Appendix 1: Thames Chase Pinch Mountain

Pinch Mountain is a site in Thames Chase Community Forest, located on the eastern edge of London, and within FE's East Forest District. The Community Forest straddles Essex and East London and is a patchwork of woodlands created since 1990 on reclaimed landfill sites with the aim of increasing the woodland cover of the area. The entire community forest currently covers over 40 square miles of green belt land.

There are some already new forests in this area, with a group of additional new woodland creation opportunities of about 20-30ha each (total 250ha over the next 4-5 years); these are either contiguous or very close to the existing woods.

This case study would look at the next of these proposed 20-30ha sites. The site as a whole is called Pinch Mountain: the northernmost part of the site is Pinches, and the southern part is known as Ahern. There are 2-3 possible options for the woodland creation for the site. Some biodiversity reduction may result from afforestation, but there may also be an increase in other aspects of biodiversity, and an increase in habitat connectivity. There will be very high levels of community use of the site.

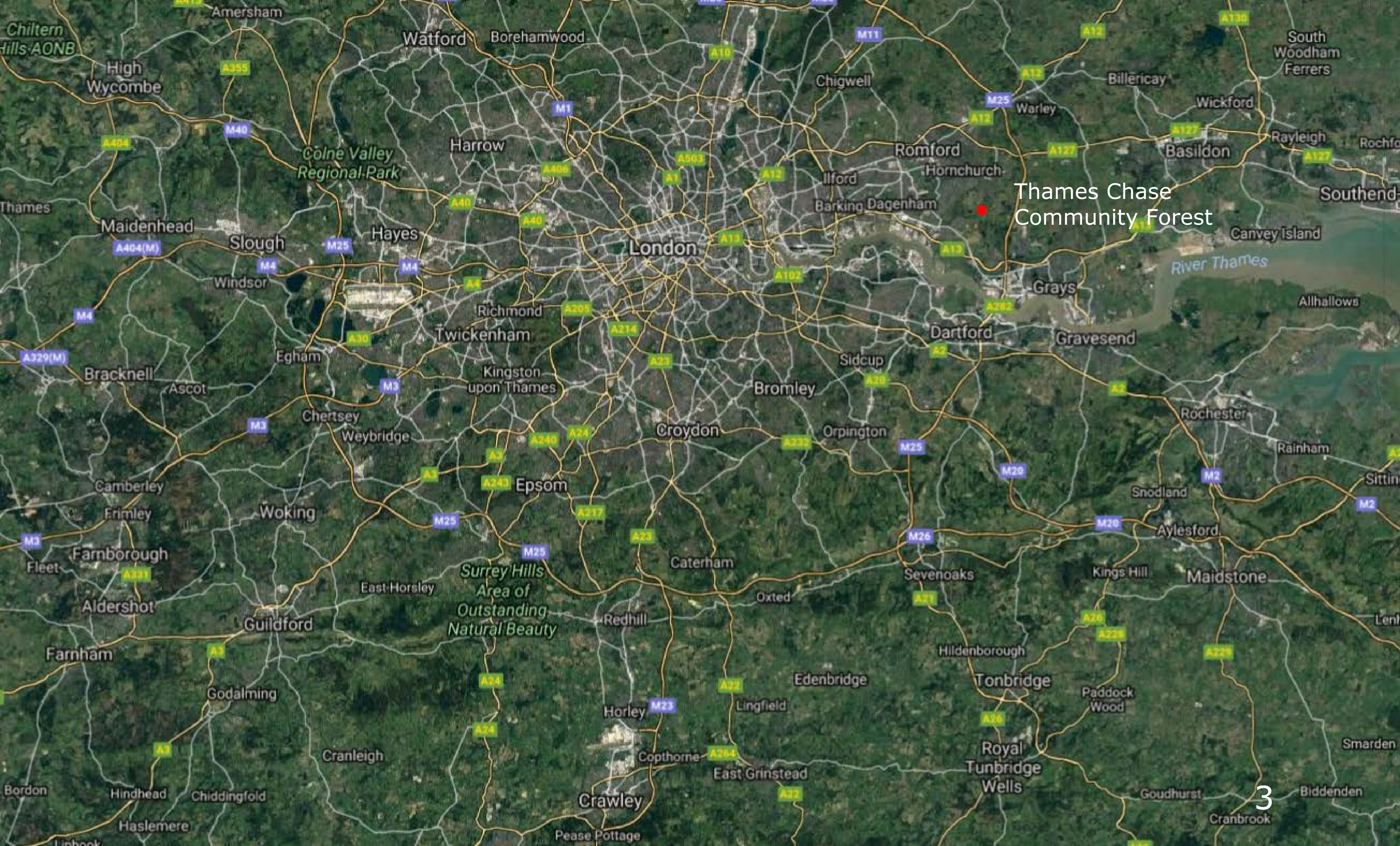
Contents

miranda.winram@forestry.gsi.gov.uk

Googlemaps View of Thames Chase in Southern England

Accessed on 30/11/2017

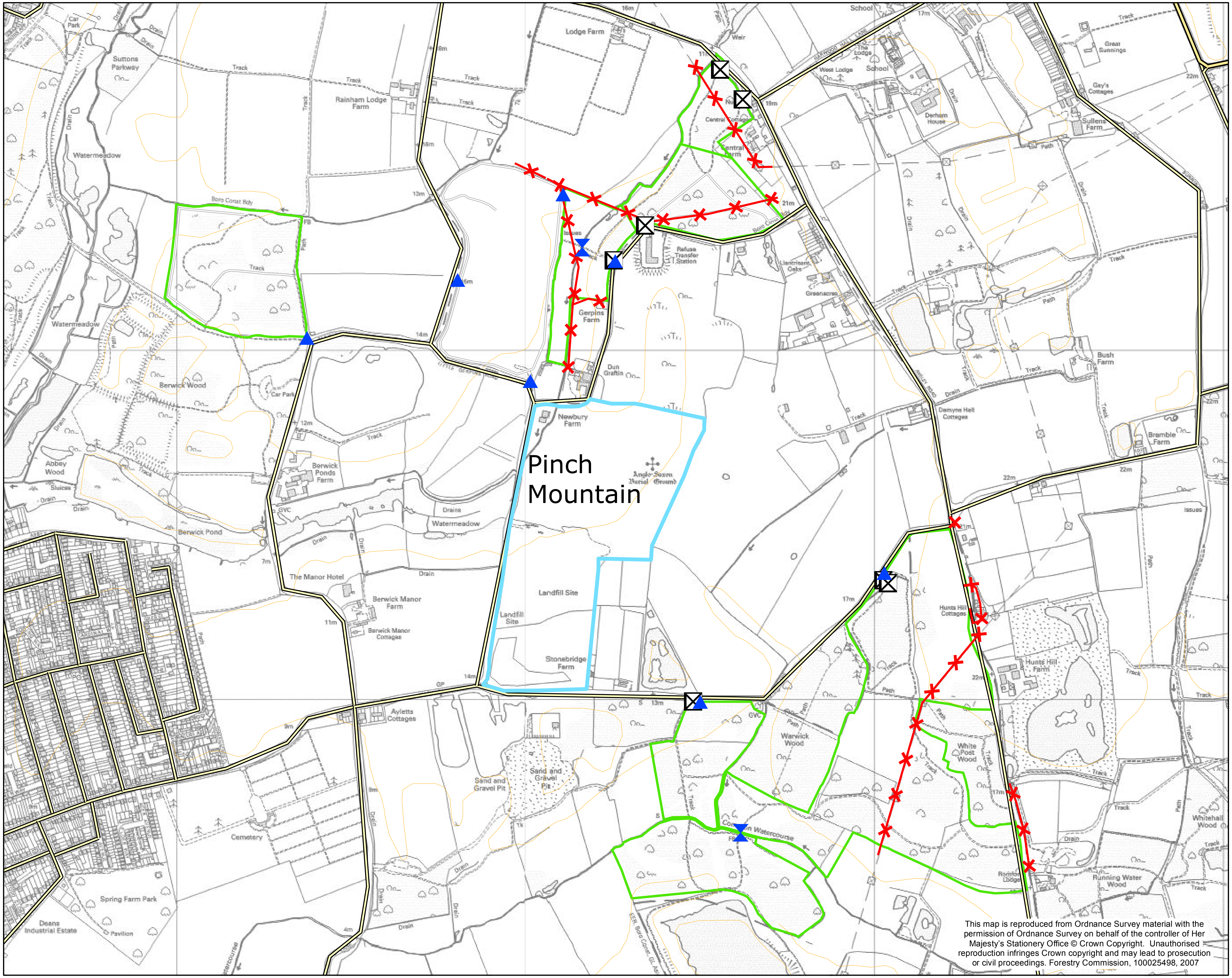
miranda.winram@forestry.gsi.gov.uk


Thames Chase
Community Forest
Chiltern
Hills AONB
Amersham
Watford
Borehamwood
High
Wycombe
Chigwell
Billericay
South
Woodham
Ferrers
Warley
Wickford
Rayleigh
Harrow
Colne Valley
Regional Park
Romford
Hornchurch
Basildon
Ilford
Barking
Dagenham
Southend
Thames
Maidenhead
Slough
Hayes
London
Canvey Island
River Thames
Windsor
Grays
Allhallows
Richmond
Twickenham
Dartford
Gravesend
Egham
Bracknell
Ascot
Kingston
upon Thames
Sidcup
Bromley
Chertsey
Weybridge
Croydon
Orpington
Rochester
Rainham
Camberley
Frimley
Epsom
Woking
Snodland
Aylesford
Farnborough
Fleet
Caterham
Sevenoaks
Kings Hill
Maidstone
Surrey Hills
Area of
Outstanding
Natural Beauty
East Horsley
Oxted
Aldershot
Guildford
Redhill
Farnham
Hildenborough
Edenbridge
Tonbridge
Paddock
Wood
Godalming
Horley
Lingfield
Royal
Tunbridge
Wells
Smarden
Cranleigh
Copthorne
East Grinstead
Bordon
Hindhead
Chiddingfold
Crawley
Goudhurst
Biddenden
Cranbrook
Haslemere
Pease Pottage
M25
M1
M11
M40
M4
M3
M20
M26
M23
M2
A12
A10
A130
A127
A13
A2
A3
A24
A23
A22
A21
A26
A228
A229
A264
A282
A102
A20
A232
A217
A214
A205
A240
A243
A40
A406
A503
A1
A4
A30
A331
A404
A355
A404(M)
A329(M)

Pinch Mountain OS Site Map

30/11/2017

miranda.winram@forestry.gsi.gov.uk



Forestry Commission

Forest District: EAST ANGLIA
Forest Name: Pinch Mountain

A3 Scale: 1:10,000

Legend

- Access point
- Bridge/culvert/ford
- Mine shaft
- Turning point
- Gate/cattlegrid
- Powerline (OH)
- Wall
- Motorway
- A Road
- B Road
- Minor Road
- Railway
- Ride
- Contours
- Management area

Pinches Planting Plan

August 2015

miranda.winram@forestry.gsi.gov.uk

KEY

- Existing features
- Site Boundary (work by others)
- Proposed contours (work by others)
- Woodland areas
- Shrub areas
- Drainage channels (work by others)
- Fences
- Gates
- Other land-use (work by others)
- Gravel/sandy bank for habitat
- Grass
- Stone tracks, 2.5m wide No steeper than 1:20
- Attenuation Pond (work by others)
- Horse ride 3.0m wide

PROPOSED SHRUB PLANTING: Low Forest & Shrub

Name							
Common Name	Scientific Name	% of total mix	Plants / Ha	Block A	Block D	Block E	Block G
				0.06ha	0.24ha	0.04ha	0.13ha
Wild cherry	*Prunus avium*	32	544	33	131	22	71
Field maple	*Acer campestre*	32	544	33	131	22	71
Rowan	*Sorbus aucuparia*	20	340	20	82	14	44
Silver birch	*Betula pendula*	6	102	6	24	4	13
Hawthorn	*Crataegus monogyna*	10	170	10	41	7	22

PROPOSED WOODLAND PLANTING: Short Rotation Forestry

Name						
Common Name	Scientific Name	% of total mix	Plants / Ha	Block B	Block C	Block F
				2.61ha	1.03ha	0.55ha
Italian Alder	*Alnus cordata*	60%	1,350	3524	1391	743
Norway Maple	*Acer platanoides*	10%	225	587	232	124
Small-leaved Lime	*Tilia cordata*	10%	225	587	232	124
Silver Birch	*Betula pendula*	5%	113	294	116	62
White Poplar	*Poplus alba*	5%	113	294	116	62
Rowan	*Sorbus aucuparia*	5%	113	294	116	62
Wild Service Tree	*Sorbus torminalis*	5%	113	294	116	62

N

Job Title: PINCHES

Drawing Title: PLANTING PLAN 7

Drawn: | Job No: | Date: 26 Aug 2015

Checked: | Scales: 1:2500@A3

Drawing No: | Revision:

Forestry Commission

Ahern Landscape Proposals

April 2016

miranda.winram@forestry.gsi.gov.uk

KEY

- Proposed Contours
- Settlement Pond
- Grass
- Sump
- Woodland Areas
- Leachate Monitoring Point
- Gravel/Sandy bank for Habitat
- Gas Borehole
- Shrubs
- Reed Bed/Wetland
- Individual trees with tree guards
- Existing Drainage
- Proposed Drainage
- Stone track 2.5m wide. No steeper than 1:20
- Horse ride 3m wide

PROPOSED WOODLAND PLANTING: Short Rotation Forestry								
Name								
Scientific Name	Common Name	% of total mix	Plants/Ha	Block A	Block B	Block C	Block D	Block E
				1.3ha	0.82ha	0.85ha	3.7ha	0.65ha
Acer platanoides	Norway Maple	10	225	295	185	190	835	145
Alnus cordata	Italian Alder	60	1350	1755	1105	1150	4995	880
Betula pendula	Silver Birch	5	113	145	95	96	420	75
Populus alba	White poplar	5	113	145	95	96	420	75
Sorbus aucuparia	Rowan	5	113	145	95	96	420	75
Sorbus torminalis	Wild Service Tree	5	113	145	95	96	420	75
Tilia cordata	Small-leaved Lime	10	225	295	185	190	835	145

PROPOSED SHRUB PLANTING: Low Forest & Shrub								
Name								
Scientific Name	Common Name	% of total mix	Plants/Ha	Block F	Block G	Block H	Block I	Block J
				0.2ha	0.09ha	0.1ha	0.63ha	0.06ha
Acer campestre	Field Maple	32	544	110	50	55	345	35
Betula bendula	Silver Birch	6	102	20	10	10	65	5
Crataegus monogyna	Hawthorn	10	170	35	15	20	110	10
Prunus avium	Wild Cherry	32	544	110	50	55	345	35
Sorbus aucuparia	Rowan	20	340	70	30	35	215	20

Project: Ahern

Landscape Proposals
Option 1

9

Scale: 1:2000@A3

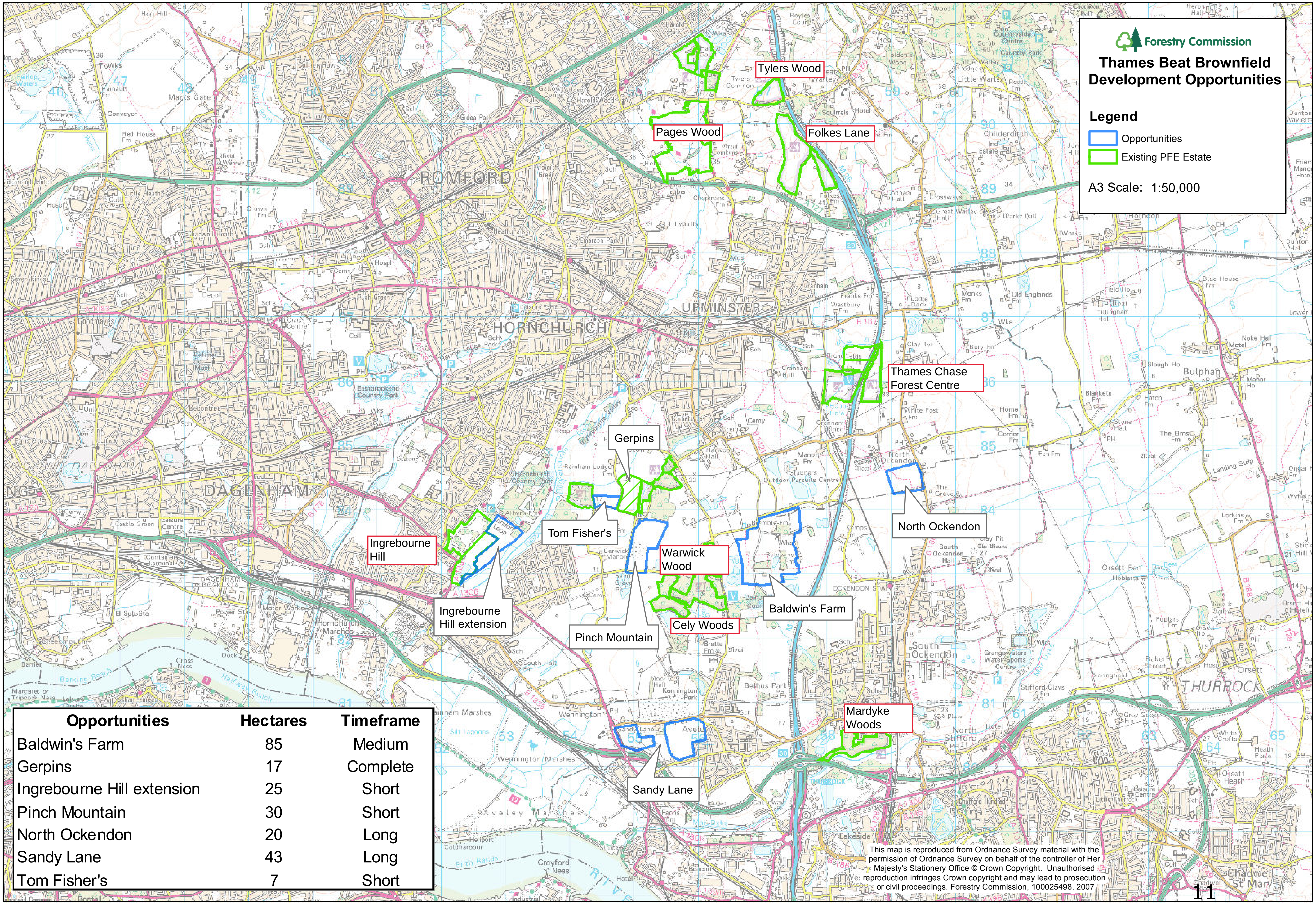
Date: April 2016

Thames Beat Brownfield Opportunities

2007

miranda.winram@forestry.gsi.gov.uk

COLOUR MAPS MUST NOT BE PHOTOCOPIED IN BLACK & WHITE



Opportunities	Hectares	Timeframe
Baldwin's Farm	85	Medium
Gerpins	17	Complete
Ingrebourne Hill extension	25	Short
Pinch Mountain	30	Short
North Ockendon	20	Long
Sandy Lane	43	Long
Tom Fisher's	7	Short

Thames Chase Plan Summary

December 2014

miranda.winram@forestry.gsi.gov.uk

The Thames Chase Plan

Summary

Thames Chase Trust
Transforming landscapes, transforming lives

Foreword

Ann Bartleet
Chair - Thames Chase Trust

It seems a very long time ago, 25 years in fact, since someone from the Countryside Commission, as it then was, telephoned me to ask if I would stop talking to landfill operators about planting a couple of dozen trees on one of their sites. The reason was that the Commission had in mind to plant 5 million trees! Working with their existing local authority partners, it had a vision for South West Essex and East London, of creating a Community Forest that would include planting all those trees.

