effect variable. A binomial distribution with a logit link was used and participant ID fit as a random effect. Different fixed effect covariates were used for each question. Interactions were tested using a forward stepwise approach and retained if they showed statistical significance ($p < 0.05$) and improved model fit according to AIC (Akaike information criterion). Type-II ANOVA tests were used to test the significance of fixed effects and the 'emmeans' package (Lenth, 2021) used to do post-hoc analyses and extract adjusted marginal means from the models. The 'multcomp' package was used to create significance-based groupings and the Tukey HSD method used to correct for multiple comparisons (Hothorn et al., 2008). Model fit was assessed using residual diagnostic functions (DHARMa package (Hartig, 2020)).

3. Results

3.1. Respondents

There were 368 completed questionnaires. Respondents were located across GB (Fig. 2). The two regions with the largest number of respondents were the South West and South East of England.

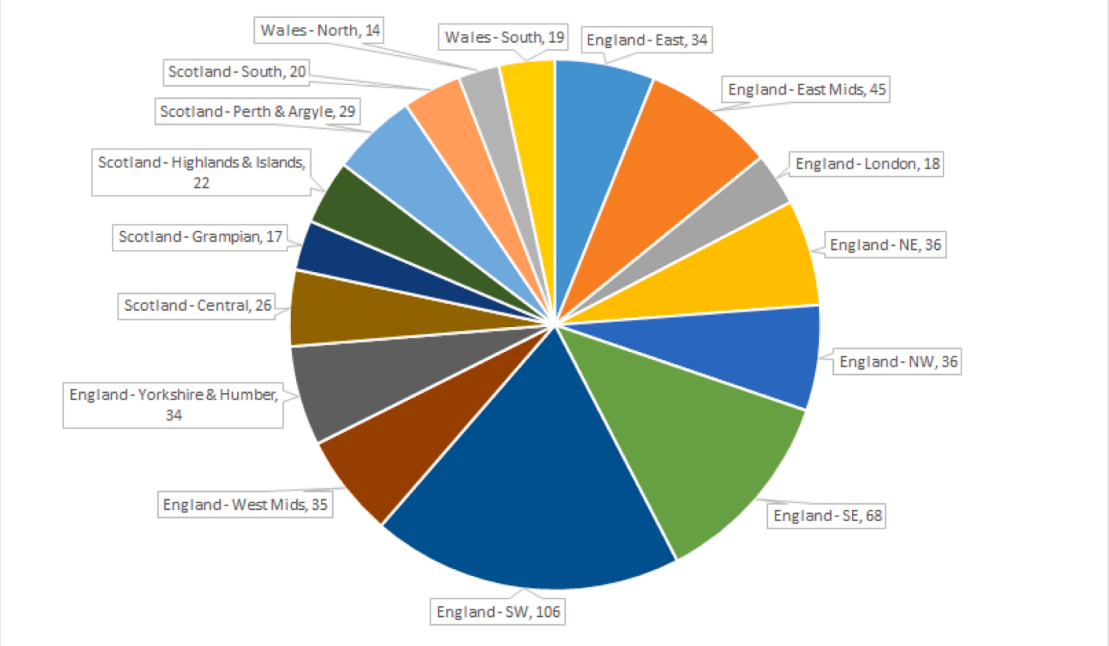

Fig. 2. GB region of the land managed by respondents.

3.2. Responsibility, land holding(s) and ash trees

Forty-six percent of respondents had full responsibility for decision-making about the management of the ash trees. Most commonly, the ash trees were in a woodland (89 %) but as highlighted in the introduction ash trees are located in many different settings and this was found to be the case. Forty-eight percent of respondents managed ash trees within designated or protected areas. Table 1 contains additional information.

3.3. Values

Ash trees were reported to be very important personally to 65 % of respondents, but only 30 % said ash trees were very important to their business. Reasons why ash trees were valued by the respondents included: wildlife/biodiversity (79 % personal; 63 % business), contribution to landscape character (76 % personal; 58 % business), and aesthetics (73 % personal; 43 % business) (Fig. 3).

Another way to understand how ash trees matter to respondents is by looking at the importance of different management aims for the trees (Table 2). The most important management aims were reported to be: protection/ improvement of nature, biological diversity, wildlife habitats, ecosystem service provision, and protection/ improvement of the landscape. The least important to respondents were: wood products, capital growth/ investment, non-timber forest products, and hunting/ shooting.

3.4. Knowledge of ADB / EAB

Self-reported knowledge of ADB and EAB was quite different. Whilst 71 % said they knew a lot about ADB, only 12 % said they knew a lot about EAB. Meanwhile, only one person said they knew nothing about ADB, but 36 % of respondents knew nothing about EAB. This is reflected in stated confidence for identifying the two tree health problems with 95 % stating they could identify ADB but only 31 % were confident about identifying EAB.

3.5. Perception of risk of ADB / EAB

Respondents perceived ADB to present the greater risk, with around 70 % believing it presented a very high risk to the survival of ash trees in different locations. The equivalent figure for EAB was closer to 30 % (Figs. 4& 5). However, EAB had a large percentage saying ‘don’t know’ or ‘not heard of’.

