Cockhaise Brook

The River Ouse Project Report No. 7

University of Sussex

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Front cover Nobles Reach on Cockhaise Brook

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1 Introduction

This is one of series of reports produced by The River Ouse Project (University of Sussex) about sites in the Upper Ouse catchment. This report provides information to the Environment Agency, Ouse Upstream Thinking (OUT), Sussex Wildlife Trust and other interested stakeholders to enable appropriate decisions to be made about biodiversity enhancement of streamside land linked to flood alleviation and run-off prevention.

Our work has focused particularly on streamside grassland, but we have also surveyed gills in upstream woodland. The two main objectives for grassland sites were to characterise species-rich sites using the National Vegetation Classification (NVC) and to assess the suitability of species-poor sites for either grassland enhancement or wet woodland restoration. Our objectives for woodland sites were to assess their contribution to preventing run-off and to characterise species-rich sites using a floristic table developed from data collected from gills in the Upper Ouse catchment between 2006 and 2012.

The report sets our work in context (Section 2) and describes the methods we used (Section 3). Site descriptions (Section 4) give location and a description of present-day vegetation including: NVC type and an indication of biodiversity value; potential for the site to act as a flash washland; and relevant changes in land-use over the last 200 years. An assessment of the Ecosystem Services currently provided by the site is considered in relation to the potential for enhanced flood alleviation and run-off prevention by washland enhancement or changes in agricultural use of land (such as a change from arable to permanent grassland or hedgerow planting). Suitably-placed debris dams and/or tree planting can also be used to slow the flow of water (Newcastle University and Environment Agency, 2011; Nisbet *et al*., 2011).

2 Context

2.1 Slowing the flow of water to prevent run-off

The River Ouse in Sussex is a flashy river, which rises quickly after prolonged heavy rain and then soon subsides. It has a wide catchment area with a large number of small streams including the Cockhaise Brook and its tributaries (Figures 1 and 2). This ‘capillary’ system is mostly well-wooded with imperfect or poor-draining soils. Mini-floodplains alternate with steep-sided sections known locally as ‘gills’.

Rain falling at the end of a dry period is absorbed initially but once the ground becomes saturated any extra rainfall causes flow rates to increase rapidly in these streams. The result is a sudden and dramatic rise in water level downstream. Some of this water spills out on to land bordering the Ouse and its tributaries. Land subject to such flooding is known as ‘flash washland’ because the flooding lasts only a few days, unlike washlands on the Cambridgeshire Ouse, which remain flooded throughout spring. The deepening of streams in the 1970s and 1980s to drain agricultural land have reduced the amount of land subject to this ‘flash’ flooding and this, together with changes in land use, have contributed to the amount of sediment accumulating in Barcombe reservoir. The Cockhaise Brook (Figure 2) is one of three pilot catchments in the Ouse Upstream Thinking project (OUT) in which South East Water hopes to demonstrate that changes in land use can lead to significant reduction in run-off with its attendant sediment load.

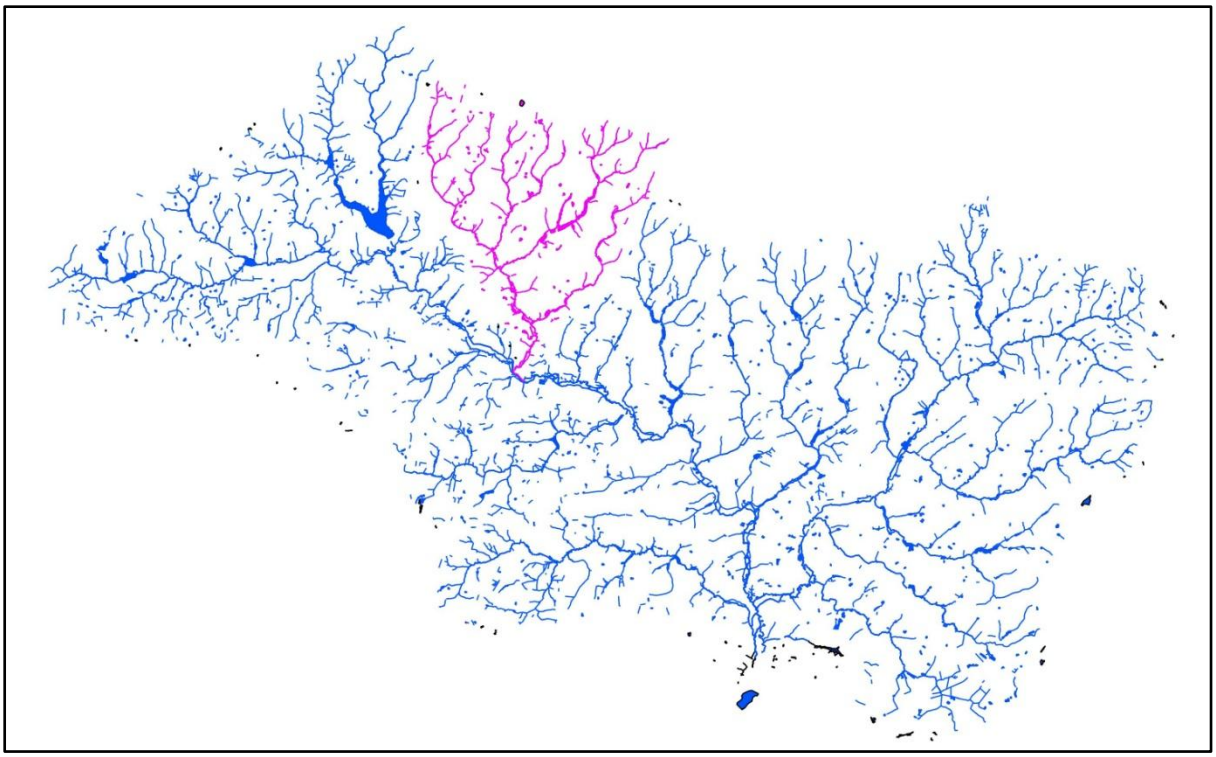

Figure 1 Stream system in the Upper Ouse showing position of the Cockhaise Brook in purple.

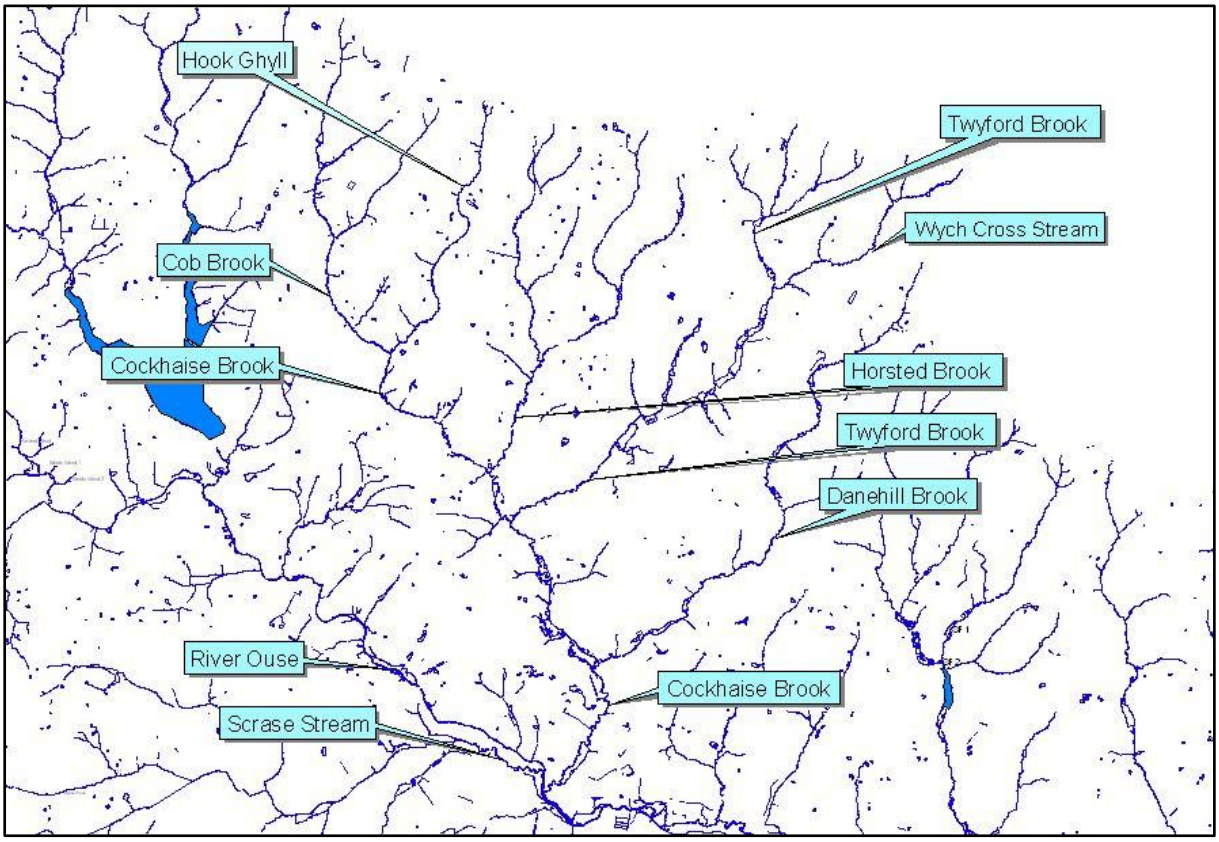

Figure 2 Tributaries of the Cockhaise Brook.

2.2 Flash Washlands along the Cockhaise Brook

Flash washlands along the Cockhaise share the following properties with washlands in the Upper Ouse:

- flood for 2–3 days during periods of peak flow after heavy and prolonged rain, usually during winter;
- have free-draining soil as a result of the sandy silt brought down in floodwaters from the High Weald;
- until the middle of the 20th century most were managed as hay-meadows or pasture with flower-rich 'Crested Dog's-tail–Common Knapweed Grassland' (MG5 grassland in the National Vegetation Classification – see section 3.1), which tolerates short duration flooding;
- are too dry for most of the year to support wetland plants unless they contain permanently wet areas fed by springs;
- have maximum biodiversity when a matrix of spring-fed wetland areas occurs within MG5 grassland.

2.3 Wildflower meadows full of butterflies and bumblebees – a Biodiversity Action Plan target plant community

Wildflower meadows (such as MG5 in the National Vegetation Classification) are rare. Despite the 1995 Biodiversity Action Plan target of no further depletion of this habitat, they have continued to vanish from our landscape. The decline in native bumblebees, which are essential crop pollinators, particularly early in the year when hive bees are inactive, is linked to the decline in flower-rich meadows.

In the days of horse transport, the best land was often used as hay meadow and all along the Cockhaise Brook there were extensive hay meadows and pastures (Figure 3). Wild flowers such as Common Knapweed (*Centaurea nigra*) and Oxeye Daisy (*Leucanthemum vulgare*) grew in profusion. Now only small pockets of flower-rich grassland remain and the connected meadow-scape essential for bumblebees has gone. The linear landscape along streams such as the Cockhaise Brook provides a wonderful opportunity for re-connecting the flower-rich fragments through grassland enhancement of suitable sites.

Our research shows that this can be done on sites where the soil fertility is low by planting wildflower plugs and sowing locally-sourced wildflower seed (The River Ouse Project Report 8). Such enhancement would retain agricultural land in good condition, enabling a return to low-input farming when oil-driven agriculture is no longer possible.

