

'Values, management, and pest and disease threats associated with Ash: A review'

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Table of Contents

| | |
|--|----|
| Table of Contents | 3 |
| Table of Figures | 4 |
| 1 Executive summary..... | 5 |
| Introduction..... | 5 |
| Key review questions and search strategy | 5 |
| The studies..... | 6 |
| Ash trees: Social, cultural and historical value | 7 |
| Social dimensions of ADB and EAB..... | 7 |
| Management actions for ADB and EAB | 8 |
| 1.1.1 Influences on decision making | 8 |
| 1.1.2 Acceptability of management approaches..... | 9 |
| 1.1.3 What might successful management look like?..... | 10 |
| Conclusions | 10 |
| 2 Introduction | 12 |
| Background | 12 |
| Approach / search strategy..... | 12 |
| 3 The studies | 15 |
| 4 Ash trees: History, folklore, uses, art and social values | 17 |
| History of ash in the landscape | 17 |
| Folklore..... | 18 |
| Uses and timber properties..... | 19 |
| Literature and art..... | 20 |
| Social and cultural values of trees, woods and forests | 24 |
| 4.1.1 Ash trees | 25 |
| 4.1.2 Other tree species..... | 27 |
| 5 Social dimensions of the twin threats to ash trees..... | 29 |
| Social dimensions of ADB | 30 |
| ADB management: What have managers done? What might managers do? What management is acceptable?..... | 32 |
| 5.1.1 Land managers may not follow official advice | 32 |
| 5.1.2 Previous experience of tree pests and diseases | 33 |

| | | |
|-------|--|----|
| 5.1.3 | Attitudes to new technologies for ash trees with improved tolerance..... | 33 |
| 5.1.4 | How important is context and location?..... | 34 |
| 5.1.5 | Advantages and barriers of an Action Plan for ADB management..... | 34 |
| 5.1.6 | Advantages of placing ADB on corporate risk registers | 35 |
| 5.1.7 | Networks | 35 |
| | Social dimensions of EAB..... | 36 |
| | EAB management: What do managers in the USA do? What might GB managers do? What is acceptable? | 40 |
| 6 | Conclusions..... | 46 |
| | Social and cultural values | 46 |
| | Stakeholder risk perceptions..... | 46 |
| | Social acceptability of management actions | 47 |
| | Evidence gaps..... | 47 |
| 7 | References..... | 49 |

Table of Figures & Tables

| | | |
|--|---|----|
| | Figure 1: Facts and figures about ash trees in Great Britain. From: Defra, 2019. Conserving our ash trees and mitigating the impacts of pests and diseases of ash: A vision and high-level strategy for ash research..... | 18 |
| | Table 1: The commonly mentioned trees in the works of famous writers (Source: Rackham, 2014, 'The Ash Tree' p.81) | 20 |
| | Figure 2: An ash tree by John Constable (© Victoria and Albert Museum, London)..... | 21 |
| | Figure 3: David Nash, Ash Dome (1977-ongoing) (Photo courtesy of the artist)..... | 21 |
| | Figure 4: Achievements of the Ash Project (Source: https://www.theashproject.org.uk/)..... | 24 |
| | Table 2: Reasons why trees add to the appeal of city streets in Toledo, Ohio (Source: Heimlich et al, 2008) | 25 |
| | Table 3: Categories of questions asked about ash dieback in emails from the public to the Forestry Commission (Source: Fellenor et al, 2018b)..... | 31 |
| | Table 4: Coding for content analysis of newspaper articles addressing EAB (Source: Clarke et al, 2020) | 39 |
| | Table 5. Strategies employed by municipalities to manage emerald ash borer and their rationales in cities found in a web search covering a 12-month period ending 04 March 2014. (Source: Sadof et al, 2017) | 41 |

1 Executive summary

Introduction

Tree species in the UK are threatened by an increasing number of pests and diseases resulting in large economic, environmental and social costs. Ash dieback (ADB) has already had a significant economic, environmental and social impact while emerald ash borer (EAB) poses a threat to the future of remaining ash. The Smarties project is a three year NERC-funded project that is applying an interdisciplinary approach to understand the key epidemiological and human behavioural factors that govern the invasion and spread of the twin threats of ADB and EAB to ash tree health in Great Britain. This report is a review of social literature about ash trees and their management, and will be used to inform the design of social research as well as the models to be constructed in the project.

Key review questions and search strategy

The key questions that have informed the review are:

- What are the historical, social and cultural values of ash trees? (and trees generally)
- What are the social dimensions of ADB and EAB?
- What are the management activities applicable to ADB and EAB and how acceptable are they to stakeholders? (i.e. how likely is it that they will engage with relevant activities?).
- What affects acceptability of management options for ash trees?
- What are the differences between stakeholders in terms of acceptability of management options?

The team applied a four-pronged search strategy:

- Meta-review
- Snowball searching
- Expert consultation
- Targeted database searches

The studies

The literature gathering process resulted in 126 publications. There was a total of 55 publications focused on ash - 49 solely focused on ash trees and the remaining six in combination with other tree species. Twenty nine of the publications reported studies from North America, 16 from the UK, five from other European countries, and four covered various locations or were not geographically specific. The following bullet points provide more information about the details of the publications gathered. (Note that some of these addressed more than one of the focus topics).

- Nine focused on social values
- 37 focused on management actions
- 10 focused on acceptability of management actions
- Two focused on stakeholders

- 19 focused on ADB
- 33 focused on EAB
- Two did not focus on either

Ash trees: Social, cultural and historical value

The importance of ash trees across cultures and continents, including historical value, is revealed through representation in art, folklore, mythology, and place names. Ash trees are also shown to have wider social and environmental value to landscape character, biodiversity, timber uses and cultural practices. All of these categories of value could be investigated further through the empirical social research to follow in this project.

In some traditional communities, species of ash tree are considered to be cultural keystone species, such is their centrality to social identity and community histories. The academic literature reviewed here adds more detail to existing evidence about social and cultural values. In line with previous studies it has been shown that trees, and in some cases ash trees specifically, add important and multi-faceted dimensions to peoples' lives. This ranges from improving the attractiveness of their street to providing an association with the natural change of the seasons.

Overall, although some of the literature reviewed around values is not focused specifically on the values associated with ash trees, the studies presented an extremely complex and detailed picture of how trees matter to people, and what aspects of value might be lost if ash trees are lost to ADB and/or EAB or otherwise impacted by management of ash trees for tree health. The studies also highlight the importance of context, including species, age and location type to the values experienced by people.

Social dimensions of ADB and EAB

Social dimensions considered in the literature on ADB and EAB are diverse but encompass the following, all of which may be relevant to the social research to be completed for Smarties and the subsequent behavioural model:

When seeking to influence management actions for threats to ash trees, it is important to understand peoples' risk perceptions of ADB and EAB and recognise that they vary between stakeholder groups.

Media representations of tree pests and diseases such as ADB and EAB can be important in influencing views of the threats.

Public concerns about threats to ash trees and the management of those threats are diverse, and need to be understood and considered when making decisions about management.

Measuring well-being losses due to ash tree management is a challenge.

Loss of ash trees in urban settings could impact residential property values.

Loss of ash trees in urban settings could impact physical human health and increase crime levels (due to a reduction in environmental quality).

Trees stand in a wider landscape, and while ash tree loss may impact the aesthetics of treescapes, people may consider other aspects such as visitor numbers and backdrops to their vista, particularly in urban settings such as city parks.

It is important to include key communities of interest in decision making.

Management actions for ADB and EAB

The following points are drawn from across the literature on managing either ADB or EAB. In most cases, the points that are drawn out of the studies are applicable to either pest or disease.

1.1.1 Influences on decision making

Some land managers have acted against advice for ADB management, perhaps through lack of information about best practice.

Some forest owners may make decisions about felling of damaged ash stands due to ADB, based on their own objectives such as economic yield. This might mean they ignore advice.