A little over optimistic I thought at the time, but how wrong I was! Over 1 million trees have been planted in the last 20 years, as well as meadows, hedgerows and ponds and footpaths created to improve habitats and landscape and give more access to countryside for local communities and visitors alike.

It therefore gives me great pleasure to introduce the third Thames Chase Plan, a document that sets out the vision for the Thames Chase Community Forest over the next 10 years. The guiding principle that underpins a Community Forest, namely the creation of restored and enhanced landscapes for the benefit of people, wildlife and economy, remains central, just as it was 25 years ago. However there have been changes in knowledge, thinking and policy in the last 20 years. This plan takes account of climate change, the importance of 'green growth' to create new jobs, the notion of a Big society and smaller government, the emerging importance of exercise and time spent outdoors as part of a healthy lifestyle, as well as threats to our native flora from pests and diseases; none of these were as well understood nor promoted 20 years ago.

The underlying principles expressed in this document, we feel sure will be of importance throughout its life. However the intention is that there should be a rolling programme of identified and prioritised projects that will be updated as and when necessary - so that this third plan for Thames Chase remains a 'live' document that continues to engage local people, supporters and funders.

I commend the 2014 Thames Chase Plan to you all.

With Best Wishes

December 2014

Cover Image: Overview of Warwick Woods from the north - credit: Malcolm Fish

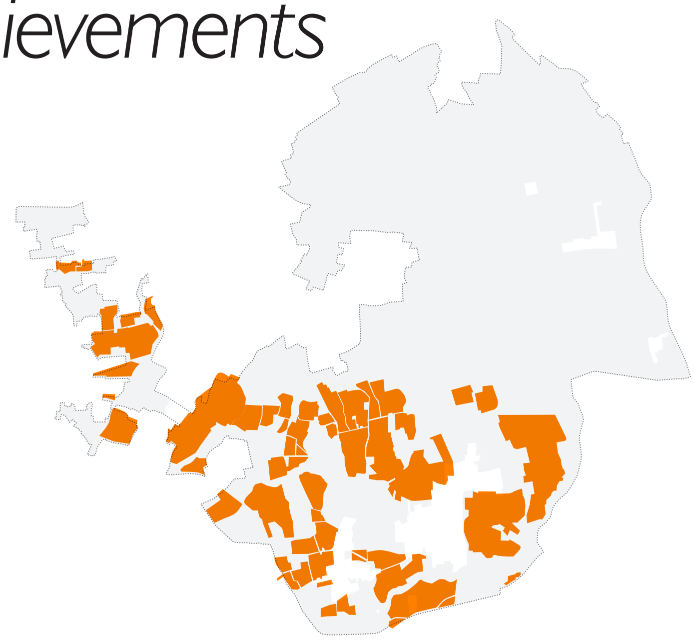
Thames Chase
Transforming landscapes, transforming lives

Welcome to the Third Thames Chase Plan which establishes the vision of the Thames Chase Trust for the Community Forest between now and 2024. This document is a summary of the full Thames Chase Plan which can be accessed via the Thames Chase website: ***www.thameschase.org.uk***

The Plan has been produced in consultation with our valued partners in local government, the private and public sector, funders and the remarkable team of volunteers, who give their time so generously to ensure the continued vitality of this essential green lung for the people of the whole area. This new plan details five areas of activity – forestry, landscape regeneration, access, people and promotion – that will ensure that this Forest continues to thrive for nature and the 650,000 living in and around Thames Chase.

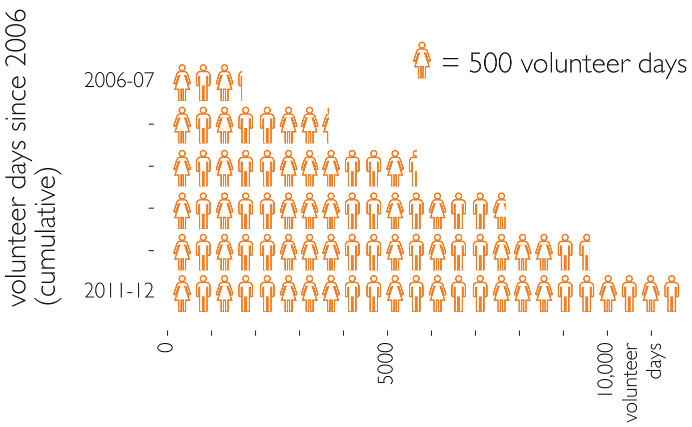
Images - clockwise from left: Ancient coppice; volunteers working on a conservation project at Thames Chase; schoolchildren enjoying a wooded playground in Thames Chase - part of an early playgrounds initiative
- credits: Thames Chase

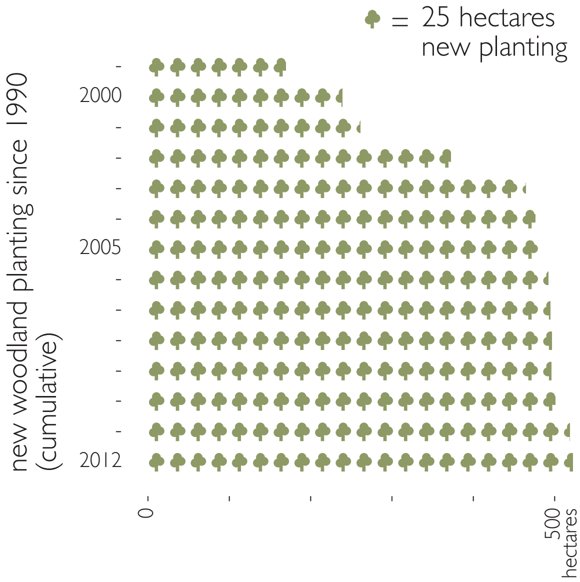
Achievements



Quarry sites make-up 20% of Thames Chase - a total of 20 square kilometers

Above: Plan showing quarry sites in Thames Chase
below left: Chart showing volunteer days since 2006
below right: Chart showing new woodland planting 1990 - present





- **1990** – Thames Chase Launch
- 1991
- 1992 – Acquisition of Thorndon Old Park by the Woodland Trust
- 1993 – Eastbrookend Country Park opens
- 1994
- **1995**
- 1996 – Thames Chase moves to Broadfields and continues the creation of 26 hectares of new woodland and 7 hectares of new hay meadows
- 1997 – Millenium Centre opens at Eastbrookend
- 1998 – Belhus Chase acquired by the Woodland Trust - 62 hectares linking Aveley with Belhus Woods Country Park.
- 1999 – Berwick Woods opened to the public - 27 hectares of new access land
- **2000** – Forestry Commission establish an office at Thames Chase; Over 25% of derelict or semi-derelict mineral workings in approved restoration schemes
- 2001
- 2002
- 2003
- 2004 – A total of 470 hectares of new woodland planting created between 1990 and 2004
- **2005** – New Forest Centre building opens at Broadfields
- 2006 – Thames Chase Trust established
- 2007
- 2008 – Opening of Ingrebourne Hill - restoration of former brownfield site creating 45 hectares of new access land
- 2009
- **2010** – Completion of £1.8 million project at Beam Parklands - restoration of 53 hectare site with new ponds reedbeds and wildflower meadow
- 2011
- 2012
- 2013 – 17 hectares of new community woodland created at Bonnetts Wood
- **2014** – Stage 1 HLF Landscape Partnership successful: potential for c. £1.8 million investment for 2016-2021
- **2015** – Big Green Fund projects completion
- 2016
- 2017

ii

1.3 million trees

planted since 1990

12,050

volunteer days since 2005

70% increase

in woodlands through new planting since 1990

41.2 km of hedgerows

created or restored since 1990

803 hectares

of non-woodland habitat created or restored since 1990

£14 secured for every **£1** invested during 2011-2014

In addition to this, since 2005 our volunteers have helped ensure the success of all aspects of the life of the Forest, from working in the landscape to welcoming people to our visitor centre and carrying out the vital back-office work without which no organisation can run successfully.

Recent years have been a time of change for the Forest, as we have moved from being a public sector initiative to being run by a charitable trust, but this has not dinted our commitment to promoting nature and the quality of life which people can enjoy in communities throughout the area of the Forest.

Vision

Opposite: Aerial view showing new woodland creation at Pages Wood - credit: Forestry Commission

Our vision for the future is that:

'By 2030, Thames Chase Community Forest will be recognised as an inspirational example of landscape regeneration where enhanced, connected woodland and green space has made a clear difference to wildlife and peoples' lives'

Our new forward plan identifies work which we will be undertaking to achieve this. Projects are subdivided into five thematic groups:

Forestry

Landscape Regeneration

Access

People

Promotion

Forestry

- We will increase the amount of woodland cover in the forest to 30% by 2030.
- We will work with partners to ensure mineral and extraction sites within the Forest become wooded on closure and restoration.
- We will implement multi-purpose forestry as our means of woodland management, seeking social, environmental and economic returns from the Forest.
- We will complete projects across all five local areas of the Forest; Lower Beam Valley, Ingrebourne Valley and Quarry Landscapes, Mardyke Valley and Aveley Forest, Thorndon and Warley Woods, Havering and Essex Fringe.

Landscape Regeneration

- We will increase the number of Countryside Stewardship schemes in the Forest.
- We will further increase the size and number of Thames Chase conservation volunteer groups to support local maintenance of enhanced habitats.
- We will work with partners to ensure that habitats are connected across the Forest and adjoining landscape.
- We will work with partners to ensure riparian landscape restoration and improved water quality and river bank quality.
- We will increase the number of initiatives funded by Corporate Social Responsibility schemes in the Forest.

Access

- We will promote our new website as a way for Thames Chase and other community groups to raise their profile, and for the public to find out more about the Forest.
- We will improve our rights of way network.
- We will further increase the size and number of Thames Chase volunteer groups which help to maintain paths and access routes into and through the Forest.
- We will improve the infrastructure and marketing of the "Forest Circle" and create further long distance Greenway routes through and around the Thames Chase area.
- We will lobby for the establishment of strategic gateways and hubs improving access to the Forest from the primary road network, urban areas and public transport.
- We will lobby for quieter roads in the Forest to be used as Greenway links.

People

- We will promote Thames Chase and other community volunteer groups through our new website.
- We will complete the "Landscape of the Fanns" project to enable communities and schools to gain greater insight into the heritage of the Forest area and achieve important cultural, educational and health results.
- We will work with partners to clarify and fully develop the health benefits which result from the Forest and participation in Thames Chase and other community groups.

Images opposite page from top: Coppice management at Franks Wood; planting new woodland;
Mardyke Valley meadows; aerial view of Hornchurch Country Park and the River Ingrebourne
Images this page from top: Footbridge in the woods at Thorndon; cyclists in the Mardyke Valley; school group in the Ingrebourne Valley; local walking group
- credits: Thames Chase

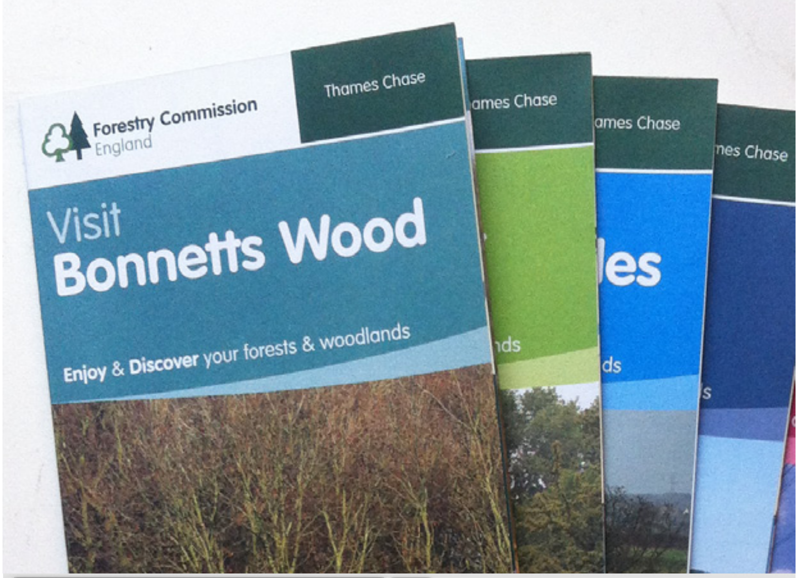
Promotion

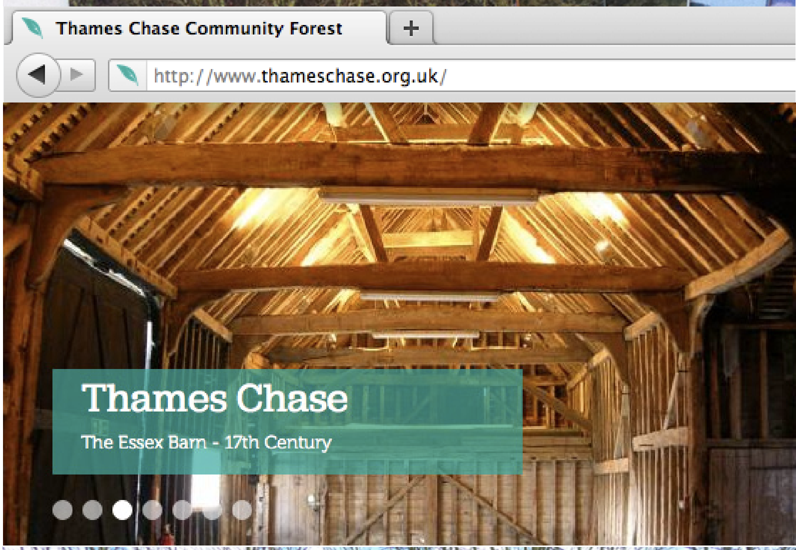
- We will introduce a new Thames Chase Interpretation System.
- We will improve the Thames Chase Forest Centre as the "shop window" for the whole of the Forest.
- We will increase the number and size of Thames Chase volunteer groups which work to raise the profile of the Forest.
- We will use our new website to promote the wider Community Forest and the work of Thames Chase volunteer groups that people may wish to join.

How to get involved

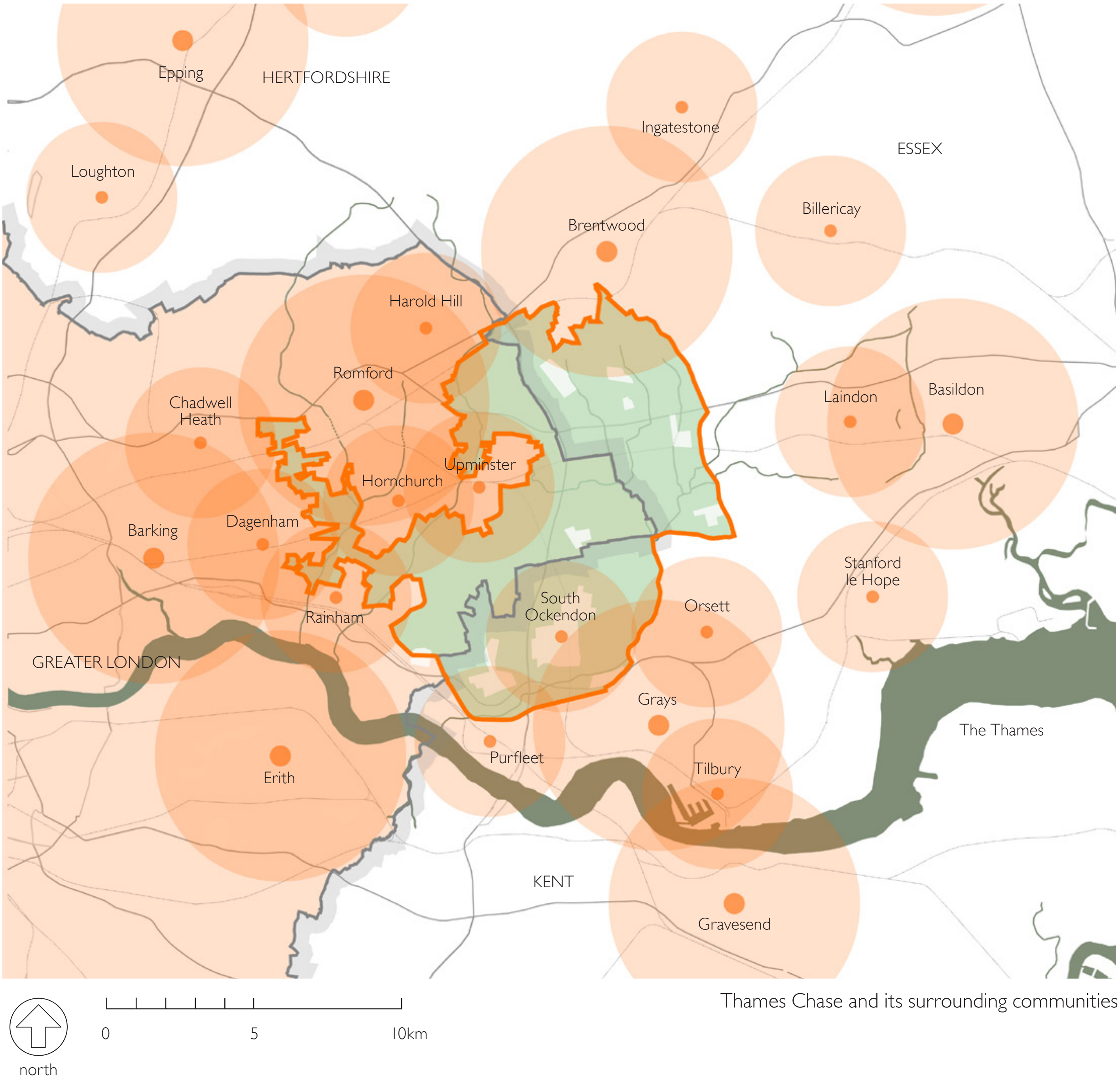
Delivering the vision for Thames Chase requires cooperation and support from everyone. Whether you represent a local authority, charity, business or funder, if you are an existing or prospective volunteer, or simply a user of the forest, there is a role that you can play.