3.6. Experience of ADB and ADB management

Eighty-eight percent had seen ADB on the ash trees they managed, 79 % had seen it on neighbouring land, 85 % had seen it elsewhere in their region and 72 % had seen it elsewhere in the country. Respondents had taken management actions for ADB, including monitoring infected trees, felling infected trees, surveillance of other ash trees, and replanting with other tree species (Fig. 6).

3.7. Influences on ADB management decisions

Those respondents who had taken management actions relating to ADB on their trees were asked what influenced their decisions about that action. There was a range of influences (Table 3). Health and safety concerns had the biggest influence on respondents, followed by advice from a trusted source. Other important influences were their understanding of the disease, and organisational management objectives for the trees.

3.8. Surveillance and management options for EAB

The surveillance activities most likely to be carried out by respondents are the use of sticky traps and branch sampling. The most likely management activity is felling of infected trees. However, the response category with the largest percentage regardless of surveillance or management action is “don’t know” (Fig. 7).

3.9. What might influence the likelihood that land-managers will carry out surveillance for EAB?

The statistical analysis revealed that personal values associated with ash trees, risk perceptions of EAB, previous experience with ADB, management objectives, and land-manager attitudes towards the surveillance actions all influenced how likely land-managers would be to carry out EAB surveillance.

Those who personally valued ash trees more highly were more likely to say they would carry out all the surveillance activities (Fig. 8a), as were those who perceived a high risk from EAB to ash trees elsewhere in GB, and those who had seen ADB on their own trees. Management objectives were also important, but only partially. For example, those who managed trees for personal pleasure were more likely to say they would be willing to plant sentinel trees (Fig. 8b), and those who managed trees for carbon capture and storage were more likely to say they would use sticky traps (Fig. 8c). How acceptable an individual believed an option for surveillance to be impacted the likelihood of them saying they would apply that surveillance method (Fig. 8d is for sticky traps but the relationship held for all surveillance options).

3.10. What might influence the likelihood that land-managers will carry out management for EAB?

The statistical analysis revealed that personal values associated with ash trees, self-reported knowledge of EAB, previous experience with ADB, management objectives, attitudes to the EAB management option, and land ownership all influenced how likely land-managers would be to carry out EAB management activities.

Table 1
Management roles, land ownership, ash trees.

Category	Responses					
Management role	Strategic decision-making responsibility	Land-management decision-making role	Both roles			
	63 %	66 %	29 %			
Land ownership	Land they own	Land they manage	Both			
	47 %	65 %	12 %			
Land ownership	Private land	Public land	Third sector land	Combination		
	71 %	36 %	18 %	25 %		
Proportion ash trees	<20 %	20–39 %	40–59 %	60–79 %	80 %+	Don’t know
	41 %	35 %	13 %	4 %	2 %	7 %
Notable, veteran or ancient ash trees?	Notable ash trees (~75–150 years old)	Veteran ash trees (~100–200 years old)	Ancient ash trees (=>225 years old)			
	75 %	52 %	16 %			

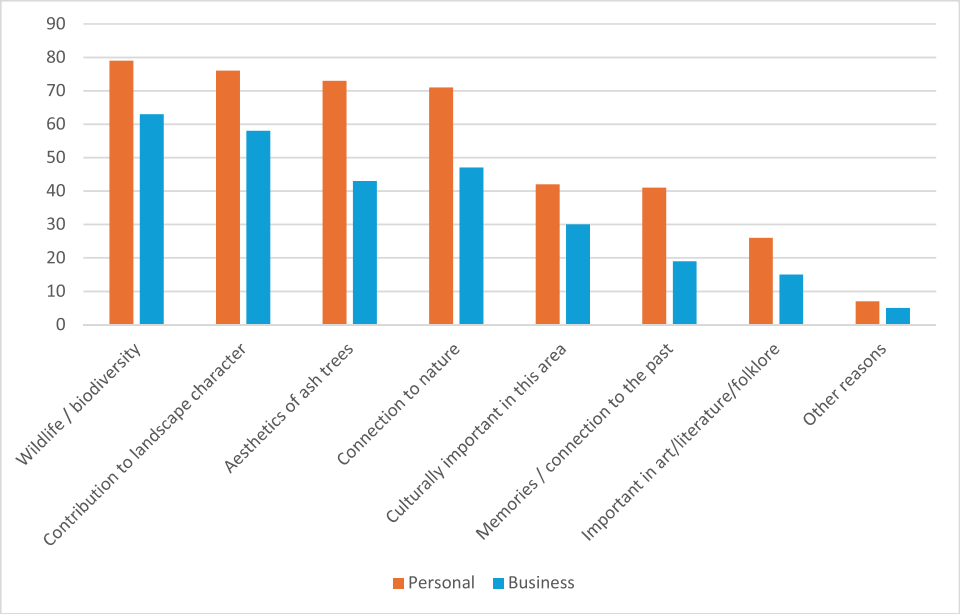

Fig. 3. Reasons why ash trees are important to respondent personally and to their business/organisation (percentage).