Previous experiences with other pests and diseases are likely to influence forest and woodland managers, when making decisions about tree health management.

The aesthetic and emotional impacts of losing ash trees to a pest or disease, can be an important determinant of behaviours and management decisions.

Public responses are likely to impact actions of land managers, particularly where lands are accessible and / or visible.

Where publics are required to take actions themselves there are likely to be multiple motivations affecting compliance. These need to be understood.

Health and safety issues are likely to be important where diseased and weakened trees pose a hazard, particularly along transport routes and in public spaces.

1.1.2 Acceptability of management approaches

Top down rapid response actions for EAB in Ontario were met with severe criticism from land owners when their concerns and views were not considered.

There may be limited support for non-native ash or use of GM-bred trees that are tolerant to ADB. Support remains higher for traditional tree breeding techniques.

The public generally demonstrate a strong 'anti-GM' position when asked about using such techniques for tree breeding. However, there is also a pragmatic attitude that science and technology should be used if they can help protect trees from disease.

1.1.3 What might successful management look like?

The production of an action plan could be a valuable tool for land managers, including Local Authorities, needing to manage ADB. There are a range of perceived barriers and advantages to creating such a plan.

Stakeholder engagement and collaboration is likely to be crucial to successful and acceptable management of ash trees for tree health.

Pre-existing knowledge sharing networks can be crucial for swift and effective action. Networks can be important for addressing management of ash trees impacted by ADB at a landscape scale.

Numerous studies from the USA on managing EAB have revealed diverse approaches, demonstrating there is unlikely to be a one-size-fits-all approach.

Conclusions

There remain evidence gaps relating to the social dimensions of ADB and EAB in Great Britain that can be explored further through the SMARTIES project, particularly in relation to types of stakeholder, their motivations to act, and likely acceptability of management options for EAB. Thus, the following questions are provided:

How will the values that people attach to ash trees (on their land, in the local area or further afield) influence management decisions?

How do differences between land managers and between sites manifest on the ground, in terms of pest management decisions? What is important: Location, type of owner, size of holding, type of manager, level of public access, proximity to populations, land use, management objectives of the manager/owner?

Will regulation and statutory requirement to act be necessary to bring about management of ash trees for protection from EAB, or will land managers act voluntarily?

How will experience with ADB affect likelihood of action for EAB – more or less? Will this depend on whether action for ADB was successful? Will this depend on how serious the impact of ADB was?

What is the role of previous experiences with other tree pests or diseases in influencing future actions?

How do key social dimensions of pest management interact with each other? For example, how important are public concerns about land manager actions in influencing land managers? How important are the actions of 'others'?

2 Introduction

Background

Tree species in the UK are threatened by an increasing number of pests and diseases resulting in large economic, environmental and social costs. Preventing the introduction of such threats is often difficult, therefore early detection and successful management are key areas where science can deliver. The Smarties project is a three year NERC-funded project that is applying an interdisciplinary approach to understand the key epidemiological and human behavioural factors that govern the invasion and spread of multiple threats to tree health.

Ash trees in the UK are currently impacted by ash dieback (ADB) (*Hymenoscyphus fraxineus*), a disease estimated to have caused a loss of £15 billion to the UK economy (Hill et al, 2019). Ash trees in the UK also face a potential additional threat from the invasion of the Emerald Ash Borer (EAB) (*Agrilus planipennis*). The Smarties project team will integrate an epidemiological model of the distribution and spread of ADB and the potential dispersal of EAB in a spatially explicit landscape with a model of stakeholder behaviour. The behaviour model will be built on social science research that captures the attitudes and behaviours that affect decisions related to surveillance and management. To inform the social science research with stakeholders, this report presents the findings of an evidence review into stakeholder values and attitudes towards possible management actions in relation to ADB and EAB.

Approach / search strategy

To inform the design of the social data collection (interview and survey questions) the evidence review encompasses a range of topics. The text from the proposal stated: "We will carry out a rapid evidence assessment of key issues related to

values, actions and social acceptability of tree pest and disease management approaches". Thus, the key questions that have informed the review are:

- What are the historical, social and cultural values of ash trees? (and trees generally) (Section 4)
- What are the social dimensions of ADB and EAB? (Section 5)
- What are the management activities applicable to ADB and EAB and how acceptable are they to stakeholders? (i.e. how likely is it that they will engage with relevant activities?) (Section 5)
- What affects acceptability of management options for healthy ash trees? (Section 5)
- What are the differences between stakeholders in terms of acceptability of management options? (Section 5)

The team applied a four-pronged search strategy:

- Meta-review
- Snowball searching
- Expert consultation
- Targeted database searches

The social science project team members have considerable previous experience of reviewing the literature on values connected to trees, woods and forests, and the actions that stakeholders can apply to manage tree pests and diseases. Thus, the evidence review for Smarties involved carrying out a meta-review of the literature

and references previously gathered for earlier and on-going work by members of the project team. These projects included:

- Euphreso project 'PREPSYS' investigating EAB and Bronze Birch Borer (BBB);
- 'Action Oak Evidence Review' - chapter on stakeholder knowledge, attitudes and actions;
- Defra funded 'Future Proofing Plant Health' project on social and cultural values at risk from tree pests and diseases (on-going);
- Defra funded 'Resilient Treescapes' evidence review;
- Scottish Plant Health Centre projects (on-going);
- Defra funded 'Future Proofing Plant Health' Ash dieback toolkit project.

Focusing on key publications the review team (Hall and Robinson) carried out a process of additional 'snowball searching' using the reference lists from those publications.

Alongside the meta-review, the review team also consulted with experts in the field to uncover additional relevant literature. Numerous recommended key texts and books have also been drawn upon.

Finally, the team carried out targeted online database searches. Specifically, Scopus was searched on 15th Dec 2020 using combinations of relevant key words and terms, including "ash trees", "ash forest", "ash woodland", "cultural values", "social values", "cultural ecosystem services", "society", "community", "importance", and "attitudes". Another five relevant studies were identified via this route.

3 The studies

The literature gathering process resulted in 126 publications. There was a total of 55 publications focused on ash - 49 solely focused on ash trees and the remaining six in combination with other tree species. Twenty nine of the publications reported studies from North America, 16 from the UK, five from other European countries, and four covered various locations or were not geographically specific. The following bullet points provide more information about the details of the publications gathered. (Note that some of these addressed more than one of the focus topics).

- Nine focused on social values
- 37 focused on management actions
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- Two focused on stakeholders

- 19 focused on ADB
- 33 focused on EAB
- Two did not focus on either

This review report is based only on those publications that referred to ash trees, and pests and diseases impacting ash. The exception to this is that some literature on social and cultural values relating to trees more broadly has been reviewed. The reason for this is that it is widely acknowledged that many people are not familiar with different species of tree but nevertheless have a strong sense of the importance of trees. Thus the values associated with trees and woodland, even

when ash trees are not mentioned specifically, can be assumed to reflect values relevant to ash trees.

4 Ash trees: History, folklore, uses, art and social values

As 12% of broadleaf woodland in Great Britain is ash (Defra, 2019) it is important to understand the contribution of ash trees to historical, cultural and social value. Losing ash trees to pests or diseases would result in damage to social values. The desire to maintain this value could be one influence on management decisions. Thus, this section considers in-depth what the social, cultural and historical values are that are associated with ash trees.

History of ash in the landscape

Place names from Anglo-Saxon charters pre-dating the Domesday Book represent the earliest written records of ash trees in Britain (Rackham, 2014). Ash and thorn (hawthorn and blackthorn) were the commonest trees to occur in place-names in these charters, with ash represented in names such as Ashmore and Aston (Rackham, 2014). The earliest record of an identifiable ash tree is thought to be from 680 AD, located in Sussex (Rackham, 2014).

