River restoration:
Benefits for integrated catchment management

Monitoring Programme

Year 2 (1995) Interim Report

LIFE project: 93/DK/A25/INT/2504

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Executive summary

This interim report describes the preliminary results of the monitoring programme for the European Union LIFE funded project "River restoration: benefits for integrated catchment management". The report includes: (i) an update of baseline information not available for the 1995 Interim Report and (ii) results of the early effects of the site construction works on the downstream 'impact' reaches.

Channel restoration works have been completed (or are close to completion) on all three demonstration sites (the R. Brëde, South Jutland, the R. Cole, Wilts/Berks, and the R. Skerne, Co. Durham). Channel lengths have been increased by between 10% (R. Cole) and 40% (R. Brëde). Mean channel widths have been reduced on the R. Cole and mean channel depths have been reduced on the Cole and the Brëde. Hydraulic modelling suggests that channel restoration will reduce flood peaks. For example, on the R. Cole it is predicted that the flood peak for a 1:100 year flood will be reduced by about 30% and floodplain water storage increased by about 70%. Monitoring is now focusing on confirming model predictions.

Impacts of the construction works on downstream reaches have been monitored. There is evidence of considerable sediment liberation from the restored reaches. On the R. Brëde approximately 80 times more sediment was exported from the restoration reach than the upstream control reach during the construction phase. Suspended sediment concentrations in the R. Cole impact reach also increased, and was at least five times greater than the upstream control during the period of early autumn rains in October 1995. On the R. Brëde releases of nutrients (particularly Total Phosphorus) were also pronounced during the construction phase, with Total Phosphorus export from the restoration reach 40 times greater than from the upstream control.

Preliminary information on the downstream impacts of restoration on plant and invertebrate communities is available from detailed monitoring on the R. Cole. Species richness and abundance of submerged aquatic plants did not change during 1995, despite considerable sediment releases. However, it should be noted that the aquatic plant community in the downstream impact reach was already extremely impoverished.

Aquatic invertebrate communities showed consistent seasonal changes in both years, with species richness lower in autumn. Species rarity remained constant in both seasons as would be expected. Invertebrate species richness, rarity and BMWP scores show the same trends at both the upstream control, restoration and downstream sites, suggesting no immediate short-term effects due to the construction work.

Appraisal of the overall economic benefits of restoration began with the pre-works public perception study on the R. Skerne. This showed that local people used the site regularly, on average visiting the site weekly in summer and every fortnight in winter. There was a high level of approval for the restoration scheme with 70% of local residents "strongly in favour" of the scheme. Results from both enjoyment valuation and willingness-to-pay assessments suggest that there is a significant monetary benefit to be obtained in improving the river and the surrounding parkland.

A literature survey has been undertaken to compile information for the economic evaluation of the benefits of restoration projects for flood defence, water quality, fisheries and recreation and effectiveness of ecological improvements. Information from all three restoration sites will contribute to the appraisal, which will be carried out in spring/summer 1996.

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1. Introduction

This report briefly reviews some of the preliminary results of the monitoring programme for the European Union LIFE funded project "River restoration: benefits for integrated catchment management". The report presents:

(i) an update of baseline information not available for the 1995 Interim Report

(ii) results from monitoring the early effects of the site construction works on downstream 'impact' reaches

(iii) observations on the early morphological responses of the new channels after construction.

1.1 Project aims

The project is a joint initiative between the United Kingdom and Denmark to encourage the restoration of rivers in Europe. The project aims are:

- To establish three European Demonstration Sites which apply new and state-of-the-art techniques to the restoration of natural habitats in damaged rivers and their floodplains.
- To demonstrate the benefits of river restoration for Integrated Catchment Management i.e. in terms of nature conservation, water quality, river hydrology, flood prevention and amenity by monitoring the physical, chemical and biological effects of restoration.
- To involve, motivate and train those who influence or undertake river management work (e.g. water managers, landowners, developers, politicians, environmental organisations).
- To widely disseminate information about river restoration using pan-European networks.

The project is led by South Jutland County (Denmark). The project partners are: South Jutland County, the Danish National Environmental Research Institute, the River Restoration Project Ltd, the National Rivers Authority, English Nature, the Countryside Commission, Darlington Borough Council and the National Trust. The UK component of the project is co-ordinated by the River Restoration Project Ltd (RRP), a non-profit making company established to promote the restoration of rivers for conservation, recreation and amenity.

1.2 The LIFE project in the UK and Denmark

The LIFE project involves the restoration and monitoring of three river demonstration sites (2-5km lengths of river and associated floodplain). The sites have been chosen to typify the problems associated with many lowland European stream and river systems and include watercourses with a range of sizes within both urban and rural catchments.

The sites are:

- River Cole (United Kingdom): restoration in a clay catchment
- River Skerne (United Kingdom): restoration in an urban environment.
- River Brēde (Denmark): restoration in a sand/peat catchment.

1.3 Overall monitoring project aims

The monitoring of these restoration schemes essentially aims to assess the environmental benefits of restoration and the ability of restoration to provide a low-cost solution to practical river catchment management problems. In particular, the monitoring programme aims to provide information which can be used to assess the value of river restoration for integrated catchment management, including the benefits for:

(i) flood storage and flood alleviation

(ii) nutrient reduction or storage

(iii) river maintenance costs

(iv) conservation

(v) recreation and amenity.

Table 1.1 The monitoring programme on the LIFE river restoration demonstration sites

	Cole	Skerne	Brĕde
Physical and chemical			
Water quality monitoring, including nutrient pollution	Special study	✔	Special study
Geomorphological change including changes in channel stability	✔	✔	✔
Hydrological regime including hydraulics	✔	✔	Special study
Biological			
Aquatic invertebrate ecology	Special study	✔	Special study
Aquatic plant communities	Special study	✔	✔
Floodplain plant communities	✔	✔	✔
Birds	✔	✔	✔
Fish	✔	✔	✔
Public perception			
Landscape assessment	✔	✔	•
Public perception assessment	✔	Special study	✔
Catchment management			
Cost-benefit analysis	Special study	Special study	Special study

2. The physical works

A brief summary of the main physical changes made on each site is given below.

2.1 Brede

The R. Brede is located in S. Jutland in rural Denmark. Between 1950 and 1960 the river was regulated by deepening and straightening to aid drainage and increase agricultural productivity within the catchment. Prior to straightening, the river had well-developed meanders and multiple channels, and regular flooding of the valley occurred.

Restoration of the R. Brede has involved remeandered a 3.2km length of channel (see Figure 2.1), giving a new channel length of 4.5km. Channel widths are broadly similar to pre-restoration widths and bed levels have been raised by about 1m. Eleven ponds have been created.

2.2 River Cole

The restoration site on the R. Cole is located in a rural area on the National Trust Buscot Estate on the Oxfordshire/Wiltshire Border, UK.

Prior to restoration the river course was almost entirely artificial, having been modified by straightening and deepening over a period of at least 400 years.

In total, approximately 2.5km of the river has been restored during the project, with a combination of newly constructed channels (1.3km) and modification of existing channels (1.2km) (see Figure 2.2). Total channel length has been increased by about 10%. Channel widths have been reduced by about 60% and bed levels raised by up to 1m.

2.3 Skerne

The restoration site on the R. Skerne lies within an urban fringe open space in the suburbs of Darlington, Co. Durham, UK. The site is owned by Darlington Borough Council.

Prior to restoration the Skerne had been greatly modified as a result of industrialisation over the last 150 years, and much of the floodplain had been eliminated by spoil-tipping. The channel itself was trapezoidal and linear and most in-stream features had been eliminated.

Restoration of the Skerne involved modifications along a 2.0km reach of the river, including remeandering of a 0.5km reach. Channel dimensions have remained similar to pre-restoration conditions due to of urban flooding constraints. New waterside features, including a pond, have been created (see Figure 2.3).