If you would like to become involved with the work of Thames Chase, you can find out more via our website ***www.thameschase.org.uk*** or pop into the Forest Centre at Broadfields Farm. We look forward to welcoming your involvement that will help us to transform landscapes and transform lives.





Images this page from top: Walking leaflets; Thames Chase website; completion of new play area at Broadfields; landscape management by volunteers
Opposite page: tree nursery at Broadfields Farm
- credits: Thames Chase



Thames Chase and its surrounding communities

prepared by:
The Thames Chase Trust
The Forest Centre, Pike Lane, Upminster RM14 3NS
Telephone: 01708 642970
E-mail: enquries@thameschase.org.uk
Web site: www.thameschase.org.uk
Charity no. 1115627. Company No. 5687558

Thames Chase

Thames Chase Trust

partner organisations

Forestry Commission

Essex County Council

The London Borough of Havering

London Borough of Barking & Dagenham

Thurrock Council

Brentwood Borough Council

Forestry Commission

Valuing Urban Forest Creation on Brownfield Land

November 2017

Forest Research

Valuing urban forest creation on brownfield land

The Research Agency of the Forestry Commission

Forest Research is the Research Agency of the Forestry Commission and is the leading UK organisation engaged in forestry and tree related research. The Agency aims to support and enhance forestry and its role in sustainable development by providing innovative, high quality scientific research, technical support and consultancy services.

Executive Summary

Brownfield land is vacant, remnant land which is not in active use and can provide opportunities to enhance greenspace provision in urban areas. Woodland creation on brownfield sites, as one form of soft-end re-use, can be a useful method of providing access to greenspace, and in doing so improve social health and well-being, support biodiversity and encourage economic regeneration for the local area. These benefits have been reported in qualitative terms but developments in Ecosystem Service Valuation (ESV), which estimates monetary values for the benefits ecosystems provide, offers a method to understand the relative value of costs and benefits of woodland creation on brownfield sites.

This scoping review aims to identify the suitability and opportunity in utilising an ESV approach to valuing woodland creation on brownfield sites. A review of ESV approaches was conducted and Natural Capital Accounting (NCA) selected as the most appropriate methodology. The challenges and advantages to using a NCA approach were explored by carrying out a scoping assessment for two case study sites: Ingrebourne Hill and Bonnetts Wood of the Thames Chase Community Forest. Despite being located within 1km of each other, the two sites presented very different local scenarios which highlighted the need for site-specific data and analyses. Ingrebourne Hill is a reclaimed brownfield site close to urban areas, while Bonnetts Wood was previously agricultural land further from local communities.

The use of a NCA approach, supported by recent guiding frameworks, helped to simplify and structure the complexity of relationships between Natural Capital (NC), Ecosystem Services (ES) and the local population into a straight-forward process. A scoping (i.e. non-exhaustive) literature review was carried out to gather indicative values for ES provided by the two sites. From this annual values and Net Present Values (NPV) were calculated. NCA's emphasis on understanding how changes in NC reflect changes in benefits was appropriate for these case studies as it allowed the change in ES provision over time as the newly planted woodlands grew to be incorporated into the account. Despite high early costs, the annual benefits were estimated to quickly grow to give a positive NPV for both sites within 11 years. The cost-benefit ratio over the lifetime of the project (75 years) was estimated at over £1:£2.4 for both sites.

The results of this work suggest there is both a rationale and capability to use NCA to value other brownfield regeneration projects and provide evidence to help underpin their long-term sustainable management. More sophisticated valuation methods and tools could be utilised to develop further the preliminary analysis used in this study and help justify further investment in brownfield regeneration, support community forest schemes and raise awareness of the values of woodland creation.

Contents

1. Introduction

1.1. Rationale for Project

Brownfield land is vacant, remnant land which is not in active use, often left over from industrial activities, it is commonly found in or near urban areas (Alker et al. 2000). Brownfield land is often ear-marked for housing developments, but regeneration to greenspace should be considered as an alternative as it could potentially produce greater environmental, social and economic benefits for society in the area. The urban location of many brownfields implies scope for regeneration to greenspace to improve the well-being of local communities is high due to proximity to the large urban population, especially as an area which may previously have been depressed by its proximity to a brownfield site (Ham et al. 2013). In particular brownfield regeneration projects can improve accessibility to local greenspace, which low-income communities are often deprived of (UK National Ecosystem Assessment (UK NEA, 2011) and consequently are unequally disadvantaged in terms of the well-being benefits these spaces provide (Mitchell & Popham, 2008). Brownfield regeneration also affords environmental benefits, such as providing natural remediation (Forest Research 2008), supporting soil , air and water quality and providing habitats for local biodiversity (Bardos et al. 2016).

Brownfield regeneration is often looked on cautiously by developers for the many challenges it presents (Loures 2014). Foremost among concerns are the potential remediation costs to remove or contain remnant contaminants from the site. Such costs can be large and not fully known prior to the start of the project, shrouding brownfield regeneration schemes with a high degree of potential risk. Additionally there are other difficulties, such as restoring a site to the satisfaction of established neighbourhoods (Doick et al. 2009), who may be wary of utilising previous brownfield sites (Rall & Haase, 2010). Despite these challenges, previous case studies have demonstrated significant environmental, social and economic gains which can justify all or part of the economic costs of regeneration (e.g. Regeneris 2009). These wider benefits, typically, can only be referred to in qualitative terms, making comparison to the costs of the regeneration difficult (Land Use Consultants 2005). Other benefits, such as air and water quality improvement or supporting biodiversity values, are often not discussed at all (O'Neill 2009; Jones 2010; Carrick 2014). The lack of a broad, integrated and monetised summarisation of benefits associated with brownfield regeneration inhibits informed decision making on current or future policies and projects (Bardos et al. 2016).

The challenge in summarising the benefits of brownfield regeneration lies in comparing social and environmental services, which do not have market values, with the regeneration and upkeep costs, which can be quantified through market values. The Ecosystem Service Approach emphasises the essential role of healthy environments in underpinning human economies and well-being (Turner & Daily, 2008). In a review of ecosystem changes, Balmford et al. (2002) found those following a sustainable management approach had a greater monetary benefit than the approach driven by a purely commercial approach. In terms of brownfield regeneration, the lack of consideration of the wider ecosystem services would lead to lost opportunity to realise the full potential of projects (Atkinson et al. 2014; Bardos et al. 2016).

An Ecosystem Service Valuation (ESV) approach offers a framework to guide inclusion of these services into decision-making through identifying relevant ecosystem services to the project, quantifying their scope, scale and impact, and estimating their value in monetary terms. In this way, the full potential of a site can be recognised and allows an informed review to take place to consider different project options for the site.

1.2. Challenges and opportunities to valuing Ecosystem Services for brownfield regeneration

Brownfield sites present additional challenges to valuation in addition to those already associated with valuing ecological benefits. While the benefits of regenerating brownfields has been recognised, it is often only reported in qualitative terms or with limited scope (Land Use Consultants 2006; Turvai & Tonin, 2008). This may therefore not aid the mitigation of the high up-front costs of brownfield projects (Doick et al. 2009; Bardos et al. 2016). For example, Newlands community woodland scheme reports improvements in community well-being, property value, economic regeneration and biodiversity, but does not estimate a monetary valuation for these services (Jones 2010). This analysis for brownfield sites is particularly difficult, as these sites are in more deprived areas and the presence of a brownfield often has a negative impact on the local area (Ham et al. 2013; Loures 2014). A further challenge of particular relevance to woodland creation projects is the long time frames over which the benefits of greenspace creation evolve and accrue in the local area. While ESV is becoming increasingly adopted, the application to site specific and long-term projects with consideration of cultural values remains rare (Haase et al. 2014). Further understanding the complex system of ecosystem service delivery and gathering data for analysis is a challenge common to valuation studies (Daily & Matson, 2008).

With the production of high level reviews using an ecosystem service approach, such as the UK's NEA, the importance of capturing benefits from ecosystems has been increasingly emphasised, and the monetary valuations increasingly accepted (Huang et al. 2014). The research and practise of ESV has demonstrated how values can be estimated and a practical and cost-effective option to support environmental decision-making (Atkinson et al. 2012) and raise awareness of the value of greenspace and regeneration projects (Vandermeulen et al. 2011). New tools have helped streamline the quantification and monetisation process, making this a more accessible approach to users (Bagstad et al. 2013). For example, i-Tree Eco has been used to assess and value the regulatory ecosystem services provided by the urban forest; including air pollution removal, stormwater interception and carbon capture (e.g. Doick et al. 2016). Utilising tools such as this helps to account for the long-term nature of many of these services, which may take time to evolve after the regeneration project itself has completed, e.g. environmental and social benefits may take many years to develop, though these can start to be provided from the inception of the project (Atkinson et al. 2012).

1.3. Research Aims

This report aims to assess and pilot the application of ecosystem valuation tools and approaches estimating the economic benefits of woodland creation on brownfield land.

To achieve this aim we applied a Natural Capital Accounting approach in scoping the economic value of brownfield regeneration at two case study sites. The case studies selected are both part of a larger restoration scheme within the Thames Chase Community Forest. Natural Capital Accounting was selected as the most appropriate approach for this task after a review of possible approaches.

2. Site valuation approaches

2.1. Defining Ecosystem Services

Ecosystems Services (ES) are commonly defined as "*the benefits people obtain from ecosystems*" (MA 2005). While this definition of what ES are is broadly accepted, the best classification of ES to use for their valuation remains under debate. More recent expansions on the ecosystem service concept have begun to incorporate ecosystem disservices, such as Pascual et al's (2017) definition of 'Nature's contributions to people' which includes both positive and negative contributions which people obtain from nature. The commonly applied categorisation is the Millennium Ecosystem Assessment's (MA) four groups of provisioning, regulating, supporting and cultural services (MA 2005). A review of the individual services within these groups with examples related to woodland creation is provided in Appendix 1.

More recently some authors have expanded the MA classification towards a process or 'ES Cascade' framework, addressing a criticism that previous definitions were overly-simplistic (Spangenberg et al. 2014). These newer classifications places ecosystem services along a pathway, incorporating the connection between the environments providing the service, and the 'end-product' benefit for people (Bateman et al. 2010; Fisher & Turner, 2008; Fisher et al. 2011; Haines-Young & Potschin, 2010; Defra 2007). Figure 1 provides a simplified version of this process-based approach. This approach incorporates more of the interactions between ES, identifying where issues of double-counting may occur (Fisher et al. 2011), but also highlights areas of interaction between services and their surrounding environmental and human context. The production of services can be influenced by the environment they are in, and the benefit to people will depend on population size and household demand for that service (Bateman et al. 2010). Both service and benefit provision can then vary over spatial and temporal scales. This approach, while more robust in explicitly addressing all these interactions, now adds a requirement to measure each of these links, adding greater complexity and information requirement for valuation (Spangenberg et al. 2014).

Figure 1. A simple process approach to defining ecosystem services for valuation (Bateman et al. 2010). This approach classifies the steps which factor into the quantity of ecosystem service produced, how this is then translated into a Benefit to humans, which is then valued in monetary terms.

Further developments have been made which reclassify ES as a hierarchical approach, as in the CICES model (Common International Classification of Ecosystem Services; Haines-Young & Potschin, 2011). Alternatively with greater relevance to accommodating the positive or negative role of external factors, 'project services' (Bardos et al. 2016) have been defined separately to ES. Project services account for the combined provision of benefit from both ecosystems and the project involved to restore or develop them, whose social and economic benefits may be difficult to disentangle between the two.

This scoping review will utilise the process approach, as this aids identification and incorporation of potential interacting factors, which are important to detect early, so that their presence can be mitigated for in the quantification and valuation stages of an assessment. The contribution of project factors can also be incorporated as external factors integrated along the ES process pathway.

2.2. Ecosystem Service valuation methodologies

Valuation of individual ES has been ongoing for many decades (Wilson & Carpenter, 1999) and over this time principles and techniques have developed and established for their measurement. These are briefly described below and full reviews are available (de Groot et al. 2002; TEEB 2010; Haase et al. 2014; Turner et al. 2015; Binner et al. 2017). The economic valuation of ecosystem services is defined by Defra (2007) as "*an assignment of monetary values to non-market goods and services*". However, as some ES can have market values this report expands on this definition to include both market and non-market goods in its valuation, which is appropriate for assessments of multiple ES and has been conducted previously in the UK's NEA (2011). Monetary values are most sought after as they are the most easily compared and understood.

Valuation approaches for individual ES can be defined in three main categories:

1. Direct market pricing: Values for goods and services which are traded on markets, such as timber values.
2. Indirect market pricing: Monetary values which are estimated from market values. Includes:
    a. Production-based – services which support economic values and can be valued through their contribution to changes in the provision of goods and services with market values.
    b. Cost-based approaches – avoided, mitigation or replacement costs.
    c. Revealed preference – values are inferred from associated decision-making such as property value (hedonic pricing) or investment in travel to a site (travel cost).
    d. Stated preference – Surveyed individuals or groups state their willingness-to-pay (WTP) under different options or scenarios.
3. Non-market pricing: Monetary values are not estimated, but importance is scored or ranked using expert opinion, individual surveys or collaborative approaches.

The indirect market pricing methods using revealed and stated preference approaches are trying to capture a 'Willingness-To-Pay' (WTP) value for services or a 'Willingness-To-Accept' (WTA) for loss of a service. They each have associated positives and negatives and are more relevant to particular ES. For instance, many cultural services can only be captured using non-market methods, while some, such as aesthetic value and well-being, can be captured using indirect market pricing such as Hedonic Pricing. Here a commonly applied method is to relate changes in property value to provision of greenspace, with the higher benefits associated with living near a greenspace expected to be reflected in a higher value (Regeneris 2009; Eftec 2015b). Regulatory services are often assessed using cost-based approaches, for example i-Tree Eco assesses the economic value of air pollution removal using the Social Damage cost which incorporates the avoided costs of impacts on human health and damage to buildings and crops (DEFRA 2015).

'Value transfer' (VT) is not a valuation method in itself, but a method of translating a value calculated for one site to another (TEEB 2010). Due to the high costs of field-based work, value transfer is a very popular tool in ESV, but is open to misuse and estimation of inaccurate values for the study site (Richardson et al. 2015). This method takes values estimated from a 'study' site and applies it to the site undergoing valuation analysis (the 'policy' site). While this may appear straight-forward, there must be careful consideration on the validity of transferring values from different sites. Many local factors will determine the estimated WTP for different sites. Some of these factors can be assessed at both sites and then used to scale the transferred WTP appropriately to the new site, such as altering for local population sizes or income levels (Richardson et al. 2015). Further the quality of the study at the donor site must be considered. Guidelines for appropriate use of value transfer (Eftec 2010a), and databases of potential donor site information (ESTT; Natural England 2014) are available. Further, individual tools are available to help structure and source information to conduct ecosystem valuation. A useful review of these is provided by Bagstad et al. (2013).

2.3. Valuation Approaches

For the valuation of a particular site or ecosystem often multiple ES are targeted to gather a comprehensive estimate. Some studies have simply applied individual evaluation techniques to multiple services (Regeneris 2009), while others have applied approaches which formalise the aggregation and valuation of multiple services. These approaches provide a frame for more comprehensive and considered assessment of individual services and aggregation of these services into final estimates for the site. Four key approaches are reviewed below and summarised in a SWOT analysis of the four methods (Table 1). There has been a rise in the use of all of these tools for environmental decision-making, driven by the growth of the ecosystem service approach and by the greater availability of data and tools to conduct analyses (Huang et al. 2011).

Cost-benefit Analysis (CBA) has a long history of use in decision-making for business and planning fields. Its strengths lie in its historic use providing it with established frameworks and principles of use (Atkinson & Mourato, 2008). It is also attractive in that it provides a simple measure (NPV) indicating whether the benefits of a project or plan exceed the costs. The inclusion of environmental values into cost-benefit analysis requires additional knowledge and consideration of how to measure and predict ecosystem service flows and changes in time and space. As an adapted tool from economics, the CBA framework is not designed for the inclusion of difficult to estimate environmental values, such as biodiversity or cultural values. This may result in a narrow selection and consideration of services and their impacts, leading to exclusion of non-monetary values and inaccuracies in assessment of total value (Wegner &

Pascual, 2011). Furthermore, the CBA approach can overlook non-linearity issues such as threshold effects and tipping points. Examples of environmental cost-benefit analysis include the use of i-Tree Eco in the US to value regulatory ES provision compared to tree management costs (McPherson et al. 2005).

Natural Capital Accounting (NCA) considers the environment as an asset within organisational financial accounts, and tracks gains and losses in the quantity and quality of the stock of this capital and estimates the change in ES flow and connected benefit as a result. Its emphasis on the connection between capital stock and ES flow is the main strength of NCA, providing the most robust approach to incorporate environmental management into organisational management and future planning to achieve sustainability objectives (Atkinson et al. 2012). It is based on the UN System of National Accounts (SNA) expanded to environmental goods and services, and was conceived from its outset with an ES focus allowing it to be comparable with an organisation's traditional financial accounting, while incorporating environmental valuation (ONS, 2017). Another strength of NCA is that it has been gaining momentum and use at international (WAVES; Cantrell 2015) and national (UK NCC) levels, which has facilitated the development of protocols and guidelines for its use (Eftec 2015; NCC 2016). It has now been applied to both national organisations, such as Forest Enterprise England (FEE 2016) and individual sites, such as Silverdale Park (Interserve 2017).