Pollarded ash trees are iconic elements of many European landscapes, including in Britain (Moe & Botnen, 1997; Jüriado et al., 2009; Palatto et al., 2011). Ash was widely planted in hedgerows in Britain, particularly when fields were enclosed in the 18th and 19th centuries. Ash trees thrive in rich agricultural soils, and as it casts light shade it is less in competition with crops for available sunlight (Bell et al, 2008). Defra (2019) presents a range of facts and figures relating to ash in Great Britain, in their strategy for ash research, as shown in figure 1. For example, there are estimated to be 60 million ash trees in the UK that are outside of woodlands, pointing to the significance of ash trees in the wider landscape. Also, there are known to be 955 species (for example, invertebrates) associated with ash trees, showing their wider importance to biodiversity.

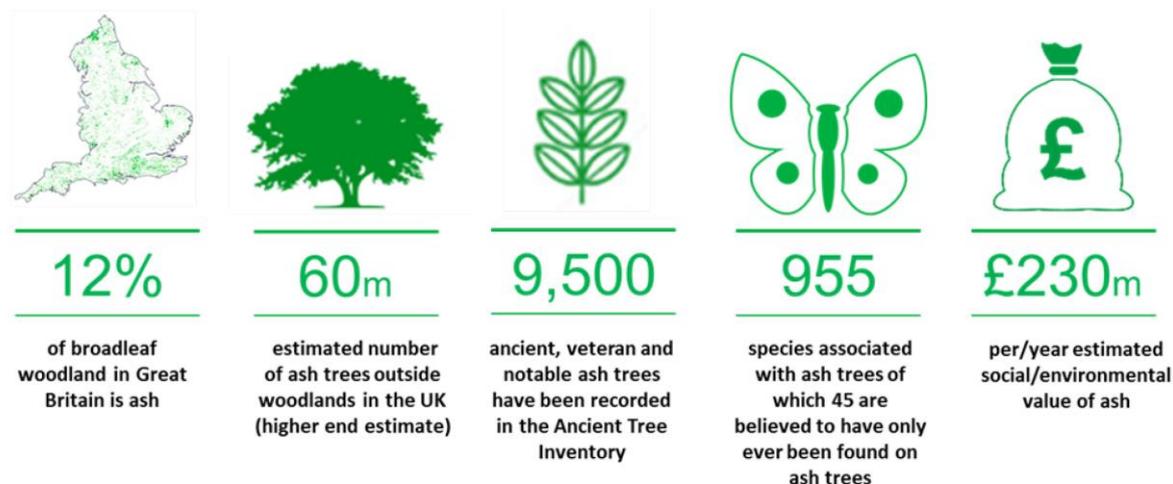


Figure 1: Facts and figures about ash trees in Great Britain. From: Defra, 2019. Conserving our ash trees and mitigating the impacts of pests and diseases of ash: A vision and high-level strategy for ash research.

Folklore

Ash has been associated with folklore through the centuries. For example, still heard today, is this rhyming couplet about the spring weather in Britain.

Oak before ash, we're in for a splash; ash before oak, we're in for a soak (Bell et al, 2008).

Ash was also thought to have a role in love divination. Seeds failing to appear on an ash tree were thought to indicate that the owner would be unlucky in love or that a future venture would fail (Bell et al, 2008). Women who put an ash leaf inside their shoe would soon after meet their spouse (Bell et al, 2008). Girls also put ash under their pillows to identify their future husbands (Rackham, 2014).

Ash has been credited with various protective and healing properties in British folklore, often associated with child health (Bell et al, 2008). For example, newborn babies were given a teaspoon of ash sap, and infants with weak limbs were sometimes passed through a cleft in an ash tree (known as 'rupture ashes') to cure them (Bell et al, 2008; Rackham 2014). The cleft was often made for the ceremony and then bound afterwards to heal as the patient healed (Bell et al, 2008;

Rackham, 2014). It was often advised that the tree be protected throughout the patient's life as their fates were thought to be interconnected (Bell et al, 2008; Rackham, 2014).

It is claimed that Yggdrasil, the World Tree of the Norsemen, centre of the cosmos and very holy, that held the universe together with its mighty roots and branches, was an ash tree (Pautasso et al, 2013; Rackham, 2014).

Uses and timber properties

The English name 'ash' is derived from 'aesc' the Anglo-Saxon name for a spear (Bell et al, 2008). The idea that ash is the wood of warriors' and hunters' spears has a long tradition linked to, for example, Homer, Ovid, Beowulf, Sir Walter Scott and Yeats (Rackham, 2014). The earliest evidence for the use of ash begins with Neolithic trackways, made of wattle hurdles, planks and posts, excavated in the Somerset levels and dated to c.3800 BC.

Ash has traditionally been used in a variety of aspects of society, including agriculture, infrastructure, weaponry, furniture and sporting equipment. Some of these uses continue today. John Evelyn in his book "Sylva" (1664) states "*The use of Ash (next to that of Oak itself) one of the most universal...*". He lists use by "The Carpenter, Wheel-wright, Cart-wright, Cooper, Turner and Thatcher" and potential uses "*Palisad-hedges, Hop-yards, Poles and Spars, Handles, Stocks for Tools, Spade-trees, &c....Carts, Ladders...*" (Rackham, 2014, p88). In the Middle Ages, ash was considered the "*third-best timber*" after oak and elm (Rackham, 2014, pp.60-61). Arrows for the English/Welsh longbow were made of ash (Bell et al, 2008). Leaf-hay harvesting from ash trees provided fodder for livestock in wooded areas during drought (Haas, 2002). Ash is regarded as excellent firewood (Bell et al, 2008; Sylva, 2014), although Rackham claims that maple and elm are roughly equivalent (Rackham, 2014, p.100).

More recently, the timber properties of ash (elasticity, hardness, resistance to pressure, toughness and pliability) have made it valuable for the production of a wide range of products including furniture, flooring, veneer, tool handles, composite wood, sport equipment, oars and wood framing for large vehicles or caravans (Pautasso et al 2013; Rackham 2014; Pliura & Heuertz, 2003; Ballian et al., 2008; Bell et al., 2008). Ash is still used today for sporting equipment, especially hockey sticks for field hockey, hurling and shinty sticks (Pautasso et al, 2013; Rackham, 2014). However, the economic importance of common ash is difficult to assess, because hardwoods are usually combined in forest statistics (Pautasso et al, 2013, p.86).

Literature and art

Ash, while not being the most commonly referred to tree by poets, playwrights or novelists (Rackham, 2014, p.80) does nevertheless appear in the works of famous writers (table 1).

Table 1: The commonly mentioned trees in the works of famous writers (Source: Rackham, 2014, 'The Ash Tree' p.81)

| | Shakespeare | Wordsworth | Tennyson | Yeats |
|------------|-------------|------------|----------|-----------|
| Oak | 31 | 49 | 54 | 21 |
| Pine | 11 | 47 | 55 | 8 |
| Yew | 5 | 23 | 22 | 16 |
| Willow | 9 | 18 | 16 | 16 |
| Hazel | 3 | 22 | 21 | 4 |
| Beech | 0 | 10 | 14 | 22 |
| Elm | 3 | 22 | 21 | 4 |
| Ash | 1 | 13 | 9 | 16 |

Ash trees have also been the subject of artworks, for example, John Constable painted 'An Ash Tree' in 1835 (Rackham, 2014, p.104) (figure 2).



Figure 2: An ash tree by John Constable (© Victoria and Albert Museum, London)

In 1977 David Nash planted the 'Ash Dome' in north Wales, designed to be a living work of art that would mature through the 21st century. It is now dying from ADB (figure 3).



Figure 3: David Nash, Ash Dome (1977-ongoing) (Photo courtesy of the artist).

