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Valuation of ecosystem services in the Nene Valley Nature Improvement Area

Dr Jim Rouquette

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Summary

The benefits that people derive from the natural environment are known as ecosystem services. They are critical to our wellbeing and economic prosperity, yet are consistently undervalued in decision-making. This report provides a monetary valuation of three ecosystem services provided by the Nene Valley: carbon, pollination, and recreation. By calculating a monetary value for these services the aim is to improve understanding of the importance of the natural environment for people and the economy.

The Nene Valley Nature Improvement Area (NIA) is a government funded flagship nature conservation initiative to promote landscape-scale conservation across the Nene Valley from Daventry to Peterborough. The analysis is conducted across the NIA and also considers the wider Nene catchment and the smaller Upper Nene Valley SSSI and SAC at the heart of the valley.

Carbon stocks were calculated using the average carbon content of soil and vegetation for each habitat found in the Nene Valley. Annual carbon sequestration (the amount of carbon absorbed from the atmosphere) was calculated based on the amount and composition of woodland and the rate of carbon uptake by these woodlands, and converted into a monetary value using the price of carbon collated from a wide range of sources. The value of insect pollination was based on the yield of arable crops and orchard fruits in the area, calculating the proportion of yield that would be lost if pollination did not take place. The value of recreational visits was calculated as the number of visits made per annum multiplied by the average spend per visit on items such as car-parking, food and drink, entrance fees and petrol.

The overall value of the three ecosystem services in the Nene Valley NIA was calculated to be £118.7M per annum, with each hectare of land delivering an average of £2,862 of services per year. The vast majority of this value was derived from the value of recreational visits (£116.7M), illustrating the importance of the river valley for visits, whether for daily dog-walking, bird watching or trips out with the family. This value is considerably higher in the NIA (the river and floodplain) than in the wider catchment. Pollination services were calculated to be worth £1.9M per annum, whilst carbon sequestration is worth £68,000 to the economy. This latter value is relatively low as woodland is not common in the Nene valley, and because a very low price of carbon was assumed; a value that is likely to increase greatly over the next decade.

It is clear that ecosystem services in the Nene Valley have a high monetary value and yet this assessment has only considered three ecosystem services on which it is possible to provide a monetary value. The natural environment actually provides a whole range of other benefits, hence the true value of the natural environment in the NIA will be considerably higher.

Contact details:
Dr J.R. Rouquette, University of Northampton
Email: Jim.Rouquette@northampton.ac.uk
Tel: 07790 105375

Website: http://www.nenevalleynia.org/

Project team at University of Northampton: Jim Rouquette, Jeff Ollerton, Stella Watts, Kat Harrold, Duncan McCollin, Janet Jackson.

Cover images: Sunset over Irthlingborough Lakes and Meadows, Nene Valley (John Abbott), recreation in Nene Park, Peterborough (Chris Porsz), pollination in a Northampton garden (Jeff Ollerton), High Wood in Northamptonshire (John Abbott).

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Introduction

The character and form of the Nene Valley has been intrinsically shaped by interactions between people and the natural environment. At its heart lies an extensive series of flooded gravel pits, created by decades of industrial gravel extraction, but now forming a network of wetland habitats. These areas are home to abundant wildlife and have been recognised internationally for their importance through their designation as a Special Protection Area (SPA) under the EU Birds Directive. The Nene Valley was designated as a Nature Improvement Area (NIA) in 2012, a flagship nature conservation initiative launched by the UK Government to promote landscape-scale conservation. The Nene Valley is also extremely important for the many and multiple benefits that it provides to people. The interactions between people and the natural environment remain of critical importance and it is these interactions that are the basis of the concept of ecosystem services.

Ecosystem services are most simply defined as the benefits that people derive from the natural environment. Adopting the ecosystem services approach is a key policy objective of the EU and UK Governments and much work is progressing on how to deliver the approach on the ground and how to use it to inform and influence management and decision-making. One of the most important steps is to recognise and quantify ecosystem service delivery and in a parallel project we have been quantifying and mapping the provision of a range of different ecosystem services across the Nene Valley Nature Improvement Area.

