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Who has a stake in ash dieback? A conceptual framework for the identification and categorisation of tree health stakeholders

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Abstract
Stakeholder engagement is increasingly recognised as an essential component of environmental management. But what does it mean to have a 'stake' in tree health? In this chapter we use case-study analysis to explore the stakeholder concept in relation to tree health. We develop a framework to underpin better understanding of the stakeholder landscape in tree health and through which to categorise individuals and groups within it. This chapter highlights how the framework can facilitate more effective engagement and communication that is sensitive to the particular needs of different stakeholder groups, with a specific focus on the case of ash dieback *(Hymenoscyphus fraxineus*) in Great Britain. We use it both to improve understanding of how the outbreak developed over time, and to identify the roles of a diverse range of stakeholders as they became involved at different points in the outbreak. Critical reflection enables lessons to be learned for future stakeholder engagement, such as recognition of how stakeholder engagement changes over the course of an outbreak, identification of potential key stakeholder groups that may be overlooked or difficult to access, and which stakeholders are likely to be most influential in driving or facilitating behaviour change.

Keywords: Tree health; biosecurity; stakeholder analysis; forest governance; *Hymenoscyphus fraxineus*; ash dieback.

1. Introduction

Stakeholder analysis has become firmly established as a core component of environmental and natural resource management (Reed et al 2009). Various methods have been applied in sectors such as forestry (Sandstrom et al 2016), fisheries (e.g. Maguire et al 2012), climate change (e.g. Van de Kerkhof 2004), and water management (e.g. Lienert et al 2013), with the aim of improving managers' knowledge and understanding of who has a 'stake', how, and why. Some biosecurity research has sought to improve understanding of stakeholders and made use of stakeholder analysis tools, primarily in relation to animal health (e.g. Gilmour et al 2011; Hernández-Jovera et al 2012), but also occasionally plant health (Mills et al 2011; Marzano et al 2015).

Originating with Freeman (1984), we define a stakeholder as *any individual or organised group (i.e. business; organisation; association) who can affect or be affected by a decision, action or policy*. The two dimensions of stake are conceptualised as relationships of *influence* (can affect) and *interest* (can be affected by). In recent years, seeking engagement with stakeholders has become a prominent feature of tree health policy in the UK and beyond (e.g. Defra and FC 2011; Defra 2014). However, to date the stakeholder label has been applied in a relatively narrow sense, to organisations (and some individuals) with a relatively strong and direct link to the issues (e.g. forestry and horticultural industries; landowning actors). Tree health 'stakeholders' are is often explicitly juxtaposed with 'the public', to denote this more direct relationship (e.g. Defra and FC 2011). Although these actors are clearly important within tree health, even the most cursory examination of the sector will reveal many others who are also bound up in this arena and that many actions taken by those beyond this narrowly defined group can have a critical impact on the outcomes of tree health policy and management. Recent experience of outbreak events ash dieback (Heuch 2014), oak processionary moth (*Thaumetopoea processionea*) (Tomlinson et al 2015) and Asian longhorn beetle (*Anoplophora glabripennis*) (Porth et al 2015), has demonstrated the limits of these traditional models of tree health governance and management, and identified the need for approaches which integrate efforts across governmental, third sector and private stakeholders. Current UK policy emphasises a primarily instrumental (Reed et al 2009) approach to non-governmental stakeholders focused on enabling them to play an increased role in tree health and biosecurity. This consists of, for example, providing more and improved opportunities for pest surveillance and monitoring (including citizen science approaches), along with clearer guidance on ensuring biosecure practices in such as plant procurement.

This chapter critically reflects on 'stakeholder landscape' of ash dieback in the UK. This comprises a wide-ranging set of stakeholders, as well as their associated interests and influences. Through a case-study analysis, we provide a novel conceptual framework to address the question 'Who has a stake in tree health?'. Environmental decision-makers can use this framework to improve stakeholder engagement by identifying and categorising the many actors connected to tree health: clarifying their current and potential roles, exploring how stakes can change through the phases of an outbreak, and better understanding the range and type of social impacts that tree pests and diseases can have.

The framework presented in this chapter was developed through case-study analysis of five forest pests or diseases drawing on a number of data gathering exercises that included interviews with key individuals; documentary reviews including scientific papers, policy documents, and grey literature; and a detailed analysis of the supply chains and pathways involved in the spread of tree pests and diseases that focused on both the case study pests and diseases *and* on the primary means of spread associated with them – namely, wood packaging used within international trade, woodfuel, and the live plant trade.

