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Dutch Elm Disease management in East Sussex

Lessons for other tree health management schemes

Final report

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Executive summary

The outbreak of a newly introduced Dutch Elm Disease (DED) fungus in the 1970s led to the death of most mature elm trees across the UK, but in some parts elm trees survived (Brasier, 1996; Tomlinson and Potter, 2010).

In Brighton and Hove and in some parts of the South Downs mature trees remain mainly due to geographic advantages. East Sussex County Council (ESCC) established the DED control programme in 1971 (ESCC, 2012) to manage the disease. However, due to a mixture of political and financial limitations the disease was not eradicated from the area after the first epidemic (Tomlinson and Potter, 2010).

The beetle population that spreads the disease decreased with the decline in available breeding grounds, as mature elm trees were especially affected by DED. Across East Sussex the beetle population may now increase again over time as younger elm trees reach maturity. Management of DED in the Brighton area, within the ESCC control zone, and in Eastbourne has seen changes over the years; in responsibility, budgets and man power. The latest wave of increasing beetle numbers has presented itself in recent years, but the population currently seems to be reducing again. This has led to a reflection on the strategy used in the past years to see whether a more targeted approach that prioritises particular areas and trees might be more cost effective.

> **Key findings**
> In East Sussex a new approach to managing Dutch Elm Disease is suggested as a more efficient and cheaper approach. This success of this priority approach that targets specific areas and trees however depends on:
>
> - A new prioritised approach to managing the outbreak was preferred by managers and the public. However, some fundamental uncertainties regarding the pest and disease dynamics remain.
> - There is a lack of knowledge about trees by the public but less so about the disease – the focus was on outbreaks and management and not the stock of trees.
> - Data has to be available and accessible to all those involved in the management of tree health to plan and monitor the success of the approach. This should include public accessibility to benefit citizen scientists.
> - As a non-statutory issue, devolved management allows for both spatial and temporal variation in responses. An organizational champion and coordinating body (such as the Elm Partnership in East Sussex) is required to organize management across administrative boundaries.
> - Sufficient financial and human resources to allow for effective monitoring are required. Funding for the new prioritization approach in East Sussex was approved after the project completed

The DED Management in East Sussex (DED MES) project, reported on here, supported this reflection by undertaking an integrated, interdisciplinary assessment of the non-statutory interventions against DED carried out by East Sussex County Council (ESCC) on the south coast for the last 40 years and analysed potential future scenarios of management: What have been past management strategies of DED in the Control Area? What are the social and

cultural values of Elm trees? And what are plausible future management scenarios for the management of Elms in the DED Control Area?

Three different management approaches were compared:

- *Business as usual*, characterised by sanitation felling and burning. This process involves identifying disease-affected trees within four to six weeks of the symptoms becoming apparent and in this window of opportunity felling the tree and burning all the associated material.
- *Doing nothing*, which will let the disease affect all elm trees in a relatively short period of time.
- *Priority approach*, which targets particular areas and trees. Rather than immediately felling and removing the tree it relies on allowing some infected trees to be utilised preferentially by beetles for feeding and egg laying rather than moving to unaffected trees. Finally trees are destroyed just before the beetle larvae emerge as adults thereby reducing beetle populations and preventing migration of the disease. It has been seen as a more cost effective approach to reduce the beetle population, and hence spread of the infection, with the minimum felling of elms.

Spatial epidemiological modelling (undertaken as a separate part of the project, and is described elsewhere, Cunniffe, 2013) showed that the least number of trees will die under the priority approach and that it can slow down the impact of DED. An economic assessment also showed that costs will be least under this approach because elm trees will live longer. Two rounds of on-street engagement produced an informative and strong starting point to attempts at gauging public values and perceptions of tree health linked to which management approach they would support. Participants were also in favour of the priority approach.

The success of a more targeted approach however depends on a number of factors. Firstly there is a gap in awareness of tree health. On-street engagement highlighted the lack of knowledge about trees in general and Elm trees in particular. It was quite striking how local inhabitants were not aware of the number of elm trees that still remained in their village/town/city, despite often being very informed about the disease. Perhaps this increased knowledge of the disease over the tree itself comes from the information sources available to them, such as newspapers and television programmes, which may tend to focus on outbreaks and management rather than presence and abundance of existing stock – the narrative *after* the outbreak story.

Secondly, data has to be available for monitoring the status of trees and beetle population. This will allow the gathering of evidence on whether the chosen approach is working or needs adapting. Citizen science could help with the baseline data collection about the current status of trees as well as monitoring a large number of trees spread over a wide area, such as the control zone in East Sussex.

Thirdly, overall coordination from central government appears important in order to maintain pest and invasive species management as a local strategic priority (within varying local priorities) by providing a clearer framework to operate within. The devolution of control to local authorities and other organisations (including charities and private sector groups) means that the priority and funding allocated to DED management can vary across geographic and administrative areas through time. This uncertainty results in sub-optimal control of the spread of the disease.

This projects findings indicate that sufficient financial and human resources are needed to plan, coordinate and monitor the management of tree health across large areas. As tree diseases do not follow administrative boundaries it is also critical to design collaboration across administrative and organisational boundaries. This in turn will ensure a continuous management of tree health and the potential eradication of diseases affecting tree species in the UK.

1. Introduction

The outbreak of a newly introduced Dutch Elm Disease (DED) fungus in the 1970s led to the death of most mature elm trees across the UK, but in some parts elm trees survived (Brasier, 1996; Tomlinson and Potter, 2010). In East Sussex, native English Elm and Wych Elm (which are susceptible to the disease) dominated the landscape (Brasier, 1996). In Brighton and Hove and in some parts of the South Downs mature trees survived mainly due to geographic advantages with the sea to the south and a range of hills to the north.

East Sussex County Council (ESCC) established the DED control programme in 1971 (ESCC, 2012) to manage the disease. However, due to a mixture of political and financial limitations the disease was not eradicated from the area after the first epidemic (Tomlinson and Potter, 2010).

The beetle population that spreads the disease, decreased with the decline in available mature elm breeding grounds, as these trees were especially affected by DED. However in East Sussex the beetle population may increase again cyclically as younger elm trees mature. Management of DED in the Brighton area, within the ESCC control zone, and in Eastbourne has seen changes over the years; in responsibility, budgets and man power. Figure 1 shows the current DED control area which is part of a wider control area that also covers Brighton and Hove. It depicts the places where single or clusters of elms are found and whether they are infected. This highlights that the disease is prevalent across the entire population. The control area was created for three main reasons (ESCC, 2012):

- To maintain the Sussex elm population, which is considered by Natural England to be of regional importance, with the National Elm Collection located in the Brighton and Hove City Council area.
- To avoid the costs of clearing the likely damage that would be expected from letting DED spread in an uncontrolled manner.
- To discharge a legal duty on organisations to manage the health and safety risk posed by diseased trees on their land, for instance on roads, motorways and railways.

In the past 40 years DED has been managed through a combination of methods, but mainly through the felling of infected trees, or parts of trees, with burning of infected material as quickly as possible to prevent further spread of the infection (ESCC, 2012). In terms of future control of DED in the area, Harwood et al (2011) suggest that management in the Brighton area can be effective, but 'repeated disease cycles will erode mature tree numbers over time, and are likely to overcome management eventually'. A new wave of increasing beetle population has presented itself in recent years, but the population currently seems to be reducing again (R. Strong, Save the Elms Campaign). This decline has led to a reflection on the strategy used in the past years to see whether a more targeted approach that prioritises particular areas and trees might be more cost effective.

1.1 Aims and objectives

The DED Management in East Sussex (DED-MES) project undertook an integrated, interdisciplinary assessment of the non-statutory interventions against DED carried out by East Sussex County Council (ESCC) on the south coast for the last 40 years and analysed potential future scenarios of management. The project represents a collaboration between SEI, FERA and The Dutch Elm Disease Office for ESCC.
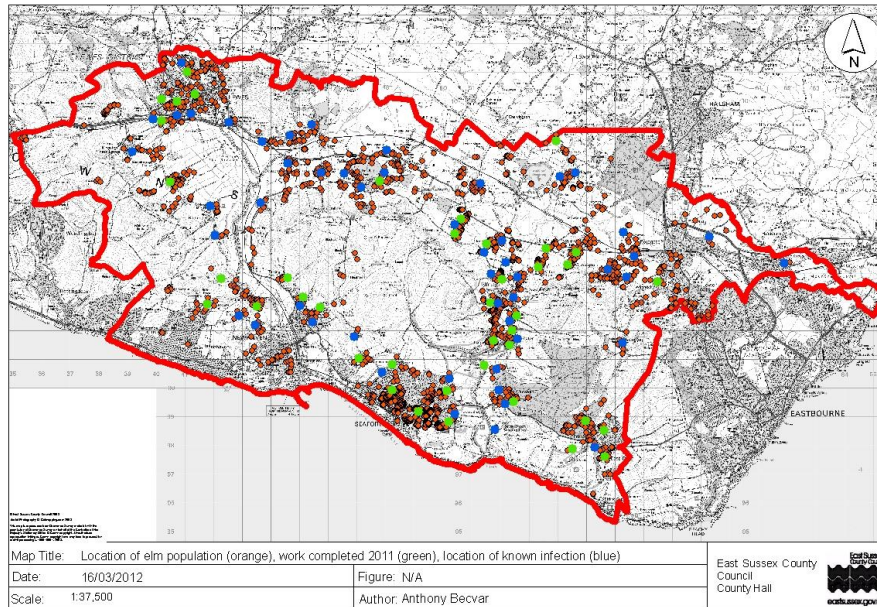
Figure 1, DED Control Area and point locations of the elm population (orange), work completed in 2011 (green), and location of known infection (blue) (ESCC, 2012)

The DED-MES project team worked together with the DED Officer for ESCC and the Elm Partnership to answer the following research questions:

- What have been past management strategies of DED in the Control Area?
  - What information was used to decide these approaches?
  - What lessons can be learned for future management?
- What are the social and cultural values of Elm trees?
  - How do residents value the remaining Elm trees?
  - Does this differ between geographic areas, participant age, and involvement with Elm tree management?
- What are plausible future scenarios for the management of Elms in the DED Control Area?
- What are the potential social and cultural costs and benefits of the identified scenarios?