2.4 Preventing run-off by absorbing rainwater on valley slopes

The amount of water entering the stream system after heavy rain will be greatly affected by how the land on which the rain is falling is used: whether it is wooded, permanent grassland, arable or built-up. In the Cockhaise catchment, the land is predominately agricultural with a patchwork of small fields, hedges and woodland, but in recent years there has been an increase in the amount of land that has been converted from permanent grassland to arable maize to provide winter feed for cattle or short-term ryegrass ley. This is a high input–high output system, which is not a sustainable method of food production (Webbelmann *et al*., 2013). It is widely recognized that it is better to use permanent grassland for animal production and arable for growing food that is eaten directly by

humans. In the present context, converting permanent grassland to maize or short-term ryegrass ley on the valley slopes along the Cockhaise Brook also has an adverse effect on water retention, leading to increased run-off and leaching of fertilizer, sediment and pesticides into the water course.

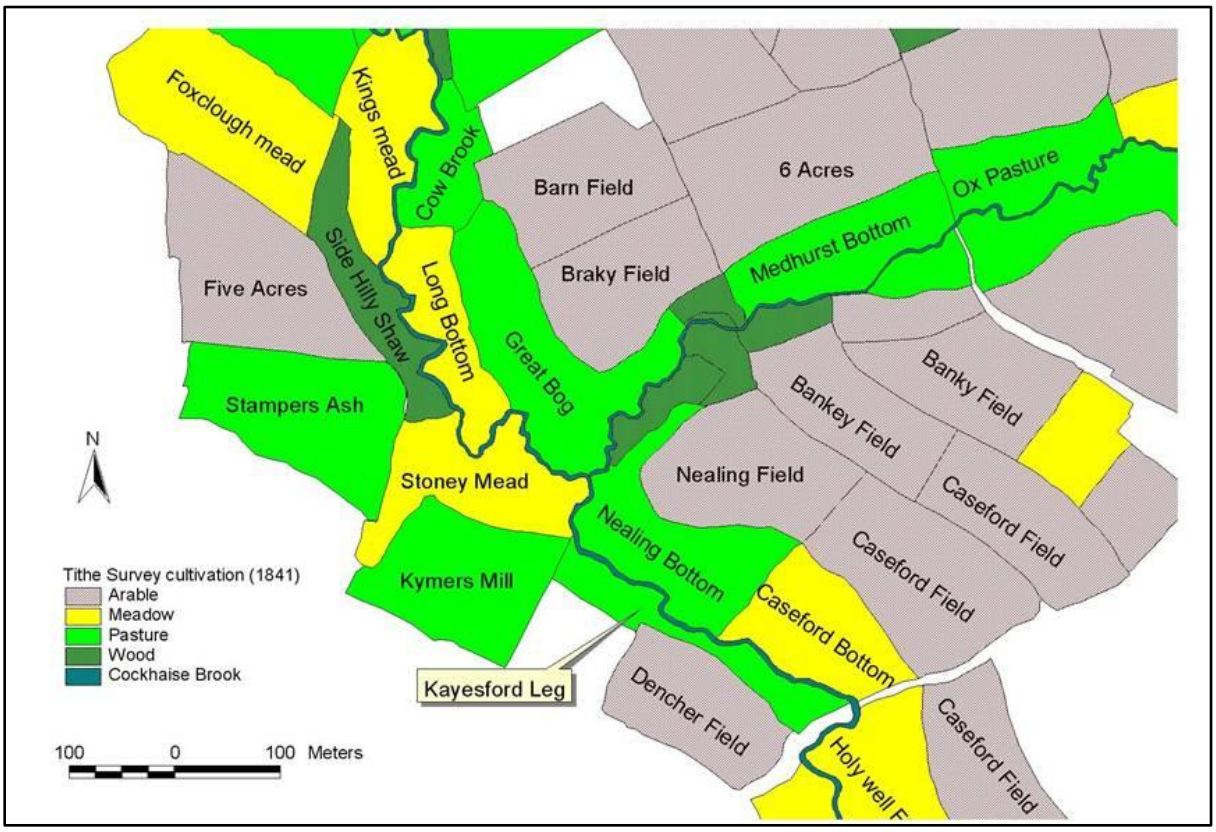

Figure 3 Land-use along a section of the Cockhaise Brook in 1841.

In contrast, permanent grassland with earthworm tunnels absorbs rainwater: “Our research shows that farmers can make a huge difference in helping to mitigate the effects of climate change. When fields are not ploughed the soil condition is improved naturally by the tunnelling of earthworms, which absorb water at a rate of four to ten times that of fields without worm tunnels. This in turn helps the soil to take up water during storms and retain it during drought” (Chris Stoate, Game and Wildlife Conservation Trust Press Release, 2011). The absorptive nature of such grasslands is even further enhanced in species-rich examples because they contain deep-rooting perennials such as Yarrow and Ribwort Plantain (Wilkinson, 2011).

Trees and shrubs are more deep-rooting than grassland plants, so the typical well-wooded landscape of the High Weald, which is found in much of the Cockhaise catchment, is making an important contribution to preventing surface run-off. The Pontbren Project in Wales (Flood Risk Management Research Consortium, 2008 and The Woodland Trust Wales, 2013) has demonstrated that both planting small areas of woodland and putting in hedgerows along contours prevent rapid run-off and retain water, sediment and nutrients. In the past, there was usually a hedge between the streamside meadows or ‘brooks’ and the arable

fields on the slope above. We identify areas where these have been lost and where new hedges could be planted with additional benefit.

2.5 Riparian woodland planting

Hydrological modeling on the River Laver in North Yorkshire showed that 40 ha of woodland planting spread over four sites would delay the arrival of a 1-in-100-year flood in downstream Ripon by almost 1 hour (Nisbet and Thomas, 2008). However, the woodland planting did not go ahead for a number of reasons:

- Restoring the land to wet grassland and applying for a HLS grant was more attractive because it would preserve the capital value of the land and the option of converting back to cereals remained.
- Stock would not be able to access the river for water.
- Farm woodland payments cease after 15 years.
- Scope for high timber yield would be compromised by the need to maintain a shrub layer and dead wood; both of which contribute to roughness and hence flood alleviation.
- Possible loss of trees and fencing from floodwater plus cost of clearing up trapped litter.

The report concluded that the most effective places to plant woodland are low-lying, wet sections and where there are relic side channels. Even small woodland plantings (20 m wide) would generate a lag effect. Washlands with riparian tree planting are more effective at holding back water than grassland sites, but may be a less attractive option to farmers. We identify the sites where we think this would be appropriate.

2.6 Large woody debris dams

Large woody debris dams are an effective way of holding water back in the upper reaches of rivers (Nisbet and Thomas, 2008). Dam construction leads to high rates of sedimentation in the upstream pool, which raises water levels and re-connects the stream with the floodplain. Water quality is improved by removal of sediment and associated nutrients such as phosphate.

These dams can be constructed around an existing overhanging fallen tree by cutting so that one end drops into the watercourse and then dragging another log (1.5 times the channel width) into place to form a cross. Debris builds up on the upstream side. The debris may be washed out during storm events, so these dams should not be constructed just upstream from culverts, which might block. However, in the upper reaches of the watercourse escaping debris is usually retained by a downstream debris dam (Nisbet and Thomas, 2008). Many of the gills we have surveyed have small, naturally occurring debris dams, which are already holding back the water and creating habitat diversity (Figure 4).

3 Methods

3.1 National Vegetation Classification (NVC) survey of principal grassland habitats bordering the Cockhaise Brook

The NVC is the most widely used system for describing vegetation and is particularly useful in the context of the present report because it relates to soil properties and site management. We followed the methods described in Rodwell (1992). The starting point is a

botanical survey, which records the abundance (determined by a visual estimate of percentage cover using the Domin scale; see Box 1 for a description) of all the species present in a series of sample squares (quadrats) of either 2 x 2 or 4 x 4 metres. From this dataset we assign an NVC community to the present-day grassland based on the frequency (percentage of quadrats in which each species is present) and abundance of each species. Points of difference between our data and the average for this type of grassland are noted. We can then draw conclusions about how this grassland has evolved in the context of past land use and about how it can be transformed in future.

Figure 4 Natural debris dam in Twyford Gill on the Twyford Brook (Figure 10).

Box 1
Frequency
I – occurs in 1-20% of samples; II – occurs in 21-40% of samples; III – occurs in 41-60% of samples; IV – occurs in 61-80% of samples; V – occurs in 81-100% of samples.
Domin values: percentage cover being assessed by eye in each sample
10, 91-100%; 9, 76-90%; 8, 51-75%; 7, 34-50%, 6, 26-33%, 5, 11-25%; 4, 4-10%; 3, <4% with many individuals; 2, <4% with several individuals; 1, <4% with few individuals.

3.2 Determination of historical land use and flooding

The historical land use of sites was investigated through document analysis and oral history interviews with local farmers.

3.3 Gill surveys

Previous gill surveys have used the NVC to describe the whole area of woodland in which the gill occurred (Burnside *et al*., 2006). In The River Ouse Project we have taken a different approach and used linear samples of 30-m lengths of stream valley; recording all the plants present in each 30-m sample. Using samples from 18 gills surveyed between 2006 and 2012 in the upper Ouse Catchment we have divided the gills into four groups. These Gill Groups are described by a floristic table (Table 1) based on average frequency of species within each group. Gills described in this report have been assigned to a Gill Group based on frequency of species occurring in at least five samples and points of difference between particular examples and the average given in the floristic table are noted. For example, we tabulate any species with expected frequencies of IV or V that have lower frequencies than this in the particular gill. We also tabulate (as additional constants) those species that have a frequency of V, rather than the frequency expected in that gill group.

Table 1 Ouse Gills Floristic Table: average frequency of species occurring in 30-m lengths of stream valley

	Group 1	Group 2	Group 3A	Group 3B
Constants				
Pellia epiphylla	V	V	V	V
Mnium hornum	V	V	V	V
Rubus fruticosus	V	V	V	V
Dryopteris dilatata	V	V	V	V
Atrichum undulatum	IV	V	V	V
Hyacinthoides non-scripta	V	IV	V	V
Oxalis acetosella	V	IV	V	V
Lonicera periclymenum	V	V	IV	IV
Ilex aquifolium	IV	V	IV	IV
Fraxinus excelsior	III	III	IV	IV
Discriminators for Group 1				
Scapania undulata	**IV**	II	I	I
Chiloscyphus polyanthos	**IV**	III	III	III
Isothecium myosuroides	**IV**	III	III	I
Betula pubescens	**IV**	III	I	II
Veronica montana	III	**IV**	**V**	**V**
Cardamine flexuosa	III	**V**	**V**	**IV**
Circaea lutetiana	I	**V**	**IV**	**V**
Carex pendula		**III**	**III**	**III**
Discriminators for Group 2				
Ajuga reptans	I	**V**	I	II
Athyrium filix-femina	I	**V**	II	IV
Lysimachia nemorum	II	**V**	I	III
Quercus robur	III	**V**	III	III
Fagus sylvatica	III	**IV**	I	II
Sorbus aucuparia	II	**IV**		I
Carex remota	II	**IV**	I	II
Pseudotaxiphyllum elegans	II	**IV**	II	II
Pteridium aquilinum	II	**IV**	I	I
Dryopteris aemula	I	**II**		

