Final Report

Valuing Ecosystem Services in the East of England Phase 2 – Practical applications of the approach Arable Agriculture Local Pilot

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Executive Summary

Background

This multi-partner project has been carried out by URSUS Consulting and Dialogue By Design for Sustainability East on behalf of a range of regional partners. It is funded by Defra and Sciencewise Expert Resource Centre (ERC), which is funded by the Department for Business, Innovation and Skills (BIS). It has been overseen by a steering group of representatives from a wide group of stakeholder bodies in the East of England including Sustainability East, EEDA, GO-East, CLA, NFU, Natural England, Environment Agency, Forestry Commission, East of England Environment Forum (EEEF), East of England Local Government Association, English Heritage, RSPB, Campaign for the Protection of Rural England, the Morley Agricultural Foundation, the Chadacre Agricultural Trust and the Felix Thornley Cobbold Agricultural Trust. We thank these organisations for their invaluable support. It should be noted that the views expressed in this document are those of the authors and not necessarily those of the sponsoring organisations.

Study Objectives

The objectives of the study were to identify the value of a wide range of ecosystems services and benefits accrued from agricultural activity so that they can be recognised and taken into consideration in future decision-making and strategy development. This pilot has applied the Ecosystem Services Approach framework developed in Phases 1 and 2 of the Valuing Ecosystem Services in the East of England (VEsSiEE) project to arable agricultural land in four contrasting, but regionally representative, locations within the East of England.

The intended outcomes were to:

- *further the wider ESA research agenda and advance the East of England's leading role;*
- *increase awareness of ESA and the reasons for valuing ecosystems services amongst the public and local decision makers;*
- *provide insights on what local people around the pilot farms really value about the natural and cultivated landscapes around them, and what they think would be the optimal balance of ecosystem benefits going forward; and*
- *meaningfully feed into the national and regional agricultural policy debate.*

Monetary Valuation of Ecosystem Services on Arable Farms

There is a growing body of research that can be used to derive monetary values for many aspects of arable farming. This includes both negative externalities of farming (see Pretty et al, 2000) and more recent attempts to balance these dis-benefits with an understanding of the wider ecosystem services which farm land provides. Some of this is applicable and transferable to arable farming in the East of England, as summarised below.

Provisioning services

Valuation techniques are well understood and data is easily available to estimate the yields per hectare, market prices and variable costs for food, fibre, fuel and biodiversity benefits associated with game hunting, medicinal crops or wild produce. Generic values for provisioning services on standard cereals farms in the East of England can be taken from gross margins from the Farm Business Survey and are estimated at more than £900/ha in 2009. The figures for larger, highly mechanised farms are likely to be higher (at least £1000/ha). Values will vary from year to year largely depending on market prices of wheat, but these are expected to stay high in the foreseeable future. Increased provision of regulating or supporting services is often – but not always - at the expense of some reduction in the quantity or quality of food production. These impacts can be calculated on the basis of income foregone from reduced cropping areas, lost yields or impacts on market prices.

Cultural Services

Many studies have been undertaken of the value of cultural services, mainly using Contingent Valuation and Travel Cost methods. Valuation is based on the direct outputs (e.g. number of visits for different purposes or specific landscape features). Studies suggest that households derive value from and are willing to pay more than £4/visit for the most attractive or wildlife rich sites and up to £35/visit to woodland. Arable farms are unlikely to provide this level of benefit. However, studies also suggest that local populations (within 5 miles) are willing to pay up to £0.40/mile for new access on arable land. Health benefits have also been calculated in terms of costs avoided by the NHS and sick days avoided by local businesses by people taking regular access on circular footpaths. These values range from £31,000 pa for a new 3km footpath in Mid Suffolk to £85,000 pa in the most densely populated parts of the region such as Hertfordshire. These values can be used to assess health benefit on farms providing 3 km or more circular routes, averaged over the total area of the farm. However, discussions with local communities suggest that footpaths or arable farms are less widely used – with the exception of coastal footpaths - than those in parks and on parkland. Other cultural benefits such as education and sense of place remain difficult to value for arable farms without location specific studies, but discussions with local communities suggest that these benefits provided by local farms are very important to them. Activities by farmers to improve landscapes – e.g by planting hedgerows – are highly valued by local communities.

Regulating Services

Valuation of regulating services requires detailed scientific knowledge and site-specific data on the relationship between different on-farm measures, local soils, geology and drainage characteristics and their impact on the regulating services. If this data is available then valuation of the benefits is relatively straightforward using market based methods (changes in yields, shadow price of carbon) or defensive expenditures avoided. Climate regulation is perhaps the easiest regulating service to value based on the growing body of knowledge of carbon sequestration, storage and emissions avoided for different land types and an established Shadow Price for Carbon used by Defra. Country Land and Business Association (CLA) have developed a CALM model which allows farms to calculate these benefits and

offset them against their emissions of other greenhouse gases. Values for other regulating services - such as flood alleviation, erosion control, air and water regulation, pollination and pest control - depend on local conditions and requires a detailed understanding of the relationship between land management and services provided. Generic estimates for the costs of property protected from flood and the replacement costs of nutrients lost through soil erosion are provided.

Supporting Services

Soil formation and nutrient cycling benefits for farmers can, in theory, be valued using market based methods to value the impacts of soil and nutrient loss or formation on food, fibre or fuel yields. The costs of replacing nutrients using artificial fertilisers can also be estimated relatively easily. However, we have not included generic values for these supporting services as they indirectly support other functions and therefore risk double-counting the erosion control benefits to farmers.

Biodiversity and Wildlife

There have been many attempts to identify the total economic value of biodiversity, specific habitats or species, mainly using contingent valuation techniques. Many of these studies relate to forests or protected areas. Some studies are relevant to arable farm settings and provide estimates of Willingness To Pay (WTP) which could be transferred to arable farms. However, much more detail is required on the local population's values in order to come up with generic rates per hectare for on farm habitat creation or species protection. For instance, a WTP study for improvements in the status of farmland species suggested that households would be willing to pay an additional £115 a year in Cambridgeshire for a reversal of the deteriorating status of familiar species. However, discussions with local communities suggested that these figures are too high to be applied to typical arable farms. There is also a risk of double-counting of cultural and regulating service benefits. We therefore propose that a valuation figure of £30/ha is used for biodiversity services provided by farmland entered into ELS and values for specific non-arable habitats – such as wetlands, grassland or woodland – transferred from other studies only where new habitats have been created.

Application to case study farms

Four case studies were selected to give coverage of typical (in terms of size, crop mix, tenure) East of England arable farm types:

- ***Monks Green, Brickendon, Hertfordshire**. A small farm in an urban fringe setting with recreational interest and many diversification options including non-arable agriculture, countryside stewardship, and property rental.*
- ***Mowness Hall, Mid-Suffolk**. A large highly productive arable farm in a deep rural setting in a largely arable area, close to small villages but without major settlements nearby and with limited opportunities for diversification;*
- ***East Hall, Bradwell, Dengie Peninsula, Essex**. A medium sized highly productive arable farm in a coastal setting with issues associated with tourism and coastal flooding and significant opportunities for conservation, particularly for non farmland bird; and*

- ***Headings, Chatteris (Cambridgeshire) and Welney (Norfolk).*** *A very large highly productive arable farm in the Fens, with issues related to flooding, soil erosion, climate regulation and very open landscapes.*

The case studies currently provide a range of different levels of existing ecosystem services delivery through their involvement in Entry Level Stewardship (representing three quarters of agricultural land in East Anglia) or Higher Level Stewardship.

Profiles for pilot farms were built up from open source data sets, farm records and through farm visits during late 2010. Data on each farm was presented at local workshops in a standard format: a description of the setting (crop rotation, tenure etc, maps, ecosystem services tables, photos and on a spider diagram using a logarithmic scale to show approximate values for ecosystem services delivered in £/ha. Farmers were invited to attend the workshop session local to their farm, although only one chose to do so.

Public Dialogue

The public dialogue process was designed by the consultants with input from the Sciencewise and the Steering Group and involved four local workshops attended by more than 60 participants in total. Three-hour sessions were held on weekday evenings, with soup and sandwiches, in pubs local to the pilot farms:

- *18/1/2010: Urban Fringe, Brickendon, Hertfordshire;*
- *19/1/2010: Coastal, Bradwell, Essex;*
- *25/1/2010: Fens, Welney, Norfolk; and*
- *26/1/2010: Deep rural, Stoke Ash, Mid-Suffolk.*

A fifth workshop applied the process to a larger spatial scale – the Fens – and involved stakeholders with wider regional interests including NFU, CLA, FC, NE, Sustainability East and Government Office.

Explaining Ecosystem Services Concepts

Many of the regulating and supporting functions and ecosystem services involve complex ideas and academic language that could have been off-putting or inaccessible to members of the public. Mindful of this challenge we used the term 'wider benefits' of farm land rather than 'ecosystem services' wherever possible. We also used a lot of visual material including photos and colour coding for explaining different ecosystem services. The process also involved interactive table sessions and the use of a spider diagram for valuation of individual benefits. The process plan (including timetable, objectives and outputs for the local sessions, PowerPoint and spider diagram) is shown at Annex A.

Given the small sample size for each meeting, the groups were clearly not expected to be statistically representative or provide statistically robust results. However, in bringing together the individuals that made up each group, every effort was made to ensure that the mix was representative of the make-up of the local area and reflected a range of age, gender and socio-economic groupings.

Outcomes of the dialogue process

The workshop methodology was largely successful in:

- *Bringing together a diverse group of local people who enjoyed the opportunity to feed in to policy-making and to meet others in the area who shared their interests;*
- *Informing them about ecosystem service concepts and the rationale for valuation in an accessible way that they felt they understood. Regardless of their prior level of knowledge, participants had very few difficulties with the language or underlying concepts;*
- *Giving them opportunities to learn from each other's local knowledge and expertise across a broad spectrum and from the technical experts that participated;*
- *Enabling deliberative discussions involving many different viewpoints which allowed their understanding and assessment of the importance of Ecosystem Services to evolve;*
- *Coming to 'valid' and interesting conclusions about the future balance of delivery of ecosystem services in each locality and refining their individual scoring of the importance of key services or benefits through deliberative group discussions. Participants particularly liked the spider diagram approach to valuing and relating different benefits because it showed the holistic nature of the ecosystems approach and enabled consideration of the interrelations between services; and*
- *Demonstrating how this quantitative assessment can be further refined when participants are asked to allocate 'real public money' to increasing ecosystem services.*

The outcomes of the deliberation process – in terms of how ESs were scored individually, through group discussions and when monetary values were allocated for the Fens – are summarised below. The highest scored ESs in almost all settings were: providing food; climate regulation; flood regulation (particularly in the Fens and coastal Essex); biodiversity and wildlife; sense of place; learning; freshwater provision and soil erosion control (in the Fens landscape).

Dissemination of results

Participants were keen to learn the outcomes from their participation and were sent a workshop report for all four workshops by email. Other dissemination events have included:

- *Natural Capital Initiative in London on February 16th which brought together those involved in participative dialogue Ecosystem Services Approaches to share experiences and lessons learnt.*
- *A seminar to present the outcomes of Defra supported ESA pilots for Defra policy makers, organised by the Natural Capital Initiative, in London on March 17th.*
- *Presentation of the results of the Arable Pilot at a workshop organised by Sustainability East on Adapting to Climate Change on 30th April.*

Summary comments on results of ES valuation exercises

Ecosystem Service	Comments and deliberations
Food	Overall scored 10 and placed #1 in all settings. But desire for more local, seasonal and less intensively and diverse food production both for the local economy and global food security.

Freshwater	Generally high for individuals but then reduced by deliberation - closely related to views on food and knowledge of local aquifers and drainage.
Timber and fuel	Generally low. Recognised as an important national issue but limited on-farm opportunities for biofuels in East of England landscapes. More interest renewables such as solar and wind.
Recreation	Surprisingly low but scores usually increased through deliberation. Seen as more important on Essex coast and Hertfordshire but low importance in Fens and mid Suffolk. Agreement that more effort needed to enhance farm PROWs (interpretation, circular routes) which is closely linked to health.
Learning	Became a key issue in local group discussions. 'We need to understand where our food comes from and at what course – vital'. Understanding farming strengthens respect for the local area. Open Farm Sundays valued everywhere but recognised as costly to farmers but worthy of support. Seen as less important for the Fens.
Health	Walking and peace and quiet key issue for both individuals and groups. Opportunity for more access for urban populations and volunteering etc.
Sense of place	Rated as #2 in local group discussions when people discussed what they really valued about their locality – 'it's why we live here' and strongly linked to agricultural skills/jobs and farming futures for young people. Efforts by farmers to regenerate or plant hedgerows were recognised and appreciated.
Climate regulation	Recognised (mostly) as globally important. Widespread support for farms being energy self-sufficient but no consensus about opportunities for carbon storage in soils at the expense of food production.
Flood	Local importance of the role of farms recognised in coastal Essex and the Fens (where the impacts of urban settlements higher in the catchment were also recognised) and of growing importance in the face of climate change.
Erosion	Through deliberations erosion (and soil and nutrient cycling) mostly increased in importance and recognised as closely tied to water quality, flooding and food productivity (Fens).
Disease, pest, pollination etc	Generally low – probably because of lack of clarity of issues packaged together as scores tended to increase after discussions. Recognition arable currently provides disbenefits for water filtering, pest control etc but with opportunities to improve e.g. creating habitats for insects also good for biodiversity.
Soil formation & Nutrient cycling	Tendency to treat both supporting issues together and with soil erosion. No difficulties in understanding the concepts (sometimes referred to as 'good husbandry') and recognised as vital for food and biodiversity. Scores almost always increased as groups discussed opportunities for non-chemical/intensive solutions.
Wildlife & biodiversity	Very highly scored and important to individuals (#2) but moderated down by groups (#4) through discussions, but rose in importance when allocation of 'real public money' was discussed. General feeling that – based on local experts and walkers sightings of small mammals and farmland birds – on farm activities have led to big improvement in recent years but there are still more opportunities to do more.

Potential Future Uses

Ultimately it is hoped that the findings of the research will help decision-makers at a number of spatial levels to use a Valuing Ecosystem Services Approach to make decisions about future land uses, the balance of ecosystem services they provide and how to incentivise their delivery.

The toolkit for farmers

The study's process for engaging local people and experts in valuing ecosystem services on arable farms appears to work well and, together with a summary table on transferable monetary values for ecosystems services (Table 2.7) and summary of findings from the local workshops, starts to provide a 'toolkit' which can be used by farmers and land managers to engage with local communities about what they value most and the implications for how they manage their land in future.

Other potential decision-making uses

It is recommended that this 'toolkit' or process could be usefully tested at other spatial levels and with different stakeholders including:

1) ***With central Government policy makers** (e.g. Defra or CLG) in the context of a specific upcoming policy review/proposal for legislation such as CAP reform. The toolkit could be used to explore policy scenarios or options with local or wider stakeholders with Defra/CLG staff attending public dialogue meetings. Equally the process could be used by policy makers themselves with a refined process for using a 'real budget' for judging what resources should be allocated to supporting preferences for different ecosystem services.*

2) ***With regional or landscape/county level stakeholders** such as Sustainability East, Natural England, Environment Agency, NFU, CLA, RSPB, farm advisors and agents and a few local individuals to agree on the desired balance of ESs which could be delivered in a specific farming landscape in the future. This approach will be further tested at the Climate Adaptation workshop organised by Sustainability East on the 30th March in respect of climate adaptation priorities for the Fens.*

3) ***Supporting the localism agenda** providing a mechanism to help citizens and communities make choices that optimise the benefits they receive from the natural environment. At local level the process would be useful in framing discussions between farmers, landowners and land managers with parishes or neighbourhoods. We consider that the process would be equally relevant for informing Community Resilience planning, Neighbourhood Action Plans, Green Infrastructure strategies and Transition Town action plans.*

Contents

1 INTRODUCTION

1.1 ACKNOWLEDGEMENTS

This multi-partner project has been carried out by URSUS Consulting and Dialogue By Design for Sustainability East on behalf of a range of regional partners. It is funded by Defra and Sciencewise Expert Resource Centre[1] (ERC) funded by the Department for Business, Innovation and Skills (BIS). It has been overseen by a steering group of representatives from a wide group of stakeholder bodies in the East of England including Sustainability East, EEDA, GO-East, CLA, NFU, Natural England, Environment Agency, Forestry Commission, East of England Environment Forum (EEEF), East of England Local Government Association, English Heritage, RSPB, Campaign for the Protection of Rural England and the Morley Agricultural Foundation, the Chadacre Agricultural Trust and the Felix Thornley Cobbold Agricultural Trust.

We thank these organisations for their invaluable support. However, it should be noted that the views expressed in this document are those of the authors and not necessarily those of the sponsoring organisations.

1.2 OBJECTIVES

In the East of England, regional partners and stakeholders identified the need to develop a practical way of applying an Ecosystems Services Approach (ESA) to the area's specific issues and needs and in particular land use, water and soil pressures, the impacts of climate change and the need for recreation and cultural services for a growing population. Partners therefore developed the Valuing Ecosystem Services in the East of England framework (VEsSiEE) which has been applied to strategic land use planning and strategic planning during Phases 1 and 2 of the programme. Building on this work partners were keen to see how this framework could be applied to local decisions about the largest type of land use in the East of England, namely arable farming.

The objectives of the study were therefore to identify the value of a wide range of ecosystems services and benefits accrued from agricultural activity so that they can be recognised and taken into consideration in future decision-making and strategy development. This pilot has applied the ESA framework developed in Phases 1 and 2 of the VEsSiEE project to arable agricultural land in four contrasting, but regionally representative, locations within the East of England.

The intended outcomes were to:

- further the wider ESA research agenda and advance the East of England's leading role;
- increase awareness of ESA and the reasons for valuing ecosystems services amongst the public and local decision makers;

[1] ERC helps policy makers to understand and use public dialogue to inspire, inform and improve policy decisions around science and technology. It consists of a comprehensive online resource of information, advice and guidance together with a wide range of support services aimed at policy makers and all the different stakeholders involved in science and technology policy making, including the public. The Sciencewise- ERC also provides co-funding to Government departments and agencies to develop and commission public dialogue activities. www.sciencewise-erc.org.uk "

- provide insights on what local people around the pilot sites really value about the natural and cultivated landscapes around them, and what they think would be the optimal balance of ecosystem benefits going forward; and
- meaningfully feed into the national and regional agricultural policy debate.

Ultimately it is hoped that the findings of the research will help decision-makers at a number of spatial levels to use a Valuing Ecosystem Services Approach to make decisions about future land uses, the balance of ecosystem services they provide and how to incentivise their delivery.

1.3 METHODOLOGY

1.3.1 Approach

Our overall approach to the pilot project was to:

- use the VEsSiEE approach for valuing ecosystem services developed during Phases 1 and 2 of the study;
- work closely with the steering group to carry out a pilot which is consistent, robust, provides real added value and is cost-effective;
- develop specific assessments for four representative case study farms using existing work from Phase 1 and elsewhere and expert judgment from our own team and stakeholders;
- present this information in a visually simple way supported by written materials which help to convey the ecosystem services concepts and farming issues in language and using tools which are easily accessible to the general public;
- carry out a public dialogue process based on the principles of Sciencewise;
- disseminate the pilot findings to stakeholders, the steering group and policy makers to raise awareness, demonstrate how public dialogue has influenced outcomes and influence the wider policy and research agendas.

Challenges for the pilot

The key challenges which we anticipated at the outset of the study included:

- the potential reluctance of farmers to commit time to 'academic' research;
- the ability to quantify ecosystem services provision for all categories for each of the case study areas;
- gaps in research on monetary value of some ecosystem services and difficulties in benefit transfer to specific case study settings;
- the possible challenges of measuring the differences between different scenarios for ecosystem service provision;

- difficulties in communicating ecosystem services concepts and assessments to the general public in a way which would allow them to value them; and
- the potential reluctance of the public to commit time to a dialogue process without an immediate policy outcome.

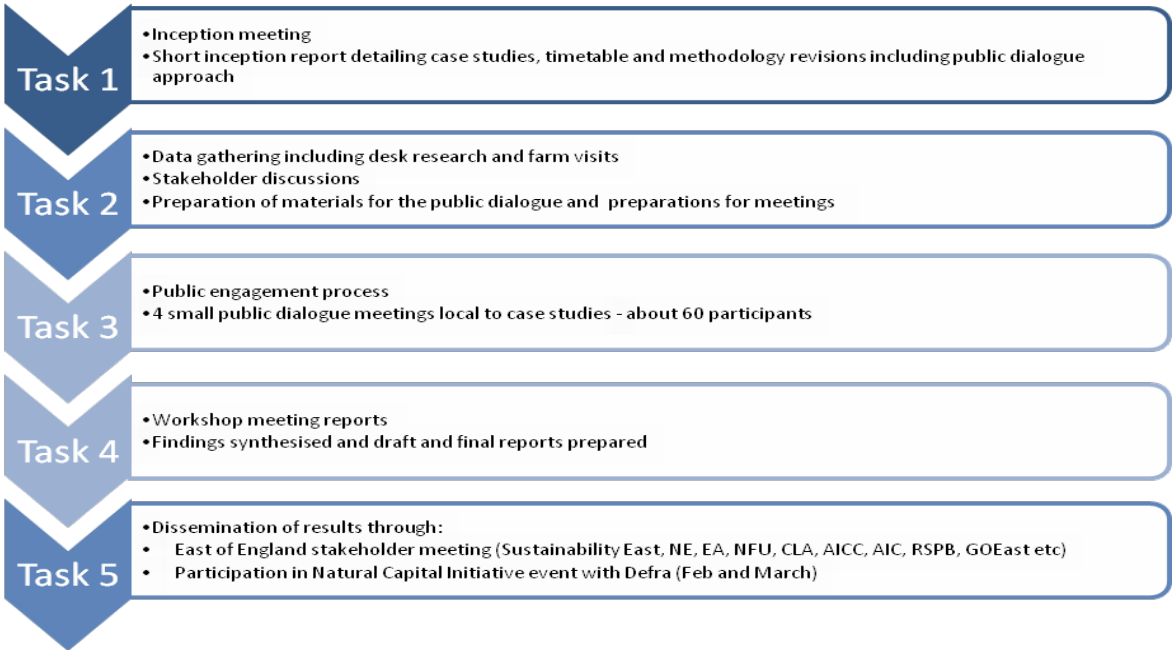
Addressing the challenges

Our methodology was designed to address these challenges by:

- Working closely with farming representatives on the steering group to identify four case study farms which would typify the different issues across the East of England and where farmers would be willing to participate and provide detailed information.
- Filling gaps from the phase 1 study on how to quantify and monetise ecosystem services for arable farms and best practice in using public dialogue for ecosystem services approaches through a wide literature review of both national and international research.
- Working with stakeholders to develop policy-relevant scenarios for how farms might be managed in the future. We had hoped to work with Defra decision makers on scenarios for future Common Agricultural Policy (CAP) reform. Since this did not prove possible the approach agreed with the steering group was to develop informal scenarios for individual farms based on foreseeable changes in: market prices for wheat, future climate or absence of grants for environmental stewardship.
- Developing a package – or toolkit – of visual and accessible information which can be used by farmers or others involved in land use decisions to engage the public in a dialogue about: why ecosystem services are important; what farms are currently delivering; and what balance of services they would like to see in the future. This included the development of a 'spider diagram' as a tool for scoring specific ecosystem services and discussing the trade-offs inherent in moving to a different balance in the future.
- Encouraging deliberative dialogue based on Sciencewise principles by organising four workshops in convenient locations, close to the case study farms and at times which would allow participation of a representative range of local people.

The overall tasks for the study are shown in *Figure 1.1* below and the methodology is described in more detail in the following paragraphs.

Figure 1.1 Key tasks undertaken



1.3.2 Detailed Methodology

Literature Review

The desk review focussed on identifying how studies both in the UK and internationally have attempted to quantify and monetise ecosystem services provided by farming systems and natural areas of relevance to arable farming in the East of England. The literature review also covered best practice in running public dialogue processes and how to convey ecosystem concepts to the general public, particularly through the experiences of other Defra and Sciencewise funded projects.

Selection of case study farms

Four case studies were selected to give coverage of typical East of England arable farm types:

- Urban fringe setting with recreational interest, trespass issues and many diversification options for arable farms;
- Deep rural setting in the middle of an arable farming area, close to small village(s) but without major settlements nearby and with limited opportunities for diversification;
- A coastal setting with issues associated with tourism, salt water incursion, coastal flooding or erosion; and
- The Fens, with issues related to flooding, soil erosion and very open landscapes.

The case studies were also selected to provide a range of different levels of existing ecosystem services delivery through:

- Entry Level Stewardship (representing three quarters of agricultural land in East Anglia)
- Higher stewardship or demonstration farms providing a higher level of ecosystem services in some areas.

We also tried to select farms of typical size and crop mix for the East of England. Steering group members provided initial details of a long list of prospective farms which met these criteria: the final selection of four was made by GO-East.

While we tried to recruit average sized farms it became evident that the pressures to achieve economies of scale meant that:

- Three of the case study farms had a similar crop mix to this average but are all much larger than the regional average, having consolidated their land by acquiring smaller farms, renting additional land and farming land under contract in order to optimize their investment in plant and equipment.
- One of the case study farms has moved out of cereals production entirely towards a mix of poultry, fodder, and environmental stewardship since it is now too small for intensive cereals production and its proximity to urban areas offers other opportunities for diversification.

The selected farmers were initially approached by a member of the pilot group to encourage them to take part and then approached by the consultants to agree visit dates and information to be collated. All farmers were happy to participate without any financial incentives. Farm visits were carried out during November and December 2010. Farmers were invited to attend the workshop session local to their farm, although only one chose to do so. The data collected about each case study is summarised in Section 3.

Public Engagement Process

The public engagement process was designed by Dialogue by Design and URSUS with input from the Sciencewise and the Steering Group. The process was also designed around interactive table sessions, including the use of a spider diagram on each table to provide a framework and focus for discussion of the relative values of each of the benefits. The process was intended to be accessible and enjoyable for participants, to allow them to increase their understanding of ecosystem services concepts, contribute their local expertise on how these are currently delivered; and to allow them to quantify or provide qualitative input on what balance they would like to see local farms delivering in the future. The workshop presentations used non-technical language and 'wider benefits of arable farming' rather than ecosystem services language. The process was also designed around a quiz, interactive table sessions and the use of a spider diagram for valuation of individual benefits. The process plan (including timetable, objectives and outputs for the local sessions) is shown at Annex B and the PowerPoint and other materials used – effectively the toolkit for engaging the public in an ESA for arable land – is shown at Annex C. The outcomes of the workshops are summarised in section 4.

The four local workshops were held on the following dates:

- 18/1: Brickendon, Hertfordshire;
- 19/1: Bradwell, Essex;
- 25/1: Welney, Norfolk; and
- 26/1: Stoke Ash, Mid-Suffolk.

It was agreed that each workshop would aim for up to 15 participants and be held in a pub local to the case study farm. The workshops ran from 18:00 to 21:00 on a weekday evening (except for Hertfordshire where participants were keen to start at 19:00 and finish at 21:30). In lieu of the

£50 incentive payment often offered for attendance at focus groups or public dialogue sessions, participants were offered soup, sandwiches and refreshments on arrival.

Given the small sample size for each meeting, the groups were clearly not expected to be statistically representative or provide statistically robust results. However, in bringing together the individuals that made up each group, every effort was made to ensure that the mix was representative of the make-up of the local area and reflected a range of age, gender and socio-economic groupings. The individuals were also selected to provide a range of local knowledge, expertise and interests across a broad spectrum from those with no knowledge of farming, to those with broad knowledge of land use management or detailed knowledge of specific ecosystem services issues. The workshop facilitation stressed that we considered all participants brought some expert knowledge about the local area and their own values.

The recruitment process involved telephone and email contacts with:

- Individuals suggested by participating farmers because they had had some involvement in identifying ecosystem services opportunities on the particular farm. These included Natural England, Environment Agency, RSPB or local Wildlife Trusts;
- Elected members e.g. parish council chairs, councillors and wardens (e.g. for footpaths) and local authority representatives (such as Village Agents in Essex);
- Environmental and amenity interest groups (including walkers, anglers, riders, skaters groups, wildlife, bird and woodland trusts);
- Other social and community groups (Women's Institutes, Young Farmers, school or mother and toddler groups); and
- Other commercial interests (other farmers and landowners, village shops/post offices, rotary clubs etc).

The events were also advertised via posters displayed in prominent locations such as community shops or local post offices or emailed by individuals to their wider networks.

Dissemination of results

Participants were keen to find out the outcomes from their participation and were all sent the workshop report of the outcomes from all four workshops by email. This was also sent to the Parish Council so that it could be disseminated more widely or reported in parish magazines if required.

During February and March the project director and project manager also took part in four dissemination events:

- A meeting to present the findings of the pilot project to regional partners and the Steering Group. The session followed a similar format to the local public dialogue workshops using the toolkit to arrive at a group view on the desired future balance of ecosystem services in the Fens. The focus was on a larger scale arable landscape and involved stakeholders with a wider regional perspective. The workshop also piloted a monetary valuation technique using 'Monopoly money'. The results are compared and contrasted with those from the public dialogue sessions in Section 4.3.

- A Natural Capital Initiative in London on February 16th which brought together those involved in participative dialogue Ecosystem Services Approaches to share experiences and lessons learnt.
- A seminar to present the outcomes of Defra supported ESA pilots for Defra policy makers, organised by the Natural Capital Initiative, in London on March 17th.
- Presentation of the results of the Arable Pilot at a workshop organised by Sustainability East on Adapting to Climate Change on 30th April.

1.4 LAYOUT OF THE REPORT

The remainder of this report is according to the following layout:

- **Section 2**: Provides an overview of the ecosystem services approach and values for different services (or dis-benefits) provided by arable farms based on the VEsSiEE framework and literature review;
- **Section 3**: An overview of the case study farms including descriptions of the ecosystem services they deliver;
- **Section 4**: Analysis of the outcomes of the local and Fens workshops; and
- **Section 5**: Conclusions, lessons and recommendations for decision makers.

Further supporting material is found in Annexes:

A. Workshop process and evaluation.
B. Bibliography

2 OVERVIEW OF ECOSYSTEM SERVICE VALUES ON ARABLE FARMS

2.1 VESSIEE FRAMEWORK

2.1.1 Ecosystems and Ecosystem Services

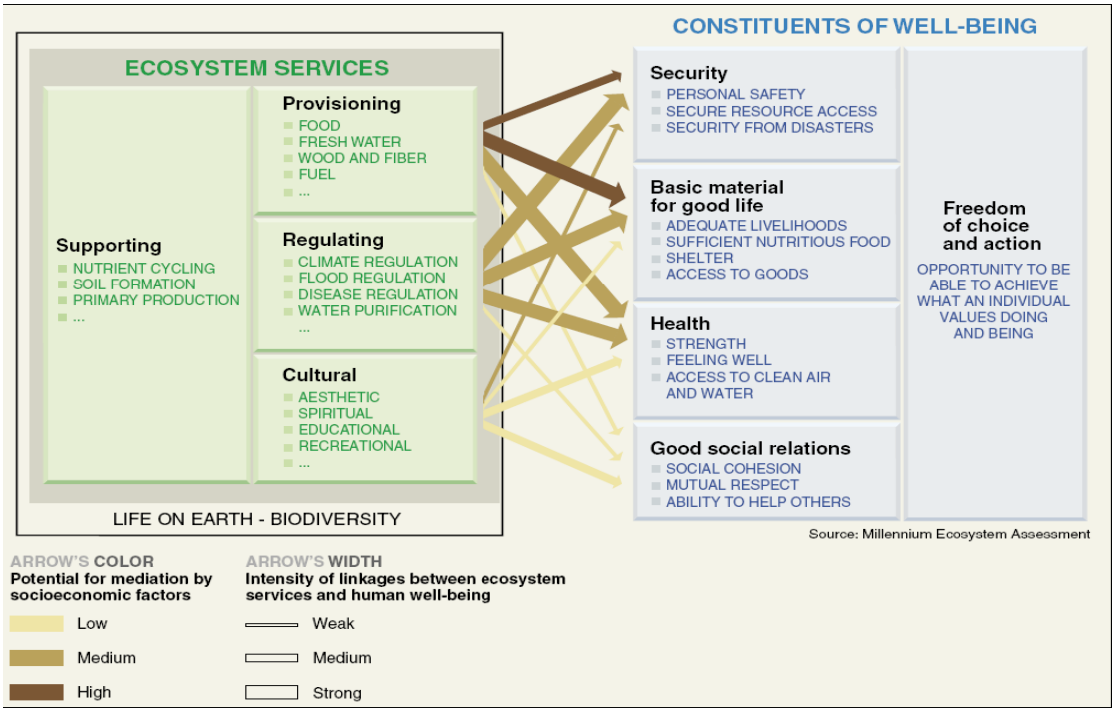
The term ecosystem was first used in the 1930s by the ecologist Arthur Tansley to explain how physical and biological components of the environment work together as a single functioning system. An ecosystem includes the plants and animals which make up a habitat as well as the other elements – soils, water, climate and human management - which enable the habitat to function. Ecosystems are found at different scales from a hedgerow, pond or field to a whole river catchment.

Human economic, physical, mental and cultural wellbeing depends on the health of ecosystems. In recognition of the way that humans rely on ecosystems for essential goods and services that underpin growth and quality of life and the need to recognise the costs of losing such services and goods, the UN developed the Millennium Ecosystems Approach to categorising the range of services provided as shown in *Figure 2.1*. This was intended to help decision makers, planners and policy makers understand the multiple benefits provided by key ecosystems and the costs of losing them or replacing their functions – such as flood or climate control – through other means. This approach has been used both globally by the Convention for Biological Diversity and increasingly by the UK government.