Social Return on Investment (SROI) grew out of CBA and its lack of integration of social impacts of policies and interventions (Nicholls et al. 2009). It utilises local public surveys to estimate the impact and value of projects, generating a final SROI ratio akin to a cost-benefit ratio (Arvidson et al. 2010). This provides an important local focus often missing from other assessment methods and allows greater assessment of impact across different groups of greenspace users. However, this approach is resource-intensive and the identification and valuation of financial proxies can be biased depending on the survey response (Arvidson et al. 2010; Hölzinger et al. 2013; Maier et al. 2015). SROI may also have weak inclusion of environmental quality and environmental ecosystem services, which may reduce its ability to inform environmental management decisions. An example of SROI is Edinburgh's review of four of its urban parks (CEC 2014).

Multi-Criteria Decision Analysis (MCDA). The main strength of MCDA is that it is the only method which can incorporate ES without any monetary value. It instead utilises a participatory ranking and weighting approach to evaluate the relative worth of different benefits and services. It can aid decision-making in evaluating how different scenarios would change the provision of services, and applying the rankings to compare the relative loss or gain of overall value from the different scenarios. To avoid bias in weightings, care must be taken in collecting a representative sample of local population and decision-makers into the deliberative process, who must be then managed to ensure fair and equal input into the process (TEEB 2010).

From the review of valuation approaches, NCA was selected as the most appropriate for valuing woodland creation on brownfield sites. This is because NCA's link to the stock and quality of capital supports the assessment of a system which will change over time, as woodland will on a new site. It is also useful for addressing how different management systems may impact value.

Table 1. SWOT analysis review of the main valuation frameworks for valuing and aggregating multiple ES.

	Strengths	Weaknesses	Opportunities	Threats
CBA	- Strong project management and financial links[6] - Clear outcome in monetary terms	- Does not explicitly address impact or long-term change in ecosystem state and effects on service flow[7] - Can be too narrowly focused	- Improved methods to support individual service valuation - Databases for value transfer - Already used to inform planning/policy decisions[6]	- Ecosystem service definition - Difficulty in valuing cultural services[5,6]
NCA	- Emphasis on link between stock of natural capital and flow of ecosystem services[3] - Comparability with financial accounts[4] - Can be used as a decision and long-term management tool	- Resource intensive[5] - How service provision changes over growth of stock not fully understood[5] - May overlook role and dependencies on other forms of capital[10]	- Improved methods to support individual service valuation - Databases for value transfer - Widespread uptake - Frameworks in development[2,3]	- Pathways between capital stocke and service provision not always fully understood[1] - Ecosystem service definition - Difficulty in valuing cultural services[5,6]
SROI	- Local and participatory input incorporating site-specific demands and impacts[12] - Strong inclusion of social and economic values	- Resource intensive[12] - Risk of being biased[11] - Results not transferable[12] - Weaker on environmental values than social	- Improved survey methods to reduce time	- Ecosystem service definition - Difficulty in valuing cultural services[5,6]
MCDA	- Only method which can address all ES - Participatory and collaborative approaches can be used allowing democratic decision-making[9]	- Lack of monetary valuation for all ES - Full inclusion of all ES and participatory approach infrequently used[8]	- Improved survey methods to reduce time - Can be integrated with other, monetary-based methods[11]	- Ecosystem service definition - Poor general knowledge of ES may bias decisions - Subjective reasons for decisions may be overlooked[8]

1. Pascual et al. (2010)
2. Eftec (2015a)
3. NCC (2016)
4. Heal (2007)
5. Hein et al. (2015)
6. Haase et al. (2014)
7. Howarth & Faber (2002)
8. Davies et al. (2012)
9. Joubert et al. (1997)
10. Eftec (2016)
11. Hölzinger et al. (2013)
12. Arvidson et al. (2010)

3. NCA Scoping for Thames Chase sites

The NCA approach was applied to two community woodland sites in the Thames Chase Community Forest. Following guidance on the key steps of NCA, the practical application of the approach was assessed. ES values were assessed to identify the magnitude of possible benefits from the two Thames Chase sites. The values produced in this assessment are indicative only, and have not been as robustly gathered or reviewed as would be needed for a full assessment.

3.1. The Natural Capital Accounting Approach

A clear framework for undertaking NCA has been a barrier in the uptake of NCA, but this has been addressed in recent years with work by Eftec (2015a; Developing Corporate Natural Capital Accounts) and the NCC (2016; Natural Capital Protocol (NCP)). Within the NCP, Natural Capital (NC) is defined as *"the stock of renewable and non-renewable natural resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people".* It aims to provide a framework which both measures NC and values it in qualitative, quantitative and/or monetary terms. This scoping review approximately follows the framework from these two guidance documents. Some deviations have been made as these frameworks take a corporate accounting focus, while this project is taking the perspective of the Forestry Commission, which as a public body is explicitly concerned with societal values. Further deviations have been made due to the limited nature of this scoping review, which aims to provide indicative values only.

The key stages to NCA followed here are:

1 Framing the project and sites
- Define the project and the changes it will implement to NC, assess the current environmental and social context of sites and define the temporal limits of the analysis including the baseline and length of the account.

2 Scoping services, context and data availability
- All possible ES from the NC are reviewed and their likely significant impacts assessed to identify only relevant ES to be incorporated into the account. A scoping report can be produced to report back on the practicality and feasibility to continue on in the valuation (e.g. Eftec 2011).

3 Produce Asset Register
- Quantify the extent, condition and changes in NC over the accounting period.

4 Produce the Maintenance Cost Account

- Estimate the initial project delivery and long-term maintenance costs for the project.

5 Produce Physical Flow Account
- Estimate the production of ES from the NC as defined in the Asset Register and accounting for local impacts on service production.

6 Produce Monetary Account
- Utilise sources of valuation identified during scoping, and where appropriate apply these to the quantities estimates in the Physical Flow Account to gain a monetary value for these services.

7 Review and assess accounts
- Review effect of spatial and temporal factors on the extent and impact of service and benefit provision. Qualify the values in relation to discounting and other factors for each ES.

8 Produce the Natural Capital Balance Sheet
- Combine the estimated values from the Monetary Account and the Maintenance Cost Account to review the overall cost-benefit of the project for the initial reporting year and for the project timeline. Calculate the Net Present Value (NPV) which estimates the total net value of the site over its lifetime today.

3.1.1. Framing project for Thames Chase sites

The two sites to be assessed are part of the Thames Chase Community Forest, a growing network of greenspace sites developed for local community well-being. The Forestry Commission is a key partner with the Thames Chase Trust, and holds leases of both Ingrebourne Hill and Bonnetts Wood to manage them for 75 years. Table 2 compares characteristics of each site. The spatial context of each site is provided in Appendix 2.

Table 2. Comparison of key information for the two Thames Chase sites.

	Bonnetts Wood	Ingrebourne Hill
Area	16 ha	57 ha
Opened	2003	2008
Ward, district	Upminster, Havering	South Hornchurch, Havering
Site history	Previously greenfield, adjacent to brownfield sites	Brownfield regeneration – former landfill site of inert material
Ecosystem Assets:	Woodland (11 ha) Open grassland (5 ha)	Woodland (13 ha) Open grassland (40 ha) Lake (4 ha)
Accessibility	No car parking on site, but parking nearby and accessible from rail and bus. Local communities within walking distance	Free car park and accessible by rail and bus. Links into Hornchurch Country Park. Local communities within walking distance
Recreation features	Over 5km of trails for walkers, bicyclists and horse-riders	Over 9km of trails for walkers, bicyclists and horse-riders
Households (population)[1] within 50m	5 (12)	240 (566)
Households (population) within 300m	37 (87)	1,509 (3,561)
Households (population) within 1000m	1,326 (3,129)	8,832 (20,844)
Surroundings	Located within a matrix of other public greenspace and private (mostly agricultural) land use.	Located adjacent to housing estate. On the edge of the greenspace matrix and closer to rail links and industrial areas to the South.

[1] Population estimated from an average of 2.36 individuals per household (ONS, 2016). Number of households estimated from OSMM topographic layer.

The timeline for the analysis and bounds for analysis should be defined at this framing stage. This includes setting the baseline for the account, which is the year and values against which future changes are compared. For the Thames Chase sites it would be prudent to use a pre-restoration baseline, as this would incorporate the many benefits associated with removing the negative impacts from brownfields. Removal of negative impacts may help justify remediation costs associated with brownfield restoration. However an alternative baseline which may be useful where different forms of regeneration are under consideration is the minimum the site could be restored to, which for Thames Chase sites would be simple landscaping and grass seeding. This baseline would explicitly address the additional value gained from woodland creation compared to the 'do-minimum' regeneration option that may help to justify its higher costs. Alternatively, target baselines can be used to facilitate the enhancement of Natural Capital to meet formal or informal objectives (Eftec 2015b). Baselines in previous work have often used the pre-intervention state (Regeneris 2009; Eftec 2015b). Here, we have selected the baseline to be the year prior to the site opening when the woodland is planted, set as year 0. This is to compare the initial investment costs in woodland creation with the future values derived from woodland ES.

3.1.2. Scoping for Thames Chase sites

The scoping section should identify possible ES related to the Natural Capital in question and assess if and how they should be incorporated into the Account. A review of possible services taken in the context of local site information is provided in section 3.2 to allow the likely significance of the benefit of each to be assessed. Significance here refers to if the service has a substantial negative or positive impact on the organisation or public. This avoids undue effort being spent attempting to measure ES which will not significantly change the balance of the account and therefore impact decision-making. The scoping phase should also assess the capability for the account to measure and value services based on available data and analytical methods.

Capture of the relationships each ES has with the local environment, population and other ES is useful at this stage to incorporate potential confounding issues such as double-counting early in the account. Double-counting, where the same benefit is valued more than once in a single account, occurs due to the interconnectedness of many ES and their contribution to producing a single benefit. To avoid this, valuation for services deemed too related to another service are dropped. For example Regeneris (2009) used property value as a proxy of well-being and recreation benefits, and did not value these individually. The review of the ES relationships within the scoping phase can help to identify the best selection of ES based on significance, feasibility of calculation, and avoidance of double-counting issues.

To identify these related factors, visually displaying the process of each ES is a useful approach. An example is shown below for landscape enhancement ES (Figure 2). This example shows how the ecosystem state is influenced by human management of the site, the state of the ecosystem then affects the production of the ES. The production of the ES will first be affected by the environmental context and secondly by the societal context. Other capital may affect the full translation of the ES before it reaches the benefit stage, where the ES has an impact on humans. The final stage is the valuation of the benefit provided to people into monetary terms. In this case there are two options shown: Willingness-to-Pay values calculated previously by Garrod (2002) and measuring uplift in property values (Gibbons et al. 2014).

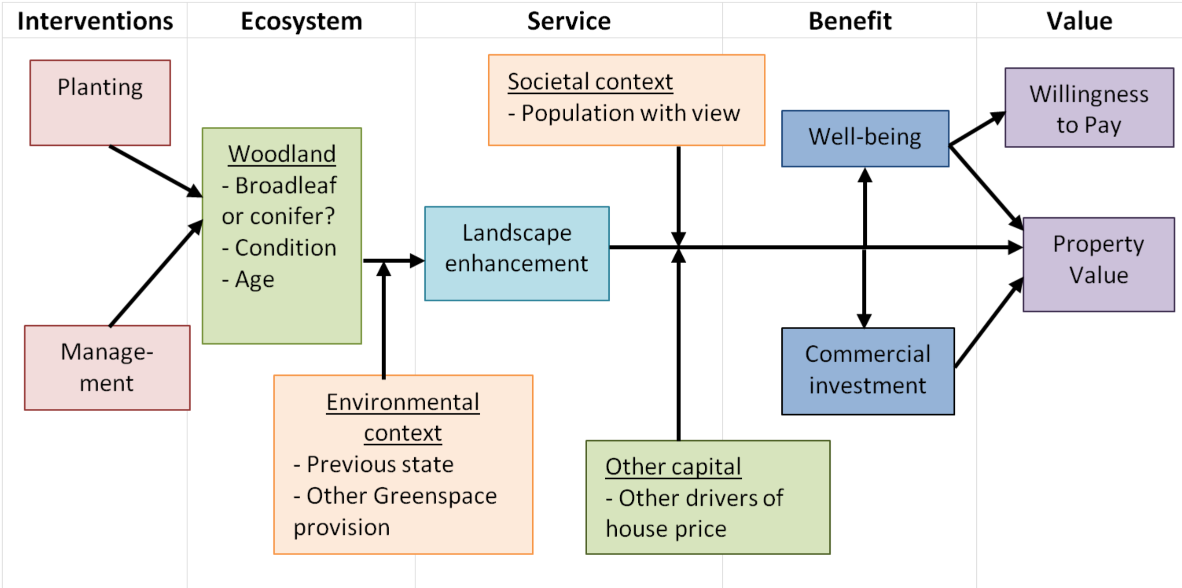


Figure 2. Diagram of a process based approach to defining a single ecosystem service (landscape enhancement) and incorporating the possible internal (within the ecosystem) and external (human or other environmental) impacts on flow from ecosystem to service to benefit and value.

The relationships identified using a process approach can change over time, particularly for woodland creation projects where ES delivery may take time to reach a meaningful level as the trees take time to grow large enough sizes to deliver ES. This was explored in this scoping review by simply plotting out expected trends in the change in production of ES over time (Figure 3). This shows how values change over time, for example, costs are highest for project delivery (3.d), while it may take decades for regulatory ES (such as air pollution removal, carbon sequestration) to reach meaningful levels (3.c). These are interrelated to the growth of woodland, here estimated in 3.a) which shows the impacts of forestry cycles on woodland stock.

Reviewing possible ES, incorporating their related process approach and changes over time allowed the significance of each ES to the Thames Chase sites to be evaluated. The availability of data and methods for ES quantification and valuation was then assessed, allowing both significant and measurable ES to be identified and selected for inclusion in the main NCA. A summary of this for approach and findings for the significance and data availability for a subset of ES is provided in Table 3.

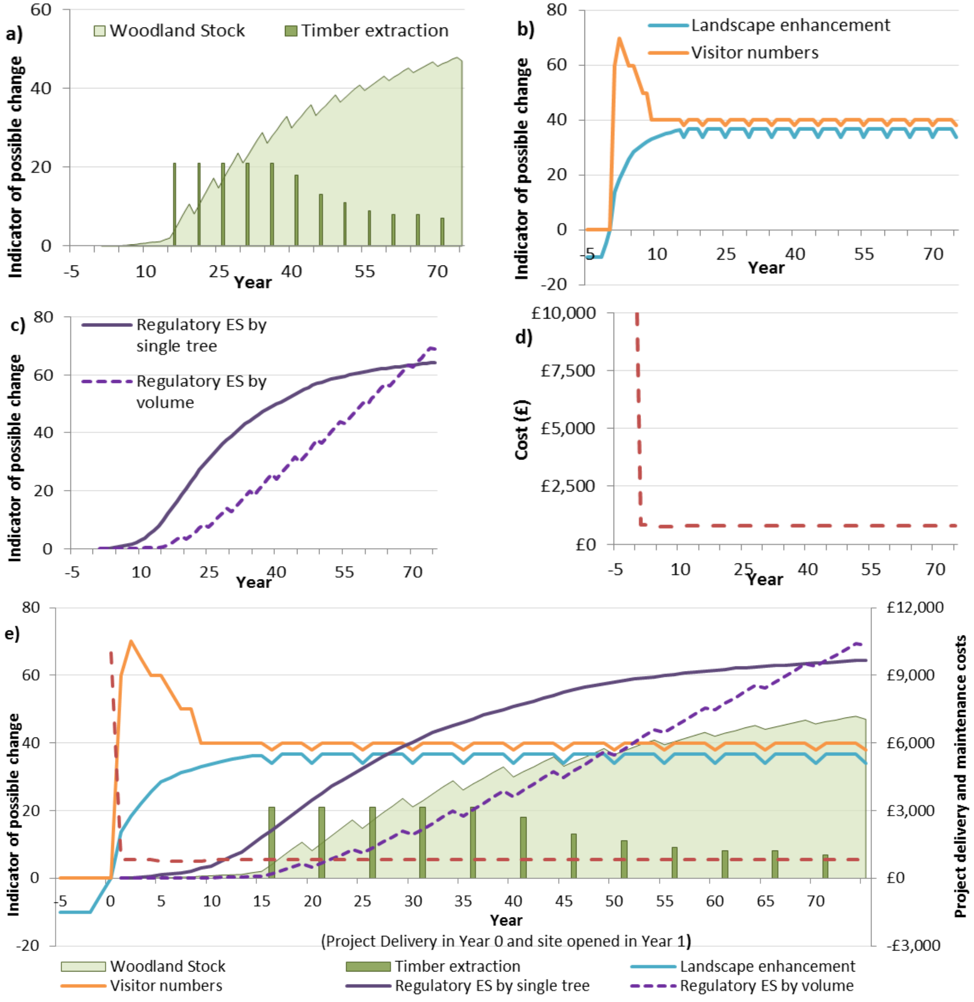


Figure 3. Visualisation of the predicted change the state and services provided in the two Thames Chase sites after project delivery in year 0. Figure a) describes the growth of woodland and removal of stock under a regular 5 year thinning regime. Figure b) displays anticipated trends in visual amenity value, which is anticipated to start in a negative state due to the unattractiveness of some brownfield sites, but increase after the site is regenerated to reach a steady state by year 15. Visitor numbers are anticipated to be highest in the years immediately after the site is first opened, as this is when the greatest number of community engagement projects may take place. The potential impacts of forestry operations on reducing the visual amenity of the sites and reducing access to the site are indicated by small dips in these values during these operations. Figure c) displays anticipated change in the provision of regulatory ES. These are shown for the individual tree (solid line), where trees are expected to spend most of the time in a semi-mature status when growth rates are highest. The dashed line indicates the change in ES provision related to tree stock, which incorporates the short-term negative impact of tree removal in forestry operations on the woodland's regulatory ES capacity. Figure d) shows the costs estimated for the site, which are highest in year 0 for the project delivery, before falling to a steady state of long-term maintenance. Figure e) combines the previous graphs to display the interactions between them. Note the values shown here are not those applied within the NCA within this scoping review - they are an aid to help identify significance and interactions between NC, ES and people. For instance, the effect of timber removal was not included in the NCA due to difficulties at this time in quantifying this impact.

Table 3. Partial scoping review of significance of woodland ES provision on the two Thames Chase sites. Evidence for the significance of each service is listed in the first column. The next two columns assess the availability of data for i) the quantification of the flow of service and ii) the monetary valuation of that service. The colours used indicate: Green = good level of available data, yellow = some data which may require or manipulation to use, orange = some data of lower quality which may have caveats to use, and red = requires site-specific field data.