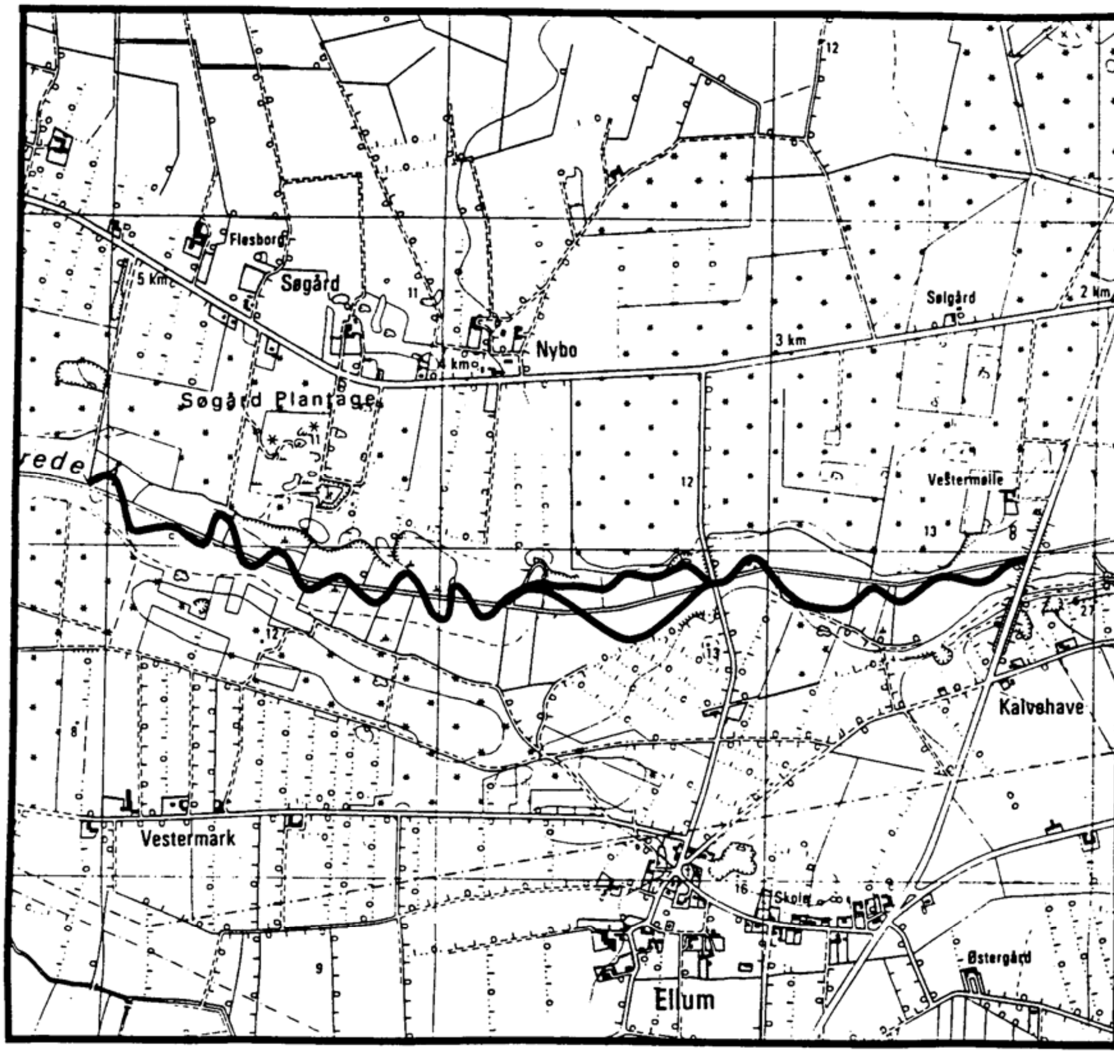

Figure 2.1. R. Brede Demonstration Site

Key

Newly constructed channel

Modified existing channel

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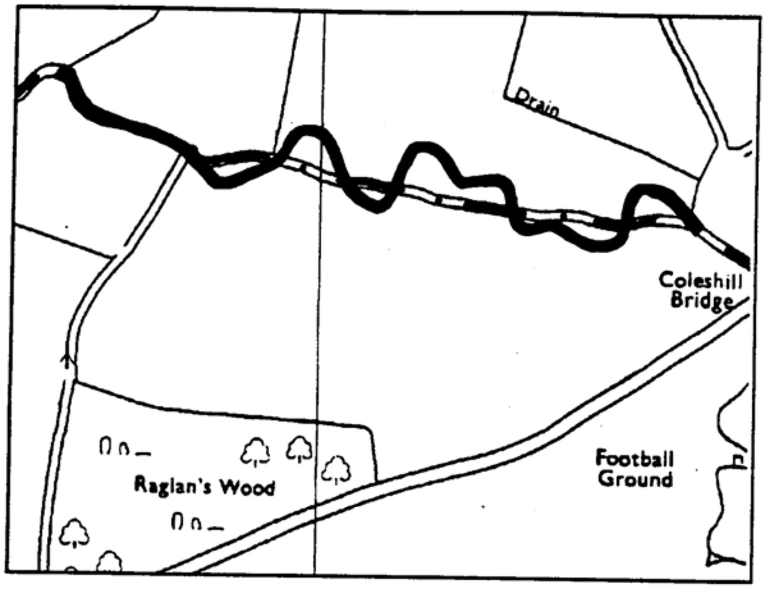

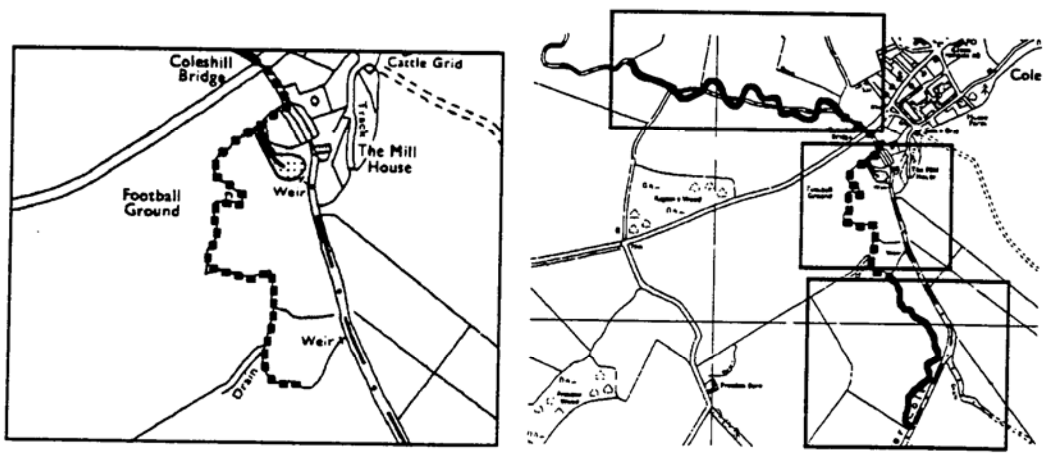

Figure 2.2. R. Cole Demonstration Site

Key

Newly constructed channel

Modified existing channel

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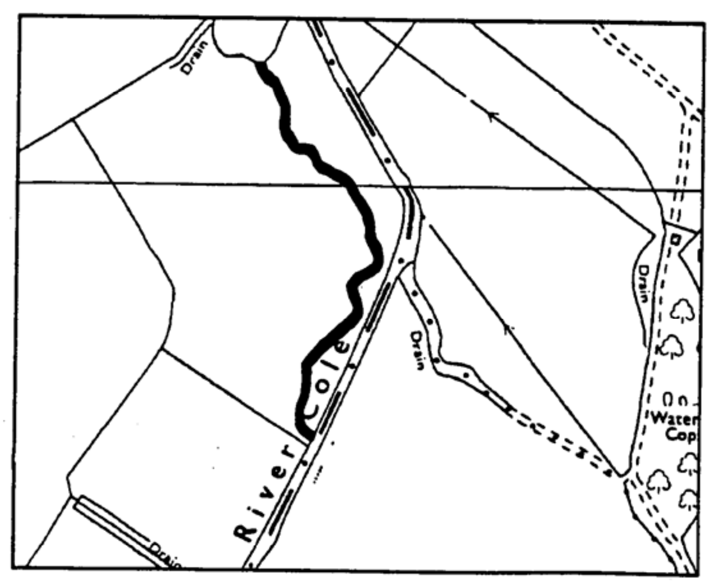

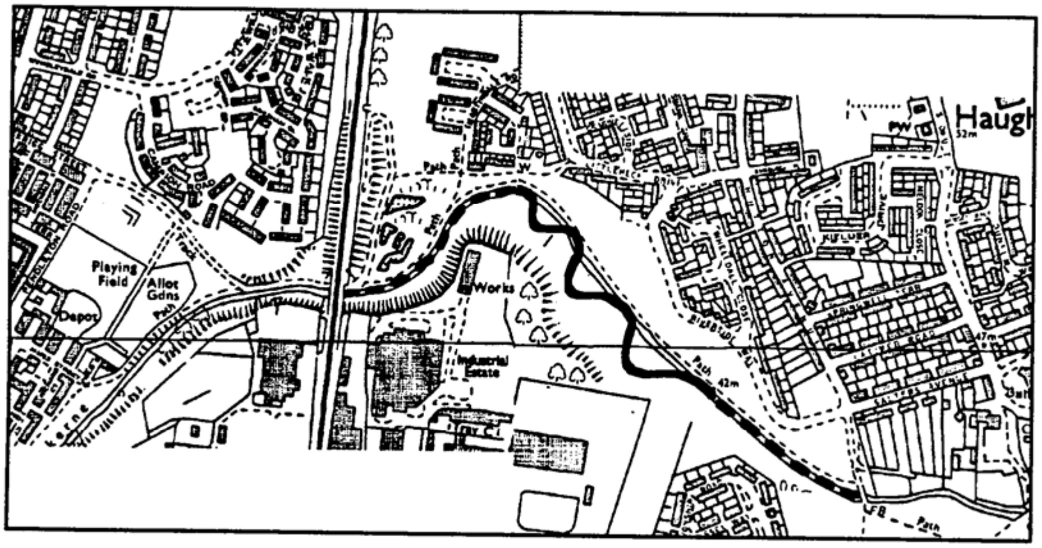

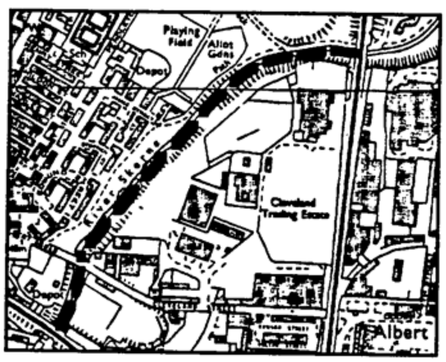

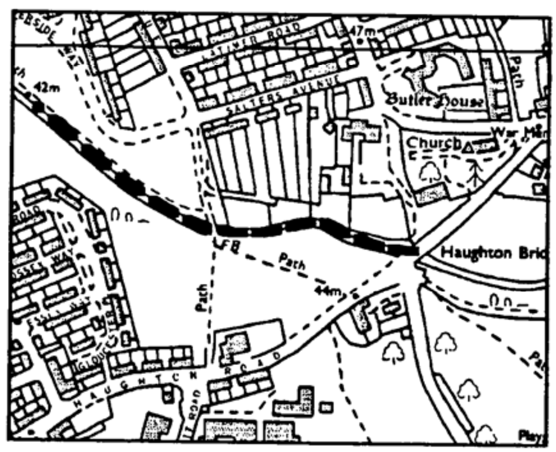

Figure 2.3. R. Skerne Demonstration Site

Key

Newly constructed channel

Modified existing channel

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3. Geomorphology

3.1 Aims

The aims of the river morphology monitoring programme are:

(i) To compare the morphology of the old and restored channels.