The Millennium Ecosystem approach defines Ecosystem Services (ESs) as *"the benefits people obtain from ecosystems"*. These benefits, provided at different scales, can be defined in the following ways:

- **Provisioning services** are the materials that ecosystems provide such as food, water and raw materials and energy. These are often traded and are generally taken into account in decision making.
- **Cultural services** are the non-material benefits of ecosystems – from recreation to spiritual inspiration, knowledge, health and aesthetic enjoyment for both those living near the ecosystem and those who visit it or simply benefit from knowing that it exists.
- **Regulating services** are the services that ecosystems provide by acting as regulators. This includes regulation of air and water quality, climate, flood and disease control and pollination services. These benefits may be enjoyed at local, catchment or global level.
- **Supporting services** (sometimes also called Habitat services) underpin almost all other services. Ecosystems provide living spaces for plants and animals and maintain their diversity. This group also includes soil formation, nutrient cycling and photosynthesis which underpin all the other services.

Figure 2.1 Millennium Ecosystem Assessment – Relationship between Ecosystem Services and Human Well Being (UN 2000)



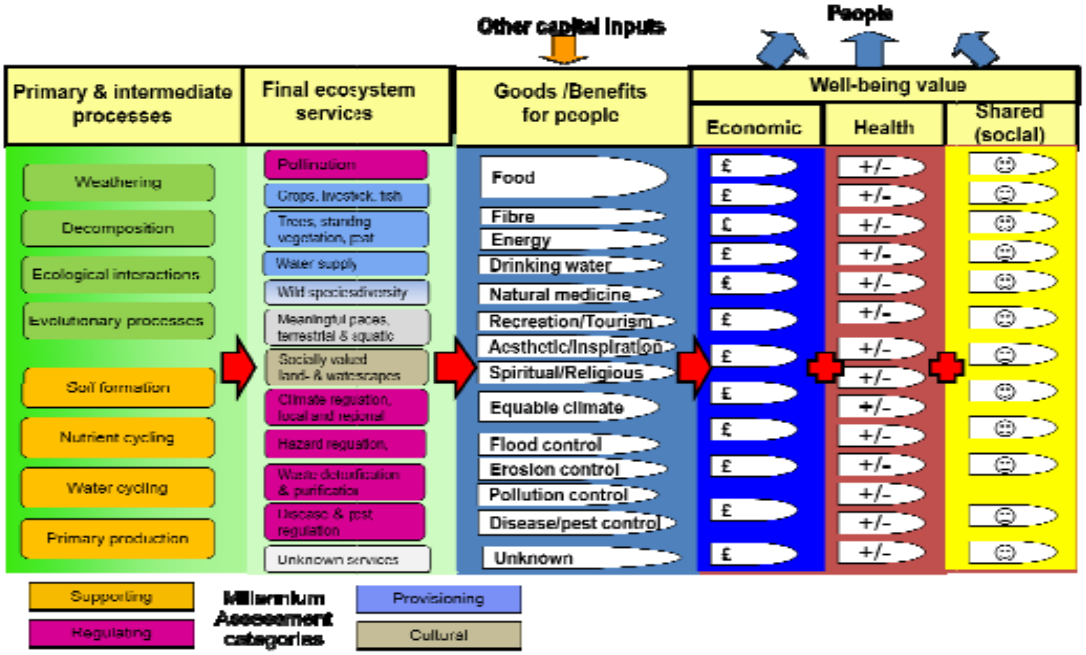
The UK National Ecosystem Assessment (Watson R, Oct 2010) suggests changes to the established Millennium Assessment approach which has so far been used by the Defra family (see *Figure 2.2*). There are a variety of outputs from ecosystems, but while ecosystems function and produce services, people place different values and choices around goods and benefits. The crucial link between services (as outputs of Ecosystems) and goods/benefits (that people value and use) is that goods/benefits can be valued both economically and non-economically including shared (social) value. The NEA approach therefore distinguishes between intermediate and supporting ecosystem services and the goods and services that they enable to avoid double counting. However, the full UK NEA will not be published until later in the spring and in order to be consistent with the body of Defra funded research, we have continued to treat supporting services as a separate category, while being mindful to avoid double counting in any valuation of services.

2.1.2 Why Value Ecosystem Services?

However, while ESs are increasingly recognised as having great value to us in everyday life, the benefits we receive mostly bypass markets, escape pricing and defy valuation. There is therefore growing interest from government and nature conservation organizations in trying to value ecosystem services to '*ensure that the value of ecosystem services is fully reflected in decision-making*' (Defra 2007). The Nature of England Discussion Document (Defra, 2010) includes a number of references to the need to link together better management of the environment and its functions with the economy through the use of ecosystems services, so that the environment is a valued asset for the services which it can deliver. Ecosystem Services Valuation (ESV) is the process of assessing the contribution of ecosystem services to meeting a particular goal or goals. This is intended to help ensure that not just the obvious provisioning and cultural services are taken into account in making decisions, but that the vitally important regulating and supporting

services are also recognised. An ecosystem services approach is expected to inform the forthcoming Natural Environment White Paper.

Figure 2.2 UK NEA framework for valuing and creating markets for Ecosystem Services



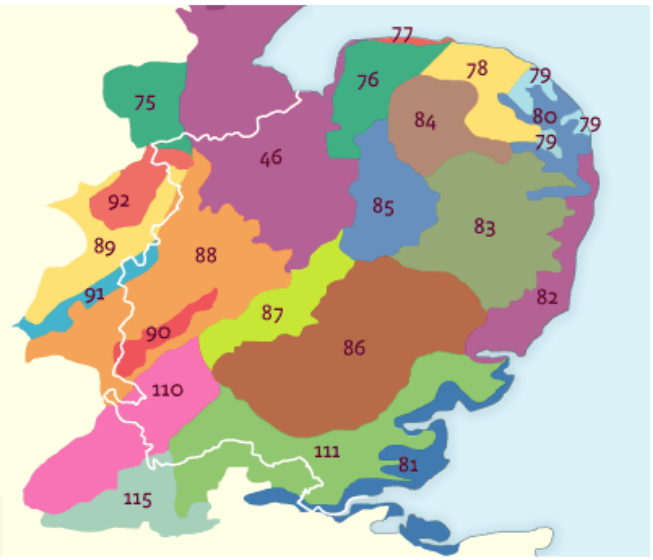
In the UK, the use of valuation techniques for securing monetary values for environmental benefits of natural areas began in the late 1960s and early 1970s, building on a large body of work in North America. Since the 1980s a number of studies to value non-market benefits in the English environment have been carried out (Turner *et al.* 1992). Environmental and resource economists have developed methods for how the range of goods and services provided by an ecosystem can be measured detailed in VEsSiEE Phase 1 and Defra (2007) reports. In the UK, a review was carried out of the methodologies available to value the natural environment (Eftec, 2010). In particular, Contingent Valuation Methods (CVM) has become widely used in public-decision making and has been applied to wildlife conservation, landscape and habitats. The valuation is given in economic terms normally as benefits in pounds per hectare per year (£ ha^{-1} yr^{-1}). Following on from the Eftec study Defra commissioned a report which further develops the evidence base in terms of the economic valuation of ecosystem services, within the overall goal of embedding the ecosystem services approach in UK decision making (O'Gorman & Bann, 2008). The O'Gorman & Bann Study (2008) provides a series of potential transferable values for ecosystem services across England's terrestrial ecosystems. Most recently a study for Defra (Land Use Consultants, 2009) assessed relevant studies for valuing the provision of ecosystem system services through the Environmental Stewardship Scheme. The most important elements of all these studies for arable land in the East of England are summarised in *Section 2.2* below.

2.1.3 Ecosystem services in the East of England

The East of England region contains a wide range of landscapes, habitats and organisms interacting as "ecosystems" described through 21 National Character Areas (NCAs) described by Natural England. These range from low-lying coastlines to large-scale arable farmland, including fenland and heathland. Each area provides its own distinctive mix of ecosystem services. Some ecosystems within these NCAs are of regional or national importance, particularly for

overwintering birds (particularly in coastal and fenland settings). Other more common ecosystems are highly valuable to local people, absorbing air pollutants, providing contact with nature and an escape from the stresses of life. Each of these landscapes and ecosystems provides a different set of benefits to people, in terms of cultural and supporting services (such as flood protection and erosion control). Natural England is in the process of developing ES based descriptions of each of these NCAs and the draft characterisation of the Fens (Natural England, 2011a and 2011b) has been used as the basis for a landscape scale assessment, as described in *Section 4.3*.

Figure 2.3 East of England National Character Area map



- 46. The Fens
- 76. North West Norfolk
- 77. North Norfolk Coast
- 78. Central North Norfolk
- 79. North East Norfolk & Flegg
- 80. The Broads
- 81. Greater Thames Estuary
- 82. Suffolk Coast & Heaths
- 83. South Norfolk & High Suffolk Claylands
- 84. Mid Norfolk
- 85. Breckland
- 86. South Suffolk & North Essex Clayland
- 87. East Anglian Chalk
- 88. Bedfordshire & Cambridgeshire Claylands
- 89. Northamptonshire Vales
- 90. Bedfordshire Greensand Ridge
- 91. Yardley-Whittlewood Ridge
- 92. Rockingham Forest
- 110. Chilterns
- 111. Northern Thames Basin
- 115 Thames Valley

2.2 Ecosystems Services on Agricultural Land

The region's agriculture is nationally important, producing more than one-third of all the country's potatoes and vegetables. Farming and food processing in the region supports at least 50,000 jobs and generates £3 billion income. Farmers in the East of England have been highly successful at increasing food production in the 20th century. Compared with 1950, per hectare yields of wheat, barley, potatoes and sugar beet have tripled. But these achievements have also brought costly environmental, health and social problems. These negative impacts or dis-benefits of farming have been quantified and given monetary values in a number of studies (cited in Pretty et al, 2000) and are not detailed again in this study which rather focuses on the wider benefits of arable farming – summarised in *Figure 2.2* – which balance some of the negative impacts.

Wheat yields per hectare have increased by over a factor of 3 between 1940 and 2008 reaching 8-10 tonnes/ha, for milling or feed. There has been a medium-term trend towards specialisation and landscape homogenisation due to mechanisation, use of inorganic fertilizers, economies of scale and market forces in combination with EU agricultural policies. *Table 2.1* summarises a study to value different types of ecosystem services, including on farmland (O'Gorman and Bann, 2008) which suggests that at 2007 prices that the East of England's farmland was contributing £1.85 billion in food, non-food and other agricultural produce and £110 million in sports shooting services. Until the 1990s provisioning services have increased while many other ecosystem

services declined: increases in total agricultural productivity slowed down during the 1990s, while the deterioration in other ecosystem services was reduced and, in some cases, reversed.

Figure 2.4 Summary of typical ecosystem services provided by farmland

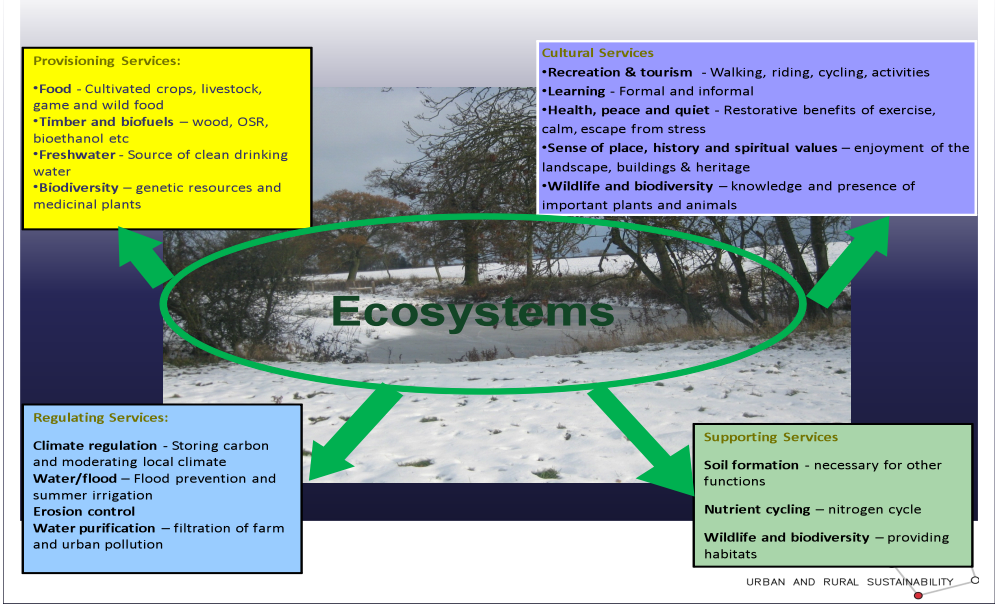


Table 2.1 Estimated values for farmland ecosystem services in the East of England

Ecosystem Service type	England £m pa 2007 prices	East of England £m pa 2007 prices
Food	8,213	
Non-food produce	1,119	
Other agricultural and non agricultural activities	984	
Total	10,316	1,856.88
Sports Shooting	Expenditure 1,098 GVA 204	Expenditure 110 GVA 30
Source: O'Gorman and Bann (2008)		

Other studies have considered different aspects of ecosystem services on arable land, as summarised in *Table 2.2* below and discussed in turn in *Sections 2.2.1 to 2.2.5*. The relevant categories for arable farming are shown in *Table 2.2*. The colour coding adopted in this table has been used for presenting valuation and qualitative assessment of ecosystem service values throughout the remainder of this report.

2.2.1 Provisioning

Food and Fibre

This is the largest ecosystem service produced by arable land and includes food – crops and livestock directly or indirectly for human consumption - and fibres (used for construction and furnishings etc). Agriculture in the East of England is mainly arable (70%) and arable ecosystems produce one third of the UK's key crops and vegetables. Farms are typically very productive with high yields of wheat, barley, sugar beet, oil seed rape, vegetables and animal fodder.

The value of food and non-food produce can be calculated based on knowledge of the cropping system, average yields (which vary marginally from year to year), market prices (which vary significantly year on year and by market segment) and variable costs (including seeds, fertilisers/nutrients, pesticides and other sprays).

Table 2.2 Description of key ecosystem services from farmland

Provisioning services	
Food	The provision of crops and livestock through agricultural practices used directly or indirectly for human consumption and wild foods derived from habitats, such as berries, nuts, fungi and honey.
Fibre	The provision of fibres used in construction, furnishings, clothes, paper and card etc including timber and coppice products, wool, livestock hides, and fibre crops.
Fuel	The provision of biological materials as a source of energy including both biomass (wood, straw and other biological materials) and biofuels derived from bioenergy crops.
Genetic resources	Prospecting of nature's genetic library for new food, medicine and pesticide ingredients.
Freshwater	The freshwater provided by water catchments which store, filter and improve water quality without the need for expensive treatment plant and chemicals.
Cultural services	
Aesthetic values, spiritual, inspiration	Characteristics of the landscape and natural world that are of aesthetic value to people (a beautiful landscape), that create a sense of place and may inspire a sense of spiritual well-being and can act as an inspiration to the arts.
Cultural heritage values	The conservation of sites and landscapes of historical importance including above and below ground archaeology and cultural features.
Educational value & knowledge systems	The use of ecosystems and the natural world in formal and informal education and the passing down of knowledge from one generation to the next.
Recreation and ecotourism	The provision of specific recreational opportunities (as in permissive access routes); the conservation and restoration of habitats that provide access under the CRoW Act (moorland, heath and down) and other habitats that are frequently available for public access (e.g. woodlands and sand dunes). This also includes benefits to field sports.
Regulating services	
Air quality regulation	The role of woody plants and trees in filtering particulate matter out of the atmosphere as a contribution to air quality.
Climate regulation	Mitigation of climate change through carbon storage and sequestration and reducing emissions of other greenhouse gases such as methane.
Water regulation	The influences of changes in land cover and changes in water storage potential on the timing and magnitude of run-off, aquifer recharge, and water table levels and alleviating flooding.
Erosion control	Preventing or reducing soil and coastal erosion and associated natural hazards such as landslides.
Water purification and waste treatment	Reducing the quantity of pollutants (organic and inorganic wastes, fertilisers and pesticides) reaching surface and groundwaters.
Pest regulation	Affecting the prevalence of pests (plants and animals) and diseases relating to crops and livestock and wildlife habitats and species.
Pollination	Changes affecting the distribution, abundance and effectiveness of pollinators.
Supporting Services	
Soil formation	The formation of soils.
Photosynthesis	The production of oxygen which is necessary for most living things.

Nutrient cycling	The assimilation, accumulation and cycling of nutrients.
Wildlife and Biodiversity	Wildlife and biodiversity is a supporting service which underpins many other ecosystem services including provisioning, cultural and aesthetic enjoyment, regulating (pest control and pollination) and soil and nutrient cycling.

We have used information from Defra (Farm Accounts in England 2009/10) on yields, farm gate prices, revenues and costs per hectare for different types of farm across England and from the annual Farm Business Survey (2009/10) for data on the East of England. In addition we have collated information from case study farm accounts (in the cases where this has been provided) as summarised in *Table 2.3*.

Where farmers decide to provide other ecosystem services by changing land uses (e.g. through extensification or taking land out of production for conservation headlands, buffer strips, field margins, grass mixes, beetle banks etc.) then there is likely to be a reduction in food production values. Likewise conversion of land from food to fuel crops will involve a trade off. Decisions to use different crop mixes (such as cover crops and green manure) for nutrient cycling or erosion control are also likely to lead to some loss of yields for food crops. These effects may be partially offset by increase in the quality or value of food products, for instance reinstatement of hedgerows or woodland cover may increase provision of edible berries, fruits and fungi or incomes from game.

Table 2.3 Estimated crop revenues, input costs and gross margins, 2009 £/ha

	Revenue			Input Costs					Gross margins
2009	Yield/ha	Price/ tonne	per ha	Seed	Fertiliser	Sprays	Crop sundries	Total input costs	
Winter wheat	9.76	153.67	1500	66	198	189	8.6	461	1039
(2ndy straw)			2	0	0	0	0	0	2
Seed wheat	10.3	364.3	3753	66	198	189	0.35	453	3300
Dried peas	4.01	335	1342	131	0	196	0	328	1014
(2ndy residues)			2.3	0	0	0	0	0	2.3
Winter OSR	5.19	297.85	1548	44	205.5	193	5.6	448	1100
Lucerne	7.74	60	464	9.4	0	34.3	0	44	420
(2ndy hay/grazing)			5.6	-		0	0	0	5.6
Source: Case study interviews									

Farm Business Survey and Defra statistics suggest that the gross margins for other crops are in the following ranges:

- Winter and spring barley - yields of ~6 t/ha generating £25-50/ha;
- Other cereals – generating ~£15/ha;
- Sugar beet – generating £50-60/ha (under quota);
- Other crops including horticulture and biomass worth £10/ha; and
- Forage by-products and cultivations worth £10-35/ha.

In addition the average East of England farm receives Single Payment grant (about £202/ha), agri-environment payments (about£ 44/ha) and output from integrated diversified activities (£57/ha).

The permanent loss of land for food production for the benefit of other ecosystem services can be calculated based on capitalised land values net of Single Payment grant. The Environment Agency uses this opportunity cost of land approach to monetise the value of agricultural land converted to wetland or lost to managed realignment (Eftec, 2007).

Based on typical rotations we have assumed that the value of food, non-food and diversification incomes to farmers in the East of England is at least £900/ha after the cost of variable inputs, but not including labour or fuel costs, are taken into account. For highly productive farms gross margins may be closer to £1000/ha. These prices reflect relatively high wheat prices over the last 2 years, but these are not expected to fall in the short or medium term.

Timber and Energy

This category includes wood fuel and coppicing and biofuels (energy crops such as oilseed rape) and straw residues which can be produced on arable land. In addition we have included other renewable energies such as wind, solar PV, anaerobic digestion (AD) and geothermal. None of the case study farms are currently producing electricity but all have opportunities to invest in solar PV in the future.

The East of England aims to produce 10% of its energy generation from onshore renewables by 2010. Farmers can contribute to this objective with limited tradeoffs for food production by planting more hedgerows and trees, selling crop residues (such as straw) for biomass power plants, or investing in renewables such as solar PV on farm buildings. Other options such as biofuels crops (such as oilseed rape) will be at the expense of food production and are only likely to be pursued where the gross margins are higher than the alternative food crop options on the land.

It is relatively easy to value energy services based on the energy produced and market prices for fuel (e.g. £6/bale for straw, £90/load for fuel wood), or electricity produced based on feed in tariffs per kWh.

Freshwater

Farmland ecosystems can contribute to the production of fresh drinking water, the availability of which will be a real limit to growth in the East of England, particularly under future climate scenarios. Much of the arable area is designated as Nitrate Vulnerable Zone, with the intention of limiting the potential for fertilizer applications to lead to nitrate leaching and create dis-benefits for other ecosystems. The dis-benefits or negative externalities of farming are covered in other studies (Pretty et al, 2000) and are not included here.

All soils contain cracks and pores. Their average size and their total volume within a soil affect the speed and direction of rainwater draining through the soil. All soils act like sponges, but some are more absorbent than others. Freely draining soils absorb rainfall readily and allow it to drain through to underlying layers. Slightly impeded drainage refers to soils with tight, compact deep subsoil that impedes downward water movement; after heavy rainfall, particularly during the winter, the subsoil becomes waterlogged. In soils with impeded drainage the effect is more severe and winter water-logging results in very wet ground conditions. In the uplands, many soils

have a greasy surface peat layer that holds water through the winter. These soils are described as having surface wetness, and can be reasonably dry beneath. In low-lying sites, permeable soils are often affected by high ground water that has drained from the surrounding landscape. They are described as naturally wet (National Soil Resources Institute, Soilscape).

Farmers can manage soils so that more water infiltrates to aquifers and reduce the use of chemical fertilisers and pesticides in order to reduce the costs of treating water for drinking downstream. Studies in the North West and South West have attempted to quantify and value expenditures avoided for potable water treatment through better management of peat upland catchments. For instance, United Utilities and Royal Society for the Protection of Birds (RSPB) have undertaken a peat bog restoration project to reverse damage to an area subject to extensive grazing, under the Sustainable Catchment Management Programme (SCaMP) on 57,000 ha of land owned by the Water Company. A major part of the programme is to ensure sensitive farming practices are employed to prevent further degradation. The project has demonstrated clear benefits of restoration in terms of improved water colour and water quality, lower long-term costs to customers, reduced flood risk downstream, and enhanced aquatic, wetland and terrestrial biodiversity. Restoration of peat bogs was estimated to provide annual benefits of between £1.2 million and £2.6 million (based on costs of 'end of pipe' water treatment expected to be avoided) suggesting benefits of £20-45/ha managed (Defra, 2007).

A study of the Slea Catchment in the East of England (Lovett *et al.*, 2006; Water4all 2005), assessed land-use scenarios to improve groundwater quality (by reducing nitrate concentrations) and estimated the cost of land use change at €1.96 million (£1.33 million) per year, equivalent to 0.068 cents (0.046p) per litre of water (based on an output of 8 Ml/d) or 12 cents (8p) per person per day (based on average per person use of 180 l/d) or approximately €44 (£30) per person per year.

Given the topography and soil types on East of England arable farms the opportunities to influence the quantity or quality of drinking water produced are less than in peat uplands. However, arable farms can increase the quantity and quality of on-farm water storage through retention ponds/basins and wetlands which increase water resources with the following benefits: promote natural groundwater and aquifer recharge, provide for summer irrigation without the need for abstraction and start to mitigate water shortages due to climate change.

However, it is difficult to apply these values to arable land in the East of England without the necessary production function data. Given the heterogeneity of the region's soils and geology and their importance in optimisation of agriculture and water catchment ESs this would require detailed research or modelling for each area. However, as a guide where farms are involved in major water conservation activities we have used an indicative rate of £20/ha for this ES.

Wildlife and biodiversity

Although wildlife and genetic diversity have an intrinsic value of their own, they also provide services for direct human use which can be quantified. For instance, genetic diversity is used directly for food, medicine and methods of crop fertilisation and protection, and prospecting the diversity of species continues to be an important source for new food, medicines and pesticide ingredients. There are now very limited medicinal plants or rare breeds on our typical farms; however it remains important to conserve rare breeds and strains of crop for their potential

future human benefits. Two ELS options - orchards and rare breeds – help conservation of genetic resources. For example, the Environment Agency Alkborough Flats case study used market prices for livestock which were considered important as a resource in the wider area.

For arable farms in the East of England the main services under this heading are shooting and hunting. Latest estimates of the economic significance of countryside sports estimate that nationally 480,000 people shoot live quarry in the UK, spending £2.0 billion annually on purchased goods and services, including £750 million of expenditures on site (PACEC, 2006) or an annual spend per person of more than £1,750 per person pa at 2010 prices. By planting trees, managing hedgerows and creating wildlife areas for game, farmers can enhance biodiversity, in the process charging around £100 or more a day or £35 per bird for shoots.

It is outside the scope of this study to attempt to place a value on the existence of species in their own right. Such exercises typically involve assessments of the public's 'willingness to pay' to see wildlife in a local area, or simply to know that species exist there, which requires a different process from the one undertaken for this study. Willingness to Pay for improvements to wildlife and biodiversity are further discussed in *section 2.2.5* below.

Summary of Provisioning Services

Valuation techniques are well understood and data is easily available to estimate the yields per hectare, market prices and variable costs for food, fibre, fuel and biodiversity benefits associated with game hunting, medicinal crops or wild produce. Generic values for provisioning services on standard cereals farms in the East of England can be taken from gross margins from the Farm Business Survey and are estimated at more than £900/ha in 2009. The figures for larger, highly mechanized, high input farms are likely to be higher. Values will vary from year to year largely depending on market prices of wheat. Increased provision of regulating or supporting services is often – but not always - at the expense of some reduction in the quantity or quality of food production. These impacts can be calculated on the basis of income foregone from reduced cropping areas, lost yields or impacts on market prices.

2.2.2 Cultural Services

Recreation & tourism

With the predicted increase in the East of England's population and over 20 million people living within two hours drive (East of England Tourism, 2009), the numbers of day visitors and tourists is expected to increase. Escape and relaxation are all cited as key reasons for visiting the region for walking, riding, cycling, bird watching and angling. These activities rely on high quality ecosystem services from coast, waterways, woodland, parkland and open countryside ecosystems. Recreation and ecotourism provides benefits to: visitors to the countryside, who gain satisfaction from their recreational experience; providers who may receive payment for the services they provide and the local economy which may derive income from visitors.

The overall value derived from visitors is a function of the number of visitors and the value per visit which can be measured using stated preference (contingent valuation or choice experiments) or revealed preference (travel cost) methods, to estimate the willingness to pay per visit. For instance, Woodland For Life (2011) estimates that some 17.5 million leisure visits each year in the

East of England are to woods and forests, which generate a total £193 million per year with average visitor spend of £35.69 a visit or an average benefit of £1,330/ha. A recent study by RSPB (2008) at their Blacktoft Sand reserve on the East Coast calculated average visitor daily spend in the local economy based on surveys over the previous five years (to October 2008). Where visitors attributed a visit to RSPB reserves as their main reason for visiting the average spend per visit was estimated at £4.17 for day visitors (80% of visits) and £24.70 per longer-term holidaymaker (10%): local visitors (10%) made no spend.

Arable farms generally provide much less recreational benefit than woodlands or wildlife reserves but do provide walking, cycling and riding opportunities on Public Rights Of Way (PROWs). Attractiveness to visitors could be improved by enhancements to paths, circular routes, signage and interpretation which encourage access and improve the experience. Improvements to access and wildlife habitats can also lead to increased recreational opportunities, amenity for people and income for landowners and increase in site use for the purpose of wildlife watching. Wider enjoyment and informal recreation in the area are also likely to be enhanced. In order to value these benefits accurately a revealed or stated preference technique such as spending in the local economy, contingent valuation for each study area or benefit transfer is required from other studies. Where arable farms attract day visitors because of the quality of their attractions, and data are available for the number of visits we propose using the RSPB value of £4/visitor averaged over the total area of the farm.

For arable areas that only attract local visitors then another study (Garrod and Willis, 1998) which estimated Willingness to Pay (WTP) for creation of an additional mile of on farm access is more applicable. The study estimated WTP for the local population (within a 5 mile radius) and recreational clubs and found that local residents were willing to pay £0.359/mile for new access within 5 miles of their home while members of recreational clubs were willing to pay up to £0.23/mile within 5-50 miles of their homes. We suggest that the figure of £0.40/mile per resident of the parish is used and averaged over the total area of the farm to give a value for each mile of access provided. However, care needs to be taken to avoid double counting with health benefits (see below).

Learning - Educational Value and Knowledge Systems

This category covers opportunities that farmland can provide for education, learning and training with regard to farming methods and countryside management, but also about landscapes, features and habitats and the passing down of knowledge and countryside skills – such as hedge laying and stock keeping - from one generation to the next. Many farms in the East of England have participated in the Open Farm Sunday initiative which provides children and adults opportunities to see how farms work and how food is produced. These visits are initially high-cost for farmers to set up requiring health and safety assessments and the preparation of materials such as information and samples etc. Farmers can also provide for school visits or encourage clubs or other specialist groups to organise farm or woodland activities on their land. In the past payments to farmers have been up to £100/day through stewardship schemes.

Woodland for Life (2011) has estimated that forest schools provided in East of England woodlands. These education opportunities provide confidence in outdoors and the tools to develop healthy lifestyles, whilst providing a unique learning experience and skills which in the

long run will benefit themselves and society. Although these benefits are difficult to value the study conservatively estimated them at £8.50/ha. We have found no other estimation of the value of educational visits, although the workshops suggest that this service is highly valued by local people and that a number of farms across the East of England provide very high quality experiences for visitors.

For this study we have therefore valued the provision of educational opportunities at the HLS rates of £500 per annum (pa) base payment and £100 pa per visit averaged over the total area of the farm the farm.

Health, peace and quiet

This service relates to the restorative benefits of exercise, calm and remoteness, and escape from stress that can be provided by access to the countryside. A considerable body of evidence now shows how access to green space and woodlands can provide opportunities for increasing physical activity and the promotion of health and mental wellbeing. The cost to business in the East of England of working days lost through ill health is estimated to be over £1 billion per year (Woodland for Life, 2011). Less than a half of people undertake adequate levels of physical activity (recommended as 30 minutes five times a week) which are so important in tackling obesity and cardio vascular disease.

For forests and woodlands the benefits of exercise in avoiding the costs of cardio vascular disease are estimated at £135/ha (Woodland for Life, 2011). This is seen as a conservative estimate because it does not include the benefits which might accrue from avoiding Type 2 diabetes and mental illness which cost the local economy £26 billion a year.

Of greater relevance to arable farms are the estimates of health benefits from circular walks in a 2004 study on behalf of RSPB (Bird, Oct 2004). The study estimated that the creation of a new 3km circular walk can give up to 16% of the local population within a 1 km radius (i.e. within a 7km2 catchment) their required 30 minutes of exercise so saving the NHS and the local economy the significant costs of treating inactivity (mainly heart disease and obesity). The values depend on local population density and for the case study farm areas are summarised in *Table 2.4*.

We propose using these figures where farms provided a 3km circular walk averaged over the total area of the farm.

Table 2.4 Estimated Benefits to the local economy and NHS in costs avoided from a 3km circular walk, based on population density within a 7Km2 catchment.

District Council	Pop density/km2	Savings to economy (£'000 pa)	Savings to local NHS (£'000 pa)
Fenland	154	40	8
Maldon	168	43	9
East Herts	273	70	15
Mid Suffolk	101	26	5

Source: RSPB, Bird 2004, Natural fit: can green space and biodiversity increase levels of physical activity?

Sense of Place, History and Spiritual Values

This service relates to the aesthetic, spiritual or religious inspiration that people can derive from both use and non-use benefits of landscapes and natural and cultural heritage. The character of the landscape, or specific features and buildings can give inspiration and a feeling of wellbeing to any visitor, or a sense of community or permanence to local residents. Appreciation of landscapes can enhance the views from people's homes (and thus property values); add to their enjoyment on journeys to and from other places, or directly through visits, thereby contributing to a higher quality of life.

Many arable farms have lost their characteristic hedgerows, ditches and trees and currently have very large field sizes to allow efficient crop management that can repay the investment required for modern arable farming techniques. However, the look and feel of farmland can be improved by restoring hedgerows, trees and ditches, breaking up larger fields and restoring historic buildings, and in the process providing habitats for farmland birds and mammals.

A number of studies have used hedonic studies to value people's revealed preferences for high quality landscapes through higher property prices. Although higher property prices is not a particularly desirable outcome, especially so in some rural areas where people on lower incomes find it impossible to find homes, it nevertheless can indicate the actual monetary value that people place on high quality landscapes. Furthermore, property price increases may benefit local economies in indirect ways, such as by encouraging further property development in an area and increasing local council tax receipts as a result. Numerous studies have used hedonic pricing to capture the aesthetic value of trees in suburban settings. This can be subjective and difficult to measure and different studies have identified a very broad range of values. For instance the value of trees in the landscape has variously be valued as adding 3-18% to adjacent properties (Woodland for Life, 2011), 15-25% depending on the total value of property, depending on size, condition, location and species rating or 7.1-7.3% for 20% woodland cover (Willis and Garrod, 2003).

We suggest that none of these valuations can be robustly transferred to value the sense of place contributed by arable farms. However, even small changes and improvements to farm landscapes can make a large difference and be highly valued by local communities, as shown in Section 4.

Summary of cultural services

Many studies have been undertaken of the value of cultural services, mainly using Contingent Valuation and Travel Cost methods. Valuation is based on the direct outputs (e.g. quantity of habitats and features maintained or created and number of visits). Studies suggest that households are willing to pay more than £4/visit - and therefore derive value from - the most attractive or wildlife rich sites and up to £35/visit to woodland. Arable farms are unlikely to provide this level of benefit. However, studies also suggest that local populations (within 5 miles) are willing to pay up to £0.40/mile for new access on arable land. Health benefits have also been calculated in terms of costs avoided by the NHS and sick days avoided by local businesses by people taking regular exercise on circular footpaths. These values range from £31,000 pa for a new 3km footpath in Mid Suffolk to £85,000 pa in the most densely populated parts such as Hertfordshire, averaged over the total area of the farm. However, discussions with local communities suggest that on-farm footpaths may be much less widely used than footpaths in

parks and parkland. Other cultural benefits such as education and sense of place remain difficult to value for arable farms without location specific studies.

