Natural England Commissioned Report NECR101

Valuing Ecosystem Services: Case Studies from Lowland England

Annex 1 - Saltram Countryside Park (Plymouth Green Infrastructure Delivery Plan): Plymouth

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Saltram Countryside Park

Preface

This report has been commissioned by Natural England under the contract reference number of 23092.

The work aims to present how a combined ecosystem services and economic valuation approach can be used to understand the implications of different environmental conservation plans. Guidance from Defra on ecosystem services and value transfer is followed (Defra, 2007, eftec, 2010). The approach is used to assess and, where possible, value the likely changes in ecosystem services resulting from an intervention.

The information thus generated can be incorporated into decision-making or support tools such as cost benefit analysis. This information could also inform the way in which the management and conservation projects are designed to maximise the ecosystem service generation.

This is one of the six case study reports prepared to illustrate the application of the ecosystem services – economic valuation approach.

The work has benefited greatly from the ideas, knowledge, data and critique provided by numerous individuals in Natural England and other organisations. These include:

Kathryn Deeney, Stewart Clarke, Julian Harlow, John Hopkins and Ruth Waters.

We know that some others have provided advice or data to those who helped us and though we cannot list these people here, our sincere thanks go to them too. And our sincere apologies to anyone inadvertently omitted from the list above. Needless to say, any remaining errors are the fault of the authors alone.

Dr Robert Tinch, Adam Dutton, Laurence Mathieu (authors) and Ece Ozdemiroglu (internal reviewer).

24 November 2011

Contents

1 The Decision Context

There is currently a masterplan containing a range of projects which will lead to the creation of the Saltram Countryside Park to the east of Plymouth. This case study assesses and values, where possible, the likely changes in ecosystem services resulting from the interventions detailed in the plans for the Saltram Countryside Park. The Saltram project is one of eight forming the Plymouth Green Infrastructure Plan (Council, 2011a). This plan is diverse and the component projects are at different stages of planning. The master delivery plan sets qualitative ambitions for changes including:

- Flood Reduction;
- Timber Wood Fuel and Energy Crops;
- Local Food;
- Active Lifestyles;
- Biodiversity and Landscape Connections; and
- Sustainable Transport.

Saltram Countryside Park is the most clearly defined and advanced of the projects, and focusing on this project keeps the analysis more manageable, although even this is composed of 22 distinct proposals under three different headings.

The project will range over 640 ha between Plymouth, Plympton and Plymstock (see Figure 1). The area forms a diverse landscape including the historic Saltram Estate with Grade I listed property and English Heritage registered park and garden, a restored landfill site at Chelson Meadow, Hardwick Wood, parts of the Plym Estuary, and privately owned farmland and pony paddocks. The landscape provides a diverse range of habitats including ancient woodland, flower-rich grasslands, mud flats, and a network of hedgerows.

A number of businesses, including farms and quarries, operate in the area. Most of the land is owned by National Trust (part let to two farming tenants), by other farming businesses, and by households. Hardwick Wood is owned by the Woodland Trust.

The new settlement of Sherford is to be built adjacent to the site on the south-east side, with 5,500 houses. There are also plans to build a settlement at Plymstock Quarry to the south west, with 1,684 houses. But the area is already subject to significant 'people pressure' primarily with visitors to Saltram House taking a short walk round the park. Almost all visitors (98%) drive in and there is a need to provide easier, safer pedestrian and cycle access to give an alternative.

Visitors need to be managed in order to protect the more sensitive habitats, and also the farming interests. Around 140ha is under agricultural use, but the new housing which will surround the site increases the risk of uncontrolled access which will discourage tenant farmers. The project therefore aims to encourage local supply chains which might yield higher prices for environmentally sensitive production in order to better support the incumbent farmers.

(source: NT, NE & PC 2010)

Figure 1: Saltram Countryside Park (marked in green)

The development of the Saltram Countryside Park plan is regarded as a key requirement to support sustainable growth and a high quality of life in the area. It is identified as one of the priority projects arising from Plymouth's Green Infrastructure. The project managers believe that without this plan, the likelihood is that the Saltram area would be degraded through uncontrolled access and agricultural abandonment, with no formal management, resulting in scrub encroachment and possibly encouraging anti-social or illegal behaviour in the unmanaged area.

2. The Ecosystem Services and Affected Population

The Saltram Project aims to provide a regionally significant recreational resource on the edge of Plymouth in ways that are sensitive to, and enhance, the area's exceptional biodiversity, landscape, historic assets and productive farmland. The strap line for the plan is "*Bringing the best of the countryside to the city*". The aim is not, however, to create an urban park, and the majority of the land will continue to be privately owned and managed as 'working countryside' delivering a wide range of benefits.

The plan being considered is a concerted programme of investment delivered by the project partners to improve the recreational and wildlife values of the area and retain the agricultural uses. The alternative is likely to see agricultural abandonment and uncontrolled access from densely populated adjacent areas, detrimental to biodiversity interests, in the absence of visitor management.

2.1 Ecosystem services

The management options for the Plan form a substantial package of interventions all contributing to the overall vision. Below, we describe the main aspects of the plan as they relate to the broad ecosystem services (and goods) categories. While most interventions will have impacts across the board, breaking them down in this way help structure the rest of case study.

(i) Provisioning services: Linking farming to local consumers and communities

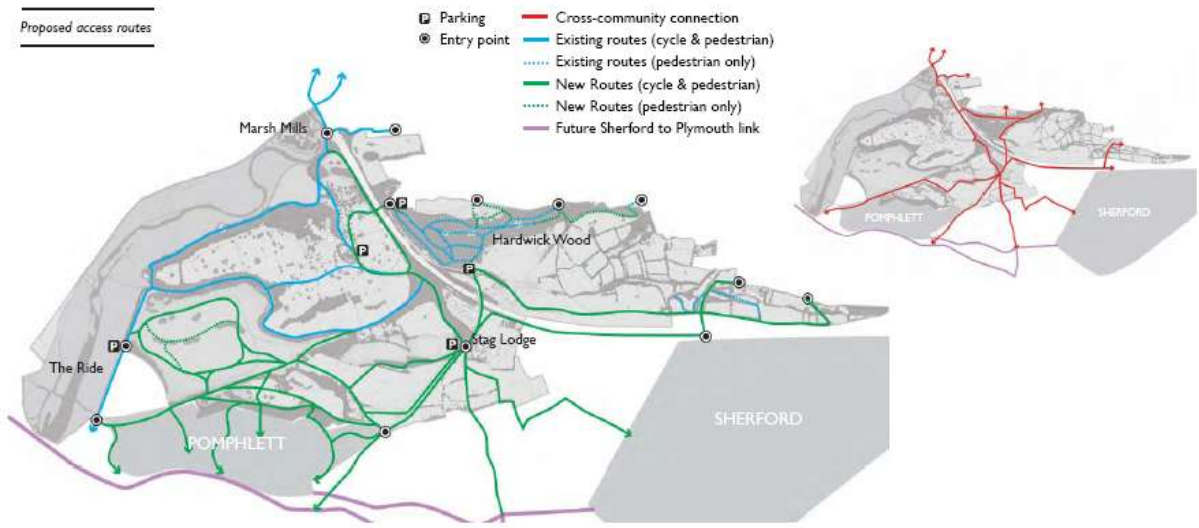
- Promoting new products from the land, high quality vegetables, salad crops, fruit, honey and other products for local sale.
- Orchard planting and production.
- Strong local market for horse hay.
- Supplying the National Trust restaurant and shop with local produce.
- Supplying public sector buyers in Plymouth, via the Public Sector Food Procurement Project.
- Retailing and distributing farm produce direct to the public. One or more farm shops, and/or 'box' distribution.
- Community supported agriculture on allotments, in orchards or livestock smallholdings.
- Potential to restore Chelson Meadow, a former landfill site, to productive pasture once gassing from the methane wells has subsided. Following restoration the pasture will be grazed by a mix of cattle, sheep and horses. This may involve capping and seeding parts of the landfill site not yet restored.

(ii) Access and recreation

- New and enhanced gateways and entrances.
- Creation of new paths and better links, for multiple users.
- In the long term, provide access to Dorsmouth Rock with panoramic views and a site of Regionally Important Geology Site.

