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The £15 billion cost of ash dieback in Britain

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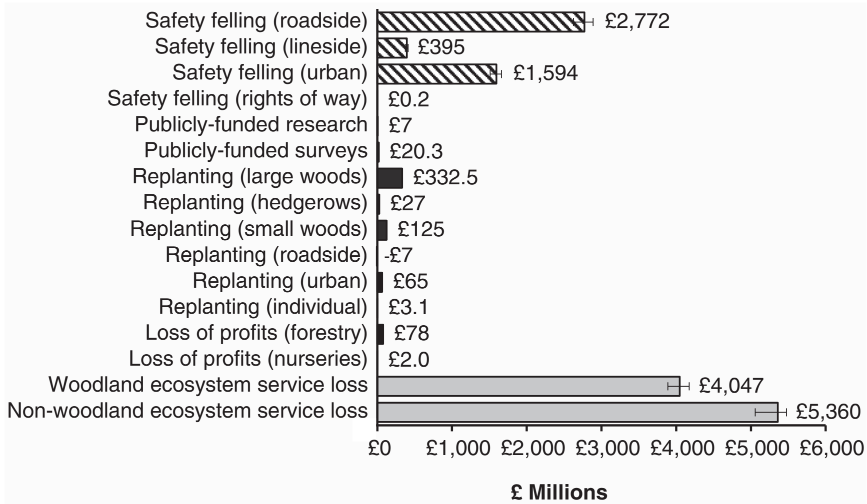

Figure 1. Components of the total tangible cost of ash dieback in Britain.
Clean-up costs are in hashed black, replacement costs are in black, and lost values in grey. Costs are estimated over the next 100 years, although approximately half of the total (£7.6 billion) is expected to be within 10 years (Methods S1). Error bars show best- and worst-case final mortality scenarios (90% and 99% mortality; see Methods S1).

Invasive tree pests and diseases present some of the greatest global threats to forests, and the recent global acceleration in invasions has caused massive ecological damage [1,2]. Calls to improve biosecurity have, however, often lost out to economic arguments in favour of trade [3]. Human activities, such as trade, move organisms between continents, and interventions to reduce risk of introductions inevitably incur financial costs. No previous studies have attempted to estimate the full economic cost of a tree disease, and the economic imperative to improve biosecurity may have been underappreciated. We set out to estimate the cost of the dieback of ash, *Fraxinus excelsior*, caused by *Hymenoscyphus fraxineus*, in Great Britain, and investigate whether this may be the case [4].

We identified an extensive list of factors contributing to the overall cost, and estimated the value of each factor in turn. We used data from a wide variety of sources, including Freedom of Information (FoI) requests to all Local and Unitary Authorities in Britain, and publicly available national surveys, to estimate separately clean-up costs, replacement costs and lost ecosystem values. For ongoing costs, we estimated net present value using HM Treasury-recommended stepped discount rates, and where costs are uncertain, we used a conservative estimate. We estimate the total economic cost of ash dieback in Britain to be £14.8 billion (Figure 1), one third greater than the estimated cost of the 2001 UK foot-and-mouth disease outbreak (adjusted for inflation) [5]. This cost is estimated over 100 years, but more than half of the total cost (£7.6 billion) is expected to occur within the next 10 years (Methods S1). A key output of our analysis is a workbook (Methods S1) containing details of the calculations, assumptions and data sources. The workbook provides a framework for estimating costs arising from tree diseases, and allows users to alter input data to explore the effects of uncertainties in the analysis. All data sources for specific factors are fully referenced in the workbook and supplemental references.

Ecosystem service loss is the largest component of the total cost, in part driven by poor natural regeneration of other tree species, meaning that ecosystem service levels may struggle to recover. However, we found that proactive management to enhance natural regeneration with tree planting could reduce the overall cost by £2.5 billion and prove highly cost-effective (Figure S1; Methods S2). Clean-up costs, such as felling dangerous roadside trees, contributed £4.8 billion to the total (Figure 1). Many of these costs will fall to local authorities — we estimated that the worst affected, Devon County Council, could incur total annual costs from roadside ash trees of over £30 million (two orders of magnitude greater than the average local authority annual tree budget; Methods S1).