(ii) To assess the stability of restored channel sections.

(iii) To assess channel sediment mobilisation and deposition, including evaluation of sediment release downstream.

(iv) To provide topographic information to facilitate plant and invertebrate surveys.

3.2 Methods

Table 3.1 outlines the work being undertaken under the geomorphological section of the monitoring programme.

Table 3.1 Outline of work undertaken and planned: 1994-1996

Subsection of programme	Description	Cole	Skerne	Brede
Fluvial audit	Description of the geomorphological context of the catchment prior to construction work, reviewing the existing geomorphology and factors which influence geomorphology (such as sediment sources and land drainage engineering).	Year 1	Year 1	n/a
Pre-construction morphological survey	River channel form and morphology described to determine the extent of channel modification. Included restoration reach and control areas.	Year 1	n/a	n/a
Pre-construction topographic survey	Topographic survey ('land survey') of river channel and floodplain in restoration section.	Year 1	Year 1	Year 1
Post-construction geomorphological survey	Transect surveys of the original and restored river channel. Detailed cross-sections taken every channel width on new channel and on two control reaches (upstream and downstream) of about 250m.	Year 2/3	Year 3	Year 3
Post-construction topographic survey	Topographic survey ('land survey') of new river channel to provide accurate maps of restored sections.	Year 3	Year 3	n/a

3.3 River channel structure before and after restoration

Summary channel statistics, including channel length, sinuosity, depths and widths are available for the Cole, Brede and Skerne. The preliminary results of a more detailed geomorphological survey are available from the R. Cole.

3.3.1 Length and sinuosity

Channel length on the restoration sites has increased by 46% on the Brede, 25% on the Skerne (over the remeandered section) and 10% on the Cole.

Sinuosity has increased correspondingly, by 41% on the Brede, 5% on the Skerne (over the *whole* section) and 8% on the Cole.

3.3.2 Width and depth

Channel widths and depths on the Brede and Cole have been reduced as a result of restoration (see Table 3.1). On the Skerne, depths and widths have remained roughly the same because of urban flood defence constraints.

Table 3.1 Channel length and sinuosity after restoration

	Length of channel (m)		Sinuosity of channel	
	Before	After	Before	After
Cole	2525	2723	1.164	1.255
Skerne	2028	2111	1.043	1.09
Brede	3200	4500	1.037	1.46

Table 3.2 Channel width and depth after restoration

	Mean width of channel		Mean depth of channel	
	Before	After	Before	After
Cole	14.9	9.4	2.8	0.62
Skerne	11.0[1]	12.5	1.8[1]	1.9[1]
Brede	14.5	15.5	0.8	0.6

[1]Provisional estimate

3.3.3 Channel features on new lengths of the R. Cole

Following the completion of the new channel works, the initial responses to floods on the Cole indicates that channel characteristics are quite different in the new channels upstream and downstream of Coleshill Bridge.

In the upper reach, the new bed is dominated by alluvial clays and silts. Limited erosion of the channel margins has occurred, stripping off some newly imported topsoil. This has been deposited on the downstream side of newly cut meanders and in the existing middle channel section. One riffle has formed at the top of the reach, but generally there appears to be insufficient gravel available from upstream or new bed sources for further riffle features to form naturally (see Figures 3.1 and 3.2).

Downstream of Coleshill bridge, the new channel has cut into natural deposits of gravels and sands. This has allowed erosion to occur, and has led to the development of a wider range of morphological features, including a mid-channel bar and at least one new riffle. Channel erosion has led to the development of undercut cliffs.

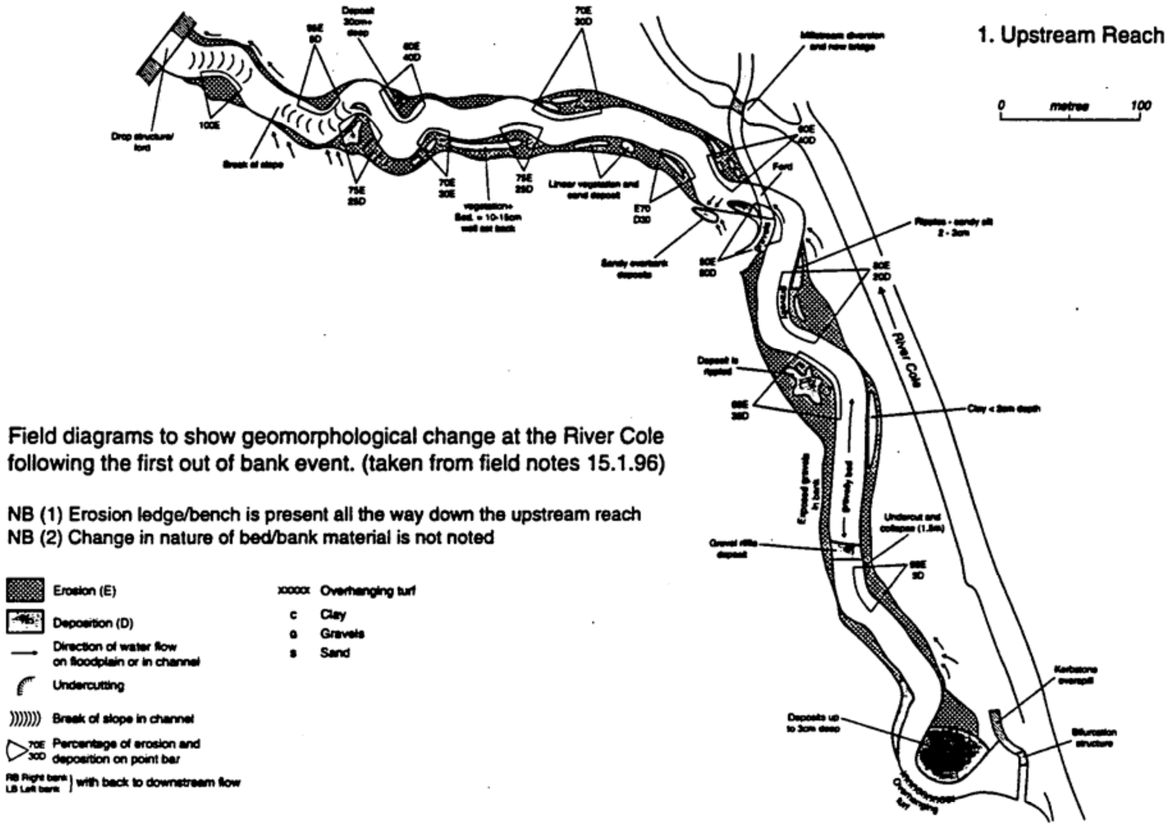


Figure 3.1 **R. Cole geomorphology: development of the new channel upstream.**

Field diagrams to show geomorphological change at the River Cole following the first out of bank event. (taken from field notes 15.1.96)

NB (1) Erosion ledge/bench is present all the way down the upstream reach
NB (2) Change in nature of bed/bank material is not noted