Table 2
How important are the following management aims for the woodlands / trees that you have responsibility for? (1 Not at all important - 5 Very important) ($n = 368$).

	1	2	3	4	5
Management aims	%	%	%	%	%
Protection/improvement of nature, biological diversity, wildlife habitats	3	2	11	18	63
Provision of all ecosystem services generally	2	4	11	20	57
Protection/improvement of the landscape	3	4	14	25	52
Carbon capture and storage	6	8	15	26	41
Promoting the health & well-being of the public	9	11	18	17	39
Recreation	13	10	17	18	37
Personal pleasure	13	6	12	15	34
Your own health & well-being	16	9	17	15	25
Pass on land to your children or other heirs	24	6	10	10	23
Protection/improvement of water resources	16	17	24	18	19
Screening - from noise, pollution, etc.	18	17	24	15	18
Wood products (timber, bioenergy, woodfuel, etc.)	26	18	17	17	15
Capital growth/ investment	48	15	10	7	10
Non-timber forest products (berries, fungi, nuts, etc.)	43	22	13	5	5
Hunting/shooting	55	11	7	6	4

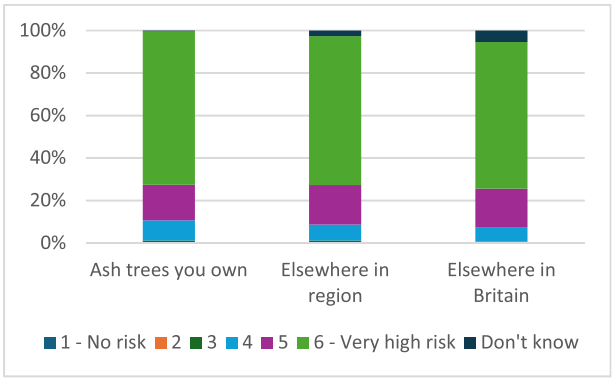

Fig. 4. How much risk do you think ash dieback presents to the survival of ash trees? (1: No risk 2; 3; 4; 5; 6: V. high risk).

Those land-managers who thought ash trees were important for a 'connection to nature' were less likely to state willingness to carry out any of the management options. Those who said they know 'a little' or 'a lot' about EAB were more likely to be willing to use biological controls to tackle EAB than those who said they knew nothing (Fig. 9a). Those who had seen ADB on their own trees were more likely to carry out all the management options.

Land-managers to whom 'hunting/shooting' was an important management objective were more likely to say they would be willing to apply all the management options (Fig. 9b). This should be treated with caution however, as this was very few respondents.

Land-managers who thought that felling ADB-infected trees was acceptable were more likely to say they would be willing to pre-emptively fell ash trees for EAB, and also to fell EAB-infected trees (Fig. 9c). Also, land-managers who thought that felling uninfected ash trees was acceptable for EAB were more likely to say they would carry out pre-emptive felling (Fig. 9d) and use chemical trunk injections.

Finally, those land-managers managing ash trees on land they owned were less likely to say they would be willing to pre-emptively fell uninfected ash trees and more likely to take no management action for EAB (Fig. 9e).

4. Discussion and conclusion

Experience from North America demonstrates that EAB has the potential to devastate whole populations of ash trees if it is undetected and uncontrolled. Given that it is moving west across Europe it may inevitably reach GB. While discussions about surveillance at borders are important, land-managers must be part of surveillance and management programmes, hence land-managers with responsibility for ash trees in any location in GB need to be willing to implement surveillance and management actions for EAB. This paper provides valuable insight into what might influence the willingness of land-managers to apply EAB surveillance and management.

Specifically, personal values associated with ash trees, previous experience with ADB, management objectives, and land-manager attitudes towards the surveillance/management actions influenced how likely land-managers were to say they would implement surveillance/management for EAB.