- New convenient pedestrian and cycle routes between the National Trust estate and the woods.
- 'Safe and inviting entrance' into the woods, away from busy road.
- Routes integrated with new car park located near-by.
- Routes linking new restored areas to National Trust estate.
- New strategic pedestrian and cycle routes as part of Plymstock Quarry residential development.
- Long term recreational ‘spine’ connecting Sherford with Plymouth through the Countryside Park.
- Improvement and restoration of historic Green Lanes that are over-grown, out of use or blocked, and restoration of historic space features at The Ride and Happy Valley.
- Direct provision of new recreational space at Blackson Piece, by thinning out woodland; other informal recreation/low key picnic areas blending with the landscape.
- Boat access to the quay at Point Cottage will be provided by restoring the existing structure.
- Access to the beach at Point Cottage will be provided for those with mobility impairments.
- Sustainable forms of water-based recreation such as canoeing, rowing, paddle-boarding and sailing will be promoted.
- Increased bird watching opportunities will be provided from new or enhanced hides at the north end of the Plym, with new information boards and leaflets on the habitats and species present.
- Increasing access and parking at Hardwick Wood, with a treetop walkway and guided walks; woodland paths and fitness trail at Pomphlett Plantation.
- Entrance to the park at The Ride enhanced with picnic and play areas and parking, southern gateway entrance made more natural with specimen trees and shrubs.
- Natural play features will be sensitively integrated into the area.

Figure 2 below shows the recreation and access priorities for the project.



(source: NT, NE & PC 2010)

Figure 2: Priorities for recreation and access management at Saltram

(iii) Cultural and spiritual services

- A logo and brand identity will be developed for the Countryside Park. There is an ambition to 'bring the park to life' with themed events and coloured maps.
- The amphitheatre is to be restored using documentary evidence and archaeological investigation. The key priority is to stabilise the structure and associated rock face and remove it from English Heritage's 'at risk' register. The restored amphitheatre could be used for performance based events with income raised contributing to restoration and management costs. The restored bastion could be used for a limited number of river landings as part of the event experience.
- Wider network of new multi-user routes could include the historic carriage drive that ran through Pomphlett Plantation to Saltram House.
- Restoration of other key historic features and views, including Happy Valley and Blackson Piece. Walking route round former racecourse, re-establishment of traditional land use management practices.
- Traditional land use management practices including use of beehives, coppicing, charcoal making and Devon hedgebank conservation.
- Restore the Bickham Farm area's function as a working orchard whilst providing opportunities for educational use and volunteering.

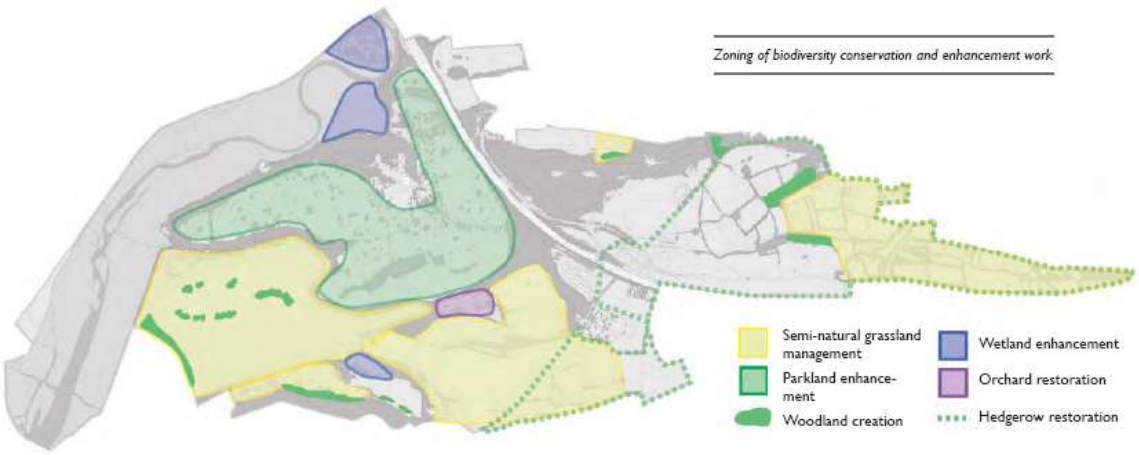
(iv) Landscape and aesthetics

- Overall objective to restore the historic designed park landscape, and integrate surrounding areas within this context.
- Several projects to restore views, primarily by active management of the mature parkland oaks, thinning of younger and inappropriate species to open views along the valley swathe to the north. Many of these views formed part of the designed park landscape and have cultural heritage interest.

(v) Habitats and biodiversity

- Flower-rich grassland management and restoration will be achieved via reduced chemical inputs and lower stocking densities or grazing periods. Targeted to areas of pre-existing species-rich grassland and areas of likely success. Advice and incentives provided to landowners and tenants.
- Measures to enhance bat populations.
- Soften landscaping and establish vegetation to improve the appearance and biodiversity connectivity of Marsh Mills where path passes under main road.
- Grassland and meadow management to create a balance between nature conservation, amenity and recreation interests with standing and fallen deadwood retained both for nature conservation and informal or natural play.
- Otter surveys, and potential to install an artificial holt to encourage further use of the undisturbed Saltram side of the estuary.
- Possible managed retreat of flood defence at Crabtree Reclaim and Blaxton's Meadow (conditional on agreement with statutory undertakers) to allow a mosaic of mudflats and saltmarshes to develop; partial compensation for previous losses in the estuary.
- Chelson Meadow is a grassed-over former landfill site. The restoration plan could seek to integrate Chelson Meadow with the designed landscape at Saltram, with planting of specimen trees and clumps. Woodland established along or near to the top of the hill.
- A 'Green Bridge' over the A38 with wide grassland and shrub planting could improve the connectivity of the area with potential to help wildlife as well as human visitors.
- Pomphlett Plantation will be extended with 2.4ha of new broadleaved woodland planting. Northern fields managed to restore 5ha of species-rich grassland.
- Construction of an artificial bat roost and a new wetland around Wixenford Quarry.

Figure 3 shows the different habitats covered within the plan.



(source: NT, NE & PC 2010)

Figure 3: Biodiversity conservation and enhancement at Saltram

2.2 The affected population

Here we report the size of the residential and visitor populations that will be affected by the implementation of the Saltram plan. Plymouth has a resident population of 250,000; Devon 1,141,600 and 5 million people live in South West England (ONS, 2011). The Saltram project is also bordered by Plympton and Plymstock with a further 55,000 people (PC, 2006). In addition to these, two new settlements will be created: Sherford with 5500 dwellings and 3 schools (Red Tree 2011) and Plymstock Quarry[1] with 1684 dwellings (PC 2011b). Sherford is planned to begin in 2012 and will take 12-15 years to complete. Plymstock Quarry will be built over 15 to 20 years. There are two tenant farmers with the National Trust as Landlord and six other agricultural businesses in the project area. Approximately 350,000 people visited Saltram House and park in 2009. Table 1 summarises these figures.

Table 1: Local resident and visitor population estimates

Area	**Population**	**Households**	Note
South West	*5,000,000*		1
Devon	*1,141,600*		1
Plymouth	250,000		1
Plymstock	25,108		2
Plympton	30,224		2
Plymstock Quarry	4041*	1684	3
Sherford (proposed settlement)	13,200*	5500	4
Number of visitors for 2009	350,000		5
*Estimated based upon an average household size of 2.4 [6]			

1 – ONS 2011; 2 – PC 2006; 3 – PC 2011b; 4 – Red Tree LLP 2011; 5 – Land Use Consultants, 2011; 6 – ONS 2009.

[1] Quarrying has been carried out to the south of the area for some time. A portion of that quarry is now to be developed into a new residential area (Plymstock Quarry) whilst another will form part of the park once blasting work is complete.

3. Ecosystem Service Changes

Here we summarise the likely effects the Saltram project may have on the ecosystem services provided in the area (as reported in Section 2.1). The changes are the difference between what is provided now and will be provided in the future without the project, i.e. the baseline (Section 3.1) and what is likely to be provided when the project is implemented (Section 3.2). All quantitative information available is reported in Section 3.2 and the spider diagram at the end of that sub-section summarises the likely changes based on our analysis of the existing information.