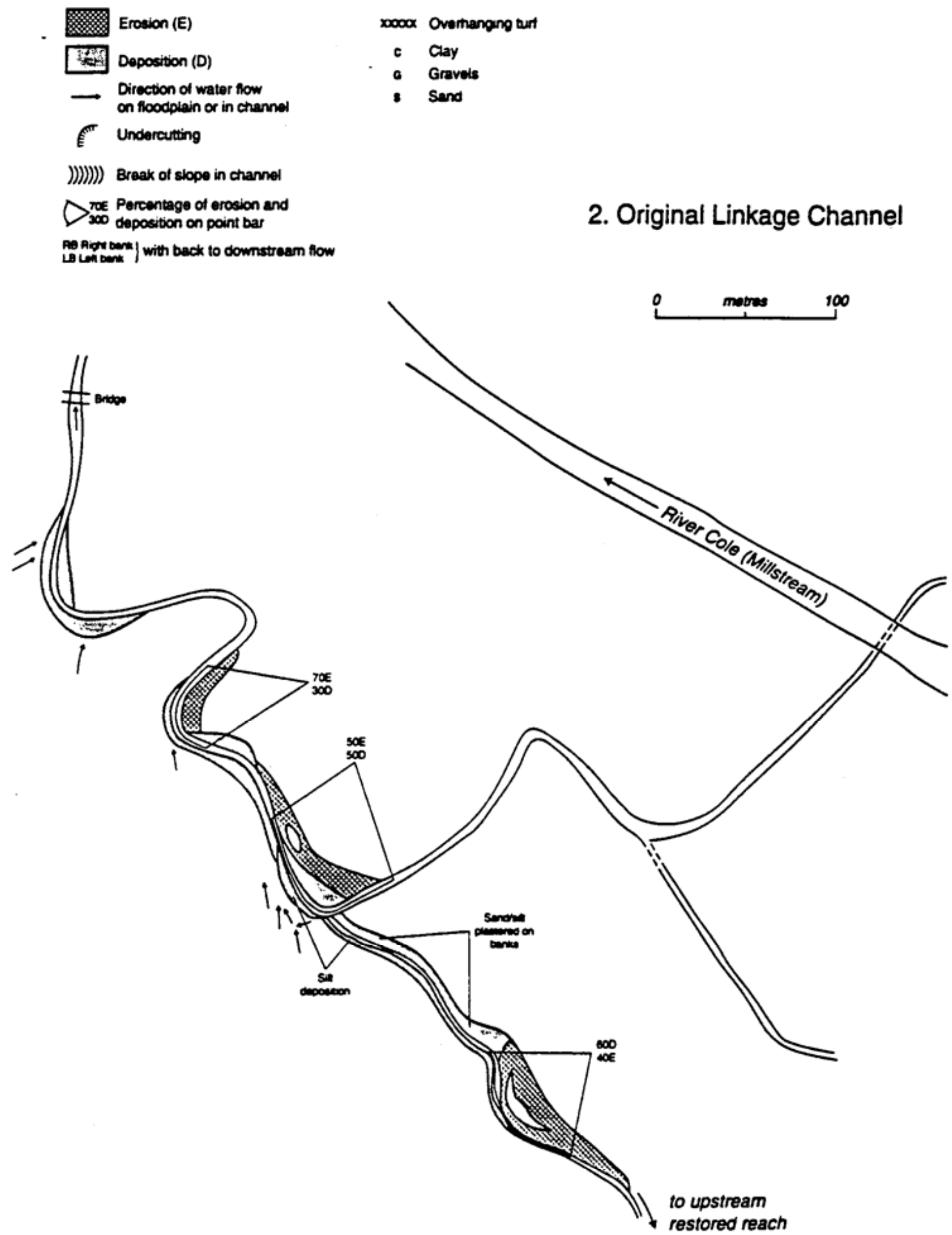


Figure 3.2 **R. Cole geomorphology: development of the modified former channel course**

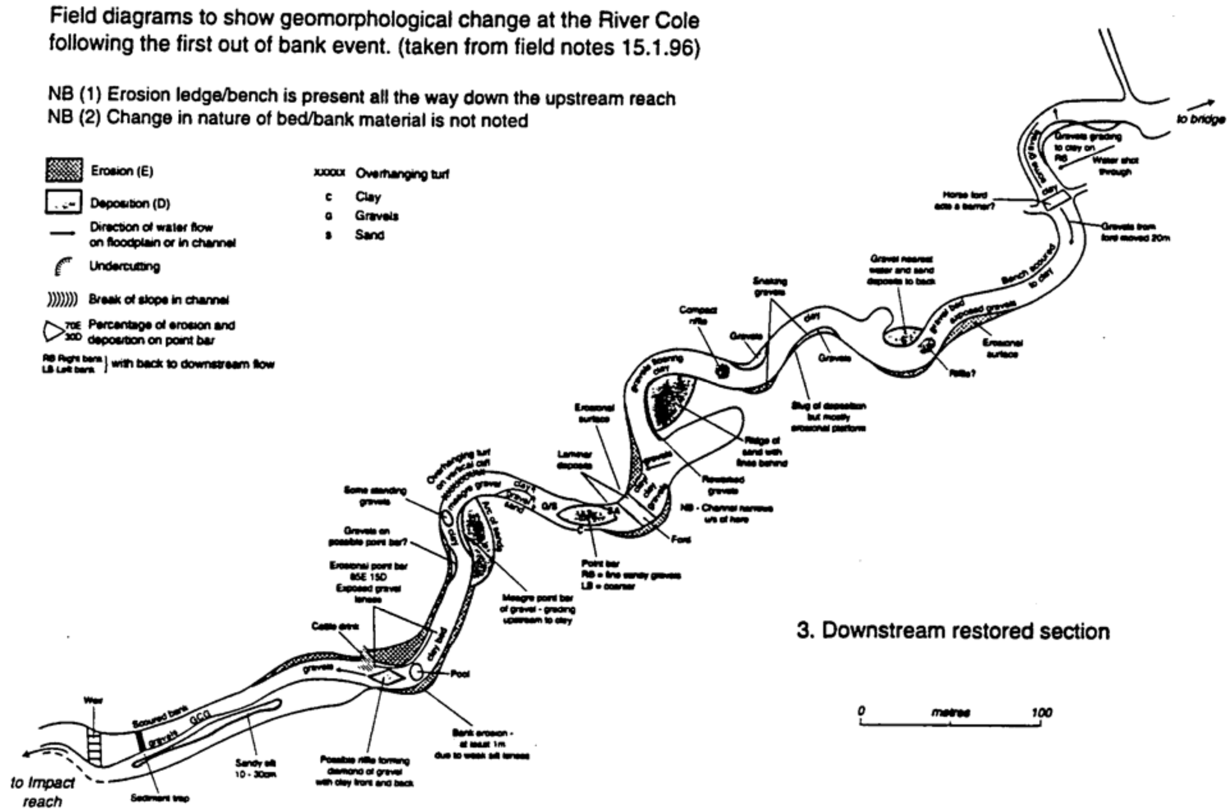


Figure 3.3 R. Cole geomorphology: development of the new channel downstream of Coleshill Bridge

4. Landscape assessment

4.1 Aims

The aims of the landscape assessment within the project are:

(i) to describe and classify the landscape of the restoration sites

(ii) to evaluate the landscape areas/features of the restoration sites.

Landscape evaluation has been undertaken on the R.Cole and R.Skerne only.

4.2 Methods

The landscape assessment followed standard NRA landscape methodology (NRA 1993). These methods were modified slightly to fulfil some of the specific requirements of the demonstration project (See Table 4.1).

Table 4.1 Landscape assessment methods

Macro river landscape types	'The macro river landscape' refers to the wider landscape of the river valley, defined by the limits of views from the river (the 'visual envelope' of the river).
Micro landscape assessment	'The micro river landscape' refers to the landscape of the river itself, created by the river channel. The following items were recorded in each of the zones identified: • a general description of the landscape character within the sample stretch; • overall impressions of the river banks and margins; • particular features in the river corridor; • a visual assessment of water quality; • an evaluation of quality and the appropriate management strategy.

4.3 Results

4.3.1 Macro landscape assessment

Prior to restoration, five landscape types were identified on the R. Cole, and three on the R. Skerne. Although the Cole has areas of higher landscape value than the Skerne, the majority of both sites are of Grade 2 - 3. In National Rivers Authority terminology, this is equivalent to areas in need of restoration (see Table 4.2).

Table 4.2 Macro landscape types: R. Cole and R. Skerne

River	Landscape type	Value class
Cole	Coleshill Village	1
	Coleshill Parkland	1 - 2
	Clay Vale Farmland	2 - 3
	Alluvial Mixed farmland	2
	Wooded Limestone Valley	1 - 2
Skerne	Amenity Grassland	3 - 4
	Semi-natural grassland	2 - 3
	Degraded industrial space	4

4.3.2 Micro landscape assessment

On the Skerne, landscape quality was predominantly Class 3, with small areas of Class 2 - 3 and 3 - 4. On the R. Cole, the pre-restoration micro landscape was Class 2 upstream of Coleshill Bridge, and Class 3 downstream of Coleshill Bridge.

Table 4.3 Micro landscape types: R. Cole and R. Skerne

River	Landscape type	Value class
Cole	Upstream of Coleshill Bridge	2
	Coleshill Mill - Coleshill Bridge	2 - 3
	Downstream of Coleshill Bridge	3
Skerne	Haughton Road Bridge to d/s Five Arches Bridge	3
	Downstream Five Arches Bridge to Albert Bridge	2 - 3
	Albert Bridge to Skerne Bridge	3 - 4

5. Hydrology and channel hydraulics

5.1 Aims

The aims of hydrological monitoring are:

(i) to provide water level and discharge data to validate hydraulic models of restored channels.

(ii) to assess the impact of restoration on floodplain groundwater/surfacewater levels.

(iii) to provide data on river channel water levels and discharge needed for the calculation of nutrient and sediment budgets in the control and restoration reaches (R. Cole and R. Brĕde).

(iv) to provide data for interpretation of floodplain vegetation change.

5.2 Methods

Table 5.1 shows the work undertaken and in progress describing the hydrology and hydraulics of the restored rivers.

Table 5.1 Outline of work undertaken and planned: 1994-1996

Subsection of programme		Description
Land survey		See Table 3.1. Land surveys have been undertaken on all three sites.
Discharge data	Cole	Inglesham Weir (5km downstream of Coleshill) provides a continuous record back to 1976. Stage/discharge relationships are also being established at key locations on restoration site.
	Brĕde	Stage/discharge relationships have been established for water level monitoring stations at upstream and downstream end of restoration reach .
	Skerne	South Park Weir (5km downstream of the restoration site) provides a continuous record back to 1952.
Water level monitoring	Cole	Four continuous water level monitoring stations have been established.
	Brĕde:	Two continuous water level monitoring stations have been established.
	Skerne	Weekly water level data collected at two sites (vandalism prevented use of water level recorders). Maximum water level recorders are to be installed.
Groundwater levels	Brede	A network of piezometers has been installed.
	Cole	Continuous groundwater level recorders have been installed upstream of Coleshill Mill. A full network of piezometers is to be installed in the Spring 1996.
	Skerne	n/a
Observations of floods		Floods are being observed, photographed and mapped, whenever possible, on all three sites.