The Elm Partnership is a group whose members are those organisations, companies, and local authorities that are directly or indirectly involved in the management of DED in the area (ESCC, 2012). The partnership was active for a long time, but became less functional in recent years. In July 2012 the new DED officer in ESCC invited all members to a meeting to re-invigorate the partnership. This meeting indicated that all members were still very interested in, and engaged with, the management of DED and agreed there was a need for future management of the disease. However, members had different opinions on the best future strategy. They raised questions including: Are we delaying the inevitable? Is the current management approach sustainable in the long term?

The DED-MES project facilitated a discussion about future management strategies in the area during two meetings with the Elm Partnership. Two rounds of on-street engagement with residents provided the means to gather complementary information around perceived benefits and costs of having elm trees in the area.

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2. Historic management

Through telephone interviews with key stakeholders in the control area a number of critical factors emerged in terms of how strategies were arrived at and what information was utilised in those decisions.

The management strategy for the control of the disease does not seem to have varied since the millennium. The ideal DED management was characterised as:
- Fell infected tree within 2 weeks of infection
- Dig a trench around the tree roots to prevent fungal spread to other trees in the vicinity
- Remove the tree stumps

(This approach is described in more detail below under sanitation burning and felling).

This practice has been used across the area by all the organisations involved in controlling the spread of DED. The evidence used for this strategy comes from recommendations made by Government Agencies such as Forest Research, Natural England and its predecessors. This evidence appears to have originated during the original wave of infection from the 1960s and 70s when control strategies were first evaluated. Most of the stakeholders referred to guidance passed onto them from previous post-holders rather than new or first-hand literature that they had evaluated in making decisions on strategy.

A number of alternative approaches were mentioned by stakeholders including pesticides, aerial pruning and root trenching. However, these were far less common or in some instances discontinued as they had proved ineffective (e.g. pesticide injections).

Meetings with the current key stakeholders (those involved in the Elm Partnership) highlighted that for most there remain a number of fundamental uncertainties concerning how the disease, the trees and the beetles affect one another. It is common knowledge that the beetle population feeds on elm trees, which is how they infect the trees. But not all trees are breeding grounds because an infected tree is not immediately in the right condition in terms of tree moisture levels to be an attractive breeding ground. The beetles only lay eggs in trees that are dried out to a particular level. This caused confusion amongst the group in terms of its implications for management.

Ray Strong and Stewart Derwent, members of the Save the Elm Campaign and part of the Elm Partnership, have been involved in the management of DED since the first outbreak. This group of volunteers have actively managed elms, monitored the disease and collected empirical evidence over the years about the behaviour of the beetle population. There appears to be 2 to 3 cycles of beetle development in the warmer months of the year, between spring and autumn (ESCC, 2012). Ray Strong described the delay between infection and the need to fell a tree in relation to the likelihood of a tree having become a breeding ground for the beetle:

'Trees that show the symptoms in June are trees that were infected the previous year, but they didn't show symptoms. We identified a number of trees that were stand-alone trees. They became infected and none of those trees had emerging beetles in September. That's one indication of the delay time before the infection and the need for getting it down. But because there is 2.5 emergence we do have the potential for identifying 3 different timings.'

2.1 DED Management Practices

Seven different strategies were identified during the phone interviews that had been used to manage DED: Sanitation burning and felling; Aerial pruning; Root trenching; Ring barking; Pesticide injection; Pheromone trapping; and Sponge or Trap trees. The most often used response involves sanitation felling and burning and, in case of an early identification of infection, aerial pruning. This approach happened in the control zone until last year and still happens in Eastbourne.

Financial and legal constraints challenge the effectiveness of any management approach. Overall health and safety requires certain trees to be cut down. In the control zone a tree can only be removed after securing an agreement of appropriation of removal costs from relevant landowners. In cases where the landowner is unknown or difficult to contact this process can take a long time. It is also constrained by available manpower to identify the infection and to remove parts of a tree or an entire tree. In Eastbourne landowners are asked to pay 50% of the costs of felling.

2.1.1 Sanitation Burning and Felling

The key response to DED in the areas of the UK where management activity still takes place is sanitation felling and burning. This process involves identifying disease-affected trees within four to six weeks of the symptoms becoming apparent and in this window of opportunity felling the tree and burning all the associated material. The ability of local authorities and management agencies to respond in this short time-span is obviously dependent on their own staffing availability for identifying or confirming the presence of the disease (where it has been reported by other parties) and also that of relevant contractors responsible for undertaking the felling and disposal. Other constraints on the rapidity of this process is securing agreement from relevant land owners and also agreeing appropriation of costs when policies for co-funding removal costs are in place.

2.1.2 Aerial Pruning

If infection is identified early the other common approach is to remove and dispose of the diseased limbs leaving the remainder of the tree to regenerate. This approach relies on rapid identification and is also constrained by resource availability to undertake the pruning swiftly to improve the likelihood that the disease does not spread (to other parts of the infected tree and also its neighbours).

2.1.3 Root Trenching

The approach of cutting roots to prevent the spread of the fungal infection between trees has been applied less commonly. This is mainly due to the cost of the procedure along with the difficulties of getting digging equipment into remote or sensitive places (parks etc.).

2.1.4 Ring Barking

This practice involves the removal of bark around the trunk, girdling the trees. This removal causes the material above the ring to die. This approach has been used relatively infrequently.

2.1.5 Pesticide injection

Early Forestry Commission guidance recommended the injection of pesticides into infected trees of high value. However, the process is now relatively uncommon primarily as it has proved less successful than hoped in combating the infection.

2.1.6 Pheromone trapping

This approach involves encouraging beetles to traps through their attraction to synthetic pheromones. Due to the poor performance of such traps this technique is not widely used, however, some experiential evidence exists that it could be successful if a sufficient plume of pheromones could be produced to encourage significant numbers of beetles to the traps.

2.1.7 Sponge or Trap trees

This technique involves identifying infected trees, but selecting which to fell and which to become sponge/trap trees. On identification of the latter, rather than immediately felling and removing the tree it relies on allowing some infected trees to be utilised preferentially by beetles for feeding and egg laying rather than moving to unaffected trees. Finally trees are destroyed just before the beetle larvae emerge as adults thereby reducing beetle populations and preventing migration of the disease. It has been seen as a more cost effective approach to reduce the beetle population with the minimum felling of elms.

2.2 Institutional changes over time

In the East Sussex control area, DED has been managed since the 1970's but the coordination of control activities to manage DED has changed over the years. Although the ESCC set up the programme, the South Downs Joint Committee (SDJC) managed the area between Brighton and Eastbourne for most of its existence, on behalf of ESCC. The SDJC approach to DED control split the control zone into 3 areas, each managed by seasonal staff and overseen by a full time Officer. The aim was to fell all infected trees, or aerial infections, as soon as they were spotted (ESCC, 2012). ESCC took over the delivery of the programme from April 2011 onwards. During the 2011 and 2012 DED seasons ESCC set up contracts with mostly local tree specialist companies to fell and burn diseased trees. Most diseased trees have been spotted by members of the public, 27 of whom became Elm Protection Volunteers, providing information on the location and numbers of infected trees in their specific area. In the same period the size and shape of the control area changed (Figure 2).

Within the control zone different local authorities have varying levels of knowledge, and priorities that influence how they manage DED. These are related to how much budget is available but are influenced by; the trees population (relative maturity) and distribution (urban vs. rural); and local factors such as health and safety for people and property taking priority over biodiversity and environmental management. Other organisations such as the Forestry Commission and National Trust also manage parts of the control zone. These and other organisations and local authorities within East Sussex, including Brighton and Hove and Eastbourne are represented in the Elm Partnership that was set up to coordinate DED management.

2.3 Future DED management

From the stakeholder interviews and the relevant academic literature a variety of recommendations for invasive disease outbreak management become apparent.