2. Tree Health Stakeholdership: A Conceptual Framework

2.1 Categorising Tree Health Stakeholders

In tree health a stakeholder may be defined as *an individual or organisation that can either affect or be affected by a forest pest or disease outbreak*. A stakeholder's 'influence' can be defined as *its capacity to affect an outbreak's occurrence, trajectory or outcomes*. A stakeholder's 'interest' can be defined as *its susceptibility to losses or capacity for gains resulting from an outbreak's occurrence or outcomes, or associated activities* (e.g. trade). The categories described in this framework are not mutually exclusive and single stakeholders can have *both* influence on and an interest in an outbreak, as well as various forms of influence and/or interest..

2.1.1 Categories of Influence – Capabilities, behaviours and practices

We have identified five categories of capability, behaviour and practice through which individuals and organisations can affect the occurrence, trajectory and outcomes of forest pest outbreaks. These are *vectors*, *governors*, *managers*, *monitors* and *networkers*.

Vectors are perhaps one of the most obvious groups of tree health stakeholders as they consist of people whose activities, either intentionally or otherwise, physically spread a pest or disease from one area to another. They include businesses or individuals who satisfy customer requests by moving commodities from infested areas to un-infested areas through key supply chains such as woodfuel, timber, live plants or trade using wood packaging. It also includes those who can transfer a pest directly between trees or forests on contaminated equipment or footwear (e.g. arboriculture workers, foresters, tourists or outdoor recreationists). This category of stake can also include many individuals, businesses or organisations involved in supply chains that have no substantive connection to trees or other plants, including transport companies and others.

Governors are those with the capacity to set formal and informal rules and regulations which impinge on the behaviour and practices of others in the tree-health arena. Such rules can originate from trade agreements, legislation, institutional/organisational arrangements, or industry best practice initiatives and codes. They define, to varying degrees of exactness, the actions of intrinsic relevance to tree health such as inspection, phytosanitary practices, purchasing, forest management, and the allocation of resources. It is not only the form of these behaviours and practices that can be set, but their presence or absence (e.g. where trade rules prevent inspection of commodities at certain points in their movement, or direct inspections towards certain commodities and not others).

Managers are individuals or groups that possess the specific technical skills and capabilities required to deal with a tree pest or disease outbreak. Those with resources to manage pests at border points (e.g. treatment of infestation or infection) also fall into this category. The stakeholdership in this category is particularly sensitive to the pest or disease and the form of management or control required. For example, where a management response requires public information provision, this may bring actors such as local authorities into the stakeholder landscape. However, if a programme of sanitation felling is deemed necessary, forestry and / or arboricultural contractors would be key 'managers'. Forest planners and business managers responsible for adapting timber harvesting strategies in response to outbreaks are a further group of stakeholders in this category.

Monitors are those with the knowledge required to predict, detect, identify, or otherwise understand pests and pest outbreaks. This includes many actors in the science sector such as plant pathologists, entomologists, epidemiologists and modellers working in universities and government institutions, but can extend beyond this to include 'lay' expertise held by non-governmental organisations and tree professionals, as well as those mobilised by 'citizen science' initiatives. These stakeholders design and undertake surveillance work, establish routines and tests to identify pests, and conduct research. They also often work closely with 'managers' in implementing responses to outbreaks through, for example, offering advice about the biology, movement and ecology of the pest.

Networkers are key to communication amongst stakeholders. They are actors with the capacity to disseminate information and key messages to and from other actors relevant to tree health. This stake is created in part by the abilities of particular individuals or groups, but also, critically, by virtue of their position, role and level of trust within established social networks. 'Networkers' are, therefore, similar to some 'governors', in that they do not necessarily have a strong direct link to trees or pests, but they can play an important role in raising awareness and exchanging knowledge . Trade bodies and associations are an example of this.

2.1.2 Categories of Interest

We have identified five categories of susceptibility to loss, or capacity for gain, resulting from a tree pest or disease outbreak, its management, outcomes, or its associated / contributory activities. Within the framework there are three core categories that describe how stakeholders can have a 'losing' stake: they can be *'value', 'cost'* and *'collateral' losers*. Conversely, pest and disease outbreaks may present significant opportunities for gain for some stakeholders in what we term '*outcome winners'* and '*contributors'*.

Value losers are stakeholders for whom the value of relevant trees and forests is reduced by pest or disease outbreaks. Trees can provide considerable economic, social and environmental values to those who own, use, view or otherwise engage with them and the spaces around them. Pests and diseases may negatively affect, for example, the value of timber, the aesthetic appearance of forest landscapes, or the biodiversity value of woodlands. This category can, therefore, conceivably consist of a very wide range of individuals and organisations. Outbreaks may in some cases not only act to reduce value, but also release the value of forests at unexpected times. This is particularly the case in relation to economic value through, for example, the need to conduct harvesting operations earlier than planned.