3.1 Assessing the baseline

The baseline is assessed in two parts:

'Now' – the type and quantity of services provided at the time of this analysis (or the latest data available) which is of course without the case study project; and

'Do nothing' future – the type of quantity of services that will be provided if the current trends continue but no management or other action is undertaken (and without the case study project).

The current human activities in the area include agriculture, recreation and mineral extraction. The area also has an important cultural heritage.

Without this plan, the Saltram area would continue to be degraded through uncontrolled or inappropriate access and the risk of agricultural abandonment due to decreasing profitability of farming. There is also a risk of deterioration and loss of historic features, which are already in poor condition. Loss of views would continue and the historic landscape would not be restored. The increased urban and industrial development adjacent to the project site would lead to increase in disturbance and use of the Countryside Park with negative effects on wildlife and habitats.

3.2 Qualitative and quantitative assessment of the change

Many of the interventions at Saltram (Section 2) will have a direct impact on habitat type and/or condition through creation of new habitats, extension of existing habitats and restoration of degraded habitats.

These changes can be summarised as:

- 159 ha of species-rich grassland, 29ha of which is grazed by horses and will come under enhanced management;
- 120 ha of parkland, woodland, scrub and orchards will be conserved;
- over 2km of hedgerows will be created, and 29km will be conserved and enhanced;
- 0.3 ha of freshwater wetlands at Wixenford Quarry will be created; and
- 4.2 ha of mudflats and salt marshes at Blaxton's Meadow and a similar size in Crabtree Reclaim will be created (ABPmer 2008).

These habitat changes in turn will have effects on the ecosystem services identified as present in the area (Section 2). These likely effects are discussed in the rest of this section.

Food and fibre: Most of the land that will be affected is grade 2 farmland and so highly productive. As food prices increase there is increasing pressure to move towards higher value crops. Currently much of the land is used for grazing which is preferable for local biodiversity.

In contrast to the soil quality and higher food price incentives to increase agricultural production, the planned new housing will create new pressure to reduce farmings. It will take land out of agricultural use and will also increase the risk of unregulated access which may effectively prevent farming. The farmsteads for a number of the farmers are outside of the countryside park in the area which will be developed for the Sherford development. There is a further worry that should farmers lose their farmsteads, they may decide that their farms are no longer viable. There are currently 140ha being farmed within the park which would be at risk of abandonment.

In order to avoid losing the tenant farmers, the project focuses on attempts to link local producers to local consumers reducing costs and increasing potential prices.

The project will also promote high quality vegetable, fruit (including traditional orchards producing apples and cider) and salad crops in some small areas. Other new products will include honey and horse hay.

In addition to the agricultural production from the existing farms, the project will support community agriculture on allotments, in orchards or livestock smallholdings. There is also some opportunity to expand the productive land area: Chelson Meadow, a former landfill, may be restored to pasture once gassing from methane wells has subsided.

Timber: Where woodland is being managed it is largely to increase woodland for amenity purposes or to thin mature oak to improve views. Some timber may result from these activities but at a small/non-commercial scale. Some coppicing may be carried out by voluntary work crews but this would be more as a social / cultural activity rather than scaled production.

Renewable energy: The Masterplan notes the possibility that charcoal creation from coppiced wood might be included in conservation work parties. There is no suggestion that this would be done on a professional basis. This suggests that renewable energy production would be minor and more at a demonstration scale, and perhaps better considered as a recreation service.

Fresh water quality: The 0.3ha of new freshwater wetland may result in good water quality at that site but is unlikely to have significant downstream benefit. There is also potential to create brackish or saline habitats through managed retreat over approximately 8ha. Additionally, 159ha of flower-rich grassland management and restoration will be achieved via reduced chemical inputs and lower stocking densities or grazing periods, and this will result in reduced nutrient loads in run-off water. But overall, since the site is coastal / estuarine,

there is no impact on downstream freshwater supply for agriculture or consumption. The water quality in the estuary may be slightly improved by the intertidal habitats if these play a role in cycling nutrients and sedimentation of fine materials.

Water flow regulation: The potential flood defence retreat over 8ha will influence flood risks around the estuary, perhaps including upstream to the tidal limit, although the storage capacities of the sites would be trivial in comparison to the volumes of tidal water. The wetlands could theoretically protect against riverine flooding but this clearly depends on their location. The retreat would be subject to a thorough appraisal within which the changes in capital and maintenance costs for flood defence, and the impacts on expected flood damages, would be specified. Since the surrounding area is urban, significant assets are likely to be at risk and any flood defence benefit could be substantial. Since the area would be protected both in the baseline and by Saltram project, the change in this service is not the benefit of protection (same in both cases) but the change in the flood defence costs.

Soil and erosion control: There is no evidence in the reports that soil erosion is or would become an issue in this area. The creation of intertidal wetland areas may reduce risks of erosion / coastal squeeze in the estuary, but this is speculative.

Climate regulation: As some of the land use is changed to improve habitat there may be some gain in carbon sequestration in plant-life and soils. Table 2 presents some of the potential gross gains in greenhouse gas (GHG) sequestration. These figures represent the maximum GHG which these land cover types can sequester per year assuming a 100 year period of collection.

To estimate precisely the total net gain or loss in GHG sequestration we would require more detailed data on land cover before and after the project is implemented. However it is possible to make broad assumptions to obtain an approximate figure. Compared with the baseline of gradual agricultural abandonment, we assume that the new habitats replace scrub habitats. This leads to a net change of Saltram project sequestering 158 tonnes more GHG each year, if we assume the carbon changes occur over a century, compared to the baseline.

Table 2: Potential Gross GHG sequestration by land-cover type based on data from Cantrello et al. (2011)

Carbon Sequestration	**Area (hectares)**	**Carbon (tonnes/hectare)**	**CO_2 equivalents tonnes over 100 years**
Broadleaved Wood	2.4	273	2,400
Scrub/woodland	120	103.1	45,400
Rich Grassland	159	124.1	72,400
Inland / salt marsh	8.3	151.4	4,610
Lost Scrub & Woodland	-289.4	103.1	-109,000
NET tonnes over 100 years			15,800
NET tonnes per year			**158**

The project will also emit GHG – which is a cost. There is no evidence available on which to base any assessment of the size of these emissions. They are therefore omitted but may be significant.

Air quality: The total area of green space provided is not increasing, but is being enhanced, and there may be some impact on air quality from new planting of woodland. But this is speculative, and quantifying any impact is not possible with current data. Important impacts on air quality may arise through traffic and visitor management plans: if the plans are successful in encouraging walk-in or cycle-in visit options, this could improve local air quality. However if plans aiming to improve parking facilities result in greater car use, or visits from further away, the results would be negative. Therefore the net impact upon air quality is at best uncertain.

Recreation: Green Infrastructure projects on the urban fringe have a general objective of maintaining living standards in the face of increasing populations and attendant urban sprawl. In order to achieve this, the Saltram project will provide access to green space as a pressure release and recreational but productive area. Significant changes will be made both in terms of access from urban areas to the edge of the park and access within the park.

This will be achieved with enhanced parking, gateways and safer and more inviting entrances outside of the park. As well as car access, strategic pedestrian and cycle routes will be created linking to existing and newly planned towns of Sherford and Plymstock Quarry. Paths and routes will then be connected to these new entrances and car parks along with new paths and better links within the park. Specific areas with high amenity value will have improved access. These include:

- Dorsmouth Rock with panoramic views;
- A new route between the National Trust estate and the woods; and
- Access to the beach at Point Cottage will be provided for those with mobility impairments.

As well as new access to existing recreational space, new recreational space will be provided (for example, at Blackson Piece by thinning out woodland). Increased bird watching opportunities will be provided from new or enhanced hides at the north end of the Plym, with new information boards and leaflets on the habitats and species present. At Hardwick Wood, a treetop walkway and guided walks and woodland paths and a fitness trail at Pomphlett Plantation will be created. The Ride will be enhanced with picnic and play areas.

The intentions for the small areas of wetlands include provision for bird watching with new or enhanced hides.