The Kent Downs Area of Outstanding Natural Beauty was one of the first areas in England to record the rapid spread of ADB. In Kent, through 2017-2018, the Ash Project was a cultural response to the impact of ADB on Kent woodlands. The project was funded by the Heritage Lottery Fund, Arts Council England, Kent County Council, Woodland Trust and North Downs Way. It was commissioned by the Kent Downs Area of Outstanding Natural Beauty. The achievements of the project were diverse and included tree planting, engagement with trees, improved knowledge of ash trees, and a lasting legacy in the form of a large sculpture. The website includes an online ash archive of artworks, writing and objects, providing a historical and contemporary record of the cultural value of ash. The achievements of this project are shown in the infographic (figure 4).

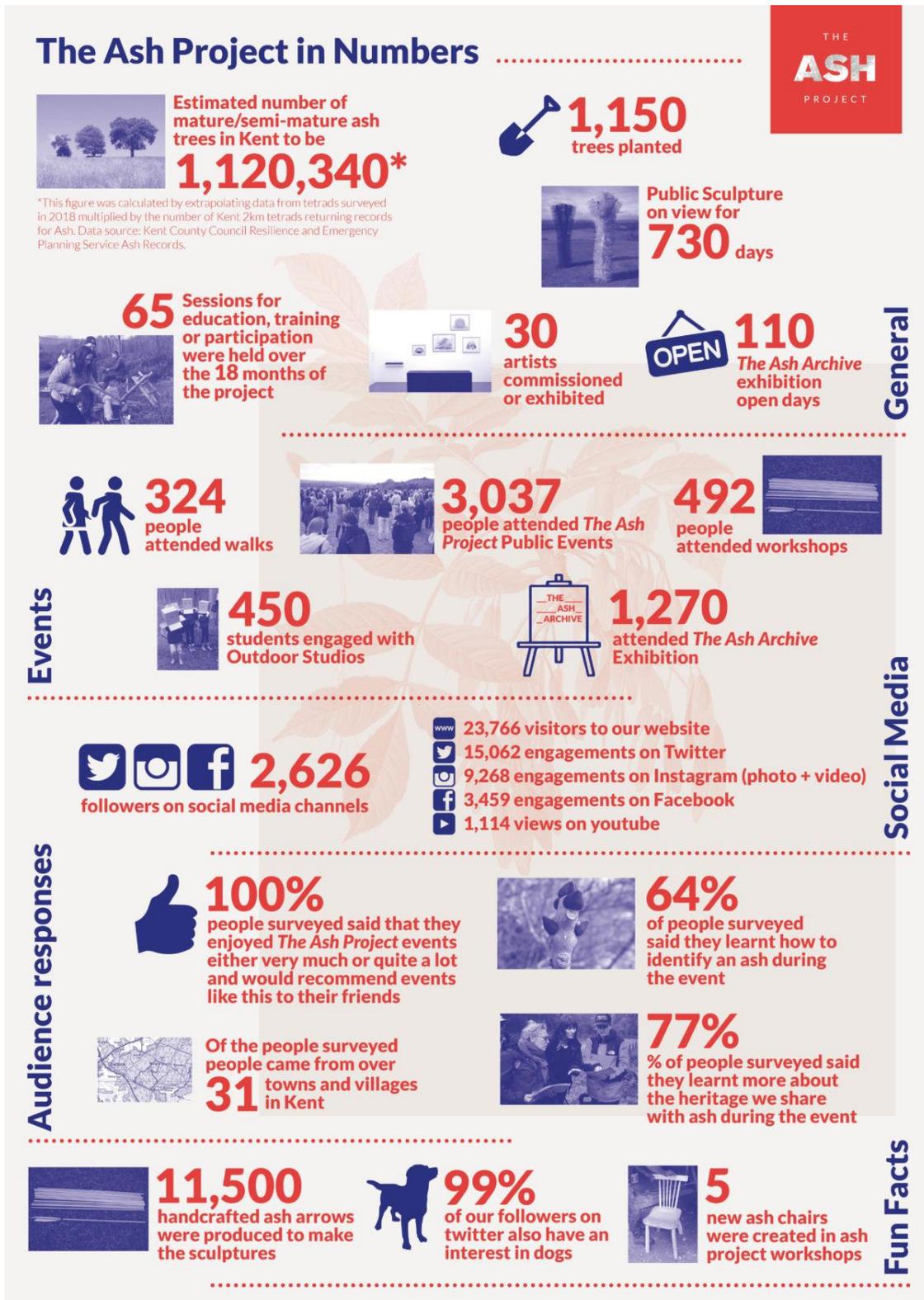


Figure 4: Achievements of the Ash Project (Source: <https://www.theashproject.org.uk/>)

Similarly, in light of ADB, the Cumbria Woodlands Ash Project (<https://sites.google.com/view/cumbriaash/home>) was a Heritage Lottery funded project which considered options for ash tree protection, and preservation of the ecological diversity and cultural heritage of ash trees. The project ran from 2016 to 2018. A range of media and materials were produced to communicate the learning and outcomes from the project. In autumn 2017 the 'Ash Conference' was held at the University of Cumbria, bringing together academics, practitioners and experts in ADB. The project legacy online is a series of videos about ash identification, pollarding, coppicing and use of ash in sculpture, among other topics.

These two contemporary ash projects from opposite ends of England were both prompted by ADB and the real possibility that ash trees may be lost completely from the landscape of Britain. They serve to demonstrate the social and cultural importance of ash trees.

Social and cultural values of trees, woods and forests

When trees are under threat, such as when ADB was first found in Britain and the media highlighted the risk to all ash trees, or when there was a proposal to sell off some of the public forest estate, or when there was a plan for large-scale felling of street trees in Sheffield, the strength and depth of values that people hold for trees is highlighted and strongly revealed. It is important to understand what these social and cultural values are, since they may be lost or negatively impacted by tree pests and diseases or the management required to deal with those pests and diseases. There are few studies in the academic literature that have considered the social and cultural values of ash trees. Those reviewed in the next sub-section represent the limited literature that has looked specifically at the social values associated with ash trees around the world. The sub-section following that considers social and cultural values associated with other tree species and trees in general, as these can provide valuable insight into the values that people hold for ash trees too.

4.1.1 Ash trees

There are limited studies that have investigated the social values of ash trees, specifically. The only literature found include two from the USA and one from Morocco.

Residents in Ohio, USA, were asked how trees added to the appeal of their street and scored those reasons in terms of their importance (Heimlich et al, 2008). The streets included ash trees. Reasons why the trees were considered to be important included aesthetic characteristics but also practical reasons such as shade from the heat and the wind, and the value added to property (table 2). These results suggest a range of social and cultural values connected to ash trees on residential streets, with the most important being “they make the street prettier”.

Table 2: Reasons why trees add to the appeal of city streets in Toledo, Ohio (Source: Heimlich et al, 2008)

| Reasons why trees add to the appeal of their street | Average score using a scale of importance 1 = does not relate / 7 = major reason |
|---|--|
| They make the street prettier | 6.26 |
| The shade cools the street and the homes | 6.22 |
| The way the trees stretch over the street is inviting | 6.16 |
| The large size of the trees | 5.67 |
| The colour in the fall | 5.67 |
| They increase my property's value | 5.39 |
| They reduce wind | 5.19 |
| They lower utility bills | 5.06 |
| The look of the trunk and branches in the winter | 4.78 |
| They are all the same size | 3.95 |
| They are all alike | 3.81 |
| Each tree is different | 3.70 |
| They help make a neighbourhood feel safe | 3.69 |

In the USA First Nation communities have placed great value on ash tree species as an economic, cultural and spiritual resource for generations (McCullough, 2019). Specifically, black ash trees (*Fraxinus nigra*) have cultural and religious significance, particularly for basket-making which is one of the oldest arts traditions in North America (Ranco et al, 2012). For example, woven brown ash baskets are a critical cultural and economic resource to Maine's Indian communities, including the Wabanaki people. Basket sales have been estimated to be worth \$150,000 annually. While the importance of ash for basket weaving is frequently emphasised its cultural importance goes beyond this, and in some tribes ash is at their spiritual centre and features in their creation stories (Costanza et al, 2017). The critical cultural significance of brown ash to Maine Indians means it is thought of as a cultural keystone species (Garibaldi & Turner, 2004).