There is also a great deal of interest in providing a monetary valuation of ecosystem services. Monetary valuation of ecosystem services has a number of key advantages: it provides a single unit for comparing options, it can be used directly in cost-benefit analysis, politicians and business people like it, and benefits not put in monetary terms are often ignored. However, it should be borne in mind that some ecosystem services remain very hard to value in this way. Hence any valuation will only provide a monetary value for a small number of ecosystem services. The overall value shown in any valuation is therefore likely to be an underestimate of the true value of the natural environment, but it does give a good indication of its importance for services that are often largely ignored in decision making.

In the work presented here I have carried out a monetary valuation of three ecosystem services, where there is enough information to enable a value to be calculated. This is for 1.) carbon, 2.) pollination, and 3.) recreation. Below I outline the methods in note form, provide a summary of the results and raise some key discussion points for each ecosystem service. I end by bringing it all together to show the overall value of the ecosystem services provided by the Nene Valley and its Nature Improvement Area.

I have carried out the analysis on three areas that sit within each other:

- The **NIA plus 3km buffer** is more or less equivalent to the whole catchment of the River Nene, to a few kilometres downstream of Peterborough, and has an area of c. 170,000 ha (1700 km^2).
- The **Nene Valley NIA** consists of the floodplain of the river and comprises 24.4% of the wider NIA plus buffer area, with an area of c. 41,500 ha.
- The **Upper Nene Valley Gravel Pits SSSI** is the heart of the NIA and most is also designated as an SAC. It comprises just 0.9% of the wider buffer area or 3.3% of the NIA, with an area of c. 1380 ha.

These study areas and the main urban centres are shown on Figure 1 (overleaf).