Care needs to be taken when using these figures for cultural benefits to avoid double counting (e.g. of recreational and health benefits) within this category or with overall valuations of landscape and biodiversity benefits by habitat.

2.2.3 Regulating Services

Climate regulation

As recognised in the draft East of England Climate Change Action Plan (Climate East, 2009) the worldwide challenge of climate change will have a direct impact on the East of England region. Impacts include significantly higher temperatures, greater seasonality, with greater potential water deficits in summer months and more torrential rainfall days. Sea levels are estimated to rise between 22 and 82 cm over the next 70 years, increasing the risk of coastal erosion and flooding. An ecosystem services approach could play a key part in mitigating some of these impacts by identifying areas and services which could provide appropriate mitigation.

The management of farmland can help to deliver climate regulation by:

- Reducing emissions of Green House Gases (GHG) by reducing N2O emissions – a significant arable contribution – arising from use of inorganic fertilisers on crops;
- Changing to lower input farming methods to reduce direct and embodied carbon emissions
- Contributing to production of renewable energy (timber, biofuels, solar and wind energy see above);
- Waste recycling to land - a wide range of degradable biosolids are returned to land for which the alternative disposal routes are to landfill (this is being closed off) or incineration. There is also a nutrient cycling value to this practice;
- Sequestering carbon in trees and hedgerows (which naturally absorb carbon as part of photosynthesis, capturing a considerable amount of carbon from the air and acting as a carbon store); and
- Halting or reversing loss of carbon from soils (e.g. by oxidation of peat and the subsequent release of carbon dioxide) and preventing nitrous oxide and methane formation and release by converting cropland to grassland or limiting inversion of soils.

Peat deposits represent a key part of the carbon storage resource of the UK.In the East of England soil carbon levels range from areas of low (0-5%) carbon content (mainly overlying sand, gravel and clays) to areas with high (5-50%) carbon content which are found in the south, south east and north of the Fens. Soils with high carbon content reflect the deep peat soils characteristic of the Fens. These peat soils are extremely valuable for agriculture (Grades 1 and 2) but loss of peat and the carbon that it stores has been very significant as a consequence of peat wastage. A recent RSPB commissioned report by Cranfield University has found that 380,000 tonnes of soil carbon is being lost from peat soils each year in the East Anglian Fens, largely as a result of drainage and arable farming. This equates to 9% of the total carbon loss from soils across England and Wales despite the peat soils of the Fens making up only 0.12% of the land area. The annual loss of carbon is equivalent to the emissions from the 65,000 households, of Peterborough (Natural England, 2011a).

Recreation of wet fens, wet grassland and washland together with changes to arable management (such as minimal tillage, greater use of organic manures, biosolids and digestate plus soil conditioners such as biochar) can help to ameliorate these significant losses if pursued on sufficient scale. Careful land management when re-wetting will be required to curb methane production.

There is now an established evidence base on the damage costs of carbon emissions and the value of emission abatement/carbon sequestration: emission reductions and carbon sequestration can be valued on a £ per tonne of CO2 equivalent. Defra (2008a) has published full revised guidance on how to value greenhouse gas emissions in government appraisals based on the concept of a shadow price of £25/tonne CO2 equivalent to assess the value of greenhouse gas abatement in the UK. In the East of England, a recent study (Woodland for Life, 2011) estimated that woodland absorbs a total 1.1 million tonnes of carbon dioxide per year, excluding soil carbon sequestration, worth £60 million annually: this compares to a UK-wide study (Jacobs, 2008) which estimated the total value of climate regulation services provided by England's woodlands, wetlands and peatland at £1,007 million annually. There are no estimates specifically for arable farmland. Other studies have estimated net CO2 sequestration by trees at: $1.29 per tree in 2007 prices (Peper et al); and £557/ha at 2009 prices in the Mersey Forest (Regeneris Consulting, 2009) but there is insufficient information about the type and age of trees for these values to be easily transferable to trees on arable land.

In theory carbon sequestration/storage can also be measured for environmental features such as hedgerows and tree planting or for reduction in fertiliser application. The Country Land and Business Association has produced an online tool, Carbon Accounting for Land Managers or 'CALM' whereby a farmer can input data on various aspects of his or her business within a year, such as the tonnage and type of fertiliser used, fuel use, tonnes of crop produced, number of livestock and manure management practices, and land use change such as conversion to grassland or woodland. CALM will calculate a carbon balance for the farm in terms of tonnes of $C0_2$ equivalent, which represents the balance between annual emissions of carbon dioxide, methane and nitrous oxide from a land-based business and any carbon sequestration activities to store carbon in soil and vegetation. Emissions from farming practices are against carbon sequestration in soil and trees.

In the US the carbon storage of grassland compared to cropland has been calculated (Costanza et al, 1997) on the basis of carbon and N_2O stored or released in soils and methane released from waterlogged soils as land uses change from wheatfields to grassland. On this basis:

- Grassland stores 0.8-2kg of carbon per m2/pa. Using cost of $0.02 cost of CO_2 emissions over a 50 year period discounted at 5% this gives a total value of $200/ha or $5.93/ha/pa (1997 prices);
- 0.191 kgN ha/pa and cost of nitrogen as $2.94 kg N pa so overall cost of $0.56 ha, pa (1997 prices);
- 0.474 kg/ C ha, pa and cost of methane of $0.11kg CH4 giving a cost of $0.05 ha, pa (1997 prices) although this will not apply to all soils in the East of England.

We have converted these rates to pounds and to 2010 prices (using the Consumer Price Index) which suggest that conversion of wheat land to grassland could lead to total carbon, N_2O (and

methane) storage benefits of £5.20/ha at 2010 prices. This benefit then needs to be averaged over the whole area of the farm.

Flood control/water regulation

Flooding affects many low-lying areas in the East of England and some 190,000 properties (7.4% of all businesses and homes) are already identified as at risk from coastal or river flooding. Coastal flooding along the east coast has been associated with a tragic loss of life. In 1953 the North Sea tidal surge killed 307 people and inundated large parts of Lincolnshire, Cambridgeshire, Norfolk and Suffolk.

Sea level rise and climate change will increase both the likely frequency and intensity of flooding. The impact on the national economy due to urban flooding is estimated at £270 million a year in England and Wales (Parliamentary office of Science and Technology Postnote, 2007) based on 80,000 homes flooded at an average cost of £3,375/property.

Farming practices can help to alleviate flood risk by promoting rainfall infiltration into the soil and reducing the rate of runoff. The root systems of plants and associated fauna give rise to increased porosity allowing greater movement of water into the sub-surface than non-vegetated land. Studies at PontBren in Wales found that infiltration rates were up to 60 times higher within young native woodland shelterbelts compared to grazed pasture, and so water storage was increased (Land Use Consultants, 2009).

Farmers can also contribute to flood regulation by:

- maintaining coastal flood defenses and sea banks which often give flood protection to a very wide area that is in some places below sea level (although there is still the risk of over-topping causing flooding);
- providing space for flood waters (e.g. on water meadows or managed realignment to create coastal salt marshes and mud flats which absorb wave and tide energy); or
- by pumping to reduce the water table (as in the Fens).

Flood alleviation measures on farms can protect property and assets in the immediate area or downstream in the catchment. They can also have the following benefits:

- Reducing the costs to government agencies for engineered flood defences;
- Reassuring the public and reducing psychological distress;
- Increasing property values;
- Promoting natural groundwater recharge for freshwater provision; and
- Improving sense of place, nutrient cycling and reducing carbon lost from soils.

The opportunities to deliver flood regulation services on arable farms will be very localised depending on types of soils and location within a catchment. The value of services will also depend on the number and value of property (including agricultural land) protected and whether land needs to be taken out of production to provide the benefit. Quantification and monetisation of values will therefore be very site-specific.

For flood protection services that simply require good management practices or maintenance of flood defences then benefits can be valued based on damage costs avoided per property protected (e.g. at a cost of £3,375 based on national averages (op cit)) or on the basis of defensive expenditure avoided. For instance, a recent Defra-funded pilot project (Defra, 2008b) tested four different models of flood resilience and resistance in six high flood risk areas[1]. The project found that measures costing £4,500 per dwelling would provide adequate flood protection in most instances.

Where farms provide major flood alleviation schemes by making space for water (e.g. conversion to water meadows) or by managed realignment, then the benefits need to take into account lost agricultural land offset by the overall value of the newly created habitat. A number of studies for the Environment Agency on Flooding and Coastal Management (Eftec, 2007 and 2010) have estimated the total economic value of wetlands created for flood regulation ranging from £200-4500/ha with an average of £1,300 for inland marsh and intertidal mudflat and £1,500 for saltmarsh as summarised in *Table 2.4*. These figures include water quality improvement, non-consumptive recreation, biodiversity and aesthetic improvement, but not carbon storage. A study of washlands in the East of England (RPA, 2001) estimated their flood protection value at £300/ha.

Table 2.5 Range of Indicative Economic Values for different habitats, £/ha/yr, 2008 prices

Habitat and ecosystem service provision (NB does not include carbon storage)	**Indicative value £/ha/yr**	**Range £/ha/yr**
Inland marsh: water quality improvement, recreation (non-consumptive), biodiversity, aesthetic amenity	~1300	200-4300
Saltmarsh: Water quality improvement, recreation (non-consumptive), biodiversity, aesthetic amenity	~1400	200-4500
Intertidal mudflat: Water quality improvement, recreation (non-consumptive), biodiversity, aesthetic amenity	~1300	200-4300

Source: Environment Agency

We recommend using transfer values of £3,375 to £4,500 per property protected from floods by on-farm flood alleviation activities, averaged across the total size of the farm to come up with a range of values per hectare.

Erosion control

Excessive removal of fertile surface soil by water and wind erosion is an important form of soil degradation and can lead to loss of agricultural productivity. However, in the UK erosion is more a sediment generation problem. The most significant impact of soil loss is on water quality and river hydrology – there is a case history of increased flooding from increased sediment loads and the blocking of culverts. Flash flooding of property in dry valleys on the chalk is a further example. Erosion can also have costs to local communities in removing soil hazards from roads. The costs of clean-up and damage costs avoided in treating water will be very localised.

In the Fens the loss of peat will also have an impact on soil fertility in the longer term.

[1] Grants were taken up by around 75% of residential and 25% of commercial properties within the six areas with the average cost of works per property of approximately £2,900 within a range from £300 to £13,000.

Box 2.1 Soil Erosion in the Fens

Soil erosion and soil wash is identified as an issue in the Little Ouse Catchment particularly in areas of steep slopes and light sandy soils, under maize and root cropping. In the Lincolnshire Coastal Rivers Catchment, soil erosion may be associated with outdoor pig rearing and areas of intensive cereal and oil seed rape production. In addition, there is potential for the loss of peat soils through peat wastage and wind erosion of exposed soils. This is particularly problematic with spring-sown root cropping (e.g. sugar beet, carrots, parsnips) where land is exposed throughout the winter and harvesting in wet conditions can be unavoidable.

Source: Natural England, 2011a

Farms can help prevent erosion by planting hedgerows and shelter belts, sowing cover crops (such as clover, grass, vetches and mustards sprayed off and incorporated in) and by growing crops under cover in very vulnerable areas. Cover crops also contribute to other ecosystem services by building nutrient and organic matter and boosting beneficial insects. Hedgerow planting will also contribute to other ecosystem services such as biodiversity, carbon storage and sense of place. Higher Level Stewardship payments are available for arable reversion to grassland with either low (£210/ha) or no fertiliser (£250/ha) input to prevent erosion or run off. These rates are intended to partly compensate for the loss of arable crop revenues and the costs of conversion.

In theory it is possible to measure the effect of erosion on yields (for instance a US study assumes that 10cm loss in soils a year will lead to a 50% loss in yields) which can then be valued using market prices for crops. For instance, Murdock and Frye (1983) estimated that the value of plant available nutrients lost from a highly fertile soil in Kentucky (USA) could range from $3 to $14 per acre (at 1981 fertiliser prices and a soil loss of 14 tons per acre). This approach would be applicable to the peat soils of the Fens erosion and crop yields, but without detailed field measurement it has not been possible to estimate values for the pilot farm area.

The benefits of erosion control can also be measured in terms of defensive or remediation expenditures avoided. The Environment Agency has estimated the national costs/benefits of erosion control but it is difficult to apply these costs to the case study areas.

We propose that this range of benefits could be used for arable farms on peat soils where major soil related initiatives are being undertaken using figures of £8-40/ha at 2010 prices. However, care needs to be taken to avoid double counting benefits from supporting services soil formation and nutrient cycling benefits (see *Section 2.2.4* below).

Other regulating services

Under this heading we have grouped a number of further regulating functions such as filtering of air and water, disease and pest control, controlling weeds and encouraging pollination. Farms can contribute to the regulation of these functions for others by managing land to control pests and weeds and by providing habitats for insects, bees and predators.

Air and Water Filtering

There has been some research on the air and water regulation benefits of the 145,000 ha of forestry and woodland in the East of England (Woodland for Life, 2011) which suggests values of over £200/ha based on hospital costs avoided from air pollution due to the affect of trees,

reducing heat island effects and the benefits from slowing downstream peak water flows, cutting soil erosion and reducing water temperatures through shading. However, this figure would involve some double counting with other ES categories such as freshwater provision, health and flood regulation and has limited application to arable land in the East of England.

It should also be noted that arable farms can also provide dis-benefits for other ecosystems under this category. For instance, non-point discharge of nutrients from agricultural land causes problems affecting wetlands, woodlands, reedbeds and coastal waters and their ability to provide ecosystem services. The scale of these impacts is summarised elsewhere (Pretty et al, 2000).

Pest and disease control

How farms control animal pests, weeds and disease can lead to enhanced yields and/or lower control costs both on farm and for adjoining land. Currently intensive arable farms mainly use pesticides, herbicides and fungicides but there is also encouragement under the Entry Level Stewardship scheme to use beetle banks and create spaces between arable crops – ditch banks, hedgerows and field margins are also provide important over-wintering habitats for beneficial predatory invertebrates (e.g. ground and rove beetles) that feed on pests. Careful management of agro-chemicals (e.g. through Integrated Pest Management approaches) may in some cases remove the requirement for chemical intervention. Evidence of efficacy is patchy, although anecdotal evidence (Natural England, March 2011) suggests that beetle banks can provide effective aphid control for up to 20m into a farm and could be more widely used across fields. While this would involve some loss of production, farmers might also benefit from reduced costs of pesticides (so increasing gross margins for food production) and there would also be important benefits in enhancing biodiversity and encouraging wild life. In theory it would be relatively easy to quantify and monetise the net impacts on food provisioning services but it would be difficult to measure the wider benefits for biodiversity without double counting.

Pollination

The main benefits of pollinating services are to enhance crop yields and to reduce the risk of crop failure. Around a third of the food we eat is dependent on insect pollination, with a significant dependency on bees to perform that function. Increasing wildflower populations increases insect pollination and crop yields both on farms and on nearby orchards. However, on arable land the main contribution to pollinating services is from the spaces between crops – such as the habitats created on the banks of ditches and dykes and the edges of farm tracks – that are the key sources of both pollen and nectar. These habitats are particularly important as they support the insects that pollinate commercial arable crops such as oilseed rape and bean crops. They are less important for wheat which is pollinated by wind.

Nevertheless, farmers can encourage pollinating insects by increasing the range of wild flowering plants, nectar mixes and flowering cover crops. Estimates are available of the value of insect pollination services (mainly bee keeping) based on the marginal value of changes in production of fruit crops but this is of limited relevance to arable farming in the East of England and we have therefore not included any values per hectare for pollination services.

Summary of Regulating Services

Valuation of regulating services requires more detailed scientific knowledge and site specific data on the relationship between different on farm measures, local characteristics and their impact on the regulating services. If this data is available then valuation of the benefits is relatively straightforward using market based methods (changes in yields, shadow price of carbon), or defensive expenditures avoided. Climate regulation is perhaps the easiest regulating service to value based on the growing body of knowledge of carbon sequestration, storage and emissions avoided for different land types. The CALM model allows farms to calculate these benefits and offset them against their emissions of other green house gases. Values for other regulating services such as flood alleviation, erosion control, air and water regulation, pollination and pest control depend on local conditions and a better understanding of the relationship between land management and services provided, although we have provided generic estimates for the costs of property protected and the replacement costs of nutrients lost through soil erosion.

2.2.4 Supporting services

Supporting services are natural processes that are essential to the working of all ecosystems. Consistent spatially defined data on supporting services relating to National Character Areas is not available.

Soil formation

Soil is a fundamental natural resource on which life depends. Soil formation is the slow chemical and biological processes that create soil or restore soil fertility. The formation of soils is necessary in order to secure other benefits such as food production, water storage and biodiversity, and the storage of carbon in soils is vital in fighting climate change. The UK currently loses millions of tonnes of soil per annum. Actual rates on different farms will vary by orders of magnitude. It is almost impossible to quantify the value of soil formation since it changes slowly – taking decades or centuries per centimetre to create - and our understanding is incomplete. Within the context of this study we have therefore treated soil as a finite and non-renewable resource within the government policy and farm economic planning time frames. However, as noted above farming practices can halt the rate of soil loss through their choice of crops, adding compost and ploughing in crops residues and cover crops. They can also increase soil fertility – which depends on the soils natural lime status and the 'reaction' of the whole soil. Soils that are naturally alkaline have high natural fertility and are naturally productive and would also be able to support base-rich pastures and woodland habitats in the absence of farming. Artificial liming of farmland reduces natural soil acidity.

Nutrient cycling

Nutrient capture and recycling prevents the build-up of polluting nutrients and maintains levels of fertility. This supporting service provides assimilation, accumulation and cycling of nutrients which support many other ecosystem services and particularly food and biofuel production and biodiversity. Harvesting crops means that some elements that plants use to grow are taken out of the soil for good, rather than returning to the soil when plants die and decay. These nutrients include lost nitrogen, phosphorous and potassium, without which productivity falls.

Farmers can replace nutrients with chemical NPK fertilisers or through other means. The Farm Business Survey for the East of England (2009/10) suggests that the average cereal farm spends £90-100/ha on fertilisers to replace nutrients, equivalent to nearly 12% of the total crop, by-product and forage gross income per hectare. Leaching of nitrates can also have dis-benefits through their impacts on aquatic ecosystems and water quality. Most arable land in the East of England is within Nitrate Vulnerable Zones.

Farmers can also improve nutrient cycling benefits by replacing lost nutrients with organic compost (from manure, household waste or sewage sludge), green fertilizers and plant residues and by integrating nitrogen-fixing crops in rotation systems. At the level of an individual farm it would be possible to measure and monetise the impacts that these different choices have on cropping yields and gross margins which would have to be offset by any changes in dis-benefits from fertilizer related pollution. It has not been possible to calculate this for pilot farms on the basis of the data they have provided.

2.2.5 Biodiversity and Wildlife

Evidence suggests that biodiversity makes a significant contribution to the rate and resilience of other supporting processes. Wildlife and biodiversity supports provisioning (for game and medicinal crops see *Section 2.2.1*), cultural services – with many aspects of recreation, education, health and sense of place closely tied to the presence and enjoyment of characteristic wildlife - and to regulating functions (e.g. in contributing to pest control and pollination). Biodiversity has therefore been treated as a separate group of ecosystem services to avoid double counting.

Arable land can provide habitats for a wide range of common and rarer plants, insects, mammals and birds. The soilscape map (National Soil Resources Institute) provides a general indication of the plant communities and habitats associated with different types of soils. It provides a good indication of what could grow were agricultural management inputs to be removed or modified. Since the 1940s biodiversity on arable land has been in decline from intensive arable farming due to the removal of hedgerows, trees and ponds, drainage, larger field sizes, decreasing diversity of cropping patterns and intensive use of chemical inputs. The Farmland Bird Index - seen as a good indicator of overall farm biodiversity - declined by 43% between 1970 and 1998 and by a further 4% between 1998 and 2008. Nature conservation efforts have focused on increasing the populations of the so-called 'Arable Six' bird species that conservationists believe have suffered the most serious decline[1] which are: grey partridge, lapwing, turtle dove, yellow wagtail, tree sparrow and corn bunting.

Arable farmers can also deliver biodiversity services by managing existing habitats and creating new ones. Entry Level Stewardship provides grants for enhancing wildlife and biodiversity and Higher Level Stewardship provides payments for biodiversity enhancing activities including management of field corners, wild bird seed mixtures, nectar flower mixtures, overwintered stubble, beetle banks, skylark plots, unfertilised cereal headlands, unharvested cereal headlands, uncropped cultivated margins for rare plants, uncropped cultivated areas for ground-nesting birds on arable land, reduced herbicide cereal crops followed by overwintered stubble and extended overwintered stubble. A combination of these features across a farm attracts a £30/ha payment, which could be seen as the minimum value that society is Willing to Pay for enhanced biodiversity

[1] http://www.birding247.co.uk/articles/rspb-to-share-latest-research-with-commercial-farmers-in-order-to-protect-the-arable-six/339.html

services. In addition under Higher Level Stewardship arable farms can provide unharvested, fertiliser free conservation headlands or cultivated fallow plots or margins for arable plants, enhanced wild bird seed mix plots and floristically enhanced grass buffer strips (non-rotational) for which they are paid from £440 to £485/ha. These payments are intended to pay for the capital costs involved and compensate for loss of arable production.

However, identifying the intrinsic value of biodiversity services remains difficult. A number of studies have attempted to identify willingness to pay for the existence of species or habitats, even where they do not deliver direct benefits to people. A 2004 study (Christie and Hanley, 2004) looked at 4 attributes of farmlands in the UK (Cambridgeshire and Northumberland) and assessed the Willingness to Pay (WTP) of local people in the form of more taxes for measures which would halt the loss or improve the status of familiar and unfamiliar (i.e. locally rare) species and habitats. The highest WTP was found to be of £115 more in taxes each year by Cambridgeshire residents to halt and ensure recovery of familiar species. A Contingent Valuation study by White et al (2001) measured WTP for mammal populations and found that households were prepared to pay a single sum for conservation (of a proposed 25-50% increase in population) for Red squirrel (£2.50), Otter (£11.88) and Water vole (£7.50) but were not prepared to pay for brown hare. The EVRI database includes many other studies which have used Contingent Valuation to estimate Willingness to Pay for increased diversity of familiar species on farm land elsewhere (such as New Zealand) which have come up with similar figures. However, the extent to which these values can be legitimately transferred to arable farms in the East of England is questionable since when individual WTP figures were presented to participants in workshops (see section 4) they were generally considered to be far too high. Nonetheless very small improvements in farmland biodiversity are regarded as significant and can be highly regarded in qualitative terms by local residents (see Section 4).

A variety of studies have attempted to place a total economic value on specific landscapes or habitats with relevance to East of England arable farming as summarised in *Table 2.6*. For example, a study by Bateman et al. (1993) placed a value on wetland areas in the North Broads, Hanley et al (2001) estimated WTP for field margins in Cambridgeshire, while Klein et al. (1998) examined the recreational value of Cley Marshes Nature reserve in North Norfolk. The estimated values of wetland habitats were shown in *Table 2.4* above.

For example, Swanwick et al (2007) conducted a scoping study on agricultural landscape valuation, while various studies cover the economic valuation of biodiversity. For instance, Christie et al (2004) estimated a total WTP of £6.2m for re-creation of wetland from farmland in Northumberland. Other studies have valued the overall benefits of agri-environment schemes in the UK. For example, Garrod and Willis (1995) estimated WTP for the English ESA scheme at £67 per household per year for residents, £94 per household per year for visitors, and £37-£138 per household per year for the general public. Willis and Garrod (1993) estimated total WTP to conserve the existing landscape of the Yorkshire Dales at £42 million per year (£236/ha/year).

Table 2.6 Studies Valuing Landscapes of relevance to East of England arable farming

Authors	Title	Study area	Valuation Method	WTP results
Bateman, Willis and Garrod (1993)	Consistency between Contingent valuation estimates of two UK National Parks	Norfolk Broads and Yorkshire Dales	CVM	Annual household mean WTP for Norfolk Broads ranged from £76-84
Hanley N and Spash C (1993)	Lowland Heaths	Avon Forest Park, Dorset	CVM and WTP	CVM study estimates the annual user benefit at £30.74. WTP into a trust fund estimated at £25.57 per respondent
Hanley N, Oglethorpe D, Wilson M and McVitie A (2001)	Estimating the value of environmental features, Stage 2	Cambridgeshire, E Yorks, Devon and Hereford	CVM	WTP per household per annum for: • increase in field margins in Cambridgeshire £11.53-16.70 (cf £12.90-18.40 for East Yorkshire • protection of hedgerows from losses Devon £14.70-26.40 and Hereford £10.70-26.10
Klein RJT and Bateman IJ (1998)	Recreational value of Cley Marshes Nature Reserve	North Norfolk	CVM and TCM	Annual recreational value: £1.60-4.80/visitor
Willis KG, Benson JF and Whitby MC (1988)	Values of user benefits of forest recreation and wildlife	England and Scotland	CVM	WTP of £0.65 per person

We propose that a valuation figure of £30/ha is used for biodiversity services provided by farmland entered into ELS and values for specific non arable habitats – such as wetlands, grassland or woodland – transferred from other studies where new habitats are created. Again it is important to avoid double counting the wider cultural and regulating ecosystem services provided by these habitats.

Summary of Supporting Services

Soil formation and nutrient cycling benefits for farmers can in theory be valued using market based methods to value the impacts of soil and nutrient loss or formation on food, fibre or fuel yields. The costs of replacing nutrients using artificial fertilizers can also be estimated relatively easily. However, we have not included generic values for these supporting services as there would be a risk of double counting erosion control benefits to farmers.

There have been many attempts to identify the total economic value of biodiversity or specific habitats, mainly using contingent valuation techniques. While some of these studies could be relevant to arable farm settings much more detail would be required on the relevant population to apply WTP estimates to in order to come up with generic rates per hectare for on farm habitats or species. There is also a risk of double counting cultural and regulating service benefits. We therefore propose that a valuation figure of £30/ha is used for biodiversity services provided by farmland entered into ELS and values for specific non arable habitats – such as wetlands, grassland or woodland – transferred from other studies only where new habitats have been created.

2.2.6 Summary and conclusions

Many studies have attempted to assess the value of different aspects of ecosystem services individually or in aggregate using a range of established techniques. These include:

- Market based approaches which are generally well understood allowing easy valuation. Market prices can be used to value changes in provisioning services (food, fibre, fuel) as well as some regulating services which affect the production of food and other goods (e.g. erosion control, pollination) and cultural services such as recreation.
- Shadow prices (based on assessments of damage costs) can be used to assess the value of climate regulation services while hedonic pricing has been used to assess the impacts of landscapes on property values.
- Defensive costs, remedial costs or costs avoided can be used to value services such as health, freshwater provision, and flooding and erosion control benefits of farmland.
- There is also a growing body of relevant studies using stated preference methods such as contingent valuation and choice experiments to value landscapes, habitats and particular species.

However, a number of challenges mean that it has not been possible to provide a complete suite of monetary values for all farmland ecosystem services. These include:

- Gaps in knowledge for how on farm measures affect ecosystem services of some types such as soil supporting functions and erosion control
- The localized nature of some ecosystem services (such as flood protection and freshwater provision) which make it difficult to use generic values;
- The significant methodological challenges and uncertainties about the validity of benefits transfer for non-market valuation techniques; and
- The risks of double counting of benefits, particularly of supporting functions such as soil formation, nutrient cycling and biodiversity and wildlife with other categories of ecosystem service.

Table 2.7 summarises the toolkit of monetary values which can be used. Areas where local knowledge is particularly needed to assess the relative importance of ecosystem services include: cultural services and particularly sense of place, flood alleviation, erosion control and 'other' regulating services, and soil formation, nutrient cycling and biodiversity and wildlife supporting services.

Table 2.7 Summary of Ecosystem Service benefits and valuation methods

Ecosystem Service	Quantification	Valuation method	Approximate value £/ha/pa
Provision of Food, Fibre, Energy, Game etc	Output of marketed products Opportunity cost of land taken out of production to deliver other ecosystem services (e.g. water storage or managed realignment)	Market based methods based on average yields, market prices and variable costs taken from Farm Business Survey. Capitalised land values net of single payment	Estimated of £900-1000 gross margin/ha. EA FMERC handbook
Freshwater	Effect of on farm measures on water quality and need for treatment	Water treatment expenditures avoided	£20/ha based on uplands studies
Recreation & tourism	Value for each visit or access opportunities.	Value per visit based on travel cost or CVM; enhanced income/rents for landowners	£4/visit for non local visitors averaged over whole farm area £0.40 per resident of local parish for a mile of access for local visitors (but avoid duplication of health benefits below)
Education and knowledge	Value for each visit	Value per visit based on travel cost or CVM or as a minimum HLS payment rates for school visits	£8.50/ha based on Forest and woodland schools Or £500 base rate pa plus £100 school visit averaged over the whole farm area.
Health	Health costs avoided to economy/NHS by encouraging higher activity rates	Costs of treatment of cardio vascular disease per person times pop density in 7km2 catchment (based on RSPB study)	For each 3km footpath range from £26kpa in North Norfolk to £765k for Ipswich averaged over the whole farm area.
Sense of place	# /area locally distinctive features/ habitats/ features conserved/	Value per visit; WTP based on CVM benefits transfer from various studies	Challenges of benefit transfer and double counting suggest local assessment of importance more reliable.
Climate regulation	GHG and N2O emissions reduced through less intensive use of fertilisers, inputs, and mechanisation. Carbon stored in hedges, soils & vegetation. GHG emissions avoided by recycling of waste to land. N_2O/methane release avoided	Carbon equivalent savings through different activities times the shadow price of carbon. Annual savings ranging from $0.05/ha/pa for methane to $5.93/ha/pa for CO2 (1997, US study)	CALM Calculator Use £5.20/ha of grassland converted from arable averaged over the whole farm area.
Flood control/ water regulation	Effect on flood risk and intensity. Impacts very localised depending in number and value of properties and return periods for flood events	Flood damage remedial costs of £3,350/property or flood resilience measures avoided of £2000-4,500 /dwelling.	Use a range of remedial costs avoided/flood damage costs avoided of £3000-45000 property, divided by flood return event averaged over the whole farm area.
Erosion control	Remedial measures required where local data available. For Fens peat soils effects on crop yield or cost of replacing nutrients lost in soil.	Cost of remediation to communities, EA or water companies. Market based methods to estimate losses in yields at market prices (FBS) for peat soils	£8-40/ha based on US studies only applicable to Fens

Other – Disease, pest, pollination	Effect on crop yields and market value of crops	Quantification and monetising remains elusive	Local assessment of importance may be more reliable.
Soil formation and nutrient cycling	Effect on crop yields and market value of crops	Quantification and monetising remains elusive	Local assessment of importance may be more reliable.
Biodiversity and Wildlife	Revealed preferences of households nearby or within wider areas for improvement in species or existence of a habitat.	Value for habitat or species based on transfer of CVM or choice experiment studies Or ELS or HLS payment rates for biodiversity enhancing activities	£30/ha rate for ELS or transfer of CVM rates for other habitats such as wetlands at £1,500 ha where non arable habitats have been created. Benefit transfer needs to be calibrated by Local assessment of importance.

3 CASE STUDY FARMS

3.1 OVERVIEW

The four case study farms were selected to be broadly representative of the average size, tenure and cropping mix for the East of England across a range of different National Character Areas, with a range and opportunities for delivering a mix of different ecosystem services. According to the Farm Business Survey (2008) for the East of England the typical cereal farm is about 260ha, mostly owned (74%) but with some tenanted land (26%) and with the major sources of annual revenue coming from winter wheat, oilseed rape and sugar beet. In practice our case study farms are mainly larger than this average – but in fact very typical of their surrounding areas. The following paragraphs

3.2 DESCRIPTIONS BY FARM

3.2.1 Monks Green, Brickendon, Hertfordshire

Context

Monks Green sits within the NCA 111 sub-character area: Hertfordshire Plateaux and River Valleys. The Hertfordshire Plateau is a varied landscape characterised by a mix of settlements, woodland and mixed agriculture. It has a predominantly rural feel with few large developments. Landform is varied with a high broad arable plateau divided by more wooded and pastured valleys. Field patterns vary from the small organic shapes found in the north to regular rectangular fields found towards the Bishops Stortford area, the result of 18th century enclosures. Many of the enclosure fields have, however, had hedgerows removed and the landscape thus appears open and featureless in the east. The woodland cover comprises a number of small ancient beech and oak woods found mainly in the valleys to the west. Most fields are defined by hedges although fences are becoming more common, in particular in areas associated with horse grazing. Since the war the landscape has changed due to loss of trees through Dutch Elm disease and loss of hedgerows due to field enlargement. In some areas, inappropriate management of set-aside land has led to an unkempt and muddled appearance to the landscape and in others there are pressures from urban-related developments including electricity pylons and general industrial development. Associated problems such as fly-tipping and vandalism can also have a marked affect on landscape character.

Agriculture has become a less dominant land use, while recreation, both formal and informal, has become a significant land use. Green belt designation has created development pressure on adjacent landscapes. Typical soils in the local area are[1]:

- Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils. On these soils, drainage is impeded and fertility is moderate. Typical habitats are seasonally wet pastures and woodlands, and typical land cover is grassland, arable and some woodland.
- Lime-rich loamy and clayey soils with impeded drainage. On these soils, drainage is slightly impeded and fertility is high. Typical habitats are base-rich pastures and classic 'chalky boulder clay' ancient woodlands, with some wetter areas and lime-rich flush vegetation. Typical land cover is arable with some grassland.

[1] http://www.landis.org.uk/soilscapes/

Environment Agency information[1] shows that flood risk is low. Some of the local area is within a designated source protection zone, i.e. water will take between 50 and 400 days to reach the borehole. There is no information available about local air and surface water quality.