The proposed change in strategy under consideration by ESCC towards a trap tree approach was identified through an assessment of literature for national and international best practice (from UK (Edinburgh, Isle of Wight), Netherlands, and New Zealand). It is a shift from an emphasis on the management of infected and dead trees to the management of the beetle population. The DED Control officer for ESCC (Anthony Becvar) was also informed by local citizen scientists who had made observations of the spread of the disease over the

past decades in the local area. These sources indicated that a new approach might be more effective in combating the spread of the disease whilst also being more cost efficient. These approaches address the need to reduce the effectiveness of the beetle vector population (Brassier, 1996).
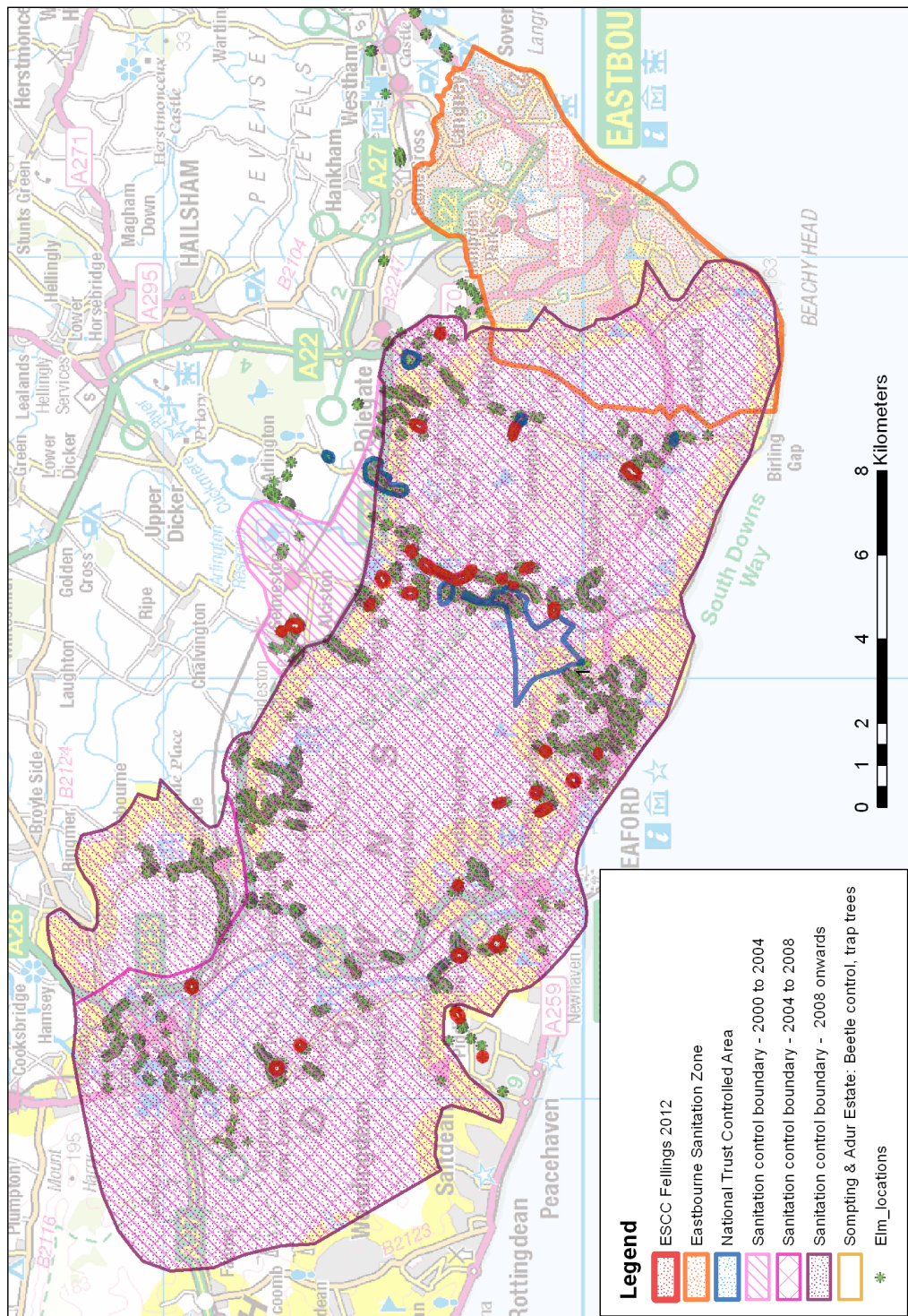
Figure 2, Current and past control zones. Sompting which is mentioned in the text lies to the West of Brighton of the map and outside the control zones.

3. Awareness and values of (elm) tree landscapes

Since the 1970's outbreak many elm trees died and the landscape across the UK changed (Brassier, 1996). This has impacted the awareness of elm trees in the population and it might be that the perceived social and cultural values of elm trees relate to this awareness. Underlying DED management in East Sussex is the regional importance of the elm trees in the landscape for wildlife, sense of history and official designation.

To inform the discussion about future management strategies of elm trees in the area, the social and cultural costs and benefits need to be taken into account. How do residents value the elm trees in their local area? Research shows that trees contribute to people's well-being, physical and mental health, and sense of place (Gómez-Baggethun and Barton, 2012). Other social and cultural values are: landscape aesthetics, cultural heritage, recreation and tourism, and spiritual and religious significance (Daniel et al, 2012); values such as social cohesion and education relate to the perceived societal benefits of the presence of elm trees. Trees and green spaces in general also have a potential to deliver disservices, especially more mature and larger trees (Gómez-Baggethun and Barton, 2012). Examples of disservices are the potential for too much shade, blocking views, accidents, fear of storms affecting the trees and consequently houses or cars, fear of the Dutch elm disease, and allergies.

The East Sussex control area features both rural and urban landscapes. Values and awareness of elm trees is likely to differ between people who live in either landscape. Gómez-Baggethun and Barton (2012) highlight: "Articulation of social and cultural values into decision-making processes can be particularly challenging in urban areas because of the very high cultural and social heterogeneity. For this reason, we would also expect values of sense of place, community, and social cohesion to be more diverse in urban settings *vis a vis* rural and wild areas." The experiences of green space and trees for people in urban areas are much more diverse than those for people living in rural areas. The spatial scale of the presence of elm trees will also influence the perceived values. It depends whether people have experiences with street trees, open spaces with elm trees, urban trees, or a forest of elm trees (Roy et al, 2012). Those experiences can also depend on interests and age.

3.1 On-street engagement

In this project awareness and perceived values of elm trees were captured during two rounds of on-street engagement. The project team captured the views of 58 participants in total. Table 1 shows the division in age and gender of participants. Most participants were residents in the area (38 out of 58 participants) and therefore had local experience of the environment.

Table 1, Overview of participants of the on-street engagement during first and second round of engagement (First round + Second round)

	18 – 25	26-40	41 – 60	60+
Men	1 + 1	3 + 3	4 + 5	10 + 4
Women	0 + 1	1 + 4	8 + 2	5 + 6

The towns and cities where on-street engagement occurred were selected to represent the different types of elm tree landscapes in the area (Roy et al, 2012). As most participants were residents in the area it makes it possible to reflect on the answers given by them also in terms of the type of elm tree area participants would have experienced.

Rapid Appraisal Participatory-Geographic Information System (RAP-GIS) engagement (Cinderby, 2010) was conducted in three areas, as seen in Figure 3: Preston Park in Brighton, East Dean village market in East Sussex and Seaford High Street in East Sussex. The second round of engagement (not involving RAP-GIS) took place in Preston Park in Brighton, Seaford train station in East Sussex, and the county library in Eastbourne.

Figure 3, A map showing the locations of the first (RAP GIS mapping) and second round (slides) on-street engagement

For the RAP-GIS activity, a map of the area was laid out on a table with numbered and coloured flags assigned to participants. People were asked a series of questions concerning elm trees, how they valued them and their thoughts on management. Participants were asked to place flags in the map to identify areas of known elm trees and known management schemes.

The second round of engagement used a series of laminated slides in a flipbook to provide information and images (see Appendix 2). Firstly passers-by were asked if they were aware of elm trees and/or elm tree management in the area. They were then shown a map of the numbers and the current distribution of elm trees across the South Downs area. They were then shown a series of pairs of images and were asked to state their preference. This technique has been used in many studies to ascertain user preferences (e.g. Barroso *et al.* 2012). The images reflected the three management scenarios being considered by ESCC (see the section 4.1 Economic assessment of scenarios for further explanation) – in a fictional landscape an elm tree was present to represent the priority approach, a landscape with no tree represented the doing nothing scenario, and the landscape with an alternative species of tree (Turkish Hazel – used in Eastbourne occasionally to replace an elm tree if removed) represented the business as usual approach. When their overall preference was identified,

the same series of images were shown again but this time with the cost associated with implementing that strategy over a 10 year period (values obtained from the economic assessment of this project, see section <mark>Error! Reference source not found.</mark>). The participant was again asked to identify their preference in light of this new information.