5.3 Interim results

5.3.1 Ameliorated flood peak after restoration

An expected effect of river restoration is the amelioration of flood flows. Hydraulic modelling based on the specifications for the new channel predicts that the peak water level in a 1:100 year flood will reduced by about 30% (see Figure 5.1). The existing baseflow water level is 78.80m and rises to 80.30m at the peak of a 1:100 year flood, a range of 1.5m. After restoration the water level ranges from 79.00m at baseflows to 79.95m at high flows (a range of 0.95m). Model predictions are currently being validated with field data.

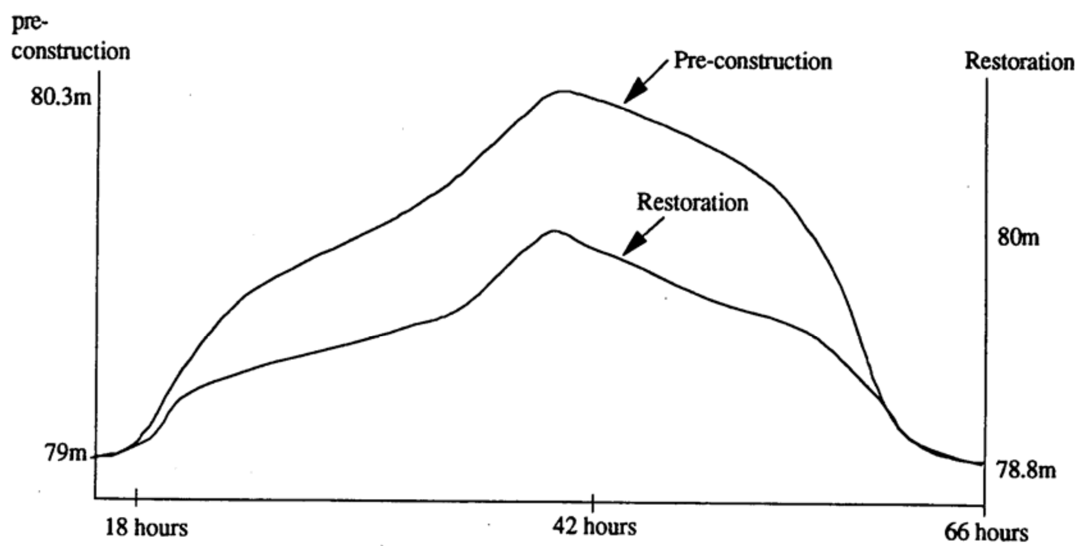


Figure 5.1 The stage (water level) hydrograph of the R. Cole at Coleshill Bridge before and after restoration, for a 1:100 year flood.

5.2.2 Floodplain water storage

Following restoration, model predictions indicate that the volume of water expected on the floodplain at Coleshill during a 1:100 year flood should increase by nearly 70%, from 2.3 million m^3 to 3.9 million m^3.

6. Water quality and sediment monitoring

6.1 Overall aims of water quality monitoring

The aims of water quality and sediment monitoring are:

(i) to assess the effect of river restoration on general river water quality and sediment loads

(ii) to assess the effects of river restoration on nutrient budgets (see Section 6.3.2)

(iii) to assess the change in floodplain soil chemistry following restoration: this is an optional aim of the monitoring programme

6.2 Methods

Nutrient and sediment studies are being undertaken in detail on the R. Brĕde and R. Cole. On both rivers automatic water samplers have been installed to collect samples at daily intervals (or every other day). Samples have been collected more frequently during storms on the R. Brĕde and during the test phase of sediment sampling on the R. Cole.

6.3 Interim results

Analysis of the short-term effects of restoration on nutrient and sediment loads has been undertaken on the Brĕde (where a full year of data is available). Preliminary observations are available from the R. Cole, covering the construction phase and the first two months post-construction.

6.3.1 Sediments

There is evidence of large releases of sediments from both the R. Brede and the R. Cole during and immediately after channel restoration work.

On the R. Brĕde, approximately 80 times more total sediment was exported from the restoration reach during the 4 month construction phase than from the upstream control (Kronvang et al 1995).

On the River Cole, analysis indicates somewhat elevated levels of suspended sediment (SS) during the construction phase: thus in late August and September 1995, SS levels were c. 2 - 2.5 times as high downstream of the on-going restoration work as they were upstream of the site (see Figure 6.1). However, monitoring data suggests that the greatest impact was in October (when most construction work had been completed), and was caused by the early autumn storms: thus October levels downstream of the site were c. 5.5 times as high as at upstream control sites. By November and early December, SS levels had begun to decline to an average of c. 2.5 times the upstream levels.

6.3.2 Nutrients

R. Brĕde

During the two-month construction phase there was a 40-fold increase in Total Phosphorus export from the restoration reach of the R. Brĕde. Total Nitrogen export was less pronounced, but there was still a three-fold increase compared to the control reach. Analogous data from the R. Cole is currently being analysed.

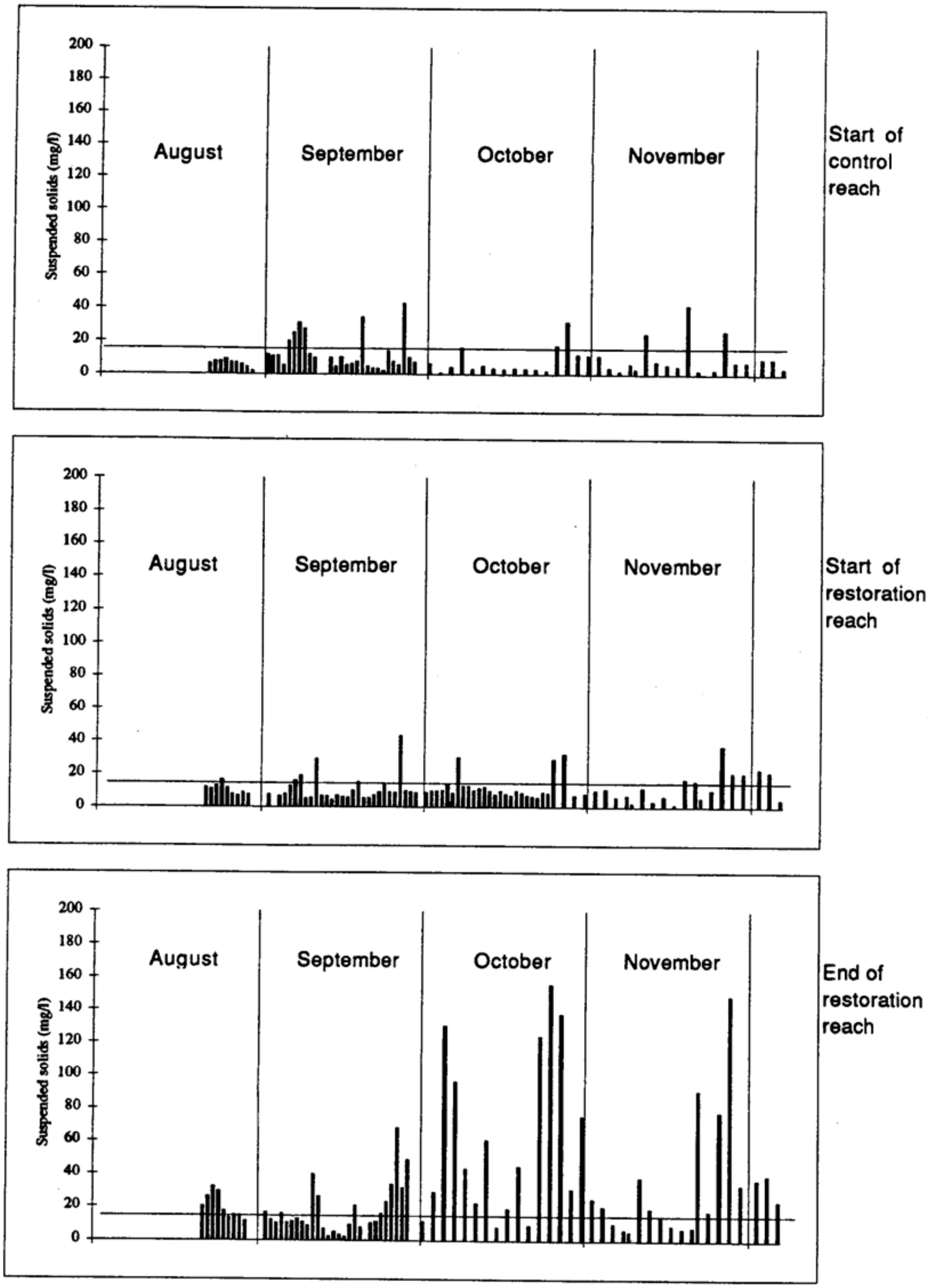


Figure 6.1 **Suspended solids concentrations upstream and downstream of the R. Cole restoration site (summer and autumn 1995).**

7. Vegetation ecology

7.1 Aims

Vegetation monitoring has involved surveys within (a) the river channel and corridor and (b) the floodplain.

For both areas, the broad aim of ecological survey work has been to enable an assessment to be made of the vegetation changes which result from the restoration of the river and floodplain. Monitoring of each river has involved the establishment of monitoring stations within:

i) The *restoration habitat* (river and floodplain).

ii) An *upstream length* of channel/floodplain to act as a control.

iii) A *downstream area* to ensure that the restoration works does not have adverse downstream impacts (eg excess sediment deposition).

7.2 Survey work in 1995

Vegetation surveys for the River Cole are an area of special (ie more detailed) ecological study. In order to monitor the impact of the restoration on the plant community during the construction phase, both river corridor and plant quadrat surveys were undertaken at upstream (control) and downstream (impact) reaches in 1995.