Table 1 (continued)	Group 1	Group 2	Group 3A	Group 3B
Ranunculus flammula	I	II		
Kindbergia praelonga	V	III	V	V
Ranunculus ficaria	V	II	V	V
Corylus avellana	IV	II	V	V
Hedera helix	IV	II	IV	V
Cardamine pratensis	V	I	V	V
Anemone nemorosa	V	I	V	IV
Carpinus betulus	II		III	II
Discriminators for Group 3				
Lamiastrum galeobdolon	III	III	V	V
Dryopteris affinis	II	III	IV	V
Chrysosplenium oppositifolium	III		V	IV
Alnus glutinosa	II	III	IV	IV
Thamnobryum alopecurum		I	II	II
Thuidium tamariscinum	V	IV	I	II
Discriminators for Group 3A				
Poa trivialis	II	III	V	III
Plagiomnium undulatum	III	III	IV	III
Brachythecium rutabulum	I	III	IV	II
Arum maculatum	I	I	IV	II
Hypnum cupressiforme	III	III	IV	I
Fissidens taxifolius	II	I	IV	I
Deschampsia cespitosa	I		IV	III
Conocephalum conicum	I		IV	III
Primula vulgaris	I	II	III	II
Conopodium majus	I		III	II
Adoxa moschatellina			III	II
Galium odoratum			I	
Allium ursinum			I	
Blechnum spicant	V	V	II	IV
Discriminators for Group 3B				
Mercurialis perennis	I		II	III
Angelica sylvestris	I		II	III
Acer campestre			I	II
Rhizomnium punctatum	V	IV	V	III
Associates				
Plagiothecium succulentum	III	IV	III	II
Geum urbanum		III	II	III
Hookeria lucens	I		I	
Cardamine amara			I	

3.4 Assessment of Ecosystem Services provided by site

Ecosystem Services have been defined as: “the benefits provided by ecosystems that contribute to making human life both possible and worth living” (Millennium Ecosystem Assessment, 2005). It can be difficult to assess these benefits in strictly economic terms, but the concept can still be usefully applied to land-use decisions by drawing attention to the benefits or detrimental effects of different land-use scenarios (Natural England, 2012). Possible benefits and detrimental effects of different land-use scenarios are listed below. These are discussed for the sites studied and, where appropriate, recommendations are made about changes that should be made.

Adverse effects of industrial/non-biological farming practices

1. Decline in crop pollinators and other beneficial insects.

2. Increase in amount of sediment, metaldehyde (widely used to control slugs) and nutrients such as phosphate getting into the river system [necessitating expensive artificial and chemical treatment of water].
3. Increase in run-off leading to flooding and increased sediment load downstream.
4. More expensive and less healthy winter feed for animals with associated increase in harmful greenhouse gases.

Ecosystem Services — benefits of permanent grassland

1. Reduces run-off and the amount of sediment, metaldehyde and nutrients (e.g. phosphate) getting into the river system. Water companies have begun to favour catchment management solutions to tackle water quality issues rather than expensive and less sustainable artificial treatment of water (Natural England, 2012). Woodland is even more effective.
2. Absorbs rainwater in worm tunnels.
3. Provides grazing for sheep and/or cattle: a more sustainable and healthy option for farm animals, which results in less greenhouse gas emissions than feeding grain-crop silage to indoor animals.
4. Provides winter feed for animals on sites that are cut for hay, haylage or silage.

Ecosystem Services — additional benefits of species-rich grassland

5. Provides pollen and nectar sources for bumblebees and other beneficial insects.
6. Takes up rainwater by roots of plants at different levels in the soil. Woodland is even more effective.

Ecosystem Services — additional benefits of washland grassland

7. Contributes to flood alleviation by holding back peak flow. Woodland is even more effective.
8. Contributes to flood alleviation and reduction in sediment load downstream by increasing roughness of the flood plain.
9. Reduces the effect of climate change, which is likely to lead to more extreme and unpredictable weather patterns.

4 Site descriptions

Site descriptions are ordered according to position in the stream system with upstream sites being considered first (Figure 5 and Table 2). The location and extent of each site is shown on the map of each tributary stream and the OS grid reference for the centre of the site is given.

Botanical survey results for grassland sites were analysed using the National Vegetation Classification (NVC) and are presented as NVC type with important specific differences tabulated. Present-day management is noted. Our target plant community is MG5 with 22 (12–38) species per sample. Where springs occur within the meadow, leading to areas of rush vegetation, the biodiversity increases, but the wet ground is unable to absorb floodwaters so the washland is less effective in reducing the surface run-off. Perennial Rye Grass (*Lolium perenne*) and Crested Dog's-tail (*Cynosurus cristatus*) generally occur at low frequency or are absent from MG5 and MG6 grasslands in the Cockhaise catchment. Site descriptions for gill sites give the gill group and any important specific differences (see Table

1 and Section 3.3). For gills surveyed in 2014 and 2015, the number of debris dams in the surveyed length is given with their approximate heights. Where appropriate, historical information based on document research and oral history interviews with landowners is given.

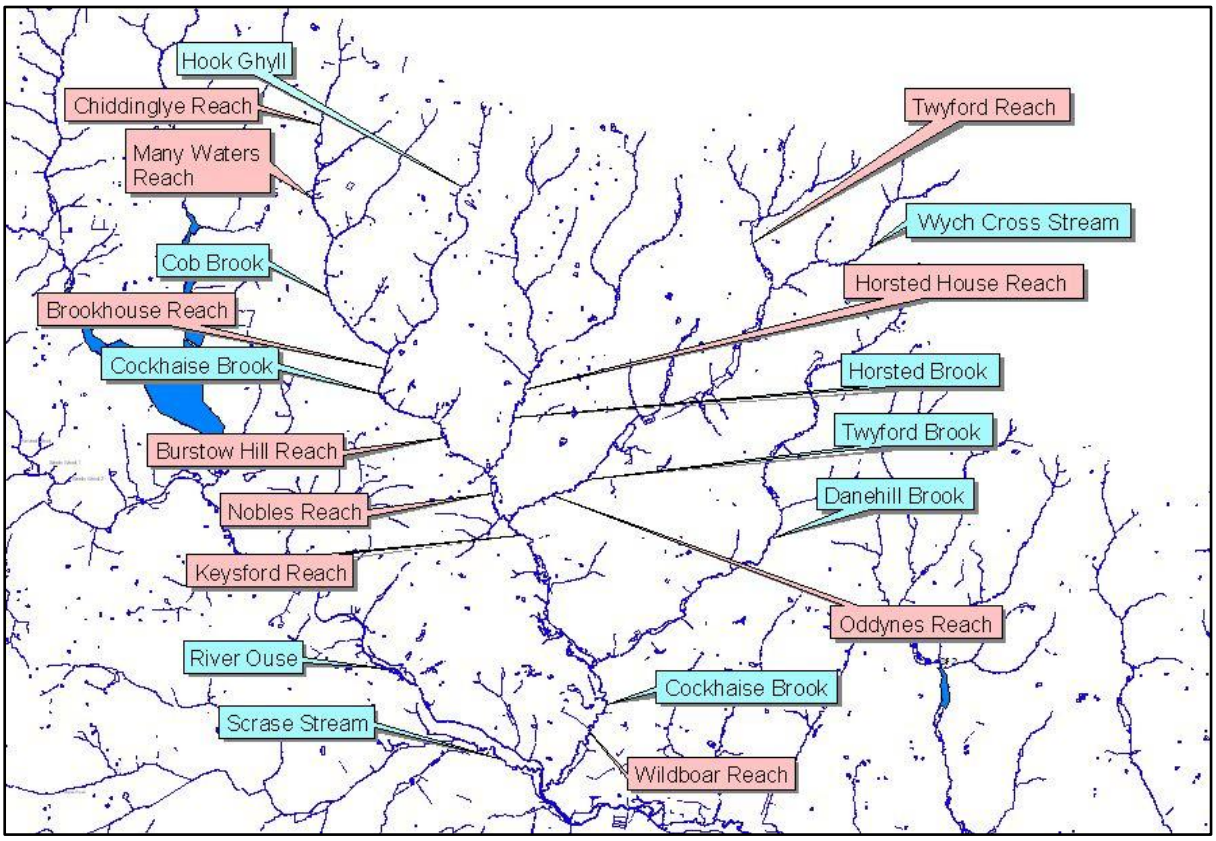

Figure 5 Position of the Cockhaise Brook tributaries (blue labels) and reaches (pink labels).

4.1 Cob Brook

Chiddinglye Wood (TQ346324, Figure 6). This was surveyed in 2006 using the National Vegetation Classification method for woodland. This Alder-Ash-Yellow Pimpernel Woodland (W7a/c) was much more species-rich than the average with 42 (34–48) species per sample and, like the surrounding woodland which we have not surveyed, will be making a big contribution to preventing run-off (Ecosystem Service 1) and contributing to flood alleviation by holding back peak flow and increasing the roughness of the floodplain (Ecosystem Services 7, 8 and 9).

Name of wood and date of survey	NVC	absent discriminators	low frequency discriminators	additional constants
Chiddinglye Wood 18 May 2006	W7a/c	*Filipendula ulmaria*		*Galium aparine* *Cardamine pratensis* *Circea lutetiana*

Many Waters Field (TQ 348315, Figure 6). This large field was surveyed in 2005 using 49 quadrats set out a random along 5 transect lines across the field. It was less species-rich than the average for MG6b with 11 (8–15) species per sample.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Many Waters Field 21 July 2005	MG6b		*Lolium perenne* *Cynosurus cristatus*	

Table 2 Position of sites in stream system

Stream name	**Name of Reach**	**Name of Site**
Cob Brook	Chiddinglye	Chiddinglye Wood
	Many Waters	Many Waters Field
Hook Ghyll		Hook Farm SSSI Grassland
		Hook Gill
		Holly Farm Meadow
		Brookhouse Gill
Cockhaise Brook	Brookhouse	Bushy Croft
	Burstow Hill	Mill Bottom
		Lower Eastlands
Horsted Brook	Horsted House	Upper Bottom
		Middle Bottom
		Lower Great Mead
		House Field
		Great Meadow
		Tom Champion
Cockhaise Brook	Nobles	Long Leg
		Bridgmer Hill
		Kingsmead
		Side Hilly Shaw
		Long Bottom
		Stoney Mead
		Great Bog
Twyford Brook		Twyford Gill
		Horncastle West Gill
		Horncastle East Gill
		Horncastle Meadow
		Marlfield
		Strouds
Wych Cross Stream		Wych Cross Place Gill
		Park Field
		Pond Mead
		The Mead
Twyford Brook	Oddynes	Waterbury Field
		Ten Acre Brook
		Square Wood Brook
		Gorse Brook
		Alder Moor
		Medhurst
		Nine Acre Brook
Cockhaise Brook	Keysford	Kayesford Leg
		Dencher Field
		Nealing Bottom (not surveyed)
		Caseford Bottom
Danehill Brook		Treemanes (walked 2015)
Cockhaise Brook	Wildboar	Both banks walked in 2006