Cost losers are those who bear the economic costs of responding to tree pests, which are incurred in addition to the loss of existing value (e.g. paying for labour and materials required for felling, financial compensation for damage caused by outbreak management, and cost of information dissemination). This category is most likely to include landowners and public bodies who are legally responsible for the management of pests or diseases affecting their property. Forest and tree owners will often be both value *and* cost losers.

Collateral losers are individuals or groups who lose indirect, non-tree related value, as a result of outbreaks and their management. This category represents a type of social cost that can include reputational loss amongst the contractors, consultant specialists, public bodies and others resulting from poor outbreak management. The impacts can cascade well beyond the immediate location of the particular outbreak and affect the incomes and livelihoods of many individuals and groups. For example, they might reduce the attractiveness of forest locations for recreation, consequently affecting livelihoods dependent on local tourism.

Outcome winners are those for whom outbreaks have benefits or are perceived positively. For example, arboricultural and forestry businesses can obtain income for control work (surveys, sanitation felling, pesticide application), along with the manufacturers of management materials and equipment. Some businesses may be created (or are able to adapt) to exploit the specific economic niches or opportunities created by outbreaks. This would include those offering legal or technical advice, or diagnostic services, along with those marketing particular types of wood products generated by outbreaks. Further to this, scientists obtain research contracts to investigate pests and diseases, and agri-chemical businesses generate revenue from the development and use of pesticides.

Contributors are individuals and groups engaged in activities that are beneficial to them, but which are implicated in the occurrence of pest outbreaks. 'Contributory' activities include trade and consumption, and occur consistently. Perhaps the clearest examples of stakeholders in this category are those engaged in trade of

particularly high-risk commodities transported in wood packaging materials and/or live plants (producers; suppliers; transporters; traders; sellers; customers). Some, but not all, of these actors may also be implicated as 'vectors'. Also, given that production-oriented forestry has created and benefitted from specific types of forest (often even-aged, non-native monocultures) that may be a host for pests and/or more vulnerable to pest outbreaks, it may also be possible to conceptualise some forest managers as falling into this category.

2.2 How stakes change

The tree health stakeholder landscape is dynamic and continually changing. The capacity of individuals and groups to affect pests and diseases, as well as their vulnerabilities to them, alter with time as stakeholder influences and interests shift, and as the outbreak progresses. The main driver of this dynamism is the development of outbreaks over time, from mobilisation of the pest or disease from its native range, through its introduction to a new environment, to societal adaptation to its presence. Stakeholdership also changes with levels of awareness and activism: individual and group perceptions and understandings shift as they are brought into, or choose to become more active in, the outbreak.

Outbreak stage
Our framework features a novel eight-stage model to reflect how outbreaks evolve over time (Table 1). This builds on the foundation provided by biological models of invasion (e.g. Heger and Trepl 2003; Williamson 2006), but expands their scope to encompass human actions relevant to tree health. Within biological models the number of pests on a pathway reduces at each stage prior to introduction, subsequently increasing again once in their new environment. To some extent the breadth and depth of the stakeholder landscape mirrors this, with the least number of stakeholders and most concentrated suite of relevant human behaviours occurring at the point of introduction. The model presented as part of our conceptual framework not only considers the human dimensions of these biologically oriented phases of pest invasion, but adds further human oriented stages. It is critical to recognise that numerous human activities are relevant to pest invasions both before and after the initial mobilisation of the pest or disease.

Table 1 Stages of Tree Health Stakeholdership

Stage Name		Description
Pre-pathway		Pest exists in its native range. Activities are taking place that form a potential pathway.
Introductory Pathway	Mobilisation	Pest is mobilised from its native location and is attached to a mobile medium.
	Introduction	Pest is moved and introduced to a new location where it was previously not present and potential host species exist.
	Release	Pest escapes containment or is released from attachment to mobile medium.
Establishment		Pest establishes a self-sustaining population in the new environment.
Spread		Pest spreads or disperses to new localities within the new environment.
Containment & Mitigation		Actions taken to halt or contain pest spread and/or mitigate its impacts.
Adaptation		Stakeholders adapt to (learn to live with) a pest's presence and impacts.