The effects of restoration on the plant community of the R. Brēde were also monitored in 1995 and plant species lists are currently under translation from Danish to Latin. Channel vegetation in the R. Skerne is not due to be monitored again until 1996. Floodplain monitoring stations have been set up on all rivers (see RRP 1995 monitoring report) and will be re-surveyed in 1996.

7.3 Results: River Cole channel

7.3.1 River Corridor Survey

The aim of the River Corridor Survey work on the R. Cole in 1995 was to provide information about the species-richness and rarity of the nine survey lengths during the construction phase. Surveys were undertaken in August 1995 at a stage when the construction of the new channel was approximately 60% complete.

Numbers of species recorded

The two upstream *control* reaches (reaches 1 and 2) showed little change in plant species-richness between 1994 and 1995 (see Figure 7.1 and 7.2). Within the *restoration* reach upstream of the mill weir, the old mill leat (which has been retained), showed slightly greater *marginal* plant species-richness in 1995 compared with 1994. The most noticeable change was the frequent colonisation of Trifid Burr-marigold (*Bidens tripartita*) on the west bank of the leat. Other species recorded for the first time were also annuals typical of bare mud (*Veronica catenata* and *Ranunculus sceleratus*). It is possible that this slight increase in richness was due to temporary cessation of grazing along the mill leat edge during construction of the new channel in the adjacent field. The most significant change in *aquatic* plant species-richness in the Mill leat was a marked drop in the number of aquatic species recorded in reach 6. This is likely to be due to the dredging of this reach early in 1995.

Figure 7.1
River corridor: marginal plants

■ 1994
□ 1995

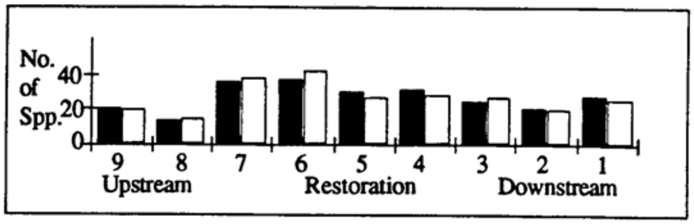


Figure 7.2
River corridor: aquatic plants

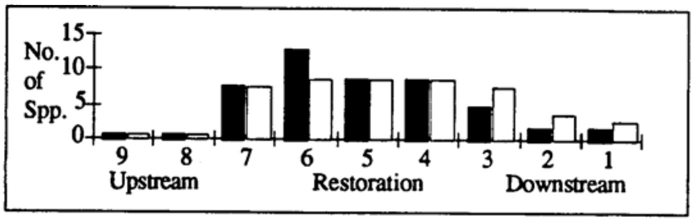
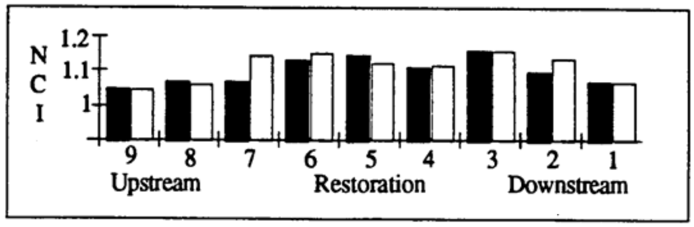


Figure 7.3
River corridor: rarity (Species Rarity Index)



In the two *restoration* reaches *downstream* of the mill weir (reaches 4 and 5) there was a slight drop in the number of marginal species recorded; however, in both reaches a large proportion of the original length (c. 50%) had been re-profiled and re-meandered during the original restoration work, leaving bare banks. Overall, therefore, there had been surprisingly little change in either the marginal or aquatic plant species-richness of these lengths at the time of the survey.

Overall, the *downstream* 'impact' reaches showed no net change in the number of *marginal* plant species recorded. The number of *aquatic* species, however, showed a consistent increase between 1994 and 1995. In the lowest reaches (reaches 1 and 2) this was, in each case, due to the occurrence of a single plant stand (of Yellow Water-lily, *Nuphar lutea* and Brook Water Crowfoot, *Ranunculus penicillatus* respectively). A more significant increase in aquatic species in reach 3 was due to the occurrence of a shallow gravel riffle which was temporarily present downstream of the silt trap. At the time of the survey, this riffle supported a diverse assemblage of young aquatic plant species, including Brook Water Crowfoot (*Ranunculus penicillatus*), Spiked Water Milfoil (*Myriophyllum spicatum*), and a new species for the area - Curled-leaved Pondweed (*Potamogeton crispus*). This gravel riffle was subsequently washed away in later floods; however, it may indicate that the more permanent riffles in the new channel will colonise rapidly in 1996.

Average rarity of river corridor reaches
Average species rarity was similar in all reaches in 1994 and 1995 (see Figure 7.3). The slightly higher average rarity in reaches 6 and 7 in 1995 was due to the occurrence of *Bidens tripartita*.

7.3.2 Quantitative monitoring

The aim of quantitative monitoring has been to provide more detailed information about vegetation associated with the river channel. Data in 1995 was collected in September/

October, when the new river channel was near to completion. Two quadrats (2c and 2d) downstream of Coleshill bridge were located in areas of new channel. No wetland plants were recorded from the newly-constructed bare banks of these channels.

The most important result from the quadrat monitoring was that the abundance and richness of the only aquatic species recorded (*Myriophyllum spicatum*) in the impact reaches (quadrats 3a, 3b, 3c) in 1994 was unchanged in 1995.

Overall, presence/absence of species recorded in the quadrats was much more variable than the total lists from the river corridor survey reaches. To some extent, this is a predictable result: free-floating aquatic plants such as duckweed (*Lemna* spp.) are obviously likely to vary considerably, even from day to day. However, rooted aquatic species such as Yellow Water-lily (*Nuphar lutea*) and Arrowhead (*Sagittaria sagittifolia*) also appear to have varied in the precise location of stands between years. Thus, for example, in quadrats 2a and 2b, there was an apparent loss in species-richness from 1994 to 1995; this is more likely, however, to be the result of natural inter-year variation in the exact location of growing plant stands. The most varied results were from the tall ruderal communities of the middle and upper banks in the fenced downstream impact reaches (3a, 3b, 3c). The decline in species-richness in marginal and wetland species in quadrat 3a, for example, was caused by the growth of an extensive stand of False Oat-grass (*Arrhenatherum elatus*), which replaced the rich herb community present the previous year on the upper river bank.

7.3.2 Impact on vegetation of sediment releases on the R. Cole

Overall, results from both quadrat and river corridor surveys indicate that there was no evidence that sediment released during active construction of the new channel adversely affected plant communities downstream of Coleshill restoration site.

Figure 7.4 Quadrats: Marginal plants

■ 1994

□ 1995

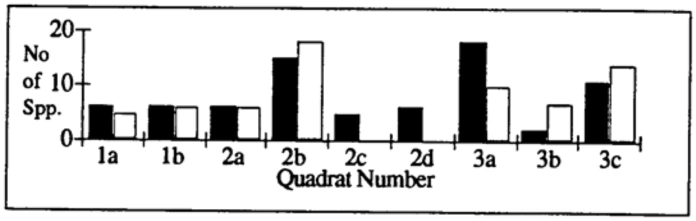


Figure 7.5 Quadrats: Aquatic plants

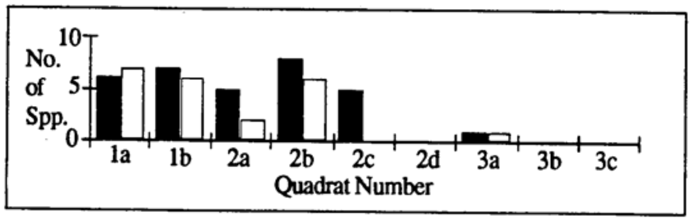
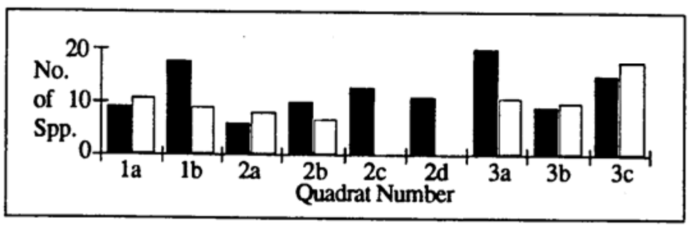


Figure 7.6 Quadrats: terrestrial plants



8. Invertebrate ecology

8.1 Aims

The aims of the invertebrate monitoring programme are:

(i) To contribute towards assessments of the ecological value of the existing river and associated ditches and floodplain pools within the restoration area, in order to provide guidance information for the restoration design.

(ii) To estimate the change in the species-richness and conservation value of the aquatic macroinvertebrate fauna in the years following restoration.

(iii) To monitor the downstream reach to assess impacts from the construction work.

(iv) To monitor changes in the value of old channels (where retained after new channel construction).

8.2 Methods

Survey methods are summarised in Table 8.1.

Table 8.1 Outline of work undertaken and planned: 1994-1996

Subsection of programme	River	Description
Changes in species richness and rarity	R. Cole	Semi-quantitative sampling of nine survey stations (2 u/s Control; 5 on restoration site; 2 d/s Impact) in two seasons (summer and autumn).
	R. Brëde	Semi-quantitative sampling of 6 survey stations (2 u/s Control sites; 3 on restoration site; 1 d/s Impact site).
	R. Skerne	Semi-quantitative sampling of 6 survey sites (2 u/s Control; 2 on restoration site; 2 d/s Impact sites).
Changes in invert-ebrate abundance	R. Brëde	Quantitative sampling of stones and sediments (using core sampler).