In other cultures, for example Berber communities in the High Atlas in Morocco, ash trees form a central part of centuries old agro-pastoral systems (Genin et al, 2018). The trees represent a keystone species for their agro-pastoral systems and hence social organisation, and are central to traditional ecological knowledge amongst the communities.

4.1.2 Other tree species

Other project work undertaken by members of the Smarties project team has uncovered a wide range of evidence relating to the social and cultural values associated with trees, woods and forests (not ash specific) that is of relevance to the current project. It is widely acknowledged that many people are not familiar with different species of tree but nevertheless have a strong sense of the importance of trees. Thus the values associated with trees and woodland, even when ash trees are not mentioned specifically, can be assumed to reflect values relevant to ash trees.

A current Defra-funded FPPH project on social and cultural values at risk from tree pests and diseases has provided an up to date review of the literature on social and cultural values connected to trees, woods and forests across a wide range of contexts internationally, and representing the values of multiple stakeholder groups (Hall et al, 2020). A review of 188 studies and a key word count of the categories of social and cultural values mentioned in the abstracts of those studies revealed that the types of social and cultural value most often addressed by the studies were:

- Recreation
- Aesthetic
- Heritage
- Spiritual
- Landscape
- Health
- Place

In 2018, Smarties project team members (O'Brien et al, 2019) worked on chapter 8 of the Action Oak Knowledge review 'Land managers and publics: knowledge, attitudes and actions associated with threats to oak trees'. That work concluded that there is a large body of literature that provides evidence of the high value of trees, woods and forests to society. Significantly, the review found that the evidence often does not attribute values to individual tree species, but does provide broad statements about the wide range of values and wellbeing benefits that people associate with trees and woodlands in general (O'Brien & Morris, 2013). This is therefore relevant to the current project. Similar to the FPPH project referred to above, the wide body of evidence referenced for the Action Oak review shows how people value particular services provided by woodlands, for example physical and mental wellbeing benefits, social connections, a feeling of escape and freedom, connections to nature, learning and skills development opportunities, and places for fun and enjoyment (Morris & O'Brien, 2011; O'Brien et al, 2010; O'Brien & Murray, 2007; Quine et al, 2011). To some extent this chimes with the findings mentioned above from the 2020 review for the FPPH project, but also adds additional categories of value that could well be relevant to ash trees.

Old trees and woods can provide people with a sense of history and continuity as well as create a sense of place and natural grandeur, and can be symbolic as markers of time, with their longevity seen as a mark of strength and resilience (Jones & Cloke, 2002). Individual veteran trees can be seen as charismatic and provide visible connections for people to natural and seasonal cycles, highlighting how important trees outside of woodland are to people. While this text does not relate directly to ash trees (or indeed any other tree species in particular) it is highly relevant to this review and the overall project as such values will apply to ash trees for many people in many contexts and locations.

In on-street consultation in locations across England, de Bruin et al (2014) found that participants felt closely connected to trees. There was a wide range of ecosystem services associated with trees, including cultural services related to sensory experiences and health and well-being. Importantly, different services and values were experienced as related associations. For example, the aesthetic experience of the seasons through trees was connected to the passing of time, historical associations, health and wellbeing, and daily life through the continuous presence of a tree. Older trees evoked stronger values than younger trees, broadleaved more so than evergreen trees, and native over exotic tree species. Values were stronger with multiple trees, for example in woodlands, than with a single tree. Overall, this study, while not specifically in regard to ash, reveals how multifaceted and inter-related social values associated with trees can be, and highlights the importance of context, including species, age and location type.

Overall, although not focused specifically on the values associated with ash trees, these studies have presented an extremely complex and detailed picture of how trees matter to people, and what aspects of value might be lost if ash trees are lost to ADB and/or EAB.

5 Social dimensions of the twin threats to ash trees

It has been shown how trees are associated with diverse historical, cultural and social values. Linked to this, when considering a tree pest or disease, there are social dimensions to that tree health threat, above and beyond any environmental impacts on the tree itself and wider biodiversity. These social dimensions include the attitudes, risk perceptions, responses and actions taken in relation to the tree pest or disease in question.

Social dimensions of ADB

When ADB was identified in Great Britain in 2012 it generated significant media attention. In the years that followed numerous researchers investigated aspects of the social impacts of the disease. This section reviews a number of these to highlight some of the social dimensions of ADB.

Within behavioural science research it is recognised that one determinant of behaviours and decision making is perception of risk. It might be expected that if land managers perceive ADB to present a high degree of risk to their ash trees they will act to try to protect those trees or stop the disease. It is therefore important to have some understanding of risk perceptions relating to ADB.

Addressing risk perceptions of ADB, Urquhart and Potter (2017) examined how experts structure their idea of risk. They found it to be multi-faceted, not objectively based, but personally constructed and socially derived. Risk perceptions were found to be based upon multiple sources of information, some professional, others anecdotal. Experts also drew on public concerns and the government response to those concerns and referred to past events to structure their own understandings of the risks posed by ADB. Local authorities were found to assess risk and response to ADB through deliberative social learning, mixing opinion, scientific and practice-based knowledge in decision-making (Ambrose et al, 2019a). This is relevant to the Smarties project as local authorities are one of the types of land managers of interest to the study. Understanding how they assess risk will help to model likely responses to threats to their ash trees.

Meanwhile an investigation of public concerns about ADB found five primary perspectives (Urquhart et al, 2019). These were firstly a belief that the government did not take tree health risks seriously before ADB. The second perspective centred

around the belief that nature is resilient and will recover in time but may need help from science. A third perspective presented a fatalistic view that human actions could not have prevented ADB arriving in Britain because of the role of the wind and climate change. There was a fourth perspective identified by the study that represented people with little knowledge or interest in the issue. In contrast, the fifth and final perspective was people who wanted to be pro-active and play a role in helping to deal with the problem of ADB in their local area. It is likely that many land managers, particularly those managing trees with public access or trees in close proximity to communities, will be influenced by the likely reactions of the public and communities to their management of diseased or threatened ash trees. Therefore, understanding these public perspectives of the disease can help to avoid conflict and generate support for action against the threat. Studying tweets that had mentioned ADB, Fellenor et al (2018a) recorded four key themes that illustrated the social dimensions of peoples' concerns about the disease. These were the spread of ADB, the fight against it, the idea that it was too late to do anything about ADB, and blame for the problem. To understand more about the public response to ash dieback, Fellenor et al (2018b) carried out a qualitative analysis of 1282 emails from people reporting suspected cases of ADB to the Forestry Commission during autumn 2012. Email content included information about where potential ADB cases had been seen, and which parts of the tree was displaying symptoms. They found that 32.4% of the emails contained 543 questions. The categories addressed by these questions are in table 3.

Table 3: Categories of questions asked about ash dieback in emails from the public to the Forestry Commission (Source: Fellenor et al, 2018b)

| Category | Number of questions |
|---------------------------------------|---------------------|
| Querying whether they had found ADB | 217 |
| Questions about action and management | 77 |
| Questions about the nature of dieback | 51 |

| | |
|---|-----|
| Process related questions such as asking whether FC could visit the site or whether they should send in a tree-part sample. | 158 |
| Rhetorical questions | 40 |

67.6% emails provided information about potential ADB symptoms they had found, for example abnormal leaf colour or symptoms on other tree parts. Some emails were from people reporting ADB beyond their property, including locations such as roadsides, railway and canal embankments, parks, and footpaths. Overall, 26.4% of emails contained negative affective terms such as frustrated, disappointed, paranoid, hate, worried, devastating and concern.

The significance of the results from these studies is in demonstrating the likely diversity of positions and concerns held by the public or any group of stakeholders.

ADB management: What have managers done? What might managers do? What management is acceptable?

A key goal of the Smarties project is to model what actions land managers might take with regard to managing their ash trees. This section reviews the literature that has reported what actions land managers have taken with regard to ADB and what might have affected what those actions were.