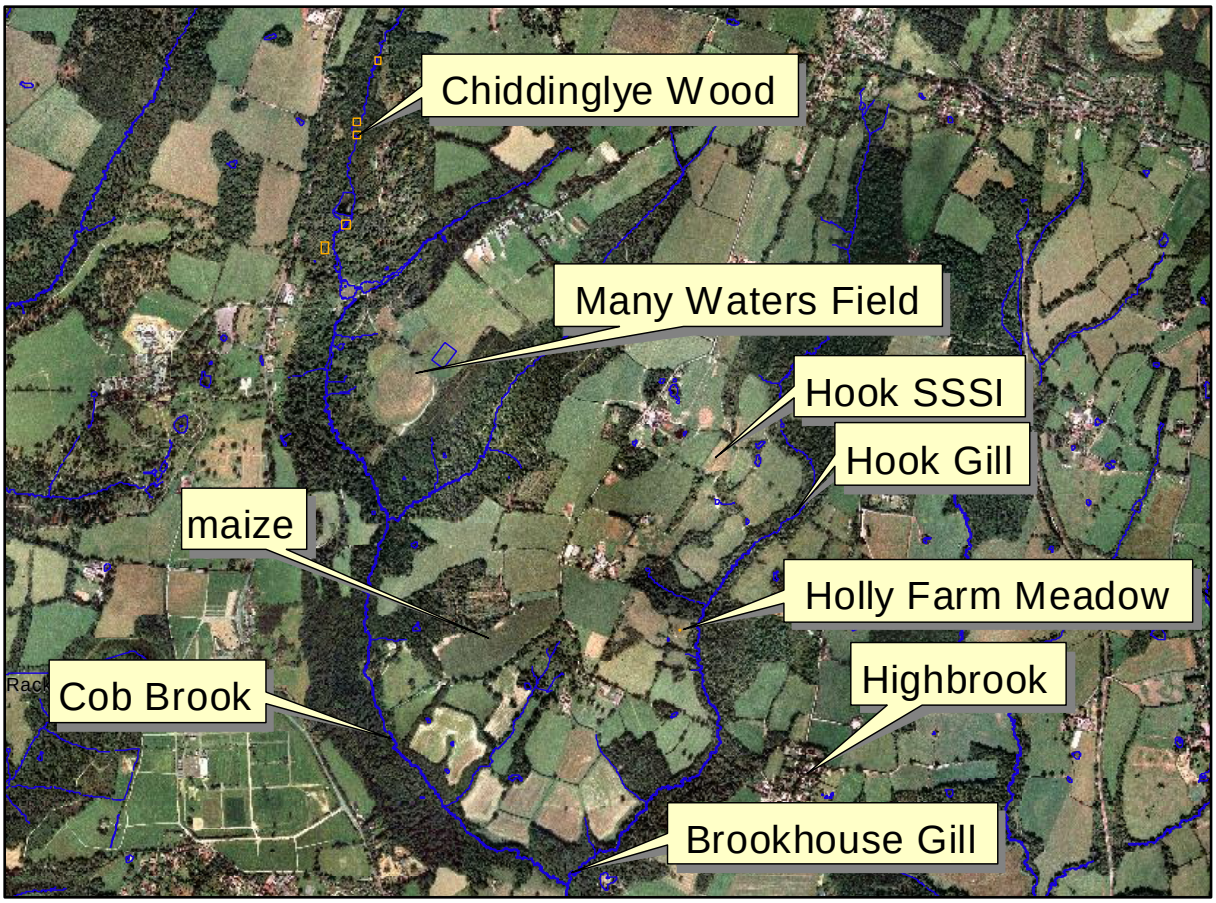

Figure 6 Sites on Cob Brook and Hook Ghyll.

In September 2007, plant plugs and wildflower seed were put into the upper part of the field (TQ350316) in a grassland enhancement field trial. In 2010, the last year in which the field trial was monitored, the following additional species had become established in this part of the meadow: Yarrow *(Achillea millefolium),* Agrimony *(Agrimonia eupatoria)*, Dyer's Greenweed *(Genista tinctoria),* Common Bird's-foot-trefoil *(Lotus corniculatus),* Burnet-saxifrage *(Pimpinella saxifraga),* Meadow Buttercup *(Ranunculus acris),* and Common Vetch *(Vicia sativa)* with some Oxeye Daisy *(Leucanthemum vulgare)* and Cowslip *(Primula veris)*, and small amounts of Selfheal *(Prunella vulgaris)* and Yellow Rattle *(Rhinanthus minor).*

The field was hay meadow in 1931 (Land Utilisation Survey) and has not been ploughed within living memory (Andrew Holmes, oral history interview with Bill Blunt, 27 March 2007). It lies on a slope above Cob Brook so it does not flood, but it should remain as permanent grassland to prevent sediment and phosphate from getting into the brook (Ecosystem Services 1-4). The increase in species diversity in the field trial area will make this more effective (Ecosystem Service 6) and provide pollen and nectar sources for beneficial insects (Ecosystem Service 5).

Downstream from Many Waters Field, and also lying on a slope above Cob Brook, was an arable field, which had a crop of maize in 2007 (Figure 6). Converting this field to permanent grassland would reduce run-off and sediment entering the Cockhaise Brook.

4.2 Hook Ghyll

Hook Farm SSSI Grassland (TQ360312, Figure 6). This pasture was hay meadow in the early 1930s and had Cowslips (Andrew Holmes, oral history interview with Tom Buckley, 13 November 2007). In 2008 it still contained Dyer's Greenweed (*Genista tinctora)*, Ragged-robin (*Lychnis flos-cuculi)*, Mouse-eared Hawkweed (*Hieracium pilosella)* and Pepper-saxifrage (*Silaum silaus)*. Greater Bird's-foot-trefoil (*Lotus uliginosus)* was present rather than Common Bird's-foot-trefoil (*L. corniculatus)*. A full NVC survey was not done, but it was possible to assign the grassland to MG5c based on subjective estimation of the abundance of species present using the ACFOR scale (A, Abundant; C, Common; F, Frequent; O, Occasional; R, Rare).

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Hook Farm SSSI Grassland 1 May 2008	MG5c	*Cynosurus cristatus* *Lotus corniculatus* *Plantago lanceolata* *Trifolium pratense*	*Trifolium repens* *Centaurea nigra*	

The surrounding grassland is in short-term ryegrass ley: it is ploughed up every 3 or 4 years and kale grown in rotation before returning to ryegrass. Maize for animal feed is grown on the better land up on the top. Large amounts of lime are required to grow these crops. This was a dairy farm until 2007; the fields are now grazed by cattle and sheep (Andrew Holmes interview with Tom Buckley, 16 May 2007).

Recommendation: Converting these fields to permanent grassland would reduce the run-off and the amount of sediment entering the Cockhaise. The stream is well-wooded and there are also hedges, but in places the stream water was petrifying because so much lime had been applied to the arable land.

Hook Gill (TQ362310, Figure 6). Six lengths were surveyed in 2009 and the data compared with the Ouse Gills Floristic Table (Table 1). This gill is characteristic of Group 3A, the most common type of gill.

Name of gill and date of survey	group	absent discriminators	low frequency discriminators	additional Constants
Hook Gill 12 May 2009	3A		*Hypnum cupressiforme* *Deschampsia cespitosa* *Conopodium majus*	*Mercurialis perennis*

Holly Farm Meadow (TQ358306, Figure 6). This was surveyed on 29 May 2008. This MG5c meadow contained some special species: Dyer's Greenweed *(Genista tinctoria),* Ragged-robin *(Lychnis flos-cuculi)* and Cowslip *(Primula veris)* but was less species-rich than the average with 19 (13–25) species per sample. At the time of the Tithe survey (1841) it was known as Hollow Field and was pasture. The field was meadow in 1931 (Land Utilisation Survey).

Recently it has been cut for hay and grazed by cattle (Andrew Holmes, oral history interview with Tom Buckley, who farms the land for the owner, 15 June 2007). This meadow is providing Ecosystem Services 1-6.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Holly Farm 29 May 2008	MG5c	*Plantago lanceolata*	*Cynosurus cristatus* *Lotus corniculatus* *Centaurea nigra* *Trifolium pratense*	*Potentilla reptans*

Brookhouse Gill (TQ354298, Figure 6). Six lengths were surveyed in 2009 and the data compared with the Ouse Gills Floristic Table (Table 1). This gill is characteristic of Group 3A, the most common type of gill. The rare moss *Hookeria lucens* occurred in one length.

Name of gill and date of survey	group	absent discriminators	low frequency discriminators	additional constants
Brookhouse	3A		*Brachythecium rutabulum* *Fissidens taxifolius* *Deschampsia cespitosa*	*Allium ursinum* *Tsuga heterophylla* *Carex pendula* *Mercurialis perennis*

4.3 Brookhouse Reach on Cockhaise Brook

Bushy Croft (TQ354296, Figure 7). Bushy Croft was surveyed on 1 July 2009. This MG5c meadow was more species-rich than the average with 24 (18–32) species per sample and contained Common-spotted Orchid *(Dactylorhiza fuchsii)* and Heath-spotted Orchid *(Dactylorhiza maculata),* Ragged-robin *(Lychnis flos-cuculi),* Lousewort *(Pedicularis sylvatica)* and Tufted Forget-me-not *(Myosotis laxa)*. In 1841 it was pasture (Tithe survey) and in 1931 it was meadow (Land Utilisation Survey). In 2009 it was managed by sheep grazing at a low intensity, but was not cut for hay. It is providing Ecosystem Services 1, 2, 3, 5 and 6.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Bushy Croft 1 July 2009	MG5c		*Cynosurus cristatus* *Lotus corniculatus* *Plantago lanceolata* *Dactylis glomerata* *Trifolium pratense*	*Ranunculus repens*

4.4 Burstow Hill Reach on Cockhaise Brook

Mill Bottom (TQ360287, Figure 7). This sheep-grazed rush pasture was surveyed on 9 July 2009. It is much more species-rich than the average for MG10b with 21 (14–33) species per sample and contained Common Spotted-orchid *(Dactylorhiza fuchsii)* and Ragged-robin *(Lychnis flos-cuculi).* It is not a washland. In 1841 Mill Bottom was being managed as pasture (Tithe survey) and in 1931 it was a meadow (Land Utilisation Survey). Currently this meadow is providing Ecosystem Services 1-6.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Mill Bottom 9 July 2009	MG10b			*Anthoxanthum odoratum* *Juncus acutiflorus* *Poa trivialis* *Ranunculus acris* *Trifolium repens*

Figure 7 Brookhouse Reach, Burstow Hill Reach and Horsted House Reach.

Lower Eastlands Meadow (TQ364284, Figure 7). This species-rich hay meadow, surveyed on 25 June 2014, was MG5c with 23 (16–31) species per sample. It was pasture in 1841 (Tithe survey) and had been grazed by Sussex Brown cattle over the winter prior to our survey (personal communication from owner).

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Lower Eastlands 25 June 2014	MG5c	*Plantago lanceolata*	*Cynosurus cristatus* *Dactylis glomerata* *Centaurea nigra*	*Cerastium fontanum*

Lower Eastlands Mire (TQ363283, Figure 7). An extensive spring-fed mire within Lower Eastlands Meadow was also surveyed on 25 June 2014. It was M23, but was very much more species rich than the average with 27 (25–29) species per sample. Lower Eastlands is providing Ecosystem Services 1, 2, 3, 5 and 6.

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Lower Eastlands Mire 25 June 2014	M23			*Anthoxanthum odoratum* *Cerastium fontanum* *Cirsium palustre* *Ranunculus flammula* *Ranunculus repens*

4.5 Horsted House Reach on Horsted Brook

Upper Bottom (TQ370294, Figure 7). Two quadrats recorded on 16 May 2007 were species-rich examples of MG5a meadow with 25 (23–30) species per sample. Cowslip *(Primula veris)* and Dyer's Greenweed *(Genista tinctoria)* were present. Upper Bottom was meadow in 1839 (Tithe survey) and in 1931 (Land Utilisation Survey). In 2007 the grassland was grazed by sheep. It is providing Ecosystem Services 1, 2, 3, 5 and 6.