8.3 Interim results

Preliminary information is available from the R. Cole relating to the early effects of restoration on the Impact reach downstream of the restoration site. Analysis of R. Brëde and Skerne data will be undertaken at the end of the 1996 field season.

8.3.1 Species richness of aquatic macroinvertebrate communities

Figure 8.1 summarises changes in species-richness over the first two years of the monitoring of the R. Cole (results from Sites 1 - 9).

Species-richness at all sites is broadly similar, mean number of species recorded varying between 52 (Site 4) and 62 (Sites 1, 5 and 6). The most pronounced trend was seen in the autumn samples: *all* sites supported more species in autumn 1995 compared to autumn 1994.

8.3.2 Impact of restoration work on invertebrate communities

The numbers of invertebrate species recorded in the first three samples (pre-construction) at all sites on the Cole have remained fairly constant. This suggests that communities are not changing greatly between years.

Invertebrate sampling in autumn 1995 shows little evidence of downstream impacts due to sediment export or water quality changes (see Figure 8.1). All sites show the same trend, with more species recorded in autumn 1995 than in autumn 1994. There is, therefore, no indication that restoration work has affected the quality of the invertebrate community (note that Site 5 was on the now filled-in old channel, and therefore no longer exists).

Species Rarity Index values, BMWP scores and ASPTs all show similar trends, with autumn 1995 values generally higher than those of autumn 1994.

Table 8.1 Aquatic macroinvertebrate species richness and rarity in the R. Cole

Site	Site No.	Species richness				Species rarity index			
		Pre-construction			Post	Pre-construction			Post
		Sum 94	Aut 94	Sum 95	Aut 95	Sum 94	Aut 94	Sum 95	Aut 95
Upstream control site	1	66	43	66	72	1.00	1.05	1.12	1.11
	2	52	36	67	63	1.29	1.17	1.12	1.16
Upstream restoration site	3	45	55	51	69	1.04	1.13	1.1	1.14
	4	51	41	57	59	1.02	1.12	1.09	1.08
Downstream restoration site	5	56	53	68	n/d	1.07	1.13	1.13	n/d
	6	52	60	63	71	1.02	1.23	1.19	1.11
	7	61	56	69	61	1.07	1.13	1.12	1.07
Downstream impact site	8	63	51	60	55	1.10	1.12	1.12	1.18
	9	68	47	65	52	1.09	1.09	1.11	1.12

Table 8.2 Aquatic macroinvertebrate species richness and rarity in the R. Cole

Site	Site No.	Species richness				Species rarity index			
		Pre-construction			Post	Pre-construction			Post
		Spr 94	Aut 94	Spr 95	Aut 95	Spr 94	Aut 94	Spr 95	Aut 95
Upstream control site	1	205	160	211	208	5.26	5.00	5.41	5.2
	2	195	155	211	202	5.13	5.34	5.27	5.32
Upstream restoration site	3	154	183	166	191	4.97	5.23	5.03	5.16
	4	175	116	173	142	5.15	4.46	4.94	4.73
Downstream restoration site	5	202	205	234	n/d	5.46	5.13	5.71	n/d
	6	216	215	225	226	5.54	5.24	5.63	5.38
	7	210	191	237	214	5.53	5.16	5.64	5.35
Downstream impact	8	228	189	240	227	5.56	5.25	5.71	5.54
	9	218	164	211	202	5.32	5.13	5.41	5.46

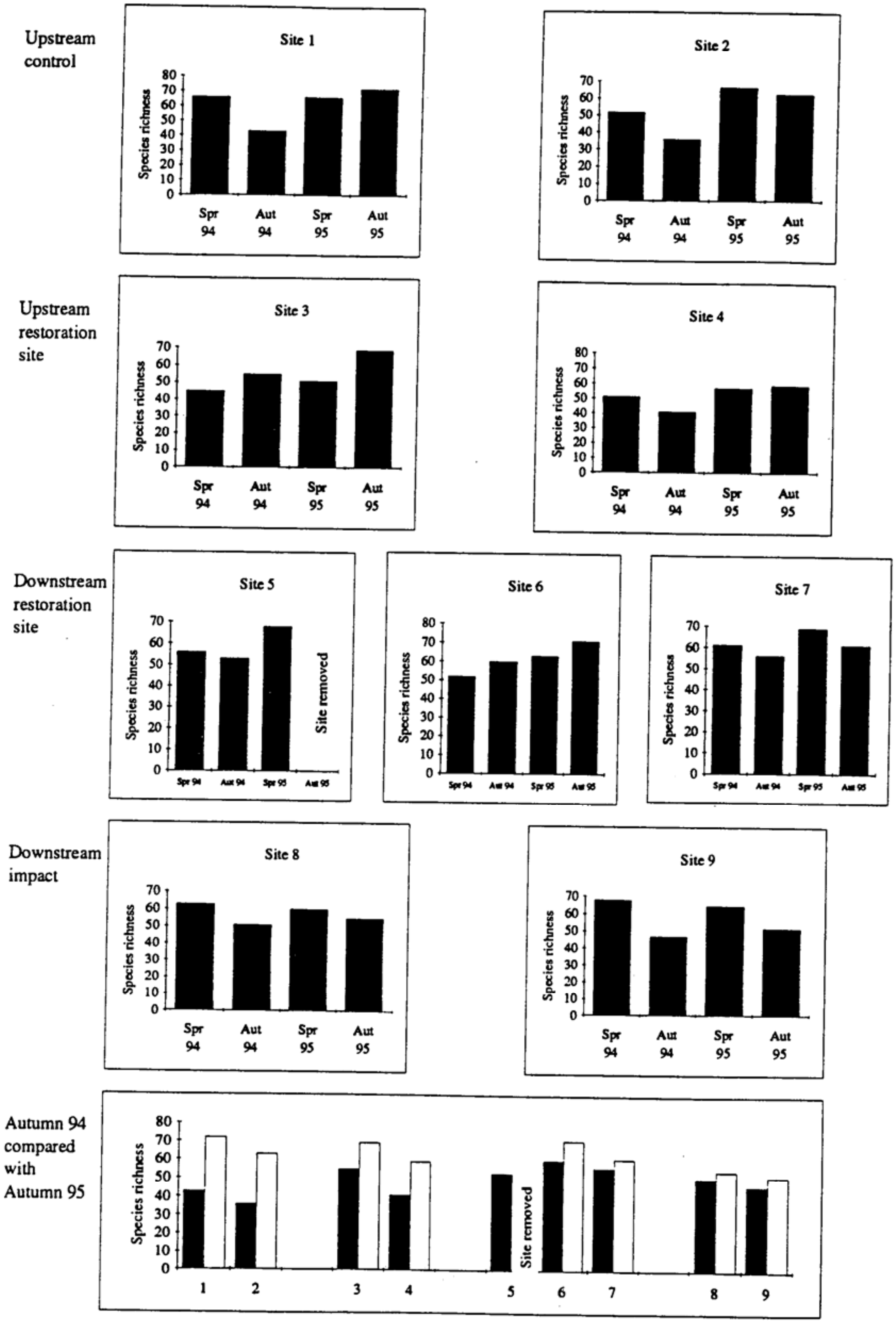


Figure 8.1 Macroinvertebrate species richness, species rarity and BMWP scores

9. Public perception

9.1 Introduction and aims

The aim of the public perception study is to assess the public appreciation of the objectives and effects of river restoration. The study focuses mainly on the R. Skerne where the detailed aims are to investigate people's views about the river and to assess the value of the scheme in economic terms. This data will form part of the overall assessment of the benefits of restoration.

The public perception study on the Skerne has had two main stages: (i) a pilot study to make a preliminary assessment of attitudes to the project; and (ii) a detailed questionnaire survey to investigate the views of Darlington residents about the current status of the river. The questionnaire survey will be repeated once the works are completed to investigate the way in which the completed scheme has been perceived in practice.

Full results of the pre-works detailed pubic perception study are reported in the RRP report "River Skerne Public Perception Survey: Stage 2". This chapter gives a summary of the results from this study.

9.2 Methods

A structured quantitative survey of local residents in Darlington was undertaken. The population was generally defined as those households living in roads within 400 metres from the section of the River Skerne between Skerne Bridge and Haughton Bridge. A systematic random sample was drawn from the electoral register for Darlington. The total population within the study area was 4,706. As 600 addresses were felt to be necessary to achieve a target of 250 interviews, a sampling interval of eight was arrived at (4,706 divided by 600) and every eighth address was selected for inclusion in the survey. In total, 432 valid addresses were finally approached. The response rate was 58%, giving a quantitative survey of 252 local residents.

9.3 Results

9.3.1 Use of the river and surrounding area

Findings show that the river and surrounding area are well used by local residents for informal recreation activities. The majority of respondents (85%) visit the river, many on a regular basis both in winter and summer (see Figure 9.1). The existing footbridge at Hutton Avenue is also regularly used by the respondents, as are the existing footpaths by the river. Respondents spend, on average, between 16 and 30 minutes visiting the river.

A variety of reasons were displayed by respondents for visiting the river and parkland, the most popular being walking and access to elsewhere. Walking the dog and wildlife were other reasons for visiting given by some respondents (See Figure 9.2).

9.3.2 Current perception of the river and surrounding parkland

The main attractions of the study area were said to be quiet open space, the more natural habitat, plants and other vegetation, and the wildlife. Several features that were mentioned by respondents as aspects they disliked about the area were dog fouling, the 'dirty and smelly' river, rubbish and litter. A number of respondents also mentioned the local 'vandals' who used the area.