5.1.1 Land managers may not follow official advice

Significantly, authors have reported that some land managers may act against advice, perhaps through lack of information about best practice. An example from Sweden is with regard to the need to leave some ash trees in situ if they appear to have a greater level of resistance to ADB. Authors reported that some land managers may have felled such ash trees due to a lack of information or because they believed that was the correct action to reduce the risk of spread (Bengtsson &

Senstrom, 2017). This is echoed by Pliura et al (2017) who claim that recommendations are not always followed, and some forest owners in Lithuania make their own decisions about felling of damaged ash stands, based for example, on economic yield, and therefore may fail to retain viable ash trees. This emphasises the importance of understanding forest managers' management objectives which may not always align with the need for actions connected to tree pests and diseases.

5.1.2 Previous experience of tree pests and diseases

Importantly, previous experiences with other pests and diseases are likely to influence forest and woodland managers, when making decisions about tree health management. This was found to be the case by Marzano et al (2019) in a study about ADB with forest advisors and managers. Those with past experiences adopted a cautious ('wait and see') attitude to dealing with ADB.

5.1.3 Attitudes to new technologies for ash trees with improved tolerance

Other management options for dealing with threatened ash trees could include new technologies for improving tolerance to pests and diseases, such as trees developed using GM breeding techniques, use of resistant varieties, and use of non-native ash. Forest practitioners may support the concept of resistant ash but have shown limited support for non-native ash or use of GM-bred trees (Marzano et al, 2019). Support remains higher for traditional tree breeding techniques although attitudes are dependent on management objectives. All such findings are relevant to the current project, in seeking to understand what may influence management decisions of land managers when faced with a threat to their ash trees.

Land managers are not the only stakeholder group who have views about the use of new breeding techniques for future trees to protect against threats from ADB. Using results from an online questionnaire with the general UK public, Jepson and Arakelyan (2017a) provided evidence on the public acceptability of tree-breeding

solutions to ADB. They found a strong 'anti-GM' position and an attitude among UK publics that was opposed to 'tampering' with nature. However, they also uncovered a pragmatic attitude that science and technology should be used if it could help protect trees from disease. In a separate phase of their research carried out at gardening and countryside events, they found that 'interested' publics such as gardeners and those with an active interest in nature, generally prefer traditional tree-breeding solutions. However, they found that some younger people may be more open to GM breeding techniques. Those shown to be more policy-empowered naturalists were more likely to be anti-GM (Jepson & Arakelyan, 2017b).

5.1.4 How important is context and location?

The same study (Jepson & Arakelyan, 2017b) found that people attending countryside events cared about the issue of ADB, and wanted to see an active response. They did not distinguish between ash trees in forestry or ecological settings, suggesting that context, while important for social values, may not influence preferences for management.

5.1.5 Advantages and barriers of an Action Plan for ADB management

Local authorities (LA) are important managers of trees in diverse contexts, and ash trees may well be found in many city parks, along transport corridors and waterways, and urban greenways. With this in mind research has sought to understand when and why local authority stakeholders might produce and use an Ash Dieback Action Plan (Stokes & Jones, 2016; Stokes & Jones, 2017). Three main reasons were found for creating an action plan. First, they wanted to avoid ADB becoming a problem that might interfere with the delivery of statutory or organisational duties. Having an action plan was seen as a means to reduce the health and safety risks of ADB. Finally, LA teams wanted an action plan that would help them understand the budgetary implications of ADB. There were, in addition, three barriers identified that might prevent an action plan being created. These were lack of awareness, lack of local understanding and lack of resources.

Nevertheless, LA stakeholders were of the view that, if created, ADB action plans would be effective at the county level. It was felt that collaborative working would help to produce an effective action plan, focused on local tactical issues. One concern about this need for the creation of a shared action plan was that there may be some barriers to working cooperatively. Nevertheless, generating locally specific knowledge could be key to landscape scale responses (Ambrose-Oji et al, 2019).

5.1.6 Advantages of placing ADB on corporate risk registers

Whilst there may be value in the creation of action plans that specifically focus on ADB, it has also been pointed out that placing ADB on LA corporate risk registers could have significant impact (Ambrose-Oji et al, 2019a). Such LA corporate risk registers cut across multiple council departments that might have to deal with the problem (environment, recreation, transport, planning, facilities, health and safety etc). This can facilitate action planning, political approval for action, and budget allocation.

5.1.7 Networks

Networks such as Devon Ash Dieback Resilience Forum (DADRF) can be important for addressing management of ash trees impacted by ADB at a landscape scale. DADRF has a strong focus on the risks of ADB and management needed to address the health and safety problems associated with diseased and weakened trees, particularly along transport corridors and in public spaces (Ambrose-Oji et al, 2019b).

These reviewed studies, all of which have focused on management options for ADB, demonstrate the depth and diversity of views from different stakeholder groups, regarding how ADB could or should be managed. All such evidence should be considered during the construction of the models in the Smarties project, and will be used to inform the design of the social science empirical tasks.

Social dimensions of EAB

As EAB has been widespread in North America various studies have addressed the social dimensions and impacts of the beetle. While there is considerable experience across the UK of the impacts of ADB there is a need to look elsewhere to understand the impacts of EAB.

As shown in the section of the review on the cultural values of ash trees, some ash species are very important to some native American communities. Therefore, potential loss of black ash due to EAB is a particular concern for many Native American and First Nation tribes in eastern North America. The threat of EAB introduction into Maine has meant that the social values and perspectives of Wabanaki basketmakers are influencing response plans and should improve inclusivity in decision making should the pest arrive there (Garibaldi & Turner, 2004). Thus one important social dimension of EAB in the USA is this potential deep cultural loss. While ash in the UK may not be so significant to a particular cultural group or community of interest, such evidence from elsewhere in the world demonstrates the importance of recognising diverse groups that may have an interest. For example, as described in the section on uses of ash wood and timber, it is still central for certain sports equipment including hockey, hurling and shinty sticks. Such interest groups should therefore be consulted about management of ash trees if it could mean they would lose desired material for their equipment.

An ongoing challenge for the social sciences is how to put a value on such social values as well-being, when ash trees might be lost to a pest such as EAB. Jones (2017) utilised a life satisfaction happiness index to try to estimate the impact of EAB on well-being. Using data from 189 counties in 15 US states over the time period 2005–2011, the author claimed to demonstrate that following EAB detection, the life satisfaction index was reduced by 0.127 on a 4-point scale. This was from using the question “In general, how satisfied are you with your life?” and the

response scale – (1) Very Satisfied, (2) Satisfied, (3) Dissatisfied, (4) Very Dissatisfied. Comparisons were made between life satisfaction for respondents before and after EAB detection in their county. They concluded that this was due to a reduction in environmental quality and that the costs of invasive species (in this an invasive tree pest) are broad-based and include subjective well-being.

Other social dimensions of EAB considered by researchers in the USA include health impacts and effects on rates of crime due to environmental impacts. Donovan et al (2013) explored the impact on human health of wide-scale ash tree death in urban landscapes infested with EAB. They found an increase in human mortality related to cardiovascular and lower-respiratory-tract illness in counties infested with EAB. The magnitude of the effect was greater as infestation progressed. Across the 15 states in the study area, EAB was associated with an additional 6113 deaths related to illness of the lower respiratory system, and 15,080 cardiovascular-related deaths. Kondo et al (2017) used tree loss data and crime figures to demonstrate a link between EAB-related loss of trees in urban area and increased crime. Authors explained that trees and urban greenspace lead to reductions in a range of criminal activities as they provide pleasant social spaces for residents to meet, thus deterring criminals. They also suggested that the loss of trees or the presence of dead and dying trees can contribute to a neighbourhood looking uncared for with evidence that unattractive areas can encourage crime. Both of these studies help to demonstrate the complex relationships between tree health, environmental quality, quality of life and human well-being.