A number of stakeholders are engaged in *pre-pathway* activities that affect the context for outbreaks by establishing or mitigating pathways and/or potential host forests. This stage does not feature in biological models of invasion. Forestry and other commercial enterprises (e.g. quarrying of stone for export utilising wood packaging) form the beginning of supply-chains, whilst everyday economic practices such as purchasing and consumption provide an end-point. A very broad range of activities undertaken in the pre-pathway stage set the context in which a pest or disease will be managed. Research, policy formulation, the establishment of biosecurity practices, and the marketing of commodities are just a few of the critical activities undertaken prior to specific outbreak events. Also important at this early stage are relatively generic and disparate processes such as problem definition, the formation of attitudes towards outbreaks, and the structuring of related political debate. Given the above, stakeholdership at this stage is very broad and can be both general (i.e. related to tree health broadly) and specific (i.e. associated with individual pests or diseases). Identification of the stakeholder landscapes of specific pests is possible either subsequent to an outbreak (by reconstructing the chain of events leading to a pest introduction) or in advance (through dedicated stakeholder analysis associated with a pest risk analysis). The identification of stakeholders in this stage is critical to the success of preventative measures.

The initial step in a pest's movement is its physical attachment to a carrier within its native range and *mobilisation* onto an *introduction pathway*. Again, this stage is rarely included in biological models that typically start at the point of introduction, however Colautti and MacIsaac (2004: 137) note that an organism is 'taken into the transport vector … usually by humans'. This human involvement in mobilisation may be relatively direct and intentional (e.g. via plant collection and movement) or indirect and unintentional (e.g. carrying the pest on vehicles, clothing or packaging). Alternatively, mobilisation may have no human involvement and be due to 'natural' spread (e.g. by wind dispersal). Phytosanitary actions (e.g. heat treatment of wood packaging through ISPN15 regulation) are particularly relevant during this stage. The next stage sees *introduction* (movement) to a new location where potential host species exist and can be reached by the pest or disease. Human involvement at this stage is potentially substantial, with various international trades and other movements (e.g. tourism) playing a central role. Border security is critical at this stage, with stakeholders implementing numerous security and surveillance practices designed to prevent pest introduction. Movement alone, however, is not sufficient to create an outbreak. At least one organism needs to 'escape' or otherwise be 'released' from its transporting medium and reach a viable host species. Human actions, albeit of a very much reduced set of stakeholders, are once again likely to be of significance during this *release* stage, including, for example, logistics companies handling the transporting medium. The release of a pest or disease can occur on borders and at ports of entry, although with contemporary modes of containerised transport, release or escape may potentially occur anywhere a container is opened and infested or infected commodities are exposed to the environment.

Following the establishment of a self-sustaining population, a pest species may spread in order to colonise further new localities. The boundary between the release and spread stages are not, however, always clear. The dispersal of a pest from a single introductory point may involve either further movement within a territory on the pest's original medium and pathway, or movement ('natural' or human-mediated) from an established population, or both. In the case of the former (onward movement on the original medium), this could conceivably result in two widely separated 'outbreaks' – albeit affecting a similar and overlapping set of stakeholders. Although ecological, climatic, topographical or other environmental factors may well limit pest spread, human factors can once again be causal during this stage. These may include plant buying and selling, forest recreation activities, and inspection and surveillance. As individuals and organisations (such as woodland owners, gardeners, and countryside visitors) begin to experience the consequences (impacts) of a new outbreak during this stage, new stakes are activated.

The successful spread of a pest species from an established population is generally the final stage in biological models of invasion. However, moving beyond the analysis of purely biological factors leads to the identification of outbreak stages wherein biological factors may not alter substantively, but human dimensions - and therefore stakeholder constellations - may change significantly. The first such stage can be conceptualised as containment and mitigation and focuses on actions to eradicate the pest, halt its spread and reduce its impacts. For many actors this stage forms the core of what is commonly perceived as 'outbreak management' and includes a great deal of the focused action undertaken by governmental bodies and others. Clearly, the boundary between this and the preceding stage is highly contingent and will vary substantially between outbreaks. Indeed, to a certain extent the two stages necessarily run contemporaneously, with perhaps the primary distinction being that relevant human activities are mainly unintentional during the spread stage, and more directed and active in the containment and mitigation stage. Given its complexity and significance in terms of active management of pests, it may be useful in some cases to sub-divide this stage into different phases. There are potentially a number of sub-phases including eradication, local containment, landscape scale management, and then mitigation. Decision to move between these phases may have profound consequences for the resources that can be mobilised and the range of stakeholders engaged in outbreak management.

When and where management has failed to contain the spread of a pest, or has succeeded only in reducing its impacts, a final adaptation stage can be identified wherein stakeholders have to learn to live with a pest's presence and impacts. During this stage some profound changes to problem definitions and significant changes to management practices are highly likely as adaption to living with the pest or disease entails different levels of engagement in tree health by a number of stakeholders with the aim of coming to terms with loss and promoting future resilience.

