UNIVERSITY OF
Hull International
Fisheries Institute
HIFI

Humber eel management issues: barriers and stocking

FINAL REPORT

A. D. Nunn, J. P. Harvey, R. A. A. Noble & I. G. Cowx

April 2007

THE
UNIVERSITY
OF HULL

TABLE OF CONTENTS **Page No.**

LIST OF TABLES **Page No.**

LIST OF FIGURES

LIST OF PLATES

ACKNOWLEDGEMENTS

The authors would like to thank the Environment Agency (especially Neil Trudgill) for funding the work. Many thanks also to Barry Byatt, Martin Christmas, Amanda Crossfield, Katy Davis, Chris Firth, Paul Frear, David Hopkins, Tim Jacklin, Alan Mullinger, Keith Norton, Reuben Page, Phil Smith, Lucy Taylor, Philip Thornton and Neil Trudgill for providing information on the fish, crayfish and obstructions in the Humber catchment.

1. INTRODUCTION

There is a widely accepted panmixia hypothesis that the European eel (*Anguilla anguilla* (L.)) migrates to the Sargasso Sea and breeds as a single, randomly mating population (Schmidt, 1922), although there is some debate over the issue (Daemen *et al*., 2001; Wirth & Bernatchez, 2001; Casellato, 2002). Upon hatching, the leptocephalus larvae drift across the Atlantic Ocean to Europe, metamorphose and migrate into fresh water, although an unknown proportion remain in coastal and estuarine waters. After a number of years in fresh water, the eel mature and return to the Sargasso Sea to spawn.

Over the past three decades, there has been a pronounced decline in eel recruitment throughout Europe (Feunteun, 2002; Dekker, 2003; Starkie, 2003; Stone, 2003; van Ginneken & Maes, 2005). A number of factors have been implicated in the decline, including physical barriers to migration, over-exploitation, pollution, parasites and shifts in the Gulf Stream (Feunteun, 2002; Briand *et al*., 2003; Dekker, 2003; Kirk, 2003; Knights, 2003; Russell & Potter, 2003). Recent European legislation has decreed that each Member State must ensure recovery of eel stocks to historical levels. To assist in the identification of methods for eel stock recovery, each Member State is required to produce eel management plans; a role taken in England and Wales by the Environment Agency. Subsequently, each Member State is required to ensure a minimum of 40% escapement of silver eel from each river basin by 2007.

It is considered unlikely, however, that the 40% escapement target will be achieved for the Humber basin, due largely to the regulation and modification of the watercourses in the catchment through the use of weirs, dams and sluices, which can be major barriers to upstream migration of eel and other fishes. Indeed, of the 60 watercourses discharging into the Humber Estuary investigated by Firth (2001), only the River Hull has a natural gravity outfall. As such, knowledge of the barriers to eel migration in the catchment is crucial so that action can be taken to address the bottlenecks to recruitment. Another potential method of enhancing eel populations in the Humber catchment is stocking of elvers. This management tool could be used to mitigate poor recruitment, but it must be carried out in a sympathetic manner to minimise impacts on the resident biota, particularly species of conservation value. The following report provides an assessment of the major barriers to eel migration in the Humber catchment and suggests potential areas for stocking of elvers, to support the Humber Eel Management Plan.

2. OBJECTIVES

The main objectives of the project were to assess and prioritise key barriers to eel migration in the Humber catchment with a view to ameliorating bottlenecks to recruitment, and to identify potential stocking sites for elvers. However, due to the industrial heritage of much of the catchment, the number of barriers is extremely high. It was decided by the Environment Agency, therefore, that only the first two *major* barriers to eel migration on each of the main watercourses feeding into the Humber Estuary would be assessed and prioritised. The analysis aimed to prioritise 20-30 barriers to eel migration, to contribute to the Humber Eel Management Plan. Sites for stocking were considered on the rivers Don, Aire, Calder, Rother, Dearne, Trent,

Ancholme, Ure, Yorkshire Ouse, Yorkshire Derwent, Swinefleet Warping Drain, Tetney Haven, Adlingfleet Drain, Pauper's Drain and Bosky Dyke (Keadby Warping Drain).

2.1 Specific objectives

The specific objectives of the project were to:

- identify the first two *major* barriers to eel migration on each of the main watercourses feeding into the Humber Estuary;
- prioritise 20-30 major barriers to eel migration based upon various criteria;
- identify suitable locations for stocking of elvers in selected watercourses feeding into the Humber Estuary; and
- prioritise locations for stocking of elvers in the selected watercourses based upon various criteria.

3. PROJECT STRATEGY

The project strategy was divided into two components to meet the specific objectives of the project.

3.1 Identification of eel migration barriers

3.1.1 *Collection and collation of fisheries data*

To identify barriers to eel migration, it is necessary to compare the distributions of eel and potential barriers and, if possible, population densities of eel in each watercourse under consideration. This was achieved by:

- interrogation of Environment Agency records (mainly NFPD) and consultation with Environment Agency staff;
- interrogation of other historical reports and records; and
- interrogation of the HIFI fisheries database, which includes considerable coverage of the region and in which semi-quantitative data are available to support the mainly categorical data available in the NFPD.

The majority of the data were supplied by the Environment Agency, and GIS software was used to assist in the interpretation of eel distributions and migration barriers. During this exercise, data on brown trout (*Salmo trutta* L.), Atlantic salmon (*Salmo salar* L.), bullhead (*Cottus gobio* L.), brook lamprey (*Lampetra planeri* (Bloch)), river lamprey (*Lampetra fluviatilis* (L.)), sea lamprey (*Petromyzon marinus* L.), spined loach (*Cobitis taenia* L.), white-clawed crayfish (*Austropotamobius pallipes* (Lereboullet)) and non-native crayfish were obtained to assist in the assessment of potential stocking sites (see Section 3.2). In addition, HIFI holds considerable data on several of these species from its own research programmes, and these were also integrated into the database.

3.1.2 *Prioritisation of eel migration barriers*

The first two *major* barriers to eel migration on each of the main watercourses flowing into the Humber Estuary were identified from interrogation of Environment Agency

records, consultation with Environment Agency staff and HIFI's knowledge from previous work on the systems (e.g. Cowx & O'Grady, 1995; Harvey, 1996; Amisah, 1998; Britton, 1999; Sykes, 2004; Nunn, 2005; Bolland, in prep.). Prior to the assessment, a prioritisation matrix, based on the National Fish Pass Prioritisation Matrix (Wilson, 2006), was developed to account for a number of parameters associated with the barriers, and availability of potential eel habitat upstream. Where available, information on habitat was obtained from the Environment Agency River Habitat Survey (RHS) database for each watercourse. The analysis aimed to prioritise 20-30 barriers to eel migration, to contribute to the Humber Eel Management Plan.

3.2 Elver stocking

Another potential method of enhancing eel populations in the Humber catchment is stocking of elvers to ameliorate recruitment bottlenecks. Possible stocking locations were identified through a review of the data collected for assessment of migration barriers. Specifically, reaches of the main stems (i.e. excluding minor tributaries and watercourses) of the rivers Don, Aire, Calder, Rother, Dearne, Trent, Ancholme, Ure, Yorkshire Ouse, Yorkshire Derwent, Swinefleet Warping Drain, Tetney Haven, Adlingfleet Drain, Pauper's Drain and Bosky Dyke (Keadby Warping Drain) were assessed:

- for the presence/absence of eel (i.e. eel should be absent or in extremely low numbers); and
- for availability of suitable eel habitat (e.g. soft sediments, vegetation), identified by interrogation of the Environment Agency RHS database.

However, potential stocking areas must:

- be downstream of trout zones (see Gray & Mee, 2002), due to productivity and potential competitive/predation interactions;
- not contain species of conservation value (i.e. salmon, bullhead, brook lamprey, river lamprey, sea lamprey, spined loach and white-clawed crayfish), although sites with non-native crayfish were considered as eel may act as a control agent. This information was requested from the NFPD database as part of the data collection process related to migration barriers (see Section 3.1.1); and
- not have major impediments to downstream migration (e.g. pumping stations, hydropower schemes), which could have detrimental impacts on eel escapement, unless mitigation methods are identified.

The majority of the data were supplied by the Environment Agency. A prioritisation matrix was developed using the above criteria, allowing provisional stocking sites to be identified and included in the Humber Eel Management Plan.

4. DEVELOPMENT OF PRIORITISATION MATRICES

4.1 Eel migration barrier prioritisation matrix

The eel migration barrier prioritisation matrix was developed from the National Fish Pass Prioritisation Matrix (Wilson, 2006), and aimed to prioritise barriers for inclusion

in the Humber Eel Management Plan based upon a variety of parameters, including eel stock status, barrier passability and availability of habitat upstream. The inputs for the migration barrier prioritisation matrix are:

Site number – unique site identifier.

Site name – the name of the site (not necessarily unique).

Multiple obstruction number – the order in which eel migrating upstream from the Humber Estuary encounter each obstruction (e.g. Crakehill Weir, the first weir on the River Swale, is obstruction number 3, as eel migrating up the Swale from the Humber Estuary must first pass the weirs on the Yorkshire Ouse at Naburn and Linton). When there are a number of obstructions in parallel (i.e. there is more than one route upstream), there may be more than one obstruction with the same number (e.g. eel ascending the Trent pass either Averham Weir or the weirs at Nether Lock and Newark).

Region, Area, Catchment, River – the region, area, catchment and river of the obstruction.

NGR – the National Grid Reference of the obstruction.

Upper NGR – the National Grid Reference of the most upstream of a sequence of obstructions.

Obstruction type – the type of obstruction.

Obstruction height – the height of the obstruction.

Existing fish pass type – the existing type of fish pass, where applicable.

Ease of rectification – the ease with which the detrimental attributes of each obstruction could be rectified and passage upstream improved; an expert judgement based upon the structure (e.g. gradient, construction material) of the barrier.

Eel stock status – the status of the eel stock downstream of each obstruction, determined from Table 1. Whenever possible, eel biomass and/or density were derived using Environment Agency fisheries data, otherwise the status of the stocks was scored using expert judgement.

Table 1 Determination of eel stock status

Reference	Score	Biomass (g m^{-2})	Density (# 100 m^{-2})
High	1	>572	>20
Good	2	285-572	10-20
Moderate	3	141-285	2-10
Poor	4	70-140	1-2
Bad	5	0.1-70	0-1
Really bad	6	0	0

Degree to which barriers are limiting – the degree to which migration barriers and other factors are limiting eel populations *in the watercourse*, determined from Table 2. The barriers were scored using expert judgement.

Table 2 Determination of eel migration barrier scores

Score	Degree to which barriers are limiting stocks (%)	Description
1	0-10	Stocks largely constrained by factors other than barriers
2	10-35	Barriers are limiting stocks, but other factors are more important
3	36-64	Barriers limiting stocks to similar extent as other factors
4	65-90	Barriers are severely limiting stocks
5	90-100	Barriers are the main factor limiting stocks

Percent passability – an estimate of the current passability at *each barrier* by eel. Note that the only fish passage improvements that can be classed as 100% efficient are barrier removals.

Eel habitat quantity upstream – an estimate of the quantity of riverine and stillwater eel habitat upstream of each obstruction, up to the next obstruction, derived from Table 3.

Table 3 Determination of eel habitat quantity upstream

Score	km	ha
1	<5	<5
2	5-10	5-10
3	10-15	10-15
4	15-20	15-20
5	>20	>20

Eel habitat quality upstream – an estimate of the quality of eel habitat upstream of each obstruction, up to the next obstruction, derived from Table 4. A function of the likelihood of recruitment (i.e. proximity to the tidal limit) and the productivity of the area (i.e. trophic status). The trophic status was determined using four WFD risk categories for phosphorus enrichment.

The outputs of the migration barrier prioritisation matrix are:

Eel score – a function of the eel stock status, the degree to which barriers are limiting, percent passability, eel habitat quantity upstream and eel habitat quality upstream.

Priority – the rank of each of the barriers in terms of their eel scores, identifying priority barriers for inclusion in the Humber Eel Management Plan. The higher the eel score, the higher priority for mitigation measures.

Table 4 Determination of eel habitat quality upstream

		Productivity (based upon WFD P risk categories)			
		At risk	Probably at risk	Probably not at risk	Not at risk
Proximity to tidal limit (km)	0-1	5	5	4	3
	1-5	5	4	3	2
	5-15	4	3	2	1
	15-30	3	2	1	1
	>30	2	1	1	1

4.2 Elver stocking prioritisation matrix

To ensure that maximum benefits accrue, it is important that stocking is targeted towards areas where eel production potential is highest. There is comparatively little information on the habitat requirements of eel, however, rendering it difficult to identify optimal stocking areas. It has been suggested that stocking sites should be upstream of major migration barriers and where eel density is likely to be below the carrying capacity of the habitat (Williams & Aprahamian, 2004). Ideally, stocking sites should have a high degree of physical heterogeneity, providing a large amount of cover and a diverse food supply. The elver stocking prioritisation matrix aimed to prioritise potential stocking areas for inclusion in the Humber Eel Management Plan based upon a variety of parameters, including eel stock status, habitat availability and abundance of conservation species. The inputs for the stocking prioritisation matrix are:

Stretch number – unique stretch identifier. Stretches were usually lengths of river between migration barriers.

d/s boundary – the name of the most downstream point of the stretch.

u/s boundary – the name of the most upstream point of the stretch.

Region, Area, Catchment, River – the region, area, catchment and river of the stretch.

Lower NGR – the National Grid Reference of the most downstream point of the stretch.

Upper NGR – the National Grid Reference of the most upstream point of the stretch.

Eel stock status – the status of the eel stock in the stretch, derived as described in Section 4.1.

Eel habitat quantity – an estimate of the quantity of eel habitat in the stretch, derived as described in Section 4.1.

Eel habitat quality – an estimate of the quality of eel habitat in the stretch, based upon RHS data where available, derived from Table 5; a function of the channel substratum characteristics, flow types, channel modifications, channel vegetation and water quality. For stretches where no data were available, habitat attributes were scored using expert judgement.

Table 5 Determination of eel habitat quality for stocking

		Water quality		
		Good[1]	Fair[2]	Poor[3]
Physical habitat characteristics	Homogeneous habitat (e.g. little variation in substratum and flow types, highly modified channel, aquatic macrophytes sparse/absent)	3	2	1
	Intermediate habitat types (e.g. some variation in substratum and flow types, partly modified channel, some aquatic vegetation present)	4	3	2
	Heterogeneous habitat (e.g. a variety of substratum and flow types, minimal channel modifications, aquatic vegetation abundant)	5	4	3

[1]chemical GQA grades A-B, [2]chemical GQA grades C-D, [3]chemical GQA grades E-F

Abundance of conservation species – an estimate of the abundance (frequent, occasional, rare/absent) of salmonids, lampreys, bullhead, spined loach and white-clawed crayfish in the stretch.

Impediments to downstream migration – the presence/absence of any potentially major impediments to downstream migration (e.g. pumping stations, hydropower schemes), which could have detrimental impacts on eel escapement.

Non-native crayfish – the presence/absence of non-native crayfish in the stretch.

The outputs of the stocking prioritisation matrix are:

Eel stocking score – a function of the eel stock status, eel habitat quantity, eel habitat quality, abundance of conservation species and the presence/absence of non-native crayfish.

Priority – the rank of each of the stretches in terms of their eel stocking scores, identifying priority stocking areas for inclusion in the Humber Eel Management Plan. The higher the eel stocking score, the higher priority for stocking activities.

5. PRIORITISATION OF EEL MIGRATION BARRIERS

5.1 River Hull

Of the 60 watercourses discharging into the Humber Estuary investigated by Firth (2001), only the River Hull, on the north bank of the estuary, has a natural gravity outfall. As such, the river supports good populations of eel throughout much of its length (Fig. 1), with a wide range of sizes and ages present (King's College London, unpublished data). The same is true for its main tributary, Frodingham Beck, and many of the watercourses associated with the lower river, such as the Leven Canal and the Beverley and Barmston Drain (Harvey & Cowx, 1999, 2000, 2002; EA, unpublished data).