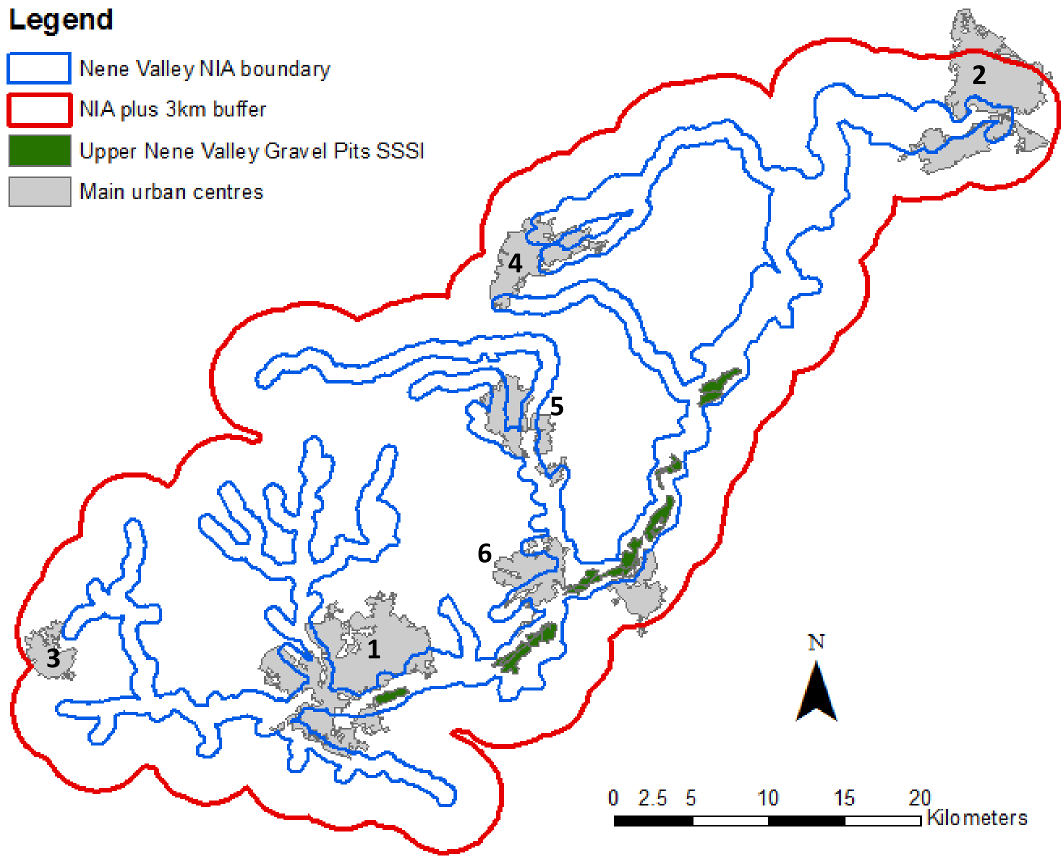

Figure 1: Map showing the boundaries of the three study areas and the main urban centres (1 = Northampton, 2 = Peterborough, 3 = Daventry, 4 = Corby, 5 = Kettering, 6 = Wellingborough).

Ecosystem services valuation

1. Carbon

The importance of carbon to the economy has become increasingly recognised as we move towards a low-carbon future. All soils and vegetation contain carbon and plants can absorb carbon dioxide from the atmosphere, but different types of vegetation and different land-uses are able to store and sequester very different amounts. In addition, poor management can lead to degradation of carbon stocks and release of CO_2 into the atmosphere. Here I examine:

A. Carbon stocks – the quantity of carbon stored in soil and vegetation.
B. Carbon sequestration – the amount of carbon that can be captured from the atmosphere over a calendar year.
C. Change in carbon stocks due to the NIA project – the difference in carbon stored in the soil and vegetation due to land-use changes enabled by the NIA project.

Methods

A.) Carbon stocks

1. Created detailed habitat map for the area from numerous sources (the EcoServ base map).
2. Each habitat was assigned a carbon storage value based on a UK-based systematic literature review which compared measurements of carbon storage within different land use classes (Cantarello *et al.*

2011). This combines the carbon storage in the vegetation and the top 30 cm of soil. It does not provide a carbon value for soils underneath sealed surfaces.

3. Created a raster of estimated tonnes of carbon stored per 10m by 10m cell using EcoServ.
4. Converted this to an integer-based raster.
5. Used the shapefiles for the NIA, NIA plus 3km buffer, and Upper Nene Valley Gravel Pits SSSI to extract the relevant data in ArcGIS.
6. Tabulated the amount of habitat within each carbon storage category.
7. Multiplied the carbon storage amount by the area and summed the total to give the total amount of carbon storage in each of the three study sites.

B.) Carbon sequestration

As well as the carbon stored in each habitat, carbon is also sequestered by growing plants. Plants that are harvested annually (e.g. arable crops, improved grassland) will be approximately carbon neutral over the course of a year as the sequestered carbon is immediately used. There is very little information about sequestration in other habitats (apart from woodland), but these are likely to be very low and we do not have any peat bogs that would also sequester significant amounts. Therefore, estimates are solely based on woodland carbon sequestration. The approach taken was:

1. Amount of woodland habitat estimated as above – coniferous, broadleaved and mixed woodlands identified.
2. Obtained most up-to-date species mix available for the East Midlands from National Forest Inventory Report (Forestry Commission 2011). This shows the overall proportion of species:
    - Broadleaves: Oak 17.4%, Ash 12.8%, Sycamore 9.8%, Hawthorn 8.8%, Birch 7.5%, Hazel 3.6%, Willow 2.4%, Beech 1.4%, Sweet chestnut 1.3%, Alder 0.7%, and other broadleaves 15.0%.
    - Conifers: Scots pine 6.9%, Corsican pine 6.5%, Norway spruce 2.0%, Larches 1.9%, Douglas fir 0.5%, Lodgepole pine 0.4%, Sitka spruce 0.2%, and other conifers 0.6%.
3. Age structure, management and typical age at harvesting:
    - Broadleaves – only some in plantations, often harvested older than conifers and significant amount of stock in area is >60 years old (Forestry Commission 2002).
    - Conifers – mostly in plantations, plantation stock typically harvested between 35 and 60 years and very little stock in Northamptonshire predates 1950s.
4. Used the Woodland Carbon Code Carbon Lookup Tables (Woodland Carbon Code 2012a) to estimate average carbon sequestration rates per year for UK woodland. Assumed average yield class and spacing.
    - Broadleaves: used mean annual sequestration rate over 100 years, for oak, beech, and SAB (sycamore, ash, birch), and followed Lookup Table Guidelines (Woodland Carbon Code 2012b) for the most appropriate model to use for the remaining species, with mean adjusted to ratio of species mix in the East Midlands.
    - Conifers: used mean annual sequestration rate over 60 years for all conifer species listed above, with mean adjusted to ratio of species mix in the East Midlands (as above).
5. Multiplied area of habitat by carbon sequestration rate for conifers, broadleaved or mixed to calculate the total amount of carbon sequestration per year in each of the three study sites and summed the total.
6. Multiplied the total tonnes of carbon sequestered annually by 3.67 to convert to tonnes of CO_2.
7. Collated and tabulated a range of prices for the monetary value of CO_2 (see section below). Used an estimate towards the bottom of the range to calculate total monetary value, plus calculated the range of values using the lowest and highest prices.

Carbon prices

One of the challenges of valuing carbon is choosing an appropriate price for carbon as there are a huge range of prices available from different sources, varying by more than an order of magnitude, described briefly below and summarised in the Table overleaf:

- The EU Emissions Trading Scheme is the largest carbon market in the world, but over the last few years prices have ranged from a few pence to above £30 per tonne of CO_2. It's currently (2015) trading at around £6.30 per tonne.
- The UK government now insists on a minimum (floor) price for carbon of £9.55 and this will rise rapidly over the next 2 years, and there is a target for the carbon price to have risen to £30 by 2020 (Ares 2014).
- The global average price for carbon sequestered through woodland planting schemes was reported to be around £6.00 in 2013 (Woodland Carbon Code 2014).
- According to a recent analysis by Dietz and Stern (2014) carbon should be priced at anything from £21-67 presently and should rise rapidly over the next few years.
- A meta-analysis of 47 studies (yielding 232 estimates) based on the social cost of carbon gave a mean estimate of €49 per tonne (c. £36 by March 2015 currency rates) (Tol 2012).
- The official government advice for performing assessments and appraisals of greenhouse gasses using the Green Book (DECC2014a) provides a current price for traded carbon (£4.48) and a separate price for non-traded carbon (£61.00) at very different levels (DECC 2014b). These prices are predicted to align over the coming few years at the level of the higher non-traded price.

Summary showing the range of carbon prices from different sources:

Valuation	**£ price per tonne of CO_2**
EU Emissions Trading Scheme current price (2015)	6.30
UK current floor price (Ares 2014)	9.55
UK government target carbon price by 2020 (Ares 2014)	30.00
Woodland carbon unit (Woodland Carbon Code 2014)	**6.00**
Appropriate carbon price (Dietz & Stern 2014) (range £21-67)	44.00
Social cost of carbon meta-analysis (Tol 2012)	36.00
UK Government (DECC 2014b) - traded prices	4.48
UK Government (DECC 2014b) - non-traded prices	61.00

In the valuation below I have used the woodland carbon unit price of £6.00 per tonne of carbon, as it is one of the lowest and therefore provides a conservative estimate, and because much of the carbon is related to woodland and carbon sequestration in woodland, hence the woodland carbon unit seems appropriate. I have also shown a range of values using the lowest and highest prices from the table.