	Service Significance	Service Quantification	Service Valuation Evidence
Air purification	- Likely high-pollution area (outer London and near major motorway). - Similar sized greenspaces show significant value for pollution removal (20ha woodland in Wardown park = £18,912 per annum; Fay et al. 2012). - Benefits may take time to develop as canopy cover grows. - Benefit will be greater for Ingrebourne Hill as a larger site and more urban location.	Data for other small sites available (e.g. Fay et al. 2012) and local (e.g. Beam Parklands; Eftec 2015b) but these are for established woodlands.	Data for other small sites available (e.g. Fay et al. 2012 and local (e.g. Beam Parklands; Eftec 2015b) but these are for established woodlands WTP for improved health (Chilton et al. 2004).
		Information on tree planting (species, date, area) available, but relationships to ES provision still in-progress.	Social Damage Costs and local pollution levels are available.
		i-Tree Eco analysis can use field data to estimate air purification based on tree species, size and condition at site and incorporate local pollution data.	
Visual Landscape enhancement	- Properties in proximity to forests have seen value uplift of 1-19% (GLA 2010; Garrod and Willis, 1992; Garrod 2002; Dunse et al. 2007; Gibbons et al. 2014; Perino et al. 2014). - Improvement of brownfield sites can remove depressant on property value (2.6%) (Ham et al. 2013). - Significance higher for Ingrebourne Hill as has more properties within close distance of site. - Benefit likely to increase over time until forest establishes (circa 15 years).	Very site specific.	WTP values available (Hanley et al. 2002).
		Census population counts available (ONS 2016).	Percentage property uplift values available (GLA 2010; Garrod and Willis, 1992; Garrod 2002; Dunse et al. 2007; Gibbons et al. 2014; Perino et al. 2014).
		ArcGIS ViewShed analysis (e.g. Regeneris 2009; Saraev 2015).	Modelling method using changes in value over spatial and temporal boundaries (e.g. DCLG 2010).
Biodiversity Support	- Peri-urban woodlands can support high levels of biodiversity compared to other urban	Literature available on general impact, but little specific to brownfield	WTP studies for woodland creation based on non-use values only (Hanley et al.

	areas (Croci et al. 2008). - Significance may be greater for Ingrebourne as larger park (Fernandez-Jurcic and Jokimaki 2001); though woodland cover is similar. - Sites are close to SSSI (Rainham Marshes).	regeneration or woodland creation.	2002).
		Currently little monitoring, but some records of protected species may be available.	Potential to use values from Woodland creation grant scheme (~£4,000 per ha; FC 2013; £200 per ha annually; NE 2017).
		On site survey and monitoring.	On site survey with visitors.
Recreation	- Brownfields regenerated to greenspace are quickly utilised by the local population for recreation (De Sousa, 2006). - As part of a larger greenspace network and within walking distance for local communities both sites likely to be significant. Value may be higher for Ingrebourne as a larger and more accessible site.	Proportion of local use of site available to estimate number of visitors from local population using UK Public Opinion of Forestry Survey (FC 2015a).	WTP and travel cost studies, but very site-specific (Scarpa, 2003). Other generalised values are available (Eftec 2010) but are recorded as per ha values while visitor numbers to woodlands does not scale linearly to woodland size
		Visitor numbers available.	
		Local resident/visitor surveys to assess frequency and impacts of visits.	Local resident/visitor surveys to assess travel costs and/or WTP.
Carbon storage and sequestration	- Urban forests can act as a carbon sink to help mitigate impacts of climate change (Davies et al. 2011). They sequester and hold more carbon than other landuses (FC 2003). - Carbon values will increase by 5 times as the woodland grows over the length of this assessment (DECC 2015). - Valuation of this service from smaller woodland has found significant values (Fay et al. 2012).	Data for other small sites available (e.g. Fay et al. 2012) and local (e.g. Beam Parklands; Eftec 2015b) but these are for established woodlands.	Carbon values are available up to 2100 (DECC 2015).
		Methods to estimate carbon in soil and landscapes available through Woodland Carbon Code (FC 2015b).	
		Information on tree planting (species, date, area) available, but relationships to between management regimes and ES provision still in-progress.	
		i-Tree Eco analysis can incorporate field data on tree size and estimated growth rate to assess local site carbon storage and sequestration.	

Rainfall interception	- Both sites are within a flood risk area (Flood risk maps, EA 2017). - Can provide value through avoided costs and risk mitigation (e.g. nearby Beam Parklands valued at £0.6 million a year; Eftec 2015b). - Urban forests can help reduce flooding (Forest Research 2010).	Information on number of households and property value available.	Value of mitigated risk can be estimated based on housing value (e.g. Eftec 2015b).
		Information on flood risk zones available (EA 2017).	Local sewerage charges can be used to calculate avoided costs (e.g. Doick et al. 2016).
		i-Tree Eco analysis can use field data to assess tree canopy interception of water.	

3.1.3. Asset Register of ecosystem stock

The Asset Register is the account keeping track of the state of NC and changes occurring to it. Table 4 gives an example for both Ingrebourne Hill and Bonnetts Wood. To assess the state of NC a number of indicators are selected to track any changes in the NC. This could be gains and losses in the total quantity of the NC, but also changes in quality (e.g. a pest outbreak reducing tree health) which may affect the production of ecosystem services. Indicators should be easy to measure and robustly connected to the natural capital. Ideally they can also relate to many different features of the NC. For NCAs at national levels (e.g. FEE 2016) indicators are often at large scales, such as simple area estimates of habitat cover, or percentages in favourable management. These large-scale indicators are less relevant to single sites where changes in the extent are likely to be smaller. However, many NC studies still rely on simple measures of area. This makes it easy to overlook changes in the condition of the habitat, leading to opportunities for unsustainable management. The identification of reliable indicators able to be practically applied to a single site would help improve the link between site management and valuation exercises (Müller & Burkhard, 2012; Davies et al. 2017).

Table 4. Basic layout for Asset Register showing estimated values for Ingrebourne Hill and Bonnetts Wood in 2017. The register can include natural capital, as well as physical and social capital as changes in these values may affect the state and/or quality of natural capital and the flow of ES. Further columns could be added to this to track the annual change in these indicators.

Capital	Indicator	Ingrebourne Hill (2017)	Bonnetts Wood (2017)
Natural:			
- Woodland	Area (ha)	13	11
	Avg. dbh (cm)	6	7
	Species diversity	-	-
	Condition (crown dieback)	-	-
- Grassland	Area (ha)	40	5
	Species richness	-	-
- Water system	Area (ha)	4	0
- Whole site	Area (ha)	57	16
Physical:	Trails (km)	8	3
- Trails	Car park (ha)	0.33	0
- Car park		-	-
- Other (e.g. interpretation boards, benches, recreation facilities)			
Social:	Community groups (#)	-	-
	Volunteer hours	-	-
	Projects run (#)	-	-
	Educational events/school visits	-	-

3.1.4. Maintenance Account of project costs

The maintenance cost account is that most related to existing accounts likely held by an organisation. It estimates the management costs for NC. For the case study sites here, costs are for initial site regeneration (creation) and long-term maintenance over the length of lease on the site (75 years). Costs were calculated from both estimates derived from the Thames Chase sites along with published delivery costs for brownfield creation projects and maintenance for woodland and grassland (Woodland Trust 2011; Selman et al. 2003; Regeneris 2009; Eftec 2015b; Valatin & Saraev 2012). These values were assessed for four phases of the project: Site delivery (Yr 0), establishment (Y1-5), post-establishment (Y6-10), and long-term maintenance (Y11-75). Costs are highest for site delivery, when the most work on site is being carried out for reclamation, infrastructure and planting (Fig 3.d). Costs in the establishment phase are slightly higher than post-establishment to account for more intensive management in the early years, but there may also be ongoing delivery work and greater input for community engagement projects. In the maintenance phase costs are expected to be at a lower steady rate accounting for general maintenance such as tree work and grass cutting. The project delivery costs were estimated at £500,000 for Ingrebourne Hill and £130,000 for Bonnetts Wood, while annual maintenance costs were estimated at around £40,000 and £10,000 respectively (rounded to nearest 10,000).

3.1.5. Physical Flow Account of ES provision

The physical flow account quantifies the production of ecosystem services from the NC on an annual basis. Indicators are used to track changes in each ES over time. Indicators should represent a measure of the provision of the service, e.g. amount of carbon stored, number of visitors. These indicators can either be measured on-site, such as for visitor numbers, or calculated based on relationships with the NC asset indicators. The Physical Flow Account for Ingrebourne Hill is provided in Table 5. This table lists each service being assessed, the NC at the site providing the service and lists an indicator to track provision of that service. The flow table allows for change in ES provision to be viewed, comparing the baseline value to the current year and tracking the gain or loss of that service from the previous year. The corresponding table for Bonnetts Wood is provided in Appendix 3.

Services which should be included in the Physical Account are those which were identified during the scoping phase to be significant and can be feasibly quantified and valued. However, it can also be useful to include ES which were identified as being significant, but do not yet have available data or methods for calculation for the target site. An example is shown here with Health ES in the bottom row of the account. The inclusion of significant but non-quantifiable ES allows for these services to be monitored to support sustainable maintenance of their provision. If and when valuation becomes available, they can then be readily incorporated in the monetary and final accounts. Methods for the quantification of ES used here are provided in Appendix 4.

Table 5. Physical flow account for Ingrebourne Hill, assessing the change for the current year (2017, year 10 from delivery). The provision of ES is shown at two different time periods: the Baseline (pre-delivery state to which all changes are compared) is shown in the third column from the right; The level of ES provision in year 10 is shown in the right-most column. The Gain/Loss in ES provision in year 10 (the marginal change in the flow of ES since the previous year, in this case year 9) is shown in the penultimate column. The reason for any gain or loss is given in brackets.

Service	Capital[1]	Indicator (unit)	Source	Base-line (Yr0)	Total Gain/ Loss since Y 9 (reason)	Level in Y10
Air pollution removal	Woodland (Grassland)	Pollutants removed (t)	Value transfer (Fay et al. 2012)	0	+ 0.04 t (woodland growth)	0.41 t
Carbon sequestra-tion	Woodland (Grassland)	Carbon sequestered (tCO_2e)	Woodland carbon code (FC 2015b)	0	31.2 $tC0_2e$ (woodland growth)	105.8 tCO_2e
Landscape enhance-ment	Woodland	Number of households with view	GIS estimate	0	+ (woodland establishing, but no housing development)	240 house-holds
Recreation	Whole site	Visits	Value Transfer (Barker Langham, 2016)	0	0 (site & use levels established)	80,000 visits
Biodiversity	Woodland (grassland, lake)	Ha. Woodland created	GIS estimate	0	0 (woodland established)	12.88 ha
Health[2]	Whole site	Visit number, duration, activity	Value Transfer (Barker Langham, 2016)	0	0 (site & use levels established)	80,000 visitors

[1] NC listed in brackets are features within the site which may contribute to the provision of ES, but whose contribution to the provision of ES is not accounted for here.
[2] Services which are provided from the site but not valued in this scoping report are shown in the coloured row. Including these services ensures their role and impact is not forgotten.

3.1.6. Monetary Account of ES Value

The monetary account adds a value onto the production of benefits identified from the physical flow account. Indicators should represent the value being applied for a unit measure of the ES. These values may change over time as markets change. The monetary values estimated in this scoping review are provided in Table 6 for Ingrebourne Hill. Values for Bonnetts Wood are provided in Appendix 3 and methods to calculations are provided in Appendix 4. Here we have primarily used value transfer to estimate monetary value of ES.

Table 6. Monetary account for Ingrebourne Hill, assessing the change in the current year (2017, year 10). The provision of ES is shown at two different time periods: the Baseline (pre-delivery state to which all changes are compared) is shown in the third column from the right; The value of ES provision in year 10 is shown in the right-most column. The Gain/Loss in ES provision in year 10 (the marginal change in the flow of ES since the previous year, in this case year 9) is shown in the penultimate column. The reason for any gain or loss is given in brackets.

Service	Capital[1]	Indicator[3] (unit)	Source	Base-line (Y-1)	Total Gain/loss since Y9 (reason)	Annual value in Y10
Air pollution removal	Wood-land (Grass-land)	Social Damage costs (DEFRA 2015)	Value transfer (Fay et al. 2012)	0	+ £921 woodland growth)	£9,215
Carbon sequestra-tion	Wood-land (Grass-land)	Carbon price (£64 per $tC0_2e$ in year 10)	Market price, (DECC 2015)	0	+£1379 (woodland growth & increase in carbon value)	£6,718
Landscape enhance-ment	Wood-land	WTP for view (£356/ household/ year)	Value transfer (Garrod 2002)	0	+ £4,268 (woodland still growing so full WTP not yet reached)	£81,088
Recreation	Whole site	Visit value (£0.78 per visit)	Value transfer (Scarpa 2003)	0	0 (site & use levels established)	£62,068
Biodiversity	Wood-land (grass-land, lake)	WTP for woodland creation (£0.66 per ha per year)	Value transfer (Hanley et al. 2002)	0	0 (woodland created)	£894
Health[2]	Whole site	-	-	-	= (site & use levels established)	

[1] NC listed in brackets are features within the site which may contribute to the provision of ES, but whose contribution to the provision of ES is not accounted for here.
[2] Services which are provided from the site but not valued in this scoping report are shown in the coloured row. Including these services ensures their role and impact is not forgotten.
[3] Unit values shown have been reflated to 2017 prices (HM Treasury's GDP deflator, 2017).

3.1.7. Review stage

The interactions between ES, between ES and external factors, as well as spatial and temporal features need to be taken into account. These should be first identified during scoping and incorporated where necessary throughout the accounting process, but this review stage provides the final stage to apply these to temper values to the local and temporal context. The main factors to consider are reviewed below, but these were not accounted for in this scoping review with the exception of discounting (see Saraev 2012 for a more detailed account of these factors).

Attribution: The benefit of an ES may be contributed to by other ES or by external physical capital or human capital inputs. For example the improved social and physical well-being from engaging in volunteering activities may be in part derived from the experience in nature, while also in part due to the social interaction which could have been achieved in non-natural environments. This is therefore a partial 'project' effect with the volunteering opportunity provided by the project, while the natural context provided by the woodland. An alternative example is recreation services, where recreation infrastructure will contribute to the value of the benefit gained by people using the area (Wang et al. 2004).

Deadweight: Some benefits which could be associated with changes in ES provision may have occurred without the project or intervention taking place. For example, recreational benefit may have taken place in other areas if the Thames Chase sites had not been opened to the public. This can be addressed in part by addressing the change in provision of a service for the area. For example Regeneris (2009) assessed the change in greenspace accessibility for the local area before and after the Mersey Forest programme.

Demand: While a service can be provided, a benefit will only be produced if there is demand for the service in the local area (Burkhard et al. 2012). For example, if there is no flood risk in an area, there will be no value for stormwater interception. Similarly if an area already has a high provision of greenspace, the addition of another unit of similar type and standard may have little overall impact. For example, the total number of visits and time spent for visits within the GS network may remain the same so that the total benefit remains the same (related to Substitution discussed below). On the other hand, in the case of Thames Chase Bonnetts Wood, this site adds a key link between other GS so this site is likely to increase the overall recreational value of the GS network, though the benefit depends on the role of the other sites as well. Demand is seldom incorporated into NCA assessments, except for in relation to measures of greenspace accessibility and the influence of population size. Demand should be explored as it can change over time, for example visual preferences for forest structure and associated WTP have changed over the past 20 years (Zandersen et al. 2007).

Discounting: a yearly discounting factor is applied to values to incorporate social time preference that considers a benefit now to be worth more than a benefit in the future (Treasury HM, 2013). This is incorporated into the net present value (NPV) estimation, which is the value of the ecosystem or service over the lifetime of the account (here 75 years). The selection of the discount rate can have significant impact on the NPV estimate. The UK Treasury’s Greenbook (Treasury HM, 2013) long-term discount factor of 3.5% for year 0 – 30; 3% for year 31-75; and 2.5% for year 76-99, is a widely accepted value and is applied here though other discount rates could be explored in further analyses. However, criticism of this rate has been made (Hölzinger 2012), and a lower rate has been argued to be more relevant to environmental benefits (Sunderland et al. 2012). Some have suggested a negative discount rate may be more appropriate for issues related to climate change and ecosystem restoration, where the demand for services may increase in future or supply decrease (Blignaut & Aronson, 2008; de Groot et al 2013).

Substitution/Displacement: The provision of a new site may transfer benefits that would have been generated from individuals using other greenspaces. For example, individuals may switch to regularly using the newly created site, but the benefit they gain may not have changed from the level they gained from using an old site (CEC, 2014).

Sensitivity analysis: Many values in NCA are developed through educated guesses, previous work and hypothesised likely outcomes. For example the benefits assessed using value transfer assumes that the study site will behave similarly to the donor site, but this may not always be the case. For this reason, sensitivity analysis is useful to identify how much variability there is in the estimates computed and therefore how much confidence can be placed in them. Variables which could be altered include visitor numbers to the park, which will affect benefits like health and recreation (e.g. Regeneris 2009).

3.1.8. Summary and cost-benefit review

The final stage in NCA is the summarisation of all monetised estimates; here provided for both Bonnetts Wood and Ingrebourne Hill in Table 7. This takes the total costs and benefits for each site with the above qualifiers applied as necessary to calculate a net value. The values are summarised at three different times; i) the baseline, which was taken as the start of Y0, prior to the site opening to the public, ii) the annual value produced after 10 years of the site being opened, and iii) the values projected in the future for the length of lease on this account (75 years). The cumulative and annual values have not been discounted to show how the benefits from ES will change over time as the woodland grows and establishes. However, future benefits are worth less to society than current ones and this is incorporated into predicted future values of the site in computing the NPV (the sum of discounted benefits minus the discounted costs using the discount rates selected in stage 3.1.7).

The summary values indicate that in Y0 there is a net loss due to the high delivery costs and negative benefit provision due to the negative value of carbon emissions associated with site preparation and planting (FC 2015b). By year 10 Ingrebourne Hill has reached a positive return on investment, with a net benefit of £450,000. In contrast Bonnetts Wood is still 'paying off' the establishment costs, with a deficit of £20,000 after 10 years, though a positive net value is reached in year 11. During these early years initial planting costs have substantially decreased and benefits from visual landscape enhancement have peaked and regulatory ES provision is rising. The larger size and more urban location of Ingrebourne Hill has resulted in this site producing a larger annual benefit compared to Bonnetts Wood, primarily due to increased property values and a greater number of visitors, generating a greater recreation value. The NPV calculated for values produced up to year 75 is £650,000 for Bonnetts Wood and £3 million for Ingrebourne Hill. The estimated cost-benefit ratio based on discounted costs and benefits in year 75 is £1:£2.9 for Ingrebourne Hill and £1:£2.4 for Bonnetts Wood.