There is a tidal barrage at the confluence of the River Hull with the Humber Estuary (Plate 1), but it is rarely closed and so is not a barrier to migrating eel for the majority of

the time (Firth, 2001). It should be noted, however, that this situation may change with the proposed barrage at the mouth of the river. Similarly, although substantial (~1.5 m head-loss), the weir at Hempholme (~29 km from estuary) (Plate 2) appears not to be a major barrier to migration as good numbers and a range of sizes and ages of eel have been reported upstream of this point (Fig. 1; King's College London, unpublished data). Eel are probably able to pass Hempholme Weir via the navigation lock, over the weir sill during periods of elevated river discharge or at high tides, and possibly through the Beverley and Barmston Drain, which joins the River Hull upstream of the weir. Eel are numerous in the stretch of the Beverley and Barmston Drain around Tophill Low (EA, unpublished data), and large numbers of elvers have been observed attempting to access the drain from the River Hull via the pumping station at Wilfholme (A. Nunn, pers. obs.). Passage through the navigation lock will depend upon either its operation coinciding with eel migration peaks or leakage (Tesch, 1977).

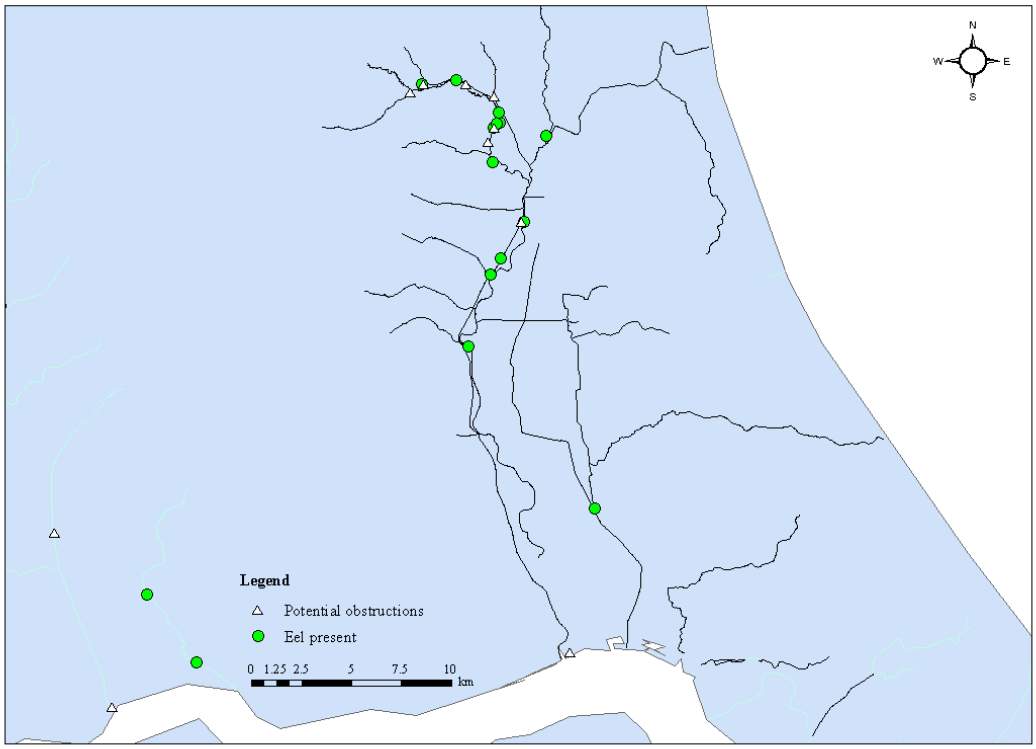

Fig. 1 The River Hull catchment, showing distributions of eel and potential migration barriers

The next potential barriers upstream are the weirs at Cleaves Farm (<0.5 m head-loss, ~34 km from estuary), Copper Hall (~35 km from estuary) and Whinhill Fish Farm (~1 m head-loss, ~42 km from estuary) (Plate 3), none of which have a fish pass or navigation lock. Passage at Cleaves Farm Weir is considered difficult for all but elvers, while Whinhill Fish Farm is impassable because of a shallow apron at the foot of the weir and the lack of shelters (A. Mullinger, pers. comm.). However, Copper Hall Weir is no longer a barrier as the boards have been removed (A. Mullinger, pers. comm.). Thus, **the first two *major* barriers most likely to impede eel migration in the River Hull are Hempholme Weir and Cleaves Farm Weir**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of an eel pass at these weirs would facilitate the upstream passage of eel and improve access to over 10 km of the main stem of the river, as well as Frodingham Beck and a number of smaller tributaries.

Table 6 Eel migration barrier prioritisation matrix

Site number	Site name	Multiple obstruction No.	Region	Area	Catchment	River	NGR	Upper NGR	Obstruction type	Obstruction height	Existing fish pass type	Ease of rectification	Eel stock status	Degree to which barriers are limiting	% passability	Eel habitat quantity u/s (riverine)	Eel habitat quantity u/s (stillwater)	Eel habitat quality u/s	**Eel score**	**Priority**
										m			1 to 6	1 to 5		1 to 5	1 to 5	1 to 5		
1	Ferriby Sluice	1	Anglian	Northern	Ancholme	Ancholme	SE 976 211		Estuary barrage	n/a	None	Difficult	3	3	75	5	1	5	1125	33
2	Harlam Hill Weir d/s	2	Anglian	Northern	Ancholme	Ancholme	TF 019 946		Weir	1.5	Navigation lock	Intermediate	3	3	50	1	1	3	270	57
3	Harlam Hill Weir u/s	3	Anglian	Northern	Ancholme	Ancholme	TF 021 943		Weir	<0.5	Navigation lock	Simple	3	3	90	1	1	3	54	65
4	Bishopbridge	4	Anglian	Northern	Ancholme	Ancholme	TF 031 911		Weir	0.5	None	Simple	3	3	50	1	1	2	180	60
5	Toft Newton	5	Anglian	Northern	Ancholme	Ancholme	TF 032 875	TF 032 875	Gauging weir	1.0	None	Simple	4	3	25	1	1	2	360	56
6	Stonebridge Farm	1	Anglian	Northern	Tetney Haven	Tetney Haven	TA 354 031		Estuary barrage	n/a	None	Difficult	3	3	75	1	1	5	225	59
7	Tetney Lock	2	Anglian	Northern	Tetney Haven	Tetney Haven	TA 343 023		Weir	1.0	None	Intermediate	3	3	50	3	1	5	1350	21
8	Alvingham	3	Anglian	Northern	Tetney Haven	Louth Canal	TF 373 927	TF 373 927	Weir	0.5	None	Simple	3	3	75	1	1	4	180	60
9	Cromwell	1	Midlands	Lower Trent	Trent	Trent	SK 809 612		Weir	3.0	Pool & Traverse	Difficult	5	5	25	2	2	5	7500	1
10	Averham	2	Midlands	Lower Trent	Trent	Trent	SK 770 535		Weir	2.0	None	Intermediate	5	5	50	3	1	4	3000	6
11	Nether Lock	2	Midlands	Lower Trent	Trent	Trent	SK 801 553		Weir	2.0	Navigation lock	Intermediate	5	5	25	1	1	4	1500	19
12	Newark	3	Midlands	Lower Trent	Trent	Trent	SK 792 537		Weir	2.0	Navigation lock	Intermediate	5	5	25	3	1	4	4500	2
13	Hazelford	3/4	Midlands	Lower Trent	Trent	Trent	SK 732 494	SK 732 494	Weir	2.0	Navigation lock	Intermediate	5	5	25	2	1	3	2250	12
14	Hazelford Back Weir	3/4	Midlands	Lower Trent	Trent	Trent	SK 732 493	SK 732 493	Weir	2.0	None	Intermediate	5	5	25	2	1	3	2250	12
15	Adlingfleet	1	Midlands	Lower Trent	Trent	Adlingfleet Drain	SE 859 219		Sluice (any type	n/a	None	Difficult	4	4	25	1	1	5	1200	24
16	Cow Lane	2	Midlands	Lower Trent	Trent	Adlingfleet Drain	SE 837 209	SE 837 209	Sluice (any type	n/a	None	Difficult	4	4	25	1	1	5	1200	24
17	Luddington	1	Midlands	Lower Trent	Trent	Pauper's Drain	SE 850 153		Sluice (any type	n/a	None	Difficult	5	4	0	1	1	5	2000	15
18	Pademoor	2	Midlands	Lower Trent	Trent	Pauper's Drain	SE 808 145	SE 808 145	Sluice (any type	n/a	None	Intermediate	5	4	50	2	1	5	2000	15
19	Keadby Outfall	1	Midlands	Lower Trent	Trent	Bosky Dyke (Ke	SE 836 121		Sluice (any type	n/a	None	Difficult	4	4	25	1	1	5	1200	24
20	Keadby Sluice	2	Midlands	Lower Trent	Trent	Bosky Dyke (Ke	SE 813 127	SE 813 127	Sluice (any type	n/a	None	Difficult	4	4	25	1	1	5	1200	24
21	Crimpsall	1	North East	Ridings	Don	Don	SE 566 037		Sluice (any type	2.0	Rock Ramps	Unnecessary	5	4	90	2	1	5	400	51
22	Sprotborough	2	North East	Ridings	Don	Don	SE 538 014		Weir	2.0	Navigation lock	Intermediate	5	4	25	3	1	4	3600	4
23	Thrybergh	3	North East	Ridings	Don	Don	SK 464 964		Weir	2.0	Alaskan A Denil	Intermediate	5	4	25	1	1	3	900	34
24	Aldwarke	4	North East	Ridings	Don	Don	SK 450 944		Weir	2.0	Navigation lock	Intermediate	5	4	25	1	1	3	900	34
25	Masbrough	5	North East	Ridings	Don	Don	SK 425 928	SK 425 928	Weir	2.0	Navigation lock	Intermediate	5	4	25	2	1	3	1800	18
26	Adwick upon Dearn	3	North East	Ridings	Don	Dearne	SE 481 018		Gauging weir	1.5	None	Intermediate	5	4	50	1	1	3	600	46
27	Wath	4	North East	Ridings	Don	Dearne	SE 436 022		Sluice (any type	n/a	None	Unnecessary	5	4	90	1	1	3	120	62
28	Darfield	5	North East	Ridings	Don	Dearne	SE 423 048		Weir	1.0	None	Intermediate	5	4	50	1	1	3	600	46
29	Little Houghton	6	North East	Ridings	Don	Dearne	SE 418 054	SE 418 054	Weir	3.0	None	Difficult	5	4	0	2	1	3	2400	10
30	Orgreave	6	North East	Ridings	Don	Rother	SK 427 874		Weir	2.0	Rock Ramps	Unnecessary	6	4	90	1	1	2	96	63
31	Beighton	7	North East	Ridings	Don	Rother	SK 446 841		Weir	1.5	None	Intermediate	6	4	25	1	1	2	720	41
32	Rother Valley Count	8	North East	Ridings	Don	Rother	SK 454 827		Weir	1.0	None	Intermediate	6	4	25	1	1	2	720	41
33	Killamarsh	9	North East	Ridings	Don	Rother	SK 446 809	SK 446 809	Weir	1.5	None	Intermediate	6	4	25	2	1	2	1440	20
34	Chapel Haddlesey	1	North East	Ridings	Aire	Aire	SE 581 260		Weir	1.5	Navigation lock	Difficult	5	4	25	2	1	5	3000	6

Table 6 – cont.

Site number	Site name	Multiple obstruction No.	Region	Area	Catchment	River	NGR	Upper NGR	Obstruction type	Obstruction height	Existing fish pass type	Ease of rectification	Eel stock status	Degree to which barriers are limiting	% passability	Eel habitat quantity u/s (riverine)	Eel habitat quantity u/s (stillwater)	Eel habitat quality u/s	**Eel score**	**Priority**
										m			1 to 6	1 to 5		1 to 5	1 to 5	1 to 5		
35	Beal	2	North East	Ridings	Aire	Aire	SE 535 256		Gauging weir	1.0	Navigation lock	Intermediate	5	4	25	2	1	4	2400	10
36	Knottingley	3	North East	Ridings	Aire	Aire	SE 493 242		Weir	2.0	Navigation lock	Difficult	5	4	25	3	1	4	3600	4
37	Castleford	4	North East	Ridings	Aire	Aire	SE 427 260	SE 427 260	Weir & sluice	2.0	Navigation lock	Intermediate	5	4	25	3	1	3	2700	9
38	Methley	5	North East	Ridings	Aire	Calder	SE 383 253		Gauging weir	1.5	Navigation lock	Intermediate	5	4	75	2	1	3	600	46
39	Kirkthorpe	6	North East	Ridings	Aire	Calder	SE 357 213		Weir	2.5	Navigation lock	Intermediate	6	4	25	1	1	2	720	41
40	Wakefield (Chantry	7	North East	Ridings	Aire	Calder	SE 336 204	SE 336 204	Weir	2.0	Navigation lock	Intermediate	6	4	25	1	1	2	720	41
41	Hull Tidal Barrage	1	North East	Ridings	Hull	Hull	TA 103 284		Estuary barrage	n/a	None	Unnecessary	3	3	100	5	1	5	0	66
42	Hempholme	2	North East	Ridings	Hull	Hull	TA 080 499		Gauging weir	1.5	Navigation lock	Intermediate	3	3	50	2	1	5	900	34
43	Cleaves Farm	3	North East	Ridings	Hull	Hull	TA 062 539		Weir	<0.5	None	Intermediate	3	3	50	1	1	3	270	57
44	Copper Hall	4	North East	Ridings	Hull	Hull	TA 065 546		Weir	n/a	Weir removal	Unnecessary	3	3	100	1	1	3	0	66
45	Whinhill Fish Farm	5	North East	Ridings	Hull	Hull	TA 051 568	TA 051 568	Weir	1.0	None	Intermediate	3	3	25	1	1	3	405	50
46	Weighton Lock	1	North East	Ridings	Foulness	Market Weig	SE 874 257		Estuary barrage	n/a	None	Difficult	4	3	50	2	1	5	1200	24
47	Sodhouse Lock	2	North East	Ridings	Foulness	Market Weig	SE 845 344	SE 845 344	Sluice (any type	0.5	Larinier (Super-a	Unnecessary	4	3	90	4	1	4	384	55
48	Holme House	2	North East	Ridings	Foulness	Foulness	SE 779 373	SE 779 373	Gauging weir	0.5	None	Intermediate	4	3	50	2	1	3	720	41
49	Swinefleet	1	North East	Ridings	Ouse	Swinefleet Warp	SE 765 217		Sluice (any type	n/a	None	Difficult	4	4	25	1	1	5	1200	24
50	Tadcaster	1	North East	Dales	Wharfe	Wharfe	SE485 437		Gauging weir	2.0	Alaskan A Denil	Intermediate	3	5	25	2	1	3	1350	21
51	Boston Spa	2	North East	Dales	Wharfe	Wharfe	SE 431 460		Weir	2.0	None	Difficult	4	5	25	1	1	3	900	34
52	Flint Mill	3	North East	Dales	Wharfe	Wharfe	SE422 473	SE422 473	Gauging weir	2.0	Pool & Traverse	Intermediate	4	5	50	1	1	2	400	51
53	Skip Bridge	2	North East	Dales	Nidd	Nidd	SE 482 561		Gauging weir	0.5	V Notch Weir	Intermediate	4	5	50	2	1	2	800	38
54	Kirk Hammerton	3	North East	Dales	Nidd	Nidd	SE 469 546		Weir	<0.5	None	Simple	4	5	75	2	1	2	400	51
55	Hunsingore	4	North East	Dales	Nidd	Nidd	SE 428 530		Gauging weir	1.5	None	Intermediate	4	5	25	2	1	2	1200	24
56	Ribston Hall	5	North East	Dales	Nidd	Nidd	SE 394 537	SE 394 537	Weir	<0.5	None	Simple	4	5	75	2	1	2	400	51
57	Naburn	1	North East	Dales	Ouse	Ouse	SE 594 445		Weir	2.5	Pool & Traverse	Intermediate	3	5	50	5	1	5	3750	3
58	Linton	2	North East	Dales	Ouse	Ouse	SE 494 600	SE 494 600	Weir	3.0	Pool & Traverse	Intermediate	3	5	50	5	1	3	2250	12
59	Boroughbridge	3	North East	Dales	Ure	Ure	SE 397 671		Weir	2.5	Pool & Traverse	Intermediate	4	5	25	2	1	2	1200	24
60	Westwick (Newby)	4	North East	Dales	Ure	Ure	SE 356 670		Gauging weir	1.5	Larinier (Super-a	Intermediate	4	5	75	4	1	2	800	38
61	West Tanfield	5	North East	Dales	Ure	Ure	SE 276 787	SE 276 787	Weir	2.0	None	Intermediate	4	5	50	3	1	2	1200	24
62	Crakehill	3	North East	Dales	Swale	Swale	SE 425 733		Gauging weir	1.5	None	Intermediate	4	5	50	2	1	2	800	38
63	Topcliffe	4	North East	Dales	Swale	Swale	SE 397 763		Weir	2.0	None	Intermediate	4	5	50	5	1	2	2000	15
64	Catterick Bridge	5	North East	Dales	Swale	Swale	SE 226 993	SE 226 993	Gauging weir	<0.5	None	Unnecessary	4	5	90	2	1	1	80	64
65	Barmby Barrage	1	North East	Dales	Derwent	Derwent	SE 681 286		Estuary barrage	n/a	None	Difficult	3	5	50	4	1	5	3000	6
66	Elvington	2	North East	Dales	Derwent	Derwent	SE 705 475		Weir	2.0	Pool & Traverse	Intermediate	3	5	50	3	1	3	1350	21
67	Stamford Bridge	3	North East	Dales	Derwent	Derwent	SE 713 557	SE 713 557	Gauging weir	2.0	Alaskan A Denil	Intermediate	3	5	50	1	1	3	450	49