Results

The headline figures are shown below:

Site	Nene Valley NIA	Nene Valley NIA plus 3 km buffer	Upper Nene Valley Gravel Pits SSSI
Carbon stocks (tonnes of C)	**3.50M**	**14.97M**	**80,000**
Carbon sequestration:			
Tonnes of carbon per annum	3,080	17,600	109
Tonnes of CO_2 per annum	11,300	64,700	402
Monetary value per annum	**£ 67,800**	**£ 388,000**	**£ 2,410**
Monetary value range – low	£ 50,600	£ 290,000	£ 1,800
– high	£689,000	£ 3.95M	£ 24,500

C.) Habitat creation and restoration

Through the NIA project, 43.5 Ha of species-rich wet and dry meadows have been created from arable or species-poor pastures, paid for by the Land Advisor Fund, and 3.1 ha of broadleaved woodland has been created from arable through supported HLS applications. It is estimated that over time the carbon storage in these habitats will increase by 1784 tonnes compared to the previous land uses, which is equivalent to 4,546 tonnes of CO_2. Thus, as a direct result of the NIA project the carbon storage value has increased by **£39,300** (range from £29,300 to £399,000).

Note that a further 161 ha of habitat has been restored from poor to good condition through HLS applications supported through the NIA project. This has included broadleaved woodland, parkland, orchard, species-rich meadow, floodplain grazing marsh, lowland fen and ponds. It is likely that these restored habitats will also be able to store more carbon than when in poor condition, but it is not possible to calculate the change without detailed site-specific knowledge of the pre and post-restoration conditions.

Discussion points

- All habitats contain carbon, including intensive arable, but most natural habitats contain considerably more. This information can be used to calculate the change in carbon stock if land use is changed or under alternative scenarios, and using this approach I have tried to capture the value that we have added through the NIA project.
- Carbon sequestration rates will vary depending upon land-use and management. However, the calculation presented here is entirely based around woodland, which is not a habitat that we have much of in the NIA or is a particular feature that we are promoting.
- The range in carbon prices is incredibly large. I have used a low price, so my estimate should be considered to be a conservative, lower-bound estimate of the carbon value. All commentators agree that carbon prices will rise rapidly over the next few years; hence this value will increase considerably.
- The approach chosen only considers carbon in the natural environment. It would be interesting to also examine CO_2, NO_x and CH_4 emissions due to livestock and farming practices, and hence the overall greenhouse gas balance of the area. This is work that is ongoing and I will report on soon.

2. Pollination

Insect pollinators are essential for human survival and for the natural environment. They pollinate 75% of the native plant species in Britain (Ollerton *et al.* 2011) and directly contribute an estimated £603 million per annum to the British economy through the pollination of agricultural crops (Vanbergen *et al.* 2014). Here I estimate the value of pollination for:

A. Agricultural crops –primarily oilseed rape and field beans.
B. Orchard produce – primarily apples, but also pears, plums and cherries.

Methods

A.) Agricultural crops

1. Downloaded agricultural census data from Agcensus (2010) showing agricultural land use in 2km by 2km squares across the study area (this is taken from Defra's annual June agricultural census). Most recent data was used, which was 2010.
2. Pollinator dependent crops identified as oilseed rape, field beans, and a very small amount of Linseed.
3. Typical yield (in tonnes per ha) calculated using average yields over the last 5 years (2010-14) from Defra statistics (Defra 2014a). Linseed averaged over 2004-2010 due to lack of recent data.
4. Average prices (farm gate price in £ per tonne) for each crop calculated over the last 5 years (2010-14) using Defra feeding stuffs prices (Defra 2015a) and the Index of Producer Prices of Agricultural Products, UK (Defra 2015b).
5. Monetary value of crop output (gross) calculated for each 2km by 2km square by multiplying the land area of each crop by the typical yield and the average price.
6. Pollinator dependency for each crop taken from Appendix B in Gallai *et al.* (2009), which is largely based on Klein *et al.* (2007).
7. Multiplied monetary value of crop by % pollinator dependency to show monetary value of pollinators for each square.
8. Projected the 2km by 2km results in GIS, then resampled at a 1ha sample size (to increase accuracy) using nearest neighbour assignment, so as to preserve the original values assigned within each 2km by 2km area.
9. Used the shapefiles for the NIA, NIA plus 3km buffer, and Upper Nene Valley Gravel Pits SSSI to extract the monetary value of pollinators for the relevant study sites.
10. Tabulated the area within each category of pollination value.
11. Multiplied each pollination value by the area and summed the total to give the total value of agricultural crop pollination in each of the three study sites, readjusting for sample size.