As is clear from previous studies relating to forest manager decision-

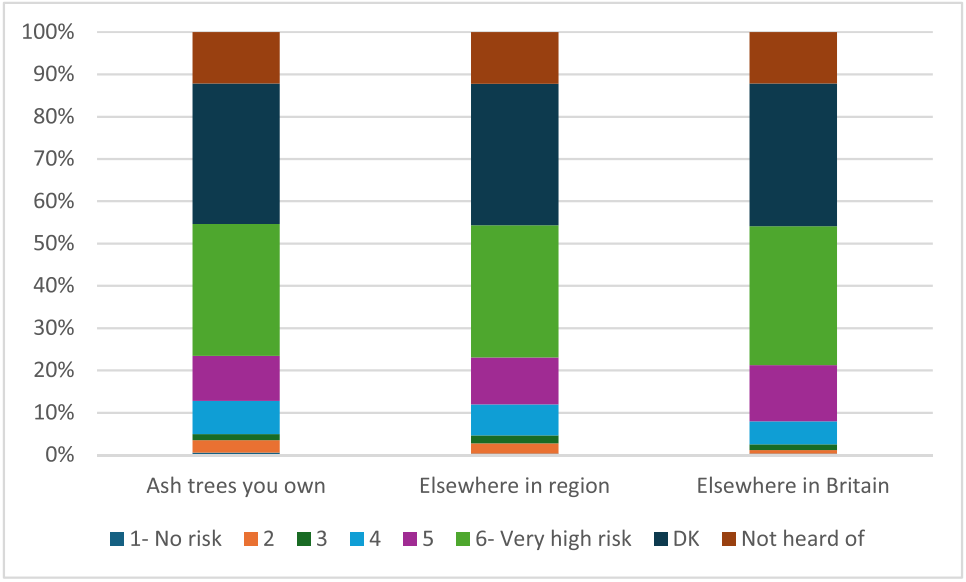

Fig. 5. If it is found in Great Britain, how much risk do you think emerald ash borer presents to the survival of ash trees? (1: No risk; 2: 3; 4: 5; 6: V. high risk).

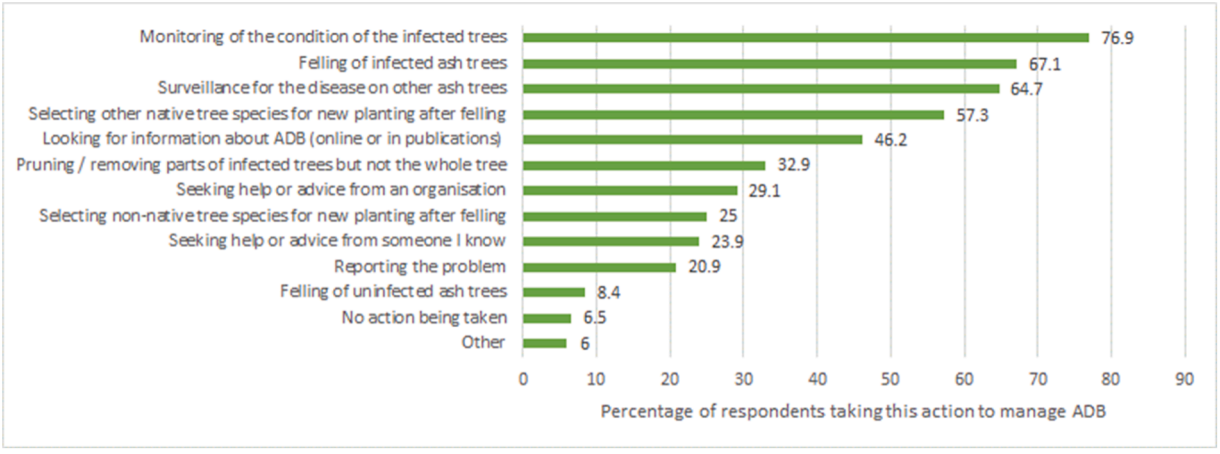

Fig. 6. Actions taken for ADB management.

making, and from the results of this study, personal values connected to trees and perceptions of the risks to those trees (from P&D, or indeed the control options for P&Ds) play an important role in influencing decisions about tree health surveillance and management. This links to previous evidence from Canada where landowners expressed strong emotional attachment to their trees and thus objected to statutory felling for EAB control (Mackenzie and Larson, 2010). Findings in this study suggest that land-managers have concerns about the impacts of the EAB management options and interventions on the environment and biodiversity, and this could influence likely decisions about managing EAB. Such personal values are difficult to influence. Policy and decision-makers seeking to influence management decisions must be appreciative of these important variables and develop greater understanding of how to utilise them rather than seek to change them. Behavioural science is central to this as it can provide ways to encourage desired actions that go beyond information provision, incentives and regulation by elucidating deeper understanding of individual values, attitudes and motivations. In turn this should enable more effective and targeted support for desired behaviours by land-managers (see for example, Balmford et al., 2021, for a discussion of the role of behavioural science in environmental and conservation interventions).

Previous experience with other tree health problems, in this case ADB, is a strong indicator of likely willingness to apply surveillance or management actions for EAB (also found by Dunens et al., 2012). Having seen the impacts of ADB on ash trees land-managers are more likely to realise the importance of seeking to address another threat to the species. Land-managers who have already had to act and fell ash trees because of ADB are more willing to do the same, if it becomes necessary, for EAB control. As more land-managers see ADB impacts they may become more willing to consider the actions needed for management of EAB, at a future date. However, previous experience with ADB could work on influencing decisions about EAB in either direction. That is, it could make land-managers more likely to take action because they understand the importance of doing so and want to protect remaining ash trees, or it could mean land-managers are less likely to take action because they hold a fatalistic attitude to remaining ash trees having experienced the losses caused by ADB (Karlsdottir et al., unpublished results).

Understanding the management objectives of land-managers is crucial as this can affect their likely willingness to adopt the required actions (as discussed by Pliura et al., 2017). Some specific management objectives (personal pleasure, carbon capture, hunting) were found to be significant influencers on expressed willingness to undertake surveillance / management for EAB. Working with different types of land

Table 3
Which of these influenced your management decisions and how significant were those influences? (1: No influence, 2, 3, 4, 5: Major influence).