5.2 Yorkshire Ouse

The Yorkshire Ouse drains the north-west of the Humber catchment, and joins with the River Trent at Trent Falls to form the Humber Estuary. Eel are present throughout the Yorkshire Ouse (Fig. 2; Whitton & Lucas, 1997) and, indeed, there is a licensed eel fishery (Masters *et al*., 2006; EA, unpublished data). In addition, eel form an important part of angler catches on the river (EA, unpublished data). Eel ascending the Ouse must negotiate the weir at Naburn (~2.5 m head-loss, ~60 km from estuary) (Plate 4). Passage may be gained via a pool-and-weir fish pass, although their effectiveness for eel is usually poor (Clay, 1995), over the weir sill during elevated flows or at high tides, or via a navigation lock (~250 m long). However, passage through the navigation lock will depend upon either its operation coinciding with eel migration peaks or leakage (Tesch, 1977). Inundated land adjacent to the weir (the site of an old lamprey trap) may also be a possible route during high flows, as observed for lamprey (M. Lee, pers. comm.). Whichever the route, it is likely that opportunities for migrating eel to pass upstream occur relatively frequently, as good populations of eel are found in the Ouse and tributaries upstream (Sections 5.4-5.6).

Further upstream, eel encounter the weir at Linton-on-Ouse (~3 m head-loss, ~86 km from estuary) (Plate 5). There is a pool-and-weir fish pass and navigation lock (~400 m long), and it is also possible that eel pass over either the weir sill or inundated land during periods of elevated river discharge. There are no further obstructions until the weir at Boroughbridge on the River Ure (~102 km from estuary). Thus, **the first two *major* barriers most likely to impede eel migration in the Yorkshire Ouse are Naburn Weir and Linton Weir**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Although both weirs are equipped with fish passes, they are likely to require some modification to encourage their use by eel. Installation of an eel pass at these weirs would facilitate the upstream passage of eel and improve access to over 40 km of the main stem of the river. Moreover, if passes are installed/modified at Naburn, Linton and the first two major barriers on the rivers Ure (Section 5.4), Swale (Section 5.5) and Nidd (Section 5.6), this would improve access to over 150 km of main river channel, plus numerous smaller watercourses.

5.3 Yorkshire Derwent

The Yorkshire Derwent drains the North York Moors and joins the Yorkshire Ouse at Barmby on the Marsh, approximately 28 km from the Humber Estuary. Eel are present throughout the Derwent (Fig. 3; Whitton & Lucas, 1997), and form an important part of angler catches on the river (EA, unpublished data). Notwithstanding, the lower reaches of the Derwent have more potential physical barriers to eel migration than the rivers Swale, Ure, Nidd and Wharfe (Jang & Lucas, 2005). There is a tidal barrage at Barmby on the Marsh (Plate 6), and closure of the barrage may act as a significant barrier to upstream movement of eel. The barrage is generally closed when the level of the tidal Ouse approaches that of the Derwent, such as at high tide. However, the barrage may be kept closed for extended periods when discharge in the Derwent is low, and even when partially open the high velocity of water leaving the river may prevent immigration of eel (D. Hopkins, pers. comm.). Indeed, a reduction in the importance of flounder (*Platichthys flesus* (L.)) in angler catches was reported after construction of the barrage in 1975 (Axford, 1991).

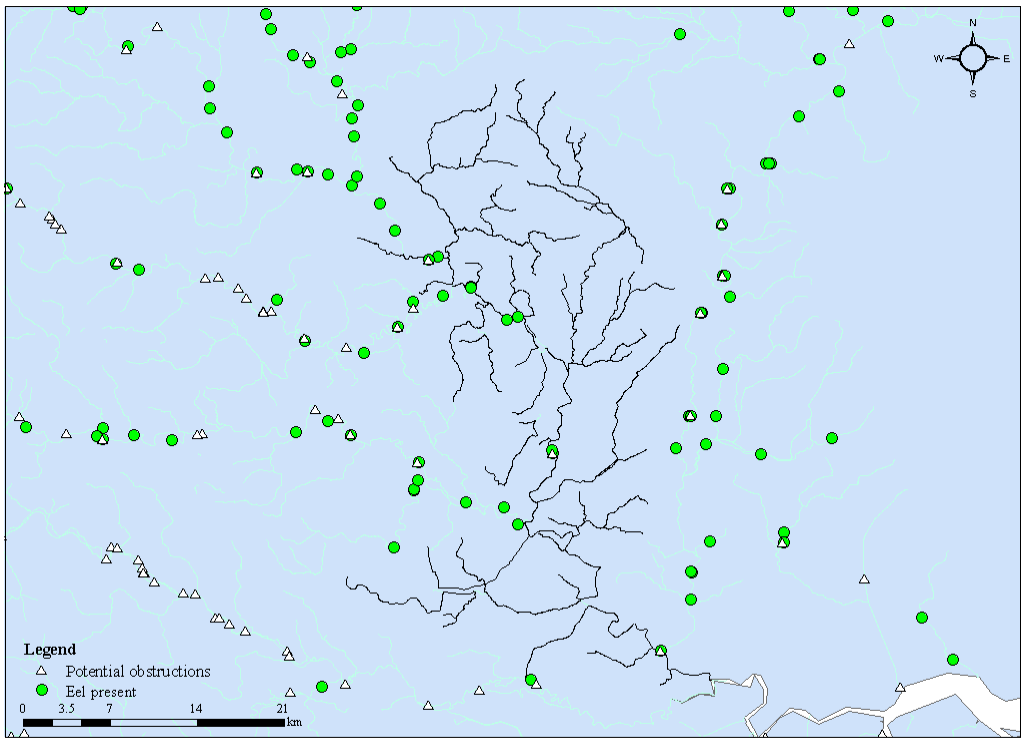

Fig. 2 The Yorkshire Ouse catchment, showing distributions of eel and potential migration barriers

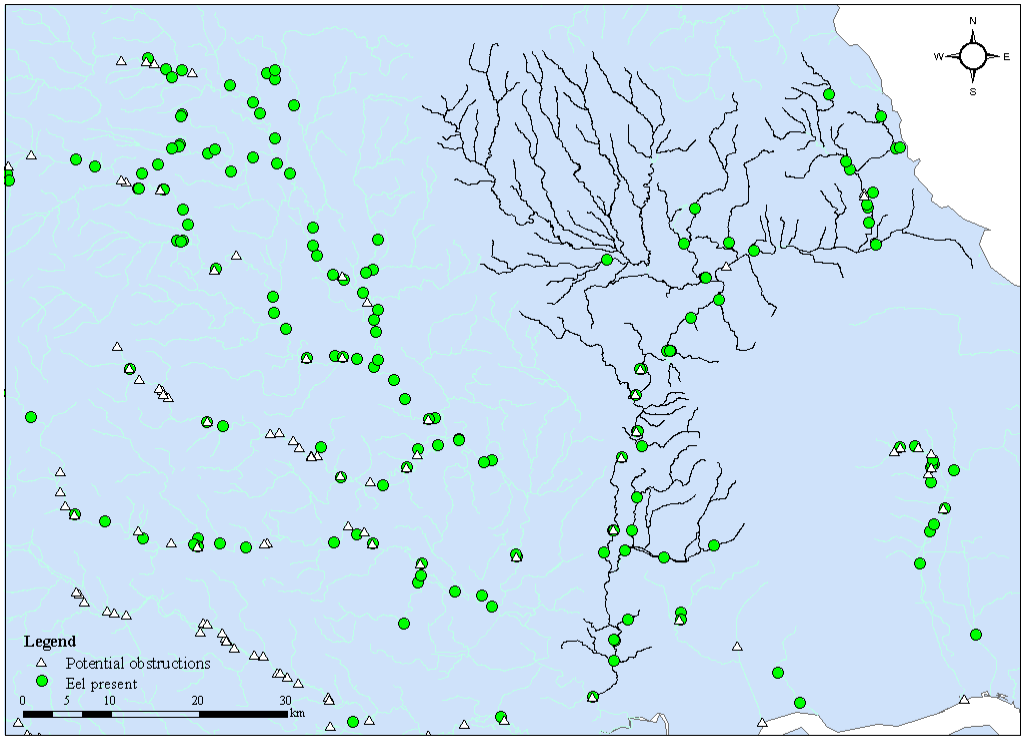

Fig. 3 The Yorkshire Derwent catchment, showing distributions of eel and potential migration barriers

Migrating eel that successfully pass the barrage then encounter a number of large weirs, including (moving in an upstream direction) those at Elvington (~52 km from estuary) (Plate 7), Stamford Bridge (~63 km from estuary) (Plate 8), Buttercrambe (~68 km from estuary) (Plate 9), Howsham (~74 km from estuary) (Plate 10) and Kirkham Abbey (~78 km from estuary) (Plate 11). Stamford Bridge Weir was identified as possibly the most significant barrier to migrating lampreys, reflected by the increasing dominance of single size classes of ammocoetes upstream (Harvey *et al*., 2006; Nunn *et al*., 2007a). There are fish passes on the weirs at Elvington (pool-and-weir), Stamford Bridge (Denil) and Kirkham Abbey (Denil), and navigation locks at Elvington and Stamford Bridge. The effectiveness of pool-and-weir fish passes for eel is usually poor (Clay, 1995), while Denil passes can be ascended if water velocities are reduced sufficiently (Baras *et al*., 1996). Passage through the navigation locks will depend upon either their operation coinciding with eel migration peaks or leakage (Tesch, 1977). Thus, **the first two *major* barriers most likely to impede eel migration in the Yorkshire Derwent are Barmby Barrage and Elvington Weir**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of eel passes, or sympathetic operation of the barrage at Barmby on the Marsh and adjustment of the existing pass at Elvington, would facilitate the upstream passage of eel and improve access to over 30 km of the main stem of the river, plus a number of tributaries. Similarly, adjustment of the existing pass at Stamford Bridge would be beneficial for eel, as well as other fish species and lampreys.

5.4 River Ure

The River Ure rises in the Pennines and flows in a south-easterly direction to the confluence of Ouse Gill Beck (NGR: SE 473 604), where it becomes known as the Yorkshire Ouse. Eel are present in the Ure as far upstream as Aysgarth (Bishopdale Beck, ~170 km from estuary), although population densities appear to be greatest in the lower reaches (Fig. 4), with the largest numbers recorded downstream of Boroughbridge Weir (P. Frear, pers. comm.). Eel ascending the Ure must first negotiate the weirs on the Yorkshire Ouse at Naburn and Linton-on-Ouse (Section 5.2). As mentioned previously, passage may be gained via the fish passes, over the weir sills during elevated flows, through the navigation locks or across land inundated during high flows.

The first three potential barriers on the Ure itself are the weirs at Boroughbridge (~2.5 m head-loss, ~102 km from estuary) (Plate 12), Westwick (Newby) (~1.5 m head-loss, ~108 km from estuary) (Plate 13) and West Tanfield (~2 m head-loss, ~127 km from estuary) (Plate 14). There is a pool-and-weir fish pass at Boroughbridge and a navigation bypass of approximately 1 km length. However, the effectiveness of pool-and-weir fish passes for eel is usually poor (Clay, 1995), and passage through the navigation locks will depend upon either their operation coinciding with eel migration peaks or leakage (Tesch, 1977). The relatively high numbers of eel below the weir compared with upstream may suggest it is a barrier, although it may simply be a reflection of differences in habitat and/or improved efficiency of electric fishing in the shallower water below the weir (P. Frear, pers. comm.). However, although adult anadromous lampreys pass this weir it appears they may be impeded in some years, possibly due to low flows (BEST, 2003; Harvey *et al*., 2006; Nunn *et al*., 2007a). The weir at Westwick has a Larinier fish pass, which are considered effective for eel (Armstrong, 1994), and there is also a navigation lock (~500 m long), but there is no fish pass or navigation lock at West Tanfield. Thus, **the first two *major* barriers most**

likely to impede eel migration in the River Ure are Boroughbridge Weir and West Tanfield Weir, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Although Boroughbridge Weir is equipped with a fish pass, it is likely to require some modification to encourage its use by eel. Installation of an eel pass at these weirs would facilitate the upstream passage of eel and improve access to almost 30 km of the main stem of the river, plus a number of tributaries.

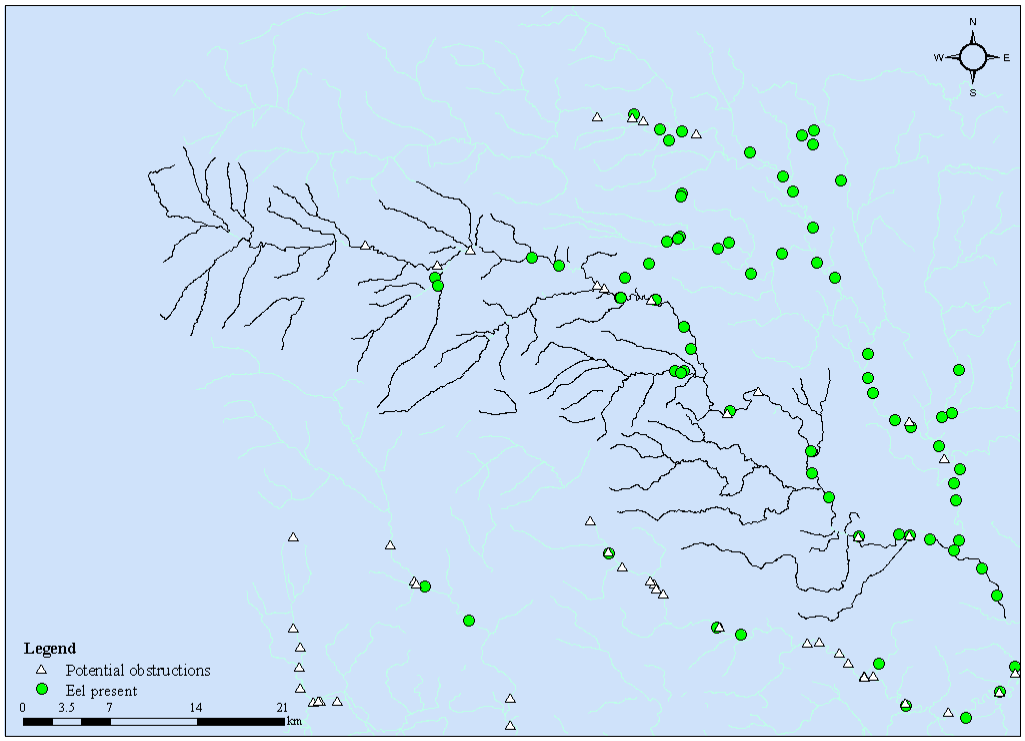

Fig. 4 The River Ure catchment, showing distributions of eel and potential migration barriers

5.5 River Swale

The River Swale joins the River Ure downstream of Boroughbridge, approximately 97 km from the Humber Estuary. Eel are present in the Swale as far upstream as Richmond Falls (~170 km from estuary), although population densities appear to be relatively low (Fig. 5; P. Frear, pers. comm.). Eel ascending the Swale must first negotiate the weirs on the Yorkshire Ouse at Naburn and Linton-on-Ouse (Section 5.2). As mentioned previously, passage may be gained via the fish passes, over the weir sills during elevated flows, through the navigation locks or across land inundated during high flows.