B.) Orchards

1. Selected and extracted all orchards identified on the habitat base map described earlier (based primarily on MasterMap) to create a new "orchards" layer.
2. Used the shapefiles for the NIA, NIA plus 3km buffer, and Upper Nene Valley Gravel Pits SSSI to extract the orchards for the relevant study sites.
3. Summed the total area of all orchards in each study site.
4. Calculated average annual yield and the production value of fruit per hectare from area, production and value of production figures over the last 5 years (2009/10 – 2013/14) available from Basic Horticultural Statistics (Defra 2014b). These were national averages based on total orchard fruits, as there were no suitable local or regional statistics available.

5. Monetary value of orchard fruits calculated by multiplying the area of orchards by the typical production value per hectare.
6. Pollinator dependency for orchard fruits taken from the UK NEA (Smith *et al.* 2011). Mean dependency was adjusted to the overall production value of different orchard fruits in the UK (no local data available). Production value was: dessert apples 46%, culinary apples 37%, pears 10%, plums 4%, others (mostly cherries) 2%.
7. Multiplied the monetary value of orchard fruits by the average pollinator dependency to give the total value of orchard pollination in each of the three study areas.

Results

Crop information is shown here:

	Oilseed rape	**Field beans**	**Linseed**	**Orchard fruits***
Average annual yield 2010-14 (tonnes/ha)	3.5	3.7	1.7	14.1
Average farm gate price 2010-14 (£/tonne)	330	180	350	559
Price range 2010-14 (low-high) (£/tonne)	237-422	131-332	275-425	-
Pollinator dependency (%)	25	25	5	82

* Orchard fruits consist of dessert apples, culinary apples, pears, plums, and others (mostly cherries).

The headline figures for the monetary valuation of pollination are shown below:

Site	**Nene Valley NIA**	**Nene Valley NIA plus 3 km buffer**	**Upper Nene Valley Gravel Pits SSSI**
Value of agricultural pollination	£ 1,536,000	£ 6,715,000	£ 59,800
Value of orchard pollination	£ 365,000	£ 1,049,000	-
Total value of pollination	**£ 1,901,000**	**£ 7,764,000**	**£ 59,800**

Discussion points

- The valuation above will be an underestimate of the true value of pollination as it does not include the value of pollination to allotments, garden produce, pick-your-own farms, or wild produce (e.g. blackberries, sloes etc.). There is no data available on most of these types of food, hence it is not possible to value these at this time, but the amount of food produced in allotments and gardens is thought to be significant and increasing as interest in home-grown produce has grown over the last decade.
- This method is actually valuing pollination demand, rather than supply. There is no indication of whether the natural environment is fully supplying the demand or if there has been a yield penalty due to a lack of pollinators. For example, Garratt *et al.* (2014) estimated that the market output of Gala apples would increase by £6,500 per ha under optimal pollination conditions compared to the present situation, although there would be little impact on Cox apples. Also, if the amount of pollinator dependent crops were increased in the study area it would show the value of pollination going up without any consideration of pollinator abundance.
- The data supplied by Agcensus is at a coarse resolution (2km by 2km). At the scale of the NIA plus 3km buffer this is unlikely to be an issue, but as sites get smaller, the potential for errors increases.

- Due to the high pollinator dependency of orchard fruits, the value of orchard pollination is high, even though orchards make up only a small proportion of the study areas.
- All orchard data is based on national averages as local or regional information was not available. There may therefore be local differences, although it is unlikely that these would make a great difference to the outcome, as most orchard fruits have similar productivity and value and all are quite heavily dependent on pollinators (65-85% of productivity across the range of fruit types).

3. Recreation

The importance of access to the natural environment is being increasingly recognised. Visits to natural areas have been shown to enhance physical and mental health and wellbeing, increase social cohesion and contribute greatly to the local economy. A major national survey – the Monitor of Engagement with the Natural Environment (MENE) – commissioned by Natural England, Defra, and the Forestry Commission, has been collecting information on the volume and value of recreational visits to the natural environment since 2009. The most recent survey estimated that between March 2013 and February 2014 there were 2.93 billion visits made to the natural environment resulting in an estimated spend of £17 billion (Natural England 2015).