The encouragement of allotment use is mentioned. There is little information within the masterplan on whether new allotments would be provided within the park. It may simply be that they would facilitate the sale of produce from existing allotments. Therefore, it is difficult to assess the effect this will have on allotment related recreation. Allotments were left out of the final calculation due to uncertainty over whether their provision would be part of the project.

Boating is an important activity in Plymouth. Sustainable forms of water-based recreation such as canoeing, rowing, paddle-boarding and sailing will be promoted. Boat access to the quay at Point Cottage will be provided by restoring the existing structure. There is no information on how large this quay is or what facilities would be provided to mooring boats.

Education and knowledge: Important education aspects of the project will arise through the restoration of historic landscapes and the use of traditional land-management practices. This may be largely informal but it is also likely that schools in the surrounding area could use the Countryside Park for educational activities. There are also plans for promoting nature walks and conservation workshops which would provide an education service. We have no quantitative (or qualitative) estimate of) who will benefit from this service and in what way.

Efforts to monitor the impacts of the project on wildlife have the potential to increase broader ecological knowledge and improve future ventures to protect and promote biodiversity. The management plan specifically mentions projects on otters and bats.

Cultural and spiritual: Many aspects of the project relate to restoring cultural heritage features associated with Saltram House and the wider park, notably including green lanes and the carriage drive. Many of the cultural features are man-made (for example, the amphitheatre) and it could be argued that these are out of scope for an assessment of ecosystem services. But in fact much of the value from ecosystem services comes about through the medium of man-made infrastructure, as recognised in the methodology of the National Ecosystem Assessment (NEA, 2011). Recreation, for example, often uses paths, cycle tracks, picnic tables, toilets and so on that are not themselves the products of ecosystems. Thus, while the amphitheatre is man-made, much of its value arises because of its outdoors location in an area of natural beauty. This value will be enhanced both through the restoration of the amphitheatre and via other landscape improvements.

Traditional land-management practices represent an important source of cultural value that can be considered within the context of cultural heritage, landscape, education and recreation.

Landscape and aesthetics: The project has the general objective of maintaining a working landscape with traditional land-management and emphasis on the cultural features. More specifically, there are several interventions planned with the explicit objective of restoring views, primarily by cutting back tree growth. Many of these views formed part of the designed park landscape and have cultural heritage interest.

Biodiversity/habitat: A range of habitats will be created and protected by the countryside park. 159ha of flower-rich grassland management and restoration will be achieved via reduced chemical inputs and lower stocking densities or grazing periods. This will be targeted to areas of pre-existing species-rich grassland and areas of likely success.

There are plans for a possible managed retreat of flood defence at Crabtree Reclaim and Blaxton's Meadow (conditional on agreement with statutory undertakers) to allow a mosaic of mudflats and saltmarshes to develop. Blaxton's meadow was first breached in 1995 in order to create saltmarsh. However, vandalism damaged the works and they collapsed in

2004 leading to constant flooding and damage to the saltmarsh. More recent work in 2006 built the defences slightly too high meaning that it flooded too little. Subsequent work increased the flood rate but cracks have appeared in the defences which have increased the flooding rates and destroyed the majority of the salt marsh. There are currently debates over the best course to take.

Crabtree Reclaim is (based on our examination of google maps) a mixture of trees and grassland. It is clear that work of this kind is complex with significant risk of failure (ABPmer 2008).

Chelson Meadow is a grassed-over former landfill site and presents a potential opportunity for biodiversity as well as agricultural production. As well as pasture there may be planting of specimen trees and clumps with woodland established along or near to the top of the hill.

An extra 2.4ha of broadleaved woodland will be created at the Pomplett plantation. Across the whole area, 2km of new hedgerow will be created and a further 29km restored and enhanced. Table 3 highlights some of the quantified habitat changes but the plans do not give quantities for all of the changes planned.

Specific enhancements are mentioned for bats including the construction of an artificial bat roost and a new wetland around Wixenford Quarry. Increases in woodland hedgerows and wetland are also likely to improve the area for bat populations by providing roots, flying routes and feeding sites respectively.

Table 3: Habitat creation by the Saltram project by type and area

Habitat type	**Area (ha)**
Flower-rich grassland	159
Parkland, Woodland, Scrub and Orchards conserved	120
Broadleaved Woodland	2.4
Freshwater wetlands	0.3
Mudflat & Saltmarsh mosaic at Crabtree Reclaim and Blaxton's Meadow	~ 8
Hedgerow (created and protected/improved) - length in Km	30

The other mammal mentioned in the plans is the otter. There are plans for otter surveys, and the potential to install an artificial holt to encourage further use of the undisturbed Saltram side of the estuary.

Figure 4 provides an overview of the relative changes in ecosystem services which we might expect from this project. This is eftec's assessment based on the information available about the project. It compares the services provided in the 'now' and 'do nothing' baseline scenarios and in the (Saltram) project scenario. A scale of 0 to 5 is used where 0 means the service is not provided and 5 means the service is provided and is at best quality possible for the site.

The key findings from the above assessment are that:

- The project is largely directed at recreation, landscape and aesthetic and cultural and spiritual services, and the greatest gains are indeed in these areas;
- The benefits to water quality and flow are uncertain and speculative and not included in the valuation; and
- Climate regulation gains are uncertain but may occur and we make some effort to value these. There may be an increase (or perhaps displacement) in greenhouse gas emissions due to development of the project and increased transport to Saltram but this is impossible to quantify.

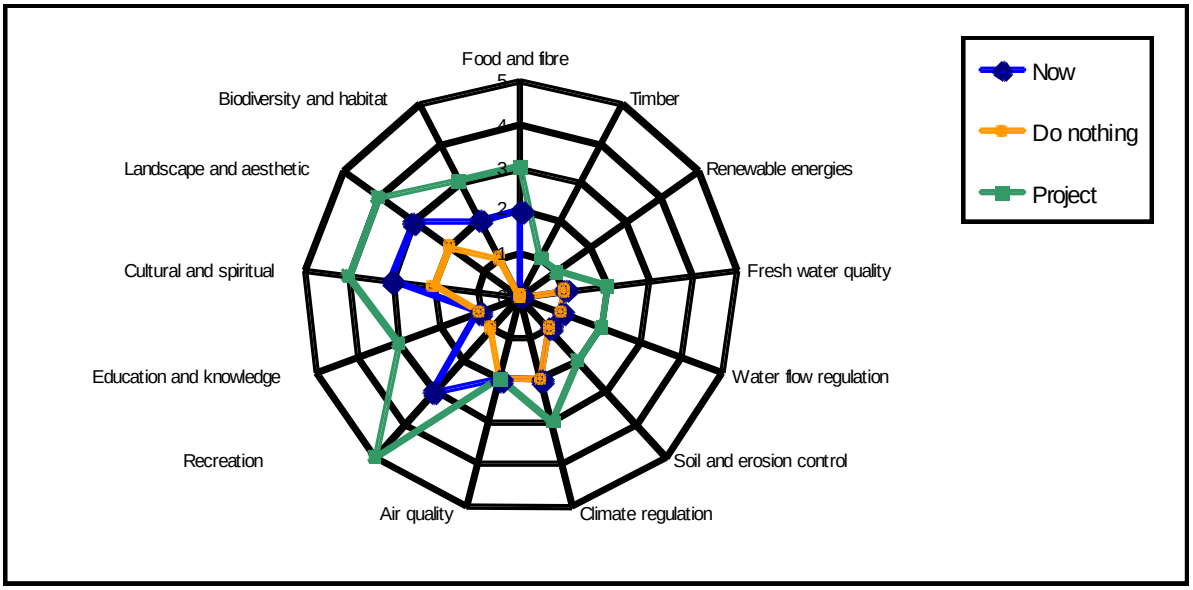


Figure 4: Ecosystem service changes in the two baselines and with the Saltram project (eftec's assessment)

Table 4 shows the quantitative data used for value transfer. Some changes discussed above could be included in more than one category (for example, changes in landscape, recreation and cultural and spiritual services could overlap). We allocate the changes under different categories as shown in Table 4 in order to avoid doublecounting. Those services which will not change significantly due to the project or those for which we do not have sufficient data do not feature in the rest of the analysis.