The Swale has fewer potential barriers to eel migration than the other large Ouse tributaries (i.e. Derwent, Ure, Nidd, Wharfe, Aire, Don). In addition, the Swale is prone to large and rapid fluctuations in river level, so opportunities to pass weirs may arise more frequently than in rivers with more stable discharge. Importantly perhaps, the Swale joins the Ure downstream of the large weir at Boroughbridge. The first three potential barriers on the Swale itself are the weirs at Crakehill (~1.5 m head-loss, ~110 km from estuary) (Plate 15) and Topcliffe (~2 m head-loss, ~116 km from estuary) (Plate 16), and the bridge at Catterick (~160 km from estuary) (Plate 17). Unlike the Ouse and Ure, the Swale is not navigable, so there are no locks bypassing the weirs. In

addition, neither Crakehill nor Topcliffe have fish passes on the weirs. The substratum beneath Catterick Bridge has been replaced by imprinted concrete, but it is only likely to pose a barrier at very low flows (K. Norton, pers. comm.), when the water flowing over the concrete is very shallow and fast-flowing. Thus, **the first two *major* barriers most likely to impede eel migration in the River Swale are Crakehill Weir and Topcliffe Weir**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of a suitable pass at these weirs would facilitate the upstream passage of eel, as well as other fish species and lampreys, and improve access to almost 60 km of the main stem of the river, plus a number of tributaries.

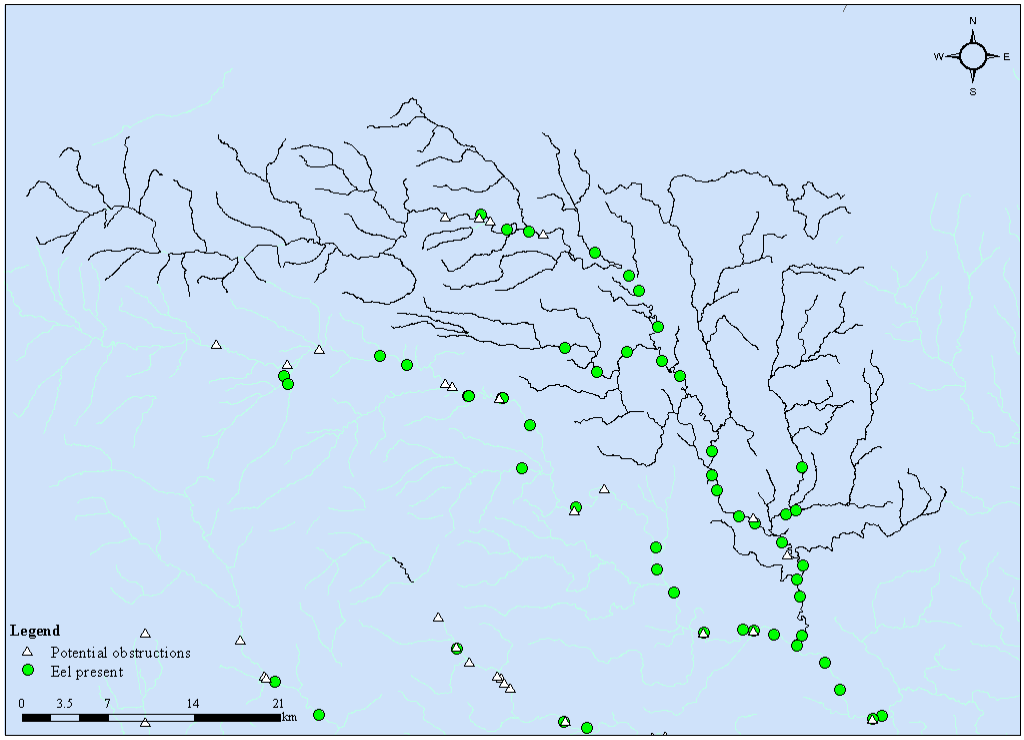

Fig. 5 The River Swale catchment, showing distributions of eel and potential migration barriers

5.6 River Nidd

The River Nidd joins the Yorkshire Ouse at Nun Monkton, approximately 82 km from the Humber Estuary. Eel are present in the Nidd at least as far upstream as Birstwith (~138 km from estuary), although densities are highest in the lower reaches of the river (Fig. 6; B. Byatt, pers. comm.). Eel ascending the Nidd must first negotiate the weir on the Yorkshire Ouse at Naburn (Section 5.2). As mentioned previously, passage may be gained via the fish pass, over the weir sill during elevated flows, through the navigation lock or across land inundated during high flows.

The weirs on the Nidd are generally smaller than those on the other large Ouse tributaries (i.e. Derwent, Swale, Ure, Wharfe, Aire, Don), although still substantial enough to restrict movements of fish (Lucas & Frear, 1997). The first five potential barriers on the Nidd itself are the weirs at Skip Bridge (~0.5 m head-loss, ~89 km from estuary) (Plate 18), Kirk Hammerton (<0.5 m head-loss, ~96 km from estuary) (Plate 19), Hunsingore (~1.5 m head-loss, ~104 km from estuary) (Plate 20), Ribston Hall

(<0.5 m head-loss, ~110 km from estuary) and Goldsborough (~1.5 m head-loss, ~116 km from estuary) (Plate 21). Although the original weir at Skip Bridge was removed, the secondary weir is still in place. As with the Swale, the Nidd is not navigable, so there are no locks bypassing the weirs. There is an easement fish pass on Skip Bridge Weir, although its effectiveness for eel is considered poor (B. Byatt, pers. comm.). There are no fish passes on Kirk Hammerton, Hunsingore, Ribston Hall and Goldsborough weirs, although the former is not considered a major barrier to eel due to its structure (boulder weir with shallow gradient) and small size, with passage possible in most flow conditions (B. Byatt, pers. comm.). Thus, **the first two *major* barriers most likely to impede eel migration in the River Nidd are Skip Bridge Weir and Hunsingore Weir**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Adjustment of the existing pass at Skip Bridge and installation of a suitable pass at Hunsingore would facilitate the upstream passage of eel, as well as other fish species and lampreys, and improve access to over 20 km of the main stem of the river, plus a number of tributaries.

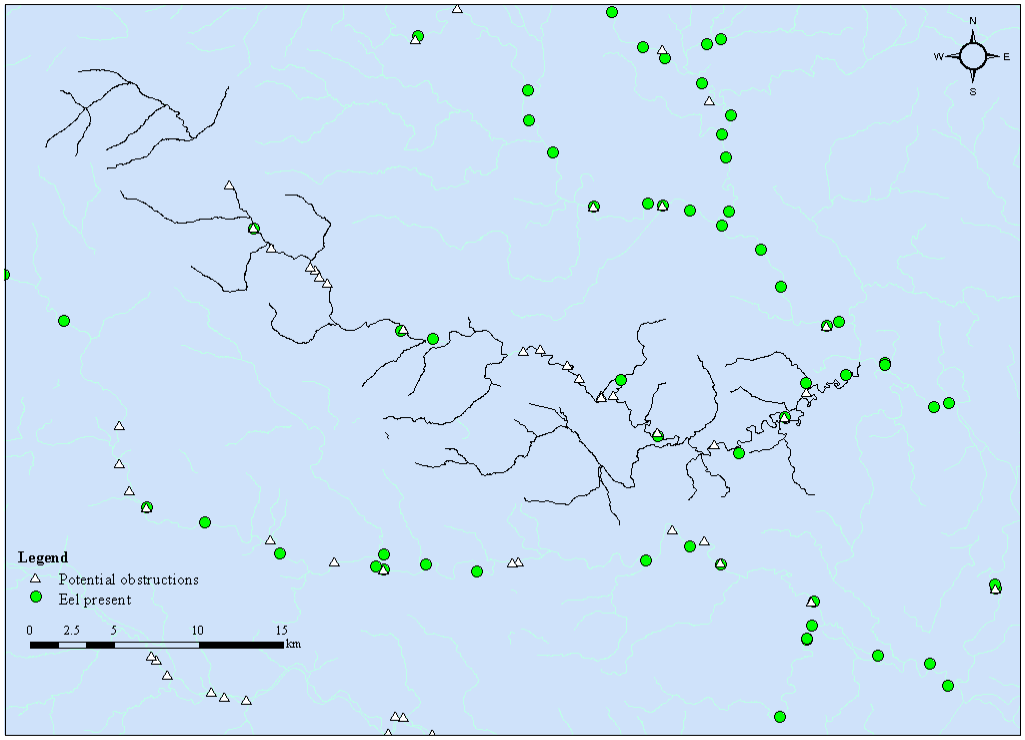

Fig. 6 The River Nidd catchment, showing distributions of eel and potential migration barriers

5.7 River Wharfe

The River Wharfe joins the Yorkshire Ouse near Cawood, approximately 53 km from the Humber Estuary. Eel are present throughout most of the Wharfe (Fig. 7; B. Byatt, pers. comm.) and, indeed, there is a licensed eel fishery on the lower reaches (EA, unpublished data). In addition, eel form an important part of angler catches on the river (EA, unpublished data). Eel enter the Wharfe directly from the tidal Ouse, and are able to migrate upstream without restriction until they reach the weir at Tadcaster (~2 m head-loss, ~68 km from estuary) (Plate 22). The next potential barriers are the weirs at Boston Spa (~2 m head-loss, ~78 km from estuary) (Plate 23), Flint Mill (~2 m head-

loss, ~81 km from estuary) (Plate 24) and Wetherby (~2 m head-loss, ~84 km from estuary) (Plate 25).

The Wharfe is not navigable, so there are no locks bypassing the weirs. There is a fish pass on the weirs at Tadcaster (Alaskan A Denil), Flint Mill (pool-and-weir) and Wetherby (pool-and-weir), but there is no pass at Boston Spa. The effectiveness of pool-and-weir fish passes for eel is usually poor (Clay, 1995), while Denil passes can be ascended if water velocities are reduced sufficiently (Baras *et al*., 1996). Thus, **the first two *major* barriers most likely to impede eel migration in the River Wharfe are Tadcaster Weir and Boston Spa Weir**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Adjustment of the existing pass at Tadcaster and installation of a suitable pass at Boston Spa would be beneficial for migrating eel, as well as other fish species and lampreys, and improve access to over 10 km of the main stem of the river, plus a number of tributaries.

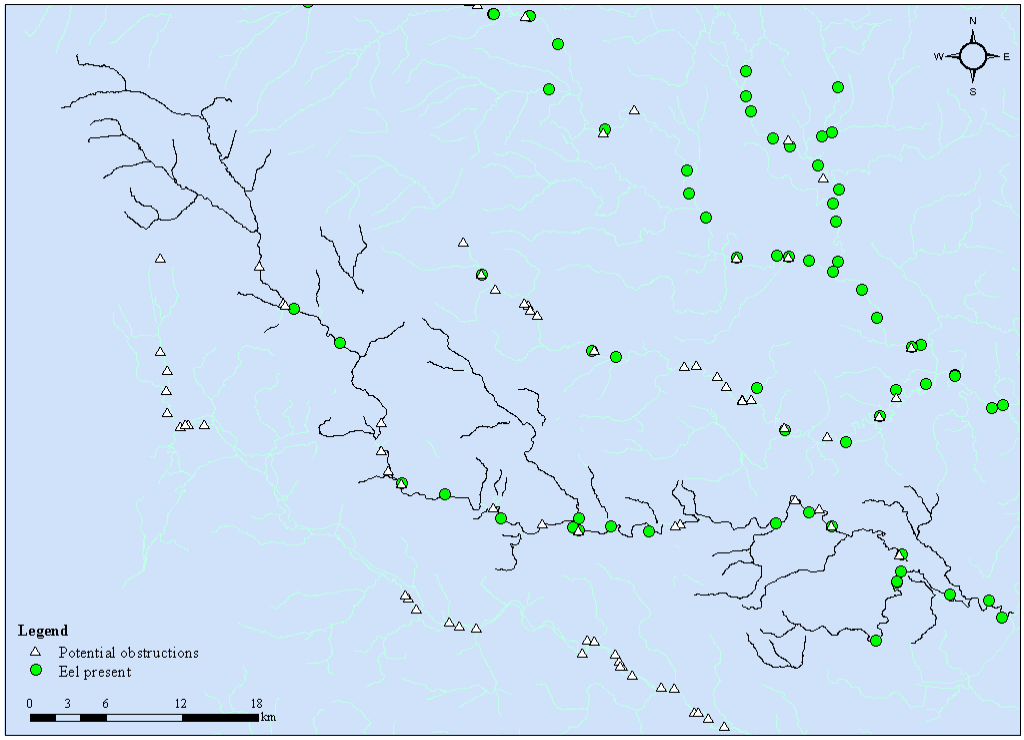

Fig. 7 The River Wharfe catchment, showing distributions of eel and potential migration barriers

5.8 River Trent

The River Trent drains the south-west of the Humber catchment, and joins with the Yorkshire Ouse at Trent Falls to form the Humber Estuary. The distribution of eel in the Trent catchment is skewed towards the tidal reaches and the upper catchment, with comparatively few records for the middle reaches and the rivers Dove, Derwent, Soar and Erewash (Fig. 8). Many of the records for the upper catchment probably originate from the stocking of elvers in the mid-1980s and in 1990 (EA, unpublished data). However, eel are common in some watercourses discharging into the tidal river (Carpenter, 1982; Whitton & Lucas, 1997; Jacklin, 2006). Indeed, there is a licensed eel

fishery on the lower reaches of the Trent (EA, unpublished data), and the species also features in angler catches on the river (Cooper & Wheatley, 1981; Cowx & Broughton, 1986; Cowx, 1991). Eel enter the Trent directly from the Humber Estuary, and are able to migrate upstream without restriction until they reach the weir at Cromwell (~3 m head-loss, ~80 km from estuary) (Plate 26). Passage may be gained over the weir sill during elevated flows or at high tides, through a navigation lock (~300 m long) or via a pool-and-weir fish pass, although its effectiveness is considered poor (Cowx & O'Grady, 1995; T. Jacklin, pers. comm.). Passage through the navigation lock will depend upon either its operation coinciding with eel migration peaks or leakage (Tesch, 1977).