Monk's Green Farm

Monks Green is a small 80ha farm. It was formerly an arable farm, but now no longer produces crops. The farm income derives from three main sources, split roughly equally. Firstly, the farmer produces poultry under contract, raising 30,000 chickens per annum from 1 day old to 18 weeks, whereupon they are sold on for fertilised egg production and then for meat. Second, two fields are rented out for intensive hay and silage production to supply the Newmarket area, with the remaining fields attracting payments under the Countryside Stewardship and Single Payment schemes. A total of 73 ha are currently in Countryside Stewardship with habitat enhancement activities including planting of trees and hedgerows and ditch management, bird scrapes, pond restoration and owl boxes. Third, some farm buildings have been converted for rental for diversification activities for residential, workshop and storage uses.

In the next five years, future developments on the farm are likely to include:

- Further diversification into non arable activities such as on farm bed and breakfast;
- Application for Entry Level Stewardship implying provision on biodiversity and wildlife services worth at least £30/ha; if grants were not available for these activities then there may be pressure to improve grassland and rent out fields as pony paddocks.
- Possible investment in on farm renewables such as wind turbines. This would increase energy values but not at the expense of food or biodiversity services.

[1] http://www.environment-agency.gov.uk/homeandleisure/37793.aspx

Figure 3.1 Aerial view of Monks Green Farm, Brickendon, Hertfordshire

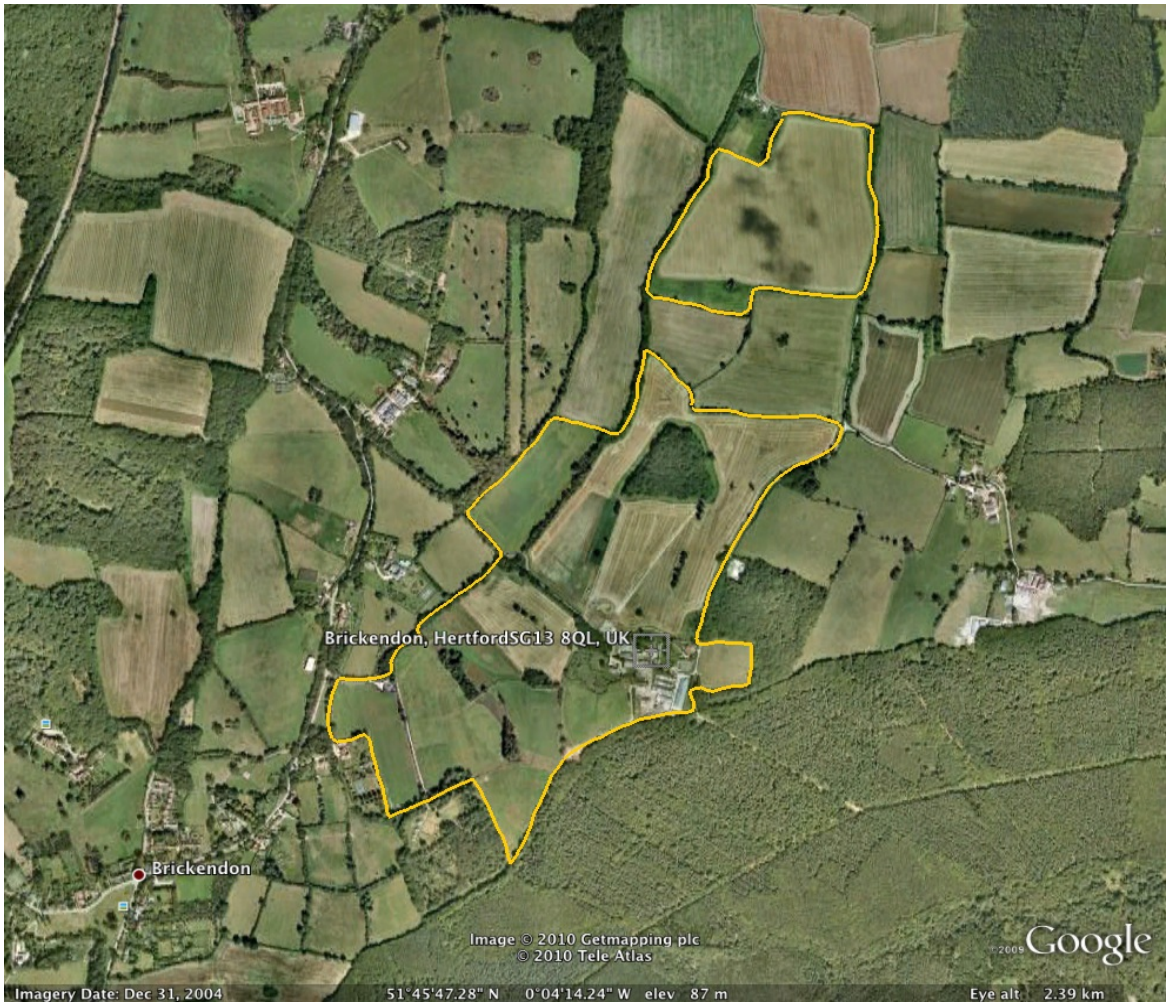
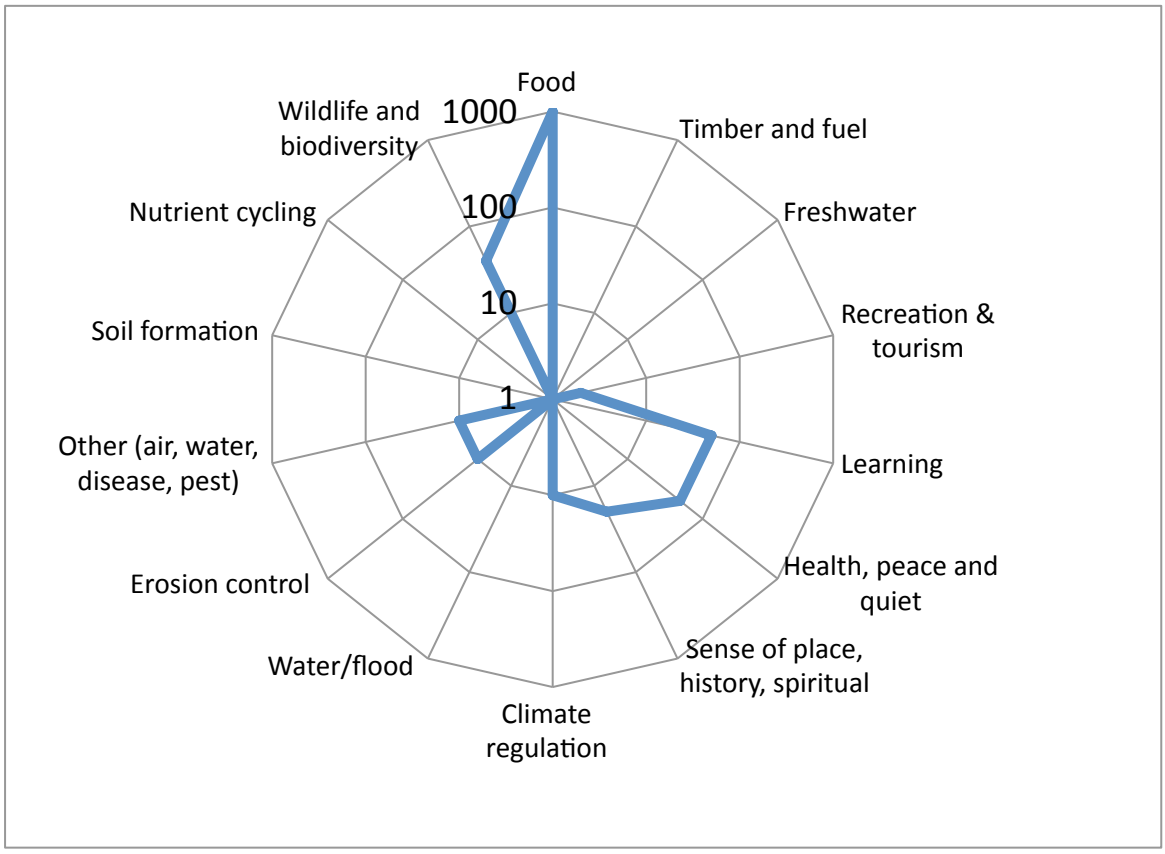


Table 3.1 Summary of current Ecosystem Services provided by Monks Green Farm

Kind of benefit provided		What is Monks Green Farm providing at the moment?
Provisioning	**Food**	30,000 18 week old chickens per annum. Hay and silage for horses and Grazing for sheep on moderate to highly fertile loamy and clayey soils. Approx 500 game birds per annum. Assume total gross margins about £900/ha
	Freshwater	EA data shows that the farm is within the catchment of major public groundwater boreholes to the east, with water taking between 50 and 400 days to reach the abstraction source.
	Timber and fuel	None currently, but may consider energy generation in future, e.g. wind power.
Cultural	**Recreation & tourism**	Paths around farm used regularly by walkers, cyclists and horse-riders, although numbers are small.
	Learning	Farm hosts 8 school parties each year, with approx 30 children per visit.
	Health, peace and quiet	Use of footpaths by walkers, cyclists and horse-riders provides health benefits and enjoyment. Game shooting restricts people's ability to walk in woodlands.

	Sense of place	Strong links with Celtic Harmony. Monks Green Farmhouse is a listed building. Landscape management to continue local traditions. Monks Green on route from Colchester to St Albans? Once belonged to Hertford Priory.
Regulating	**Climate regulation**	Storage of carbon in grassland soils, vegetation and trees.
	Water/flood	Quite an important service for the Lea Valley but difficult to value
	Erosion control	Soils are slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soil and rich loamy and clayey soils. 73 ha of permanent grassland prevent soil erosion.
	Other	Some land under permanent cultivation – benefits water quality – although intensive grassland is fertilised. No real contribution to air quality, pest and disease control or pollination.
Supporting	**Soil formation**	Land converted to arable to permanent pasture aids soil formation but not possible to value this impact.
	Nutrient cycling	Nutrients added as chemical fertiliser on intensive grassland.
Wildlife and biodiversity		73 ha of positively managed land, including extensive meadows, scrapes, 1.5 km of new/managed hedgerows, tree planting, 0.5 km of ditch management, nest boxes, 1000 m^2 of restored ponds.

Figure 3.2 Estimated values of ESs provided by Monks Green Farm



3.2.2 East Hall, Bradwell-on-Sea, Dengie Peninsula, Essex

Context

East Hall farm is within NCA 81: The Greater Thames Estuary. Extensive open spaces tend to be dominated by the sky within a predominantly flat, low-lying landscape. The proximity to coastline and estuary extend the maritime influence far inland. The area has a strong feeling of remoteness and wilderness on the reclaimed farmed marshland and also on the mudflats populated by a large and varied bird population. Traditionally unimproved wet pasture was grazed with sheep and cattle. Extensive drained and ploughed productive arable land is protected from floods by sea walls. Hedgerows are absent from the large, rectilinear fields. Generally, tree cover is limited to farmsteads and dwellings on the higher, drier pockets of ground. In the past the landscape would have been more wooded but many trees were lost to Dutch elm disease in the 1970s. Many of the hedgerows and ditches have been realigned and the landscape has lost its diversity. In other similar areas, such as Foulness farmers and Natural England are working together to reinstate more irregular landscape features.

There is pressure on land around the estuaries, from urban, industrial and recreational developments that tend to be highly visible in the landscape. Bradwell nuclear power station is currently being decommissioned but is very prominent in the landscape and has been a major source of local employment. The site is one of eight proposed for the next generation of nuclear power stations. The coast also has a distinctive military heritage including Napoleonic military defenses and 20th century defenses some of which are found on farm land.

Typical soils in the local area are[1]:

- Loamy and clayey soils of coastal flats with naturally high groundwater. These soils are naturally wet, with lime-rich to moderate fertility. Typical habitats are wet brackish coastal flood meadows, and typical land cover is arable with some grassland.
- Loamy soils with naturally high groundwater. These soils are also naturally wet, with low fertility. Typical habitats are wet acid meadows and woodland, and typical land cover is arable grassland and woodland.

Environment Agency data[2] shows that the local area is at moderate to significant risk of flooding. There are no significant groundwater abstraction points in the locality. No data is available on local air or surface water quality.

East Hall and Eastlands Farms

East Hall Farm is a highly productive wheat farm at Bradwell-on-Sea at the tip of the Dengie Peninsula, which is jointly managed with the adjoining Eastlands Farm (under contract). East Hall was the first farm in the country to get yields of 10t/ha for wheat and is mostly grade 1 and grade 2 agricultural lands. It now produces premium milling wheat, dry peas for the Japanese market, Lucerne for a local horse feed producer and winter oilseed rape (OSR). The wild, open landscape

[1] http://www.landis.org.uk/soilscapes/

[2] http://www.environment-agency.gov.uk/homeandleisure/37793.aspx

with ditches and large field patterns is typical of the Dengie peninsula. Gross margins are at the top end of the scale for East of England cereal farms.

East Hall Farm is 438 ha and together with Eastlands Farm makes a 700 ha unit. East Hall is all in the Higher Level Stewardship (HLS) scheme centred on 35ha of Site of Special Scientific Interest (SSSI) permanent grazing marsh that is managed as a habitat for Brent geese. This was designated 20 years ago and is the last grazing marsh on the Dengie peninsula. It is managed without cropping, tillage, fertilisers or pesticides. None of Eastlands Farm is in either the Entry or Higher level stewardship schemes although the rest of the owner's landholding further inland is in HLS.

Sixty percent of the land (420 ha of the total 700 ha) is below sea level. The farm and some land and property beyond it are protected from coastal erosion and coastal flooding by 8km of sea wall which, together with the dyke behind it, provide important conservation habitat. The wetland beyond the seawall has very high nature conservation interest and is an important site for birds.

The Chapel of St Peter-on-the-Wall sits on the coast and is surrounded by East Hall and Eastlands Farms. St Peter's is probably the oldest surviving church in England. It is also the sole monument to Celtic Christianity in Essex (the former kingdom of the East Saxons). The chapel was built by Bishop Cedd around 654 AD, almost entirely of Roman building materials taken from the fort of Othona, one of the nine Roman forts built along the south east coast to repel Saxon invaders. The fort has long since been eroded by the sea and buried inland. The unique history of St Peter's chapel is a draw to thousands of visitors and a place of pilgrimage on the first Saturday of July every year. East Hall also has important military heritage infrastructure.

In the next five years, future developments on the farm are likely to include:

- A similar crop rotation, assuming prices for wheat do not fall dramatically;
- Fencing of the 35 ha of permanent grazing marsh to allow permanent grazing and an increase in lamb and wool production; and
- More investment in renewables such as anaerobic digestion using corn stubble. This would increase energy values but would divert residues which are currently being ploughed back into soils for conditioning which will have to be managed in other ways.

Figure 3.3 Aerial view of East Hall and Eastlands Farms, Dengie Peninsula, Essex

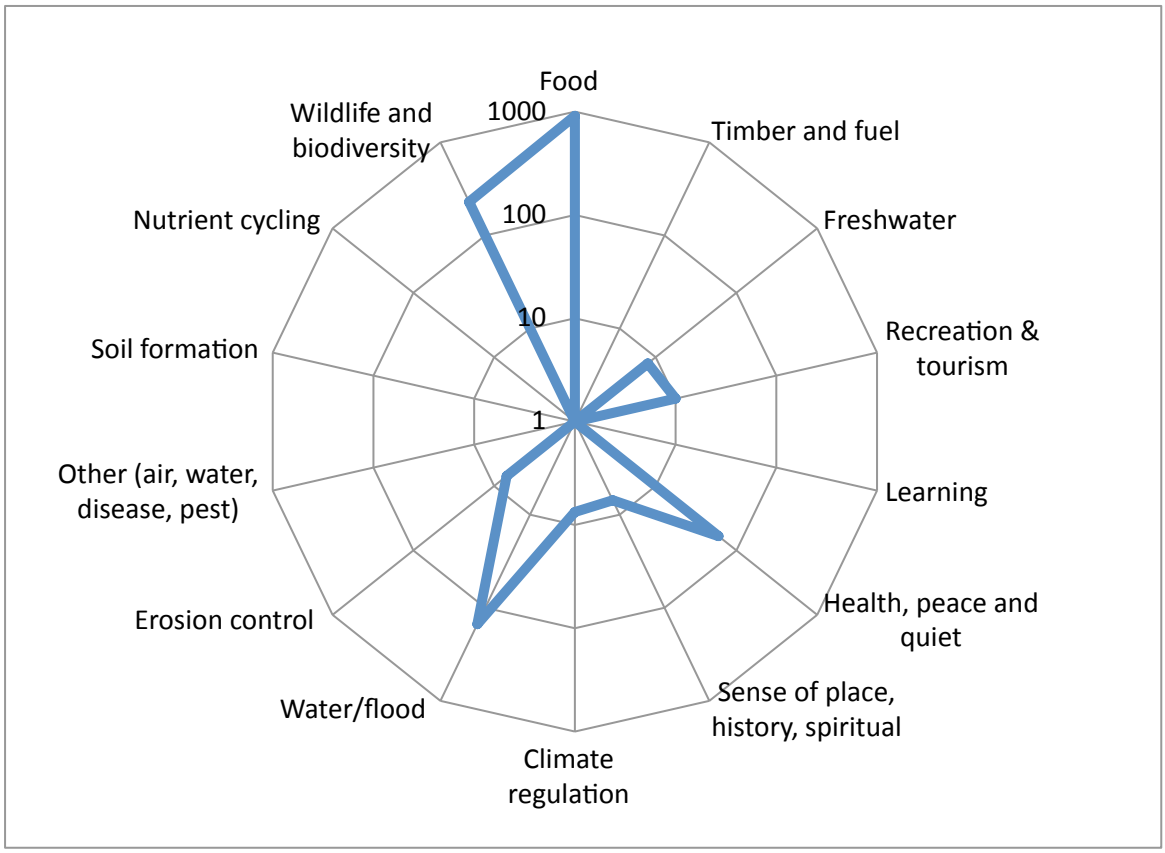
Table 3.2 Summary of current Ecosystem Services provided by East Hall Farm

Kind of benefit provided		What is East Hall providing at the moment?
Provisioning	**Food**	Average gross margin per ha for food provisioning (not including 5 FTE labour and fuel costs) is £910/ha in 2009 and projected to be £986/ha in 2010. Bread wheat equivalent to 13,000 loaves of bread/ha
	Freshwater	License to abstract water from ditches and pump into reservoir to July which is then used for irrigation or stock watering during summer if required. There are no catchment management activities that might improve water quality in the wider area and reduce water treatment costs. However, ponds and dykes behind the sea walls provide irrigation water for crops during summer to an estimated value of £10/ha. Ponds also provide valuable wildlife habitats.
	Timber and fuel	Straw is a secondary product from winter wheat production with an estimated value of £2/ha. Previously it would have been burnt with air quality and climate regulation implications but is now being ploughed back in for soil conditioning. In the future it may be pelletised for anaerobic digestion. In the future biofuels from sugar beet or OSR could be produced but this would be at the expense of food production.
Cultural	**Recreation & tourism**	PROWs exist along the roman road to St Peter's Chapel and along the sea wall. A circular walk of 6km has improved access and interpretation boards. Thousands visitors make individual visits or pilgrimages to St Peter's On the Wall (the earliest consecrated church in the country) during July each year. The chapel is on the site of the Othona roman fort, and is owned by English Heritage, but a car park is provided

		on Eastlands and access is across East Farm. During July each year thousands of visitors picnic on the grass and music, dance, stalls and refreshments are provided. Visitors are encouraged to buy refreshments in the 3 local pubs. Based on RSPB estimates of £4/day spending by tourists in the local area and assuming at least 4,400 day visitors pa to St Peters (200/month and 2000 in July and hundreds more to the bird observatory we estimate that the farm contributes about £25/ha in tourism/recreation services.
	Learning	In the past the farms have hosted annual visits by the Bradwell-on-Sea Primary school with about 30 visitors pa but there are good interpretation boards. This has not happened for the last 3 years. However, many schools use the Othona Community facilities (the owners of part of the farm) as there is much to study in the area including the rich wildlife and the Saxon history of the area. We have not included any value for education from the farm land.
	Health, peace and quiet	Restorative benefits of exercise, calm and remoteness, escape from stress. The 5.9 km of circular walks are widely used by local people for dog walking and by longer distance walkers as the final stretch of the50 mile long distance walk. Based on RSPB estimates of values of 3km circular walks and based on the population of Bradwell which falls within the 7km2 catchment we have estimated the benefits in health costs avoided to the local economy and NHS as £60/ha pa.
	Sense of place	The visitor book at St Peters Chapel shows that at least 50 visitors to the site a week who comment on the sense of peace, calm, tranquility and spirituality that they have enjoyed from the visit. We have estimated these benefits at £7/ha.
Regulating	**Climate regulation**	Storage of carbon in grassland soils + storage in 17 km of managed hedgerows. Potential for savings in electricity, diesel & fertiliser use. About £7/ha
	Water/flood	60% of the farm is below sea level. Sea walls jointly maintained by EA and the farmer (through grazing and hay cutting) protect at least 420ha of farm land and some 24 dwellings and a caravan park, and the access to St Peter's chapel. In the past managed realignment and creation of saltmarsh was proposed as a compensatory project for lost of saltmarsh from harbour extension at Harwich. However this would have flooded the shell beach in front of existing wall which is seen as one of the area's main recreation assets. NB Bradwell-on-Sea is above 5m asl and would not be affected by realignment of sea wall. Saltmarsh which provides both habitat and additional flood protection is maintained by the Essex Wildlife Trust and provides additional protection for the wall. Based on the dwellings behind the seawall which would not be flooded but would be cut off if the sea wall were breached we have estimated flood defense services at £150 /ha.
	Erosion control	35 ha of permanent grazing marsh and 3ha of grass margins limit water erosion on part of the farm and could be valued in relation to their effect on crop yields or remedial measures but quantification and monetary values have not been included.
	Other	No real contribution to air or water quality filtering since water drains to the sea. A beetle bank has been established as habitat creation but could be replicated for natural aphid control. Natural predators such as sparrowhawk and hen harriers reduce pests without the need for bait. Quantification and monetary values have not been included.
Supporting	**Soil formation**	35 ha permanent grassland and 3 ha grass margins halt soil loss (see soil erosion above). US studies show that permanent conversion of arable to grassland can have beneficial impacts on soil formation over 50 years. WE have valued these benefits at £7/ha pa
	Nutrient cycling	Nutrients are mainly added as chemical fertilizer at an average cost of £200/ha for winter wheat, seed wheat and winter OSR. Corn stubble is ploughed back in (as a trade off to use for energy). Other approaches to nutrient cycling (green manure, compost, nitrogen fixing crops in rotation would reduce fertilizer costs but would

	involve some trade off in loss of food. It has not been possible to value these benefits.
Wildlife and biodiversity	**On-Farm**. 35 ha of designated SSSI provide the last remaining grazing marsh on the Dengie Peninsula. The main drainage ditches which flow into the dyke have grass wildlife corridors planted beside them. Rich flora includes yellow-horned poppy, slender birdsfoot trefoil, grass-leaved orache and marram grass. Elsewhere the farm provides grass habitats (including margins, field corners, wild bird and flower mix, beetle banks, 3ha of grass margins, wildflower mix, field corners, wild bird mix, beetle banks etc and 23.7 km of managed hedgerows. **Adjacent to the farm** the Bradwell Bird Observatory is operated by the Essex Birdwatching Society which also works with Essex Wildlife Trust, to run the Bradwell Cockle Spit Reserve which is 12 ha of shell bank together with extensive salt marsh. Mudflats and sandflats to the east of the reserve are part of the Dengie National Nature Reserve and are internationally important for a wide variety of over wintering waders. Habitat is provided for Bar-tailed and Black-tailed Godnit, Hen Harrier, Grey Plover, Knot, Dunlin, Lapwing, Oyster Catcher, Dark-bellied Brent Goose, Cormorant and Great Crested Glebe. Salt marshes also provide a habitat for a number of salt tolerant plants. Shrubby sea blight is locally widespread (but generally rare). Other plants of interest include sea holly and sea lavender which colours large areas purple in July and August.

Figure 3.4 Estimated values of ESs provided by East Hall Farm



3.2.3 Heading's, Chatteris (Cambridgeshire) and Welney (Norfolk)

Context

Chatteris and Welney lie within NCA 46: The Fens. The landscape is very flat with distinctive large-scale vistas. The soils over the central and coastal fens comprise rich, fertile, stoneless,

calcareous, silty soils while inland are swathes of dark, friable, fen peat susceptible to wind erosion. The original courses of the rivers meandered slowly across the level fens causing widespread seasonal waterlogging by river water and high tides. Four major rivers drain into the Wash: the Witham, Welland, Nene and Great Ouse. The Fens are now predominantly cultivated and there is little semi-natural land left. All rivers now have artificial canalised courses which run straight for miles and are bounded by high banks to contain the watercourse from the lower adjacent fields which are below sea level. The dark peat soils have subsequently shrunk due to continuous cultivation, drainage and wind erosion of the peat. This irreversible shrinkage creates an ever-greater demand for artificial drainage of the land with pumping costs of at least £50/ha to farmers.

There is negligible woodland, with the majority of trees found lining roads or clustering around villages and the fen estates. Extensive orchards and associated windbreaks are located in the Wisbech area to create a distinctive though dwindling landscape cover. Much of the Peaty Fens comprise field vegetables, root and cereal crops. Here field sizes are large and rectilinear with dykes and crop demarcation providing the subdivision of units. The 'Washes', between the Old and New Bedford rivers and the Nene Washes, provide a man-made yet valuable wildlife resource of international significance for wildfowl. These are periodically flooded to provide wetland habitat and floodwater storage. The fens are a Nitrate Vulnerable Zone.

Typical soils in the local area are[1]:

- Loamy and sandy soils with naturally high groundwater and a peaty surface. These soils are naturally wet, with low to high fertility. Typical habitat is wet meadows, and land cover is mostly arable.
- Loamy and clayey soils of coastal flats with naturally high groundwater. These soils are also naturally wet, with lime-rich to moderate fertility. Typical habitats are wet brackish coastal flood meadows, and typical land cover is arable with some grassland.

Environment Agency data[2] shows that the local area is at risk of flood, varying from low (chance of 1 in 200 of flooding in any year) to significant risk (chance of 1 in 75 of flooding in any year). Chemical and biological water quality in the New Bedford River near to Chatteris and Welney is generally classed as fairly good, although there are very high levels of nutrients (nitrates and phosphates). The River Nene to the north also has high levels of nitrates. There are no significant groundwater abstractions in the local area, and no data available about local air quality.

Heading's Farm

The farm covers a very large area of Fens farmland. Of the total 1627 ha farmed, 1530 ha is arable and comprises non contiguous parcels of land comprising 9 owned, rented or contracted farms. The farm is managed under an 8 year rotation of wheat interspersed with potatoes, sugar beet, peas and onions or oilseed rape. Vegetables are supplied to supermarkets (Sainsbury's and Asda). Gross margins are at the top end of the scale for East of England cereal farms.

[1] http://www.landis.org.uk/soilscapes/

[2] http://www.environment-agency.gov.uk/homeandleisure/37793.aspx

Nearly all land is below sea level and is protected by drainage channels and constant pumping, at a cost of £50/ha in payments to the Internal Drainage Board. There is no on-farm diversification. The farm land borders the Ouse Washes SSSI and the Wildfowl and Wetlands swan reserve, and is host to a surprisingly wide range of birds. The farmers manage the land for biodiversity benefit, with 97 ha of headlands, field margins, buffer strips, bird cover and skylark plots. Reservoirs have been constructed to store water to be used for irrigating potatoes and onions.

There is very limited provision of footpaths, which are seldom used, and no education activities on the farm.

Over the next five years it is likely that the farm will:

- Continue to grow in size through land purchase, rental and contracting
- Follow a similar crop rotation assuming that the price of wheat does not fall dramatically; and
- Invest in renewables in the form of solar PV on farm building roofs in order to supply some on-farm energy needs (e.g. for refrigeration of vegetables).

Figure 3.5 Maps of A&J Heading Farmland, Chatteris/Welney, Cambs/Norfolk

Figure 3.6 Estimated values of ESs provided by Heading farmland

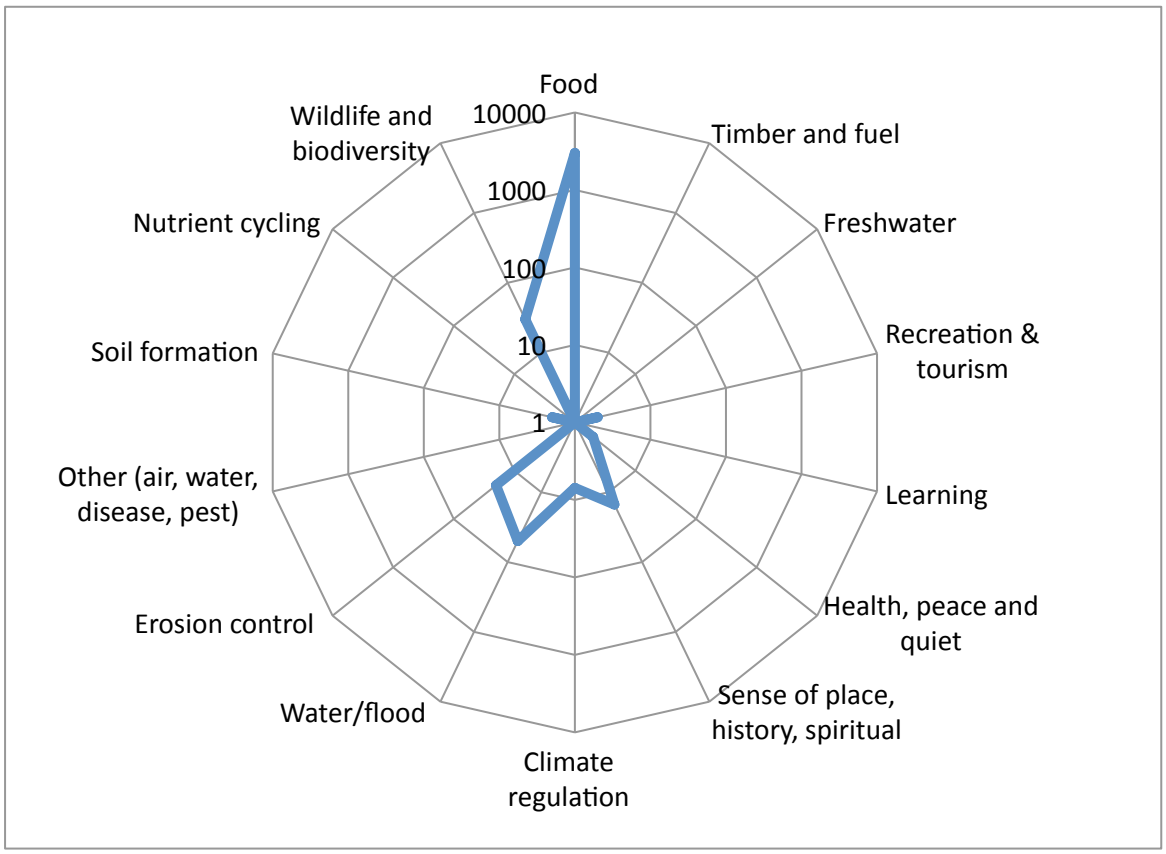


Table 3.3 Summary of current Ecosystem Services provided by Heading farmland

Kind of benefit provided		What is the Heading farmland providing at the moment?
Provisioning	**Food**	Mainly highly productive soils (Fen peat, loamy and sandy, loamy and clayey with naturally high water table) make this a productive wheat and vegetable farm of 1627 ha spread across various non-contiguous parcels of land, producing milling and feed wheat, potatoes, onions, sugar beet, peas and OSR. Managed on an 8-year rotation. 17 red poll cattle kept for beef.
	Freshwater	Farmer has created 3 ponds for irrigation. 1000m^3 applied per hectare last year.
	Timber and fuel	None currently, but may consider installation of solar panels in future.
Cultural	**Recreation & tourism**	Paths around farm used regularly by walkers, although numbers are small. Angling in Old Bedford River. Dog-walking country. Skating is important for Welney's heritage.
	Learning	None currently.
	Health, peace and quiet	Use of footpaths by walkers provides health benefits and enjoyment.
	Sense of place	Landscape enhancement on farm, mainly through restoration of hedgerows. A Roman route goes across one parcel of land.
Regulating	**Climate regulation**	Storage of carbon, nitrogen and methane in soils and vegetation. Farmer has considered taking green waste as a soil improver, but not done so to date.
	Water/flood	Regular ditch management is required to ensure drainage of land. Settlements also use the drainage network for management of run-off. Local canals/rivers protect a very large area of population from flooding.

	Erosion control	Parts of the farm are highly vulnerable to wind erosion (loamy) and water erosion. Removing soil from drains has direct costs to the farmer in high wind blow years.
	Other	Intensive production may lead to run-off affecting water quality. No real contribution to air quality, pest and disease control or pollination.
Supporting	**Soil formation**	Ploughing-in of stubble.
	Nutrient cycling	Nutrients added as chemical fertiliser on crop land.
Wildlife and biodiversity		The area is rich in birdlife. The farm land is managed positively for biodiversity benefit, including buffer strips along ditches, taking field corners out of production, sowing of nectar flowers, retention of 3.5 ha of unimproved grassland, beetle banks, hedgerow and ditch management, overwintering stubble, and up to 30 ha of rotational grass.

3.2.4 Mowness Hall, Mid-Suffolk

Context

This farm lies within NCA 83: South Norfolk and High Suffolk Claylands**.** Comparatively little remains of the historic wood pasture that once characterised this area but the area retains some remaining woodland and hedgerow oaks (both standards and pollards). Copses have been planted as game cover and pheasants wander along the fields and road verges.

In the past dairy and grassland were the chief agricultural practices in this area, until the advent of mechanisation and better drainage enabled landowners to convert to arable farming. On the heavy soils oilseed rape and sugar beet are now common break crops between intensive cereal crops on the moisture-retentive soils. Since the war rationalisation has changed the face of this landscape in many places, as hedgerows have been removed, trees felled, ponds filled, ditches piped and fields enlarged. Workshop participants described much of the wider area as 'arable desert'.