A couple of studies have considered the impact on residential house prices once EAB is found in urban settings and ash trees are lost. Aukema et al (2011) estimated that ash mortality resulting from spreading EAB infestation in the eastern USA would cost homeowners \$380 million per year in the decade 2009-2019 in residential property value loss. Meanwhile Li et al (2019) conducted a hedonic property value analysis to evaluate the impact of ash tree damages due to EAB on house prices in Milwaukee. Results showed that the EAB outbreak had a negative

impact on house prices for properties close to ash trees in the urban forest. The result was strongest in neighbourhoods where EAB had already been detected.

In the previous section related to social dimensions of ADB, evidence was presented about the range of views across different media that were expressed following the early discovery of ADB in Britain. Similar studies in the USA with regard to views about EAB reveal some closely corresponding sentiments about concerns and impacts. However, Dunens et al (2012) found considerable variation in the optimism and pessimism related to EAB, something not found so strongly in the UK with regard to ADB where negative views dominated. Through interviews, observation of public meetings, content analysis of online and print media, and focus groups, authors found comments about EAB that ranged from 'doom and gloom', 'disaster' and 'devastating', to 'not as bad as expected' and 'people should not panic'. Their diverse stakeholders also had differing views about whether the spread of EAB could be controlled, on a spectrum from "We can contain this" to "There's no hope".

Other authors in the USA found a stronger representation of the negative views found by Dunens et al through a content analysis of 924 news articles about EAB from 2002 to 2017 (Clarke et al, 2020). The majority of articles were framed using what the authors call 'negative attribute frames' relying on terms that were suggestive of invasion-militaristic events or fatalistic experiences to describe EAB management. Table four is included to show the full range of coding that the authors applied to the articles. This demonstrates that there were some positive aspects to the coding categories including the role of EAB management in galvanising public support and increased business opportunities for some sub-sectors of the forest management sector who would likely see increased workloads to carry out felling and other tree management. Again, this evidence demonstrates the complexity of the social dimensions of a tree health challenge like EAB.

Table 4: Coding for content analysis of newspaper articles addressing EAB (Source: Clarke et al, 2020)

| Category | Coding options | No. of articles |
|--|---|-----------------|
| Framing language used | Invasion-militaristic | 422 |
| | Fatalistic | 386 |
| | Anthropomorphic | 144 |
| | Optimistic | 79 |
| Impacts of EAB | Negative impacts | 848 |
| | Death of ash trees or other tree species | 796 |
| | Economic costs | 393 |
| | Ecosystem services loss | 163 |
| | Other | 143 |
| | Danger to people, property or hazardous | 130 |
| | Loss of biodiversity of other ecological impacts | 91 |
| | Positive impacts | 259 |
| | Galvanise public support | 130 |
| | Wildlife benefits like habitat, food | 108 |
| | Increased business (i.e. arborists, private foresters) | 29 |
| | Other (furniture, memorabilia, woody biomass) | 19 |
| Call to action for the public | Private landowners | 453 |
| | Adhere to firewood regulations (not move firewood, etc) | 182 |
| | Be aware / educate themselves | 152 |
| | Contact professionals | 127 |
| | Inspect their trees | 120 |
| | Apply chemical treatment | 119 |
| | Recreationists, other | 117 |
| | Adhere to firewood regulations | 114 |
| | Decide what to do | 114 |
| | Other (i.e. donate money, adopt a tree etc) | 101 |
| | Volunteer data collection | 75 |
| | Remove ash trees | 69 |
| | Workshops | 66 |
| | Replant trees | 52 |
| | Tree specialist's selection | 40 |
| Do not disturb EAB traps | 6 | |
| Discuss management and treatment options | Silviculture | 478 |
| | Cutting or removal of tree species | 384 |
| | Diversity of tree species | 211 |
| | Pre-emptive removal of ash trees | 78 |
| | Disposal | 117 |

| | | |
|--|---|-----|
| | Containment and eradication (quarantine) | 332 |
| | Chemical treatment | 295 |
| | Traps | 129 |
| | Biological control | 63 |
| | Do nothing | 26 |
| | Other (including use of sniffer dogs etc) | 17 |

Whilst the studies reported from the USA relate to social dimensions of EAB after it had been found, Arnberger, et al (2017) sought to discover how visitors to urban parks in a European city might react to management if EAB was introduced. The hypothetical study used a photo questionnaire with manipulated digital images to represent different levels of EAB impact at different distances from park trails, combined with varied viewsapes beyond the park, different visitor types, and differing visitor numbers. They found that EAB management impacts were significant but not as important as the backdrop and visitor numbers in the scene. This helps to emphasise the importance of pest management in combination with other considerations relating to the context and setting of where that management takes place. People may not only be focused on the loss or removal of the ash tree or trees but will take a wider view of the visual environment when considering their aesthetic appreciation.

EAB management: What do managers in the USA do? What might GB managers do? What is acceptable?

In understanding what land managers in Great Britain might decide to do in response to EAB there may be lessons to be learned from experiences in the USA. However, evidence from the USA reveals a diversity of responses. For example, actions of property owners, municipal foresters and land managers to EAB in the US have ranged from a passive 'do nothing' approach to removing ash trees, either proactively or as they decline and die (McCullough, 2019). Understanding why

actions and management decisions differ between land managers is central to Smarties.

At a city level, beyond individual land managers, Sadof et al (2017) looked at strategies adopted in urban areas in the USA to manage EAB. Google was used to search for information about city-wide EAB programs in the news over one year, and reported management practices were categorised into five strategies (Table 5). These ranged from full scale removal of all ash, regardless of infestation or not, through to using other non-felling options to protect more than 50% of the healthy ash trees. The most 'popular' option was to try to protect and retain less than 50% of healthy ash trees. The extent to which such strategies might be applied in European cities remains to be seen.

Table 5. Strategies employed by municipalities to manage emerald ash borer and their rationales in cities found in a web search covering a 12-month period ending 04 March 2014. (Source: Sadof et al, 2017)

| Strategy | Rationale | Percentage of cities (n = 40) |
|--------------------------------|--|-------------------------------|
| Proactively removing all ash | Removing ash over time to reduce annual cost | 17.5 |
| Reactively remove ash | Remove dying ash to prevent hazard | 20 |
| Protecting only legacy ash | Only healthy trees of historic or significant landscape importance are protected | 5 |
| Protecting <50% of healthy ash | A substantial proportion beyond legacy ash trees are protected | 40 |
| Protecting >50% of healthy ash | Most of the healthy ash are protected | 17.5 |

When considering views about EAB in the USA, some stakeholders referred to previous pests where a lot of resource was directed at control attempts which subsequently failed (Dunens et al, 2012). In particular, the gypsy moth was mentioned. Specifically, some stakeholders were disillusioned by the effort that they considered was wasted on trying to control the gypsy moth and that came to nothing, that is, failed to prevent the impact from it or remove it from the

landscape. Similar suspicions have been noted with regard to the development of resistant American chestnut trees (Marzano et al, 2019). This chimes with some of the findings reported above about land-managers and ADB in the UK who drew on previous experience to 'wait and see' before deciding what to do.

The USA is not the only part of the north American continent to be impacted by EAB. Parts of Canada has also been infested. Mackenzie et al (2010) explored land owner views about a rapid response action programme implemented when EAB was found in southern Ontario, Canada. To try to prevent the spread of EAB, a government agency implemented the felling of a 10-km-wide swathe of ash trees, many of which were on private land. There was widespread dis-satisfaction with this rapid response action. Local landowners did not agree with the action, expressed doubt about the agency's competence to carry out the program, and considered the program to be ill-managed. Land owners felt that the agency lacked the knowledge to support the eradication program and were making decisions based on unproven science. Related to this, some land owners felt that there was a lack of research and planning, and considered the program to be an experiment. They described the program as "ineffective", "a useless thing to do" and thought "it made no difference". Underlying these views, land owners described a strong emotional attachment to their trees, significant personal connection to their woodlands, and had an appreciation of the values of their forests. It seems that the strongly negative views about the government enforced felling programme sprang from this connection and the sense that it had been ignored by the agency. This demonstrates the importance of understanding and taking into consideration any such personal values of those likely to be impacted by any attempts to manage EAB. As highlighted by Marzano et al (2020) comprehensive stakeholder engagement is necessary to establish the relevance and reason for using different management approaches, and to build awareness and trust. This engagement must include opportunities for stakeholders to express why trees matter to them.