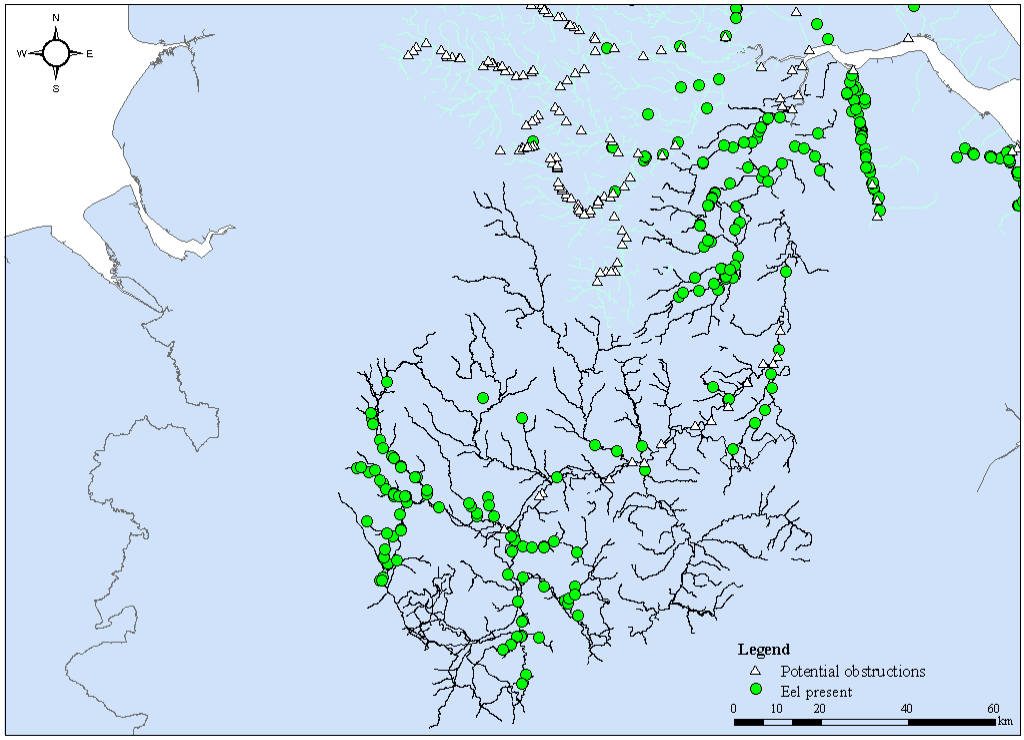

Fig. 8 The River Trent catchment, showing distributions of eel and potential migration barriers

The next potential barriers are the weirs at Nether Lock (~2 m head-loss, ~87 km from estuary) (Plate 27), Averham (~2 m head-loss, ~91 km from estuary) (Plate 28), Newark (~2 m head-loss, ~89 km from estuary) (Plate 29), Hazelford (~2 m head-loss, ~103 km from estuary) (Plate 30), Gunthorpe (~2 m head-loss, ~111 km from estuary) (Plate 31), Stoke Bardolph (~2 m head-loss, ~119 km from estuary) (Plate 32), Holme Sluices (~4 m head-loss, ~124 km from estuary) (Plate 33), Beeston (~2.5 m head-loss, ~135 km from estuary) (Plate 34), Thrumpton (~2 m head-loss, ~143 km from estuary) (Plate 35) and Sawley (~1.5 m head-loss, ~147 km from estuary) (Plate 36). The weirs at Nether Lock, Averham and Newark are located in approximately the same locality as one another (near Newark), but Averham Weir is on a different branch of the river. Holme Sluices (canoe slalom) and Beeston Weir (Denil) have a fish pass, and all but Averham have navigation bypass channels.

Thus, **the first two *major* barriers most likely to impede eel migration in the River Trent are the weirs at Cromwell Lock and Averham**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential

obstructions. Although the weir at Averham was considered less of a barrier to eel than that at Nether Lock, the former was prioritised due to the greater quantity of habitat available upstream (i.e. it is ~2 km to the next obstruction upstream of Newark, whereas it is ~10 km to the next obstruction upstream of Averham). Although the weir at Cromwell is equipped with a fish pass, this will require some modification to encourage its use by eel. Installation of a suitable pass at Cromwell and Averham weirs would facilitate the upstream passage of eel, as well as other fish species and, potentially, lampreys, and improve access to over 20 km of the main stem of the river. However, **the benefits of installing passes on only the two most downstream barriers on the Trent are limited because the river and its tributaries are systematically impounded throughout their lengths; for the Trent, a catchment-wide approach to improving access is required, including consideration of the barriers between Cromwell and Sawley weirs**. In addition, it should be noted that many tributaries in the lower Trent catchment, including the rivers Torne, Eau, Idle, Ryton, Poulter and Maun, contain good stocks of eel, but are not included in this report. However, they may represent important refuges for eel and should be given due consideration in the Humber Eel Management Plan.

5.9 River Don

The River Don joins the Yorkshire Ouse near Goole, approximately 14 km from the Humber Estuary. Eel populations in the River Don are substantially poorer than in many of the other major rivers in the Humber catchment. Poor water quality was a major problem historically (Firth, 1997; Amisah & Cowx, 2000a, b), but physical migration barriers may now be a more important issue. The species is present in low densities in the river between Rotherham and Doncaster (Harvey *et al*., 2004), although there are few records upstream of the confluence of the River Dearne (Fig. 9). A single eel was captured from the River Rivelin, a tributary of the upper Don, in 2003 (EA, unpublished). Eel enter the Don directly from the tidal Yorkshire Ouse, and are able to migrate upstream without physical obstruction until they reach Crimpsall Sluice (~2 m head-loss, ~46 km from estuary) (Plate 37). There is a rock chute fish pass at Crimpsall that is considered suitable for use by eel (N. Trudgill, pers. comm.), and a navigation bypass channel is also a potential route upstream.

The next potential physical obstructions are the weirs at Sprotbrough (~2 m head-loss, ~51 km from estuary) (Plate 38), Thrybergh (~2 m head-loss, ~64 km from estuary) (Plate 39), Aldwarke (~2 m head-loss, ~68 km from estuary) (Plate 40), Masbrough (~2 m head-loss, ~72 km from estuary) (Plate 41) and Ickles (~2 m head-loss, ~74 km from estuary). Navigation locks are a possible route past all five weirs, although passage will depend upon either their operation coinciding with eel migration peaks or leakage (Tesch, 1977). In addition, Thrybergh Weir is equipped with an Alaskan A Denil fish pass, which are suitable for eel if water velocities are reduced sufficiently (Baras *et al*., 1996), and a rock chute fish pass is planned for Ickles Weir (N. Trudgill, pers. comm.). Notwithstanding, **the first two *major* barriers most likely to impede eel migration in the River Don are Sprotbrough Weir and Thrybergh Weir**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of an eel pass at Sprotbrough and modification of the existing pass at Thrybergh would facilitate the upstream passage of eel and improve access to approximately 20 km of the rivers Don and Dearne. However, **the benefits of installing passes on only the two most downstream barriers are limited as the Don**

and its tributaries are systematically impounded throughout their lengths. Nonetheless, the quality and quantity of eel habitat downstream of Rotherham is such that improving passage at Sprotbrough and Thrybergh would be beneficial.

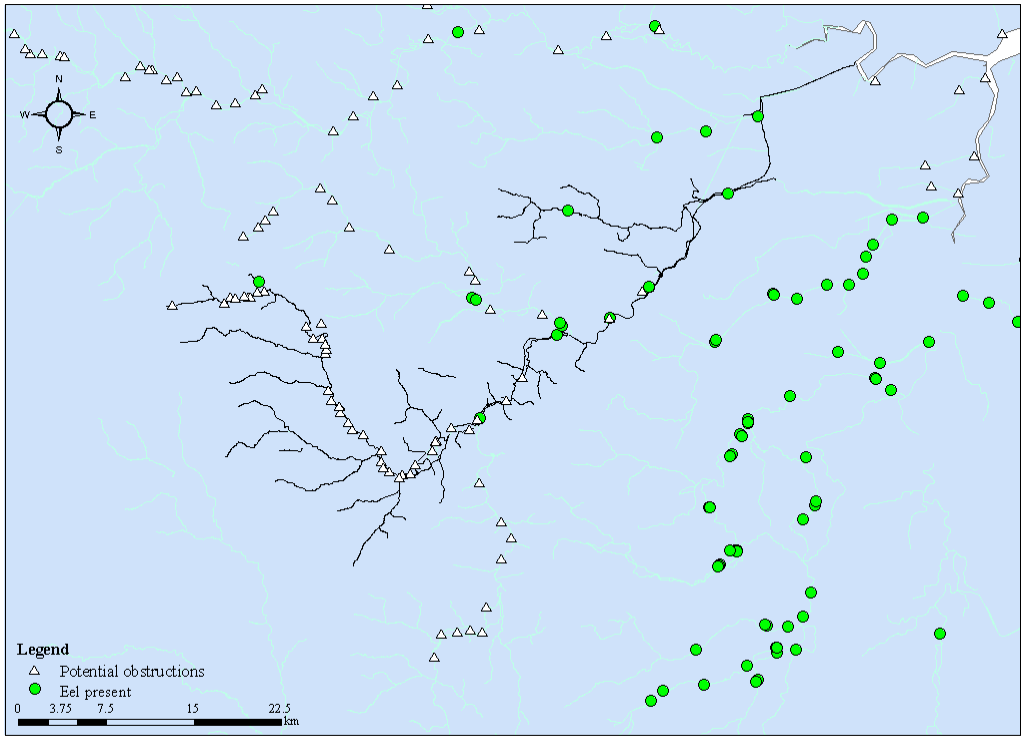

Fig. 9 The River Don catchment, showing distributions of eel and potential migration barriers

5.10 River Rother

The River Rother joins the River Don near Rotherham, approximately 73 km from the Humber Estuary. Eel appear to be absent from the Rother (Fig. 10). Poor water quality was a major problem historically (Firth, 1997; Amisah & Cowx, 2000a, b), but physical migration barriers may now be a more important issue. Eel ascending the Rother must first negotiate the weirs/sluices on the River Don at Crimpsall, Sprotbrough, Thrybergh, Aldwarke and Masbrough. As mentioned previously (Section 5.9), eel are able to pass Crimpsall via the rock chute, but the weirs at Sprotbrough, Thrybergh, Aldwarke and Masbrough may pose significant barriers to upstream migration.

The first four potential physical barriers on the River Rother itself are the weirs at Orgreave (~2 m head-loss, ~80 km from estuary) (Plate 42), Beighton (~1.5 m head-loss, ~85 km from estuary) (Plate 43), Rother Valley Country Park (~1 m head-loss, ~87 km from estuary) (Plate 44) and Killamarsh (~1.5 m head-loss, ~90 km from estuary) (Plate 45). There is a rock chute fish pass at Orgreave that is considered suitable for use by eel (N. Trudgill, pers. comm.), but the weirs at Beighton, Rother Valley Country Park and Killamarsh may pose significant a significant barrier (C. Firth, pers. comm.). Thus, **the first two *major* barriers most likely to impede eel migration in the River Rother are Beighton Weir and Rother Valley Country Park Weir**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of an eel pass at these weirs would facilitate the upstream passage of eel and improve access to almost 4 km of the main stem of the

river. However, no action should be considered on the Rother barriers until passage problems on the River Don at Sprotbrough, Thrybergh, Aldwarke and Masbrough have been resolved.

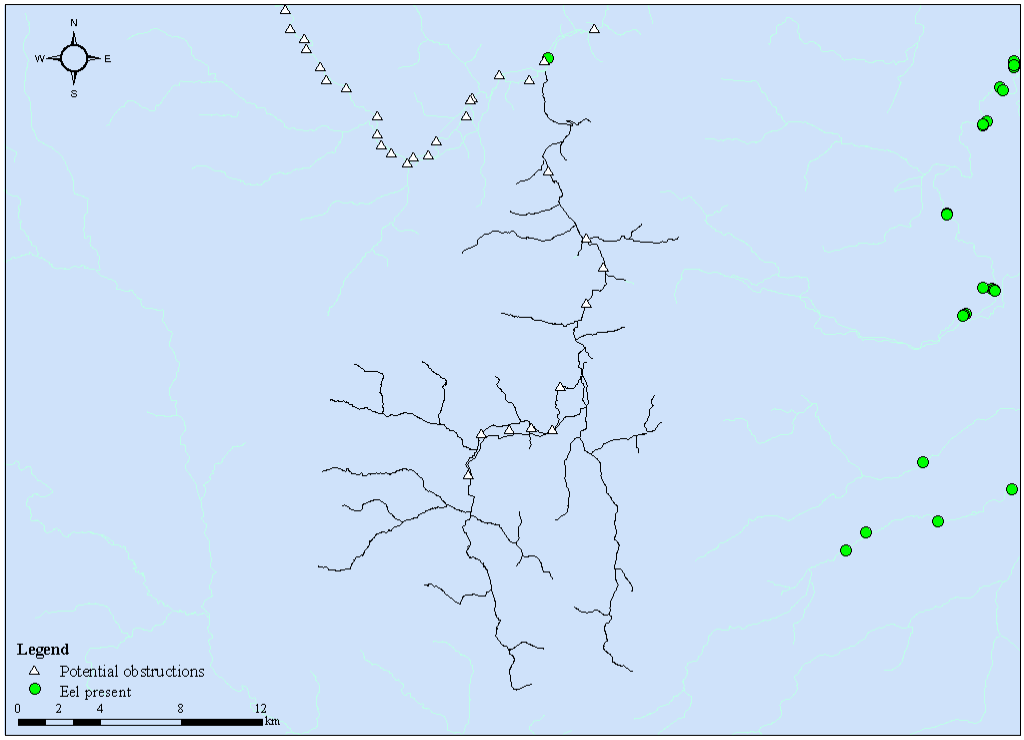

Fig. 10 The River Rother catchment, showing distributions of eel and potential migration barriers

5.11 River Dearne

The River Dearne joins the River Don near Conisbrough, approximately 56 km from the Humber Estuary. Eel appear to be present in only very small numbers in the River Dearne (Fig. 11). Poor water quality was a major problem historically (Firth, 1997; Amisah & Cowx, 2000a, b), but physical migration barriers may now be a more important issue. Eel ascending the Dearne must first negotiate the weirs/sluices on the River Don at Crimpsall and Sprotbrough. As mentioned previously (Section 5.9), eel are able to pass Crimpsall via the rock chute, but the weir at Sprotbrough may pose a significant barrier to upstream migration.

The first four potential physical barriers on the River Dearne itself are the weir at Adwick upon Dearne (~1.5 m head-loss, ~59 km from estuary) (Plate 46), the flood barrier at Wath (~64 km from estuary) and the weirs at Darfield (Middlewood Park) (~1 m head-loss, ~68 km from estuary) (Plate 47) and Little Houghton (~3 m head-loss, ~69 km from estuary) (Plate 48). The flood barrier is only an obstruction when closed (infrequent), but the weirs may pose a significant barrier (C. Firth, pers. comm.). Thus, **the first two *major* barriers most likely to impede eel migration in the River Dearne are the weirs at Adwick upon Dearne and Darfield**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of an eel pass at these weirs would facilitate the upstream passage of eel and improve access to almost 10 km of the main stem of the

river. However, no action should be considered on the Dearne barriers until passage problems on the River Don at Sprotbrough have been resolved.