Typical soils in the local area are[1]:

- Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils. On these soils drainage is impeded and fertility is moderate. Typical habitats are seasonally wet pastures and woodlands, and typical land cover is grassland and arable with some woodland.
- Lime-rich loamy and clayey soils with impeded drainage. On these soils fertility is high. Typical habitats are base-rich pastures and classic 'chalky boulder clay' ancient woodlands, with some wetter areas and lime-rich flush vegetation. Typical land cover is arable with some grassland.

Environment Agency data[2] shows that land close to watercourses is at risk of flooding near Wetheringsett, Mendlesham, Debenham, Stonham Aspal and Earl Stonham. Some of these areas are at significant risk (1 in 75 chance of flooding in any year). Water quality in the River Dove to the north is fair to good, although levels of nutrients are very high (nitrate and phosphate). The

[1] http://www.landis.org.uk/soilscapes/

[2] http://www.environment-agency.gov.uk/homeandleisure/37793.aspx

local area is a catchment for groundwater abstraction points. There is no information available about local air quality.

Mowness Hall Farm

The farm is a highly productive 1,050 ha wheat and sugar beet farm employing high input, high output precision farming techniques centred around Little Stonham in Mid-Suffolk. The farm is made up of a combination of non contiguous owned, rented and contracted fields, typical of the area.

The crop rotation is a based on a six year cycle of wheat interspersed with oilseed rape, sugar beet and linseed. In the past, vining peas were also part of the rotation but local processing capacity has been lost and it is no longer viable to grow this crop. Gross margins are at the top end of the scale for East of England cereal farms. The farmer has reintroduced a few Suffolk traditional breed cows and sheep for diversity rather than as a major contributor to food production.

Three quarters of the farm (750 ha) is managed for Entry Level Stewardship including:

- field margins, headlands & hedgerows (especially along the A140); and
- ponds and fenced-in pasture.

In the next five years future developments on the farm are likely to include:

- increase in size through land purchase, rental or contracting agreements and management under a similar crop rotation;
- Possibly growing some biofuels if prices and gross margins are attractive;
- Further improvements to the 'look and feel' of the land through hedgerow management and planting, particularly adjacent to roads, planting of more tree cover and game cover, and restoration of historic canal ponds. These measures involving capital costs would require stewardship grants.
- Use of more compost from municipal recycling.

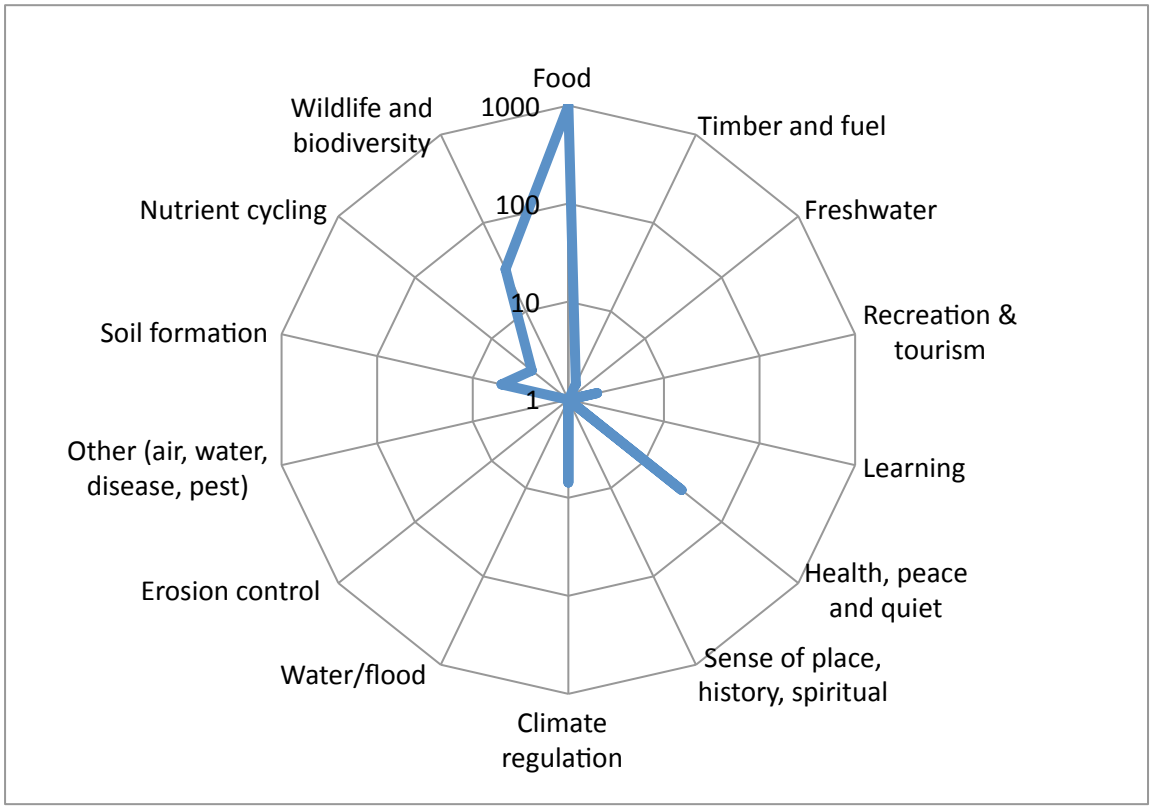
Table 3.4 Summary of current Ecosystem Services provided by Mowness Hall Farm

Kind of benefit provided		What is Mowness Hall providing at the moment?
Provisioning	**Food**	Current crop mix, yields and market prices gross margins (before own labour , fuel and capital) above regional average of £925/ha
	Freshwater	>12 ponds around farm and fields help to recharge water courses but difficult to value
	Timber and fuel	Small quantities of fuel wood - value about £125 /m3
Cultural	**Recreation & tourism**	Some PROW on Mowness Hall and Lodge Farm well walked by local dog walkers (not horses or bikes). Some longer distance. Half a game shoot pa. Est £2/ha +
	Learning	Previously provided visits for primary school children, but not currently
	Health, peace, quiet	Health benefits of 3 Km of circular walks could be worth up to £30/ha pa
	Sense of place	Planting, coppicing and regeneration of hedgerows along A140 and breaking up larger

		fields people value sight of trees but difficult to value
Regulating	**Climate regulation**	Storage of carbon in soils, under grass and in 3 ha woodland planting, 9km hedgerows. Potential for savings in electricity, diesel & fertiliser use. About £7/ha
	Water/flood	Keeps water courses and ditches well cleared to minimise risks. Difficult to quantify
	Erosion control	Limited soil erosion/run off risks on loamy and clayey soils which are either slowly permeable and seasonally wet or with impeded drainage
	Other (pest, air & water filter, pollination)	No significant contribution
Supporting	**Soil formation**	2.75 ha cropping land converted to grass + ditches , field margins + corners est. £5/ha
	Nutrient cycling	Nutrients added with chemical fertilisers, compost from local recycling schemes and stubble as soil conditioner. £3/ha
Wildlife and biodiversity		2.75 ha fenced grassland plus field margins & corners and 9Km new hedgerows 6 km existing hedgerow and ditch management. Game and wild cover, wild bird and nectar flower mix, management of woodland edges, barn owl boxes. Estimated value of £30/ha.

Figure 3.7 Aerial view of Mowness Hall Farm, Mid-Suffolk

Figure 3.8 Estimated values of ESs provided by Mowness Hall Farm



4 WORKSHOP OUTCOMES

4.1 INTRODUCTION

The objectives of the workshops were to:

- Identify the value of the full range of services and benefits accrued from arable farmland so that they can be recognised by and taken into consideration in decision making and strategy development;
- Deepen understanding of the value of ecosystem services provided by the case study farms and others in the area and fill the gaps in valuation and calibrate others identified in Section 2; and
- Provide insights into what local people really value about the arable farmland landscapes around them and the balance of different benefits they would like to see in the future.

The workshops were structured in order to achieve the above objectives. In particular, the structure was designed to allow the following:

- To provide participants with an introduction to 'wider benefits' of farm land and how we might value then on arable land so that they would all be starting from a common understanding of ecosystem services concepts;
- Discussion about what participants value in the local farm environment and an initial evaluation;
- Presentation of the local case study farm as an indication of the types of ecosystem services being delivered in the area, including a spider diagram showing our assessment of the current monetary values of ecosystem services;
- Discussion on what participants would like to see more of in the future, using a spider diagram with moveable counters at each table to reflect the evolving discussion; and
- Discussion on how farmers might be encouraged to deliver this.

A more detailed description of the workshop structure is given in Annex B.

4.1.1 Participants

The participants were recruited from the community local to each case study farm. Contact was made by telephone and email, but also notices were placed in public places where possible, e.g. in shops and on community websites. Potential participants were sought from community groups/organisations, or by individual recommendations/word of mouth. Technical experts were also included in each meeting. The following participant numbers were achieved:

- 18/1: Brickendon, Herts; 14 participants plus 1 steering group member (Forestry Commission) and 1 from Foresight Land Use team;
- 19/1: Bradwell, Essex, 15 participants including local Natural England staff;
- 25/1: Welney, Norfolk, 14 participants plus 3 steering group members (Natural England, Sciencewise and VEsSiEE chair); and
- 26/1: Stoke Ash ,Mid- Suffolk, 12 participants plus 2 steering group members (NFU and Sustainable Farming East of England) and the case study farmer.

In addition on the 18th March a final workshop was held with a group of regional stakeholders. This was intended to test the toolkit with a group of regional expert stakeholders and to focus on a larger spatial scale – using the Fens as a pilot. This was a three hour day time session running from 10:00 to 13:00 at the NFU's offices in Newmarket. There were 8 participants; all members of the Steering group (see section 4.3).

4.2 ANALYSIS OF OUTCOMES

4.2.1 The assessment methods

During the workshops, participants were asked to take part in two evaluation exercises. For the first exercise, participants were asked to put a value on each type of ES between 0 (low) and 10 (high), in order to indicate to what extent they considered the ES important in a general sense for the area. The assessment was done after 'wider benefits' of farming had been presented by the team and discussed at tables but before the assessment of the case study farm had been presented. The assessment therefore reflected the participants' understanding of ecosystem services concepts and their own knowledge of their importance in the area. The exercise was completed in pairs for the first workshop (Brickendon) and individually in subsequent workshops. The results are set out in *Table 4.1*.

Figures 4.1 through 4.4 show the standard deviation and highest and lowest scores in each location.

For the second evaluation, participants were divided into two groups and asked to come to a collective decision among the group about the value to place on each ES from 0 to 10 when considered in terms of the specific local area. In doing this they used a large spider diagram with each of the 'wider benefits' and a set of counters with a starting position of 5. The group then discussed each benefit in turn and their deliberations were recorded. The exercise worked best when each individual was allowed the opportunity to suggest an initial score for one of the 'wider benefits' which they thought most important and the group used this as the basis to discuss the likely trade offs with other benefits and their desired balance. The results of this exercise are set out in *Table 4.2.*

4.2.2 Interpreting the results

Table 4.1 shows the average of the values placed by participants on ES in a general sense, and the standard deviation[1] from the average. It indicates that food and wildlife and biodiversity were consistently the highest rated benefits in all four workshops, and these were also the ESs with the greatest degree of consensus about the value (i.e. the lowest standard deviations). Freshwater was also a clear third in terms of ranking. In almost all cases, ESs were given an average score of at least 5, suggesting that all ESs are regarded as quite important. The few exceptions to this occurred for the categories of 'timber and fuel' and 'other (disease, pest, pollination etc.)'.

[1] Standard deviation (SD) is a measure of the spread of results, or more accurately the degree of clustering of values around the average. The SD value indicates how close to the mean two thirds of the results lie. The smaller the SD value, the more tightly the results are clustered around the average. For example, at the Brickendon workshop, the average score for timber and fuel was 7.4 and two thirds of the scores lay between 6.2 and 8.6 (i.e. 7.4 ± 1.2)

It is interesting to note that the Brickendon participants appeared to struggle with valuing the 'disease, pest, pollination etc.' category of services and generally found it most difficult to value ESs at the general level because they were working in pairs to reach a consensus without having had much opportunity for deliberation.

Table 4.1 Average values for ESs in a general sense when asked to score from 0 to 10

Average ranking	Ecosystem service	Brickendon (5)		Bradwell (15)		Welney (15)		Stoke Ash (12)		All (47)	
		Ave	SD	Ave	SD	Ave	SD	Ave	SD	Ave	SD
1	Food	8.8	1.9	8.9	1.1	8.5	1.5	9.4	1.0	8.9	1.4
3	Freshwater	9.6	0.8	8.0	2.6	8.0	2.1	7.3	2.4	8.0	2.4
14	Timber and fuel	7.4	1.2	6.2	2.0	4.9	3.3	6.3	2.1	5.9	2.6
9=	Recreation	7.0	2.3	7.3	1.2	6.1	1.6	6.5	2.5	6.7	1.9
9=	Learning	6.8	1.9	7.7	1.3	6.3	2.5	5.9	1.9	6.7	2.1
5	Health	6.8	2.1	7.8	1.7	7.3	2.0	6.3	2.6	7.1	2.2
6	Sense of place	7	2.2	7.9	1.9	6.9	2.1	6.2	2.8	7.0	2.3
13	Climate regulation	6.4	2.6	5.7	2.5	7.4	2.6	5.9	2.9	6.2	2.7
4	Flood	6.6	1.4	7.5	1.5	8.3	2.2	5.8	3.0	7.2	2.4
11=	Erosion	5.4	2.4	6.6	2.6	7.4	2.4	5.3	2.5	6.4	2.6
11=	Disease, pest, pollin etc	0	0.0	7.1	2.0	7.4	2.3	4.9	3.1	6.4	2.8
6=	Soil Formation	7	0.6	7.1	2.0	7.1	2.8	7.2	2.7	7.0	2.4
6=	Nutrient cycling	7.8	0.7	7.1	2.0	7.0	1.6	6.7	3.0	7.0	2.1
2	Wildlife & biodiversity	9.2	1.2	8.6	1.4	8.9	2.2	9.0	1.7	8.7	1.8

Figure 4.1 Brickendon: average and standard deviation of value scores

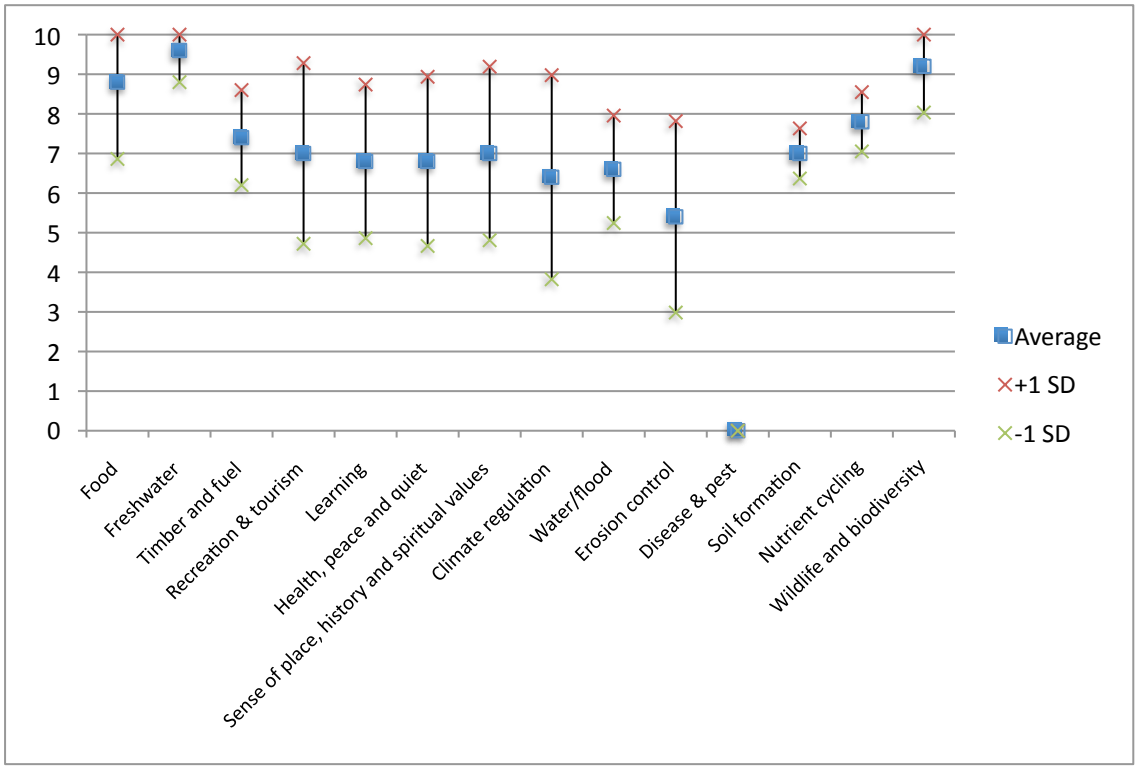


Figure 4.2 Bradwell: average and standard deviation of value scores

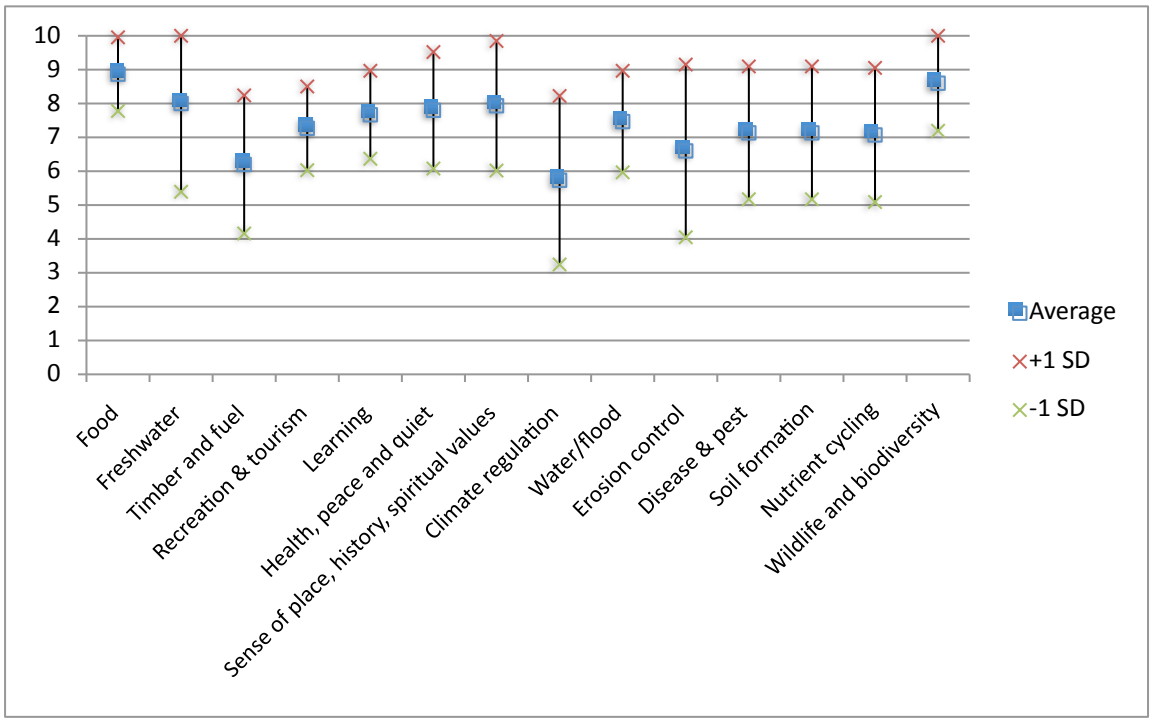


Figure 4.3 Welney: average and standard deviation of value scores

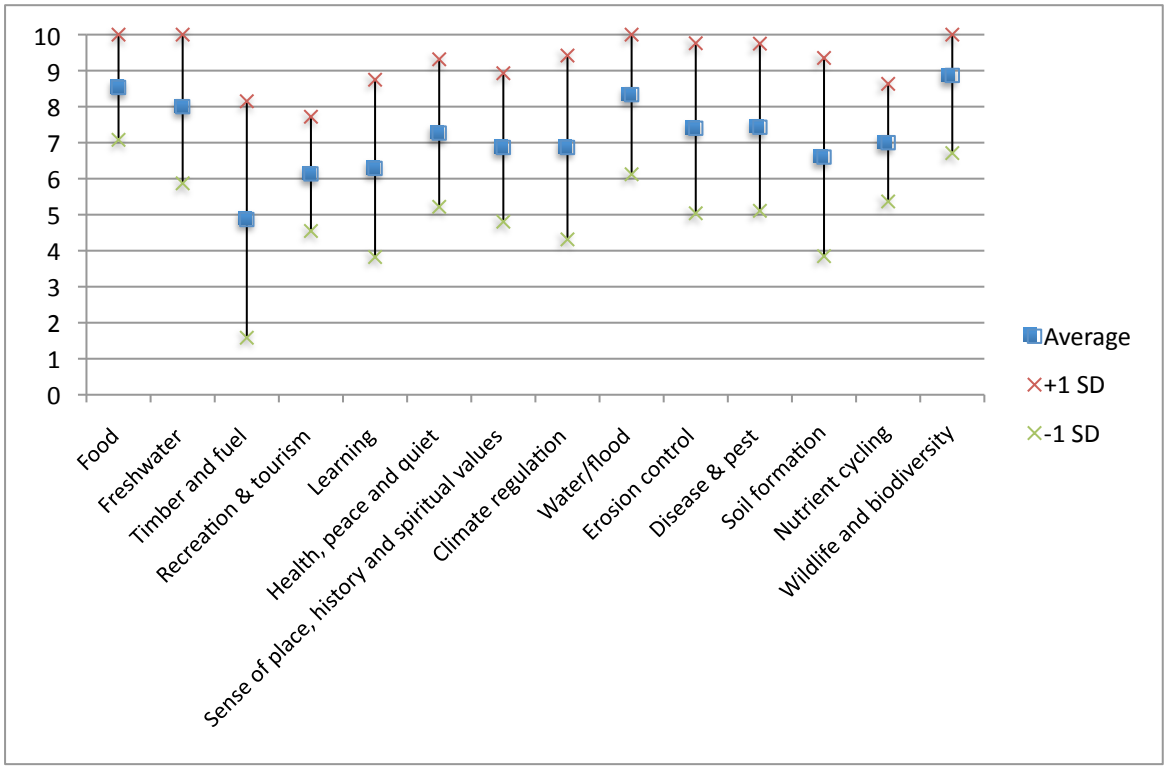


Figure 4.4 Stoke Ash: average and standard deviation of value scores

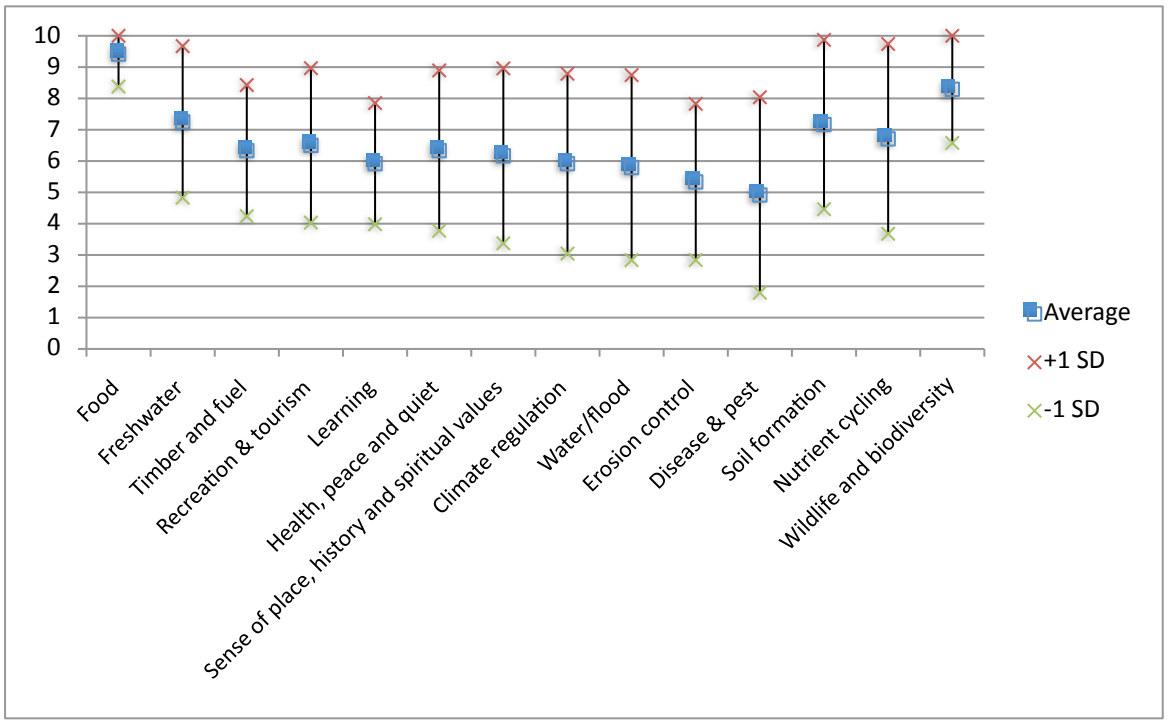


Table 4.2 shows the values placed on ESs for the case study area by each of the two groups at each workshop based on deeper knowledge of the typical farm in the area and a chance for much more deliberation within the table group. Again, food production was ranked fairly consistently high, except in Welney where climate regulation came out top. Interestingly, once the groups had had the opportunity to discuss and reflect 'sense of place' was broadly ranked the second highest

important benefit of local farming systems and wildlife and biodiversity slipped to fourth place. Freshwater provision also fell in the rankings to the lowest ranked ES overall.

Table 4.2 Values placed by participants on ESs for local area when asked to score from 0 to 10

Spider ranking	Ecosystem service	Brickendon		Bradwell		Welney		Stoke Ash	
1	Food	10	10	9.5	10	5	9	10	10
14	Freshwater	10	9	9	0	5	4	6	8
12	Timber and fuel	8	6	7	7	2	5	5	4
7	Recreation	6	10	5	9	6	8	9	8
6	Learning	5	9	9.5	10	6	7	7	8
4	Health	6	10	8	10	8	9	8	7
2	Sense of place	6	10	8	10	9	10	9	6
9	Climate regulation	10	9	8	1	10	10	8	8
11	Flood	5	7	7	8	9	5	3	5
8	Erosion	5	9	7	8	9	10	3	8
13	Disease, pest, pollination etc	5	3	7	10	5	9	3	6
3	Soil Formation	5	9	8	10	8	10	3	5
10	Nutrient cycling	5	5	8	5	5	10	10	8
4	Wildlife & biodiversity	7	10	9	10	10	5	9	7

Figures 4.5 to 4.8 show how the valuation changed at each workshop from the first exercise (value in a general sense) to the second exercise (value for the specific case study farm). For some ESs, the valuations changed little between the two exercises. The most notable changes in valuation were for:

- freshwater, which at all workshops was rated less important when considering the specific case study area than in a general sense;
- disease and pest control, which at Brickendon was given a higher rating for the specific case study than in a general sense, although in the score nevertheless remained fairly low;

- climate regulation, which at Brickendon and Welney was given a higher valuation for the specific case study area than in a general sense, whereas at Bradwell and Stoke Ash it was rated less important for the specific area than in a general sense.

However, it is difficult to ascribe reasons for the apparent changes in valuations between the two exercises in any reliable way. These may have been due in some measure to improved understanding of the ESs as the discussions proceeded, as much as any clear differences in perceived value deriving from local circumstances.

In terms of local differences between workshops it can be noted that:

- At Brickendon cultural services and all regulating services were generally scored higher after deliberations amongst the group – only freshwater, biodiversity and nutrient cycling were scored lower;
- At Bradwell all but climate regulation, freshwater provision and freshwater were scored higher after deliberation. The relatively low score for climate regulation was skewed by the very strongly held views of an individual climate sceptic;
- At Welney the picture was more complex with cultural services and soil/erosion/nutrient cycling services all scored higher after deliberations while food, biodiversity and freshwater provision were all scored lower; and
- At Stoke Ash cultural services and soil related services were scored higher while all regulating services, freshwater and biodiversity were scored slightly lower by groups after deliberation.

Tables 4.3 to 4.6 summarise some of the key points that were made during the workshop deliberations, indicating the values which are attached to each of the ESs by participants.

Figure 4.5 Brickendon: comparison between general and locally specific valuations