Influence	1 %	2 %	3 %	4 %	5 %
Health and safety concerns	5	2	5	15	53
Advice from a trusted source	4	4	9	19	42
My own understanding of the problem	3	3	14	26	34
Management objectives (Organisational)	9	5	12	17	31
Concern about wider environmental impacts of the disease	4	8	14	26	29
Regulations / statutory requirement for action	12	9	12	16	28
Information I saw or received	6	5	19	23	25
My perception of the feasibility of management options	8	5	19	22	23
My perception of the effectiveness of management options	7	5	18	24	23
Management objectives (Personal)	9	7	16	20	21
Previous experience with another tree pest or disease	15	10	16	15	20
Financial considerations (e.g. costs of action)	14	12	14	20	19
Availability of time	15	10	18	20	15
Availability of skills	17	12	18	17	15
Availability of equipment	19	13	18	16	12
Public opinion about management of trees	26	20	19	10	5
Conditions connected to a grant	38	8	9	4	4
Something else	26	3	4	1	1

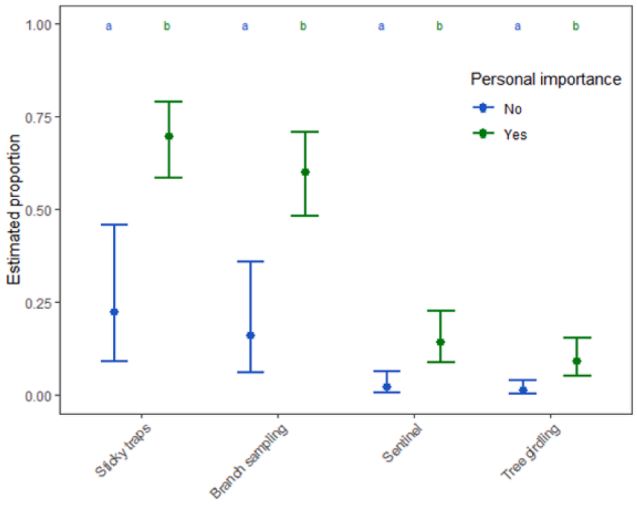

Fig. 8a. Estimated proportion of participants likely to carry out a surveillance option for EAB according to how they personally value ash trees. Error bars are 95 % C.I. and letters denote significance groupings.

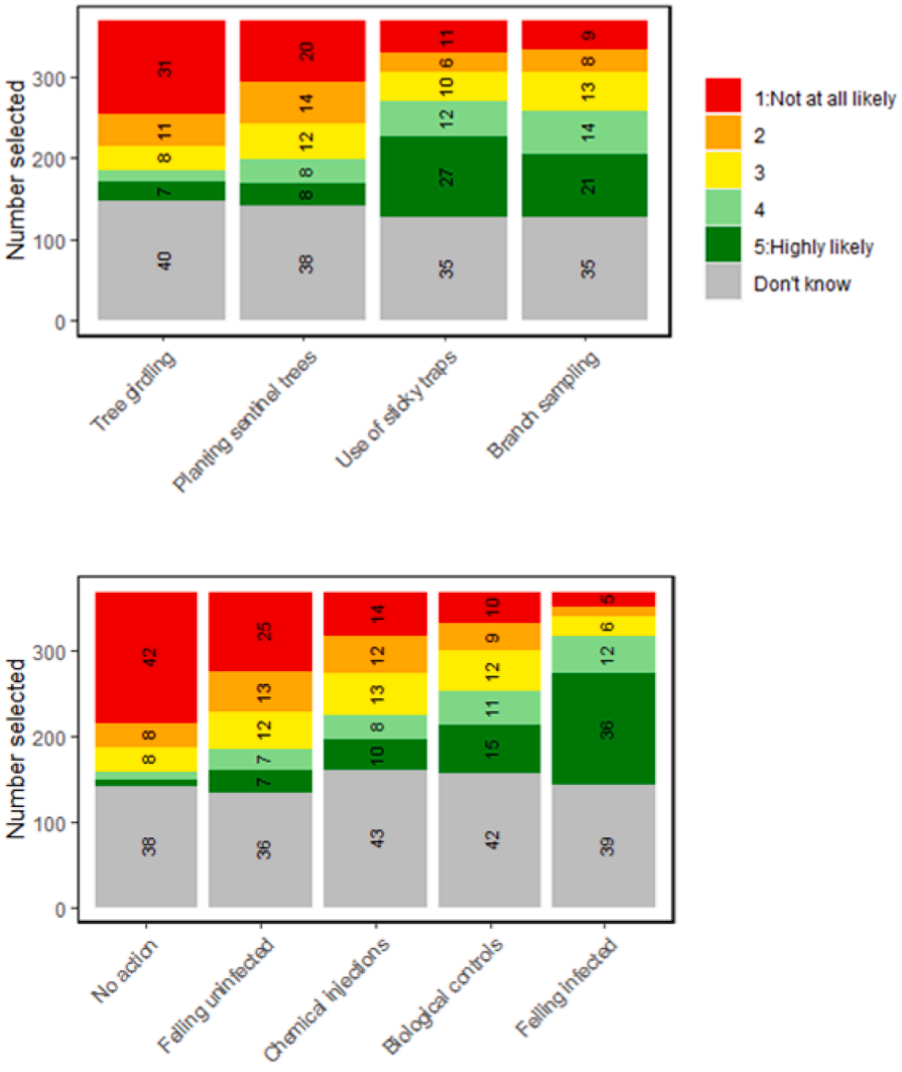

Fig. 7. How likely are land-mangers to apply options for the surveillance / management of EAB?.