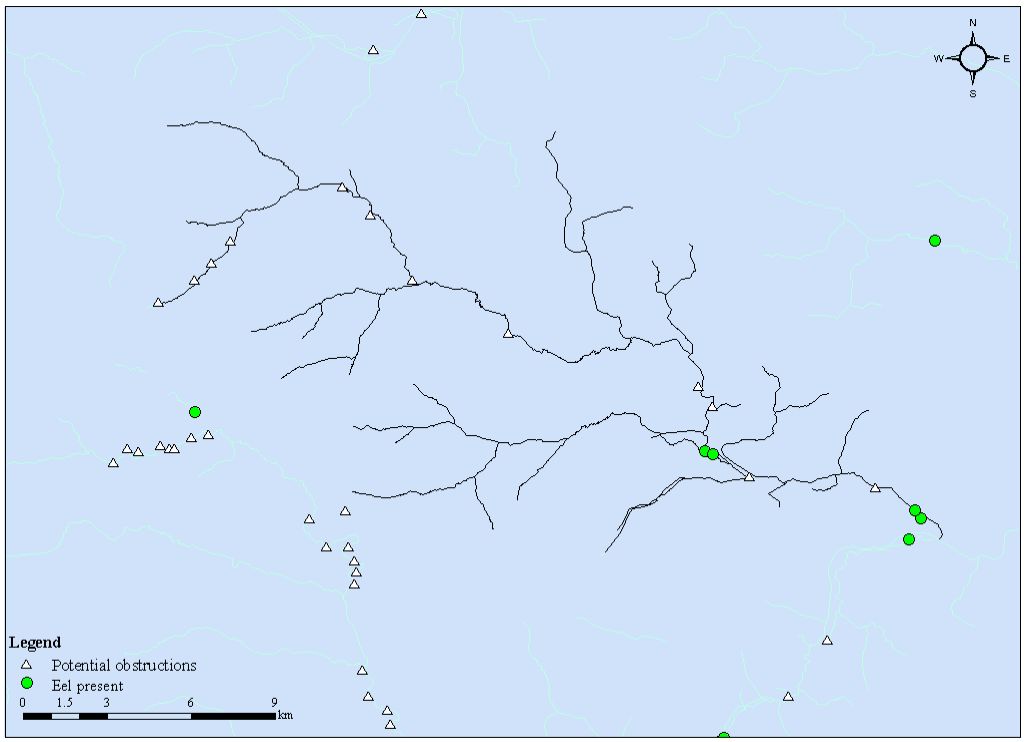

Fig. 11 The River Dearne catchment, showing distributions of eel and potential migration barriers

5.12 River Aire

The River Aire joins the Yorkshire Ouse near Airmyn, approximately 23 km from the Humber Estuary. Very few eel have been recorded from the River Aire (Fig. 12), probably due to physical migration barriers, with a number of the records probably originating from small-scale stocking events (EA, unpublished data). Eel enter the Aire directly from the tidal Ouse, and are able to migrate upstream without physical obstruction until they reach the weir at Chapel Haddlesey (~1.5 m head-loss, ~48 km from estuary) (Plate 49). The next potential barriers are the weirs at Beal (~1 m head-loss, ~55 km from estuary) (Plate 50), Knottingley (~2 m head-loss, ~61 km from estuary) (Plate 51) and Castleford (~2 m head-loss, ~71 km from estuary) (Plate 52).

None of the weirs have a fish pass, although a Larinier pass with a bristle section is planned for Castleford Weir in 2007 (N. Trudgill, pers. comm.). Navigation locks are a possible route past all four weirs, although passage will depend upon either their operation coinciding with eel migration peaks or leakage (Tesch, 1977). Thus, **the first two *major* barriers most likely to impede eel migration in the River Aire are the weirs at Chapel Haddlesey and Beal**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of an eel pass at these weirs would facilitate the upstream passage of eel and improve access to over 13 km of the main stem of the river. However, **the benefits of installing passes on only the two most downstream barriers are limited as the Aire and its tributaries are systematically impounded throughout their lengths.**

Nonetheless, the quality and quantity of eel habitat in the lower reaches of the Aire is such that improving passage at Chapel Haddlesey and Beal would be beneficial.

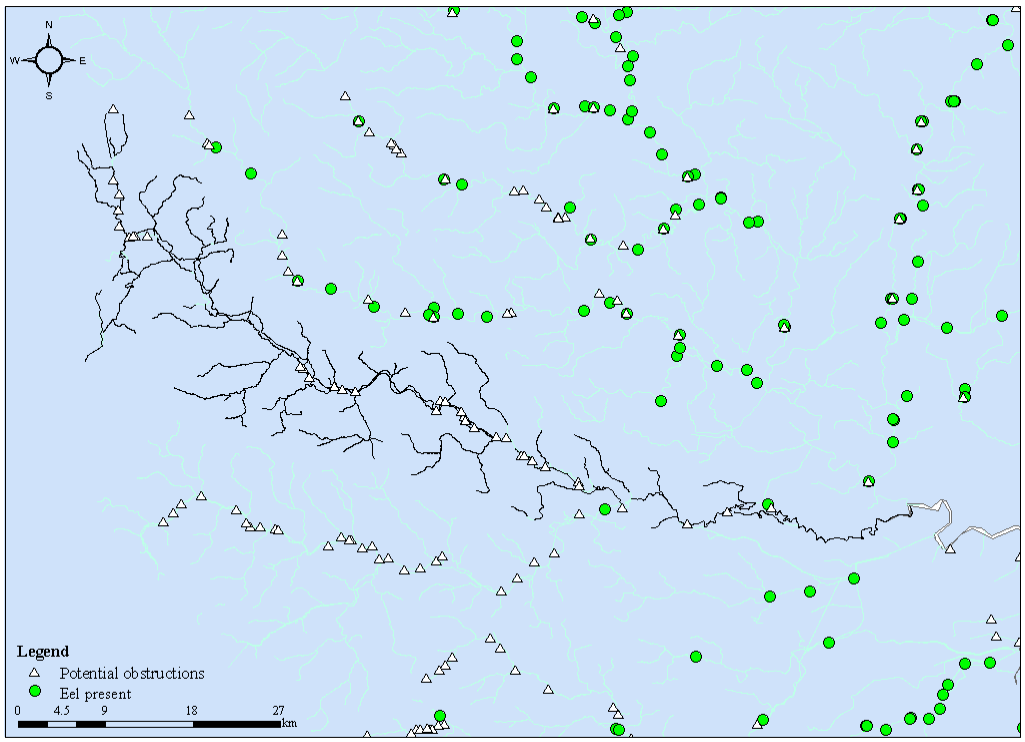

Fig. 12 The River Aire catchment, showing distributions of eel and potential migration barriers

5.13 River Calder

The River Calder joins the River Aire near Castleford, approximately 72 km from the Humber Estuary. Very few eel have been recorded from the Calder (Fig. 13), probably due to physical migration barriers, with the only record restricted to a single fish probably originating from small-scale stocking events (EA, unpublished data). Eel ascending the Calder must first negotiate the weirs on the River Aire at Chapel Haddlesey, Beal, Knottingley and Castleford (Section 5.12). None of these weirs have fish passes, although a Larinier pass with a bristle section is planned for Castleford Weir in 2007, but navigation locks are a potential route upstream (Section 5.12).

The first three potential physical barriers on the River Calder itself are the weirs at Methley (Penbank) (~1.5 m head-loss, ~77 km from estuary) (Plate 53), Kirkthorpe (~2.5 m head-loss, ~88 km from estuary) (Plate 54) and Wakefield (Chantry Bridge) (~2 m head-loss, ~91 km from estuary) (Plate 55). None of the weirs have a fish pass, although navigation locks are a potential route upstream (Tesch, 1977). However, Methley is not considered a *major* barrier to eel due to its structure (boulder weir with shallow gradient) (N. Trudgill, pers. comm.). Thus, **the first two *major* barriers most likely to impede eel migration in the River Calder are the weirs at Kirkthorpe and Wakefield**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of an eel pass at these weirs would facilitate the upstream passage of eel and improve access to over 6 km of the main stem of the river. However, no action should be considered on the Calder

barriers until passage problems on the River Aire at Chapel Haddlesey, Beal, Knottingley and Castleford have been resolved.

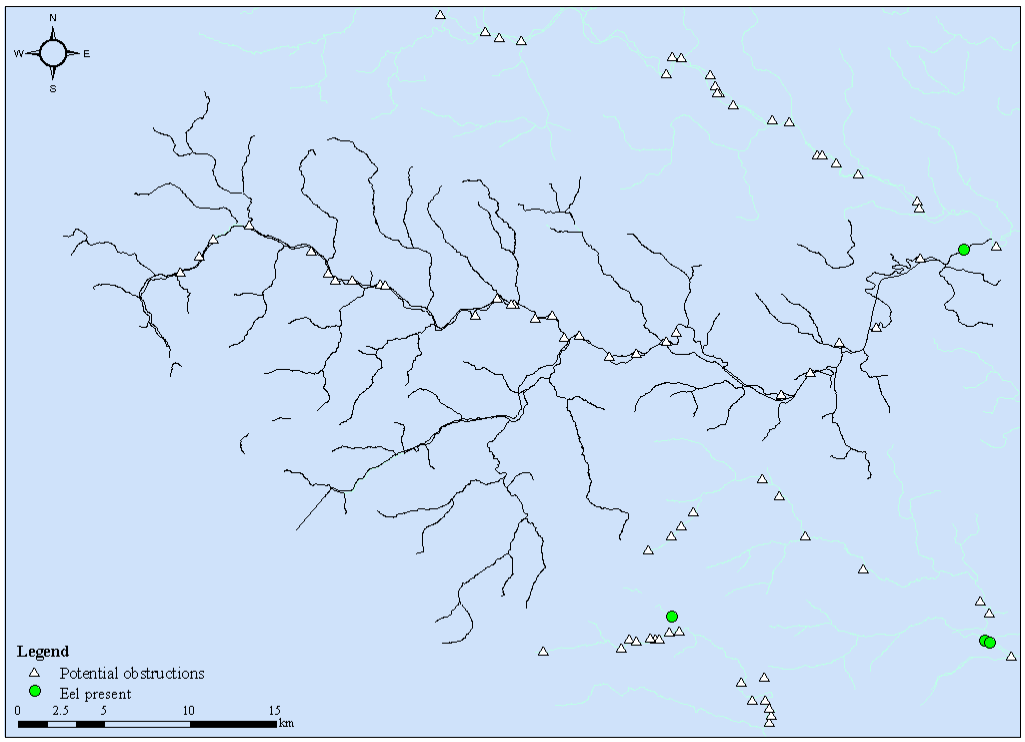

Fig. 13 The River Calder catchment, showing distributions of eel and potential migration barriers

5.14 River Ancholme

Eel are present throughout most of the River Ancholme (Fig. 14) and, indeed, there is a licensed eel fishery on the lower reaches (Firth, 2001). Eel enter the Ancholme, on the south bank of the estuary, directly from the Humber, but can be impeded by the presence of a tidal barrier near South Ferriby (Plate 56) (Firth, 2001). The barrier is used to hold back water during periods of low flow and to control the ingress of saline water from the estuary. Even when partially open, the high velocity of water leaving the river may prevent immigration of eel (Firth, 2001).

The next potential obstructions are the weirs at Harlam Hill (~1.5 m and <0.5 m head-loss, ~27 km from estuary) (Plates 57 & 58), Bishopbridge (~0.5 m head-loss, ~31 km from estuary) (Plate 59) and Toft Newton (~1 m head-loss, ~36 km from estuary) (Plate 60). None of the weirs have a fish pass, but a navigation lock is a potential route past the Harlam Hill Weirs. Thus, **the first two *major* barriers most likely to impede eel migration in the River Ancholme are the tidal barrier at South Ferriby and the downstream weir at Harlam Hill**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of an eel pass at these barriers would facilitate the upstream passage of eel and improve access to over 30 km of the main stem of the river.

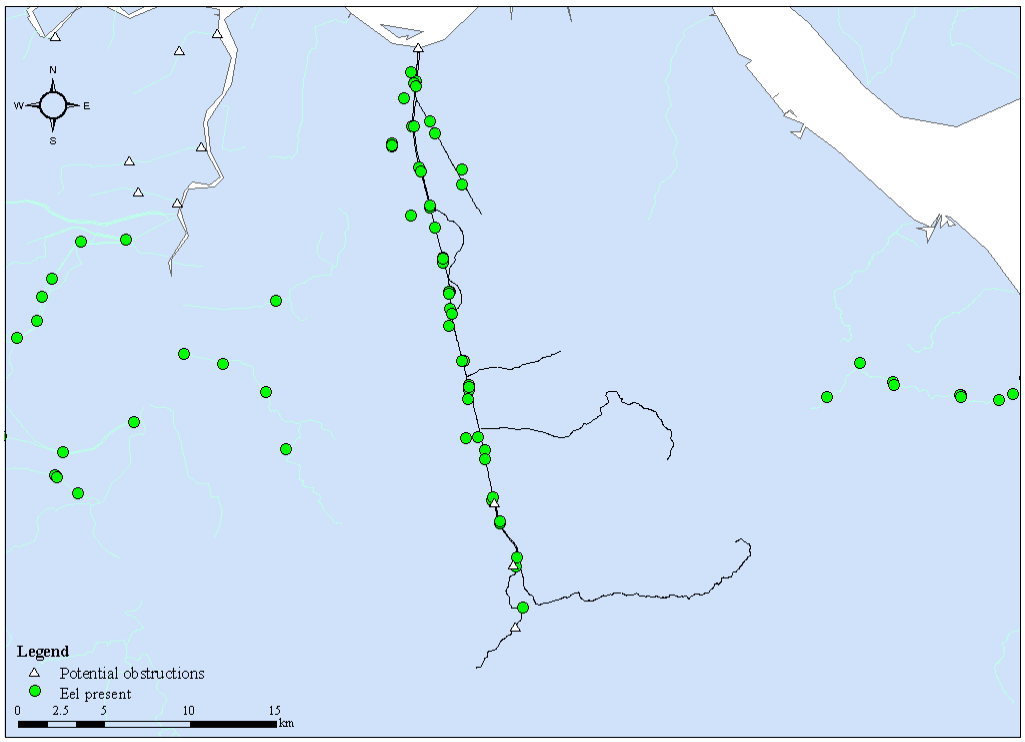

Fig. 14 The River Ancholme catchment, showing distributions of eel and potential migration barriers

5.15 River Foulness/Market Weighton Canal

Eel are present throughout most of the River Foulness/Market Weighton Canal (Fig. 15), and form an important part of angler catches on the system (Firth, 2001). Eel enter the watercourse, on the north bank of the estuary, directly from the Humber, but can be impeded by the presence of a tidal barrier on the estuary at Weighton Lock (Plate 61), near Broomfleet (Firth, 2001). Indeed, repairs to the tidal barrier in the early 1990s were followed by a reported decline in eel numbers in the system suggesting the tidal barrier may be a problem, but this may have been coincidence as similar declines were also reported elsewhere (Firth, 2001).

The next two potential obstructions are Sodhouse Lock (disused) (Plate 62) on the canal near Wholsea Grange (~9 km from estuary) and a gauging weir (~0.5 m head-loss) on the river itself near Holme House (~19 km from estuary) (Plate 63). The gauging weir may pose a significant barrier at low flows, but Sodhouse Lock has recently been fitted with a Larinier fish pass that includes a bristle section, so should no longer be a problem (A. Mullinger, pers. comm.). Thus, **the first two *major* barriers most likely to impede eel migration in the River Foulness/Market Weighton Canal are the tidal barrier at Weighton Lock and the gauging weir near Holme House**, based upon their comparatively high obstruction scores (Table 6) and their location downstream of other potential obstructions. Installation of an eel pass at these barriers would facilitate the upstream passage of eel and improve access to over 20 km of the main stem of the river.