The estimated NPVs are lower than those found for other sites, such as £43 million for Beam Parklands (99 year value; Eftec 2015b) or £20 million for Sefton Meadows (50 years; Regeneris 2009). These higher values are likely due to i) that they do not incorporate site establishment costs, ii) a different set of ES were valued, and iii) they value the whole site instead of focusing on the woodland component only. For example, for the largest values in the Beam Parklands Account were ES not included in this account, including flood risk mitigation and community benefits, whose net annual values were estimated at £591,000 and £796,000 respectively (Eftec 2015b). Regeneris (2009) assessed a much wider range of services, calculating net annual values for provision of jobs (£10,200), value generated from tourism (£64,000) and avoided health costs from improved health and well-being (£3,300).

The reported cost-benefit ratios for Ingrebourne Hill and Bonnetts Wood are also low compared to those measured elsewhere. Other studies using a variety of methods have estimated values ranging from 1:7 to 1:36 (Everard et al., 2011; Vivid Economics 2016; CEC; 2014). A similar CBA value of £1:£1.12 was estimated for trees along an area of Highways in England using the i-Tree Eco model (Rogers & Evans, 2015). The lower values reported here and in this study are likely due to the limited number of ES which are valued within i-Tree Eco, underlining that these should not be taken as the value for the whole site, but only part of the total ES provide by the woodland component of the site. The valuations provided here are therefore not directly comparable values to studies of larger scope.

The limited range of ES considered in this study indicates that the true value of the ES provided at the two sites is much higher than the value estimated here. Incorporation of other ES would increase the estimated values for the two sites.

Table 7. Summary of monetised costs and benefits of woodland creation on Ingrebourne Hill and Bonnetts Wood. Negative values shown in brackets. Values have been rounded to nearest 10,000. Values are shown for the Baseline (end of Y 0 for each project), 10 years into the project, and then projected forward for 75 years from the baseline. Values undiscounted[1] except for NPVs.

Bonnetts Wood			
	Baseline (2002)	**Y 10 (2012)**	**Y 75 (2077)**
Costs			
Annual	(£130,000)	(£10,000)	(£10,000)
Cumulative	-	(£250,000)	(£1.1 million)
Benefits			
Annual	£0	£30,000	£75,000
Cumulative	-	£240,000	£3.9 million
Net value			
Annual	(£130,000)	(£20,000)	£60,000
Cumulative	-	£20,000	£2.9 million
Capitalised (NPV)	-	-	**£650,000**
Ingrebourne Hill			
	Baseline (2007)	**Y 10 (2017)**	**Y 75 (2083)**
Costs			
Annual	(£430,000)	(£40,000)	(£40,000)
Cumulative	-	(£860,000)	(£3.7 million)
Benefits			
Annual	£10,000	£160,000	£210,000
Cumulative	-	£1.3 million	£13.8 million
Net value			
Annual	(£430,000)	£120,000	£170,000
Cumulative	-	£450,000	£10.2 million
Capitalised (NPV)			**£3 million**

[1] The annual values have not been discounted in order to illustrate the increase in annual benefits over time as the woodland grows.

4. Discussion

In this report the opportunity to utilise NCA for ES valuation of community woodland creation in brownfield regeneration has been explored. A scoping NCA account has been produced for two woodland creation projects, one from a brownfield site and the other a greenfield. Using recently published guidelines to NCA (Eftec 2015a; NCC 2016) and available data on ES provision and value using predominantly a value transfer approach, indicative values for the two sites were estimated. These estimated figures, while conservative as limited to a sub-sample of ES and not based upon site-specific data, indicate a good return on investment on these regeneration projects in spite of the substantial costs of woodland creation. This exercise illustrates how applying a NCA approach to woodland creation on brownfield sites can raise awareness of the benefits of these projects and help justify investment in their creation and maintenance.

There are caveats about the values estimated here in that this is a scoping report and as such the full NCA approach has not been applied. For instance, while local data has been applied where possible, detailed information on natural capital stock and use of the sites by the public was not available to be integrated into the account. The development of community woodlands on brownfield sites generates specific issues which require a more local dataset to capture both environmental and social context. Furthermore, there has been little consideration in this review of wider factors, such as displacement of benefits from other sites. The NCA approach itself has a number of challenges which were encountered during this exercise, such as the high data requirements to understand the steps along the ecosystem service process. These challenges have been detailed below in section 4.1.

While a number of challenges exist, there are a number of methods available which can help remove, mitigate and improve upon valuations presented here (summarised in section 4.2). Full accounts could produce more reliable estimates and increase the aggregate values for each of the two sites. An expansion of this work could allow this account to be extended to assess different management schemes on ES provision, and provide a long-term monitoring system to track changes in NC and the benefits it affords. The availability of quantitative monetary values can help land managers justify investment in more costly management actions, such as including woodland rather than grassland only, and advertise the value of the site and long-term support to local decision-makers. Additionally comparisons of different long-term management plans could be conducted to help prioritise project and environmental actions to maximise their objectives. For example, the trade-offs between the economic value from timber harvesting operations against the loss of other ecosystem services those trees provide. It could be used to assess the potential impact of

Thames Chase vision of 30% woodland cover for its sites (Thames Chase Trust, 2014). The next steps to take this accounting approach forward are summarised in section 4.3.

4.1. Challenges to valuation of woodland creation on brownfield sites

A number of challenges to carrying out ES valuation and aggregation using a NCA approach were found from its application here. Some challenges are general to ES valuation while others are specific to the particulars of woodland creation on brownfield sites. The main issues encountered are summarised below.

ES definition remains under scrutiny and development which limits the comparability between different valuation studies. It is important to adopt a definition for valuation which integrates the interconnectivity of ES and impacts from associated factors such as project impacts (Atkinson et al. 2012; Bardos et al. 2016). This uncertainty limits the ability for ES valuations to be comparable and may mask issues of double-counting between ES. The process approach provides a useful framework, but no standard classification is in place. While the CICES method offers a standardised approach to classifying ES to improve comparability between studies, it does not incorporate a process approach which was found to be useful for these case studies.

Double-counting. There is great complexity in how ES are produced, how they feedback and interact with each other, and how social or manufactured capital interact to co-produce benefits. This difficulty raises concerns of double-counting the benefits. This often means that one service valuation will be dropped as it may be related to another. For example, mental health and well-being values are often considered to be closely related to uplift in housing prices and so not individually valued (Regeneris 2009). However, housing uplift has not been shown to be a reliable indicator of mental well-being, and so to assume all of the value of mental wellbeing afforded by woodland can be assigned within housing uplift may undervalue this service. Improving knowledge of how ecosystem services flow from NC to benefits and how they interact with each other and other factors will help to better identify individual flows and measure them separately without double-counting.

Long timescales. A strength of the NCA approach is it considers long time frames appropriate to how an environment changes over time. However gaps remain in the evidence base, and how benefits from woodlands change over time with tree growth is not fully understood or, therefore, considered in this scoping review. Opportunities are available to improve this work and incorporate the uncertainty associated with predicting change in the future (see below). The values calculated here are based on woodland growth models which are not site-specific, and therefore do not capture local conditions or management which could affect woodland growth and the provision of ES.

Site-specificity. It is only recently that valuations have begun to be applied to single sites, but many tools for valuation or value transfer involved large sites which are assessed using large-scale indicators, such as hectares of woodland. The low resolution of resultant values does not allow for the nuances between sites to be identified, accounted for, or adapted in undertaking valuations for other study sites (Pandeya et al. 2016). A particular challenge is understanding the site in question, and what the demand and current state of provision for that site is in order to determine the baseline. This information could then be used to qualify the use of value transfers and select more meaningful indicators for each site. Additionally, the regeneration of a brownfield to greenspace can be associated with the further difficulty that the site's history may leave a residual depressant effect on the local community and affect how they view the redevelopment of the site (Ham et al. 2013; Rall & Haase, 2011). Understanding if and how the removal of the brownfield will change the ES provision, and if and how this should be valued within an NCA account should be further considered.

4.2. Opportunities for development of NCA to Thames Chase sites

There are a number of tools and approaches which could be applied to support spatially and temporally robust analysis of changes in ecosystem services provision.

ES Mapping can be applied using GIS systems to more accurately map and gauge both provision of and demand for ES at local sites. As was shown during the scoping phase, there is a large variation between these two sites. Spatial mapping allows these variations to be explicitly accounted for, and also allows factors such as distance decay, where the benefit decreases with increasing distance from the site, to be accounted for. For example, the change in house prices with distance to Ingrebourne Hill and Bonnetts Wood could be mapped in GIS to identify the percentage of housing uplift after the sites were redeveloped. GIS can also allow interactive factors to be gauged, such as changes in accessibility of greenspace which can tie in to whether councils' meet accessibility targets such as the ANGSt standards (Natural England 2010). GIS approaches can also be utilised in a participatory approach to gather values from local people, and can be particularly helpful for cultural values (Plieninger et al. 2013).

i-Tree Eco uses field surveys of greenspace to measure woodland structure and composition and calculates the provision of regulatory ecosystem services from this. Field surveys of the two Thames Chase sites would allow site specific values to be calculated. Further the Forecast tool could be utilised to predict the growth of the woodland and its services over time (Steenberg et al. 2016). As an alternative to field surveys, a selection of trees could be drawn from the i-Tree database built upon surveys across the UK that are most similar to those expected at Thames Chase sites, and an i-Tree Eco analysis and forecast run from this dataset. This would remove the need for field surveys, but this would not fully represent specific conditions at Thames Chase sites. The Forecast tool can also be used to compare different planting strategies and risk factors such as pest and disease outbreaks.

ArcGIS contains a viewshed tool which allows areas which have a view of woodland to be identified and allow measurement of the number of people who benefit from this view (Saraev 2015). This can be applied to measure the potential value of views from both homes and while travelling on roads (Garrod 2002). This can be used to improve the values estimated in the account here which estimated the number of homes with a view based purely upon the number within 50m of the site.

4.3. Next steps to development of NCA for Thames Chase sites

Developing the indicative values in this scoping study into a robust assessment would allow for a broader range of estimates to be provided, e.g. return-on-investment, which can be used to justify and encourage woodland creation on brownfield sites. Potential next steps to extend this analysis into a robust account of the values of Ingrebourne Hill and Bonnetts Wood are listed below.

- Gathering site specific information to improve accuracy of valuations for the two sites. This data can be sourced from:
    - Forest Enterprise - Visitor counts, management plans, community engagement activities. This information can be used to more accurately estimate values, as well as extend the assessment to include cultural services.
    - Public data – census, deprivation, housing values. This information can be used to extend the analysis of changes in house prices, by incorporating socio-demographic factors, and also supporting inclusion of cultural ES. This may also allow any pre-existing detriment to the area caused by proximity to brownfields, such as depressed housing prices, to be identified, allowing the associated additional benefit of regeneration to be incorporated.
- Modelling woodland growth over time to improve estimates of change in service provision over time. Information gathered above can be used to

inform this and using tools such as i-Tree forecast can be used to generate a site-specific timeline and change in both forest stock and ES provision.

- Extending valuation to include more ES:
  - Health and well-being – explore quantification and valuation potential, such as helping achieve access to greenspace standards.
  - Stormwater interception & flood risk mitigation – can be assessed using i-Tree Eco (Doick et al. 2016) or a risk-based approach (Eftec 2015a).
  - Timber (and potentially woodfuel) values – can be estimated based on the site's management regime.
  - Incorporate disservices into net value calculations. For example, carbon dioxide produced as part of woodland establishment (FC 2015) or management (Strohbach et al. 2012).
- Comparison to different baselines to allow interpretation for project management. For example a regeneration scheme which produced a grassland only site may be seen as a cheaper option rather than woodland. This alternative could be used as the baseline to compare the relative costs and benefits of woodland creation.
- Comparison of the impact of adopting different discount rates on the estimated NPV. Selection of the standard discount rate applied here reduces the NPV estimated for the two sites compared to adopting lower rates, which may be more appropriate for assessing ecosystem restoration projects (Blignaut & Aronson, 2008).
- Sensitivity analysis to incorporate uncertainty into estimates, this could be assessed for different discount rates and numbers of visitors.
- Scenario analysis could be applied to explore the impact of different management options on the total value of services provided by the sites. Strategies which could be addressed include:
  - Timber removal: While timber removal was not modelled in this account due to lack of information, it was clear that removing trees, particularly before they reach highly productive stages, has a short-term detrimental impact on ES provision.
  - Woodland cover targets: assess the potential impact from the Thames Chase Community Woodland plan to achieve 30% woodland cover across all sites (Thames Chase Trust 2014).

References

Alker, S., Joy, V., Roberts, P., & Smith, N. (2000). The definition of brownfield. Journal of Environmental Planning and Management, 43(1), 49-69.

Arvidson M., Lyon F., McKay S., Moro D. (2010). The ambitions and challenges of SROI. Third Sector Research Centre. Working Paper 49. Available from: http://www.birmingham.ac.uk/generic/tsrc/documents/tsrc/working-papers/working-paper-49.pdf

Atkinson, G., & Mourato, S. (2008). Environmental cost-benefit analysis. Annual review of environment and resources, 33, 317-344.

Atkinson, G., Bateman, I., & Mourato, S. (2012). Recent advances in the valuation of ecosystem services and biodiversity. Oxford Review of Economic Policy, 28(1), 22–47.

Atkinson, G., Doick, K.J., Burningham, K. and France, C. (2014). Brownfield regeneration to greenspace: Delivery of project objectives for social and environmental gain. Urban Forestry & Urban Greening, 13(3), pp.586-594.

Balmford, A., Bruner, A., Cooper, P., Costanza, R., Farber, S., Green, R. E., ... & Munro, K. (2002). Economic reasons for conserving wild nature. Science, 297(5583), 950-953.

Bardos, R. P., Jones, S., Stephenson, I., Menger, P., Beumer, V., Neonato, F., ... & Wendler, K. (2016). Optimising value from the soft re-use of brownfield sites. Science of the Total Environment, 563, 769-782.

Bagstad, K.J., Semmens, D.J., Waage, S. and Winthrop, R. (2013). A comparative assessment of decision-support tools for ecosystem services quantification and valuation. Ecosystem Services, 5, 27-39.

Barker Langham. (2016). Land of the Fanns Landscape Partnership Scheme. London. Available from: http://www.thameschase.org.uk/uploads/Thames_Chase/Trust_Projects/Land_of_the_Fanns/Audience_Development_Plan_FINAL.pdf

Bateman, I. J., Mace, G. M., Fezzi, C., Atkinson, G., & Turner, K. (2011). Economic analysis for ecosystem service assessments. Environmental and Resource Economics, 48(2), 177–218.

Binner, A., Smith, G., Bateman, I., Day, B., Agarwala, M., & Harwood, A. (2017). Valuing the social and environmental contribution of woodlands and trees in England, Scotland and Wales. Forestry Commission, Edinburgh.

Blarbuie Woodland Partnership. (2008). The impact of Working and Walking in Blarbuie Woodland at Argyll and Bute Hospital on mental Health and Wellbeing. Analysis of Health Research Interviews in 2008. Reforesting Scotland, Edinburgh.

Blignaut, J., & Aronson, J. (2008). Getting serious about maintaining biodiversity. Conservation Letters, 1(1), 12–17.

Burkhard, B., Kroll, F., Nedkov, S., & Müller, F. (2012). Mapping ecosystem service supply, demand and budgets. Ecological Indicators, 21, 17–29.

Cantrell J. 2015. Natural Capital Accounting. The World Bank. Available from: http://www.worldbank.org/en/topic/environment/brief/environmental-economics-natural-capital-accounting

Carrick, K. (2014). Social Return on Investment Analysis: Clyde Muirshiel Park Authority. Clyde Muirshiel Park Authority. Available from: http://clydemuirshiel.co.uk/wp-content/uploads/2011/03/SROI-report-2014.pdf

CEC (City of Edinburgh Council). (2014). Calculating the value of Edinburgh's Parks: Social Return on Investment Analysis: Technical report. City of Edinburgh Council.

Chilton, S., Covey, J., Jones-Lee, M., Loomes, G. and Metcalf, H. (2004). Valuation of Health Benefits Associated with Reductions in Air Pollution: Final Report. London: DEFRA.

Christie, M., Hanley, N., Warren, J., Murphy, K., and Wright, R.E. (2004). A Valuation of Biodiversity in the UK Using Choice Experiments and Contingent Valuation. London: DEFRA.

Christie, M., Hanley, N., Garrod, B., Hyde, T., Lyons, N., Bergmann, E., Hynes, S. (2006). Valuing heterogeneity of forest recreation activities: final report. Forestry Commission, Edinburgh.

Croci, S., Butet, A., Georges, A., Aguejdad, R., Clergeau, P. (2008). Small urban woodlands as biodiversity conservation hot-spot: a multi-taxon approach, Landscape Ecol. 23, 1171-1186.

Daily, G.C., Matson, P.A. (2008). Ecosystem services: from theory to implementation. Proc.Natl. Acad. Sci. 105 (28), 9455–9456.

Davies, A., Bryce, R., Reed, M., Kenter, J., Cowap, C. (2012). Multi-Criteria Decision Analysis Tool Review. Ecosystem Knowledge Network. Available from: http://neat.ecosystemsknowledge.net/pdfs/cba_mcda_tool_reviews.pdf

Davies, Z.G., Edmonson, J.L., Heinemeyer, A., Leake, J.R., Gaston, K.J. (2011). Mapping an urban ecosystem service: quantifying above-ground carbon storage at a citywide scale. Journal of Applied Ecology 48, 1125e1134.

Davies, H., Doick, K., Handley, P., O'Brien, L., & Wilson, J. (2017). Delivery of ecosystem services by urban forests. Forest Research, Edinburgh.

DCLG (2010). Valuing the Benefits of Regeneration Economics Economics paper 7: Technical report - Environmental quality and amenity. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6385/1795702.pdf

de Groot, R. S., Wilson, M. A., & Boumans, R. M. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological economics, 41(3), 393-408.