3.2 Awareness of elm trees and management

Generally participants were very positive about the presence of trees; some were specific about elm trees. The residents in Brighton tended to be the most aware of elm trees and DED management in the surrounding area and valued elm trees highly. This was shown through their extensive knowledge of elm trees and DED in the past and present, and comments about how elm trees were part of Brighton's history and culture. Seaford participants were the least aware of elm trees in their area although they were keen for more trees to be planted. Seaford participants were also among those who saw the most issues with elm trees, stating problems around tree roots in pavements and the blocking of light. East Dean participants were aware of elm trees but less so than Brighton participants, and not many were aware of trees in their area.   They were more aware of tree management in a nearby forested region, managed by the National Trust (see Figure 2). Participants felt that removal was necessary if trees were infected and it was worth it if it meant protecting healthy trees. Eastbourne participants were unaware of elm trees in their area but were relatively well informed about previous management attempts, commenting on tree surgeons operating in the area, knowledge of DED spread in the area and information from television programmes.

Rotherham (2007) discusses how the landscape as we see it now is a depiction of decennia of human management of that landscape. Old and mature trees represent part of that history, but as such can be looked at from a historic perspective or a current ecological and social perspective based on how they look like now. Rotherham describes how in some landscapes this knowledge about the historic use of elements within that landscape is forgotten but in East Sussex this is not the case. Several participants related to the historic use of the elm tree in which the wood was used to build coffins.

Participants in all locations in the second engagement exercise were surprised by the map showing the numbers and the location of the current elm tree population; many commented on how many more were present than they realised. This was particularly noticeable in Eastbourne and Seaford.

Many participants mentioned watching a documentary programme broadcast on Southern television a few weeks prior to the second on-street activity. We have been unable to discover what this was, but participants told us it was a review of elm tree management today in the Sussex region. Those who mentioned it were very positive about the provision of information through this programme and found it very informative. Participants at all locations were also very receptive to information that we provided, and many people stated that they had learnt something from the exercise. This highlighted the gap in existing knowledge and indicated a willingness of people to learn more. There is a need for more education and public engagement on this topic in this region to provide underlying backing for management options and funding.

Brighton

Over 70% of the participants in Preston Park were aware of elm trees in the area, and many knew of Dutch Elm Disease and the management of elm as a consequence. Many participants could identify exact locations on the map where they were aware of elm trees being present, although in the second activity certain participants were surprised to find out that many of the trees around them in the park were elms.

Certain participants were well informed on the DED issue and its history with several aware of the Friends of Preston Park group. Participants were positive about the management of elm and trees in general, mentioning monitoring, replanting and public education as priority management strategies, but also they were aware that it is an expensive process. One participant talked about his orienteering group and how recreational uses of wooded areas could have a negative impact on the control of disease.

Seaford

Four of the nine participants in Activity 1 and two of the eight in Activity 2 were aware of elm trees in the area and only three were aware of DED. Most participants in Activity 2 were surprised by the number of elm trees still standing in Seaford. Most participants were aware of management of trees in and around Seaford, not necessarily elm tree management, and one participant wanted more trees in Newhaven. Participants felt trees were being removed as they were bringing up the pavements, blocking views from buildings and clogging drains with leaves – some were happy for this to happen, others less so. Generally participants wanted felled trees to be replaced.

A participant who did not know of management in Seaford knew of management in Brighton. Participants said that removal was necessary if trees were infected and it was worth it to protect healthy trees.

East Dean

Six of the eleven participants in East Dean were aware of elm trees in the area. Several people were aware of the National trust involvement in management of trees in West Dean and Friston Forest. Preferred management strategies were replanting trees, protecting native species and education. One participant was a DED management volunteer in West Dean and was very knowledgeable on DED.

Eastbourne

Three of the twelve participants were aware of elm trees in Eastbourne and most were surprised by the number of trees still present when shown the map. One person mentioned that they were aware of management in Preston Park in Brighton but not in the local area. Another participant felt very strongly about the management of trees; he believed that trees were chopped down too quickly and was concerned that "rogue tree surgeons" had no ecological knowledge of what they were doing. Several people believed that management was important but also the problems of trees in urban areas (root, blocking the light, dropping sap on parked cars, "some trees are wobbly and past it", disputes with neighbours) were an issue.

3.3 Values of (elm) trees

Although the research looked at the values of elm trees not all participants were aware of elm trees or able to distinguish them from other trees. In those cases the same questions were asked but the participant was asked to think about trees in general.

Residents described the values of trees as ecological (habitats for wildlife), environmental (fresh air), recreational (meeting points, play areas for children), visual (beautiful, brightens up towns, nice to look at), emotional (makes you feel good and relaxed, love them, beautiful, make you smile) and medicinal (healthy).

In every instance in Activity 2 the participant's preference was the picture of the elm tree. This was usually due to its appearance (green, bushy, natural) when compared to the other species of tree, and due to the value of having trees (I'd rather have a tree than no tree) when compared to having no trees. When comparing the other species of tree with the option of no trees, participants gave a mixed response. Some preferred having a tree than none at all, others were more particular about the type of tree they wanted to see and chose no tree. This may have been an artefact of the images shown, but overall participants preferred a tree, preferably an elm tree, above no tree.

Brighton

Participants referred to elm trees as a part of history. Here participants described the value of trees as ecological (habitats for animals, shade), environmental (fresh, clean air), visual (beautiful), cultural (part of history) and emotional (beautiful, make you smile). Two participants talked about the elm tree in their village as being the centre of the village, morris men used to dance around it and the local pub was named after it. It had to be cut down and many residents fought to keep it. Other participants said it was important to protect elm trees as they wanted their children to grow up knowing what one looks like.

Several participants here also commented on the value of the elm being a native species and how these especially should be protected.

Seaford

All participants were positive about the presence of trees, describing the value as ecological (habitats for animals), recreational (meeting points, play areas for children), visual (beautiful, brightens up towns, nice to look at), emotional (friendly) and environmental (they are the lungs of the world). However much less emphasis was placed on elm trees specifically and value was expressed with regards to trees more generally. The problems of trees in urban areas, such as roots lifting up pavements, were expressed in Seaford more so than in Brighton.

East Dean

Participants described the values of trees as ecological (habitats for wildlife), environmental (fresh air), emotional (makes you feel good and relaxed, love them) and medicinal (healthy).

Eastbourne

The people involved in Eastbourne value trees ecologically (habitat for wildlife), environmental (reducing soil erosion, fresh air, more robust landscape), emotionally (love trees, stewardship, precious) and medicinally (healthy). It was felt that trees are important and that we should protect them but that they also cause problems in urban areas.

3.4 Lessons for other tree management schemes

The techniques used proved useful for engaging the public. The map in the RAP-GIS activity provided an excellent focus for people to think about the questions and the relevance to themselves and their surroundings (Cinderby, 2010). It gave the issue context as well as being an effective data collection method. It was also a great way to attract people to take part in the first place, as it looks different to other survey techniques.

The laminated slides in Activity 2 were also a useful tool in providing a visual aid to the survey and made the activity very mobile. It made it very easy to provide information and key facts on these slides, which appeared to be popular with participants, many of whom felt they had learnt something through the exercise. It would be interesting to review to what extent the quality of the photos influenced the respondents answer. The quality, clarity and appropriateness of the photos themselves would undoubtedly have affected the extent of how positively or negatively participants felt about the image. This would make an excellent further study.

In nearly every case the participant asked for more information about a topic or commented on a piece of information as being new. These types of engagement inform and educate participants as well as gaining their opinions with these exchanges being useful for improving local awareness and public perception of an issue.

The demographics of the participants did not appear to affect the responses they gave. It would be easy to assume that older participants would be more aware of DED as it was an issue that affected the entire country from over 40 years ago. However there were many younger participants who were just as knowledgeable. Perhaps their experience of DED is different (younger people might remember trees being removed whereas older people might be much more aware of the national extent of the problem). The more noticeable variable that depicted knowledge of the issue was location. Brighton residents were the most aware and valued elm trees the most. This is likely to be because of the status the trees hold in the city (being home to the national collection), the level of protection they receive, the budget employed for management, and the park locations of many of the oldest trees. The opposite appears true in places like Seaford, where the elm tree is not celebrated.

This engagement work was an informative and useful starting point in attempts at gauging public values and perceptions of a problem. It gave an insight into people's views and opinions; things they have seen and read; where they obtained their information; and how they interpreted it. This is of particular relevance when considering current national-scale, highly topical issues such as Ash Dieback. It was quite striking how local inhabitants were not aware of the number of elm trees that still remained in their village/town/city, despite often being very informed on DED. Perhaps this increased knowledge of the disease over the tree itself comes from the information sources available to them, such as newspapers and television programmes, which may tend to focus on outbreaks and management rather than presence and abundance of existing stock – the story *after* the outbreak story. This is an interesting area that has significance for any future awareness programme.

4. Scenarios

Historic management in East Sussex has led to the cutting down of many elm trees, but also to the continued presence of elm trees 40 years after the first outbreak. Without management the disease would have likely infected all English elm trees in the area. As indicated in Chapter 1. Introduction**Error! Reference source not found.**, ESCC started an evaluation in 2012 of the effectiveness and efficiency of the management to date in consultation with several experts in the area.