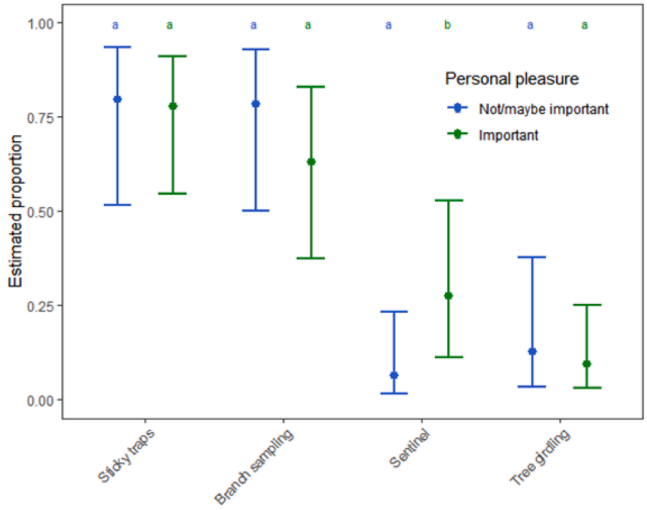

Fig. 8b. Estimated proportion of participants likely to carry out a surveillance option for EAB according to perceived importance of personal pleasure as a management aim.
Error bars are 95 % C.I. and letters denote significance groupings.

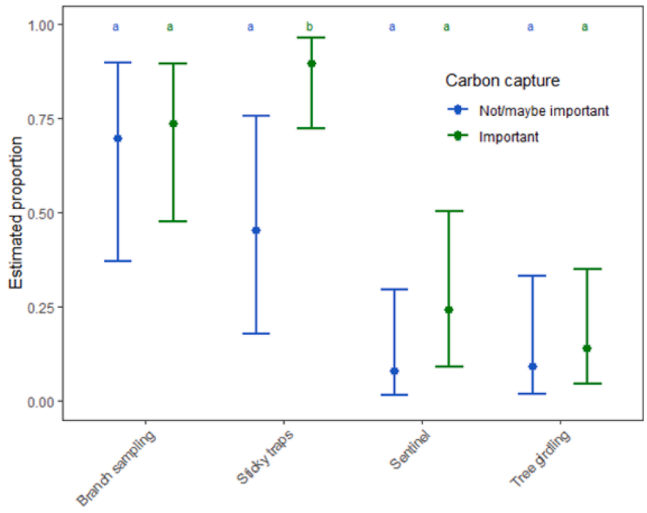

Fig. 8c. Estimated proportion of participants likely to carry out a surveillance option for EAB according to perceived importance of carbon capture as a management aim.
Error bars are 95 % C.I. and letters denote significance groupings.

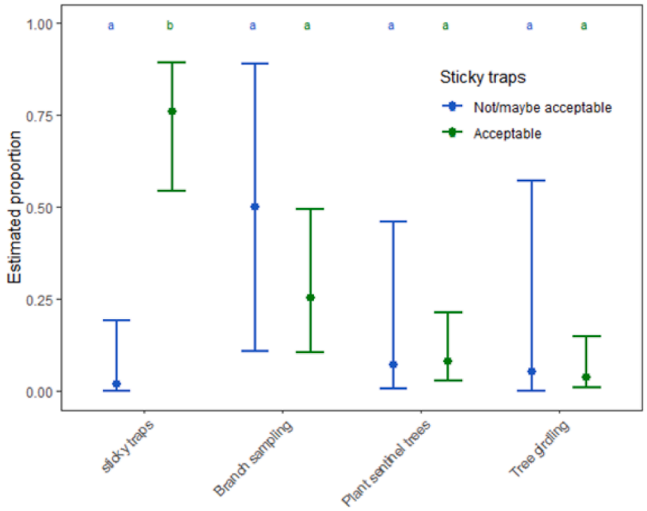

Fig. 8d. Estimated proportion of participants likely to carry out a surveillance option for EAB according to perceived acceptability of sticky traps.
Error bars are 95 % C.I. and letters denote significance groupings.