Table 4: Key statistics of ecosystem service changes due to the Saltram project

Ecosystem service change	Value	Source
Food and fibre		
Orchard area created by the project	1 ha	Estimated by eftec for the case study
Beehives created by the project	600	Estimated by eftec based on the area of the park
Climate regulation		
Carbon Sequestration with the project	158 tonnes CO_2/year	Estimated from (Cantarello, Newton, & Hill, 2011) and estimated land cover changes (Table 2)
Recreation		
Number of moorings created by the project	100	Estimated by eftec for this case study
Current visits	350,000	(Land Use Consultants, 2011)
Number of visits expected following the project	500,000 / year	Estimated by eftec for this case study
Number of households	Before new build ~ 75,000 After new build ~ 82,000	(Statistics, 2007) (Council, 2011b) (LLP, 2011)
Cultural and spiritual		
Maintenance of landscape features	75,138 households before new build and 82,138 households following new build	Affected population (Households)
Landscape and aesthetics		
Hedgerows recreated by the project	2 km	(National Trust et al., 2010) (see Table 3)
Biodiversity / habitat		
Grassland created by the project	159 ha	(National Trust et al., 2010) (see Table 3)
Broadleaved woodland planted by the project	2.4 ha	(National Trust et al., 2010) (see Table 3)
Area of wetlands	8.3 ha	(ABPmer 2008) & estimated from google satellite images (see Table 3)

4. Appropriate Monetary Valuation Evidence

Here we report the process of review and selection of the unit economic value estimate that is appropriate to the case study. The value evidence includes market prices, estimated premia where relevant and estimates of willingness to pay (WTP) or willingness to accept compensation (WTA) for non-market goods and services.

The appropriateness is determined by similarities between the context on which the estimate is based and the context of the case study. The key factors that define this context are decision making context, place, ecosystem services and population affected. The estimates also need to be robust or at least variations explainable.

Table 5 shows the unit value estimates that are selected for further analysis. The same estimates are presented in bold throughout the text.

Table 5: Unit economic value estimates used in the analysis

Ecosystem service	Value	Reference	Key reason for selection
Food and fibre			
Orchards/hectare/year	~£3000 - £33,000	Nix, 2010	Standard Farm pricing booklet
Beehive/hive/year	£166	CALU, 2006	Estimate for income per hive based on available factsheet from University agricultural unit
Climate regulation			
Non-traded carbon price	£51.70 per tonne in 2010 to £268 in 2100	DECC, 2010	Standard UK carbon prices
Recreation			
£ per visit	£1	eftec assumption based on values from the literature	A conservatively low estimate given uncertain visitor estimates
£ per mooring per year	£91.25	("Plymouth City Council - Boat moorings," no date)	Only available price
Cultural and spiritual			
£/household/year to protect the cultural heritage	£0.50	Based on eftec 2006	Potentially a poor fit but there are no other value estimates for cultural services of a landscape

Table 5 cont: Unit economic value estimates used in the analysis

Ecosystem service	Value	Reference	Key reason for selection
Landscape / aesthetic			
£ per hedgerow km per household per year	£0.02	(eftec, 2006)	The higher end value chosen but lower than an alternative valuation
Biodiversity / habitat			
Grasslands protection/household	£17.53	Garrod et al. (1994)	Closest lowland value found
£ per household per 12000 ha of broadleaved woodland	£0.84	Willis et al. 2003	Both of these are based on strong meta-analyses and so based on a range of studies, and more likely to be accurate and transferable than an individual valuation.
£ per hectare of wetland per year	£2200	(Brander, Florax, & Vermaat, 2006)	

Food and fibre: The project focuses on attempts to link local producers to local consumers. Edwards-Jones (2010) and Edwards-Jones et al. (2008) explain why, whilst not damaging on a small scale, the complexities of food production mean that the benefits of local food are at best uncertain. Varying productivity levels and transport requirements mean that the net impact of efforts to increase consumption of locally produced food can be hard to determine. For these reasons we make no attempt to estimate any environmental "added value" for local food. We do however reduce the costs of production and hence where appropriate, many of the transport and extra packing costs are removed from the calculations.

There is evidence of consumer willingness to pay (WTP) a price premium for locally produced goods compared with national production. Lobb et al. (2006) found that WTP for local lamb exceeded WTP for national by £1.76 per kg, while for strawberries the difference was £1.96 per kg. This benefit will be shared partly in higher prices (benefit to producers) and partly in greater satisfaction for consumers (consumer surplus). We do not have data to estimate the specific benefits in the Saltram case, but they may exist for some consumers, and could justify some increase in the values presented below. However we are unconvinced by these small increases, particularly given the levels of uncertainty inherent in our assumptions regarding food production and hence premium for local production has not been included in the analysis.

Income per hectare for apples and salad crops can be estimated from Nix farm management handbooks pre 2010. The 2010 edition explain that most vegetable and salad production is carried out by relatively few and large specialist producers reducing the usefulness and accuracy of average income estimates. Gross margins were still reported in the 2009 edition for lettuce crops of £3,500 per ha (Nix 2008). **In the 2011 edition the gross margin for**

vegetables was approximately £700 per ha and **apples between £3,525 and £33,425 per hectare depending upon the density and productivity of the trees** (Nix 2010).

Honey production per hectare of forage is generally based upon a trial and error method. The British Beekeeping Association online forum[2] suggested that 1 colony might need 2 hectares of year round forage each to work effectively. A hive can produce 18kg of excess honey per year and sold in jars that are 453g on average. If we assume £5 per jar which is sold directly to the public in farmers markets (and includes any premium to local production), the gross annual income from each hive is estimated as £196. ALU technical note 040401 (CALU 2006) estimate the cost of running a hive at £30 per year. This gives a net income of £166/hive.

In the baseline (without Saltram project), abandonment of current agricultural land is a possibility. The potential loss of income from this depends upon what is currently produced. In 2007 average winter wheat net margins were £74/ha for England, Dairy was £67/ha and lowland ewes lost -£69/ha (Wilson and Cherry 2010). The farmer's labour is included in these costs. Assuming a profitable venture, these farms might be earning around £10,000 per year, but could alternatively be loss-making, without agricultural payments (which are transfer payments from the government to farmers and therefore are not net increases in welfare and hence are not included in a cost-benefit analysis).

Climate regulation: Can be valued using DECC guidance figures for carbon values. In this case, the relevant figures are those for non-traded carbon. **The mid-range values rise from £51.70 per tonne in 2010 to £268 in 2100 (DECC 2010).**

Recreation: The most common unit value of informal recreation is expressed in terms of £ per visit and estimated through individual willingness to pay by stated preference and travel cost studies. Estimates in terms of £ per visit can be applied to current and future number of visits. This assumes that the quality of each visit (and hence its value) is the same. So the Saltram project would only be valued in this way if it leads to increase in the number of visits since the evidence is too coarse to pick up the value increase due to increase quality of a given visit. Alternative units used in the literature are £ per type of access, £ per household or £ per hectare.

There is no estimate that exactly matches the context of Saltram. Therefore we discuss some likely estimates and which ones are chosen or not and why.

Saltram project is not an urban park but neither is it considered open countryside – therefore it is challenging to find value estimates that fit the Saltram context. Willis et al. (2003) found that the UK public is willing to pay £1.66 to £2.75 for each recreational visit to a woodland. Bennett et al. (2003) estimated the WTP for a day permit onto the Ridgeway national trail within the North Wessex downs as £1.24. These figures give a reasonable idea of ballpark WTP for informal recreation in a natural environment, and could be used in conjunction with

[2] http://www.bbka.org.uk/members/forum.php?r=250&c=2&f=4&t=2173

estimated visit numbers to derive a total estimate. **A conservative value of £1/visit was chosen since it is close to these figures.**

Greenspace in or near urban areas can provide high values. Bateman (1995) found that respondents in the rural market town of Wantage, Oxfordshire had a mean WTP of £9.64 per household per year for a new and accessible woodland. Part of this value is for recreation, though it will also cover biodiversity/conservation concerns. The high values are observed outside the UK too – studies from Hong Kong, Australia and Spain show the importance of availability of alternatives. In highly urbanised Hong Kong, Lo and Jim (2010) found a mean WTP of HK $77.43 per household per month (~£72/year) to prevent a 20% loss of greenspace near to their homes. In Perth where the greenspace near urban area is more common, Pepper et al. (2005) found a mean WTP of $A21.60 (~£16 in 2010) per person per annum for a bushland park, and Saz Salazar and Menendez (2007) found a mean WTP of 8920 pesetas (~£36 in 2010) per year per household over four years for a new park in Valencia, Spain. These examples are provided to show the effect of local conditions on the WTP estimates – they are not otherwise applicable to the context of the Saltram project.