Clean-up and replacement costs comprise more than one third of our total cost estimate (Figure 1), yet are typically absent from analyses such as Natural Capital accounting and Payment for Ecosystem Services schemes. Economic assessments that focus exclusively on loss of ecosystem services and fail to account for creation of new ecosystem disservices, such as the increased environmental risks described here, may be dramatically underestimating true costs of biodiversity loss.

Lack of biological data presents a barrier to reducing uncertainty in our analysis. A sensitivity analysis using Monte-Carlo simulations to permute each uncertain model input randomly showed that the annual ecosystem service value of urban ash trees presents the largest single source of uncertainty, followed by estimates of numbers of trees (Methods S1). These knowledge gaps underline a deep issue regarding insufficient investment in ecological monitoring, as without such information, evidence-based responses to environmental crises could be compromised.

A search of the UK's Plant Health Risk Register [6] identifying those threats that, like ash dieback, have the highest impact and value ratings, revealed 47 other tree pests and diseases that may have the potential to cost one billion pounds or more to the British economy if they were to become established (Methods S1). This preliminary assessment suggests a major and poorly considered economic risk, yet only describes the known risks for Britain — emerging pests and pathogens are continually being identified worldwide, but are very challenging to detect before problems become apparent.

The magnitude of these estimated costs suggests that increased investment in effective prevention of invasive pathogen and pest introductions is likely to be a highly cost-effective policy. International trade in live plants for planting is known to be a major route by which tree diseases are transported within and between continents [7], and is thought to be the largest factor behind the recent dramatic growth in pest and disease invasions [8]. As well as spreading known tree health threats, trade in live plants facilitates the movement of novel pests and diseases. Such unknown threats are particularly insidious and difficult to control through screenings in trade, but can be just as severe and damaging [2]. Ash dieback – which is now considered to have spread to Britain from continental Europe both via wind and via imported plants – is believed to have been first imported into Poland as an unknown organism on live ornamental plants, thus beginning the European epidemic [4].

Historically, trade in live plants has been prioritized over plant health [3], even though its value is small when compared with other sectors of the UK economy and the scale of disease impacts. In 2017, the annual value of trade (imports and exports) in live plants to and from Britain was roughly £300 million [9], representing only 2% of our estimated cost of ash dieback. Ignoring the potential costs of invasive species distorts market economics in ways that are likely to inflict economic costs to society and harm to ecosystems — the magnitude of our estimated costs suggests a severe market failure. Strengthening national biosecurity measures, as well as those laid down by the International Plant Protection Convention, are likely to be highly cost-effective policy measures, as well as being critically important for environmental protection.

We examined a single pathogen epidemic in isolation, but the impacts of multiple epidemics could accumulate, either additively or in complex, unpredictable ways. As more species are lost, reduced or weakened due to disease epidemics, so the resilience of ecosystems might be reduced, and simultaneously the value of ecosystem services from remaining trees may increase [10]. Such events could only increase the costs to society and strengthen the conclusions drawn here.

International trade in live plants and soil contributes greatly to the global movement of pests and diseases, but its value is dwarfed by the potential and realised costs of tree disease invasions, making international trade an obvious target for policy changes aiming to strengthen biosecurity measures. An enhanced international focus on prevention and resilience is required to limit the impacts of invasive tree pests and diseases, economically as well as ecologically, and should be urgently sought.

SUPPLEMENTAL INFORMATION

Supplemental Information includes supplemental experimental procedures, one figure and two methods files and is available at https://doi.org/10.1016/j.cub.2019.03.033.

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DECLARATION OF INTERESTS

The authors declare no competing interests.

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