The Elm Partnership had a meeting in July 2012 to restart their discussions and coordination of the management. In two consecutive meetings with the Elm Partnership the implications of three potential future strategies were discussed: *Business as usual*, *Doing nothing* and a new *Priority approach*. The first meeting helped to define the different management strategies, especially the *Priority approach*, and think through the legal, financial and spatial implications. The second meeting presented three scenarios. This included results in map-form from the epidemiological modelling, that was done as a separate part of the project, and is described elsewhere (Cunniffe, 2013). The maps that were shown indicated a spatial distribution of likelihood of trees dying in ten years under each management scenario. An economic cost benefit assessment was also undertaken to compare the management costs across the three different scenarios.

In this chapter the economic assessment is presented as well as the discussion that ensued after presenting all three scenarios to the Elm Partnership. The feedback received from residents when they were presented with the costs of the three scenarios is also presented.

4.1 Economic assessment of scenarios

4.1.1 Business as usual

This scenario looked at the implications of DED management being taken forward in the same way as has been done over the last 40 years. The control zone would stay the same and it was assumed that financially and institutionally ESCC would manage the control zone, and that Brighton and Hove and Eastbourne would control their urban areas. In Eastbourne land owners would continue to pay for half of the removal costs. In the control zone landowners would pay for removal and in Brighton and Hove the council would pay. The cost implications are shown in Table 2.

4.1.2 Do nothing

In this scenario it was assumed that budgets would be cut and no money would be spent on managing the spread of DED. This would rapidly affect all English elm trees because the beetle population would be able to rise rapidly and infect an increasing number of trees. Because infected trees would die this scenario causes, in a short period of time, high costs in management. All street trees will have to be cut down, pavements will need to be reinstated and potential new trees will be purchased to replace the mature elm trees. In the economic assessment it was assumed that all trees will have to be replaced within 7 years. The costs are shown in Table 2.

4.1.3 Priority approach

The targeted approach of priority management of DED has been suggested for the control zone. As mentioned in Chapter

2. Historic managementthis approach is based on empirical evidence collected about how the beetle population behaves and focuses on managing the beetle population, not the infected trees. The priority approach fells trees that are likely to host (or are hosting) beetle grubs, an indication of breeding beetles. Felling those trees should lead to a reduction in breeding beetles that year which then prevents infection the following year. There is a risk when, due to a lack of resources, the management team could leave trees that are in the right condition to host beetle grubs and beetles could consequently emerge.

When translating this approach into a scenario, the economic assessment had to make assumptions. These assumptions were designed in direct communication with the DED officer for the ESCC. The economic model assumed that management would slow down the spread of the disease and that therefore all elm trees would be cut down within 72 years, including replacement in comparison to the '*business as usual*' approach in which all trees would be cut down within 60 years. Table 2 shows the costs for this scenario

4.2 Comparing the scenarios

In the economic assessment the predicted life span of street elm trees was taken as a proxy for how well the disease is managed and elm trees are kept alive in each scenario. The overall life expectancy of an elm tree was considered to be 100 years (according to an Eastbourne council member, personal communication). Thus more effective management will spread the costs of tree removal over a longer time period: 60 years in the business as usual approach, 7 years in the doing nothing approach, and 72 years in the priority approach as set by the DED management officer of ESCC (personal communication).

Table 2, Costs of managing elm in the three different scenarios: Business as usual, Doing nothing and Priority approach

	Business as usual	Doing Nothing	Priority approach
ESCC	£1,092,224	£2,414,258	£950,795
Eastbourne	£887,957	£292,180	£883,505
Brighton and Hove	£10,979,712	£32,364,233	£9,032,903
TOTAL	£12,959,893	£35,070,672	£10,867,203

The calculated costs are presented in Table 2. The assessment took into account the control zone of ESCC, Eastbourne and Brighton and Hove. The two urban areas are greatly impacted by the success of elm tree management in the more rural control zone. The assessment looked at street trees because they are most costly to deal with and rural highway elms are the responsibility of ESCC. There are around 3,700 trees in total of which 1,800 street trees in Eastbourne and 248 in the control zone. The high costs for Brighton & Hove reflect the high number of street elms and the high cost for the Do Nothing scenario reflects the more rapid removal of elms. The costs relate simply to removal of infected trees and reinstatement of pavements – it does not include any impacts on higher levels of works disturbance (e.g. delays), nor the loss of services such as amenity values. Figure 4 shows the costs of managing elm trees in the three scenarios over time.
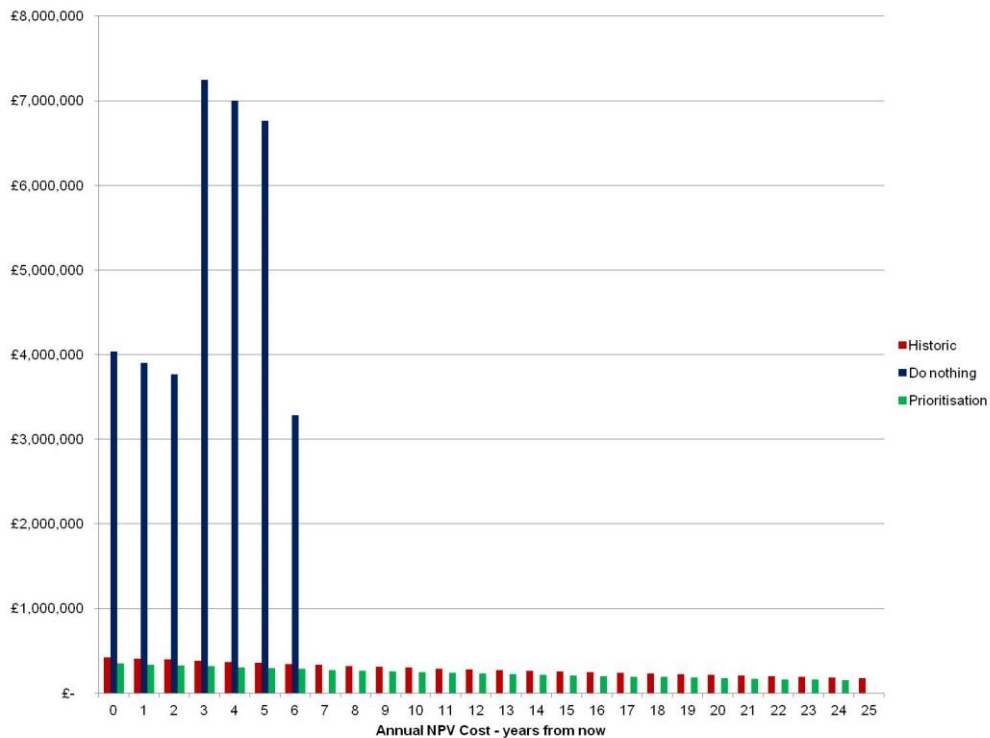
A major risk is that a lack of resources may result in some potential trap trees being left unnoticed. This may cause the infection to spread, or worse, allow the beetles to disperse. The management zone is large and the team, at the moment, is small which led to the discussion about the size of the control zone and whether management should not only target specific trees as trap trees but also target specific geographic areas.

Having presented the results of all the scenarios the participants at the meeting were in agreement that the priority approach was most useful in terms of managing the disease spread for the least amount of budget.

The priority approach does need further development concerning: How to identify elm trees in the right condition to become a trap tree; how the monitoring of those trap trees should be done; and what geographic area will be the priority for management and monitoring. To date DED management has been challenged by limited resources to monitor and manage the size of the control zone.

4.3 Targeting geographic areas

Figure 2 shows the current and past control zones as drawn by participants of the elm partnership. In the discussions around the priority approach participants suggested that the control area is rather large. Looking at the topography of the area it is defensible that the Lower Downs are the current focus for management, however outside of the control zone there are elm trees that are dying, dead, or infected and these trees will influence the beetle population within the control zone. In addition to this, DED is present within the control zone and therefore this approach should also prioritise geographic areas that are still defendable within a tight budget.

The participants suggested that the focus of DED management should remain concentrated on keeping the elm tree collection in Brighton and Hove, the elms in Eastbourne, but to include some trees within the South Downs area that have high landscape and biodiversity

values (such as trees in Alfriston and the hedgerow elms near Sompting) although these are outside of the current area of management. Their inclusion was agreed as they were considered the only places left with that historic landscape.

To be able to manage these geographic locations it was suggested that trees around the river valleys near Lewes and Arlington should be used as trap trees, in order to 'plug' those areas. This would allow the beetle population to be managed as it enters into the control zone. It was unclear what the extent of 'plugging' the river valleys should be, but someone will have to make an informed decision and monitor success over time. The downside of that approach is that it leaves a channel to infect Eastbourne from Alfriston towards Willingdon.