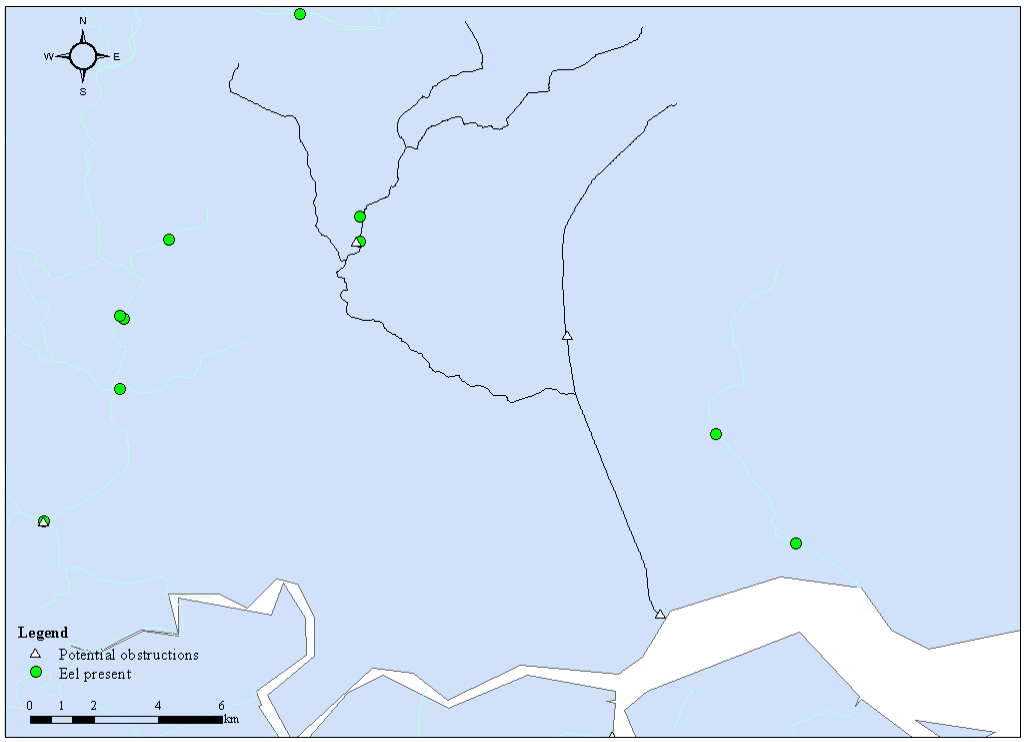

Fig. 15 The River Foulness catchment, showing distributions of eel and potential migration barriers

5.16 Swinefleet Warping Drain

It is unknown whether eel are present in Swinefleet Warping Drain as no surveys have been conducted, although habitat quality is considered suitable for the species (Firth, 2001). Eel are presumably able to enter the watercourse from the tidal Ouse at Swinefleet (~11 km from estuary), but may be impeded by the flapped outfall (Plate 64) (Firth, 2001). There appear to be no further barriers on the drain. However, the natural acidity of the catchment (Thorne Moors) probably restricts the fisheries potential of the drain, although the water quality should be suitable for eel (Firth, 2001). Thus, **the only *major* barrier likely to impede eel migration in Swinefleet Warping Drain is the flapped outfall at Swinefleet** (Table 6). Installation of an eel pass at this barrier would facilitate the upstream passage of eel and improve access to the entire Swinefleet Warping Drain catchment (~8 km of drain).

5.17 Tetney Haven

Eel are present throughout the Tetney Haven catchment (Fig. 16). Eel enter the watercourse, on the south bank of the estuary, directly from the Humber, but may be impeded at high tide by the presence of a tidal barrier on the estuary near Stonebridge Farm (Plate 65) (Firth, 2001). However, access throughout the remainder of the tidal cycle should not be problematic (Firth, 2001). The next potential barriers are the weirs Tetney Lock (~1 km from estuary) (Plate 66) and Alvingham (~12 km from estuary) (Plate 67). Thus, **the first two *major* barriers most likely to impede eel migration in Tetney Haven are the tidal barrier near Stonebridge Farm and the weir at Tetney Lock** (Table 6). Installation of an eel pass at these barriers would facilitate the upstream passage of eel and improve access to almost 13 km of the main stem of the system.

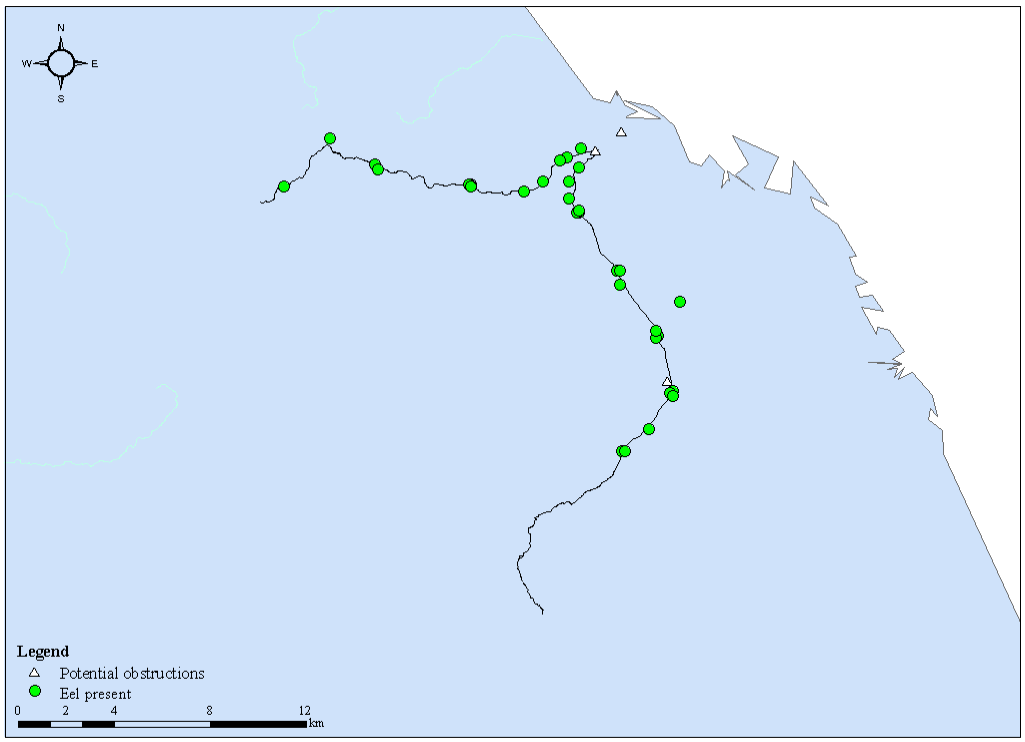

Fig. 16 The Tetney Haven catchment, showing distributions of eel and potential migration barriers

5.18 Adlingfleet Drain

It is unknown whether eel are present in Adlingfleet Drain as no surveys have been conducted, although habitat is considered suitable for the species (Firth, 2001). Eel are presumably able to enter the watercourse from the tidal Trent at Adlingfleet (~1 km from estuary), but may be impeded by the flapped outfall (Plate 68) (Firth, 2001). The next potential barrier is the sluice and pumping station at Cow Lane (~4 km from estuary) (Plate 69), but there appear to be no further barriers thereafter. However, there are possible water quality issues as the watercourse drains part of the reclaimed Don saltmarsh, with low pH and high metal concentrations a potential problem (Firth, 2001). Indeed, there were signs of poor water quality (i.e. discolouration of the water due to the presence of ochre) on a site visit in March 2007. Thus, **the only two *major* barriers likely to impede eel migration in Adlingfleet Drain are the flapped outfall near Adlingfleet and the sluice and pumping station at Cow Lane** (Table 6). Installation of an eel pass at these barriers would facilitate the upstream passage of eel and improve access to the entire Adlingfleet Drain catchment (~7 km of drain).

5.19 Pauper's Drain

It is unknown whether eel are present in Pauper's Drain as few surveys have been conducted, although habitat is considered suitable for the species (Firth, 2001). Eel are presumably able to enter the watercourse from the tidal Trent near Luddington (~9 km from estuary), but are likely to be impeded by the flapped and pumped outfall (Plate 70) (Firth, 2001). The next potential barrier is a sluice near Pademoor (~14 km from estuary), but there appear to be no further barriers thereafter. However, there may be water quality issues relating to the drainage of reclaimed areas of saltmarsh, which can

cause episodes of low pH and elevated metal concentrations, although the water quality should be suitable for eel (Firth, 2001). Thus, **the only two *major* barriers likely to impede eel migration in Pauper's Drain are the flapped and pumped outfall near Luddington and the sluice near Pademoor** (Table 6). Installation of an eel pass at these barriers would facilitate the upstream passage of eel and improve access to the entire Pauper's Drain catchment (~10 km of drain).

5.20 Bosky Dyke (Keadby Warping Drain)

Eel were present in reasonable numbers in Bosky Dyke (Keadby Warping Drain) in the early 1980s (Carpenter, 1982), but no surveys have been conducted since. Eel enter the watercourse from the tidal Trent at Keadby (~14 km from estuary), but may be impeded by the flapped outfall (Plate 71) (Firth, 2001). The next potential barrier is a sluice near Keadby (~17 km from estuary) (Plate 72), but there appear to be no further barriers thereafter. Thus, **the only two *major* barriers likely to impede eel migration in Bosky Dyke (Keadby Warping Drain) are the flapped outfall and a sluice near Keadby** (Table 6). Installation of an eel pass at these barriers would facilitate the upstream passage of eel and improve access to the entire Bosky Dyke (Keadby Warping Drain) catchment (~5 km of drain).

6. PRIORITISATION OF ELVER STOCKING AREAS

Throughout this section the potential for stocking is assessed against eel stock status, habitat availability, the abundance of conservation species and the presence/absence of non-native crayfish (see Section 4.2). Note, the rivers Hull, Swale, Nidd, Wharfe and Foulness/Market Weighton Canal were not considered for stocking, as instructed by the Environment Agency, due to the existence of established eel populations. All stocking activities should follow the guidance of Williams & Aprahamian (2004).

6.1 Yorkshire Ouse

Eel are present throughout the Yorkshire Ouse (Section 5.2; Whitton & Lucas, 1997) and, indeed, there is a licensed eel fishery (Masters *et al*., 2006; EA, unpublished data). By contrast, although anadromous salmonids migrate through the Ouse to spawning grounds upstream, there do not appear to be large resident populations in the Ouse itself (Figs 17 & 18; Axford, 1991). Similarly, although lampreys have been recorded throughout the Yorkshire Ouse (Fig. 19; Vesey, 2004; Bradbury, 2005; Masters *et al*., 2006), there are unlikely to be large resident populations. The exception may be lamprey ammocoetes, as the Ouse appears to have an abundance of suitable ammocoete habitat, although this has yet to be verified through targeted surveys (Harvey *et al*., 2006). However, ammocoetes have been captured in micromesh seine nets from Linton downstream to Naburn (HIFI, unpublished data).

Although present, bullhead are only a minor component of the fish community in the Yorkshire Ouse, and spined loach are absent (Fig. 20; Nunn, 2005). There are a few records of white-clawed crayfish in the River Foss (a tributary of the Ouse), but none for the Ouse itself, and there are no records for non-native crayfish species (EA, unpublished data). Thus, **the Yorkshire Ouse is designated as LOW PRIORITY for**