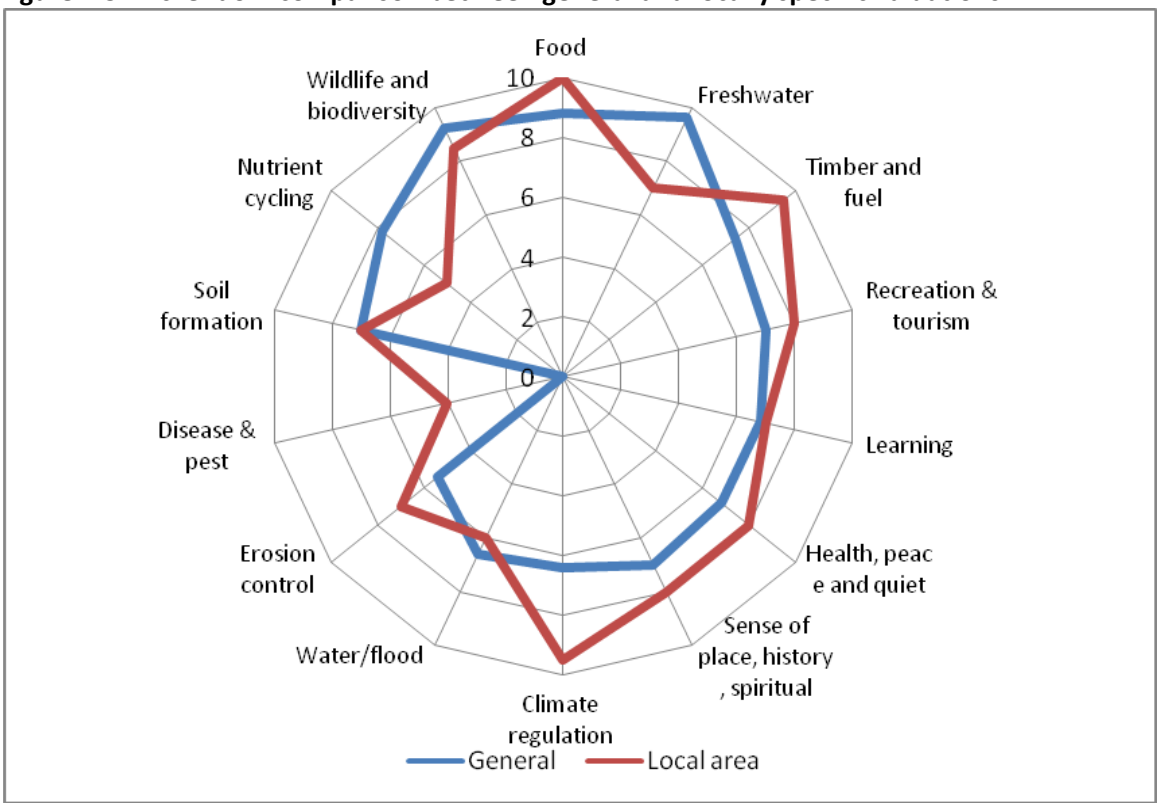


Figure 4.6 Bradwell: comparison between general and locally specific valuations

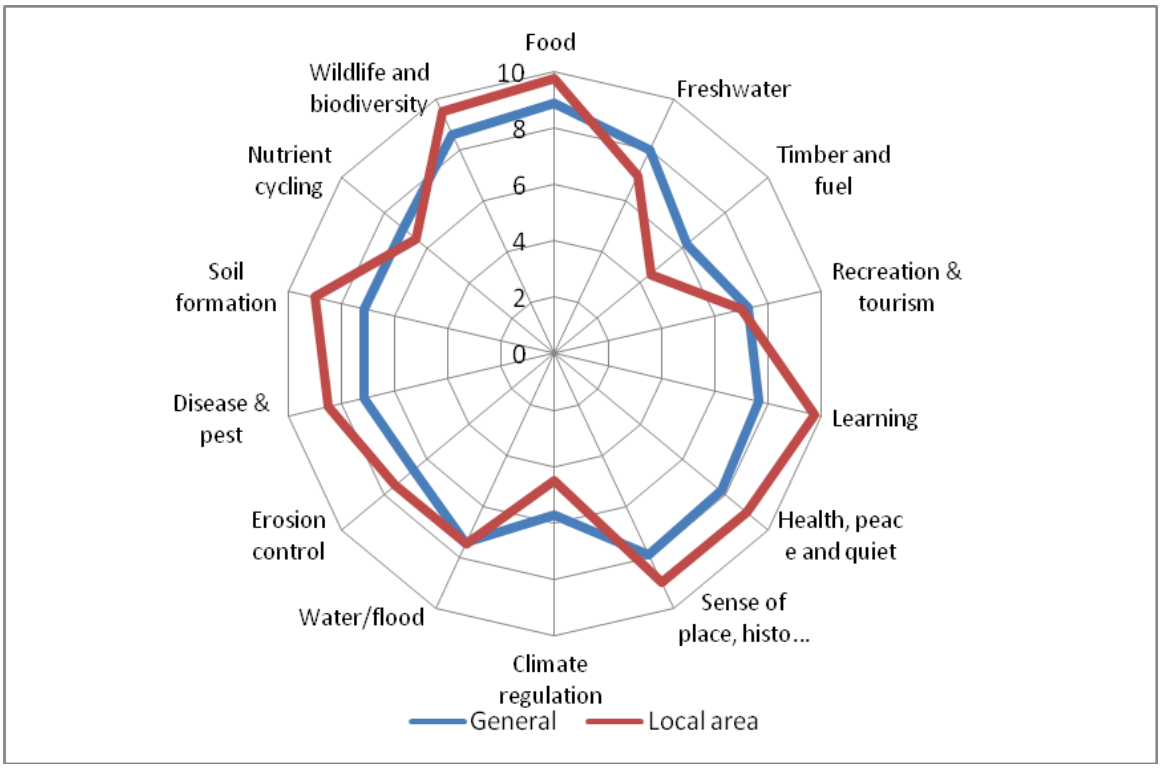


Figure 4.7 Welney: comparison between general and locally specific valuations

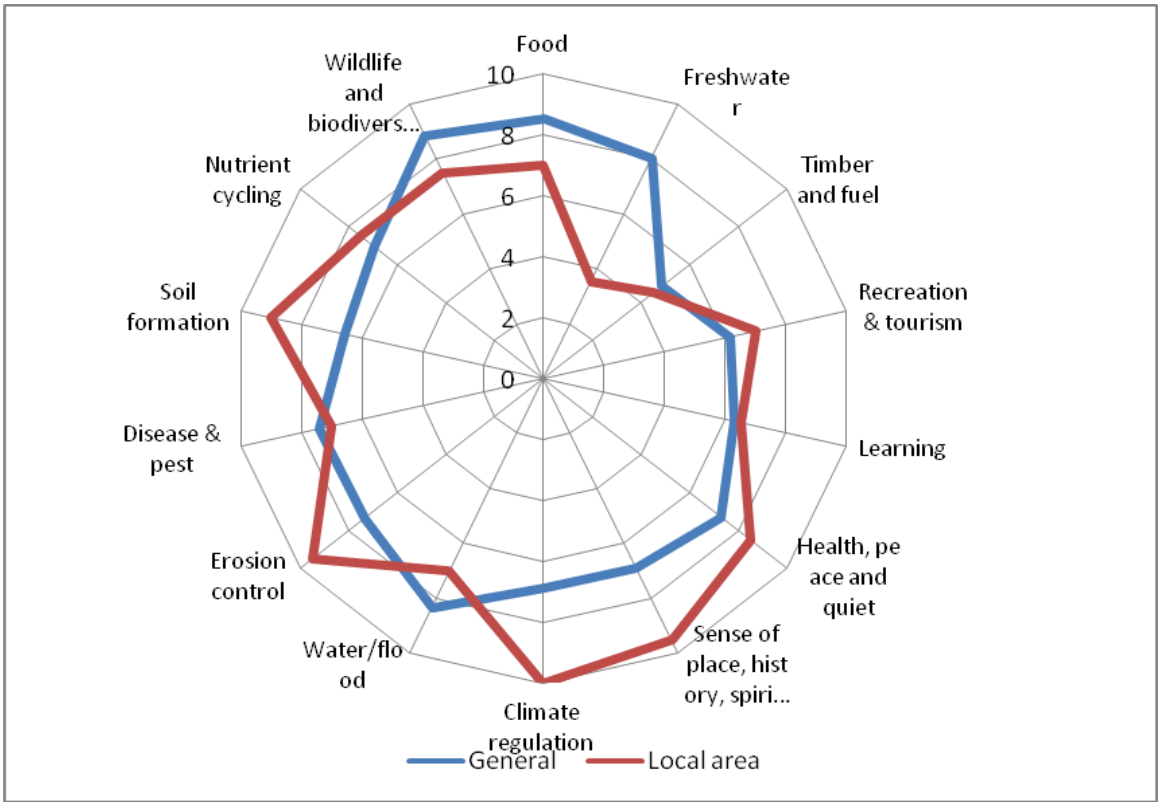


Figure 4.8 Stoke Ash: comparison between general and locally specific valuations

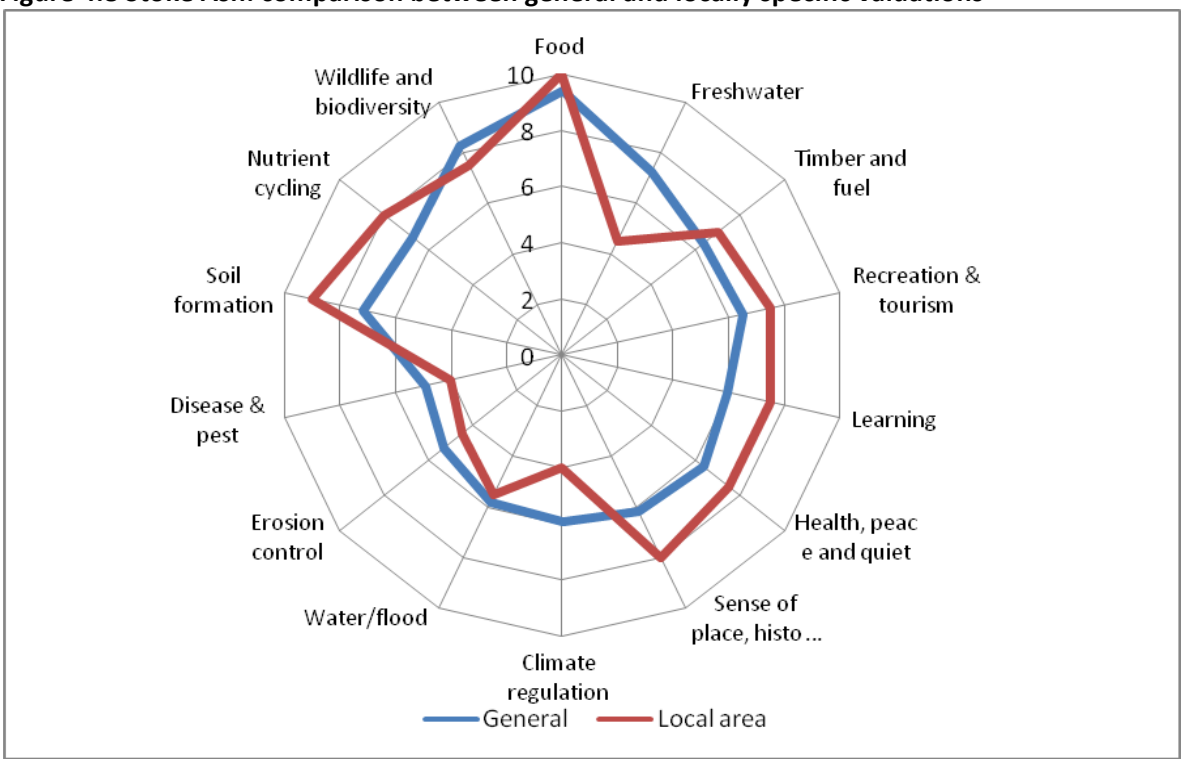


Table 4.3 Brickendon deliberations

Provisioning Food	• This area is producing very little food indeed and should produce more, but not intensively. • More locally grown produce for local use would be welcome • It would be good to have more livestock
Timber and fibre	• Despite the size of Broxbourne woods there has been no fuel production to date, although coppicing wardens are leaving fire wood for people to collect and use. This will become increasingly important in the future
Freshwater	• This is important here because we don't want it to become polluted • Run off from chicken sheds is a visible problem.
Cultural Recreation	• Walking and good access to public rights of way very important • We could use more on farm B+B accommodation and specialist accommodation on farms • Litter is a major problem because of the proximity to high density population areas • The existence of the woods was one of the reasons we came to live in this area, but game shooting can create conflicts with other users • It's a shame that farms are being turned into pony paddocks and golf courses. It has happened a lot round here.
Education	• The public need to be educated about the services provided by farming and the role of the countryside. We need more connections with schools and communities. • Education is important because we want youngsters to know where food comes from. They need to be taught what's on their doorstep and to appreciate it.
Health, peace and quiet	• Connection with nature is really important for physical health and for those suffering from mental illness.
Sense of place	• Very important
Regulating Climate	• Very important for everything else
Flooding	• Flooding is an issue here because this area is important for the wider water catchment, protecting other areas – particularly on the River Lea and into London - from flooding.
Supporting Nutrient cycling	• Waste is an important issue on chicken farms. This isn't a "benefit" or "service".
Soil formation	• Without soil formation and nutrients then we can't have everything else.
Wildlife and biodiversity	• This is so important for the area. Red kites, sparrow hawks, buzzards and hares are an important part of the sense of place • Wild food is becoming a commercial product e.g. crayfish from the Lea supplies many London restaurants. Deer/rabbit/pigeon are shot and trapped. Berries/fungi increasingly picked.

Table 4.4 Bradwell deliberations

Provisioning Food	• The group felt that food production should have the highest score – particularly given the good soils and temperate climate – and this goes hand in hand with soil formation and nutrient cycling • Recognised that production is currently focused on global rather than local markets, which could provide more local economic benefits • The area has almost no remaining livestock farming and key stock rearing skills have been lost, as have sources of non chemical nutrients. • Food production and biodiversity enhancement can be delivered together. • And other food products such saltmarsh grazed lamb, 'local product' and sweet chestnut good be good be good for both.
Timber and fuel	• Timber and fuel is currently not very important but energy should be more important in the future. • Trees and hedgerows are still important for a range of benefits: shelter, shade, biodiversity, hydration, microclimate, soil water retention and firewood. More coppicing and regenerating scrub could be carried out. • Biofuels such as OSR could be produced but this would be at the expense of food production. • Anaerobic digestion not currently relevant in this area because of limited livestock but corn stubble which is currently sent to a power station in Norfolk could produce local fuel. • There could also be opportunities for community wind power generation on arable land.

Freshwater	• On farm ponds are important for summer irrigation and biodiversity benefits but not so important for producing drinking water because farm land drains direct to the sea. • The Othona Community has reedbeds for wastewater treatment. • The Dengie peninsula is not a Nitrate Vulnerable Zone so water quality is not such a big issue as elsewhere. Nevertheless there are opportunities for water treatment with biodiversity benefits (e.g. neighbouring Othona Community has reedbeds for waste water treatment.
Biodiversity	• Game shooting not a major issue
Cultural Recreation	• Recreation is a hidden treasure based on the coastal setting and big landscapes. • There are lots of opportunities for cultural, historical buildings, walking, rambling, bird watching, cycling and spiritual/church recreation and dog walking are all very popular in the area • The Mundon-St Peters Way along the seawall is a 50 mile route from Chipping Ongar attracting at least 50 long distance walkers a week. It is also a bridleway. • Some parts of the seawall are blocked (not on East Hall or Eastlands) but the village economy could benefit from opening up access and promoting recreation services further. • It would be nice to provide more displays to explain farming systems in a way that reflects crop rotations and wider benefits. • It would be nice to see greater public access to water-based recreational facilities
Education	• It's invaluable having children visit the countryside, for education, health, connection with the environment, respect for the community and an understanding of farming. This is really important in ensuring subsequent generations understand farming and the countryside and that other ecosystem services are delivered. • In fact everything on the spider diagram should be in the curriculum. It's wrong that it isn't • There are opportunities to do more in this area based on good practice from other farms/ landowners: • 20 local farms (the Essex Farming Group) run a voluntary school day for primary school children on Farm Sunday and have developed really good supporting materials and health and safety systems without HLS payments. • Othona provides pond dipping for school parties (but the costs are still too high for the local community). • Another farmer has done some really good ones and highlights lots of very interesting features.
Health, peace and quiet	• Health, peace and quiet are wonderful here and we need to keep it. • Because of St Peters, this is an amazing place. • More people should enjoy it
Sense of place	• The land was reclaimed in the 17th century therefore wouldn't have had many trees on it, although there were more until they were lost to Dutch Elm disease. Farm buildings have also been demolished at the expense of landscape character. • Sense of place and connection to the landscape is so important in underpinning other cultural benefits – recreation, health, learning • Some crops such as Lucerne and borage can be very attractive in the landscape • Wildlife is an integral part of the feel of the landscape
Regulating Climate	• Trees are vital for each one of the regulating services. Coppiced woodland can provide logs and is a carbon sink. • A lot can be done by taking out land for margins and hedges without much land loss. • But views were polarised in thinking that every service in the spider diagram depends on climate regulation, with small local changes adding up to global effects to those sceptical that this is a major issue for local farms.
Flooding	• The area suffered bad flooding in 1953 and 1976 with overtopping and flooding over a wide area • Flood defences should be sound for 100 years and are seen as well maintained on Eastlands/East Hall. The Environment Agency cleared the outer side of the seawall this summer, and that was the first time in a long time. Flood protection is therefore seen as easy to achieve and highly rated. However, there is some disagreement as to whether this is necessary to reduce damage to structures or whether vegetation can help to halt coastal erosion. The question of who should maintain flood defences in the future was also debated. The main issues being liability for protecting third party land and how owners should be compensated • Alklands farm has managed realignment over of 40ha of ex pasture and 40 ha ex arable land with annual compensatory payments. Now in its 1st year it has been established as saltmarsh. Some participants felt that this approach could also be taken at East Hall flooding unproductive land, with erosion control and associated biodiversity benefits but that there would be some trade off with food production.
Erosion control	• This is easy to achieve on-farm, so should be given a high rating. • Soils are reasonably stable and can be stabilized with cover crops and crop rotation. So

	closely linked to food production that should be very important.
Other	• It would be better if we were able to value air quality and disease/pest control separately. We want to give it a high score for air quality, but not for disease and pest control. • Control of crop pests link very closely to food, soil and wildlife • Farmers could be using natural pest control more (e.g. Beetle banks enable aphid control for 20m into a field and so could reduce the need for spraying). More beneficial insects are good for every other aspect of biodiversity and wildlife.

Supporting
Soil formation
Nutrient cycling
	• Trees are vitally important - they're the only crop where you produce soil.
	• Soil formation and nutrient cycling are fundamental and closely linked to freshwater protection and farm productivity.
	• Current cropping is mostly annuals so reducing soil nutrients. Also losing N, P and K by leaching with heavy rains.
	  ○ Need to reduce NPK fertiliser which would reduce costs to farmers. Replace nutrients with:
	  ○ More mixed farming, because this puts back animal products into the soil and possibly even bird excreta.
	• cover crops and rotations of nitrogen fixing crops such as Lucerne as a way of increasing soil nutrients
	• But will always need to add some Potassium and Phosphorous to maintain productivity

Wildlife and biodiversity	• Dengie area is key to many nationally important and threatened species – has 8% of corn buntings that have declined by 50% over the last 40 years nationally. • Wildlife is very diverse on seaward side of flood defences at East Hall/Eastlands. • If we can encourage farmers to do a bit of habitat for bees and insects the rest will follow. • But opportunities to do so much more nationally important species such as corn bunting on the leaward side. • It's very important to get the wildlife/biodiversity links between fields and between farms • We should be prepared to get a bit more of a balance between doing something for wildlife and biodiversity and intensive food production

Table 4.5 Welney deliberations

Provisioning Food	• Arguably the most productive land in the country so food production is always going to be important. Farmers really driven by cereal prices. • Perhaps this isn't the most important area for food production if it's at the expense of flood control. • Typical farming system locally is cereals, potatoes, sugar beet and vegetables. Some farms have diversified and have e.g. medicinal plants and herbs for essential oils
Timber and fuel	• Not too relevant in this area unless use special crops, miscanthus or willow • Viewed as 'crop' would take up food space • OSR and biofuel will be required in future but this will be at the expense of food • There can't be much timber and fuel production if we want to keep our sense of place. • We don't have turbines here because of the swans.
Freshwater	• Not providing drinking water because land drains to the sea. • But it is a Nitrate Vulnerable Zone and good water quality is closely related to soil erosion and nutrient cycling. • On-farm reservoirs and ponds are important for summer irrigation and will become more so with climate change. • Undervalued and taken for granted.
Cultural Recreation and tourism	• Skating is important for Welney's heritage. • Access to farmland is quite poor with virtually no circular walks. Most people would rather walk along river banks and drains but can be frustrated when they can't cross • There are a number of farm tracks around Welney. Could farmers be asked for these to become permissive paths? • Not really very close to major centres of population so not much more formal recreation • There is a tension between increased access and people not appreciating and caring for farmland. • Compared to the Norfolk Broads, tourism is a non-starter. Game shooting is small. Birdwatchers come to Wicken Fen, but the numbers are small. Fishing numbers are smaller than they used to be. The area should be massive for cycling. • Disagreement about whether more tourism is desirable.
Education	• Important for children. They still don't know enough about where food comes from • Open Farm Sunday is a good example of farmers providing access and demonstration. It is resource intensive but really appreciated – needs help e.g. local volunteers

Health, peace and quiet	• Very important
Sense of place	• There is a big sense of "the wild" in the Fens. • Very distinctive landscape and economy. Really important to maintain and improve sense of place. • Openness of landscape is key. • Trees and hedgerows have been lost and fields become bigger and less diverse – there used to be 35 farms around Welney, now only 3. • Hedgerows and field margins now being reinstated • The big skies and the isolated feel are what brought us to Welney in the first place
Regulating Climate regulation	• We need to manage the remaining peat more effectively to store GHGs. • Storing carbon on any scale would mean re-wetting peat land so that it starts to absorb rather than lose carbon. But this means losing it to arable production – although could use it for livestock. • You can't do everything in one area and maybe carbon is not a priority here.
Water/flooding	• Area is very susceptible to flooding. We have to put up with other people's water in Welney's rivers, e.g. from Milton Keynes. This is true for all catchments, but it's particularly exaggerated in the fens because of the size of the catchment. We should be compensated in some way because we're suffering the effects of too many supermarket car parks being built in Bedfordshire. • RSPB provide flood alleviation on the Ouse and Nene Washes, a direct benefit to agriculture as well as wildlife. • If it wasn't for farmers paying IDB for pumping then Welney and Manea would be frequently flooded – a huge amount of the area is below sea level • Retaining, enhancing and creating wetlands to provide flood alleviation, store carbon and provide for biodiversity • There is a lot of re-wetting of land in the area.
Erosion	• There are issues with peat erosion, which is a loss of resource and productivity and creates GHG emissions. • Fen blow is partly due to prairie sized farms and fields and lack of diversity and winds get a chance to speed up. • Keep soil under grass and install hedges
Pest and disease control	• More mixed farming could help this. • Are other methods of control which require less generic prophylactic spraying and save farmers money e.g. for slug control spray a parasite. • Organic farming needs more research on plant breeding and yields for pest control because its ok on small farms but very difficult to scale up • Field edge planting to encourage bee life is important.
Supporting Soil formation	• Arable cultivation losing 2cms soil a year from wind blow, oxidisation, and shrinking because of drainage. How do you stop it or reverse it without livestock? • We need mixed farming to put soil structure back, both through rotations and livestock. • Also need to be putting 4-5 tonnes straw an acre back in – but many selling it to power station at £6-7/bale.
Nutrient cycling	• White clover is a good crop for fixing nitrogen • Non chemical options include mustard crop and break crops but these are expensive in terms of lost cash crops. But would have huge benefits for wildlife and biodiversity. • Mixed farming would help – organic wastes applied to land • What are the regulations about applying human waste to farmland? Surely it could be used if treated properly with no pathogens
Wildlife and biodiversity	• This area is a hotspot in the UK for birdlife. Things are holding on here whereas have been lost from elsewhere. Unique environment in UK - needs preserving • Needs linking to other areas more, e.g. learning • We need wetlands interspersed with nature-friendly, more extensive farming. • I haven't seen much evidence of field edges and corners in the local area and would value seeing more of that.

Table 4.6 Stoke Ash deliberations

Provisioning Food	• Food production is highly important for the local area. • Food production is compatible with increased wildlife. • What if a local community wants a different, more mixed form of farming with local production? • Encourage farmers to provide for community gardening/allotments close to villages • Local and seasonal food are important

	• We need more diverse agriculture and then we'll have more diverse landscapes and biodiversity and livestock can supply slurry for nutrient cycle • It's essential for arable farms to have profitable businesses in order to provide some of the wider benefits.
Freshwater	• Water is going to be the limiting factor for agriculture in the future. • It's not an issue here on the clay lands. • Need more on-farm ponds and reservoirs.
Timber and fuel	• Timber and wind aren't suitable here. • Producing biofuels is at the expense of food production • The worst scenario would be to start growing biofuels in order to offset importing high food miles produce from overseas • Farms could provide provisioning services other than food only if there's someone who's willing to pay for them. E.g. coppiced wood. • Timber and biofuels would have to be on the most marginal land. • Incorporating straw back into the soil is more important than for energy
Cultural Recreation & tourism	• Lots of PROW are not very much walked , but farmers could do a lot to make them more used (signage, circular routes etc) • Farmers need a bit of cross-compliance where they get paid per Km well maintained • Footpaths can disturb the peace and quiet, e.g. noisy motorbikes, horses. • There's no need for new footpaths, just open up the existing ones and link them up. • Our Parish has a good network of footpaths.
Learning	• Learning should be linked to biodiversity because intensive farms are very dull. Diverse farms are more interesting. • If communities were more involved in farming, it would be easier to incorporate all of the ecosystems benefits, connecting people back to the land. • There is a disconnection between farming and consumers – people don't know where food comes from or what it involves to produce it • There is huge demand for school visits to farms – lots of interest. Farmers can get paid through HLS. It's difficult for schools to pay unless the farm is offering facilities such as a work room, wash rooms, picnic areas etc
Health, peace and quiet	• We live in a very beautiful county, which is a fantastic resource and which is important for health. • Farming generates nuisances so we can't expect a lot of peace and quiet. • But it is important that people get access to the opportunities for peace and quiet
Sense of place, history and spiritual values	• People think of this area as prairie land, but actually it's more wooded than many other areas • Looking at the landscape that we thought we had shouldn't be the only thing shaping farming patterns • Really appreciate the sense of place in the area and want it to stay looking as it does. • Accept the need for big fields but really appreciate where hedgerows have been put back and the grass margins and ditches with grass
Regulating Climate regulation	• People in this part of the world will achieve more on climate regulation by changing their lifestyles than farming can. • We could be doing more with new approaches such as agro-forestry. • Non inversion and non tillage improves the soil and locks up carbon. There is a yield penalty but it feels like going in the right direction • Biochar is great for some soils but you need to have nearby production facilities
Water/flood	• This isn't really a farming issue at all. Houses shouldn't be built in flood plains, and we should expect floods from time to time anyway. • One of our local landowner has built a wetland area, which has increased biodiversity and reduced flooding in the village (Helmingham). • Farmers can enter into an agreement with EA to flood land in return for payment, or even to leave land permanently flooded. • Management of local farms will definitely affect flooding lower down in the Deben • Some local farms are re-recreating water meadows to hold flood waters and slow the rate of run off – but depends on the other benefits provided by the land • Reservoirs on farms • Wetheringsett is in a hollow and liable to flooding – not sure how much affected by ditch management etc.
Erosion control	• If supermarkets want perfect potatoes then you have to take stones and clods out of the earth and then you start to get compaction, faster run-off • There is not too much wind erosion here. • But we do get mud on the roads.

Pest, disease etc	• Helmingham's experience of non tillage and non inversion has shown increasing populations of beetles and a reducing requirement for slug pellets (down from 200 t to 40 t a year). • GM crops could be important in disease and pest control and reduce the need for pesticides but this has to be compatible with not losing biodiversity. • Beetle banks, set aside areas. Pollen and nectar margins to encourage pollinators in the mono-crop deserts e.g. bees in oil seed rape
Supporting Soil formation	• Soil is fundamental but needs to be managed on a catchment wide basis
Nutrients	• Lots of manure and straw from duck and poultry production (e.g. Gressingham Duck nearby) is stored and applied to local arable fields. • Before the war manure and coal and wood ash was being brought out of London by Thames barges and reincorporated in local arable fields – we need a strategic response to this problem • Helmingham is using human sewage sludge (by product from methane energy production at Ipswich waste treatment farm) for spreading on farmland – rich in phosphate. • Note that selling straw also has a cost in terms of the need to replenish nutrients • It's not sustainable to produce fertilisers from oil. We need to be preparing for using the land differently – how to farm with communities, on a small scale, sustainably and localised. • More mixed farms including livestock to fertilise soils
Wildlife and biodiversity	• Really been seeing an increase in wildlife and farm birds over last 5 years since hedgerows have been replanted/ regenerated and field margins and headlands been left unplanted. Barn owls, grey partridge, skylarks all more common and good indicators of wider biodiversity. • Seeing more voles and shrews and therefore more barn owls.

4.3 FENS SCALE WORKSHOP

A final workshop was held with steering group members in their roles as representatives of stakeholder bodies with interests in Ecosystem service delivery across a wider landscape. The focus was on the Fens. A characterisation of ES at this scale was based on work by Natural England for the Fens Natural Character Area (NCA 46) and outputs from the assessment of the pilot farm in the Fens. This is summarised in *Table 4.7*.

The scoring of individual ESs by individuals and by groups through deliberation are summarised in *Table 4.8*. The range and standard deviation between individual scores is shown in *Figure 4.9* while the differences between individual scores and group scores, after deliberation is shown in *Figure 4.10*. At this scale participants tended to place higher value on regulating ESs and lower ones on cultural services than local groups around the Fens pilot farm had done.

Table 4.7 Assessment of Ecosystem services provided by arable farmlands in the Fens

Provisioning Food	89% of the soils in the Fens are Grade 1 and Grade 2 soils resulting in a rich and varied agricultural land use including wide range of cereals (44%), cash roots potatoes and sugar beet (15%), vegetables (11%), oil seeds and livestock. By 2009 +3000 holdings (falling since 2000), 77% of holdings >100ha. In reality consolidated farms are much larger. Average gross margins of £1000/ha.
Freshwater	770 km of rivers and dykes draining to sea. Major rivers including the Great Ouse, Nene, Witham and Welland are increasingly artificially channelled. 94% of area Nitrate Vulnerable Zone. Water table is naturally high. The Ely Ouse to Essex Transfer Scheme transfers surface water to Essex (Rivers Stour and Pant) and uses groundwater to augment flows in the Little Ouse. The scheme has been developed to support river flows and abstractions for public water supply in Essex. At times of low flow there is insufficient water in the Ely Ouse to meet abstraction demand for the Transfer Scheme. As a result, a supplementary scheme has been developed using a series of groundwater boreholes to pump water into the Little Ouse and Thet Rivers with an additional transfer from the Little Ouse at Hockwold. On-farm ponds also slow water flow to the sea and are used for crop irrigation or livestock.

Timber and fuel	Woodland and hedgerow cover very sparse (areas >2ha only 0.5%) plus some shelter belts and pollarded willow. Oilseeds (OSR and linseed fast growing crops). Growing number of wind turbines on Cambridge County Council land and increasing number of on farm wind and - most recently - solar farm planning applications being received.
Cultural Recreation & tourism	2,314 km of PROW with a relatively low density of 0.60 km/km^2. Recreation much less than the broads (small game shooting & fishing) but birdwatching popular and opportunities for more circular walks, cycling, wild skating.
Learning	Farm Sunday initiative of open farms has proved very popular
Health, peace and quiet	Tranquillity is an important feature of the NCA, with 64% classified as undisturbed according to the CPRE Intrusion Map 2007 (representing a decrease from 90% since the 1960s). The open and empty landscape means different things to different people; some can find it featureless and intimidating whereas others find it exhilarating and value its tranquillity, which still persists away from the settlements and major transport corridors.
Sense of place, history/spiritual	Large-scale, flat and open reclaimed landscape with long views and expansive skies. This feeling of scale is further emphasised by the rich and varied intensive agricultural land use that produces strong seasonal changes. A hierarchy of embanked rivers, drains and ditches form a distinct geometric pattern and provide a strong influence throughout the area. Marshes, swamps and fens add a further distinct character, notably adjacent to the Wash where the exceptionally open aspect is broken only by sea walls. Despite apparent uniformity, marked variations occur throughout the Seen as very distinctive landscape which reflects a distinctive economy. Changes in farming (larger farm sizes, loss of boundary features, and loss of farm jobs) impacted negatively on sense of place and community.
Regulating Climate regulation	High input systems (fertilisers, energy for refrigeration) produce GHGs. Tillage of crop land releases CO2. Only 11% of the area is grassland. Loss of carbon storage by oxidation of peat and the subsequent release of carbon dioxide is a major concern. Recreation of wet fens, wet grassland and washland together with changes to arable management (specifically minimal tillage, greater use of organic manures, biosolids and digestate plus soil conditioners such as biochar) could help to ameliorate these losses if pursued on sufficient scale. Careful land management when re-wetting will be required to curb methane production. Opportunities for carbon storage in peaty soils would be at the expense of food production.
Water/flood	The Fens represents the outfall of four major catchments (rivers Witham, Welland, Nene and the Great Ouse). The area is low lying (average 2.33 m asl) with many areas below sea level (and of rivers and drains) and the Environment Agency Flood Risk map indicates that the majority of the Fens is at high risk of river and coastal flooding. Thousands of acres of land have been inundated with crops lost, livestock drowned and infrastructure swept away from a common flood pattern experienced between January and March. Farmers pay £50/ha to Independent Drainage Boards for pumping which also benefits settlements. Opportunities for alleviating flood by creating space for water on sizeable areas of lowland fen, reedbeds, coastal floodplain grazing marsh, and wet woodland concentrating on areas at risk near settlements. (e.g. RSPB Ouse and Nene Washes)
Erosion control	Soils over the coastal and central fens are rich, fertile calcareous and silty. Further inland soils are defined by dark, friable fen peat vulnerable to peat wastage from shrinking and wind erosion of exposed soils. This is particularly problematic with spring-sown root cropping (e.g. sugar beet, carrots, parsnips) where land is exposed throughout the winter and harvesting in wet conditions can be unavoidable. Fen blow exacerbated by 'prairie' field sizes, crop rotations and lack of windbreaks. Erosion can involved substantial remediation costs to farmers (clearing ditches and lost crops) and to communities (clearing roads)
Other – pests, pollination, water quality etc	Arable farming currently produces negative impacts on 'other' ecosystem services. Pest control is mainly by chemical means and pollination is mainly important for oilseed rape and bean crops. It is mainly spaces between crops (such as the banks of ditches and dykes and the edges of farm tracks) that are the key sources of both pollen and nectar and provide over-wintering habitats for beneficial predatory invertebrates (e.g. ground

	and rove beetles) that feed on pests. Pollination most important for numerous - although diminishing - 19th century orchards and associated shelter belts in the area around Wisbech. Excess nitrates, phosphates and pesticides leaching into watercourses from arable and horticultural food production are identified as issues within Priority Catchments and have led to diffuse pollution and eutrophication in water courses, while sedimentation (resulting from soil erosion) of rivers is also a feature.
Supporting Soil formation	Overlying soils made up of clay and silt (61%), Peat (17%). The dark humus rich peaty fens and the finer lighter silty fens add a distinctive tone to the landscape and are the key natural resource that results in the area being a major producer of foods. Loss of soils has direct costs to farmers (see erosion above). Corn stubble being widely sold for power production.
Nutrient cycling	Nutrients mainly replaced with NPK fertilisers. Reduction in livestock numbers (except poultry and pigs) has reduced manure availability. Opportunities for green manure and break crops.
Wildlife and biodiversity	Predominantly cultivated with little semi-natural land remaining. Clearance and drainage of the Fens over the last 300-400 years has led to a dramatic loss of fenland habitat with a high toll on biodiversity with loss of specialist plants and invertebrates which depend on the fenland environment. Many species are known to have become extinct, although the Great Fen Ragwort did re-appear in 1972 from buried seed after a period of documented extinction. Fragments of relic wet fen such as Wicken, Woodwalton and Holme are biodiversity hot spots that are diverse in terms of micro-organisms, are entomologically rich, contain many species of plants, birds and mammals and attract many visitors as a consequence. There are over 13,057 ha of BAP priority habitats covering approximately 3% of the Fens. Habitats include 5,564 ha of coastal and floodplain grazing marsh, 4.091 ha of lowland meadows, 1,729 ha of purple moor grass and rush pastures, 657 ha of reedbeds and 362 ha of fens. Other habitats (each covering less that 300 ha) include mudflats, saline lagoons, coastal vegetated shingle and sand dunes, wet woodland together with lowland mixed deciduous woodland, lowland calcareous grassland and lowland heathland. The Fens contain 5 SPAs, 6 SACs, 6 RAMSAR sites and over 8,938 ha are nationally designated as SSSI (2.34% of which only 70% are of good or recovering status). On arable land banks provide good grazing and grassland habitats while small scale habitats (ditches, drain, small watercourses and field margins and headlands) provide some wildlife connectivity. Declines in Water Vole and farmland birds.

Source: Natural England, (March, 2011a & b), National Character Area: 46 – The Fens: Character Area Profile, Description report and Facts and Data Report.