A rough estimate based on a conservative interpretation of the above studies might be approximately £10 to £25 per household, per year, and could be used in conjunction with the population of the surrounding area to give an alternative value estimate. However this would be an estimate of the total value of the green space, not the added value due to improvements associated with the Saltram project. Therefore, it is not chosen as the unit value for further work.

Allotments are not included in the analysis due to lack of information about whether or not they will be provided (Section 3). However, the unit value for allotment benefits is rather large as shown by Perez-Vazquez et al. (2006). They estimate the mean annual WTP for protecting local allotments (above payments for access) of allotment holders were approximately £79, £36 and £79 and for local residents were £42, £46 and £284, in Wye, Ashford and London, respectively. Thus if allotments are included in the project their benefit is likely to be considerable.

For water-based recreation, a quay will be re-opened at Cottage point. **Plymouth Council currently charges £91.25 per year for a mooring** (PC 2011c). This price does not measure the full willingness to pay for boat trips, however there are alternative mooring options in the area and so the marginal increase in benefits from another mooring can be approximated by the price of that mooring.

Cultural and spiritual: eftec (2006) reports values for conserving cultural heritage in severely disadvantaged areas. Cultural heritage in that study was broadly defined to include aspects such as traditional farm buildings, presence of animals, traditional breeds and/or traditional farming practices. There is some relevance to the objectives of the Saltram project, but value transfer is difficult, going from a regional estimate for SDAs, to a specific local urban fringe project. Particularly since the original work was done in the uplands and so these values are an imperfect fit and should be considered uncertain. However, in the absence of other estimates, they are used here.

The study estimates that in the South West for a 'small' change ('rapid decline' to 'no change') the mean value was approximately £6 (2010) per household per year (95% confidence interval -0.11 to 11.59); for a 'large' change ('rapid decline' to 'much better conservation') the mean value was approximately £8 (2010) per household per year (95% confidence interval 1.24 to 15.03). **We chose a value of 50 pence per household per year**. The 95% confidence interval for moving to no change included negative values and the low end of the "better conservation" scenario was 1.24. The 50 pence-estimate lies somewhere between these. If the value transfer fit had been better we may have chosen an average value but in its absence it is more defensible to choose a value which is likely an underestimate of the actual value.

Landscape and aesthetics: There is a basic choice between valuing whole landscapes/areas, and valuing specific features. Examples of the "features" approach include Hanley et al. (1998), who found strong preferences for increases in broadleaved woodland, heather moors and wet grasslands, and lower values for dry stone walls and archaeology, for an ESA in Scotland. The Environmental Landscape Features (ELF) model (IREM/SAC 1999, 2001, Oglethorpe 2005) is a form of meta-analysis / value transfer for valuing landscape features in England. Values, based on contingent valuation studies, were included for rough grassland, heather moorland, salt marsh, woodland, wetland and hay meadow (1999) and hedgerows and field margins (2001). For example, a feed-in study for ELF by Hanley and others (2001) estimates WTP per household per year for increases in field margins in Cambridgeshire (£13.95 to £20.20) and East Yorkshire (£15.60 to £22.26) and in hedgerows in Devon (£17.78 to £31.93) and Hereford (£12.94 to £31.57).

The estimates are intended only to account for values of residents, and to allow for diminishing marginal values of additional units of a feature, but aim to value the entirety of a given resource within an area. The ELF model "assumes that the base reference amount of a particular feature referred to in a study relates to the total abundance in that region" and then "assumes that the average 'loss' … that each study is referring to and attaching a WTP estimate to is equivalent to a fall in abundance in the region of 10%". This is a reasonable approach to take, given the problems of the data. The results of ELF are generally broadly consistent with the results of eftec (2006) as shown in Table 6.

The estimate of 2 pence per household per kilometre of hedgerow is chosen as it is the high bound estimate of eftec (2006) but it is below the ELF values.

For woodlands, Willis et al (2003) found that providing a view of broadleaved woodland is worth £269 per household on the urban fringe. We do not have estimates of the number of households with a direct view over the affected area in Saltram. Therefore, it is not possible to use this value. It is also likely that some of this value is already captured by recreational visit estimates.

Table 6: Comparison of the 95% confidence intervals for £ per household WTP found by eftec 2006 and the mean values from ELF model (£, 2008)

Study	Rough Grassland	Broadleaved and mixed woodland	Field Boundaries (hedgerows)	
eftec 2006	-0.62 – 0.43	-0.01 – 0.86	-0.12 – 0.02	The results presented are the 95% confidence intervals for WTP for a 1% change in the attribute found by this study except for field boundaries where it is per km.
ELF	0.04 – 0.11	0.07 – 0.09	0.03 – 0.04	Here the results are the estimated mean range given in the ELF model for WTP for the whole attribute in the region, divided by 200 to make it comparable to the eftec study. Note that this is not a 95% confidence interval.

Biodiversity/habitat: Such evidence as is available on the monetary valuation of biodiversity improvements is generally difficult to separate out from values associated with recreation, cultural heritage aspects and/or landscape and aesthetics.

Whilst there are many valuations of British uplands and a few for wetlands there is a dearth of valuations of lowland grasslands in the UK. Contingent valuations were carried out for **English lowlands in the Somerset levels ESA** (Environmentally Sensitive Area) **(£17.53 / household /year)** and for the Culm grasslands (£12.50 / household / year) (Garrod et al. 1994). This study was under taken in 1993 and looked at the value of designating the area as an ESA and providing agri-environmental payments to encourage good stewardship.

Another study valued the culm grasslands in 2003 and estimated the value of a 10% increase in the total coverage of Culm grasslands over a 10 year period within the Culm grassland area (Burgess et al 2004). These values will include an element of cultural and aesthetic values, though they may be considered as primarily biodiversity focused studies, and again it is important to avoid the risk of double counting if attempting to value these linked impacts. We did not use this value as it is for a relatively rare and specific form of wet grassland that does not match to the habitat in the project area.

Willis et al (2003) find that UK households are willing to pay £0.84 per household for an extra 12,000 ha increase in broadleaved native forest across the UK. This does not include any increased willingness to pay of local people for the amenity value of the forest, so there is in principle no double-counting with recreation or aesthetic values.

Garrod and Willis (1997) estimate WTP of approximately 52 - 56 pence for another unit of biodiversity rich forest compared to 30-33 pence for "standard" forest. 70% of respondents stated that the value was linked to a desire to visit, highlighting the overlap with recreation values.

White et al. (1997) valued the biodiversity action plan for otters in Yorkshire. They found a mean WTP of approximately £12 (~£15.50 in 2010) per household as a one-off payment for otter protection. It is difficult to transfer this value to Saltram, as the impact of the project on the otters is not well defined.

Brander et al. (2006) present a meta-analysis of wetland valuation studies, estimating an average value for UK wetlands of €2,480 (~£2,200) per year per hectare, approximately double the European average. This meta-analysis value was chosen as the value of wetlands created by the project. However this application is in its simplest form of transferring the average figure as there is not enough data to apply the meta function which offers a more subtle valuation.

5. Monetary Value of Ecosystem Service Changes

Having selected (or assumed) the appropriate unit value estimate, here we aggregate this to the affected ecosystem service and/or population. In many cases, this is a simple multiplication of the unit of change (from Section 3) and the unit economic value (from Section 4).

Table 7 summarises the results and the rest of this section explains the process behind these. The unit estimates from different years are converted to 2010 £ using the Retail Price Index and Consumer Price Index (Note the Consumer Price Index only began in 1996).

Food and fibre: In the baseline we assume that farming in the area would be gradually abandoned. The net farm income for the 140 ha, based on the prices defined in Section 4, is between -£10,000 and +£10,000 per year (without subsidy) depending upon the farm enterprises. Given that this range runs over a loss and that the average is 0 we have left it out of the calculations.