Figure 9.1
Frequency of visits to the river

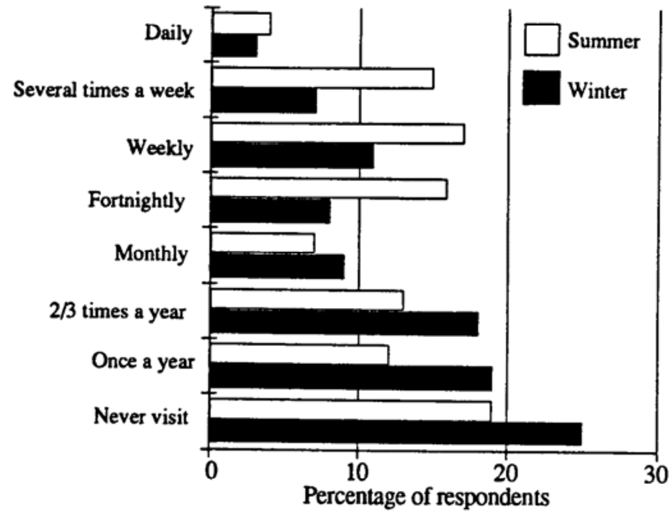
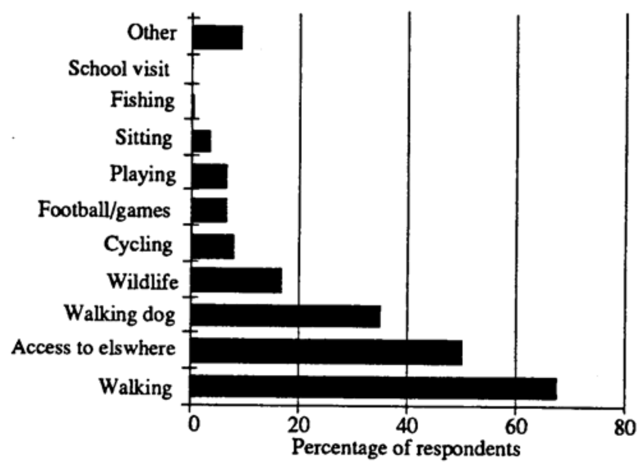


Figure 9.2
Purpose of visit to the river

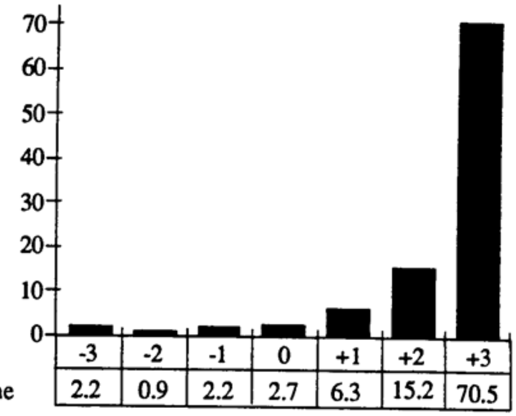


9.3.3 Perceptions of the proposed river restoration scheme

The proposals for the river restoration scheme were generally welcomed by the majority of the respondents and seen as being a great improvement to the local area (see Figure 9.3). The vast majority of respondents (92%) were in favour of the river restoration scheme, 71% strongly in favour. It was felt by 64% of respondent that they would visit the river more often if the proposed scheme were to be carried out. One third of respondents said that they would definitely get more enjoyment from visiting the river should the scheme be completed, and over half felt that they would get more enjoyment from their visits. Concern was expressed by a minority of respondents that the additional vegetation could provide a cover for criminals and burglars.

The restoration project proposal for an additional footbridge and footpaths were generally welcomed: very few residents totally rejected these proposals, opening up the potential for a circular walk using both sides of the river. Most respondents were in favour of refurbishment of the existing bridge, as well as having an additional bridge.

Figure 9.3
Ratings in favour of the scheme
Percentage of respondents visiting river



-3 = strongly against the scheme
+3 = strongly in favour of the scheme

9.3.4 Economic benefits from restoring the river

Over half the respondents who visited the river were able to place a monetary value on their enjoyment of their visits. It should be emphasised, however, that the results obtained need to be treated tentatively, as the population sample was too small for a reliable Contingent Valuation Method study to be undertaken.

Results from both the enjoyment valuation and willingness-to-pay questions in the survey suggest that there is a monetary benefit to be obtained in improving the river and surrounding parkland. In particular, respondents were willing to pay significant sums in additional national and local taxes each year for a River Skerne restoration scheme (see Table 9.1). These findings are broadly comparable with other FHRC studies.

Table 9.1 The mean value of enjoyment of visit by visitor type

Visitor type	Before scheme			After scheme		
	Respondent able to value		Value given	Respondent able to value		Value given
	N	%		N	%	
Riverside properties	12	66%	£4.67	11	61%	£7.75
Within 250m	29	43%	£6.25	32	47%	£8.53
Between 250-500m	44	56%	£5.15	39	50%	£6.22
Over 500m	36	40%	£7.27	33	37%	£8.45
All respondents	**121**	**48%**	**£6.00**	**115**	**45%**	**£7.65**

9.3.5 Public consultation and involvement in site management

Respondents gave a high importance to the issue of public consultation, and half of them rated this as very important. The most preferred form of consultation is letters or leaflets, although personal visits and public meetings were also quite popular. Many respondents were pleased to have been consulted over the proposed scheme: this gave them a feeling of involvment and a sense that their views were regarded as important. It is recommended that local people should continue to be kept informed at all stages of the project development and construction. There appears to be a valuable opportunity to utilise local resources (i.e. people and their skills and knowledge) in management of the site.

10. Economic appraisal

10.1 Aims

The main objective of the LIFE demonstration project is to assess the value of river restoration as a tool for Integrated Catchment Management. This aim of this section of the project is to assess the overall economic benefits of restoration in terms of:

(i) flood defence

(ii) water quality and pollution control

(iii) fisheries

(iv) nature conservation

(v) public amenity and recreation

Data from all three restoration sites will contribute toward the economic assessment.

10.2 Methods

During 1995 the methods which will be used to undertake economic analysis have been refined.

10.2.1 Flood defence

Assessment of the effects of restoration on flood defence will focus on the R. Cole, with additional data from the R. Brěde. The effects of restoration on channel hydraulics at Coleshill will be scaled-up to the whole catchment for the R. Cole using an existing flood routing model created by Thames Water in 1988.

Economic appraisal of the effects of this change will include:

(i) assessment of the capital costs associated with the construction/replacement of flood defences and/or land drainage in the future.

(ii) calculation of the cost of maintaining defences and/or drainage systems, including labour, machinery etc.

(iii) assessment of changes in flood damages, using methods recommended for flood defence schemes in MAFF Project Appraisal Guidance Notes.

This section will also incorporate an assessment of the effects of changing agricultural land-use.

10.2.2 Water quality

The applicability of existing water quality models to the calculation of catchment-scale effects of restoration will be assessed. The site-specific data from the restoration sites will be used to predict the likely effects of catchment-scale changes.

Improvements in water quality will be assessed in terms of water supply (costs to water companies of water treatment) and the benefits for other river uses (e.g. recreational fisheries, water-based recreation).

10.2.3 Fisheries

The benefits of restoration for fisheries will be assessed in terms of the economic value of recreational fisheries. Most recreational fisheries are priced and therefore have an economic value comprised of the economic rent and the consumer surplus to anglers (the amount anglers may value a fishery above the rent actually paid).

Economic rent

There are no formal techniques for assessing the economic value of coarse fisheries. However, average lease values or day ticket prices for similar sites can be used to estimate the potential value of the fisheries on the restored sites.

Estimates of salmonid fishery average costs per day are available (ECOTEC 1993a, b) and are estimated to range between :

£4.10	for wild fisheries in upland waters
£10.20	for wild fisheries in lowland rivers
£11.30	for stocked waters

Consumer surplus

A literature review has been undertaken to define a range of values for anglers consumer surplus (for example the distance they may be willing to travel, in addition to paying for the fishing).

Values estimated as the consumer surplus vary from £1.00 to £8.00 with a central estimate of £4.50. These values will be used as the basis for a sensitivity analysis.

ECOTEC (1993a) also estimated that anglers were willing to pay additional costs of about 50% of the rental value of the fishery.

Participation rates

Methods for assessing participation rates have been reviewed and techniques proposed.

Overall calculation of benefits

Specimen calculations have been prepared for the overall assessment of benefits of restoration for fisheries.

10.2.4. Amenity and recreation

Analysis of amenity and recreation benefits will consider in-stream and out-of-stream benefits. Since there are likely to be few benefits to commercial recreation operators, benefits will be considered in terms of individuals.

The approaches which will be adopted for estimating changes in consumer surplus have been developed. Methods for estimating participation rates will be similar to those for fisheries.

Out-of stream recreation

Estimates of consumer surplus for out-of-stream recreation range from:

Lower bound estimate	£0.50 per visitor day
Central estimate	£1.00 per visitor day
Upper bound estimate	£3.50 per visitor day.

Note, however, that on the Skerne, members of the public indicated an *annual* willingness to pay for restoration work of £1.02. Given that residents surveyed on the Skerne visited (on average) weekly in summer and fortnightly in winter, willingness to pay for individual visits might be lower than the above estimates. For example, if a person made 30 visits a year this represents only £0.03 per visit.

In-stream recreation benefits

Estimates of the value of in-stream recreation have been reviewed. Estimates of consumer surplus for in-stream recreation range from:

Lower bound estimate	£4.00 per visitor day
Central estimate	£6.50 per visitor day
Upper bound estimate	£15.00 per visitor day.

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