This idea of focussing on particular geographic areas was further extended during the second meeting. It was suggested that the most important areas to defend were Seaford and Alfriston valley. According to Ray Strong beetles come into the control zone from two directions. One wave comes from West to East over the Chichester plane and runs into West Worthing. A bigger wave comes from West to East, North of the Downs. There is no hope at all to manage DED in that area as the topography of the landscape is against any management. The effect of this wave can be observed in Worthing where there used to be a large number of elms, but few remain. The consensus was that the control zone needs to be smaller with better consideration and utilisation of the landscape topography.

Prioritisation needs to happen in areas that will show clear benefits. The best possible place to defend is Seaford. Ray Strong suggested that if there is enough money then management can be done further north along the valleys focussed on plugging these. Although Alfriston was mentioned as a priority in the first meeting in the second meeting it was considered to be very costly locations to manage. The hedgerow English elms in Sompting were again suggested as a priority as well as Brighton.

Eastbourne is still undefendable in this scheme as is Polgate. Eastbourne will therefore need to manage the consequences. Money will need to be spent on Eastbourne to manage the retreat. In these urban areas Wych elms are getting to the size that they are a potential health and safety issue. It was suggested that health and safety arguments is another justification for DED management of potential large streets elms going against any campaigns from residents who are against the removal of trees. Another participant suggested removing those trees that are difficult to monitor, but the potential number of sponge trees should not be reduced which meant this option was turned down. At the meeting no representation of Eastbourne or Polgate was present to agree or disagree with this approach.

It was also mentioned that maybe not all infection symptoms (leaves and branches that have visible been affected) are attributable to DED. Honey fungus is another fungus that affects elm trees. One of the participants wondered whether trees that have died of honey fungus could host beetles or not. He mentioned that this fungus may affect whether or not a tree will develop any grubs. Research is needed to understand the interaction between the honey fungus and the beetle population.

Within the control zone certain geographic areas get priority for continued protection whilst other areas are going to be used as traps and thus management in these areas is not aimed at retaining elm trees. One participant highlighted the difficulty to sell this to the general public and local authority budgets that certain areas should fell trees or use the existing

trees as trap trees to create a buffer zone between the control zone and the higher valued areas with elm trees. Other participants agreed with the idea of not spending more money on managing DED, but letting trees that were already likely to die from old age to be used as trap trees. Instead of taking away dead or dying trees because of the disease they will be removed when they become a hazard. When trees are removed in areas that would work as a buffer they would not replace them. But it was considered unlikely that those areas used as buffer and therefore contain trap trees would be willing to pay for monitoring costs.

Reducing the area of the control zone will help target monitoring and budget spend. It was also highlighted that elm trees in a woodland/forest might not be of priority as they are not as important as individual trees more visible in the landscape or those in urban areas. Replacing individual trees that are an aesthetic feature of the landscape would be much harder. On the other hand the majority of residents during then on-street engagement considered elm trees to be part of the landscape and should be maintained where possible.

At the Elm Partnership meetings the point was made that this new approach sounded like a managed retreat of elm trees. With this targeted geographic approach it was estimated that around 60 to 70 % of the trees would be managed with money preferentially spent to successfully keep elm trees in the areas that would be a benefit.

4.4 Residents perceptions of scenarios

Residents that were presented with the options of the three different strategies (methodology used is described in detail in Chapter 3 and in Appendix 2 – Social and Cultural values of Elm trees methodology) overwhelmingly voted for trees in the landscape and although some where not particularly in favour of the elm tree, the majority supported the priority approach as their final preference as shown in Table 3.

Table 3, Number of participants in each location who voted for a particular scenario A: Business as usual, B: Priority approach, C: Doing nothing. Pictures used to represent scenarios are in Appendix 2.

	Choice 1		Choice 2		Choice 3		Final preference			
	A	B	B	C	A	C	A	B	A/B	C
Seaford	0	7	7	0	5	2	0	3	4	0
Brighton (Preston Park)	0	7	7	0	7	0	0	5	2	0
Eastbourne	1	10	10	0	8	2	1	8	2	0
Total	1	24	24	0	20	4	1	16	8	0

When shown the range of images with the relative economic costs of each option, the rationale behind each scenario was explained. The economic cost of each option did not appear to alter people's preference. The most common response was "why is the 'No Tree' option the most expensive?" On explanation (many diseased trees requiring felling in the short term) all commented that this was their least preferred option anyway and were pleased it was the most expensive. Even on explanation that in the longer term the difference between the scenarios would decrease, participants still put this option last. The option to prolong the life of elm trees under the '*Priority approach*' scenario was every participant's preference.

4.5 Next steps

The *'Priority approach'* has been written into a draft strategy that will be presented to the scrutiny panel of the ESCC. This panel would need to approve any budget spending on DED management for the coming year. Assuming that budget would become available the participants suggested a number of key steps, outlined below, that would need to be taken to ensure the new priority approach would be adopted successfully across the control zone. Overall more monitoring is needed before a final outline can be made of the priority approach, but there is a significant potential for implementing this strategy.

4.5.1 Training

Training is needed so that volunteers and others will be able to recognise beetle grubs and the state of trees from the ground. Those with enough experience are able to mark what priority a certain tree has for management. However, this needs training and commitment from volunteers or those employed by ESCC to continuously monitor the area they are responsible for. In the experience of the 'Save the Elm campaign' this training has worked well and their classifications were correct. With this knowledge an informed prioritisation could be made taking into account grubs on trees, moisture of the wood and states of nearby trees.

A guide or training course needs to be developed to train those who will be in charge of monitoring. Those who manage the disease need a change in mind set from 'speed is of the essence – the tree must come down when it is infected' to monitoring and see how the beetles use the tree. On ESCC property, health and safety concerns also apply in a decision as to whether a tree is cut down. Some land owners do not care about wider priorities and want trees cut down anyway despite any potential to be used as a trap tree. A well-designed website would help inform residents about the relative risks of having an infected tree on their property.

Students, some with the ability to climb have formed useful volunteers in the past. They will be supporting the management of DED this year and will get training on tree felling and monitoring infection symptoms. They will likely be climbing into trees to monitor the presence of grubs and beetles which will help identify whether or not trees need to be cut down.

Previously when opportunities have been offered for students to interact directly with the DED management team no students responded. It was observed that there seems to be little interest from students in the rest of the country since elms are not part of the wider UK landscape. This could be overcome by focussing on students within the control zone. In addition to students doing a piece of research on DED, there are also opportunities to create an internship position (at ESCC or for example at ES Biological Records) that could help with building a Geographic Information System database to combine data across the different administrative areas within the control zone.

4.5.2 Communication

The new priority approach should coincide with a high profile education program to make people aware. The BBC programme *'Inside Out'* has covered different plant diseases and the issue is relevant for *'Country File'*.

The Forestry Commission is organising a series of tree health events. A video could help to highlight the landscape scale changes that have happened in this area. An educational

campaign could link interested people with those who have a lot of experience of DED management. It would also help if a well-known local celebrity were appointed as the champion of DED management in East Sussex to give the priority approach publicity and support.

Engagement with other organisations or people can also be sought:

- Local Nature Partnership funded by Defra has just started.
- The Tree Council
- Engage with schools, universities to further develop learning. There is Merrist Wood College in Surrey, or Plumpton College which does forestry.
- The Conservation Foundation is interested in elm trees and may work together with ESCC and may support media engagement.

5. Discussion

5.1 Lessons for tree health management

According to one participant at the meeting, *Chalara fraxinea* (Ash dieback) has changed the mind set of people. It has raised the profile of tree health amongst a cross-section of scientists, decision takers and policy makers, and the general public. For those involved in the management of tree health it has increased the awareness of the need to engage with a wider community and broader network of relevant people. "DED management can help other organisations and other counties to work together to prepare for *Chalara* as it is likely that this disease will arrive in the UK" (which has subsequently occurred (www.forestry.gov.uk/chalara)).

5.2 Data collection and monitoring for gathering evidence

In terms of DED management the use of citizen science expertise (Silvertown, 2009) has proved beneficial in identifying new options for control of the disease spread and seems to address Brasier's (1996) call for improved 'knowledge based management'. This example of the input of residents (including local people with specialist knowledge and training) indicates how informed and passionate volunteers could contribute to surveillance and monitoring of pest and disease outbreaks in the future. This could address the needs identified by Pautasso et al (2013) for data in relation to ash dieback on whether the disease is spreading everywhere regardless of ash density or whether isolated ash trees are less affected than ash trees located close to many other ash trees. Forest inventory data is lacking in this regard but volunteered geographic information (Goodchild, 2007; Mooney & Corcoran, 2011) from local residents could provide a cost effective means of sourcing this quality of data for management (Kelly et al 2012).

Information about where trees are, who owns the land they are on and their current condition are all important aspects enabling the appropriate targeting of disease management. Unfortunately these datasets are not complete in the control zone of East Sussex despite years of management. Due to changes in responsibilities over the years and no standardised spatial collection of data from the beginning of the outbreak, data has been collected in different ways through time or not at all during some years.