Honey production across a 600 hectare site might use 300 hives. Based on yields of 18kg per hive and £5 per jar this would provide a gross profit of just under £200 per hive per year and net of £166 per hive. Total income might be £50,000 per year. However this is without labour or set up costs. Set up costs might be £100 per hive assuming economies of scale can bring down hive and colony prices (CALU, 2006). There would also be a need to employ staff. If a single skilled bee-worker could tend 600 hives over the 8-9 months they are active this might mean a further cost of £15,000 per year or more. This would bring the net profit of closer to £35,000 per year.

Table 7: Summary of Values for Likely Ecosystem Service Changes

Ecosystem service	Environmental Change	Economic Value	Net value £/Year
Food and fibre			
Orchard area created by the project	1 ha	£18,500 Averaged value from highest and lowest possible	£18,500
Beehives created by the project	600	£166/hive/year	£49,951
Climate regulation			
Carbon sequestration with the project	158 tonnes/year	Yearly carbon price as in DECC (2010) guidance	£8,420 (2012; then rising)
Recreation			
Number of moorings created by the project	100	£91.25 per mooring per year	£9,125
New Visits	£150,000	£1 per visit	£150,000
Cultural services			
Restoration	75138 households before new build 82138 households after new build	£0.50 value per household of cultural restoration	£37,569 before new build £41,069 after new build
Landscape and aesthetics			
Hedgerows recreated by the project	2 km created 28km conserved	£0.62 per km based on 2 pence per household per km	£50,925
Biodiversity / habitats / freshwater			
Grassland created by the project	159 ha	£669/hectare /household value * total households coverted to 2010 prices	£106,436
Broadleaved woodland planted by the project	2.4 ha	£2,155 0.84/household/12,000 hectares, multiplied by UK households and divided by 12,000 converted to 2010 prices	£5,172 (single up-front payment)
Area of wetlands	8.3 ha	£2,200	£18,260

The size and productivity of the orchards is unknown and estimates could therefore run from a gross income of less than £2,000 per year for 0.5 hectare of low density and yield trees to closer to £200,000 (£167,000) per year for 5 hectares of high yield orchard based on Nix Farm Management Handbook estimates. If we assume a 1 hectare orchard and take a mean from the low and high yields the gross income is approximately £18,500 per year.

We have unit value for salad crop margins as reported in Section 4 but since we don't know the area or the farming method we cannot use this value.

Climate regulation: Precise estimation of carbon impacts is not possible with the data available, but we can produce estimates based on assumptions about baseline land cover types. We assume that the baseline involves agricultural abandonment and transitional/scrub-type vegetation. We assume that the sequestration begins in 2012 with attempts to convert the land. Section 3 shows how we calculated the net change per year of approximately 158 tonnes per year. This value is multiplied by the DECC carbon price described in Section 4.

Recreation: There are two main components to the impact: new visits to the site, and improved visit quality for existing visitors. We do not have sufficient quantitative or monetary data to estimate the latter and hence calculation for the former is presented below.

Current visitor numbers are approximately 350,000 per year. The extra housing will increase the local population by approximately 17,000 people. If we assume that the improved facilities and increased population bring visits up to 500,000 we can begin to estimate the added recreational value. Given the coarse estimates being made it is sensible to begin with a conservatively low estimate for the added value of £1 per visit (£150,000 per year for new visits). This value is a very conservative estimate using a figure below those presented in Section 4 and ignoring any increased value for existing visitors. We might also consider that, without intervention, the number of visitors may fall – the landscape would be less attractive, and perhaps less safe. With more detailed data a more refined value might be estimated where greater confidence could be placed in higher figures, for these purposes a more conservative and so defensible figure is more appropriate.

For boating, the price per mooring can be multiplied by the number of new moorings. This number is not known to us, but estimating 100 moorings gives less than £10,000 per year, which is minor in relation to other parts of the recreation service.

Cultural and spiritual: The project is preserving farming practices, recreating green paths and restoring the amphiteatre. eftec (2006) results were mean £6 per household per year for a movement from a rapid decline in cultural heritage to no change and £8 per household per year for changes from 'rapid decline' to 'much better conservation'. This estimate was based on a whole region, but also the whole regional population. We could either attempt to assess the proportion that this specific area contributes to regional cultural heritage, or scale with respect to populations. The most straightforward approach is to focus on the immediate local population around the periphery of the site, accepting both that others further away would also be willing to pay something for conserving the cultural heritage of the Saltram area, and

that the local willingness to pay for conservation would in reality be spread across a wider range of sites. Given the scale of interventions envisaged, and the likely consequences of no action, the value for “much better conservation” rather than “rapid decline” is appropriate. There are approximately 300,000 people in Plymouth, Plymstock and Plympton including only half of the population of Plymouth (the half closest to the park). There are a further 7000 new households planned for the area. Using an average of 2.4 people per household we can estimate the total number of households for the area will eventually be over 82,000 but less until the new areas are built (15-20+ years for completion). We therefore multiplied £0.50 (the low end of the 95% confidence interval) by 72,000 local households to provide a value of approximately £38,000 per year for the first 15 years and £41,000 once the new residential areas are completed.

Landscape and aesthetics: It is difficult to estimate landscape values in a way that avoids overlap with cultural, recreation or biodiversity values. We consider woodlands under biodiversity. Most aesthetic aspects such as views and green lands, and the ongoing presence of grazing animals and agriculture more generally, could be considered as covered under cultural heritage (for non-use aspects) and recreation values (for enjoyment of the landscape). One aspect that is likely not covered in those estimates is the benefit to households with views directly over the landscape – potentially significant values for a relatively small number of homes situated directly on the fringe of the area. The benefit of the project is not directly in providing these views, but rather in enhancing them / preventing their deterioration. We do not attempt to value this but note it as an omission at this stage.

The value chosen for the 30km of hedgerow preserved or created was 2 pence per household per km. It is the high bound estimate of eftec (2006) but it is below the ELF values. This value was multiplied by the total number of households in the area and the length of hedgerow leading to a total value of £50,925.

Biodiversity/habitat: The WTP per household for the Somerset Levels ESA was chosen as it is the closest valuation found for lowland grasslands. Somerset is clearly a different context. But the context difference is more prominent in other services such as recreation. For biodiversity the Somerset Levels value is thought to be the closest for lowland grassland. The Somerset Levels WTP per household is divided by the total area of the levels and then multiplied by the number of households in Devon (since that was the equivalent sample area from the study). That value was then multiplied by the area of species rich grassland, scrub, parkland and orchard described in the Saltram masterplan. This results in £106,000 per year (in 2010 prices).

The broadleaved woodland was valued using the Willis et al (2003) estimate of £0.84 per household for 12000 ha. We multiplied this by the number of UK households (this being the sample described by Willis et al 2003) and then divided by 12000 to get the value per hectare. We then multiplied this by the area of new woodland described by the master plan and updated to 2010 prices. This results in a benefit estimate of over £5,000.

The £2,200/ha value chosen for wetlands was multiplied by the 8.3 hectares. The implication of using the median estimate from this study for the value transfer results is discussed in Section 7.

6. Aggregation

The benefit from the Saltram project is largely assumed to begin immediately. This is a first working assumption that can be refined to reflect options about the time-path of deterioration in the site under the baseline, and the detail of when population increases occur in the new settlements around the site.

The benefits identified above can be summed over time to give a comparison of the baseline (do nothing) and the project scenario (Table 8). The values are estimated on a year-by-year basis over 10, 50 and 100 years, discounted at the HM Treasury Green Book (2003) rate declining over time: 3.5% for years 1-30; 3.0% for years 31-75; and 2.5% for years 76-125.

Table 8: Aggregate benefits over time

	Present Value		
Ecosystem service	**10 years**	**50 years**	**100 years**
Provisioning / food	£486,000	£1,560,000	£1,990,000
Climate Change	£59,200	£377,000	£615,000
Recreation	£1,380,000	£4,070,000	£5,170,000
Culture	£323,000	£1,000,000	£1,280,000
Biodiversity	£1,080,000	£3,180,000	£4,030,000
Gross Total	£3,320,000	£10,200,000	£13,100,000

A project of this sort will have significant upfront costs that we have not estimated. There are also likely to be some running costs, though these are likely to be small in comparison to yearly public benefits. The up-front costs would be the main determinant of the overall profitability of the project. Our estimates suggest that an up-front cost of approximately £3.3 million could be 'paid back' within 10 years through the demonstrable public benefits of the project; any upfront cost greater than £10-12 million might not be recouped from public benefits – though there are additional benefits that we have not been able to value in monetary terms.