This stage-based model of stakeholdership does not necessarily develop in a linear fashion. Whilst biological models of invasion can to some extent be represented chronologically, boundaries between the socially defined stages in this framework can be relatively fluid. It is possible for some stages to occur or reoccur at different

points of an outbreak, depending on the social factors involved. For example, a tree pest or disease could be defined as a problem prior to introduction (i.e. at the pre-pathway stage) via a pest risk analysis, or it may not be defined as a problem until the post-introduction stage, once impacts begin to be recognised. Furthermore, different stakeholders can be located within different stages of the same outbreak at the same moment in time, depending on how they engage with it; for example, some stakeholders may be working on adaptive strategies, whilst others may still be focused on mitigation or containment[1]. This highlights the intrinsic dynamism, or 'messiness', of outbreaks.

Active, passive or latent stakeholders
Alongside the development of an outbreak over time, changes in stakeholdership brought about by varying levels of knowledge, awareness and certainty relating to tree pests and diseases can also have a major influence on the make-up of the tree health stakeholder landscape. In essence, whilst a *de facto* stake may exist for particular individuals and groups, a lack of awareness, knowledge or certainty as to the character and extent of that stake deeply influences those stakeholders' participation in tree health management. Differences in awareness can be the result of numerous factors or events such as direct encounters with the pests or pest management activities, media coverage, or informational campaigns. This generates a particular stake for some – especially media and other actors who have a stake as networkers. These actors have the capacity to make people aware of their stakes and thus enrol them into prevention, containment or adaptation efforts.

At a basic level, a divide can be made between stakeholders who have recognised a stake (even if not necessarily fully or correctly) and those who have not. Those who have recognised their stake in tree health can be classed as either active or passive stakeholders. Active stakeholders have realised their stake and are actively engaged in the outbreak - at least in terms of knowledge gathering or monitoring events. Passive stakeholders have also realised their stake, but have made a choice not to engage, perhaps on the basis of judgements about vulnerability, responsibility, or a lack of resources. This might include householders and businesses who stand to bear significant, uncompensated costs for eradication or containment measures such as felling and chemical treatments, or woodland owners who may be aware of the threat to their trees, but who judge the investment of time and resources in good biosecurity not to be worthwhile. Those who have not recognised their stake in tree health can be labelled as unrealised (or latent) stakeholders and are very unlikely to be engaged with the outbreak. Local residents, who may be vulnerable to an outbreak but have no knowledge of it fall into this category. Others may include those with a potential networking stake but are not engaged because their stake is less direct and not immediately connected to tree health.

3. Case-study: Who has a stake in ash dieback?

In this case-study we focus on the ash dieback outbreak in the UK, drawing on the conceptual framework to categorise the stakeholders involved. We trace when different stakeholders became engaged in the outbreak and identify their role as influencers and stakeholders of interest. We then reflect on the usefulness of our framework as a critical tool for stakeholder engagement.

3.1. Outbreak timeline

Pre-pathway and mobilisation: Early warning signs and emergence in the UK
Ash dieback was first identified in Europe in Poland in 1992 (Kowalski 2006). Once established there, it was mobilised onto the pathway and subsequently spread to about 25 European countries over the following decades. Prior to 2012, there was no systematic surveillance in the UK for ash dieback beyond general monitoring for general tree health, assessments for the disease during the National Forest Inventory (NFI), and the UK Plant Health Service's general pest and disease surveillance programme (Sansford, 2013). Although the FC had discussed whether an import ban might be appropriate with the European Commission's Plant Health Standing Committee (PHSC), confusion about the identification of the pathogen made this problematic.

Ash dieback was first identified at a nursery in Buckinghamshire amongst 600 trees from the Netherlands during a routine inspection in February 2012 by the Food and Environment Research Agency (FERA) By August of the same year, ash dieback had been confirmed at four other nursery sites in England. A Rapid Pest Risk Analysis

[1] Scale can be particularly influential here as adaptation may, for example, be the goal of national stakeholders and directly affected stakeholders, whilst those at local levels and (as yet) unaffected by the pest or disease may be focused on avoiding spread.

by Forest Research (Webber and Hendry, 2012) in August 2012 found a range of sites of infection, including newly planted amenity woods and nursery stock, but also extending into the wider environment, especially in eastern and south-eastern England and Scotland.

Introduction, establishment and spread: The ash dieback 'crisis'
In October 2012 the situation escalated with intense media coverage and public concern over the disease. Concern focused on the potential loss of a beloved British tree and the impact on wider biodiversity. At the same time, the disease was attracting political attention and was seen as a 'national crisis' (HCDeb, 2012). A Plant Health Order was issued in October 2012, placing restrictions on importing ash trees into Britain (FC, 2012) which effectively meant a ban on all movements of ash plants or seeds within Britain. Few in the wider forest sector were aware of the extent of the plant trade, including the high number of UK ash seedlings that were being sent to the continent for growing, which is otherwise known as 'ex-importing' (Brasier 2008) A survey by the Horticultural Trades Association (HTA) estimated that around 4 million ash trees had been imported between 2009-2012.