Historic data exists but is very sparse. Changes in responsible authorities have made it difficult to provide reliable evidence that can be used to effectively assess the impact of management strategy changes. For the priority approach to work this gap needs to be addressed through geographic database of all the elm trees with information about who owns them and what state they are in, especially on the top of the valleys. Together, with the different organisations around the table, it was agreed that a spatial GIS database shared between organisations was needed to be set up to allow informed decision making about what trees to target for felling or to monitor for potential beetle population development. Allowing access to the information by all parties involved in the management of DED in the area would help coordination efforts and support cross-scale and cross-organisational boundary work enabling informed decision making on which areas to tackle in the coming season.

Monitoring of the disease and beetle will also help to improve understanding about how they are distributed across the control zone. In the meetings it became clear that there is still a lack in understanding how the disease functions and how the beetle population develops amongst the officers managing the disease locally. This monitoring would also

support research to answer how long it takes for beetles to emerge from a tree after egg laying and therefore when the management team should fell a trap tree to ensure maximum egg laying has occurred but before mature beetles emerge. This type of basic management knowledge gap is relevant for other pathogens. Tree health management requires improved recording, monitoring and sharing of information on disease occurrences and successful management strategies between different organisations (Fisher et al 2012).

In relation to other diseases (including new and emerging threats) it is critical from the start of management to collect such data to allow longitudinal monitoring. Not only will this help to target any management interventions, it will also provide an opportunity to evaluate the usefulness of the chosen approach over time. Monitoring and evaluation often happens with a constrained time and budget allocation, but recoding and keeping track of where management has taken place in a spatially explicit dataset, has the potential to benefit long term management greatly. As highlighted by one of the participants: '*from now on we all have to be better at gathering data and not just elm disease but any project really and make it part of the daily routine*'.

5.3 Areas for further research

A phase two project in this area could involve the general public to map all trees via the development of a mobile phone app. For example, The Isle of Man developed one for elm trees, using a photo, location, and description. The company who developed this software was available to develop something similar for East Sussex dependent on a suitable budget. If this was developed and implemented research could be applied to be monitor and evaluate: How reliable the data gathering was; where data hot-spots occurred versus areas of limited or no data; how the data was used (or not) by managers; what impact it had on the views and knowledge of the local population with regards trees and tree health; and any co-benefits for participants (well-being, social networks, etc.).

The epidemiological modeling could be further developed, if better data were available, and extend the spatial extent to include Brighton and Hove and Eastbourne. The epidemiological modeling could also be used to run scenarios on what the effects of a reduced control zone and a geographically targeted approach could be on the disease occurrence.

Research into the genetic diversity of the population and associated disease or beetle attractiveness would also be useful. Anecdotally it appears some elms (Dutch Elm tree) do not seem to be attractive breeding ground for beetles. In West Dean there are a few dead trees that have no grubs although the conditions would suggest these trees would be ideal for beetles. Overall more research is needed on the dynamics of the beetle population, breeding preferences and the tree state.

5.4 Coordination of management and budget

Overall coordination from central government appears important in order to maintain pest and invasive species management as a local strategic priority (within varying local priorities) by providing a clearer framework to operate within (Mills et al, 2011). The devolution of control to local authorities and other organisations (including charities and private sector groups) means that the priority and funding allocated to DED management can vary across geographic and administrative areas through time. Funding for the work in the control zone is provided by the ESCC and has decreased in the last three years. Eastbourne is given money by the ESCC so any increase in funding would affect the control zone and Eastbourne.

Other tree research has used funding from EU. However, recently many other tree diseases have increased in importance and research funding may get directed towards those rather than DED. This uncertainty results in sub-optimal control of the spread of the disease. Participants of the Elm Partnership felt strongly that more funding is needed to allow for further collaboration across administrative and organisational boundaries.

Within an improved operating framework, a better understanding of the stakeholders relevant to plant and tree diseases and their stake in the problem would potentially benefit management strategy implementation (Reed, 2008; Reed et al, 2009) in terms of effective local ownership and coordination.

In this project the Elm Partnership meetings presented an opportunity to get feedback on proposed future management strategies. Other cases suggest a combination of expertise would support the development of future strategies. Mills et al (2011) propose a governance framework including policy makers, economist, publics and experts. To take forward the management of Ash dieback, a more recent disease outbreak in Europe, Pautasso at el (2013) emphasise the importance of including multiple disciplines in the discussion to formulate policies. Kelly et al (2012) strongly recommend including the public as participants in this multi-agency approach because of the potential benefits.

Having a wide range of people and viewpoints around the table helped broaden the conversation about future management strategies. Two representatives of the 'Save the Elms Campaign' acted as experts in the disease and its management in the meetings based on their extensive experiential and professional knowledge. The DED-MES project team included an economist who with help of the local East Sussex DED Control officers constructed a cost benefit analysis that supported prioritisation of management. The potential impacts and values of the different strategies were commented upon by members of the public during the on-street engagement. The close working relation between the project team and the ESCC helped to provide weight to the meetings and use the existing network of the Elm Partnership to good effect. ESCC also played a role in the design of the meeting in such a way that the DED officer led the meetings, whereas the researchers were only facilitating the dialogue. This helped to keep the conversation relevant to the local context; enabled and empowered questioning allowing clarifications within the Elm Partnership to emerge. This approach facilitated a sense of being listened to and an opportunity for each participant to contribute to the discussion. At the end of the second meeting one participant who had been part of the entire process evaluated the project by saying: '*It highlights the value of putting knowledge together and trying to find a way to take this forward together. No individual or individual organization can do that*.'

Previous experiences with research done in the area had not always had a positive end result. Some modelling done in the past had been a top down process, with limited consultation with local experts. The first meeting of this project was deliberately set up in a participatory way around the expertise of the participants, not of the research team. This was done to ensure and enable everyone to contribute to the discussion.
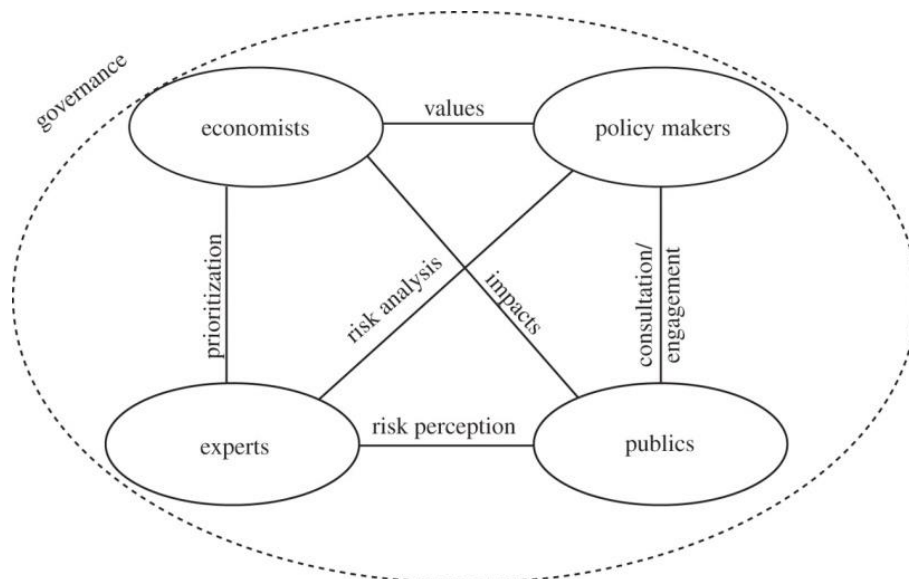
Figure 5, . 'A model for multi-dimensional plant health policy formulation.' From Mills et al, 2011

Although a large part of the Elm Partnership was represented at the meetings, not all spatially relevant stakeholders attended. This was despite any future management in the control zone having a potentially large impact on their district and their management of DED. A number of reasons could explain the lack of participation from this group of stakeholders. First of all, their future management strategy was not in question and a locally administered budget would be available in that area. In the control zone this was not a certainty and therefore there was more willingness to engage with the Elm Partnership amongst those stakeholders responsible for management in this area. Secondly, the meetings could be seen as taking up valuable time for each stakeholder and coordinating an appropriate meeting around busy stakeholders is often problematic (for example, the second meeting occurred during local school half term which made it difficult for some stakeholders to attend). This shortfall was addressed by setting up individual meetings between the DED officer of ESCC and the required stakeholders.

In order to ensure a local legacy to the process and outcomes of the project it was important to engage with an existing organisation, the Elm Partnership. In other disease management contexts, such a local grouping may not exist, but instead be generated solely to take place in a research project. A lack of local ownership of project processes and findings runs a greater risk that post project (and funding) outcomes will not be maintained or implemented in the local setting significantly reducing the benefits of the stakeholder engagement and research activity. In the final meeting of this project the results were fed into a decision making process focussed around available budgets. Depending on funding being available in the coming year(s) it was already suggested by the DED officer of ESCC to hold another meeting in a few months. This indicates that the process initiated in this project should have a local legacy into the future.

A lesson from this project is that harnessing and coordinating this breadth of viewpoints and range of knowledge could be usefully applied to other diseases and pest outbreaks. This diversity would ensure the complexity of diseases and management regime options are debated and understood by all parties involved in their control.