Method

1. Downloaded data from MENE for the 5 completed years of the survey (2009-14).
2. Used the MENE data to estimate the number of visitors to the three study area, averaged over the 5 years. The NIA and the Upper Nene Valley Gravel Pits SSSI are directly incorporated into the MENE data set, so visitor use could be extracted easily. For the NIA plus 3km buffer I used Borough Council boundaries, including the whole borough where most or all of the borough was in the study area, and excluding the whole borough where only a small part of the borough was in the study area.
3. Collated data on average visitor spend in the three study areas according to MENE and compared this to the national sample. The average spend in the study areas did not appear to be very different from the national sample, hence I used the national spend projection provided by MENE. This was preferred as it has been adjusted from the national sample to be representative of the wider population.
4. Averaged the national spend projection per visit over the 5 years of the survey.
5. Multiplied the number of visitors annually by the average spend per visit to provide a valuation of the recreational value of the three study areas.

Results

According to MENE it is estimated that an annual average of 25.4% of visits resulted in some form of spending (so 74.5% of visits involved no spending). Where spending did occur, an average of £27.56 was spent on the trip on items including petrol, entrance fees, food and drink, bus fares, and car parking. Including those that spent nothing, this means that an average of £6.91 was spent per visit to the natural environment over the last 5 years.

The headline figures for annual visits and their value in the study areas are shown below:

Site	Nene Valley NIA	Nene Valley NIA plus 3 km buffer	Upper Nene Valley Gravel Pits SSSI
Average annual visits 2009-14	16.9M	25.8M	1.57M
Value of recreational visits	**£ 116.7M**	**£178.2M**	**£ 10.85M**

The Nene Valley NIA has the second most visits (and the second most spend) out of the 12 original NIAs, only behind Birmingham and the Black Country NIA which is almost entirely urban and has a very large population.

The MENE survey extrapolates from the surveyed sample to estimate annual visits and so can be inaccurate, especially for small or less visited sites. I therefore tested adjusting the figures against a different estimate of visitor numbers. For the Upper Nene Valley Gravel Pits SSSI the MENE survey estimates that there were 1.57M annual visits made in the 2010-14 period. However, a survey of visitors conducted for the NIA project (Liley *et al.* 2014) estimated there to be 900,000 visitors annually. Using this figure instead, the value of recreation to the SSSI would be £6.22M.

Discussion points

- The visit number for the NIA is particularly high as this includes all visits to outdoor areas, so will include visits to the major country parks (Barnwell, Irchester, Fermyn Woods, Sywell, and Brixworth), Nene Park in Peterborough, the borough parks, major attractions such as Wicksteed Park, visits to urban parks, and dog walks along the river. Hence many of the visits may well not be strongly related to the natural environment (but they do take place **in** the natural environment).
- Using an alternative lower estimate of visitor numbers for the Upper Nene Valley Gravel Pits SSSI still results in a very high valuation of recreation. Note also that the Liley *et al.* (2014) estimate is likely to be an underestimate of visitor numbers as it makes a number of assumptions such as assuming a constant number of visitors year round (and the survey was conducted in the winter and spring). This may be true for regular dog walkers or bird watchers, but visits to the more popular sites (such as Stanwick Lakes) will increase dramatically over the summer.
- The results suffer from the same limitations as the overall MENE survey. It collects info on money spent during the trip rather than the expense that people incur in making the trip (e.g. food and fuel bought before the trip). The travel cost method would provide this type of info but would require much more data.
- Therefore overall costs per visit are likely to be a major underestimate, although number of visitors may be overestimated.