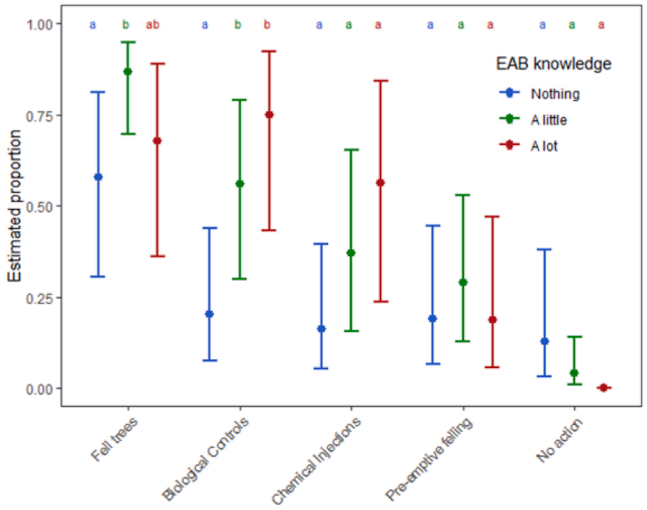

Fig. 9a. Estimated proportion of participants likely to carry out a management option for EAB according to whether they have knowledge of EAB.
Error bars are 95 % C.I. and letters denote significance groupings.

management organisations, depending on their management objectives, will help to identify which approaches are likely to be most acceptable to different sectors.

Knowledge of the tree health problem has an important influence on uptake of management methods as found in this study (see also Bengtsson and Senstrom, 2017). This demonstrates a role for improving early outreach and engagement in relation to EAB, its identification, probable impacts and the risks it poses to remaining ash trees in GB. While increasing knowledge is no guarantee of uptake of actions (see for example, Reincke et al. (2020) for a discussion of the criticisms relating to the knowledge deficit model) it should improve the likelihood that more land-managers have a greater understanding of the consequences of not implementing surveillance and management.

One influencing variable considered in this study was land ownership, which was found to be important for influencing decisions relating to EAB. This finding, that those with ash trees on their own land are less likely to be willing to take action that might be seen as damaging or destroying the trees is important. It signifies the importance of working with landowners to understand their concerns about potentially invasive and destructive management approaches and to highlight the implications of inaction. This stresses the importance of land-manager attitudes to the surveillance or management approach itself and perceptions of likely harm arising from the action, not only the actual pest. In turn, this has a connection to awareness and understanding of implications of action versus inaction.

One strength of this study, and an important addition to existing literature, is the recognition that land-managers do not make decisions about one pest or disease problem in isolation, but operate in an environment where their trees will likely face multiple threats. In this respect the GB land-managers that responded to the questionnaire are not unique. The results found in this study will therefore be of value in other contexts, locations and scenarios, where land-managers have to decide how to act when faced with a new potential threat, on top of existing threats, and where variables such as their management aims, personal values, land ownership status, previous experiences and levels of knowledge will all influence their behavioural choices.

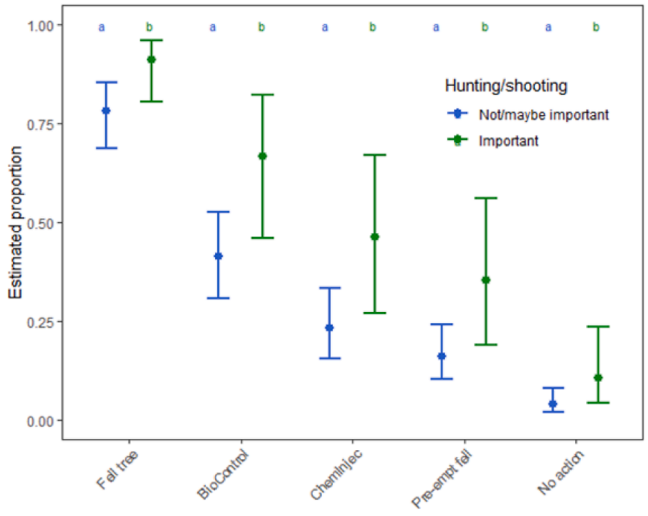

Fig. 9b. Estimated proportion of participants likely to carry out an EAB management option according to perceived importance of hunting/shooting as a management aim.
Error bars are 95 % C.I. and letters denote significance groupings.

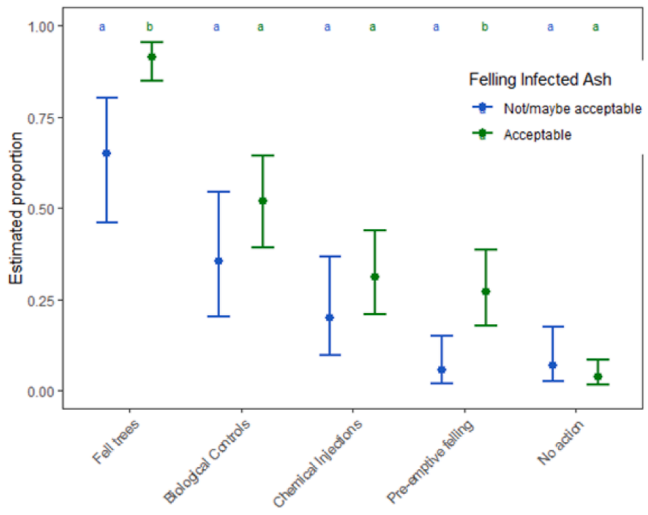

Fig. 9c. Estimated proportion of participants likely to carry out an EAB management option according to perceived acceptability of felling infected ash trees to manage ADB.
Error bars are 95 % C.I. and letters denote significance groupings.