De Groot, R. S., Blignaut, J., Van Der Ploeg, S., Aronson, J., Elmqvist, T., & Farley, J. (2013). Benefits of Investing in Ecosystem Restoration: Investing in Ecosystem Restoration. Conservation Biology, 27(6), 1286–1293.

De Sousa, C. A. (2006). Unearthing the benefits of brownfield to green space projects: An examination of project use and quality of life impacts. Local Environment, 11(5), 577-600.

DECC. (2015). Valuation of energy use and greenhouse gas (GHG) emissions. Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government. Available from: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

DEFRA. (2007). An Introductory guide to valuing ecosystem services. Defra, London. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191502/Introductory_guide_to_valuing_ecosystem_services.pdf

DEFRA. (2015). Air quality: economic analysis. DEFRA, London. Available online at: https://www.gov.uk/guidance/air-quality-economic-analysis.

Doick, K., Albertini, A., Handley, P., Lawrence, V., Rogers, K., Rumble, H. (2016). Valuing the Urban Trees in Bridgend County Borough: Technical Report. Forest Research, Farnham.

Doick, K. J., Sellers, G., Castan-Broto, V., & Silverthorne, T. (2009). Understanding success in the context of brownfield greening projects: The requirement for outcome evaluation in urban greenspace success assessment. Urban Forestry & Urban Greening, 8(3), 163-178.

Dunse, N., White, M. and Dehring, C. (2007). Urban parks, open space and residential property values. RICS Research Paper Series. Royal Institute of Chartered Surveyors, London.

EA. (2017). Flood Warning areas. Environment Agency. Available from: http://maps.environment-agency.gov.uk/wiyby/wiybyController?topic=fwa&layerGroups=default&lang=_e&ep=map&scale=5&x=531500&y=181500#x=553890&y=183974&lg=1,2,&scale=7

Eftec. (2010a). Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal. Value transfer guidelines submitted to Defra. Economics for the Environment Consultancy, London. Available from: http://archive.defra.gov.uk/environment/policy/natural-environ/using/valuation/

Eftec. (2010b). The economic contribution of the public forest estate in England. Report to the Forestry Commission England. Economics for the Environment Consultancy, London.

Eftec. (2011). Scoping Study on Valuing Ecosystem Services of Forests Across Great Britain. Final Report to the Forestry Commission, Economics for the Environment Consultancy, London.

Eftec. (2015a). Beam Parklands Natural Capital Account, Final Report for the Greater London Authority. Economics for the Environment Consultancy, London. Available from: http://thelandtrust.org.uk/wp-content/uploads/2017/01/Beam-Parklands-Natural-Capital-Account_Final-Report_Eftec_November-2015.pdf

Eftec. (2015b). Developing Corporate Natural Capital Accounts: Guidelines For the Natural Capital Committee. Economics for the Environment Consultancy, London. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516971/ncc-research-cnca-guidelines.pdf

Eftec, Dickie, I., Royle, D. & Anderson, S. (2016). Integrated Reporting and Natural Capital Accounting. JNCC Report, No. 587. JNCC, Peterborough.

Everard, M., Shucker, L., Gurnell, A. (2011). The Mayes Brook restoration in Mayesbrook Park, East London: an ecosystem services assessment. Environment Agency. Bristol.

Fang, C. F., Ling, D. L. (2005). Guidance for noise reduction provided by tree belts. Landscape and urban planning, 71(1), 29-34.

Fay, N., with Rogers, K., Jarratt, T., Griffiths, J. (2012). I-Tree Ecosystem Analysis Wardown Park Luton.

FC. (2003). Sustainable woodlands for thriving communities: The impact of the Capital Modernisation Fund (CMF) Woodland Programme 2000-2003. Available from: https://www.forestry.gov.uk/pdf/LRUFRCMFSummary.pdf/$FILE/LRUFRCMFSummary.pdf

FC. (2013). English Woodland Creation (EWGS) grant scheme. Available from: https://www.forestry.gov.uk/pdf/ewgs7-guide.pdf/$FILE/ewgs7-guide.pdf

FC. (2015a). Public Opinion of Forestry 2014, UK and England. Forestry Commission, Edinburgh. Available from: https://www.forestry.gov.uk/pdf/pof2015ukeng.pdf/$FILE/pof2015ukeng.pdf

FC. (2015b). Woodland Carbon Code. Forestry Commission, Available from: https://www.forestry.gov.uk/forestry/BEEH-A26GJB

FEE. (2016). Natural Capital Accounts 2015/16. Forest Enterprise England. Available from: https://www.forestry.gov.uk/pdf/160715-FEE-Natural-Capital-Account-web.pdf/$FILE/160715-FEE-Natural-Capital-Account-web.pdf

Fernandez-Juricic, E., Jokimaki, J. (2001). A habitat island approach to conserving birds in urban landscapes: case studies from southern and northern Europe, Biodivers. Conserv. 10, 2023-2043.

Fisher, B., Bateman, I., & Turner, R. K. (2011). Valuing ecosystem services: benefits, values, space and time. Ecosystem Services Economics. Working Paper Series. Paper No. 3.

Fisher, B., Turner, R.K. (2008). Ecosystem services: classification for valuation. Biol Conserv 141(5):1167–1169.

Forest Research. (2008).Woodland Establishment on Landfill Sites: Ten Years of Research. Department for Communities and Local Government. London.

Forest Research. (2010). Benefits of green infrastructure. Report to Defra and CLG. Forest Research, Farnham.

French, C. J., Dickinson, N. M., & Putwain, P. D. (2006). Woody biomass phytoremediation of contaminated brownfield land. Environmental pollution, 141(3), 387-395.

Garrod, G.D.,Willis, K.G. (1992). Valuing goods' characteristics: an application of the hedonic price method to environmental attributes. Journal of Environmental Management 34, 59-76.

Garrod, G.D. (2002). Social and environmental benefits of forestry phase 2: landscape benefits. Report to the Forestry Commission. Centre for Research in Environmental Appraisal & Management University of Newcastle. Available from: http://www.forestry.gov.uk/pdf/fclscaperep.pdf/$FILE/fclscaperep.pdf

Gibbons, S., Mourato, S., & Resende, G. M. (2014). The amenity value of English nature: a hedonic price approach. Environmental and Resource Economics, 57(2), 175-196.

Gill, S.E., Handley, J.F., Ennos, A.R., and Pauleit, S. (2007) Adapting Cities for Climate Change: The Role of the Green. Infrastructure in Built Environment, Vol. 33, no. 1.

GLA. (2010). Valuing housing and green spaces: Understanding local amenities, the built environment and house prices in London. GLA Economics Working paper 42, September.

Haase, D., Larondelle, N., Andersson, E., Artmann, M., Borgström, S., Breuste, J., ... & Kabisch, N. (2014). A quantitative review of urban ecosystem service assessments: concepts, models, and implementation. Ambio, 43(4), 413-433.

Haines-Young, R., Potschin, M. (2010). The links between biodiversity, ecosystem services and human well-being. In: Raffaelli, D., Frid, C. (Eds.), Ecosystem Ecology: A New Synthesis. Cambridge University Press, Cambridge, pp. 110–139.

Haines-Young, R., Potschin, M. (2011). Common International Classification of Ecosystem Services (CICES): 2011 Update. Nottingham: Report to the European Environmental Agency.

Ham, Y. J., Maddison, D. J., & Elliott, R. J. (2013). The valuation of landfill disamenities in Birmingham. Ecological Economics, 85, 116-129.

Hanley, N., Willis, K.G., Powe, N., Anderson, M. (2002). Valuing the Benefits of Biodiversity in Forests. Report to Forestry Commission.

Heal, G. M. (2007). A Celebration of Environmental and Resource Economics. Review of Environmental Economics and Policy, 1(1), 7–25.

Hein, L., Obst, C., Edens, B., Remme, R. P. (2015). Progress and challenges in the development of ecosystem accounting as a tool to analyse ecosystem capital. Current Opinion in Environmental Sustainability, 14, 86-92.

HM Treasury (2013). The green book: appraisal and evaluation in central Government. The Stationery Office, London. Available from: http://greenbook.treasury.gov.uk

HM Treasury. (2017). GDP deflators at market prices, and money GFP. HM Treasury. Available from: https://www.gov.uk/government/collections/gdp-deflators-at-market-prices-and-money-gdp

Hölzinger, O. (2012). The Economic Evaluation of Moseley Bog and Joy's Wood LNR. Valuation Case Study. Birmingham. Available from: http://ceep-online.co.uk/images/Publications/2012_case_study_moseley_bog/the%20economic%20evaluation%20of%20moseley%20bog%20%20joys%20wood%20lnr.pdf

Hölzinger, O., Sunderland, T., Kenter, J., Cowap, C., von Essen, E., Corstanje, R., Davies, A. (2013). Valuation tools: a literature review. Ecosystem Knowledge Network. Available from: http://neat.ecosystemsknowledge.net/pdfs/valuation_tools_literature_review_full.pdf

Howarth, R. B., & Farber, S. (2002). Accounting for the value of ecosystem services. Ecological Economics, 41(3), 421-429.

Huang, I. B., Keisler, J., & Linkov, I. (2011). Multi-criteria decision analysis in environmental sciences: ten years of applications and trends. Science of the total environment, 409(19), 3578-3594.

Interserve. (2017). Natural Capital Account for Silverdale Country Park. Available from: http://thelandtrust.org.uk/wp-content/uploads/2017/01/The-Land-Trust-Natural-Capital-Valuation-of-Silverdale-Country-Park-Final-edited.pdf

Jones, K. (2010). Newlands Executive Briefing: Transforming brownfield land into thriving, durable and economically-viable natural environments. Available from: http://www.newlandsproject.co.uk/sites/default/files/newlands_exec_briefing_for_website%20updated.pdf

Joubert, A. R., Leiman, A., de Klerk, H. M., Katua, S., & Aggenbach, J. C. (1997). Fynbos (fine bush) vegetation and the supply of water: a comparison of multi-criteria decision analysis and cost-benefit analysis. Ecological economics, 22(2), 123-140.

Land Use Consultants, with SQW Ltd. (2005). Evaluation of the Community Forest Programme. Countryside Agency. Available from: http://www.communityforest.org.uk/resources/evaluation_report.pdf

Loures, L. (2014). Post-industrial landscapes as drivers for urban redevelopment: Public versus expert perspectives towards the benefits and barriers of the reuse of post-industrial sites in urban areas. Habitat International 45(2),72-81.

Maier F., Schober C., Simsa R., Millner R. (2015). SROI as a Method for Evaluation Research: Understanding Merits and Limitations. voluntas. ISSN 09578765. from: http://epub.wu.ac.at/4289/1/Maier_Schober_Simsa_Millner_-_SROI.pdf

McPherson, G., Simpson, J.R., Peper, P.J., Maco, S.E., Xiao, Q. (2005). Municipal forest benefits and costs in five US cities. Journal of Forestry. 103:411-416.

Millennium Ecosystem Assessment (MA). (2005). Ecosystems and human well-being: a framework for assessment. Island Press, Washington DC.

Mitchell, R.,Popham, F. (2008) Effect of exposure to natural environment on health inequalities: an observational population study. The Lancet 372(9650), 1655-1660.

Müller, F., Burkhard, B. (2012). The indicator side of ecosystem services. Ecosystem Services, 1(1), 26-30.

NCC. (2016). Natural Capital Protocol. Natural Capital Coalition. Available from: www.naturalcapitalcoalition.org/protocol.

Natural England. (2010). Nature Nearby – Accessible Natural Greenspace Guidance. Available from: http://webarchive.nationalarchives.gov.uk/20140605090108/http://publications.naturalengland.org.uk/file/95015

Natural England. (2014). Ecosystem Services Transfer Toolkit (NECR159). Natural England. Available from: http://publications.naturalengland.org.uk/publication/5890643062685696

Natural England (2017). Countryside Stewardship Manual: Woodland Creation Grant 2017. Natural England. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/596540/cs-woodland-creation-manual-2017.pdf

Navrud, S. (2002). The state-of-the-art on economic valuation of noise. final report to European Commission DG Environment, 14.

Nicholls, J., Lawlor, E., Neitzert, E. and Goodspeed, T. (2009) A guide to social return on investment. London: Office of the Third Sector, The Cabinet Office. Available from: https://www.bond.org.uk/data/files/Cabinet_office_A_guide_to_Social_Return_on_Investment.pdf

O'Neill, E. (2009). Social Return on Investment (SROI) Analysis of the Greenlink, a partnership project managed by the Central Scotland Forest Trust (CSFT). Greenspace Scotland. Available from: http://greenspacescotland.org.uk/SharedFiles/Download.aspx?pageid=133&mid=129&fileid=133

ONS. (2016). Families and Households. Statistical Bulletin. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2016

ONS. (2017). Principles of Natural Capital Accounting. ONS & Defra. Available from: https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/principlesofnaturalcapitalaccounting

Owen, R., Powell, J., Reed, M., Kambites, C. and Lewis, N. (2008) An Evaluation of Cydcoed: the Social and Economic Benefits of Using Trees and Woodlands for Community Development in Wales. Forest Research, Edinburgh.

Pandeya, B., Buytaert, W., Zulkafli, Z., Karpouzoglou, T., Mao, F., & Hannah, D. M. (2016). A comparative analysis of ecosystem services valuation approaches for application at the local scale and in data scarce regions. Ecosystem Services, 22, 250-259.

Pascual, U., Muradian, R., Gómez-Baggethun, E., Armsworth, P., Brander, L., Cornelissen, H., Farley, J., Loomes, J., Martinez-López, B., Pearson, L., Perrings, C., Polasky, S., and Verma, M. (2010), 'Valuation of Ecosystems Services: Methodology and Challenges', in P. Kumar (ed.), The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations, London, Earthscan.

Perino, G. Andrews B., Kontoleon, A., and Bateman, I. (2014). The Value of Urban Green Space in Britain: Methodological Framework for Spatially Referenced Benefit Transfer. Environmental Resource Economics, 57, 251-272.

Plieninger, T., Dijks, S., Oteros-Rozas, E., & Bieling, C. (2013). Assessing, mapping, and quantifying cultural ecosystem services at community level. Land use policy, 33, 118-129.

Rall, E. L., & Haase, D. (2011). Creative intervention in a dynamic city: A sustainability assessment of an interim use strategy for brownfields in Leipzig, Germany. Landscape and Urban Planning, 100(3), 189-201.

Regeneris. (2009). The Economic Contribution of the Mersey Forest's objective one-funded investments. A Final report by Regeneris Consulting Ltd for The Mersey Forest. Available from: http://www.merseyforest.org.uk/files/Economic%20Contribution%20of%20The%20Mersey%20Forest's%20Objective%20One-Funded%20Investments.pdf

Richardson, L., Loomis, J., Kroeger, T., & Casey, F. (2015). The role of benefit transfer in ecosystem service valuation. Ecological Economics, 115, 51-58.

Rogers, K., Evans, G. (2015). Valuing the Natural Capital of Area 1. Report for Highways Agency by Treeconomics & Evans Associates. Available from: http://www.treeconomics.co.uk/wp-content/uploads/Area-1-iTree-Report.pdf

Saraev, V. (2012). Economic benefits of greenspace: a critical assessment of evidence of net economic benefits. Forestry Commission Research Report. Forestry Commission. Edinburgh.

Saraev, V. (2015). Estimating the amenity value of woodland views at a national scale with applied GIS spatial analysis., Scottish Forestry, 69(1), pp. 18–25.

Scarpa, R. (2003). Social & Environmental Benefits of Forestry Phase 2: The Recreation Value of Woodlands. Forestry Commission, Edinburgh.

Selman et al (2003) Capital Modernisation Fund: Measuring Delivery of Economic, Social and Environmental Outputs. University of Gloucestershire. Final report to the Forestry Commission.

Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health benefits from nature experiences depend on dose. Scientific Reports, 6.

Spangenberg, J. H., von Haaren, C., & Settele, J. (2014). The ecosystem service cascade: Further developing the metaphor. Integrating societal processes to accommodate social processes and planning, and the case of bioenergy. Ecological Economics, 104, 22-32.

Steenberg, J. W., Millward, A. A., Nowak, D. J., Robinson, P. J., & Ellis, A. (2016). Forecasting Urban Forest Ecosystem Structure, Function, and Vulnerability. Environmental Management, 1-20.

Strohbach, M. W., Arnold, E., & Haase, D. (2012). The carbon footprint of urban green space—A life cycle approach. Landscape and Urban Planning, 104(2), 220-229.

Sugiyama, T., Francis, J., Middleton, N. J., Owen, N., & Giles-Corti, B. (2010). Associations between recreational walking and attractiveness, size, and proximity of neighborhood open spaces. American Journal of Public Health, 100(9), 1752-1757.

Sunderland, T., Rogers, K., & Coish, N. (2012). What proportion of the costs of urban trees can be justified by the carbon sequestration and air-quality benefits they provide?. Arboricultural Journal, 34(2), 62-82.

Thames Chase Trust. (2014). The Thames Chase Plan. Thames Chase Trust, Upminster, UK.

TEEB. (2010). The Economics of Ecosystems and Biodiversity: ecological and economic foundation. Kumar P, editor London and Washington: Earthscan.

Townsend, M. (2006). Feel blue? Touch green! Participation in forest/woodland management as a treatment for depression. Urban Forestry & Urban Greening, 5(3), 111-120.

Turner, K. G., Anderson, S., Gonzales-Chang, M., Costanza, R., Courville, S., Dalgaard, T., ... & Ratna, N. (2016). A review of methods, data, and models to assess changes in the value of ecosystem services from land degradation and restoration. Ecological Modelling, 319, 190-207.

Turner, R.K. & Daily, G.C. (2008). The Ecosystem Services Framework and Natural Capital Conservation. Environ Resource Econ 39:25-35.

Turvani, M.,d Tonin, S. (2008). Brownfields Remediation and Reuse: An Opportunity for Urban Sustainable Development. In Sustainable Development and Environmental Management (pp. 397-411). Springer Netherlands.

UK NEA. (2011). UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge.

Valatin, G., Saraev, V. (2012). Woodland Creation case study. Forest Research Report. Available from: https://www.forestry.gov.uk/pdf/NEF_Woodland_Creation_Case_Study_Sept2012.pdf/$FILE/NEF_Woodland_Creation_Case_Study_Sept2012.pdf

Vandermeulen, V., Verspecht, A., Vermeire, B., Van Huylenbroeck, G., Gellynck, X. (2011). The use of economic valuation to create public support for green infrastructure investments in urban areas. Landscape and Urban Planning, 103(2), 198-206.