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Upper Bottom 16 May 2007	MG5a	*Cynosurus cristatus* *Plantago lanceolata*	*Lotus corniculatus*	*Juncus inflexus* *Carex flacca* *Cirsium arvense* *Poa trivialis*

Middle Bottom (TQ368290, Figure 7). Middle Bottom, surveyed on 1 June 2006, was M27b mire and much more species-rich than the average with 22 (11–38) species per sample. It contained Common Spotted-orchid *(Dactylorhiza fuchsii),* Water Forget-me-not *(Myosotis scorpioides),* Adder's-tongue *(Ophioglossum vulgatum)* and Wood Club-rush *(Scirpus sylvaticus).* Within living memory, it was cut for hay until 1985 (Christine Zaniewicka, oral history interview with Bill Blunt, 29 September 2008), but is now unmanaged. It was meadow in 1839 (Tithe survey) and in 1931 (Land Utilisation Survey). This mire is providing Ecosystem Services 1, 2, 5 and 6. The scrub and woodland developing on the site will increase the effectiveness of flood alleviation (Ecosystem Service 1) and reduce the amount of run-off (Ecosystem Service 6), but there will be a reduction in pollen and nectar sources (Ecosystem Service 5).

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Middle Bottom 1 June 2006	M27b			*Lychnis flos-cuculi* *Poa trivialis* *Rumex crispus*

Lower Great Mead (TQ367290, Figure 7). Lower Great Mead, surveyed on 11 July 2006, was MG10a/b rush pasture and more species-rich than average with 24 (22–28) species per sample. In 1839 Lower Great Mead was being managed as pasture (Tithe survey) and in 1931 as meadow (Land Utilisation Survey). Like Middle Bottom on the other side of the stream, this area is now unmanaged, but it is providing Ecosystem Services 1, 2, 5 and 6. The scrub and woodland developing on the site will increase the effectiveness of Ecosystem Services 1 and 6, but will reduce Ecosystem Service 5 because, although trees are more effective at reducing run-off, there will be fewer pollen and nectar sources for beneficial insects (p. 12).

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Lower Great Mead 11 July 2006	MG10a/b			*Agropyron repens* *Cerastium fontanum* *Juncus conglomeratus* *Pulicaria dysenterica* *Rumex conglomeratus*

House Field (TQ368287, Figure 7). House Field, surveyed on 17 June 2015, was MG5a meadow and slightly less species-rich than average with 21 (18–25) species per sample but contained Adder's-tongue (*Ophioglossum vulgatum*), Common Spotted-orchid (*Dactylorhiza fuchsii*) and Southern Marsh-orchid (*D. praetermissa*). It was being managed as pasture in 1841 (Tithe survey) and was meadow in 1931 (Land Utilisation Survey). In recent years it has been grazed by sheep and horses.

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
House Field 17 June 2015	MG5a	*Festuca rubra* *Plantago lanceolata* *Centaurea nigra*		*Cerastium fontanum* *Poa trivialis* *Ranunculus repens*

Great Meadow (TQ367285, Figure 7). The rushy area (0.35 ha) of Great Meadow (Figure 8) was surveyed on 17 June 2015. It was MG10b rush pasture with 22 (17–25) species per sample, which is considerably more species-rich than the average. It contained many interesting species such as Ragged-robin (*Lychnis flos-cuculi*), Marsh Speedwell (*Veronica scutellata*) and Hemp-agrimony (*Eupatorium cannabinum*). It was meadow in 1841 (Tithe survey) and in 1931 (Land Utilisation Survey). In recent years it has been grazed by sheep and horses.

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Great Meadow Rush 17 June 2015	MG10b		*Agrostis stolonifera* *Ranunculus repens*	*Carex hirta* *Poa trivialis*

Tom Champion Meadow (TQ366284, Figure 7). This long, thin meadow extending from Great Meadow down to the confluence with the Cockhaise Brook was also surveyed on 17 June 2015. It was species-rich MG6b meadow with 16 (14–18) species per sample. It was meadow in 1841 (Tithe survey) and in 1931 (Land Utilisation Survey). In recent years it has been grazed by sheep and horses.

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Tom Champion 17 June 2015	MG6b	*Cynosurus cristatus* *Festuca rubra*		*Alopecurus pratensis* *Poa trivialis* *Ranunculus repens* *Rumex acetosa*

Figure 8 Rush vegetation in the southern part of Great Meadow, 17 June 2015.

4.6 Nobles Reach on Cockhaise Brook

Long Leg Mire (TQ365284, Figure 9). This M23a mire, surveyed on 15 July 2011, was much more species-rich than the average with 25 (23–27) species per sample. It was pasture in 1841 (Tithe survey) and is still grazed by cattle at a low level of intensity: slightly more than 35–40 young cattle (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes).

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional Constants
Long Leg Mire 15 July 2011	M23a		*Galium palustre*	*Alopecurus pratensis* *Poa trivialis* *Ranunculus repens* *Stellaria graminea*

Long Leg Grassland (TQ365283, Figure 9). This MG6b grassland, surveyed on 15 July 2011, was more species-rich than the average with 16 (14–23) species per sample. It was pasture in 1841 (Tithe survey) and was still being grazed in 2007 by cattle at a low level of intensity: slightly more than 35–40 young cattle (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). Long Leg is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9 and has a considerable amount of scrub and trees within the area, which will be increasing the effectiveness of flood alleviation (Ecosystem Service 1) and reducing the amount of run-off (Ecosystem Services 7, 8 and 9).

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Long Leg Grassland 15 July 2011	MG6b	*Lolium perenne* *Cynosurus cristatus* *Festuca rubra*	*Trifolium repens*	*Heracleum sphondylium* *Ranunculus repens* *Rumex acetosa* *Stellaria graminea*

Bridgmer Hill (TQ365283, Figure 9). This field was planted with Christmas trees when we visited in 2014.

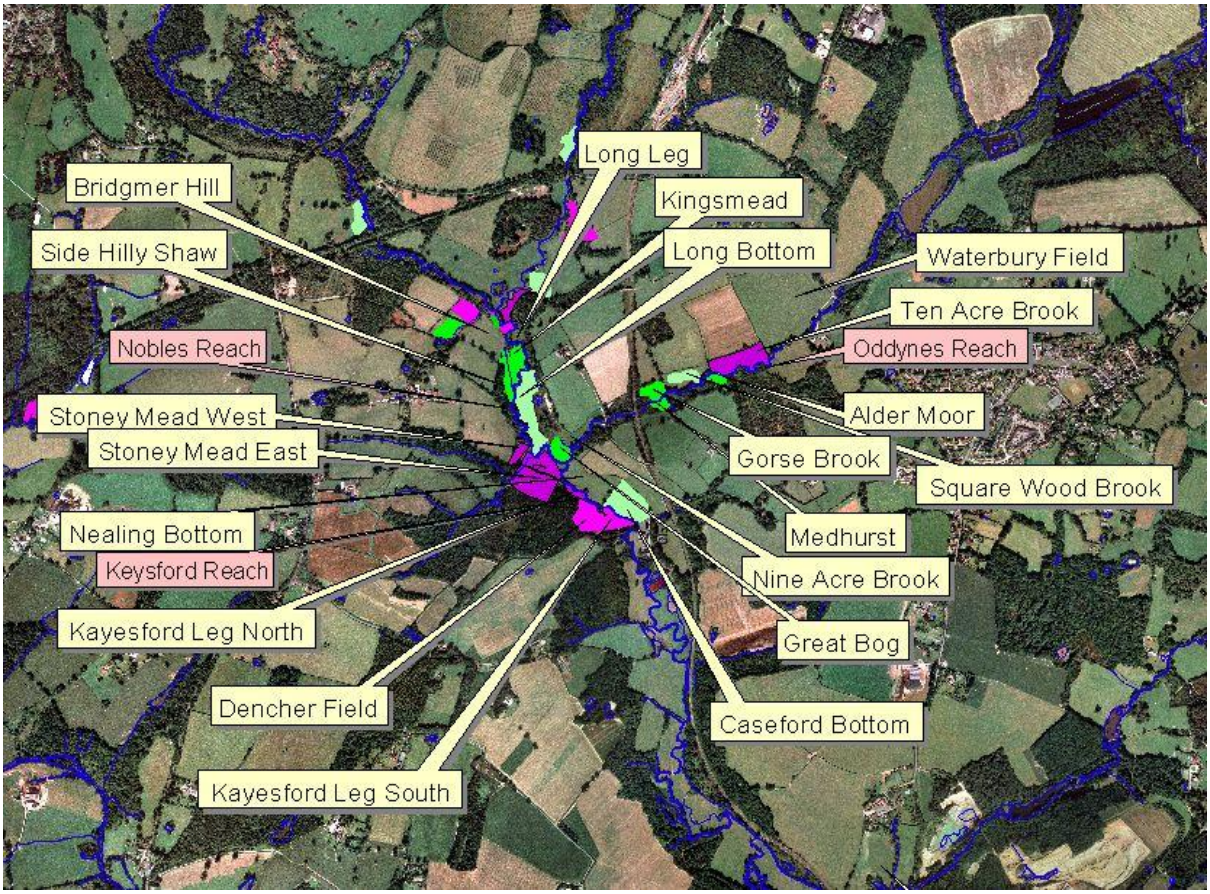

Figure 9 Nobles Reach and Keysford Reach on Cockhaise Brook; and Oddynes Reach on Twyford Brook: pink = MG5 grassland; purple = MG6b grassland; pale green = MG10 pasture; bright green = MG23 rush pasture.

Kingsmead (TQ366282, Figure 9). This species-rich mire was being managed as hay meadow in 1841 (Tithe survey) and in 1931 at the time of the Land Utilisation Survey, but it has also been used to grow hops (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). In recent years it has been managed by cattle grazing at a low level of intensity: slightly more than 35–40 young cattle (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). Ragged-robin *(Lychnis flos-cuculi),* Water-forget-me-not *(Myosotis scorpioides)*, Wood Club-rush *(Scirpus sylvaticus)* and Branched Bur-reed *(Sparganium erectum)* were present in 2007 and, with 22 (19–28) species per sample, it was slightly more species-rich than the average for MG23a. Kingsmead is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9 and has a considerable amount of scrub and trees within the area which will be increasing the effectiveness of flood alleviation (Ecosystem Service 1) and the reduction in the amount of run-off (Ecosystem Services 7, 8 and 9).

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Kingsmead 14 June 2007	M23a			

Side Hilly Shaw (TQ365281, Figure 9). This very wet Alder wood had pools of chalybeate water with tussocks of *Carex paniculata* (Tussock Sedge) and patches of *Scirpus sylvatica* (Wood Club-rush) when we walked through on 10 September 2014.

Long Bottom (TQ366281, Figure 9). This rush pasture, which is more species-rich than average with 15 (14–18) species per sample, was surveyed on 15 May 2007. It was hay meadow in 1841 (Tithe survey) and in 1931 (Land Utilisation Survey). It was last cut for hay about 15 years ago (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). Since then it has been grazed by cattle each year at a low level of intensity: slightly more than 35–40 young cattle. It has never been ploughed and acts as a washland. It is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9 and has a considerable amount of scrub and trees within the area which will be increasing the effectiveness of flood alleviation (Ecosystem Service 1) and reducing the amount of run-off (Ecosystem Services 7, 8 and 9).