6. Recommendations for other tree health management schemes

- Setting up spatial databases to record and share data between different organisations about the current tree health will help to monitor and evaluate the effectiveness of management strategies and coordinate the management across different organisational boundaries.
- Sharing information on success and failure of management strategies rapidly through data and knowledge exchange could provide significant benefits to improving control practices.
- The need for on-going research on diseases after the initial outbreak to inform strategy development was highlighted by the DED case study. DED management strategies used were based on the evidence mainly obtained from historic research undertaken at the onset of the disease. Revisiting pest and disease issues periodically with new techniques or analysis approaches may be useful for identifying novel management strategies that were not evident when the disease originated.
- A set up like that of the Elm Partnership in which different experts, policy makers, economists and some members of the public come together to support the design of future management strategies appears to produce benefits in so far as engagement is continuous over time with practical and tangible outcomes resulting from meetings. An assessment or typology of which similar organisations could be relevant across the country in the context of different diseases could be a useful asset to inform and coordinate local responses.
- Targeted support of a specific local champion in a relevant organisation (in this case the East Sussex DED officer) contributes significantly to the success of strategy development.
- A priority approach to management is dependent on availability of data, financial support and enough local coordination to cover a large area such as the control zone in East Sussex. These factors could also be required in the context of many other pests and diseases.

7. References

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Appendix 1 – Past management efforts methodology

The past management efforts in East Sussex will be analysed in two steps. First a detailed time line will be developed through in depth phone interviews with those stakeholders who have been part of past management efforts. These in depth phone interviews inform a detailed time line about what happened when, but also what information was used to decide what activities to undertake. In appendix A the outline of the phone interviews is presented.

Secondly, the overall time line of DED management strategies will then be used as input into a focus group discussion using a participatory mapping approach to identify where the different management efforts were made. This focus group discussion with members of the Elm Partnership will reflect on the collected timeline and provide a spatial representation of the different management activities. Any gaps in the timeline will be filled during the focus group.

Aim

To investigate past and current control strategies with managers from the different groups responsible for deciding and implementing management of Dutch Elm in the South East of England. We would like to understand specifically:

- How control strategies have evolved through time?

- What information influences strategy?

- What other factors drive the strategy?

    o Finances/Resources

    o Perceived extent of problem

    o Pressure from local residents/politicians

    o Environmental factors

- What coordination has occurred across the area?

Specific contacts will be made with representatives from East Sussex Council, South Downs National Park, Brighton and Hove Council, Eastbourne Council, Forestry Commission, and key long-term contractors responsible for Dutch Elm control.

Interview Questions

1. Can you talk me through the control strategies that you have used since 2000?

2. Could you describe how you (or other colleagues) decided on these strategies – and what motivated any changes in strategy?

    a. What are the key factors that have influenced the strategy?

    b. Have these changed through time?

3. Could you describe the information used to inform strategy development? Particularly:

    a. Where do you get information from to identify the strategy?

    b. Are there any sources of information you exclude? If so why?

4. Can you describe to what extent you have coordinated your strategy with that of neighbouring organizations, authorities or other contractors?

Appendix 2 – Social and Cultural values of Elm trees methodology

Geographic locations of on-street engagement

Both rounds of on-street engagement were undertaken in places with a different type of landscape in terms of elm trees. Table 4 indicates the reasons for the different places visited. Locations included those with a different number of Elms, some locations where a lot or little management had taken place, and they were in rural as well as urban areas. This allowed a comparison between the perceptions of participants in relation to these different types of landscapes. Unfortunately on both occasions challenging weather and logistics meant no visit was made to Alfriston. This is a town with a large number of elms and management efforts were aimed at preserving these.

Table 4, Places for on-street engagement

Places	Round 1, 2	Reasons why
East Dean	1	In this rural village in the heart of the control zone. There are few elms, but residents may be aware of elm trees in nearby Eastbourne and Friston forest.
Brighton	1, 2	This large town hosts the national Elm tree collection and two of the oldest elms are in Preston park. Across the city elm trees have been planted along the streets and define the street landscape.
Seaford	1, 2	A more rural seaside town with lots of elms but not too much management has happened here.
Eastbourne	2	A city where management of elm trees has taken place in many locations. There are still a large number of elm trees lining the streets

Recruitment strategy for participants

The recruitment strategy for the types of people to engage with was based on purposive sampling. Across the DED control area, Eastbourne, and Brighton and Hove the aim was to engage with a range of residents to capture the views on social and cultural values of Elm trees. The aim was not to engage a representative sample of the population, but a cross section of the population. By standing in places at different times of day and in locations where local residents would pass of all ages and gender participated. The aim was to recruit men and women across four different age categories: 18-25, 26-40, 41-60, and 60+.

The following pages show the materials used as part of the first and second round of on-street engagement.

The fieldwork sheet used for the first round of on-street engagement

Flag #   Place _____ Date _____

Why are you here today?					
Work	Shopping	Visiting	Resident	Travelling Through	Other

Age	18-25	26-40	41-60	60+	**Home Postcode**	**Gender**	M	F

Are you aware of Elm trees around here? *(If YES, locate them on the map)*

Thinking about trees around here (AND SPECIFICALLY ELM TREES):

What are the benefits of having them around here? (Use numbers of keywords)

Any trees in particular? *BLUE flag*

Are there any issues related to having them around here? (Use numbers of keywords)

Any trees in particular? *Green flag*

How do you feel about having (ELM) trees around here?

Have you been aware of management of Elm trees in this area, where? *Yellow flag*

How do you feel about the management of Elm trees?

If you had to prioritise management of Elm trees what would you do?

Second round of on-street engagement

The project team will also gather local thoughts on the impacts of the priority management strategy through another on-street mapping exercise.

Participants were asked to comment on the following slides.

Figure 6, Map of elm trees in the area

Figure 7, Representing current day landscape with Elm trees

Imag
e A

Imag
e B

Figure 8, Comparing different future scenarios - option A, historic management and B, Priority management

Imag
e C

Imag
e B

Figure 9, Comparing different future scenarios - option C, Doing nothing and B, Priority management

Imag
e C

Imag
e A

Figure 10, Comparing different future scenarios - option A, historic management and C, Doing nothing

£35 million

£1.2 million

£0.8 million

Figure 11, Compare the costs of these three scenarios

The fieldwork sheet used for the second round of on-street engagement

Place_____ **Date**_____

Why are you here today?					
Work	Shopping	Visiting	Resident	Travelling Through	Other

Age	18-25	26-40	41-60	60+	Home Postcode	Gender	M	F

Are you aware of Elm trees around here?

Where:

Are you aware of Elm tree management around here? (where?)

Which scenario is your preference?

A/B:

C/B:

C/A:

What do you think about these costs?

A/B:

C/B:

C/A:

Any further comments?

Appendix 3 – Future management scenarios methodology

The two groups this project is aimed at are the ESCC and the Elm Partnership. For the focus groups the aim is to get those members and people involved in the management of Elm trees around the table. With the help of Anthony Becvar from the ESCC we will recruit participants for the focus group meetings via email. After the first meeting we will assess whether members are missing and whether we need to try to contact these in a different way to get their viewpoints on the results of the focus group meeting.

Agenda first meeting 6 December 2012

'Past and future DED management', ESCC offices, County Hall, Lewes, East Sussex

Time	Activity
1:00-1:15	Welcome and introduction by Anthony Becvar
1:15-2:15	Past management strategies • A **timeline of past management strategies** is presented that is based on the phone interviews and some of the reports we received. Any missing information is added if necessary. • In smaller groups we will discuss and map the **spatial extent of previous DED management**. • Group discussion about **lessons learned** – what worked well and should be taken forward in future management and what did not work well and should be avoided?
2:15-2:30	*Coffee break*
2:30-3:45	Plausible future scenarios • Current situation • What will happen if… using as starting point 2 different management strategies • What areas will be impacted positively, negatively, or remain unaffected? • What are factors that could compromise the success of DED management in each scenario?
3:45-4:00	*How this meeting informs the decision making process in ESCC* *Next steps in the project*

Agenda Second meeting 20 February 2013

Priority management of DED – what are the implications?
ESCC offices, County Hall, Lewes, East Sussex

Time	Activity
10:00-10:15	Welcome and introduction by Anthony Becvar
10:15-10:45	• Introduction to methodologies: epidemiological model and economic assessment
10:45-11:15	Scenario 'Business as usual' • Presentation of results from spatial model of the likelihood of trees dying in 25 years' time when carrying on with felling of trees as they appear to be diseased, i.e. have first symptoms of yellowing/browning leaves.
11:15-11:30	*Coffee break*
11:30-12:00	Scenario 'Doing nothing' • Presentation of results from spatial model of the likelihood of trees dying in 25 years' time when DED is not managed.

12:00-12:30	Scenario 'Priority management' • Presentation of results from spatial model of the likelihood of trees dying in 25 years' time when only trees are felt that have been dead for a year or more (have about 40%dead wood in the crown) to manage the beetle population • Discussion – what are spatial and administrative implications?
12:30-1:00	*Lunch break*
1:00-3:00	What are next steps to put priority management in place?