Overall valuation and discussion

A summary table of all the ecosystem service valuations reported above is shown here:

Ecosystem service valuation	Nene Valley NIA	Nene Valley NIA plus 3 km buffer	Upper Nene Valley Gravel Pits SSSI
Natural capital stocks:			
Carbon stocks (tonnes of C)	3.50M	14.97M	80,000
Increase in carbon stock due to NIA:	1784 tonnes of carbon, valued at £39,300		
Annual flow of ecosystem services (£ per annum):			
Carbon sequestration	£ 67,800	£ 388,000	£ 2,410
Pollination	£ 1,901,000	£ 7,764,000	£ 59,800
Recreational visits	£116,700,000	£178,200,000	£10,850,000
Overall annual value of ES flow	**£118,700,000**	**£186,300,000**	**£10,910,000**

It is clear that ecosystem services in the Nene Valley have a high monetary value. In particular, the value of recreational visits is exceptionally high. The value of carbon sequestration is quite low, but this reflects the low carbon price chosen and the fact that woodland cover in the area is relatively low. Note that the overall valuation has only considered three ecosystem services on which it is possible to provide a monetary value. The natural environment actually provides a whole range of other benefits, which includes amongst many others, flood water storage which reduces flood risk downstream, air quality regulation, water quality regulation, aesthetic enjoyment and improvements in health and wellbeing. If it were also possible to place a monetary value on these and other ecosystem services, then the overall value of the natural environment in the Nene Valley would be seen to be even greater that the figures reported above. Some of these services can be quantified even where a monetary valuation is not feasible. Hence a broader range of ecosystem services have been quantified and mapped as part of a parallel project and the two projects together provide a more complete understanding of the ecosystem services provided by the Nene Valley.

A further analysis of the results reveals the particular importance of the River Nene and the Nature Improvement Area for ecosystem service value. If everything was equal, then the ecosystem service value of the NIA and the SSSI should be approximately 24% and 0.9% respectively of the value of the wider buffer area, reflecting the proportional areas, and the value per hectare would be equal across the three study locations. The table below shows these values per hectare, and reveals some major differences between the three areas:

Annual value per hectare (£/ha/yr)	**Nene Valley NIA**	**Nene Valley NIA plus 3 km buffer**	**Upper Nene Valley Gravel Pits SSSI**
Carbon sequestration	£ 1.63	£ 2.29	£ 1.74
Pollination	£ 45.85	£ 45.68	£ 43.28
Recreational visits	£2,814.56	£1,048.25	£7,850.45
Overall annual value of ES flow	**£2,862.05**	**£1,096.22**	**£7,895.48**

The value of pollination is more or less equal across the areas, showing the general spread of arable farming and orchards across the wider area. The value of carbon sequestration is highest in the wider area and this reflects the fact that there are few woodlands close to the river. However, most striking is the difference in the value of recreational visits. It is estimated that 66% of all visits made to the wider area actually take place in the 24% of the land that comprise the NIA, giving it a recreational value of over £2,800 per hectare per year. It is not clear whether people are particularly attracted to the habitats found close to the river or whether these areas are simply more likely to have public access, but either way, the value of the NIA is clear. Furthermore, the Upper Nene Valley Gravel Pits SSSI and SAC at the heart of the NIA is a real focus for recreational activities with a value of £7,850 per hectare per year. Even using a lower estimate of visitor numbers, this area still provides recreational value of £4,500 per hectare per year. And this estimate is an underestimate of true recreational value as it does not include the true cost of travelling to the site, the value that people place on their visit, or the health and wellbeing benefits that they receive. It is interesting to note that the overall ecosystem service value of this site and the wider NIA (even with only three ecosystem services valued) is far higher than if it was managed purely for intensive arable production.

I have also placed a value on the habitat creation work facilitated by the NIA project, with the increase in carbon stock estimated to have a value of £39,300. We are not able to estimate the change in recreational value without site specific data on the change in visitor numbers. However, it is likely that the habitats created and restored will deliver a wide range of additional ecosystem services such as enhancement in water quality, provision of pollinator habitat and so on that are not valued. The monetary value of the NIA works is therefore likely to be considerable and much greater that the figure reported here and this is in addition to the biodiversity benefits delivered.

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