The week after a Plant Health Order was issued, the UK Government's emergency 'Cobra' committee met to discuss how to deal with the outbreak. A rapid survey over the following weekend of a thousand sites that had been planted with ash saplings from infected nurseries was undertaken. Alongside this, a Tree Health and Plant Biosecurity Expert Taskforce was set up to provide independent multi-disciplinary academic expertise, develop strategy and assess the current disease threats to plant health more broadly.

In December 2012, the UK Government published an 'Interim Chalara Control Plan' that outlined a strategy for reducing the spread of ash dieback, developing tolerance in the UK's native ash tree population, and encouraging public and industry action to tackle the problem. Part of the plan involved providing funding for the continued development of citizen science programmes and several ash dieback-specific research projects.

Kent and East Anglia were the first areas in England to be badly affected by ash dieback. In East Kent there have been hot spots of severe infection since 2012, with both young and mature ash being killed. This has led to extensive landscape change in some areas. Kent County Council and other partners declared the outbreak a 'major incident' in November 2012 under the Civil Contingencies Act (2004). As a result, the council set up a multi-agency Strategic Co-ordinating Group (SCG). Partners included county and borough councils, Department of Communities and Local Government, Environment Agency, Kent Tree Officers Group, the Highways Agency, Kent Police, Forest Research and the UK Power Networks. A key concern was the potential financial costs of the outbreak in terms of effective monitoring and timely outbreak management actions (SCG, 2012).

A Pest Risk Analysis published in 2013 identified four main pathways of entry for ash dieback into the UK: the live plant trade, wood, seeds, and contaminated soil (both as a commodity, or with host or non-host plants) (Sansford, 2013). It is believed that the importation of infected plants is the main route of entry into the UK (Sansford, 2013). In addition, meteorological modelling by the University of Cambridge suggested that airborne incursion from the continent was also likely and explained the appearance of ash dieback in natural woodland sites (Defra, 2013), although these findings are contested (Chandelier et al., 2014, Mabbett, 2014).

Containment and mitigation: 'Slowing the spread'
The enrolment of stakeholders in this stage is largely contingent on the geographical spread of the disease. For those dealing with ash dieback in Kent or East Anglia, where the impacts have been the most acute to date, the focus is on containing the disease to slow the spread into uninfected areas, as well as mitigation activities such as removing or pruning diseased trees where there is a public safety risk, and building resilience in existing woodlands. Some stakeholders in these areas, such as public stakeholders, landowners and local authorities, may be moving into the 'adaptation' stage where they recognise that ash dieback cannot be eradicated and there is a need to 'learn to live with it'. Indeed, the government's early recognition that it would not be possible to eradicate ash dieback led to strategies that focused on containment and mitigation, while adaptation measures (such as identifying tolerant strains of ash and building resilience in woodlands) were developed. This is reflected in documents such as the Tree Health Management Plan published by Defra (Defra, 2014).

3.2 Applying the conceptual framework to ash dieback

Through an analysis of the ash dieback case, we have identified a broad range of government, private, civil society and other actors with a stake in ash dieback (Table 2).

Table 2: Stakeholder categories for the ash dieback case study

	Private Sector	*Governmental*	*Civil Society*
	INFLUENCE		
Governors	ConFor	Forestry Commission EPPO EU PHSC DEFRA WTO UK Border Agency Chief Plant Health Officer	
Vectors	Plant nurseries Private land managers Outdoor recreationists Forestry & Arb. Contractors	Forest Enterprise Local Authorities	Land managing organisations (National Trust; Wildlife Trust; Woodland Trust)
Managers	Forestry & Arb. Contractors Forest owners & managers	Forestry Commission Forest Research Local Authorities UKBA FERA SCG in Kent	National Trust Wildlife Trusts Woodland Trust
Monitors	Forestry / Arb. Contractors Environmental consultants Forest owners Citizen scientists General public	Forest Research Forestry Commission FERA Universities & research institutes European plant pathologists Tree Health & Plant Biosecurity Taskforce Norfolk County Council Kent County Council EU projects	Woodland Trust Suffolk Wildlife Trust
Networkers	ConFor CLA HTA Local & national media	Forestry Commission EPPO	ICF National Trust Woodland Trust RHS
	INTEREST		
Outcome Winners	Forestry / Arboricultural Contractors Environmental consultants Scientists	Forest Research Universities & research institutes	
Value Loser	Homeowners / Landowners Forest owners Local residents & communities Recreationists	Forest Enterprise	CPRE National Trust Wildlife Trust Woodland Trust
Cost Loser	Homeowners Forest owners Plant nurseries Plant traders & importers	DEFRA Forestry Commission Local authorities	Land managing organisations (e.g. National Trust Wildlife Trust Woodland Trust)