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Long Bottom 15 May 2007	MG10a		*Agrostis stolonifera*	*Alopecurus pratensis* *Anthoxanthum odoratum*

Stoney Mead (TQ366279 and TQ367279, Figure 9). Stoney Mead is divided into an east and west part by a small tributary, which crosses it to join the main Cockhaise Brook at the end of Long Bottom. Our survey of 21 May 2015 found that it was all MG6b grassland with 15 (11–20) species per sample, which is slightly more species-rich than average. *Lotus* was frequent. It was meadow in 1841 (Tithe survey). In 1931 (Land Utilisation Survey) there was a small arable field in the east part by the Cockhaise but all the rest was meadow. In recent years it has been grazed by cattle.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Stoneymead 21 May 2015	MG6b	*Cynosurus cristatus*	*Lolium perenne* *Cerastium fontanum*	*Ranunculus repens* *Rumex acetosa*

Great Bog (TQ367279, Figure 9). This M23 mire is one of the first areas to flood in winter and it is semi-bog (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). Records were taken from two quadrats on 13 June 2007; species richness at 19 and 21 species per sample is average for this community. It was pasture in 1841 (Tithe survey) and meadow in 1931 (Land Utilisation Survey). In recent years it has been grazed by cattle at a low level of intensity: about 30–40 young cattle that eat the grass off and then are taken out (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). It is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9 and has a considerable amount of scrub and trees within the area which will be increasing the effectiveness of flood alleviation (Ecosystem Service 1) and reducing the amount of run-off (Ecosystem Services 7, 8 and 9).

4.7 Twyford Brook

Twyford Gill (TQ403316, Figure 10). Five lengths were surveyed in 2014 and the data compared with the Ouse Gills Floristic Table (Table 1). This was an atypical gill in which *Atrichum undulatum* was present at an unusually low frequency and the Gill Constants Ash *(Fraxinus excelsior),* Bluebell *(Hyacinthoides non-scripta)* and Wood-sorrel *(Oxalis acetosella)* were completely lacking. This is perhaps not surprising because the gill is located within heathland on Ashdown Forest. The moss *Hyocomium armoricum*, associated with the Ashdown beds, occurred in all lengths. Seventeen debris dams were present ranging in height from 10 to 110 cm.

Name of gill and date of survey	group	absent discriminators	low frequency discriminators	additional constants
Twyford 15 May 2014	1	*Chiloscyphus polyanthos*		*Dicranella heteromalla* *Diplophyllum albicans* *Hyocomium armoricum* *Polytrichastrum formosum* *Pseudotaxiphyllum elegans*

Horncastle West Gill (TQ395314, Figure 10). Five lengths were surveyed in 2014 and the data compared with the Ouse Gills Floristic Table (Table 1). Although geographically close to Twyford Gill, this was a typical gill with all the gill constants present and could be assigned to Group 2. The moss *Hyocomium armoricum*, which occurred in all lengths, is associated with the Ashdown beds. The rare moss *Hookeria lucens* occurred upstream from the part of the stream which was surveyed. Eight debris dams were present ranging in height from 10 to 50 cm.

Name of gill and date of survey	group	absent discriminators	low frequency discriminators	additional constants
Horncastle West 1 May 2014	2		*Ajuga reptans*	*Alnus glutinosa* *Angelica sylvestris* *Chrysosplenium oppositifolium* *Hyocomium armoricum* *Kindbergia praelonga* *Lamiastrum galeobdolon* *Ranunculus ficaria* *Scapania undulata*

Horncastle East Gill (TQ401307, Figure 10). Five lengths were surveyed in 2015 and the data compared with the Ouse Gills Floristic Table (Table 1). Like Horncastle West Gill, this was a typical gill with all the gill constants present. The Group 1 discriminant species, Lady-fern (*Athyrium felix-femina*) and Yellow Pimpernel (*Lysimachia nemorum*) were again constant, but the rest of the data fitted Group 1 better. The moss *Hyocomium armoricum*, which is associated with the Ashdown Beds, again occurred in all lengths. Thirteen debris dams were present ranging in height from 10 cm to 1 m.

Name of gill and date of survey	Group	absent constants	low frequency constants	additional constants
Horncastle East 29 April 2015	1		*Chiloscyphus polyanthos*	*Athyrium felix-femina* *Lysimachia nemorum* *Pteridium aquilinum* *Lamiastrum galeobdolon* *Alnus glutinosa* *Thuidium tamariscinum*

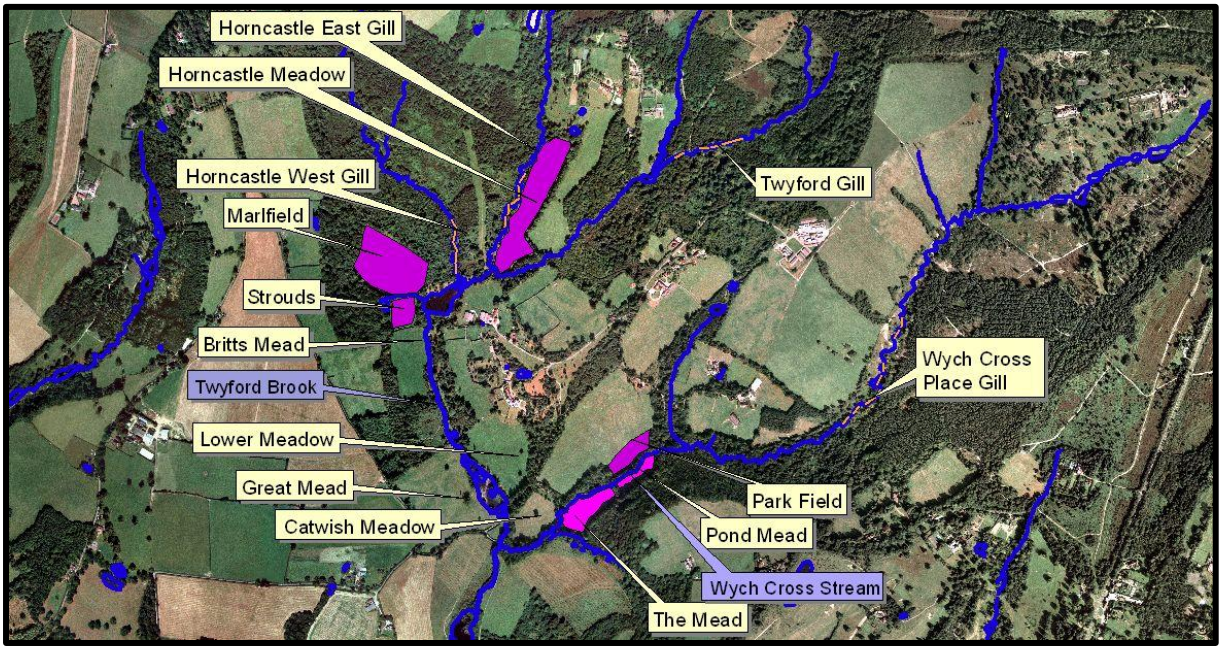

Figure 10 Twyford Stream and Upper Wych Cross Stream: pink = MG5 grassland; purple = MG6b grassland.

Horncastle Meadow (TQ397315, Figure 10). Horncastle Meadow, surveyed on 4 June 2014, was part of Horncastle Wood in 1842 (Tithe survey), but by 1931 it was meadow (Land Utilisation Survey). Recently it has been managed by sheep grazing. It was MG6b and, with 16 (12–20) species per sample, was more species-rich than the average. Unusually for June, fruiting bodies of an orange wax cap (*Hygrocybe strangulata* or *H. miniata)* were present, suggesting that the field has not been ploughed. The Countryside Restoration Trust acquired Twyford Farm in 2014 and has appointed tenant farmers who are keen to manage the meadow with a hay cut and aftermath grazing to increase the wildlife interest. The meadow does not flood, but is providing Ecosystem Services 1, 2, 3, 5, 6, and will provide 4 under the new management.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Horncastle 4 June 2014	MG6b		*Festuca rubra*	*Brachythecium rutabulum* *Prunella vulgaris* *Ranunculus repens*

Marlfield (TQ393313, Figure 10). This meadow looked very similar to Horncastle Meadow from a walkover on 4 June 2014 and we concluded it was MG6b. In 1841 it was being

managed as pasture (Tithe survey) and in 1931 as meadow (Land Utilisation Survey). In recent years it has been grazed by sheep.

Strouds (TQ394312, Figure 10). This meadow, which is adjacent to Marlfield, contained Red Clover (*Trifolium pratense),* Common Spotted-orchid *(Dactylorhiza fuchsii)* and Pignut *(Conopodium majus*), which made it look more interesting than Horncastle Meadow, but the 4 June 2014 survey showed that species-richness was average for MG6b with 14 (10–17) species per sample. In 1841, it was being managed as pasture (Tithe survey) and in 1931 as meadow (Land Utilisation Survey). In recent years it has been grazed by sheep. The Countryside Restoration Trust acquired Twyford Farm in 2014 and has appointed tenant farmers who are keen to manage the meadow with a hay cut and aftermath grazing to increase the wildlife interest. The meadow does not flood, but is providing Ecosystem Services 1, 2, 3, 5, 6, and will provide 4 under the new management.

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Strouds 4 June 2014	MG6b	*Cynosurus cristatus* *Festuca rubra*	*Cerastium fontanum*	*Ranunculus repens* *Poa trivialis*

4.8 Wych Cross Stream

Wych Cross Place Gill (TQ408310, Figure 10). Eight lengths were surveyed in 2014 and the data compared with the Ouse Gills Floristic Table (Table 1). This was a typical Group 1 gill with some additional constants including *Hyocomium armoricum,* a moss associated with the Ashdown Beds. Eight debris dams were present in the part of the gill surveyed ranging in height from 10 to 30 cm.

Name of gill and date of survey	group	absent discriminators	low frequency discriminators	additional constants
Wych Cross Place 30 April 2014	1			*Hyocomium armoricum* *Hypnum andoi* *Pseudotaxiphyllum elegans* *Pteridium aquilinum* *Taxus baccata*

Park Field (TQ400307, Figure 10). The grass sward throughout most of this large field was long and dominated by Yorkshire-fog (*Holcus lanatus*) on 18 June 2014, but at the bottom of the slope where we placed our samples there were more broad-leaved species and here the grassland was MG6b of average species-richness with 13 (10–16) species per sample. Red Clover *(Trifolium pratense)* was frequent and Common Bird's-foot-trefoil *(Lotus corniculatus)* occasional, suggesting that the diversity in the whole field could be increased with appropriate management. In 1840 the field was arable and was divided into several smaller fields (Tithe survey). It was still divided up in 1931 but only one small field at the top of the slope was still arable, the rest being managed as meadow (Land Utilisation Survey). The Countryside Restoration Trust acquired Twyford Farm in 2014 and has appointed tenant farmers who are keen to manage this meadow with a hay cut and aftermath grazing to increase the wildlife interest. The meadow does not flood, but is providing Ecosystem Services 1, 2, 3, 5, 6, and will provide 4 under the new management. The streamside is

wooded, but run-off could be reduced and wildlife interest could be increased by re-instating hedgerows that were present in 1879 (Figure 11).