Table 4.8 Average values placed by participants on ESs in a general sense when asked to score from 0 to 10 and by groups when asked to score their importance for the Fens

Ecosystem service	Importance for Individuals (7)		Importance for the Fens	
	Ave	SD	Table 1	Table 2
Food	10.0	0.0	10	9.5
Freshwater	9.0	1.6	10	7
Timber and fuel	5.3	2.9	5	4
Recreation	6.3	1.0	2	3
Learning	5.4	1.0	5	3
Health	6.9	1.6	7	6
Sense of place	7.4	0.9	4	7
Climate regulation	7.9	1.2	9	8
Flood	8.3	1.3	10	9
Erosion	7.9	1.1	8	8
Disease, pest, pollin etc	0.0	0.0	7	4
Soil Formation	7.7	1.2	2	5
Nutrient cycling	8.0	0.5	7	5
Wildlife & biodiversity	8.1	1.5	6	8

Figure 4.9 Newmarket: average and standard deviation of value scores

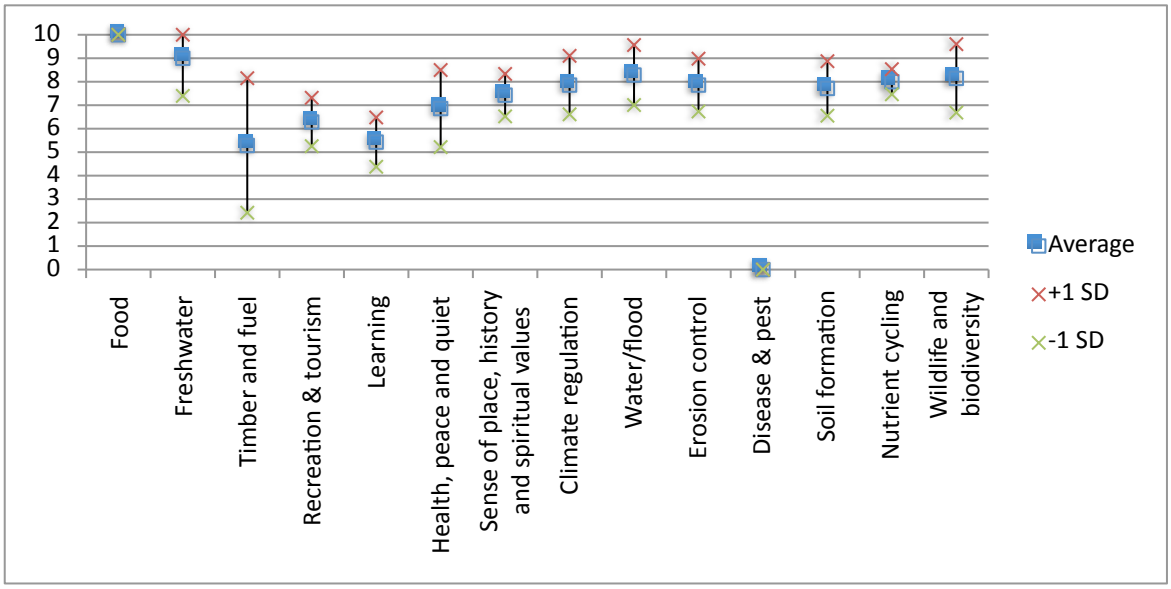


Figure 4.10 Newmarket: comparison between general and locally specific valuations

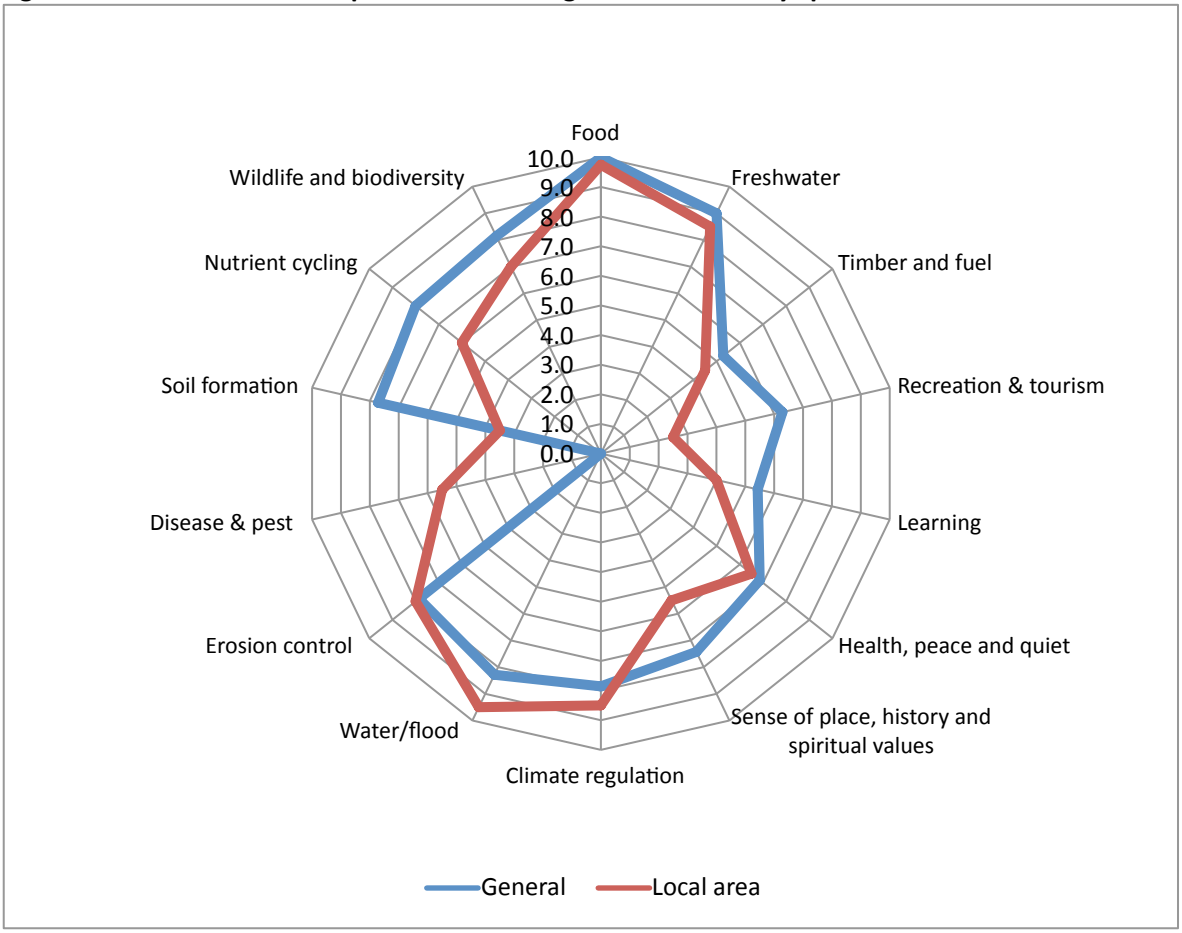


Table 4.9 Fens deliberations

Provisioning Food	Food security is a major issue rated at 10 by both groups but reduced through deliberation 9.5 to reflect desired balance in climate regulation and biodiversity. Fruit is an important crop around Wisbech.
Timber and fuel	Potential for fire and fuel wood is low in the Fenland (scores of 4 and 5) landscape but maybe this benefit area should also include renewables and particularly on farm solar and wind. The first applications for solar farms in the Lincolnshire part of the Fens are already being received. But this would be at the expense of food production. Visual impact of turbines is not necessarily a problem here because people see it as a working landscape.
Freshwater	The two groups scored water at 7 and 10 respectively. Although freshwater provision is generally not considered an issue for the area because of the naturally high water table and rivers and drains flowing to the sea this is likely to become more of an issue with climate change. Arable chalk lands filter groundwater in Cambridge, Suffolk and Norfolk. The Great Ouse is already diverted north of Ely to feed the Amberton Reservoir which supplies Essex. Diverting freshwater could have implications for siltation of rivers and of water availability for irrigation for downstream farmers. Farm reservoirs provide massive benefits.
Cultural Recreation and tourism	Groups identified a trade off between recreation/tourism and sense of place and did not score recreation highly (2 and 3) for the Fens because of the low population density, with most tourism opportunities on the Fens fringes near major population centres. Through discussion the initial score of 4 was reduced to 3 for one group as they agreed that informal recreation opportunities are limited by the network of water features with few crossings and that tourism (spend) benefits are mainly enjoyed by those running a few honeypot sites such as nature reserves.

Education	Likewise education seen as relatively unimportant in the Fens (scored at 3 and 5) because of low population density, although there are lots of arable land learning opportunities on the Fen edges e.g. at Cambridge and Spalding. However, education about farming in general was seen as important in helping people to value local food and understand why it costs more.
Health, peace and quiet	Peace and quiet rated highly – even by those not living or working in the Fens - because of the sparse population (scored at 6 and 7). Seen as important for quality of life after food production.
Sense of place	Sense of place was seen as important (7) by one group which felt the specialness of the Fen's wide open landscapes was closely related to low tourism numbers and that if visitor numbers increased the character of the landscape would be spoilt. The other group saw the sense of place as much less important (4) because they do not live there although its uniqueness and history was acknowledged.
Regulating Climate regulation	Seen as very important in terms of the big picture (scored at 8 and 9) but with less clarity about whether there are opportunities to do anything on a large scale to reduce carbon emissions or store carbon in soils in the Fens. Discussions highlighted that nitrogen fertilisers can have lower carbon impacts per tonne of food produced than organic production (which requires larger areas and longer rotations). Precision farming in the Fens helps to reduce climate impacts.
Water/flooding	Flooding is seen as a local issue of great importance (initially scored at 10 by both groups) on a par with food production. However, the unforeseen consequences of managing flood waters to prevent flooding of farmland by rewetting some areas to create space for water and in the process creating habitats which have been designated and so reduced opportunities for food production was noted. Through deliberation flood benefit scores were reduced to 9 by one group.
Erosion	Very important on almost all Fens soils (score of 8) and closely linked to food productivity. The future of the Fens depends on erosion control.
Pest and disease control	Initially crop pests and wild bird grazing of crops seen as quite important (7 and 5) but through discussions and in the context of major countryside pests (deer, rabbits and wood pigeons) across the East of England one group reduced the score to 4.
Supporting Soil formation	Soil formation and nutrient cycling seen as closely related to soil erosion, freshwater and food production. Soil formation as opposed to halting erosion not seen as a real possibility for the Fens. Nutrient cycling seen as more important (7 and 5) with some opportunities for less reliance on NPK fertilisers. We have a duty to flag the importance of nutrient cycling as an issue to policy makers.
Nutrient cycling	
Wildlife and biodiversity	Biodiversity was rated very highly (8 on a par with flooding for one group) as the biodiversity of the Fens is unique and the group felt that more actions are required by farmers in order to enhance it. Actions need to be both on a larger scale (based on outcomes of the Lawton Review) with some bigger patches of habitat creation as well as current field edge activities to improve connectivity between habitats. The other group felt that this was of secondary importance compared to food and water for the Fens.

Monetary Valuation

The Fens workshop involved an additional round of deliberation, during which we asked participants to use monetary values to identify how they would allocate a fixed budget of public spending to secure the Ecosystem services that they most valued in the Fens. Each participant was given £1,574 in monopoly money in denominations of £1, £5, £10, £20, £50, £100 and £500. The total allocation by the 8 participants, the average spend per head and the percentage of the total budget allocated by ES is summarised in *Table 4.10*.

Table 4.10 Monetary scores for Ecosystem Services Delivery in the Fens

	Total allocation – 8 participants (£)	Average per participant (£)	Average allocation, (percentage)
Food	3220	403	26
Freshwater	680	85	5
Timber and fuel	354	44	3
Recreation & tourism	209	26	2
Learning	304	38	2
Health, peace and quiet	251	31	2
Sense of place	608	76	5
Climate regulation	1599	200	13
Water/flood	2365	296	19
Erosion control	400	50	3
Disease & pest	44	6	0
Soil formation	21	3	0
Nutrient cycling	120	15	1
Wildlife and biodiversity	2416	302	19
Total	12591	1574	100

When asked to allocate monetary values to ESs, participants' behaviour changed from the previous scoring approach. When given the opportunity to allocate 'real money' about half the participants only allocated money to the top three or four ESs of most interest to them, while the others spread their resources more thinly, allocating small amounts to most ESs.

However, these differences in behaviour did significantly change the outcomes: the vast majority of resources (77%) were placed on four priorities for the Fens, namely food, climate regulation, flood regulation and wildlife and biodiversity. The remaining 23% was thinly spread over the remaining 10 ESs. Two areas - freshwater provisioning and sense of place – were each allocated 5% of the budget.

It is interesting to note that the top 3 ESs – food (1), flood (2) and climate regulation (3) were the same in both exercises. The real differences between the exercises were in:

- valuation of wildlife and biodiversity – which was important to individuals, scored down by the groups and then became very important again when monetary values were assigned (moving from sixth to joint second);
- freshwater provision, which was ranked highly by individuals and in group discussions, but was seen as much less important (moving down from joint third to joint fifth place) when valued in money terms. It is not clear whether this was because participants were asked to assign public money to this area; and

- erosion control which was scored as very important (8) in the Fens by both individuals and groups, but only attracted 3% of the available budget in the monetary valuation exercise.

4.4 CONCLUSIONS

In conclusion, the workshop methodology was largely successful in:

- Bringing together a diverse group of local people who enjoyed the opportunity to feed in to policy-making and to meet others in the area who shared their interests;
- Informing them about ecosystem service concepts and the rationale for valuation in an accessible way that they felt they understood, and giving them opportunities to learn from each other and technical experts;
- Enabling deliberative discussions involving many different viewpoints which allowed their understanding and assessment of the importance of Ecosystem Services to evolve;
- Coming to 'valid' and interesting conclusions about the future balance of delivery of ecosystem services in each locality using a spider diagram which allowed groups to discuss and refine their individual scoring of the importance of key services or benefits; and
- Demonstrating how this quantitative assessment can be further refined when participants are asked to allocate 'real public money' to increasing Ecosystem services.

Table 4.11 summarises the key points which emerged from the workshop deliberations about each of the ecosystem service areas and the value that participants placed on them. Together with the summary of monetary valuation techniques in *Section 2.5*, this starts to become a 'toolkit' for farmers understanding and communicating about ecosystem service values on their farms to local areas.

Table 4.11 Summary comments on results of ES valuation exercises

Ecosystem Service	Comments and deliberations
Food	Overall #1 in all settings. But desire for more local, seasonal and less intensively produced – not necessarily organic - food. And more diversity of livestock, crops, rotations and cover crops. Importance both for local economy and global food security.
Freshwater	Generally high for individuals but then reduced by deliberation - closely related to views on food and knowledge of local aquifers and drainage.
Timber and fuel	Generally low. Recognised as an important national issue but limited on-farm opportunities in arable landscapes (particularly Fens and coastal Essex) unless biofuels at the expense of food. More interest renewables such as solar and wind.
Recreation	Surprisingly mid-table. In all cases became more important through deliberation. Agreement that more effort needed to enhance farm PROWs (interpretation, circular routes) but closely linked to health. Also important in Dengie and Hertfordshire as an opportunity for sustainable local economy.
Learning	Initially mid table but became a key issue in group discussions. 'We need to understand where our food comes from and at what course – vital'. Understanding farming strengthens respect for the local area. Open Farm Sundays valued everywhere but recognised as costly to farmers but worthy of support.
Health	Walking and peace and quiet key issue for both individuals and groups. Opportunity for more access for urban populations and volunteering etc.

Sense of place	Pushed up to #2 in group discussions and people discussed what they really valued about their locality – '*people need to care about and respect our countryside*' '*it's why we live here*'. Efforts by farmers to regenerate or plant hedgerows were recognised and appreciated (especially in Stoke Ash) Interesting linkages made under this service with agricultural skills/jobs and aspirations for young people to go into farming being lost and impacts on the sense of community.
Climate regulation	Recognised (mostly) as globally important. Widespread support for farms being energy self-sufficient but no consensus about opportunities for carbon storage in soils at the expense of food production. A widely held view was '*one area or farm can't provide everything*'.
Flood	Local importance of the role of farms recognised in Dengie and the Fens (where the impacts of urban settlements higher in the catchment were also recognised. Growing importance in the face of climate change was recognised.
Erosion	Through deliberations erosion (and soil and nutrient cycling) mostly increased in importance and recognised as closely tied to food productivity, water quality, and flooding. Through discussions erosion and soil rated very high in the Fens as people realized the implications of peat loss.
Disease, pest, pollination etc	Generally low – probably because of lack of clarity of issues packaged together as scores tended to increase after discussions. Recognition arable currently provides dis-benefits for water filtering, pest control etc but with opportunities to improve e.g. creating habitats for insects also good for biodiversity. Discussions about the future role of GM crops were raised as relevant here.
Soil Formation & Nutrient cycling	Tendency to treat both supporting issues together and with soil erosion. No difficulties in understanding the concepts (sometimes referred to as 'good husbandry') and recognised as vital for food and biodiversity. Scores almost always increased as groups discussed opportunities for non-chemical/intensive solutions (green manure, cover crops, low/zero tillage, biochar, animal/human manure etc.) and the positive impacts these might have on other ESs.
Wildlife & biodiversity	Very highly scored and important to individuals (#2) but moderated down by groups (#4) through discussions, largely it appears in relation to the previously unrecognised importance of other cultural and supporting ESs. General feeling that – based on local experts and walkers sightings of small mammals and farmland birds – there has been a big improvement in recent years since farmers have been paid to encourage biodiversity. Dengie and the Fens areas were recognised as being important for rarer species too and measures to support the work of Wildlife organisations were appreciated. But opportunities to do more on farm were also identified, especially in Dengie and the Fens.

5 CONCLUSIONS, LESSONS AND RECOMMENDATIONS FOR DECISION MAKERS

5.1 INTRODUCTION

This section presents our conclusions from the literature reviews, case studies and public dialogue workshops. It also incorporates conclusions from the landscape scale workshop held at Newmarket 14th March which was designed to:

- Test the methodology at a slightly larger spatial scale
- Be held with a group of technical experts and decision-makers from a wide range of interests rather than with the general public; and
- Include an exercise to try and link the monetary valuation and scoring/ranking approaches taken so far.

5.1.1 Valuation of Ecosystem Services

Despite concerns that a valuation approach is anthropocentric and does not fully recognise the intrinsic value of ecosystems and their services, there is now quite a body of research which can be used to derive monetary values for many aspects of arable farming. There is also growing interest in using this approach by both farmers and others. Our conclusions about how these values can be applied to arable land are summarised in Table *5.1*.

Care needs to be taken when using these figures, particularly for cultural benefits (e.g. of recreational and health benefits) and erosion, soil and nutrient cycling supporting services or using transfer values for biodiversity or habitats which could involve some double counting of other ecosystem services categories.

It is also important to recognise that some of the services provided by farmland (particularly under our catch-all 'other regulating services' category) are currently in fact negative benefits or externalities from intensive farming. These have been quantified elsewhere (Petty et al, 2000). While the opportunities for changing practices to increase farming's net benefit have been identified in discussions they are not currently reflected in the monetary valuation.

In conclusion, since monetary valuation is intended to help decision makers at all levels ensure that the wider benefits or ecosystem services of farming are recognised alongside food production issues, we feel there are some values which can usefully be applied in a number of areas. However, there are still gaps which need to be filled by further research or through involvement of local people in revealing and discussing their preferences.

Table 5.1 Summary of scope for using monetary valuation for the ESs of arable land

Provisioning services	Valuation techniques are well understood and data is easily available to estimate the yields per hectare, market prices and variable costs for food, fibre, fuel and biodiversity benefits associated with game hunting, medicinal crops or wild produce. Generic values for provisioning services on standard cereals farms in the East of England can be taken from gross margins from the Farm Business Survey and are estimated at more than £900/ha in 2009. The figures for larger, highly mechanized, high input farms are likely to be higher. Values will vary from year to year largely depending on market prices of wheat. Increased provision of regulating or supporting services is often – but not always - at the expense of some reduction in the quantity or quality of food production. These impacts can be calculated on the basis of income foregone from reduced cropping areas, lost yields or impacts on market prices.
Cultural Services	Many studies have been undertaken of the value of cultural services, mainly using Contingent Valuation and Travel Cost methods. Valuation is based on the direct outputs (e.g. quantity of habitats and features maintained or created and number of visits). Studies suggest that households are willing to pay more than £4/visit - and therefore derive value from - the most attractive or wildlife rich sites and up to £35/visit to woodland. Arable farms are unlikely to provide this level of benefit. However, studies also suggest that local populations (within 5 miles) are willing to pay up to £0.40/mile for new access on arable land. Health benefits have also been calculated in terms of costs avoided by the NHS and sick days avoided by local businesses by people taking regular access on circular footpaths. These values range from £31,000 pa for a new 3km footpath in Mid Suffolk to £85,000 pa in the most densely populated parts such as Hertfordshire, averaged over the total area of the farm. However, discussions with local communities suggest that on-farm footpaths may be much less widely used than footpaths in parks and parkland. Other cultural benefits such as education and sense of place remain difficult to value for arable farms without location specific studies.
Regulating Services	Valuation of regulating services requires more detailed scientific knowledge and site specific data on the relationship between different on farm measures, local characteristics and their impact on the regulating services. If this data is available then valuation of the benefits is relatively straightforward using market based methods (changes in yields, shadow price of carbon), or defensive expenditures avoided. Climate regulation is perhaps the easiest regulating service to value based on the growing body of knowledge of carbon sequestration, storage and emissions avoided for different land types. The CALM model allows farms to calculate these benefits and offset them against their emissions of other green house gases. Values for other regulating services such as flood alleviation, erosion control, air and water regulation, pollination and pest control depend on local conditions and a better understanding of the relationship between land management and services provided, although we have provided generic estimates for the costs of property protected and the replacement costs of nutrients lost through soil erosion.
Supporting Services	Soil formation and nutrient cycling benefits for farmers can in theory be valued using market based methods to value the impacts of soil and nutrient loss or formation on food, fibre or fuel yields. The costs of replacing nutrients using artificial fertilizers can also be estimated relatively easily. However, we have not included generic values for these supporting services as there would be a risk of double counting erosion control benefits to farmers.
Wildlife and biodiversity	There have been many attempts to identify the total economic value of biodiversity or specific habitats, mainly using contingent valuation techniques. While some of these studies could be relevant to arable farm settings much more detail would be required on the relevant population to apply WTP estimates to in order to come up with generic rates per hectare for on farm habitats or species. There is also a risk of double counting

	cultural and regulating service benefits. We therefore propose that a valuation figure of £30/ha is used for biodiversity services provided by farmland entered into ELS and values for specific non arable habitats – such as wetlands, grassland or woodland – transferred from other studies only where new habitats have been created.

5.2 PUBLIC DIALOGUE FINDINGS

The following sections summarise our findings to date on the methodologies, outcomes and role of public dialogue in assessing the value of arable farming ecosystem services.

5.2.1 Ecosystems concepts and language

Many of the regulating and supporting functions and ecosystem services involve complex ideas and academic language that and we anticipated might be off putting or inaccessible to members of the public. Mindful of this challenge we tried to use the term 'wider benefits' of farm land rather than ecosystem services wherever possible. We also used a lot of visual material using photos and colour coding for explaining different ecosystem services. We attempted to use plain English throughout.

Based on the four workshops we found that:

- Most people did not have any problems in engaging with the underlying concept or the language used: rather they showed a good understanding of the ideas and importance of most of the categories of services, and valued them highly.
- Participants particularly liked the spider diagram approach to valuing and relating different benefits because it showed the holistic nature of the ecosystems approach and the interrelations between services.
- In only one case did a participant say that they did not feel they knew enough to quantify the value of the services but that was in relation to lack of understanding of farming policy and subsidies rather than ecosystem service concepts.
- The exception was the 'other regulating services' category, possibly because a number of disparate services were grouped into one category in order to make the overall number of categories manageable, or possibly because they were more complex services, some of which are currently actually dis-benefits associated with of agricultural production. For instance, use of fertilizers, pesticides and herbicides and their impacts on water quality, pest control and pollination and the introduction of GM crops and pest control all were raised under this heading.
- Some services – specifically supporting services of soil formation, nutrient cycling and biodiversity which we had anticipated being difficult for participants were highly rated and their links with food production and good husbandry were very well understood.
- Treatment of wildlife and biodiversity as a standalone supporting or overarching theme appeared to work well, with participants often giving it a high ranking.

In summary we felt that the language of 'wider benefits' worked well and was accessible to all participants, even those with little prior knowledge. However, we feel that more extensive use of the term "Ecosystem Services" could well have meant participants were less clear about the subject of the workshops.

5.2.2 Methodology: individual scoring and the spider diagram

Some other observations and conclusions about the scoring methodology can usefully be made:

- With such small groups of people, the results are clearly not statistically robust, and it is in no sense a 'vote' by the local community for what it wants, but nonetheless it is a useful way of eliciting views from interested individuals who care about what happens on particular areas of farmland.

- In reviewing and synthesising the comments and discussions at the workshops, it has been possible to come to some broad conclusions regarding the value placed by participants on ESs. However, it was very clear from listening to the discussions at each individual workshop that a range of views was held on many ES issues, and in some cases it was difficult (and occasionally impossible) to come to a consensus. Similarly, the two groups at each workshop did not always concur about the particular value (0-10) to be placed on each ES, and in some instances differed markedly. A further round of deliberation as a whole group might have started to address this, but it was not possible to test this within the available time.

- The views expressed at the workshops about the nature of the values participants place on ESs in the local area (see *Tables 4.3 to 4.6 in section 4*) have been used to inform the evaluation of ESs carried out by the consultant team as summarised in Section 3. However, it has not proved possible to use the workshop outcomes to improve the quantification of ES values for the case study farms where there is insufficient existing data to enable monetised values to be placed on specific ESs. There are two main reasons for this:

- The workshops enabled us to understand much more clearly what participants regard as important, but not what monetary value might be attached to that.

- The valuation exercises enabled participants to attach a value of 0-10 to each ES. This allows us to understand relative values, whereas in reality the monetary value of food provisioning tends to be orders of magnitude larger than other ESs. Note that the spider diagrams produced by the consultants in Section 3 have a logarithmic scale (0-1000) whereas the spider diagram used by workshop participants has a linear scale (0-10). This therefore does not translate into monetary values on a realistic scale.

5.2.3 Monetary valuation of Ecosystem Services

The final workshop attempted to move the approach forward by giving each participant a 'budget' to allocate across areas they wanted to see increase. When asked to allocate 'real public money' to different ecosystem services the participants' behaviour changed from the previous scoring approach. About half the participants only allocated money from their individual budgets to the top three or four ecosystem services of most interest to them, while the others spread their resources more thinly, allocating small amounts to most categories.

The vast majority of resources (77%) were placed on four priorities for the Fens, namely: food, climate regulation, flood regulation and wildlife and biodiversity. Two areas - freshwater provisioning and sense of place – were each allocated 5% of the budget. The remaining 13% was thinly spread over the remaining 8 ecosystem services. This quick exercise showed that the top

priorities changed little between the two approaches. However, in order to make a fully-considered allocation, participants would have needed to know more about the relative costs to farmers of delivering more of the desired services.

Participants commented that this exercise lacked the element of deliberative discussions which were felt to be useful and important, and therefore that it should be carried out in addition to and not in place of the spider diagram exercise.

5.2.4 Participation in public dialogue

Recruitment

The approach to getting public participation in the workshop sessions was based on a time intensive but relatively low cost approach which involved:

- Analysis of the kinds of stakeholders in the area and starting with those likely to have a general interest in local decision making because of their existing engagement in the community (parish councils, community groups, individuals with environmental, recreational or cultural interests in land management);
- Inviting people to have a go at being part of the 'Big Society' e.g. parish councils, WI, community groups;
- Contacting individuals and organisations using telephone, email, posters in central locations (e.g. village shop or post office where applicable) or information items at local meetings;
- Resisting the temptation to rely too much on key individuals' or organisations' networks which might have skewed the groups.

We found responses were surprisingly positive: almost no one was uninterested; many others would have liked to come including local farmers not involved in the case study. The only group that did not want to take part were the case study farmers – with one exception – possibly because they feared the group discussions would be hostile. In practice the discussions were very supportive of the challenges that farmers face: the case study farmer who did attend certainly accrued social capital in doing so.

We also found that, despite lessons learnt from other public dialogue processes – e.g. around planning decisions – that a long lead (typically 6 weeks) is required to recruit participants, the subject matter was interesting enough to very local audiences to require a much shorter recruitment period and indeed two weeks would have been adequate. Indeed a longer lead would not necessarily have produced any better results.

In conclusion, while it is challenging and resource-intensive to get the public to participate in any process without the immediate outcomes and possible impacts of, for example, a local planning application, it was not as difficult as expected in this case. However, applying this process to other local land use decisions would also require a significant commitment of time and effort to secure participation.

Willingness to Engage

Participant's evaluations were largely positive (see Annex A) and it seems that participants derived benefits from the workshops as well as the organisers.

Generally participants were very engaged with the subject matter and appeared to care very much what happened. They seemed pleased to be part of a wider policy process. All participants were very keen to see the outcomes of the process and how it would feed into the policy process. They were also keen to see how their own discussions compared to those in other areas and so all participants were sent a copy of the workshop report for all 4 areas.

- *'Very interesting and enjoyable - I'd like to believe our thoughts and comments might have some influence, however small, on government policy*'
- Interesting to hear ….. '*discussion from range of groups', 'to hear other views', 'such diverse views' 'local views*'
- '*Good idea to engage with local people*'
- '*invited participants were very well-informed*'
- '*it would be interesting to use this process for village planning*'

In many areas participants brought considerable expertise and local knowledge to the deliberations. Even those that described themselves as knowing little about farming or environmental issues were happy to be recognised as 'expert' in their assessment of the importance of cultural services and pleased to have their views taken into account by others.

Without effective facilitation it is, however, possible for some individuals to dominate discussions and 'bully' others into accepting their views in table discussions.

Facilitation

The process proved a lot less controversial than we had expected, but there is always the potential for conflicts to arise as people held strong views about some ecosystem services. Our approach to facilitation was therefore based on Sciencewise principles and in particular:

- Using an independent facilitator who understood the ecosystem services approach but whose focus was on delivering a fair process with no in-built bias;
- Agreeing ground rules at the outset to help avoid confrontation and ensure that no faction was allowed to dominate discussions and that all participants were treated respectfully;
- Allowing time and space to enable participants to understand and question others' claims and knowledge; and
- Encouraging deliberation and allowing participants to reflect on their own and others' views and explore issues in depth with other participants.

Based on the experience of the four workshops:

- Tables of up to 10 worked best for deliberative discussion (although lower numbers allow each participant more 'air time');
- Estimates of attendees in advance indicated that one table would accommodate the participants at each event and we did not want participants to perceive the events as being 'overstaffed'. But as it turned out, our estimates were exceeded, and 2 tables were needed in each case. In these circumstances, a facilitator as well as a note-taker/expert at each table would have helped ensure full participation as well as a full note of points made.

Based on the experience of the four workshops we therefore recommend that future workshops seek to:

- Involve a neutral and experienced facilitator. Arguably this should be someone who is not local and is therefore trusted as having no vested interest in the outcomes of the process. However, a local person with professional facilitation training who is able to make their independence clear to participants could also usefully facilitate the process.
- Ensure that there is a person on each table who has some technical expertise, to clarify points of information and to point out and explore issues if participants make unfounded or incorrect claims. Depending on the resources available, this person can also facilitate conversations at his/her table, and take notes of key points/agreements.
- If resources allow, include a table facilitator at each table as well as a technical person, to help facilitate and take notes of conversations at tables – especially for larger tables.
- Ensure that some policy-makers attend the meetings, as this enables them to get a direct sense of the deliberations, and to take part in them. This in turn can only help improve the quality of policy.

Venues and timing

Pubs work well as a convivial, accessible and neutral venue for this type of meeting. Although other venues such as Wildlife Trust buildings were suggested we felt - but did not test out - that these venues would not have worked so well because they could have been seen as partisan, and would not have been as welcoming as a pub. However, it is essential that the venue is able to provide a separate room, as noise and interruptions at one meeting certainly detracted from the quality and participant's enjoyment of the meeting.

Some form of incentive to attend is definitely needed. 'Soup and sandwiches' appear to work well as a substitute for the normal monetary inducements to attend meetings. These costs were only a tenth of what might be spent per participant in incentivising attendance at a focus group.

The 18:00 to 21:00 weekday evening slot worked well for most people. Generally views were that timings were good and allowed a good balance between explanation and discussion. However, some respondents would have liked a little more time for deliberation.

- '*More discussion around the future of farming and food production'*
- *'To discuss the first part of evening. Too short time for each module'*
- *'General discussion and learning more about farming in general'*
- *'A whole day of more detailed discussion leading to specific ideas would be good'*

At the final workshop in Newmarket participant's familiarity with the concepts meant that the additional time could be used for a further round of deliberation based on monetary valuation. As noted above this added a layer of value to the process.

5.2.5 Future uses for Decision Making

Toolkit for Farmers

The study's process for engaging local people and experts in valuing ecosystem services on arable farms appears to work well and, together with a summary table on transferable monetary values for ecosystems services (*Table 2.7*) and summary of findings from the local workshops, constitutes a 'toolkit' which can be used by farmers and land managers to engage with local communities about what they value most and the implications for how they manage their land in future.

Other Potential Decision Making uses

In the future it is recommended that this 'toolkit' or process could be usefully tested at different spatial levels and with different stakeholders including:

4) **With Central government policy makers** (e.g. Defra or CLG) in the context of a specific upcoming policy review/proposal for legislation such as CAP reform. The toolkit could be used to explore policy scenarios or options with local or wider stakeholders with Defra/CLG staff attending public dialogue meetings. Equally the process could be used by policy makers themselves with a refined process for using a 'real budget' for judging what resources should be allocated to supporting preferences for different ecosystem services.

5) **With regional or landscape/county level stakeholders** such as Sustainability East, Natural England, Environment Agency, NFU, CLA, RSPB, farm advisors and agents and a few local individuals to agree on the desired balance of ESs which could be delivered in a specific farming landscape in the future. This approach will be further tested at the Climate Adaptation workshop organised by Sustainability East on the 30th March in respect of climate adaptation priorities for the Fens.

6) **Supporting the localism agenda** providing a mechanism to help citizens and communities make choices that optimise the benefits they receive from the natural environment. At local level the process would be useful in framing discussions between farmers, landowners and land managers with parishes or neighbourhoods. We consider that the process would be equally relevant for informing Community Resilience planning, Neighbourhood Action Plans, Green Infrastructure and Transition town movements.

Annex A Workshop Process and Evaluation

VEsSiEE Phase 2 – Arable Agriculture – Local Pilot
Process plan for public dialogue sessions January 2011

Attendees
4 groups of around 15 participants
Representative from VEsSiEE Steering Group
URSUS technical expert/note takers
Facilitator from Dialogue by Design

Locations
18th Jan: Brickendon, Herts
19th Jan: Bradwell, Essex
25th Jan: Welney, Norfolk
26th Jan: Stoke Ash, Mid-Suffolk

Overall Aims for this phase:

- Identify the value of the full range of services and benefits accrued from agricultural activity so that they can be recognised by and taken into consideration in decision making and strategy development. This pilot will apply the ESA developed in Phase 1 of the project to arable agricultural land in a number of contrasting but regionally representative locations (two to four, depending on depth and breadth of dialogue required) within the East of England. These will be agreed with the Pilot Steering Group at the outset.

- Deepen understanding of the value of ecosystem services and valuing them

- Provide insights on what local people in the pilot sites really value about the natural and cultivated landscapes around them, and what they think would be the optimal balance of ecosystem benefits going forward.