7. Sensitivity Analysis

This is an ambitious project with many facets. It is possible that some will be more successful than others and we have not attempted to factor this risk element into our valuation. Nor have we estimated the role of the Saltram project within the wider context of the Plymouth Green Infrastructure plan. This could result in higher values (Saltram as a crucial link in the bigger picture) or in lower values (lower marginal importance of Saltram if other projects go ahead) but this is difficult to account for at this stage.

The **climate change** impacts we were able to analyse are relatively small, in the context of the overall gains of the project. Against this should be set the carbon emissions from the work carried out on the project, currently unknown. There are additional carbon impacts associated with transport to and from the site, and with the displacement of travel (people travelling here instead of further afield, or cycling or walking through the park as an alternative to driving) that similarly have not been taken into account due to lack of data. There is substantial uncertainty regarding the likely carbon sequestration impacts of the project, since the baseline is unclear. We have assumed agricultural abandonment leading to growth of scrubby vegetation over former pastures. Hewever it is possible that agriculture would continue in which case the carbon picture would change somewhat. However it is clear that overall the cost-benefit analysis for this project is not sensitive to assumptions about the amount of carbon sequestration.

Recreation values may change significantly. A lot depends on how visit numbers and values evolve in the baseline – if the 'do nothing' option results in a significant decrease in attractiveness or accessibility, and/or in much of the area feeling unwelcoming or unsafe – then the difference in value may be rather greater. Our main estimate is based on £1 per visit for new 150,000 visits only. If instead we assume that the baseline results in a substantial decline in visit numbers and values, we might have 150,000 visitors who would have continued to visit who now have a £1 per visit benefit each (for improvements to existing visits). In addition, 350,000 new visitors might value each trip more highly – at £2 each, this would give an estimate of £850,000 per year. Table 9 describes a set of alternative assumptions for the recreational visit benefits. Estimates for recreational value based on intuitively reasonable assumptions may lead to anything from a halving to a tripling in total benefits.

Table 9: Alternative scenarios for valuing recreation

Scenario			Present Value		
New visitors/year over baseline	**£ per existing visit**	**£ per extra visit**	**10 years**	**50 years**	**100 years**
150,000	0	0.5	£731,653	£2,164,577	£2,743,945
75,000	0	0.5	£301,269	£891,296	£1,129,860
150,000*	0	1	£1,377,230	£4,074,498	£5,165,073
150,000	0	2	£2,668,383	£7,894,339	£10,007,329
150,000	0.25	1	£2,130,402	£6,302,739	£7,989,722
150,000	0.25	2	£3,421,556	£10,122,580	£12,831,978

*the values used in Section 5.

The cultural and spiritual value took the low end of estimates from those available for the sort of change envisioned. However these values were also for a larger change. If we had used the high end unit estimate for cultural services, the total would be almost 15 times higher (approximately £20 million over 10 years) but this is unlikely to be accurate for the Saltram project. It could be that the value should in fact be lower. A cultural value per household of £0.50 yields a 10 year present value of £0.5 million.

Biodiversity estimates are based only on quantified land cover. The actual impact upon biodiversity may be much higher if sensitive agricultural practices are linked with careful land management over the remainder of the site. Conversely if much of the land concentrates on the productive agricultural values and the recreational worth of the land biodiversity benefits would decline. Without sufficient data, it is difficult to define these differences in monetary terms.

For sensitivity analysis, the 95% confidence interval from the Somerset levels WTP estimates can be used (£7.57 - £27.49 per household per year). Table 10 summarises the impact of these differing prices on the overall value for biodiversity: over 100 years it can add or remove £2 million from the current value of the project.

Table 10: Sensitivity analysis for biodiversity values whilst varying grassland valuation

Somerset levels WTP used (Garrod et al, 1994)	**Present Value**		
	10 years	**50 years**	**100 years**
Low	£558,120	£1,641,053	£2,078,911
Mid*	£1,078,523	£3,180,653	£4,030,598
High	£1,598,927	£4,720,253	£5,982,286

* The values used in Section 5

Grassland makes up 159 ha of the project area, over 90% of the area valued for biodiversity and more than 80% of the total value. As such it is by far the dominant factor in the biodiversity value of the park.

We could also consider the large difference in the median and mean value of wetlands taken from Brander et al (2006). The mean value is ~£2,200 per ha per year but the median value is only ~£107 per ha per year indicating that there are some large value areas skewing the average wetland value upwards. Using the median value would mean that we underestimate the values held by 50% of the wetlands we might value and overestimate the rest if we randomly sample wetlands. It is standard practice to use the mean value in analysis like this but in this case the median may have been more appropriate. This is because we have little information on the specific value of the wetland to suggest we should use a higher value. We could argue that the median is more likely to be closer to the true value for a randomly selected hectare of wetland.

If the median had been used the biodiversity value would have been ~£150,000 lower over ten years, and closer to £0.5 million lower over 50 and 100 years. Thus, even for a small area as in this case study, the choice of unit value can result in significantly different value results. This highlights the need to know as much as possible about the site so that the most appropriate value data can be chosen.

All of these values are rough estimates based on largely qualitative descriptions of the Saltram project. A more detailed assessment with a fuller data set may give different results. The study suggests that the key uncertainties are:

- The total visitor numbers;
- The areas which will be farmed; and
- The form of farming taking place, the impact the park will have on the value of the new and old houses near to the park (broader estimates of the landscape value).

Total visitor numbers may be the largest issue. Unit estimates (for example, per person) of use values are usually far higher than unit estimates of non-use value, and if the total number of visitors to this site were to increase significantly then the recreational value may increase more than suggested above.

We may also be underestimating the landscape and aesthetic values of the area: the surrounding area is becoming increasingly built up, and the marginal value of green space, from both aesthetic and recreation perspectives, might be significantly higher than the average values we are presenting here.

8. Conclusions

There are many significant assumptions made here and a number of changes which have gone un-estimated. Nevertheless the broad line of argument mapped out in this case study describes the wide range of benefits that might be expected and begins to provide some idea of the possible scale of these benefits. Overall, our approach has been conservative, with care to avoid double-counting the benefits, so the total service change values are more likely to be underestimates than overestimates. However since we do not know the costs of the proposed interventions, it is difficult to contextualise the present value figures for the service change benefits associated with the scheme.

Better data on service changes would enable refined calculations, even though significant uncertainties regarding service values are likely to remain. Key uncertainties include visitor numbers, farming areas and practices and actual local landscape and cultural values. A primary valuation study might be considered, however this would only be warranted if the costs of the project are such that cost-benefit ratio of the project is borderline on the basis of evidence available once the costs and key physical evidence gaps are filled. We suspect this is unlikely, because there is a large human population around the area and the contrast between the proposals and the consequences of no action is stark. However cost information is needed before firm conclusions can be drawn.

These results are very approximate and significant changes might be made with better data. However they do begin to present the scale of the benefits which might be expected from the Saltram project. They may allow planners to better understand what might constitute a reasonable up-front investment. £3.3 million would be a significant cost but could be ameliorated by public benefits within 10 years. However any costs reaching £12 million or more would risk failing a cost-benefit analysis – note that these thresholds exclude those benefits that were not possible to value in this case study.

Summary

Saltram Countryside Park is one part of Plymouth's Green Infrastructure planning. It is in turn made up of a complex set of plans to improve and protect the area to better provide recreational amongst other ecosystem services for a growing population. The 640 hectare site will eventually be bordered on all sides by new and old urban environments making its protection all the more important. The most significant benefits are likely to be from recreation and biodiversity. This evaluation found that over 10 years the site is likely to produce in the order of £3 million in ecosystem services in present value terms. However, this estimate excludes some changes (both positive and negative) due to lack of qualitative, quantitative and/or monetary data.

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