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Park Field 18 June 2014	MG6b	*Festuca rubra*	*Cynosurus cristatus* *Trifolium repens*	*Ranunculus repens*

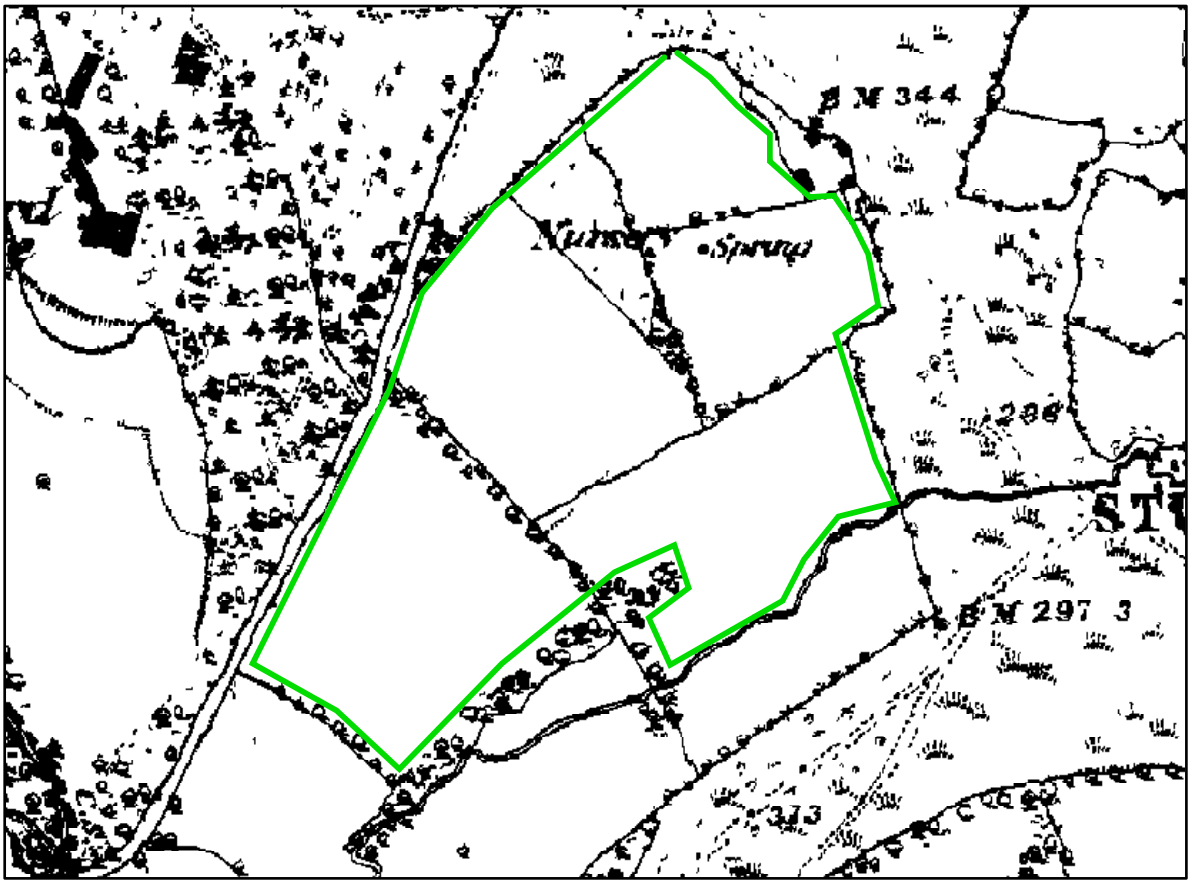

Figure 11 1879 Ordnance Survey map of Park Field (outlined in green) showing position of hedges.

Pond Mead (TQ401307, Figure 10). This MG5c meadow, surveyed on 18 June 2014, was less species-rich than average with 19 (14–22) species per sample, but Common Spotted-orchid *(Dactylorhiza fuchsii)* was present in two quadrats. Pond Mead was meadow in 1840 (Tithe survey) and in 1931 (Land Utilisation Survey). The Countryside Restoration Trust tenant farmers are keen to manage this meadow appropriately but the terrain makes it difficult to cut and lack of good fencing makes it difficult to graze at present. Currently the meadow, part of which floods, is providing Ecosystem Services 1, 2, 5, 6, 7, 8 and 9.

Name of meadow and date of survey	NVC	absent Constants	low frequency constants	additional constants
Pond Mead 18 June 2014	MG5c	*Cynosurus cristatus* *Festuca rubra* *Centaurea nigra* *Plantago lanceolata* *Trifolium pratense*	*Dactylis glomerata*	*Juncus conglomeratus* *Ranunculus repens* *Rhytidiadelphus squarrosus* *Veronica chamaedrys*

The Mead (TQ399306, Figure 10). This MG5c meadow surveyed on 18 June 2014 was of average species-richness with 21 (14–33) species per sample. Common Spotted-orchid *(Dactylorhiza fuchsii),* Sneezewort *(Achillea ptarmica),* Burnet-saxifrage *(Pimpinella saxifraga)* and Cowslip *(Primula veris)* were present in one or more quadrats. The Mead was meadow in 1840 (Tithe survey) and in 1931 (Land Utilisation Survey). The Countryside Restoration Trust tenant farmers are keen to manage this meadow appropriately but the terrain makes it difficult to cut and lack of good fencing makes it difficult to graze at present. Currently the meadow, part of which floods, is providing Ecosystem Services 1, 2, 5, 6, 7, 8 and 9.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
The Mead 18 June 2014	MG5c		*Cynosurus cristatus* *Festuca rubra* *Dactylis glomerata* *Centaurea nigra* *Plantago lanceolata* *Trifolium pratense*	*Ranunculus repens* *Veronica chamaedrys*

4.9 Oddynes Reach on Twyford Brook

Waterbury Field (TQ375284, Figure 9, p. 22). An NVC survey has not been done. In 1841 this field was hay meadow (Tithe survey) and there was a hedge at the bottom of the slope separating off the streamside strip of meadow. It was meadow in 1931 (Land Utilisation Survey) and the field has always been grass (Geering Senior, oral history interview 29 October 2007 by Andrew Holmes). It has always been boggy and is full of dandelions, which are still picked for wine by local people (Nick Geering, oral history interview 29 October 2007 by Andrew Holmes). Dandelions have long roots and so will be particularly good at capturing rainwater. There are Marsh-marigolds *(Caltha palustris)* and Pignut *(Conopodium majus)* by the stream. This field is providing Ecosystem Services 1, 2, 3, 5 and 6.

Recommendation: re-instating the hedge at the bottom of the slope would reduce run-off even further (Ecosystem Services 1 and 6).

Ten Acre Brook (TQ374282, Figure 9, p. 22). This lovely MG6b streamside meadow (known as 'Brook' by the farmer) is named after the 10-acre arable field on the slope above (all the streamside meadows on this farm are known as 'Brooks' by the farmer). Surveyed on 14 May 2008, it was more species-rich than the average with 17 (15–18) species per sample. It is separated from the arable field by a hedge and is a washland. The stream has kept its shape because it hasn't been dug out so when it floods the water comes over but is soon gone (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). In 1841 it was pasture (Tithe survey) and meadow in 1931 (Land Utilisation Survey). The last hay crop was taken about 15 years ago (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes) and since then it has been grazed by cattle between May and October each year at a low level of intensity: about 30–40 young cattle are put in until they have eaten the grass off and are then taken out (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). The brooks have never been ploughed (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). Ten Acre Brook is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Ten Acre Brook 14 May 2008	MG6b	*Cynosurus cristatus*	*Festuca rubra*	*Alopecurus pratensis* *Cardamine pratensis* *Ranunculus repens*

Square Wood Brook (TQ372282, Figure 9, p. 22). This MG10a pasture, named after the arable field above, is a washland and was much more species-rich than the standard with 17 (13–25) species per sample when we sampled on 20 June 2007. It was being managed as pasture in 1841 (Tithe survey) and was meadow in 1931 (Land Utilisation Survey). Recently it has been grazed between May and October each year at a low level of intensity: about 30–40 young cattle are put in until they have eaten the grass off and are then taken out (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). This field has never been ploughed (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). A hedge separates the arable field on the slope above from the washland. Square Wood Brook is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional Constants
Square Wood Brook 20 June 2007	MG10a			*Anthoxanthum odoratum* *Cynosurus cristatus* *Trifolium repens*

Gorse Brook (TQ371281, Figure 9, p. 22). This M23a rush pasture, surveyed on 20 June 2007, was of average species richness, with 21 (18–26) species per sample, but contained Marsh-marigold *(Caltha palustris),* Common Spotted-orchid *(Dactylorhiza fuchsii),* Marsh Pennywort *(Hydrocotyle vulgaris),* Ragged-robin *(Lychnis flos-cuculi),* Bogbean *(Menyanthes trifoliata),* Water-forget-me-not *(Myosotis scorpioides*) and Marsh Speedwell *(Veronica scutellaria).* It was being managed as pasture in 1841 (Tithe survey) and was a meadow in 1931 (Land Utilisation Survey). Recently it has been grazed by cattle each year at a low level of intensity: 30-40 young cattle just put in between May and October until it is grazed off, and then taken out (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). An area has been fenced off to keep the cattle out and encourage snipe (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). The field has never been ploughed (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). Gorse Brook is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Gorse Brook 20 June 2007	M23a	*Heracleum sphondylium*	*Dactylis glomerata*	*Agrostis canina canina* *Anthoxanthum odoratum* *Ranunculus flammula*

Alder Moor (TQ373282, Figure 9, p. 22). This M23a rush pasture on the south side of the stream was slightly less species-rich than the average with 20 (15–22) species per sample when we surveyed on 21 June 2007, but contained Sneezewort *(Achillea ptarmica),* Common Spotted-orchid *(Dactylorhiza fuchsii),* Heath Spotted-orchid *(D. maculata),* Ragged-robin *(Lychnis flos-cuculi)*, Wood Club-rush *(Scirpus sylvaticus),* Betony *(Stachys betonica),*

Devil's-bit Scabious *(Succisa pratensis)* and Reedmace *(Typha latifolia).* It has three or four big springs, one of which Nick Geering describes in an interview in 2007 as containing watercress 10–15 years ago (Nick Geering, oral history interview 29 October 2007 by Andrew Holmes). When we did the botanical survey in June 2007 there was standing water in places from these springs. It was pasture in 1841 (Tithe survey) and meadow in 1931 (Land Utilisation Survey). Recently it has been topped by the bird shoot once a year, but the cattle are not in there regularly (Nick Geering, oral history interview 29 October 2007 by Andrew Holmes). It is providing Ecosystem Services 1, 2, 5, 6, 7, 8, and 9).

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Alder Moor 21 June 2007	M23a		*Galium palustre*	*Agrostis stolonifera* *Angelica sylvestris* *Anthoxanthum odoratum* *Rumex acetosa*

Medhurst (TQ371281, Figure 9, p. 22). This M23a rush pasture on the south side of the stream was of average species-richness with 21 (18–26) species per sample when we surveyed on 21 June 2007, but contained Common Spotted-orchid *(Dactylorhiza fuchsii),* Marsh Pennywort *(Hydrocotyle vulgaris),* Ragged-robin *(Lychnis flos-cuculi),* Water-forget-me-not *(Myosotis scorpioides)* and Marsh Speedwell *(Veronica scutellaria)*.

It was pasture in 1841 (Tithe survey) and meadow in 1931 (Land Utilisation Survey). Recently it has been grazed by cattle each year at a low level of intensity: 30–40 young cattle just put in between May and October until it is grazed off, and then taken out (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes. This meadow has never been ploughed (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). This washland is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Medhurst 21 June 2007	M23a		*Juncus effusus*	*Ranunculus flammula*

Nine Acre Brook (TQ368280, Figure 9, p. 22). The stream has been dug out here and the bank is caving in. It was pasture in 1841. The northwest part has been planted with poplar (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes).
Recommendation: Tree planting here would reduce run-off and help to stabilize the eroding banks.