What this study has not investigated is the interaction between different potential influences. For example, would organisational management objectives over-ride personal values? Both of these variables were found to be significant in this study. Further investigation is needed.

Finally, on reflecting on these results it is necessary to bear in mind that while ADB is a known and present threat in GB, so far, questions about managing EAB are based on hypothetical scenarios. In addition, the surveillance and management approaches that land-managers were asked about in this study feature actions which in many cases are new and unknown. This likely presented challenges for respondents given their current lack of experience with EAB and about which there is currently low awareness and knowledge.

5. Recommendations

Further investigation through behavioural science will be valuable to more fully understand how personal values of land managers and forest managers will influence their uptake of actions for surveillance and management of Emerald Ash Borer.

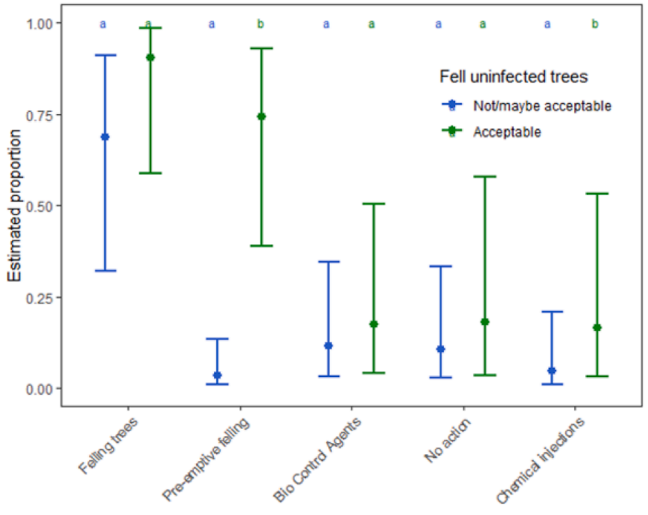

Fig. 9d. Estimated proportion of participants likely to carry out a management option for EAB according to perceived acceptability of felling uninfected trees. Error bars are 95 % C.I. and letters denote significance groupings.

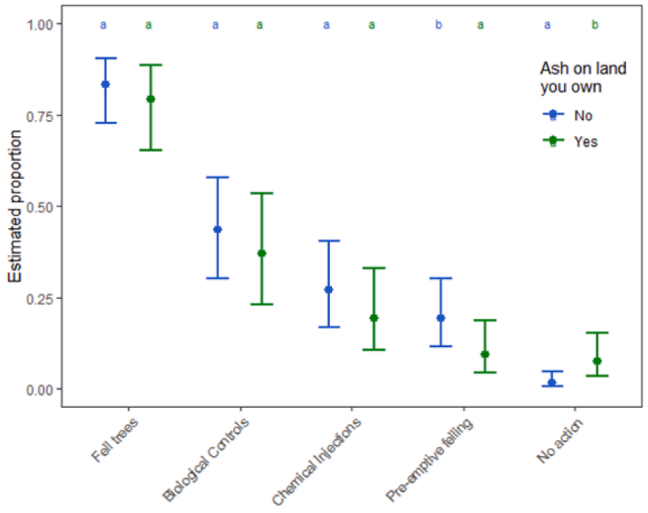

Fig. 9e. Estimated proportion of participants likely to carry out a management option for EAB according to whether they have ash trees on land they own.
Error bars are 95 % C.I. and letters denote significance groupings.

Working with different types of land management organisations, depending on their management objectives, will help to identify which surveillance and management approaches are likely to be most acceptable to different woodland and forestry sectors.

There is a place for improving early outreach and engagement in relation to EAB, its identification, probable impacts, and the risks it poses to remaining ash trees in Great Britain. While increasing knowledge is no guarantee of uptake of actions it should improve the likelihood that more land-managers have a greater understanding of the consequences of not implementing surveillance and management.

It is important for policy makers to work with landowners to understand their concerns about potentially destructive management approaches.

Further investigation is needed into the interaction between different potential influences on behaviours. For example, would organisational management objectives over-ride personal values? Both of these

variables were found to be significant in this study.

CRediT authorship contribution statement

C. Hall: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **M. Marzano:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **B. Karlsdóttir:** Writing – review & editing, Methodology, Conceptualization. **T. Clarke:** Formal analysis. **A.J. Dyke:** Writing – review & editing, Methodology, Data curation, Conceptualization. **J. Morris:** Writing – review & editing, Methodology, Conceptualization. **N. Brown:** Writing – review & editing, Methodology, Conceptualization. **V. Alonso-Chávez:** Writing – review & editing, Methodology, Conceptualization. **A.E. Milne:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Conceptualization. **L. O'Brien:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Clare Hall reports financial support was provided by UK Research and Innovation Natural Environment Research Council. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The work was supported by the Natural Environment Research Council (Grant NE/T007729/1).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tfp.2025.100915.

Data availability

The data that has been used is confidential.

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