However, the need to act quickly can make active stakeholder engagement a challenge as this can take time to instigate.

An effective demonstration of successful engagement and collaboration is found in the response to EAB in Colorado (Alexander et al, 2019). There the Colorado EAB Response Team (CORT) was established in advance of the arrival of EAB. The preparedness and established working relationships between stakeholders and authorities in CORT facilitated an effective, prompt, and united response when EAB was found, hence advanced preparation is key.

Other examples of successful co-management in the USA are evident. In three New York counties knowledge networks and task forces brought together local and state government, university and stakeholders to manage EAB invasion (Nourani et al, 2018). Through shared social learning, task force members gained knowledge of EAB and better understood perspectives of other members. Communication and cooperation between task force members was enhanced. The Nourani et al study of these three task forces concluded that pre-existing knowledge-sharing networks can help to facilitate learning-in-action and co-management between groups of stakeholders when a new problem such as EAB arrives. Such an approach may also help with engagement of communities.

Considering specifically how different stakeholder groups might accept or reject the use of chemical injection for control of EAB, Dunens et al (2012) found that there were different perspectives with regard to efficacy and safety. A group of scientists and resource managers with experience in EAB management expressed a high level of confidence regarding safety but a moderate level of confidence in the efficacy of chemical injections for ash trees. A group of 'interested public' of gardeners, arboriculturalists, environmental and neighbourhood organisations were moderately confident in the chemical safety and slightly more confident that it was effective. Participants from the 'general public' expressed confidence that chemical treatment would work but were concerned about safety. Concerns from all participants were

expressed with regard to potential unintended consequences for the environment. Concerns about chemical safety were related to uncertainty regarding potential harm and misuse. Stakeholders also questioned the cost-effectiveness of its use. Differences between stakeholders has already been presented above with regard to the potential of different approaches to ash tree breeding for ADB resistant trees. This study from the USA with regard to the use of chemicals for EAB helps to emphasise the point that new and potentially controversial approaches to management of tree pests, where different people may perceive differing levels of risk, are unlikely to receive widespread acceptance and this could impact on successful implementation.

In Toledo, residents living on streets due to have ash trees removed for EAB control wanted to see replacement trees planted before the removal of existing trees to help to mitigate the impacts of felling (Heimlich et al, 2008). They also favoured large replacement trees that would provide summer and autumn colour, again to try to maintain existing aesthetics and mitigate impact. Residents also valued the shade provided by the trees due to be felled so this was another consideration that needed to be included in selecting replacement trees. While this is a study relating to a specific context and location, it demonstrates to land and tree managers the importance of considering the views, concerns and preferences of those likely to be impacted by any management decisions relating to ash trees for tree health. This echoes the Canadian study with land owners in Ontario who felt their views and values had been ignored and therefore held extremely negative views of the felling programme.

The aesthetic and emotional impacts of losing trees to a pest such as EAB, can be an important determinant of behaviours and management decisions. However, different groups, for example, the public and forest managers, may view the felling of trees very differently (Dunens et al, 2012). The important point for the Smarties project is that if the public are opposed to tree felling, even when it is for tree

health reasons, this may impact on the decisions of managers whose trees and land may be very visible and / or accessible to the public.

Relevant management actions for EAB in the USA have not only related to authorities and land managers but also to the public and recreationists. Numerous studies have considered compliance with programmes trying to prevent the movement of ash firewood by campers (see for example, Peterson & Diss-Torrance, 2014; Diss-Torrance et al, 2018). Surveys with campers reveal a complex range of motivations affecting compliance that includes social norms and costs of complying. They also found that increases in compliance were high early on in the programme but then levelled off. Therefore, messaging for awareness raising needs to be persistent and consistent while not becoming overly familiar which can lead to complacency and a failure to continue to engage. Another way to interpret the levelling off in compliance is that there are individuals more likely to comply, but then the remainder may be harder to convince.

Another study with recreationists (Schlueter et al, 2016) found acceptance for management of EAB on public recreational land. Options for management were ranked by visitors. Acceptance, in order, was as follows: Wood regulations (relating to movement of ash wood), sanitation felling of infested trees, progressive thinning, biological control using natural EAB predators, creating sinks (buffer zones cleared of host trees), chemical treatment through stem injection, clear felling, doing nothing. Such studies are important for land managers to consider, especially where they have areas open to visitors, and are likely to influence management decisions by those responsible for managing ash trees. However, the efficacy of different approaches is also crucial. For example, biological control for EAB has so far proved to be somewhat effective, but researchers have noted the need for more evidence of effectiveness in different climatic zones (Duan et al, 2018) and on different age classes of ash trees (Margulies et al, 2017).

Crucially, for the aims of the Smarties project, while there is considerable evidence of attitudes and responses to ADB and EAB, not much is known about the social dimensions of the interaction of twin threats to tree health, beyond some understanding that previous experiences of a tree health threat do affect peoples' attitudes towards a new pest or disease.

6 Conclusions

This review set out to identify existing literature on the social dimensions of ADB and EAB with a focus on understanding the range of values attached to ash trees in order to understand the values that might be impacted by pest management responses. The review also explored whether there may be differences between stakeholders in terms of motivations to act and acceptability of management options for ADB and EAB. The following are key highlights:

Social and cultural values

The review highlights the social and cultural importance of ash as part of the British landscape, as well as landscapes elsewhere in the world. Values influence attitudes and behaviours and are an important component to take into account when considering how to implement actions and support for the management of ADB and future responses to EAB.

Stakeholder risk perceptions

The studies in the review emphasise the need to understand perceptions of risk and how these can vary between different stakeholder groups. There are likely to be a number of influences on risk perceptions such as media representation of the pest or disease as well as direct experience or experiences of peers and significant networks. Understanding how stakeholders perceive the risks of ADB and EAB and ways in which these influence decision-making will be important when considering

how to engage with relevant individuals, groups and organisations on how ash is and should be managed in the future.

Social acceptability of management actions

The literature shows that different stakeholders exhibit varying levels of acceptability for management approaches that involve monitoring and reporting, chemical use, felling and planting of tolerant varieties of ash. There is a need for more focus on working with stakeholders to discuss management actions for responding to ADB and potentially EAB and identifying what mechanisms could help to support them to take appropriate action. The need for thorough and meaningful stakeholder engagement poses a challenge when rapid action is required.

Evidence gaps

There remain evidence gaps relating to the social dimensions of ADB and EAB in Great Britain that can be explored further through the SMARTIES project, particularly in relation to types of stakeholder, their motivations to act, and likely acceptability of management options for EAB. Thus, the following questions are provided:

- How will the values that people attach to ash trees (on their land, in the local area or further afield) influence management decisions?
- How do differences between land managers and between sites manifest on the ground, in terms of pest management decisions? What is important: Location, type of owner, size of holding, type of manager, level of public access, proximity to populations, land use, management objectives of the manager/owner?
- Will regulation and statutory requirement to act be necessary to bring about management of ash trees for protection from EAB, or will land managers act voluntarily?

- How will experience with ADB affect likelihood of action for EAB – more or less? Will this depend on whether action for ADB was successful? Will this depend on how serious the impact of ADB was?
- What is the role of previous experiences with other tree pests or diseases in influencing future actions?
- How do key social dimensions of pest management interact with each other? For example, how important are public concerns about land manager actions in influencing land managers? How important are the actions of 'others'?

7 References

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