4.10 Keysford Reach on Cockhaise Brook

Kayesford Leg North (TQ368277, Figure 9, p. 22). This species-rich MG6b meadow had 17 (15–18) species per sample when we surveyed on 3 June 2015. It leads into Kayesford Leg South through a narrow waist and is continuous with Dencher Field on the slope above (Figure 12). There is a small, spring-fed area of rushes at the base of the slope. It was managed as pasture in 1841 (Tithe survey) and as meadow in 1931 (Land Utilisation Survey). In recent years it has been managed as cattle-grazed pasture.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Kayesford Leg North 3 June 2015	MG6b	*Cynosurus cristatus*	*Lolium perenne* *Cerastium fontanum* *Festuca rubra*	*Ranunculus repens*

Figure 12 Kayesford Leg North looking towards Kayesford Leg South with Dencher Field on the slope above the area of rush.

Kayesford Leg South (TQ368277, Figure 9, p. 22). This MG5a meadow, surveyed on 3 June 2015, is less species-rich than average with 19 (17–22) species per sample. It was managed as pasture in 1841 (Tithe survey) and as meadow in 1931 (Land Utilisation Survey). In recent years it has been managed as cattle-grazed pasture.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Kayesford Leg South 3 June 2015	MG5a	*Cynosurus cristatus* *Plantago lanceolata* *Centaurea nigra*	*Lotus corniculatus*	

Dencher Field (TQ368277, Figure 9, p. 22). This MG5a meadow, surveyed on 3 June 2015, was less species-rich than average, with 19 (15–22) species per sample. It is separated from Kayesford Leg South by a more species-rich bank of MG5c grassland with 22 (20–24) species per sample. Dencher Field was arable in 1841 (Tithe survey) and in 1931 (Land Utilisation Survey), but has been managed as cattle-grazed pasture in recent years.

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Dencher Field 3 June 2015	MG5a	*Cynosurus cristatus* *Plantago lanceolata* *Centaurea nigra*	*Lotus corniculatus*	*Cirsium arvense* *Ranunculus repens* *Rumex acetosa* *Stellaria graminea*

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Dencher Bank 3 June 2015	MG5c	*Cynosurus cristatus* *Plantago lanceolata*	*Centaurea nigra* *Trifolium pratense*	*Achillea millefolium* *Pimpinella saxifraga* *Stellaria graminea* *Taraxacum officinale*

Nealing Bottom (TQ368278, Figure 9, p. 22). This field has not been surveyed. It was managed as pasture in 1841 (Tithe survey) and as meadow in 1931 (Land Utilisation Survey).

Caseford Bottom (TQ370277, Figure 9, p. 22). This MG10a pasture is a washland and was much more species-rich than average with 20 (16–30) species per sample when we surveyed on 13 June 2007. Sneezewort (*Achillea ptarmica*) and Ragged-robin (*Lychnis flos-cuculi*) were present. It was hay meadow in 1841 (Tithe survey) and in 1931 (Land Utilisation Survey). Recently it has been grazed by cattle between May and October each year at a low level of intensity: about 30-40 young cattle are put in until they have eaten the grass off and are then taken out (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). This field has never been ploughed (Nick Geering, oral history interview 21 August 2007 by Andrew Holmes). This washland is providing Ecosystem Services 1, 2, 3, 5, 6, 7, 8 and 9 (Figure 13).

Name of meadow and date of survey	NVC	absent constants	low frequency constants	additional constants
Caseford Bottom 13 June 2007	MG10a			*Alopecurus pratensis* *Anthoxanthum odoratum* *Carex ovalis* *Juncus acutiflorus* *Ranunculus flammula*

Figure 13 Caseford Bottom washland in flooded state.

4.11 Danehill Brook

Treemanes (TQ379264 to 378263, Figure 14). The public footpath across these fields was walked on 17 January 2015. These are horse paddocks divided up by chestnut fencing and containing horse-jumps. They have been re-seeded with ryegrass at some point, but broad-leaved herbs are starting to invade as well as indigenous grasses such as Yorkshire-fog *(Holcus lanatus)* and Bents *(Agrostis* spp.*).*

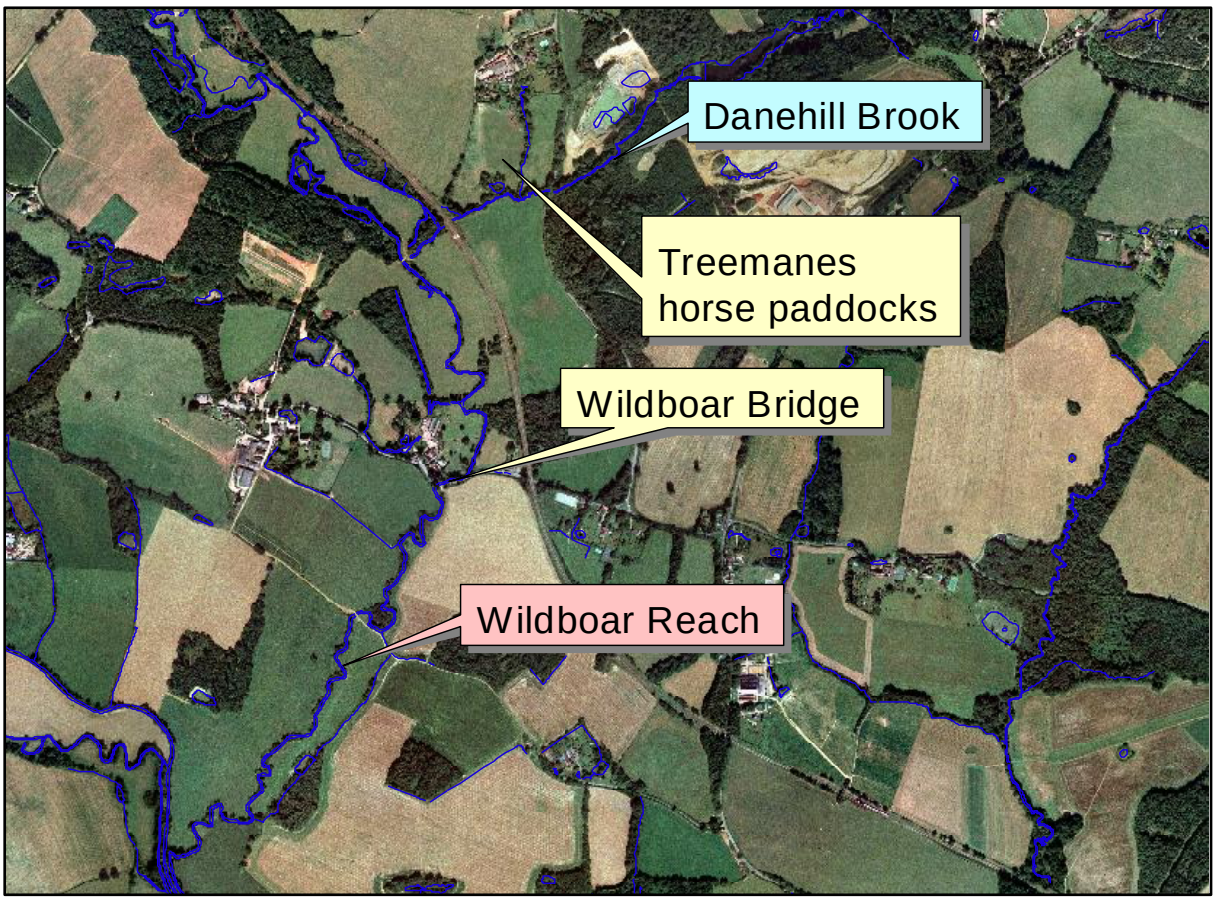

Figure 14 Danehill Brook and Wildboar Reach on Cockhaise Brook.

Recommendations: Making the sward more species-rich by adding deep-rooting perennials such as Ribwort Plantain *(Plantago lanceolata),* Yarrow *(Achillea millefolium)* and Common Bird's-foot-trefoil *(Lotus corniculatus)* would benefit the horses and help to prevent sediment getting into the adjacent stream. Planting mixed species hedgerows along the fence-lines which run across the slope would also help to prevent run-off.

4.12 Wildboar Reach on Cockhaise Brook

Wildboar Reach (Figure 14). Both sides were walked on 22 November 2006. It is a lovely stretch of stream, which has retained its original meandering course and tree-lined banks containing Guelder Rose *(Viburnum opulus),* Alder Buckthorn (*Frangula alnus*), Hazel *(Corylus avellana),* Goat Willow *(Salix capraea),* Alder *(Alnus glutinosa)* and some good-sized Peduculate Oak *(Quercus robur).* At the upstream end, there was Field Maple *(Acer campestre*) and Hornbeam *(Carpinus betulus).* The streamside grassland was re-seeded rye-grass and clover ley with unploughed margins 6-15 m wide. It was grazed by cattle.

Recommendation: converting the grassland ley to permanent grassland would reduce run-off and the amount of sediment getting into the stream (Ecosystem Services 1 and 2). Herbal Leys are now being used on the farm. These contain deep-rooting perennials such as Yarrow and Chichory (*Cichorium intybus)* and a mix of legumes such as Red Clover, Bird's-foot-trefoil, Sainfoin (*Onobrychis viciifolia*) and so provide Ecosystem Services 5 and 6 to some extent. They are also more long-lasting than ryegrass and white clover leys.

5 Conclusions from our research

5.1 Tree planting

There is not a lot of potential for woodland planting. Much of the streamside is already wooded with gills containing a specialised and particularly diverse flora as well as areas of wet alderwood. There is also a considerable amount of species-rich grassland providing a wide range of ecosystem services and such sites should not be used for woodland planting. We have identified only one site where we think some tree planting would be beneficial: Nine Acre Brook (p. 30).

5.2 Hedgerow planting

There is not a lot of potential for hedgerow planting. Most of the streamside meadows are still well- hedged. There are three sites where we think re-instating the hedges present in 1879 would be beneficial: Park Field (p. 27), Waterbury Field (p. 28) and Treemanes (p. 33).

5.3 Debris dams

Most of the gill woodland contains natural debris dams, which are increasing habitat diversity as well as retaining run-off. The part played by these natural features in flood alleviation needs to be recognised together with the ecological importance of retaining gill woodland.

5.4 Converting arable to permanent grassland

We have only found maize fields above Cob Brook (p. 15) and at Hook Farm (p. 16). Converting these to permanent grassland would reduce run-off and the amount of sediment, metaldehyde and nutrients getting into the water course. Run-off and the

amount of sediment getting into the Cockhaise Brook could also be reduced by converting the ryegrass leys on either side of Wildboar Reach (p. 34) and upstream at Hook Farm (p. 16) into permanent grassland.

5.5 Species-rich meadows

The direction of our studies and hence this report focuses on the remaining areas of species-rich grassland along the Cockhaise Brook. Such sites are vital for the range of ecosystem services which they provide including those relating to flood alleviation and maintaining water quality. This applies especially to those which are washlands, but also to grassland on the slopes above the water course. Every encouragement should be given to the landowners of such sites to continue managing the sites appropriately. Such sites should not be used for tree planting.

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Plant names: scientific names follow Rodwell, J.S. (editor), 1992 and English names follow Dony, J.G., Perring, F.H. and Rob, C.M., 1974. *English Names of Wild Flowers.* Cambridge University Press, Cambridge.