Table 2 (continuation)			
Collateral Loser	Plant nurseries	DEFRA Forestry Commission High Weald AONB MPs & political parties	Woodland Trust National Trust
Contributors	Plant nurseries & buyers Outdoor recreationists Landscape planners Forest managers/owners	Forest Enterprise Forestry Commission	Woodland Trust National Trust

Categories of influence

Government bodies that include national government departments, EPPO and the World Trade Organisation are the main *governors* in the ash dieback case study. During the pre-pathway stage, UK government bodies such as Defra, the Forestry Commission and the UK Border Agency were responsible for ensuring biosecurity of the live plant trade and undertaking surveillance for pests and diseases not yet present in the UK. However, there were particular difficulties faced by these stakeholders, including the early confusion over the identification and nomenclature of the pathogen which made it especially difficult for the government to regulate. Eventually, once ash dieback was introduced to the UK and received the associated public and media attention, Defra was able to issue a Plant Health Order to ban imports and movement of ash in the UK, to commission the Tree Health and Plant Biosecurity Taskforce, and to undertake the national survey of the disease and provide funding for scientific research. Strong links between governors and monitors are evident here.

The largest group of *vectors* were private businesses, such as tree nurseries, involved in the importation of ash saplings. This trade also involved government bodies such as Forest Enterprise and civil society organisations, such as the Woodland Trust and National Trust. As the outbreak developed, further vectors for spread included forestry and arboricultural contractors dealing with infected trees. Outdoor recreationists were also potential vectors, although this pathway is less likely.

Government agencies and local authorities also had a lead role as '*managers'* of the outbreak , through surveillance and by engaging in control and treatment of infected trees. Organisations such as the Highways Agency and Network Rail were also important managers, as ash is a common tree on roadside verges and railway embankments and these organisations had the skills and responsibility to both monitor and care for them. In addition, the UK Border Agency is responsible for managing infected plants at the border. Private forestry and arboricultural contractors, as well as forest managers, were also engaged in directly undertaking works on infected trees, or, in the early phases of the outbreak, removing newly planted infected ash saplings.

Key *monitors* during the pre-pathway stage were plant pathologists across Europe who were trying to identify the pathogen responsible for the disease. During the early phase of the outbreak, the Tree Health and Plant Biosecurity Taskforce had an important monitor stake through its assessment of the government's approach and recommendations for a future management strategy. As the outbreak unfolded further, scientists, universities and research institutions were enrolled in the outbreak in order to: identify pathways of introduction (including potential for natural windborne spread), improve detection methods, identify tolerant strains of ash, and explore the potential societal impacts and public risk perceptions associated with the disease. Community and public groups were also engaged with, first by early calls from the Forestry Commission urging them to be on the lookout for signs of disease, and then through a number of citizen science programmes aimed at enrolling the public in wider early detection, monitoring, and networking.

The '*networkers'* group of stakeholders is particularly interesting in the ash dieback case. The national media has played a significant role in communicating about the emergence and spread of the disease, with many of the stories calling into question the government's competence to deal with breaches in biosecurity. The intense media focus in late 2012 catapulted ash dieback into the public spotlight and as a result spurred government action. Some civil society organisations, such as the CLA and the Woodland Trust, were vocal in expressing their concerns about the disease, and one of the early 'networkers' was the HTA, who wrote to the FC in 2009

expressing concern about a disease of ash that their members had witnessed in Denmark. Private nursery businesses also express their concern about the disease through the Nursery Group of ConFor. Kent County Council's action to bring together a wide range of government, private and civil society stakeholders in order to coordinate management of the disease in the county is a rare example of a networker playing a more positive role.

Categories of interest
Value losers included residents affected by landscape change, biodiversity loss and recreational impacts (either through degraded recreational space or closed sites). Other value losers include private, public and NGO woodland and tree owners, both in terms of negative impacts on stock, and to ecosystem services (e.g. timber, woodfuel). However, perhaps the most numerous value losers in this were members of the public who saw significant potential to lose a much loved and valued British tree.