Briefing papers/materials on the day
Photo cards for quiz and for use during the workshop
1 pager on key ecosystem services
Table sheets
Spider diagrams and counters for session 2
Evaluation forms

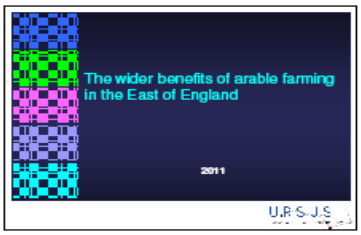
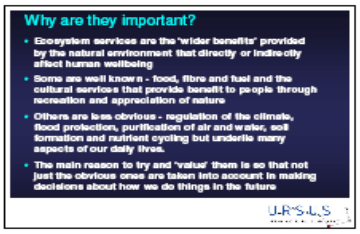
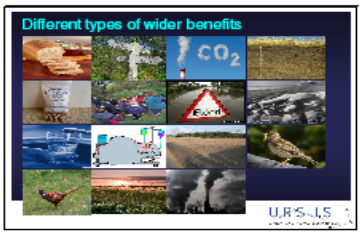
Other materials
Flip charts and Facilitator's toolkit (pens, blue tack)
Overhead projector
PowerPoint presentation

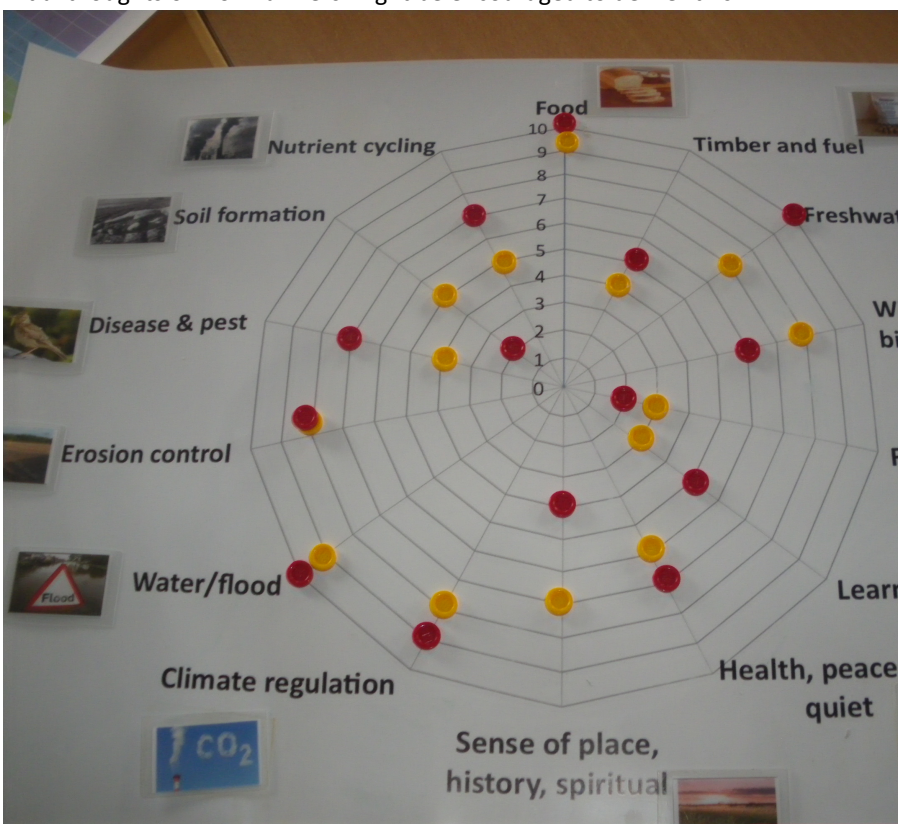
TIME	*ACTIVITY*	*NOTES*
	Overall set up and preparation (URSUS lead on…) - Recruitment - Joining instructions - Presentation technology and materials - Catering (refreshments etc.) - Reminders/follow-up (Dialogue by Design lead on…)	

TIME	*ACTIVITY*	*NOTES*
	- Room lay out - Flipcharts and toolkit - Plenary recording wall - Plenary space and layout - Name badges – address labels for participants to write their first names on, on arrival	
1630	**Set up**: • Paper banks • Front wall with objs, agenda, ground rules, bike rack, action list, table discussion instructions, etc. • Flip listing members of the group of local organisations working on these concepts • Flip listing 4 farms and communities we are working with in Hertford, Essex, Suffolk and Cambridge • Spider charts & cards ready for session 2 • Handouts and lists of ecosystem benefits on each table • 2 mixed tables of 7 or 8, each including an expert	• Toolkit
1800	**Arrivals and registration** – hand out ecosystem photo cards and ask participants to agree which of them farmers can affect by the way they manage their land. Invite them to do this together with one or two others before the session starts…encourage them to do this sitting at the meeting tables, so that the tables start forming early and to help us get started promptly. Refreshments – soup and sandwiches	Name badges [Note: in practice we found there was not time to fit in the quiz]

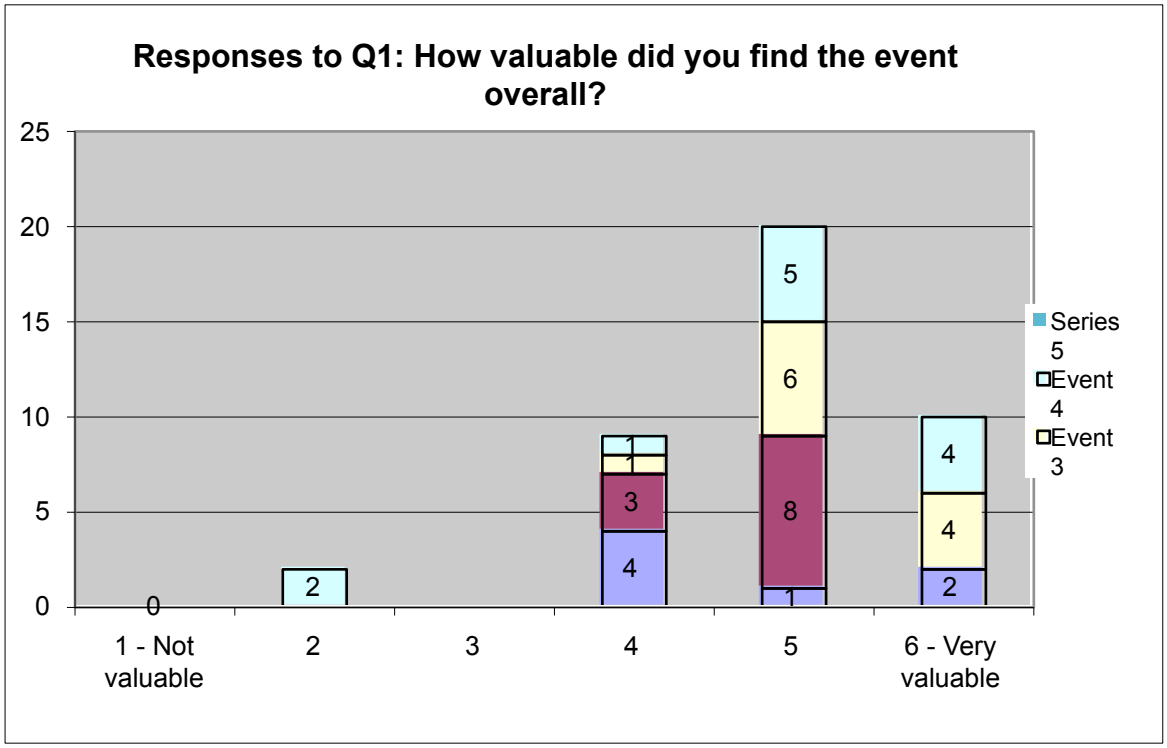
1830
15
	Opening session
	<u>Welcome & thanks for coming – short introduction</u> on the aims of this session and the agenda– the ESA and where you come in.
	
	• Housekeeping
	• Introductions at tables (probably only time for name and where you live)
	• Aims/agenda/
	  • Introduction to 'wider benefits' - ecosystem services concepts and delivery of different aspects by case study farm
	  • Discussion about what participants value from local farm environment
	  • Discussion about what participants would like to see more of in the future and how farmers might be encouraged to deliver this
	• Ground Rules /how we will work today
	• Context: invite visiting experts and project team to summarise the context of this project to broadly cover:
	  • The term ecosystems – the way in which the physical and biological components of the environment work together as a single functioning system - was first coined in the1930s.
	  • But it wasn't until 2000 that the United Nations recognised that in order to limit the damage that we are doing to the natural environment we needed to make decision makers think about how nature provides benefits and supports humans.
	  • This is the so called Ecosystem Services or 'wider benefits' approach.
	  • Since then there has been a lot of interest internationally and from the UK government in academic research on ecosystems approaches and how we get decision makers to think about the issues.
	  • In the East of England regional partners and stakeholders [lists of
		Except Brickendon which opened at 7.00pm
		
		Facilitator
		
		Introductio n by Steering group and team

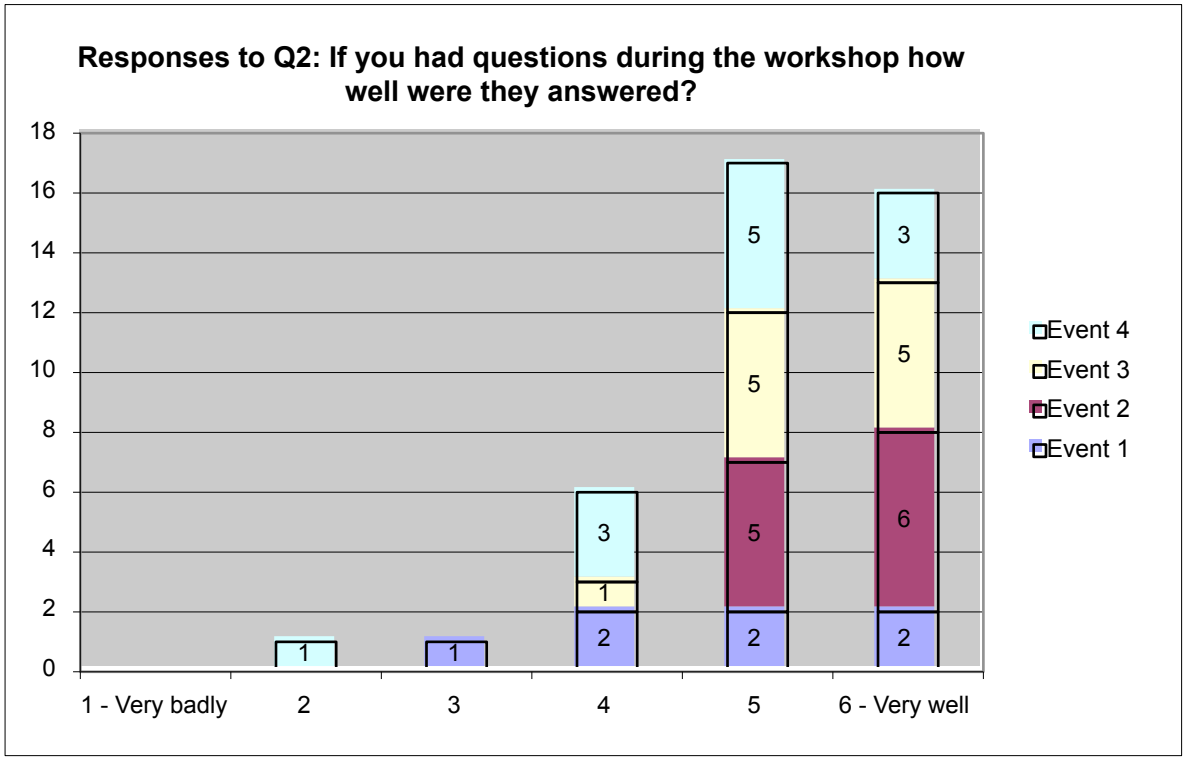
TIME	ACTIVITY	NOTES
	supporting organisations and participating farmers on flip charts on the wall] saw the need to develop a practical way of applying this thinking to our specific issues – land and water pressures, climate change, need for recreation, the economy. • The Valuing Ecosystem Services in the East of England (VEsSiEE) framework was developed during Phase 1 and tested it on strategic planning. • But realised it could be far more useful for real decisions about how we manage our land. • And specifically farming - such an important revenue earner, employer and land use in the East of England. • We have worked with 4 'typical' farms as pilots (see flip chart) • And now want to find out what local communities really value about farm land now and in the future. • Our findings can then feed into the forthcoming Natural Environment White Paper • And Defra's thinking about how we fund agriculture in the future. Product: Participants are clear about how the evening will proceed.	
18455	**What in the world are ecosystem services?** <u>Background</u> 1 pager for each participant at tables on the key services and benefits of natural and cultivated ecosystems, starting e.g. with text on slide 22 of v4 slide presentation: - • Ecosystem services are the 'wider benefits' provided by the natural environment that directly or indirectly affect human wellbeing • Some are well known - food, fibre and fuel and the cultural services that provide benefit to people through recreation and appreciation of nature • Others are less obvious - regulation of the climate, flood protection, soil formation and nutrient cycling purification of air and water. • The main reason to try and 'value' them is so that not just the obvious ones are taken into account in making decisions Process: 4 rounds of discussion at tables – walk through the slides and handouts category by category. After each category summary, invite discussion of each service/benefit at tables in turn – comments/ questions/thoughts – and note discussion and any key points to feed back:- • Provisioning • Cultural • Regulating • Supporting • Plenary feedback Product: Participants understand the concept of ecosystem services and have indicated their personal initial valuation for each – they are up to speed on ecosystem services, why they are important and why we are trying to value them Invite participants to do a quick snapshot of the values they would just now give to each of the ecosystem benefits discussed – 1 to 10 (10 high) – and add comments if time NB PowerPoint is available as a PDF or PowerPoint file	See PowerPoint For each, add a couple of additional key points and a sentence or two on the broader context Record discussion points here at each table and in plenary James walks participants through it; questions & comments answered by Anna, Hilary, and/or ESA strg gp rep

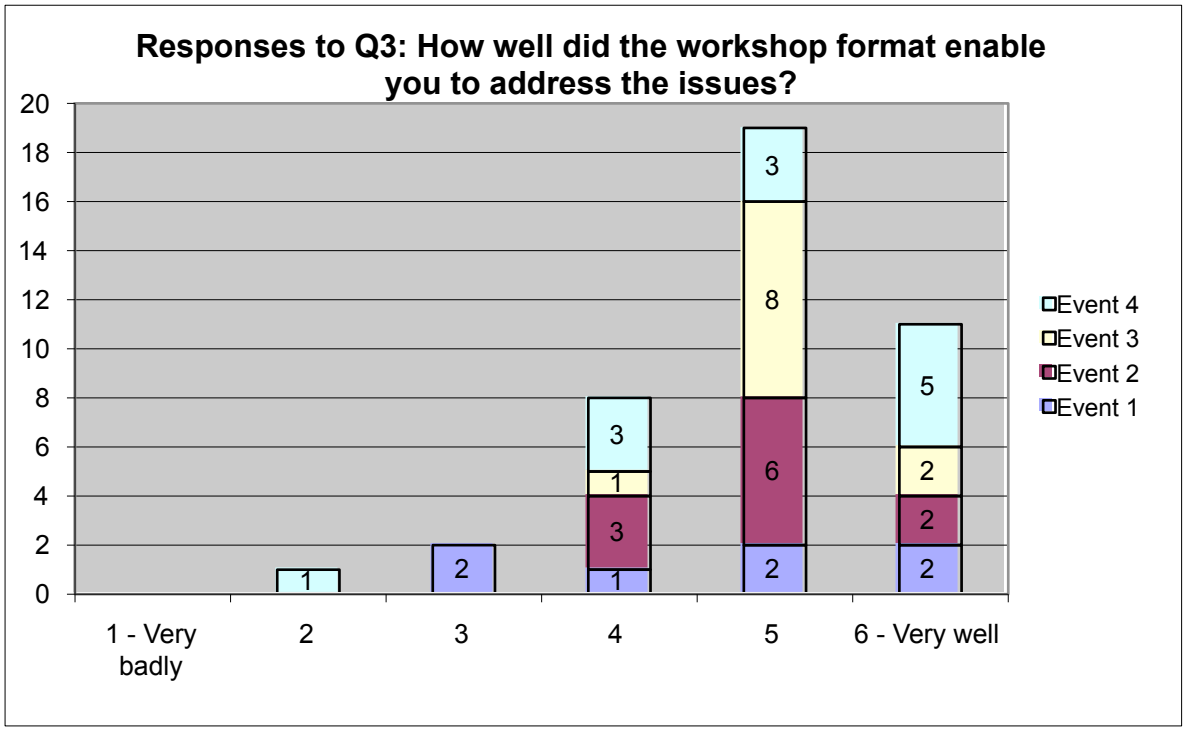
TIME	ACTIVITY	NOTES
	     	
1930 10	**Short break - refreshments**	
1945 15 5 30- 40	**The results of URSUS study of the local farm - and the optimal balance of ecosystem benefits for the future** Purpose: Agree what the best possible balance of ecosystem benefits of your local farms would be, using the local study farm as the starting point for this. Process: Presentation: URSUS talks about results from the local farm study; followed by table discussion and plenary feedback Presentation Questions of clarification (plenary) Brief: give each table: 1. spider diagram and 2. counters (1 for each ecosystem benefit). Invite each table: for each ecosystem benefit to agree (if possible) how high a value you would like to see in the local area in the future and to position the counters for each benefit on the spider diagram accordingly – showing what for you would be the optimal balance of ecosystem benefits in the future Discussion at tables Plenary feedback: each table reviews the results of the other table [works best to put the counters from one table onto the spider diagram of the other table]: discussion – comparison of scores and discussion leading to the results. Product: an initial comparative assessment of what the participants think would be the optimal balance of ecosystem benefits in their area going forward and	James Technical expert Each table has a chart with a spider diagram with the ecosystem benefits around it; plus a counter for

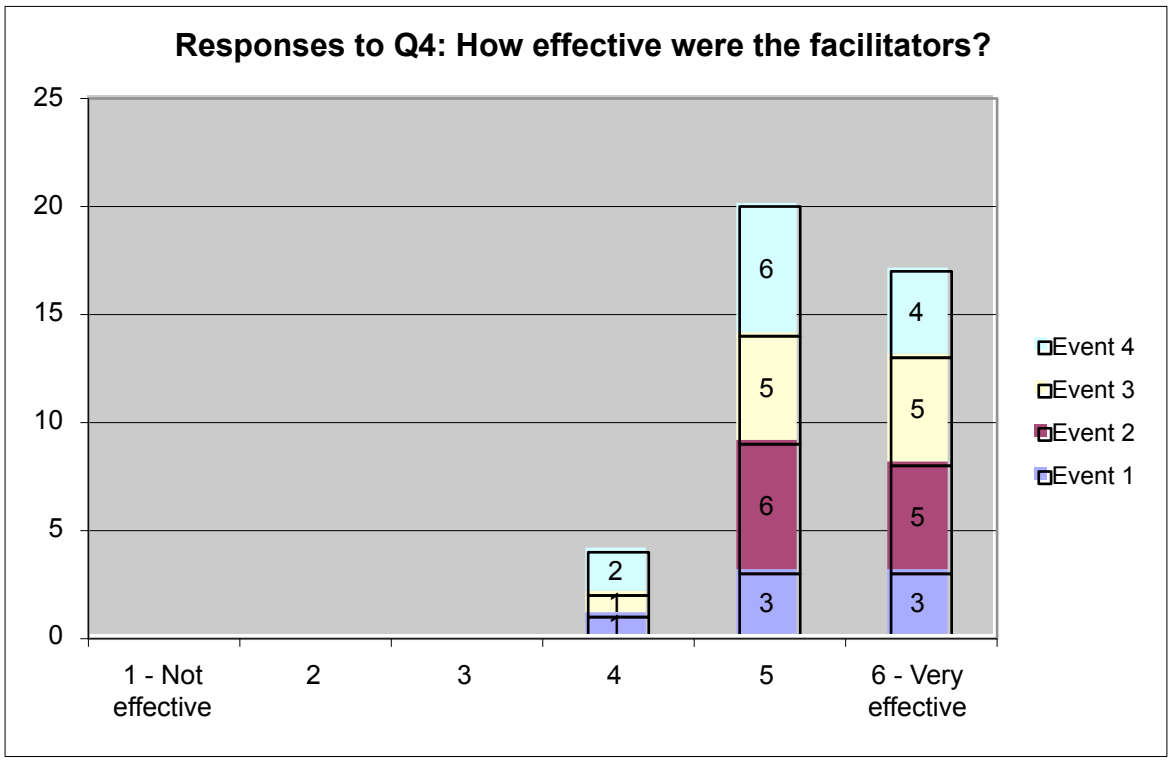
TIME	ACTIVITY	NOTES
5-10	initial thoughts on how farmers might be encouraged to deliver this.  **The Spider Diagram** Plenary: invite initial thoughts on how farmers might be encouraged to deliver this	each of the ecosystem benefits. The task is to position the counters to illustrate the priority attached to each Record discussion points at each table and in plenary
20.50	Wrap up:, evaluation, thanks and close End by 21.00	Facilitator

Participant's Evaluation of the workshops






Responses to Q3: How well did the workshop format enable you to address the issues?
20
18
16
14
12
10
8
6
4
2
0
1 - Very badly
2
3
4
5
6 - Very well
Event 4
Event 3
Event 2
Event 1


Responses to Q4: How effective were the facilitators?
25
20
15
10
5
0
1 - Not effective
2
3
4
5
6 - Very effective
Event 4
Event 3
Event 2
Event 1

Annex B Bibliography

Alcamo J., Bennett E. et al (2003), *Ecosystems and Human Wellbeing: A Framework for Assessment/Millennium Ecosystem Assessment*, World Resources Institute.

Bird, D. W. (Oct 2004), *Natural Fit: Can Greenspace and Biodiversity Increase Levels of Physical Activity?* RSPB.

Bjorner TB, J Hauch, S Jesperson, 2004, Danish Economic Council: *Biodiversity, Health and Uncertainty: A Contingent Ranking Study*.

Christie M., Hanley N., Warren J., Murphy K., and R. Wright (2004), *An Economic Valuation of UK Biodiversity Using Stated Preferences*, A report to Defra.

Climate East, The East of England Climate Change Partnership (2009), *Climate Change Action Plan*.

Collison and Associates Limited, *2020 Vision for the East of England Food and Farming Sector*, East of England Sustainable Farming and Food Group.

Costanza R., d'Arge R., de Groot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., O'Neill R V., Paruelo J., Raskin R.G., Sutton P. and van den Belt M. (1997), *The Value of the World's Ecosystem Services and Natural Capital.* Nature, Volume 387 no 6230.

Defra (2007), *An Introductory Guide to Valuing Ecosystem Services,* London, Defra Publications. www.defra.gov.uk

Defra (2008a) *How to use the Shadow Price of Carbon in Policy Appraisal*. http://www.defra.gov.uk/environment/climatechange/research/carboncost/pdf/HowtouseSPC.pdf

Defra (2008b), *Consultation on a grant scheme for adapting to flood risks*.

Defra (undated), *Air quality Guidance on the environmental impacts of air quality including recommended damage cost values to apply*: http://www.defra.gov.uk/environment/airquality/panels/igcb/index.htm

Defra (2010), *The Nature of England Discussion Document*.

East of England Food and Farming Group (2009), *East of England Sustainable Farming & Food Action Plan.*

East of England Regional Assembly Environment and Resources Panel, (Oct 2008), *Ecosystem services and Environmental Capacity* update.

Eftec (2007a), *Policy Appraisal and the Environment: An Introduction to the Valuation of Ecosystem Services. Wareham Managed Realignment Case Study.* Report for Defra, London.

Eftec (2007b), *Flood and Coastal Erosion Risk Management: Economic Valuation of Environmental Effects*. 15500. Handbook for the Environment Agency for England and Wales

Eftec. (March 2010). *Flood and Coastal Erosion Risk Management (FCERM): Economic Valuation of Environmental Effects Handbook.* Environment Agency.

Environment Agency (2002, *Agriculture and Natural Resources – Benefits, Costs and Potential Solutions.* http://www.environmentagency.gov.uk/commondata/acrobat/natrespt1_673325.pdf

Environment Agency (2004), *The State of Soils in England and Wales.*

Environment Agency (undated), *Soil: a Precious Resource. Our Strategy for Protecting, Managing and Restoring Soil*.

Environment Agency (2009), *Using Science to Create a Better Place: Ecosystem Services Case Studies*, FMRC.

The Environmental Valuation Reference InventoryTM (EVRITM). https://www.evri.ca/

Everard M. (2010a), *Ecosystem services assessment of sea trout restoration work on the River Glaven, North Norfolk*, Environment Agency.

Everard M. (2010b), *Ecosystem services assessment of buffer zone installation on the upper Bristol Avon, Wiltshire*, Environment Agency.

Everard M. (2009), *Ecosystem services case studies*, Environment Agency.

Farm Business Survey, East of England (2009/10), http://www.farmbusinesssurvey.co.uk/regional/GOR.asp

Foresight Land Use Futures Project (2010), The Government Office for Science, London.

Forestry Commission (2003), *The Social and Environmental Benefits of Forestry in the UK*. www.forestry.gov.uk/economics

Garrod G, K Willis, M Riley & M Rudde (1998)*, Economic Evaluation of Access Provisions in MAFF Agri-Environment Schemes.*

Garrod, G. D. and Willis, K. G. (1995), *Valuing the benefits of the South Downs Environmentally Sensitive Area*, Journal of Agricultural Economics, 46, 2, 160-173.

Ghermandi, A., van den Bergh, J.C.J.M., Brander, L.M., de Groot, H.L.F. and Nunes, P.A.L.D., 2008, *The Economic Value of Wetland Conservation and Creation: A Meta-Analysis*. FEEM (Fondazione Eni Enrico Mattei) Note di Lavoro Series Index http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm

Glaves P., Egan D., Smith S., Heaphy D. Rowcroft P. and Fessey M. (2010), *Valuing Ecosystem Services in the East of England, Phase Two: Regional Pilot Technical Report*, Sustainability East.

Glaves P., Egan D., Harrison K. and Robinson R. (2009), *Valuing Ecosystem Services in the East of England*, East of England Environment Forum, East of England Regional Assembly and Government Office East England.

Globe Regeneration Limited Delta Simons and Glyn Owen Associates (2008), *Coastal Initiative Socio- Economic Research* Final Report.

Haines-Young R., Potschin M. and D. Cheshire (2006ab), *Defining and identifying Environmental Limits for Sustainable Development.* A Scoping Study. Final Overview Report to Defra, 44 pp, Project Code NR0102.

Haines-Young R., Potschin M., and D. Cheshire (2006): *Defining and identifying Environmental Limits for Sustainable Development.* A Scoping Study. Final Full Technical Report to Defra*,* 103 pp + appendix 77 pp, Project Code NR0102.

Haines-Young R., Fish R., Potschin M., Brown C.; Tindall C. and S. Walmsley (2008a), *Scoping the potential benefits of undertaking an MA-style assessment for England*. Overview Report to Defra (Project Code NR0118).

Haines-Young, R., Fish, R., Potschin, M., Brown, C.; Tindall, C. and S. Walmsley (2008b), *Scoping the potential benefits of undertaking an MA-style assessment for England*. Full Technical Report to Defra (Project Code NR0118).

Halcrow (2008), *Delivery of Making Space for Water: HA6 Catchment Scale Land-Use Management; HA7 Land Management Practices*. Report for the Environment Agency. http://www.defra.gov.uk/environ/fcd/adaptationandresilience/ha6ha7/landuserole.pdf

Institute for European Environmental Policy. (2006). *Value of Biodiversity: Documenting EU Examples where biodiversity has led to loss of Ecosystem Services.*

Jacobs (2008), *Valuing England's Terrestrial Ecosystem Services*. Final Report. NR0108. http://randd.defra.gov.uk/Document.aspx?Document=NR0108_7324_FRA.pdf

Land Use Consultants and GHK Consultants (2009), *Provision of Ecosystem Services Through the Environmental Stewardship Scheme*, Final Report, Prepared for Defra (research contract NR0121*)*.

Land Use Consultants (2008), *Environmental Capacity in the East of England: Applying an Environmental Limits Approach to the Haven Gateway* Final Report, Prepared for the East of England Regional Assembly and Partners.

Land Use Consultants (2007), *Environmental Capacity in the East of England.* Stage 3 Report, Prepared for the East of England Regional Assembly and Partners.

Land Use Consultants (2007), *Environmental Capacity in the East of England.* Stage 2 Report, Prepared for the East of England Regional Assembly and Partners.

Land Use Consultants and Cranfield University (2007a), *Environmental Capacity in the East of England* Draft Stage 1 Report, Prepared for the East of England Regional Assembly and Partners.

Land Use Consultants and Cranfield University (2007b), *Environmental Capacity in the East of England* Appendix 1: Draft Stage 1 Topic Reports, Prepared for the East of England Regional Assembly and Partners.

Linstead C., Barker T., Maltby E., Kumar P., Mortimer M., Plater A. & Wood, M. (2008). *Reviewing Targets and Indicators for the Ecosystem Approach*. Final Report. Defra Project Code NR0119.

Luisetti T, K. T. (2008). *An Ecosystems Services Approach to Assess Managed Realignment Coastal Policy in England.* CSERGE Working Paper ECM 08-04 School of Environmental Sciences, University of East Anglia.

Murdock L. and Frye W.W. (1983), *Erosion – Its Effect on Soil Properties, Productivity and Growth*. http://www.ca.uky.edu/agc/pubs/agr/agr102/agr102.htm

NFU (2010a) *Why farming matters in the Fens.*

NFU (2010b) *Why farming Matters to the Broads.*

National Soils Resources Institute, *Soilscape* http://www.landis.org.uk/data/datafamilies.cfm

Natural England. (March 2011a), *National Character Area: 46 The Fens. Character Area Profile (Draft).*

Natural England. (March 2011b), *National Character Area: 46 The Fens. Facts and* Figures (Draft).

Natural England. (Oct, 2009a). *Experiencing Landscapes: Capturing the Cultural Services and Experiential Qualities of Landscapes.* Natural England.

Natural England. (Oct, 2009b). *Experiencing Landscapes: Capturing the Cultural Services and Experiential Qualities of Landscape. Annex A.* Natural England.

Natural England. (Oct 2009c). *Experiencing Landscapes: Capturing the Cultural Services and Experiential Qualities of Landscape. Annex B.* Natural England.

Natural England. (Oct 2009d). *Experiencing Landscapes: Capturing the Cultural Services and Experiential Qualities of Landscape. Annex C.* Natural England.

Natural England. (Oct 2009e). *Experiencing Landscapes: Capturing the Cultural Services and Experiential Qualities of Landscape. Annex D.* Natural England.

Natural England. (Oct 2009f). *Experiencing Landscapes: Capturing the Cultural Services and Experiential Qualities of Landscape. Annex E.* Natural England.

Natural England. (2009g). *No Charge? Valuing the Natural Environment.*

Newsome D H and C. D. Stephen, (1999) *Water Science and Technology Vol 40 No 10 pp 153–160 'What's it Worth? Improving Surface Water Quality*'.
http://www.iwaponline.com/wst/04010/wst040100153.htm

O'Neill D (2007), *TheTotal External Environmental Costs and Benefits of Agriculture in the UK*.
http://www.environmentagency.gov.uk/commondata/acrobat/costs_benefitapr07_1749472.pdf

PACEC (2006), *Shooting Sports. Findings of an economic & environmental survey*.
http://www.shootingfacts.org.uk/

Parliamentary office of Science and Technology Postnote, (2007).

Participatory Ecosystems Project, http://participatoryecosystems.blogspot.com/

Pretty J.N., Peacock J., Hine R., Sellens M., South N., Griffin M. (2007), *Green exercise in the UK Countryside: Effects on Health and Physiological Well-Being, and Implications for Policy and Planning*. Journal of Environmental Planning and Management, 50(2), 211-231.

Pretty J.N, Brett, C., Gee, D., Hine, R. E., Mason, C. F., Morison, J. I. L., Raven, H., Rayment, M. D. and van der Bijl, G. (2000), *An Assessment of the External Costs of UK Agriculture*, Agricultural Systems 65, p113-136.

Quine and Walling (2007) *Rates of soil erosion on arable fields in Britain: quantitative data from caesium-137 measurements Soil Use and Management*. Volume 7 Issue 4, Pages 169 - 176 http://www3.interscience.wiley.com/journal/119352833/abstract

RSPB (2008), *Visitor Spending at Blackstoft Reserve*, Paul.Morling@rspb.org.uk,

Sciencewise Expert Resource Group. *The Government's Approach to Public Dialogue on Science and Technology.* BIS, Department for Business, Innovation and Skills. http://www.sciencewise-erc.org.uk/cms/assets/Uploads/Strategic-Research-documents/Citizen-Involvement.pdf

Sustainable Development Commission (2008), *Health, place and nature: How outdoor environments influence health and well-being.*

Swanwick, C., Hanley N and Termansen M (2007), *Scoping Study on Agricultural Landscape Valuation.* Report for Defra, London.

Turner, R.K., Georgiou, S. and Fisher, B., (2008), *Valuing Ecosystem Services: The Case for Multi-functional Wetlands*. Earthscan, London.

Valuing Ecosystem Services in the East of England

Wallasea Wetland Creation Project. http://www.abpmer.net/wallasea/monitoring.asp
Watson R, S. A. (Oct 2010), *UK National Ecosystem Assessment: Draft Synthesis of Current Status and Recent Trends.*

Wheater H,S et al, (2008), *Impacts of Land Management on Flood Risk, FRMRC RPA2 at Pont Bren, FRMRC Final Report*.

Willis, K.G. and Garrod, G.D. (1993). *Landscape Values: A contingent valuation approach. Journal of Environmental Management* 37:11, 1-22.

Willis, K. (1990), *Valuing non-market wildlife commodities: an evaluation and comparison of benefits and costs.* Applied Economics, 22, 13 – 30.

Woodland for Life, (Jan 2011), *Reappraising the East of England's Woodland: The Value of Trees, Woods and Forests in the East of England*. www.woodlandforlife.net

Woodward, R.T. and Wui, Y. (2001), *The economic value of wetland services: a meta-analysis*, Ecological Economics, 37:257.