Vivid Economics. (2016). The contribution made by Sheffield's parks to the wellbeing of the city's citizens. Available from: http://www.vivideconomics.com/wp-content/uploads/2016/11/Briefing-The-value-of-Sheffields-parks.pdf

Waterfield, C. (2008). Case study 9: Moston Vale Community Woodland—part of the Newlands programme. Forestry Commission. Available from: http://www.ketso.com/sites/default/files/docs/Case%20Study%209%20-%20Moston%20Vale%20Community%20Woodland%5B1%5D.pdf

Wegner, G., Pascual, U. (2011). Cost-benefit analysis in the context of ecosystem services for human well-being: A multidisciplinary critique. Global Environmental Change, 21(2), 492-504.

Wilson, M. A., Carpenter, S. R. (1999). Economic valuation of freshwater ecosystem services in the United States: 1971–1997. Ecological applications, 9(3), 772-783.

Woodland Trust. (2011). Trees or turf – best value in managing urban green space. Available from: https://www.woodlandtrust.org.uk/publications/2011/05/trees-or-turf/

Zandersen, M., Termansen, M. Jensen, F.S. (2007). Testing benefits transfer of forest recreation values over a twenty-year time horizon. Land Economics, 83(3), 412-440.

Appendix 1. Woodland creation on brownfield sites ES

Table A1. Selection of main services identified from benefits of urban forestry, or in particular restoration of brownfields to woodland or part woodland. Services have been grouped into Supporting, Regulating, Cultural and Provisioning services. Where available examples of ES for woodlands on brownfield sites and methods for quantification and/or valuation are provided.

Ecosystem Service	Example	Method	Reference
Supporting			
Reclamation	Trees can be used successfully to aid restoration of contaminated brownfields.		Forest Research (2008)
Soil formation/protection	Protection from soil erosion and slope failure	Avoided management costs	Everard et al. (2011)
	Soil formation/nutrient cycling.		Interserve (2017)
Nutrient Cycling	Removal and storage of Nitrogen and Phosphorous	Avoided costs for nutrient removal	Everard et al. (2011)
Habitat for species and biodiversity	Help achieve targets for biodiversity	Qualitative	Waterfield (2008)
	Existence value for increased biodiversity from habitat creation	Contingent valuation	Christie et al. (2004)
	Avoided costs for bespoke conservation actions	Avoided costs	Everard et al. (2011)
Regulating			
Air quality & benefit to human health	Bridgend's trees remove over 60 tonnes of pollutants annually, mitigating health risk to local populations	Avoided costs	Doick et al. (2016)

Carbon storage and sequestration	Bridgend's trees remove over 2000 tonnes of carbon annually, and store over 50,000 tonnes, contributing to climate change mitigation	Valued using carbon prices	Doick et al. (2016)
Temperature regulation	Trees can reduce energy requirements of neighbouring buildings, reducing costs	Avoided costs	Regeneris (2009)
	Reduce temperatures in urban areas, reducing climate stress		Gill et al. (2007)
Stormwater and/or flood management	Trees and greenspace intercept rainfall reducing stormwater flows	Avoided sewerage charges	Doick et al. (2016)
	Reduces risk for property damage by flooding	Mitigated risk value	Eftec (2015a)
Shielding/soundscaping	Tree belts can reduce noise from roads	Hedonic pricing, contingent valuation	Fang and Ling (2005) Navrud (2002)
Cultural			
Commercial investment	Help attract business investment in local industrial estates	Qualitative	Jones (2010)
Community well-being (social cohesion, sense of place)	Frequent visits to greenspace supports greater social cohesion		Shanahan et al. (2016)
	Supports reduction in local community disturbances	Qualitative	O'Neill (2009)
	Supports local nature education opportunities	SROI	CEC (2014)
Recreation	Improved accessibility and quality of greenspace increases likelihood of use		Sugiyama et al. (2010)
	Brownfield to greenspace projects are quickly utilised by local populations for a range of activities		De Sousa et al. (2006)

Amenity/visual landscape value	Amenity asset value of Bridgend's urban trees valued at £686 million	CAVAT method	Doick et al. (2016)
	Willingness-To-Pay for woodland view	Contingent valuation	Garrod (2002)
Property value uplift	Properties closer to greenspace and woodlands have higher value then those further away	Hedonic Pricing	Dunse et al. (2007) Gibbons et al. (2014) Perino et al. (2014)
Mental and physical health	Engagement in woodland community groups improves mental health	Avoided costs	Townsend (2006)
	Improved physical and mental health can reduce health costs		Regeneris (2009)
	Perceived improved mental physical health by users		Blarbuie Woodland Partnership (2008)
Employability and skill gain	Skills gained by volunteers working in woodland	SROI	Carrick (2014)
	Community Woodland scheme in Wales (Cydcoed) created over 60 jobs	Qualitative	Owen et al. (2008)
Provisioning			
Timber	Viable timber crops can be grown on brownfield sites.		French et al. (2006)

Appendix 2. Spatial context for Thames Chase sites

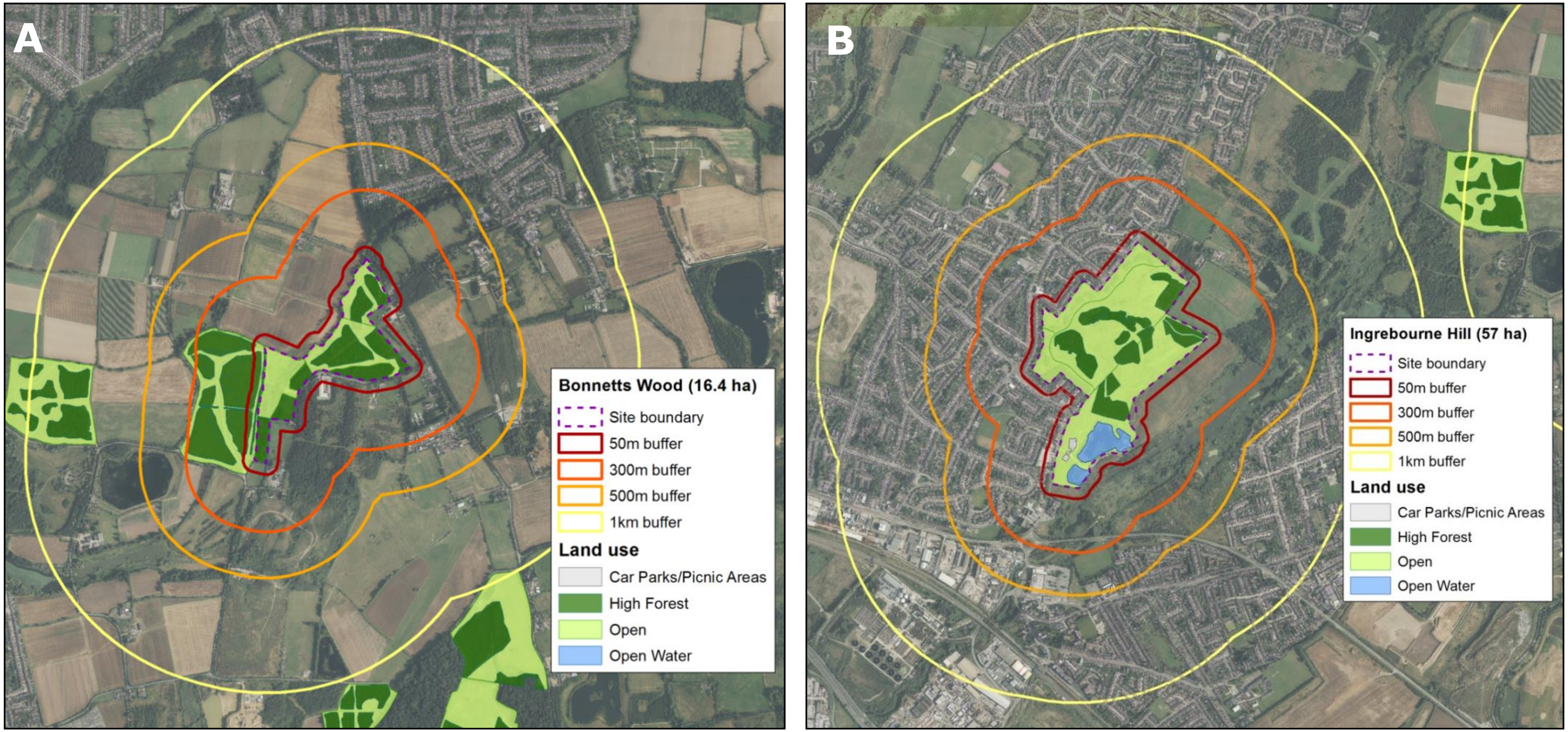


Figure A1. Spatial context of A) Bonnetts Wood and B) Ingrebourne Hill highlighting visual and recreational accessibility to each site.

Appendix 3. Bonnetts Wood NCA tables

Table A3.1. Physical flow account for Bonnetts Wood, assessing the change for the current year (2012, year 10 from delivery). The provision of ES is shown at two different time periods: the Baseline (pre-delivery state to which all changes are compared) is shown in the third column from the right; The level of ES provision in year 10 is shown in the right-most column. The Gain/Loss in ES provision in year 10 (the marginal change in the flow of ES since the previous year, in this case year 9) is shown in the penultimate column. The reason for any gain or loss is given in brackets.

Service	Capital[1]	Indicator	Source	Baseline (Y0)	Gain/loss from Y9 (reason)	Level in Y10
Air pollution removal	Woodland (Grassland)	Pollutants removed (t; annual)	Value Transfer (Fay et al. 2012)	0	+ 0.04 (woodland growth)	0.37 t
Carbon sequestra-tion	Woodland (Grassland)	Carbon sequestered ($tC0_2e$; annual)	Woodland Carbon Code (FC 2015b)	0	+18 (woodland growth)	94 $tC0_2e$
Landscape enhance-ment	Woodland	Number of households with view (annual)	GIS estimate	0	+ (woodland establishing, no housing development)	5 house-holds
Recreation	Whole site	Visits (annual)	Value transfer (Barker Langham, 2016)	0	0 (site & use levels established)	20,000 visitors
Bio-diversity	Woodland (grassland, lake)	Ha. Woodland created (lifetime)	GIS estimate	0	0 (woodland created)	11.4 ha
Health[2]	Whole site	Visit number, duration, activity	Value transfer (Barker Langham, 2016)	0	0 (site & use levels established)	20,000 ha

[1] NC listed in brackets are features within the site which may contribute to the provision of ES, but whose contribution to the provision of ES is not accounted for here.
[2] Services which are provided from the site but not valued in this scoping report are shown in the coloured row. Including these services ensures their role and impact is not forgotten.

Table A3.2. Monetary account for Bonnetts Wood, assessing the change in the current year (2012, year 10). The provision of ES is shown at two different time periods: the Baseline (pre-delivery state to which all changes are compared) is shown in the third column from the right; The value of ES provision in year 10 is shown in the right-most column. The Gain/Loss in ES provision in year 10 (the marginal change in the flow of ES since the previous year, in this case year 9) is shown in the penultimate column. The reason for any gain or loss is given in brackets.

Service	Capital[1]	Indicator[3]	Source	Baseline (Y0)	Gain/loss from Y9 (reason)	Y10 annual value
Air pollution removal	Woodland (Grassland)	Social Damage costs (DEFRA 2015)	Value transfer (Fay et al. 2012)	0	+ £818 (woodland growth)	£8,185
Carbon sequestration	Woodland (Grassland)	Carbon price (£61 per $tC0_2e$ in Yr 10)	Market price, (DECC 2015)	0	+£1,172 (woodland growth)	£5,708
Landscape enhancement	Woodland	WTP for view (£356/ household/ year)	Value transfer (Garrod 2002)	0	+ £89 (woodland still growing so full WTP not yet reached)	£1,689
Recreation	Whole site	Visit value (£0.78 per visit)	Value transfer (Scarpa 2003)	0	0 (site & use levels established)	£15,517
Biodiversity	Woodland (grassland, lake)	WTP for woodland creation (£1.11 per household per year for a 12,000 ha)	Value transfer (Hanley et al. 2002)	0	0 (woodland established)	£793
Health[2]	Whole site	-	-	-	= (site & use levels established)	

[1] NC listed in brackets are features within the site which may contribute to the provision of ES, but whose contribution to the provision of ES is not accounted for here.
[2] Services which are provided from the site but not valued in this scoping report are shown in the coloured row. Including these services ensures their role and impact is not forgotten.
[3] Unit values shown have been reflated to 2017 prices.

Appendix 4. Calculation methods

Air pollution removal

Air pollution removal for the two sites was calculated using a value transfer approach. An i-Tree Eco evaluation of Wardown Park, Luton, (Fay et al. 2012) provided values for a single urban park providing a similar site and context to the Thames Chase sites. The values for Wardown Park were transferred based on per hectare values, and as an established site were used to provide a value for when the woodlands are anticipated to reach a mature age (around 70 years). Previous year's values were then linearly back-calculated to a zero value for Year zero. This approach could be improved using i-Tree Eco to incorporate the tree species at the site, tree size and condition to get a more site-specific estimate of air pollution removal. The i-Tree Forecast tool could be used to then predict change in air pollution removal by trees as they grow over time.

Carbon Sequestration

The Woodland Carbon Code guidance for projects was used to estimate carbon sequestration. This approach was used as it factors in both woodland growth and initial emissions from planting phase (FC, 2015b). Weaknesses in this approach include difficulty in incorporating site specific factors and growth rates and survival of trees at the site. An alternative approach could use i-Tree Eco and Forecast tools to estimate growth over time.

The value reported was the total claimable project carbon sequestration. This can account for the lack of permanence of the carbon remaining stored in trees, due to its release through tree thinnings or clearfell, by setting a maximum carbon sequestration value which can be claimed. This was incorporated in estimated carbon sequestration here as the site is expected to undergo short-rotation forestry for wood biomass. This assumes ongoing felling and planting at the site over time, though at the end of the 75 year lease it is possible all trees could be removed. In this scenario, a more conservative estimate of the value of carbon sequestration would be to remove the discounted value from the total benefits at the 75 year horizon. This would account for the fact that all trees would be removed from the site, and hence the carbon stored would be released back to the atmosphere. In this result, the total value of carbon sequestered for Ingrebourne (£315,000) and Bonnetts Wood (£239,000), would be lost from the final value for the account in year 75.

Landscape enhancement

The visual amenity value was valued using a value transfer from Garrod (2002). Garrod estimated a WTP for a view of broadleaved woodland from home was £269 (2002 prices). Crucially this value excludes the recreational opportunity value, which was estimated at £227. This separation allows the visual amenity value to be separated from the well-being benefits from directly using the site. The number of households estimated to have a view of the house was calculated in GIS. Houses within 50m of the site (Table 2, Appendix 2 Figure 1.b) were assumed to have a view of the site and were counted. Landscape values were assumed to increase to a threshold level as the woodland grows (Figure 3.a), attaining their full value by year 15. Woodland growth was estimated using Forestry Commission models for a sycamore-ash-birch woodland with 5 year thinning intervals.

This approach could be improved by utilising an ArcGIS Viewshed tool to identify all houses with a view of the site (Regeneris 2009; Saraev 2015). This can also be applied to nearby major roads, such as the M25, as the WTP for a woodland view while driving has also been calculated by Garrod (2002). Alternative analyses could utilise available housing price data and assess if there is a property uplift effect for homes closer to the site. A temporal analysis could also be undertaken to examine if there a visible uplift in value after the sites were created, though this approach can be challenging and previously has not found any change related to greenspace improvement (DCLG, 2010). A simpler method would be to simply utilise a per ha value calculated by Eftec (2010b) which values the aesthetic values of woodland at £4,000 per ha. Using this value the landscape enhancement values for Ingrebourne and Bonnetts wood are £52,520 and £45,760 respectively. The Garrod (2002) method was utilised as it was the most site specific method of calculating landscape enhancement.

Recreation

Recreation values were valued using WTP estimates calculated by Scarpa (2003), who estimated a scale of values dependent on the distance travelled to visit the site. The lowest value (£0.6 per visit) was selected as it applies individuals travelling less than 1 mile, which is suitable as these sites attract mostly local visitors (J. Wilson pers. Comm), but remains a conservative estimate. The number of visits to the site was estimated from available visitor numbers from Hornchurch Country Park (Barker Langham 2016). These were assigned to Ingrebourne Hill and Bonnetts Wood on a per hectare basis. These values corresponded well to average values estimated by Eftec (2010b) of 1145 visitors per ha per year to urban community woodlands. The value from Barker Langham (2016) was utilised in the study as reflected a more locally calculated value which may better reflect visitor numbers in similar local sites than a GB average value.

This analysis could be improved by gathering site specific visitor numbers and information on how far they travelled to visit, how often they visit, and why. This information could be used to more accurately apply values from Scarpa (2003) and other studies (Christie et al. 2006), and may also help to measure associated health and well-being benefits.

Biodiversity

The existence value of biodiversity was assessed using value transfer. Values for woodland creation were transferred from Hanley et al. (2002) and assessed across the population of East London, of which Havering borough is within (750,000 households), though this value could be valued nationally (Regeneris 2009), making the biodiversity value worth around £30,000 per year for both sites (ONS, 2016). Further biodiversity value could be assessed as a factor in well-being gained from visiting sites, as well as a factor driving recreational use of sites. Other approaches could be used in future which base the value on the whether a site is a low or high priority for biodiversity conservation (Eftec 2010a).

Alternative values could be assessed using grants for woodland creation, such as under agri-environment schemes (FC 2013; Natural England 2017). Information on the biodiversity present at sites could also be applied to gage site improvement, and apply either WTP for improved biodiversity (Christie et al. 2004), or avoided costs from bespoke conservation interventions.

Forest Research

Alice Holt Lodge
Farnham
Surrey GU10 4LH, UK

Tel: 0300 067 5600

Fax: 01420 23653

Email:research.info@forestry.gsi.gov.uk

www.forestry.gov.uk/forestresearch

Northern Research Station
Roslin
Midlothian EH25 9SY, UK

Tel: 0300 067 5900

Fax: 0 131 445 5124

Forest Research in Wales
Edward Llwyd Building
Penglais Campus
Aberystwyth
Ceredigion
SY23 3DA

Tel: 01970 621559

If you need this publication in an alternative format, for example in large print or another language, please telephone us on 0300 067 5046 or send an email request to: diversity@forestry.gsi.gov.uk