Cost losers in the outbreak were plant nurseries that had to destroy large quantities of infected ash sapling stock, as well as woodland owners who have been and will be financially affected by the costs of undesired or early felling, and of restocking woodland. Local authorities in affected areas undertake the cost of funding public safety arboriculture work on diseased or dead trees in their areas, which is likely to increase over time as the disease spreads and further local authority stakeholders become enrolled. Another major cost loser is central government through funding management of the disease and funding scientific research: although some of this resource went to other government bodies increasing their resources

Perhaps the most prominent *collateral loser* is the UK government, specifically in regard to their loss of reputation. Much of the early public and media scrutiny criticised the government's handling of the outbreak, and it could be argued that many subsequent government actions have been blame avoidance strategies to reduce risks to reputation. Further, private plant nursery businesses also face risks to their reputation, due to their role as 'vectors' of the disease.

The ash dieback case highlights a wide-range of *contributors* across government, private and civil society domains. This reveals the difficulty of managing a plant disease that is embedded in the global trade in live plants. Public, private and NGO forest managers seeking stock at the best price created a market for the trade in live ash trees. Growers, suppliers, traders and customers all benefit from this demand, but their activities are complicit in the introduction and spread of the disease.

Arboricultural and forestry contractors are clear *outcome winners*, at least in the short term, as the emergence of the disease provided increased sources of income in dealing with affected ash trees. Further financial benefits accrue for environmental consultants, scientists, universities and research institutions who have also benefited from increased funding for work on ash dieback and tree health more broadly.

4. Conclusion and Policy Implications

This brief analysis of the ash dieback case study has enabled us to sort and classify the stakeholders currently involved in tree health. It also provides insight into how stakeholdership changes over the course of an outbreak. Very few outcome winners were identified, but there were a large number of government, private and civil society losers. The 'vectors' and 'contributors' were largely those businesses associated with the live plant trade, along with their customers. However, those implicated in the introduction and spread of ash dieback have also often been 'cost' and 'collateral' losers. A broad range of governmental bodies have been identified, including several (such as transport bodies) that have seemingly limited involvement with tree health. The media and some private and civil society institutions also emerge as networkers.

We are also able to reflect more critically on tree stakeholder engagement through the framework's lens, and learn lessons for the future. For instance, it is useful to make explicit links between the strong behaviours exhibited by monitors and governors. In the ash dieback case, scientific uncertainty fed inertia amongst policy-makers who did not act on less formal observational 'evidence' of the threat. There are, however, some encouraging signs understanding amongst monitors is improving in the wake of ash dieback, as this category has proactively expanded through engagement initiatives like citizen science. However, governors need to ensure that appropriate processes are in place to effectively take advantage of information that originates from these new sources.

Various arms of the UK government are identified in the ash dieback case, each with their own priorities and stakes in a tree health outbreak situation, but criticism was often directed at 'government' as a whole. Arguably, this case illustrates the political power of public opinion because much action was instigated by the widespread anger at the thought of losing an iconic British tree species. This is similar to what happened with the occurrence of Dutch Elm disease in the UK in the 1970s and '80s.

Due to the nature and evolution of the ash dieback case in the UK, stakeholder engagement has been primarily focused on managing the outbreak itself – that is, on the spread and containment stages. Critically, there is little evidence in this case of pre-pathway engagement, despite knowledge that the threat of ash dieback existed. Furthermore, positive engagement with networkers was virtually absent throughout the outbreak. An understanding of the role these networker stakeholders can play *should* incite their early engagement. In the case of ash dieback, networkers focussed on a reactive critique of the situation, without acknowledging that they could have taken a more productive role in raising awareness. In the case of ash dieback, plant nurseries are 'contributors' and 'vectors', but also 'cost' and 'collateral' losers. Improving understanding about the balance between potential costs and benefits amongst this group seems particularly important. Networker stakeholders have a key role in facilitating such learning and might employ a range of regulatory and market mechanisms, along with strategic communication and education activities.

The retrospective application of our conceptual framework has allowed us to categorise who has which stake in tree health. It has also helped us to reflect on the tree health stakeholder landscape more broadly and critically to identify possible interactions between different categories of stakeholders. Acknowledging these dynamics can lead to improved interventions to better prevent or control future tree disease outbreaks. The tree health sector, and forestry sector more widely, has begun to take stakeholder analysis and engagement seriously: but this has brought significant challenges. Particularly challenging is identifying which actors have important stakes, when and, critically, who should engage them and how? The tree health stakeholder landscape is broad and complex. If stakeholder analysis is too narrow, subsequent engagement will have only limited impact on the outcomes of pests and diseases. If it is too broad, engagement will be too difficult and costly a job for whichever organisations take it on. The framework described here should allow those charged with responding to the threats of tree pests and diseases to rationalise and manage their engagement: targeting it towards the right stakeholders at the right times. It can also facilitate a more holistic and efficient view which takes in multiple pest and disease threats, instead of continuously focusing efforts on individual organisms.

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