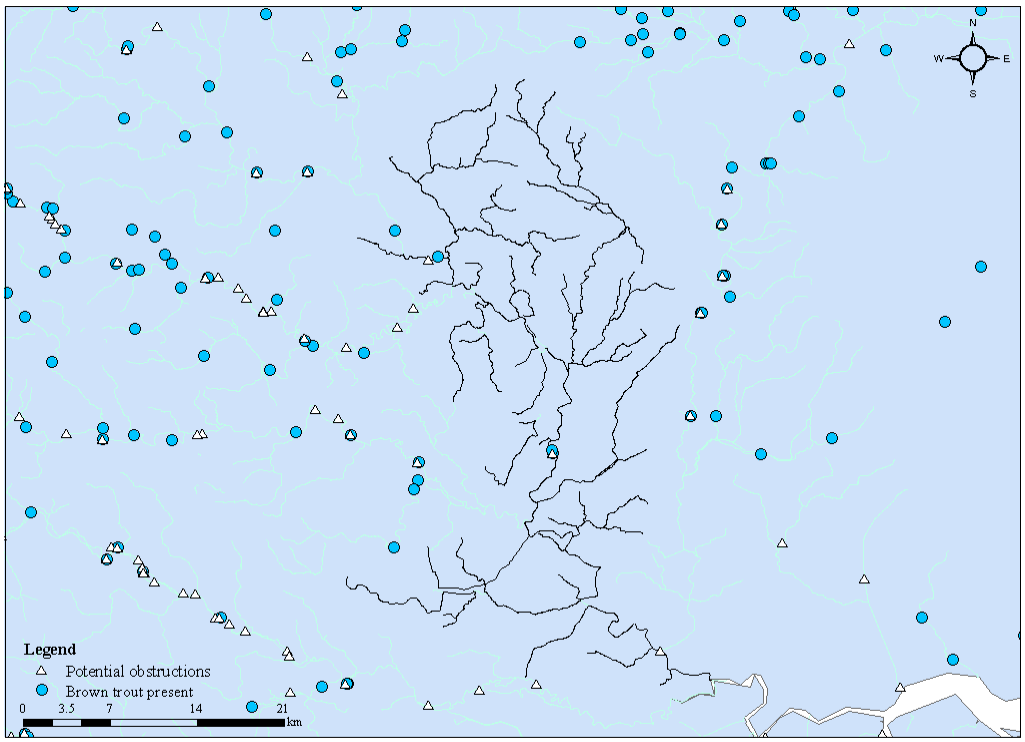

Fig. 17 The Yorkshire Ouse catchment, showing distribution of trout

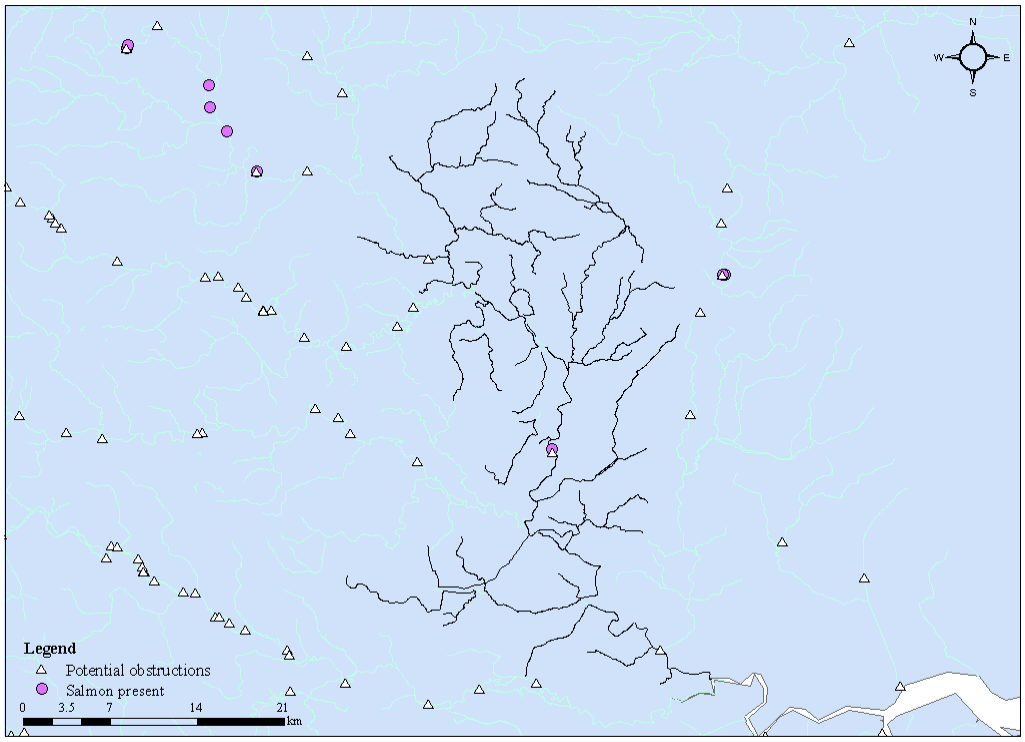

Fig. 18 The Yorkshire Ouse catchment, showing distribution of salmon

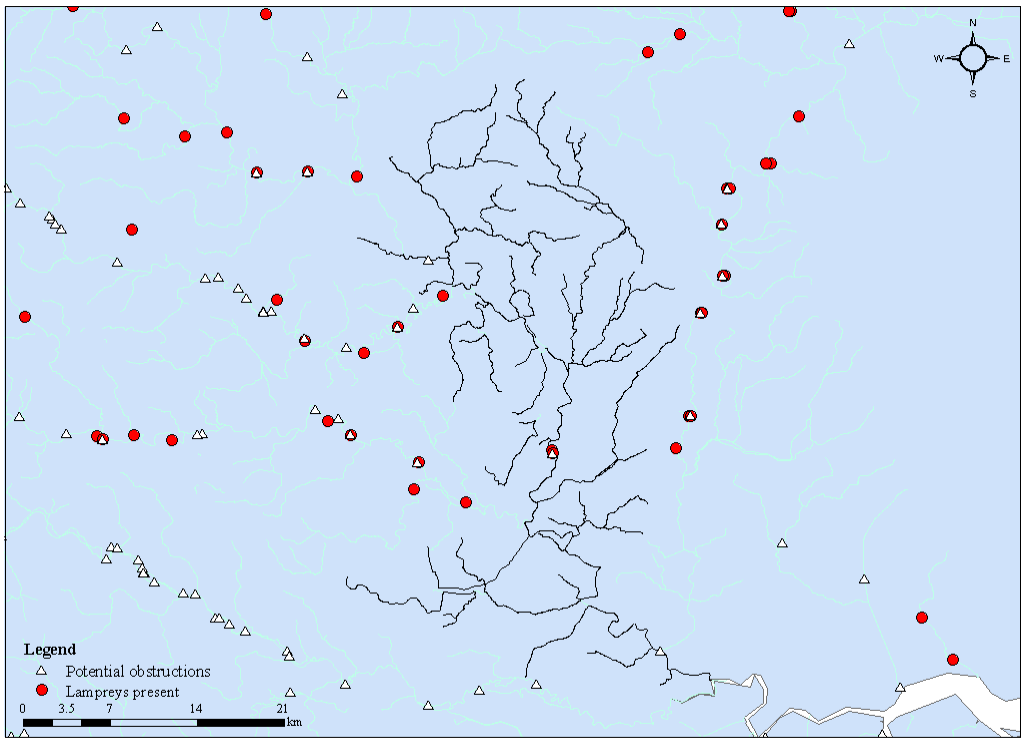

Fig. 19 The Yorkshire Ouse catchment, showing distribution of lampreys

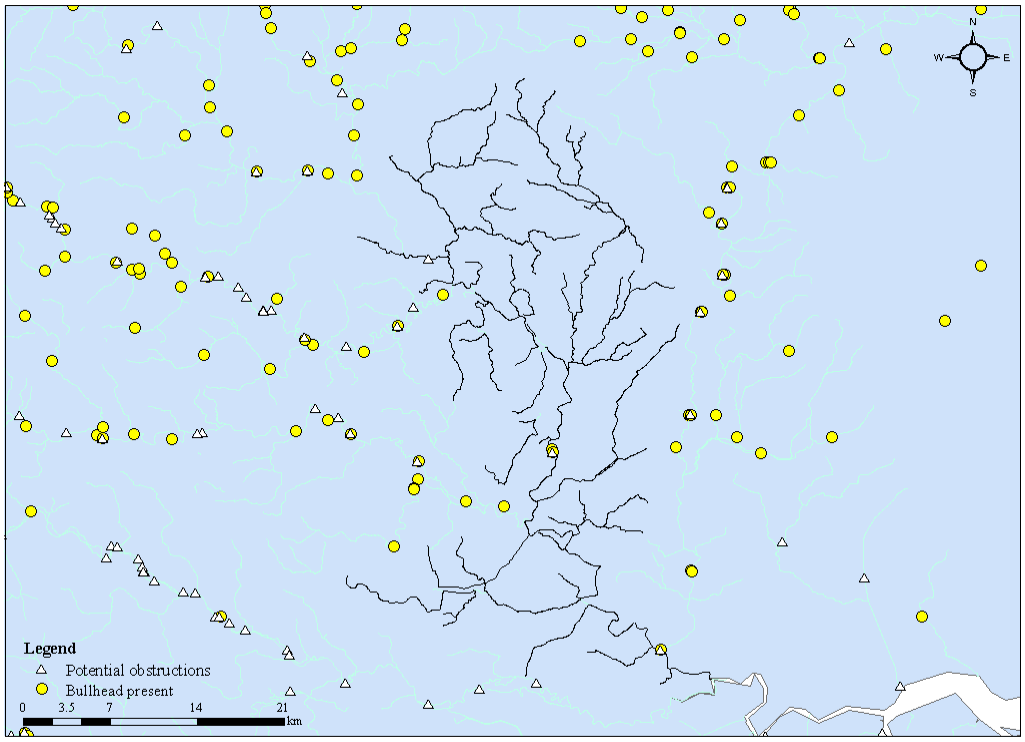

Fig. 20 The Yorkshire Ouse catchment, showing distribution of bullhead

Table 7 Elver stocking prioritisation matrix

Stretch number	d/s boundary		u/s boundary	Region	Area	Catchment	River	Lower NGR	Upper NGR	Eel stock status	Eel habitat quantity (riverine)	Eel habitat quantity (stillwater)	Eel habitat quality	Salmonids present?	Lamprey present?	Bullhead present?	Spined loach present?	White-clawed crayfish present?	Non-native crayfish present?	Impediments to d/s migration?	**Eel stocking score**	**Priority**
										1 to 6	1 to 5	1 to 5	1 to 5	F/O/R	F/O/R	F/O/R	F/O/R	F/O/R	y/n	y/n		
1	Ferriby Sluice	to	Harlam Hill Weirs	Anglian	Northern	Ancholme	Ancholme	SE976211	TF020947	3	5	1	3	Rare/abs	Rare/abs	Rare/abs	Occasion	Rare/abs	No	YES	7290	10
2	Harlam Hill Weirs	to	Bishopbridge	Anglian	Northern	Ancholme	Ancholme	TF020947	TF031911	3	1	1	4	Rare/abs	Rare/abs	Rare/abs	Occasion	Rare/abs	No	YES	1944	62
3	Bishopbridge	to	Toft Newton	Anglian	Northern	Ancholme	Ancholme	TF031911	TF032875	4	1	1	4	Rare/abs	Rare/abs	Rare/abs	Occasion	Rare/abs	No	YES	2592	51
4	Stonebridge Farm	to	Tetney Lock	Anglian	Northern	Tetney Have	Tetney Have	TA354031	TA343023	3	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	2187	60
5	Tetney Lock	to	Alvingham (lower)	Anglian	Northern	Tetney Have	Tetney Have	TA343023	TF373927	3	3	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	6561	16
6	Alvingham (lower)	to	Alvingham (upper)	Anglian	Northern	Tetney Have	Louth Canal	TF373927	TF358903	3	1	1	4	Occasion	Occasion	Occasion	Rare/abs	Rare/abs	No	No	864	113
7	Cromwell	to	Nether Lock/Averham	Midlands	Lower Trent	Trent	Trent	SK809612	SK770535	5	2	2	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	6480	17
8	Nether Lock	to	Newark	Midlands	Lower Trent	Trent	Trent	SK801553	SK792537	5	1	1	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	1620	92
9	Averham/Newark	to	Hazelford	Midlands	Lower Trent	Trent	Trent	SK792537	SK732494	5	3	1	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	Yes	YES	5670	19
10	Hazelford	to	Gunthorpe	Midlands	Lower Trent	Trent	Trent	SK732493	SK688437	5	2	1	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	3240	34
11	Gunthorpe	to	Stoke Bardolph	Midlands	Lower Trent	Trent	Trent	SK688437	SK650405	5	2	1	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	3240	34
12	Stoke Bardolph	to	Holme Sluices	Midlands	Lower Trent	Trent	Trent	SK650405	SK613393	5	1	1	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	1620	92
13	Holme Sluices	to	Beeston	Midlands	Lower Trent	Trent	Trent	SK613393	SK535353	5	3	5	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	24300	1
14	Beeston	to	Thrumpton	Midlands	Lower Trent	Trent	Trent	SK535353	SK497309	5	2	5	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	Yes	YES	17010	2
15	Thrumpton	to	Sawley	Midlands	Lower Trent	Trent	Trent	SK497309	SK467311	5	2	1	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	3240	34
16	Sawley	to	King's Mills	Midlands	Lower Trent	Trent	Trent	SK467311	SK416273	5	2	4	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	12960	4
17	King's Mills	to	Burton	Midlands	Lower Trent	Trent	Trent	SK416273	SK262239	5	5	1	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	8100	9
18	Burton	to	Alrewas	Midlands	Upper Trent	Trent	Trent	SK256234	SK174156	5	4	2	4	Rare/abs	Rare/abs	Rare/abs	Frequent	Rare/abs	No	YES	12960	4
19	Adlingfleet	to	Cow Lane	Midlands	Lower Trent	Trent	Adlingfleet D	SE859219	SE837209	4	1	1	1	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	972	111
20	Cow Lane	to	n/a	Midlands	Lower Trent	Trent	Adlingfleet D	SE837209	n/a	4	1	1	1	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	972	111
21	Luddington	to	Pademoor	Midlands	Lower Trent	Trent	Pauper's Dra	SE850153	SE808145	5	1	1	1	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	1215	109
22	Pademoor	to	n/a	Midlands	Lower Trent	Trent	Pauper's Dra	SE808145	n/a	5	2	1	1	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2430	58
23	Keadby Outfall	to	Keadby Sluice	Midlands	Lower Trent	Trent	Bosky Dyke	SE836121	SE813127	4	1	1	2	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	1944	62
24	Keadby Sluice	to	n/a	Midlands	Lower Trent	Trent	Bosky Dyke	SE813127	n/a	4	1	1	2	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	1944	62
25	Crimpsall	to	Sprotborough	North East	Ridings	Don	Don	SE566037	SE538014	5	2	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	7290	10
26	Sprotborough	to	Thrybergh	North East	Ridings	Don	Don	SE538014	SK464964	5	3	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	10935	6
27	Thrybergh	to	Aldwarke	North East	Ridings	Don	Don	SK464964	SK450944	5	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	3645	29
28	Aldwarke	to	Masbrough	North East	Ridings	Don	Don	SK450944	SK425928	5	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	3645	29
29	Masbrough	to	Ickles	North East	Ridings	Don	Don	SK425928	SK418919	5	2	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	7290	10
30	Ickles	to	Blackburn Meadows	North East	Ridings	Don	Don	SK418919	SK40392	6	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	4374	21
31	Blackburn Meadows	to	Kelham Island	North East	Ridings	Don	Don	SK40392	SK38990	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
32	Kelham Island	to	Brightside	North East	Ridings	Don	Don	SK38990	SK38790	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62

Table 7 – cont

Stretch number	d/s boundary		u/s boundary	Region	Area	Catchment	River	Lower NGR	Upper NGR	Eel stock status	Eel habitat quantity (riverine)	Eel habitat quantity (stillwater)	Eel habitat quality	Salmonids present?	Lamprey present?	Bullhead present?	Spined loach present?	White-clawed crayfish present?	Non-native crayfish present?	Impediments to d/s migration?	**Eel stocking score**	**Priority**
										1 to 6	1 to 5	1 to 5	1 to 5	F/O/R	F/O/R	F/O/R	F/O/R	F/O/R	y/n	y/n		
33	Brightside	to	Sanderson's	North East	Ridings	Don	Don	SK38790	SK37288	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
34	Sanderson's	to	Burton	North East	Ridings	Don	Don	SK37288	SK36888	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
35	Burton	to	Burngreave	North East	Ridings	Don	Don	SK36888	SK36188	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
36	Burngreave	to	The Wicker	North East	Ridings	Don	Don	SK36188	SK35887	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
37	The Wicker	to	Infirmary	North East	Ridings	Don	Don	SK35887	SK35088	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
38	Infirmary	to	Steel Bank	North East	Ridings	Don	Don	SK35088	SK34588	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
39	Steel Bank	to	Parkwood Springs	North East	Ridings	Don	Don	SK34588	SK34389	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
40	Parkwood Springs	to	Owlerton	North East	Ridings	Don	Don	SK34389	SK34390	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
41	Owlerton	to	Niagra	North East	Ridings	Don	Don	SK34390	SK32891	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
42	Niagra	to	Beeley Woods	North East	Ridings	Don	Don	SK32891	SK31891	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
43	Beeley Woods	to	Beeley Woods	North East	Ridings	Don	Don	SK31891	SK31592	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
44	Beeley Woods	to	Outibridge (lower)	North East	Ridings	Don	Don	SK31592	SK30893	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
45	Outibridge (lower)	to	Outibridge (upper)	North East	Ridings	Don	Don	SK30893	SK30793	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
46	Outibridge (upper)	to	Wharncliffe Side	North East	Ridings	Don	Don	SK30793	SK30094	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
47	Wharncliffe Side	to	Wharncliffe Side	North East	Ridings	Don	Don	SK30094	SK29895	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
48	Wharncliffe Side	to	Stocksbridge Woods	North East	Ridings	Don	Don	SK29895	SK29598	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
49	Stocksbridge Woods	to	Wortley (lower)	North East	Ridings	Don	Don	SK29598	SK29698	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
50	Wortley (lower)	to	Wortley (upper)	North East	Ridings	Don	Don	SK29698	SK29599	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
51	Wortley (upper)	to	Huthwaite	North East	Ridings	Don	Don	SK29599	SK29399	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
52	Huthwaite	to	Huthwaite Hall	North East	Ridings	Don	Don	SK29399	SK28599	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
53	Huthwaite Hall	to	Thorgoland	North East	Ridings	Don	Don	SK28599	SE27900	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
54	Thorgoland	to	Penistone Bridge	North East	Ridings	Don	Don	SE27900	SE24303	6	2	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	1296	94
55	Penistone Bridge	to	Penistone Cemetary	North East	Ridings	Don	Don	SE24303	SE23703	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	No	648	117
56	Penistone Cemetary	to	Saville Lane	North East	Ridings	Don	Don	SE23703	SE23103	6	1	1	4	Frequent	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	1944	62
57	Saville Lane	to	Plumpton Mills	North East	Ridings	Don	Don	SE23103	SE22903	6	1	1	4	Frequent	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	1944	62
58	Plumpton Mills	to	Scole Hill	North East	Ridings	Don	Don	SE22903	SE22603	6	1	1	4	Frequent	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	1944	62
59	Scole Hill	to	Mill House	North East	Ridings	Don	Don	SE22603	SE21803	6	1	1	4	Frequent	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	1944	62
60	Mill House	to	Bullhouse (lower)	North East	Ridings	Don	Don	SE21803	SE21403	6	1	1	4	Frequent	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	1944	62
61	Bullhouse (lower)	to	Bullhouse (upper)	North East	Ridings	Don	Don	SE21403	SE20902	6	1	1	4	Frequent	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	1944	62
62	Bullhouse (upper)	to	Townhead	North East	Ridings	Don	Don	SE20902	SE16402	6	1	1	4	Frequent	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	1944	62
63	Orgreave	to	Beighton	North East	Ridings	Don	Rother	SK427874	SK446841	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
64	Beighton	to	Rother Valley Country	North East	Ridings	Don	Rother	SK446841	SK454827	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62

Table 7 – cont

Stretch number	d/s boundary		u/s boundary	Region	Area	Catchment	River	Lower NGR	Upper NGR	Eel stock status	Eel habitat quantity (riverine)	Eel habitat quantity (stillwater)	Eel habitat quality	Salmonids present?	Lamprey present?	Bullhead present?	Spined loach present?	White-clawed crayfish present?	Non-native crayfish present?	Impediments to d/s migration?	**Eel stocking score**	**Priority**
										1 to 6	1 to 5	1 to 5	1 to 5	F/O/R	F/O/R	F/O/R	F/O/R	F/O/R	y/n	y/n		
65	Rother Valley Country	to	Killamarsh	North East	Ridings	Don	Rother	SK454827	SK446809	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
66	Killamarsh	to	Slittingmill Farm	North East	Ridings	Don	Rother	SK446809	K43376	6	2	1	4	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	5184	20
67	Slittingmill Farm	to	Stavely (lower)	North East	Ridings	Don	Rother	K43376	K42974	6	1	1	4	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	2592	51
68	Stavely (lower)	to	Stavely (upper)	North East	Ridings	Don	Rother	K42974	K41974	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
69	Stavely (upper)	to	Brimington	North East	Ridings	Don	Rother	K41974	K40874	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
70	Brimington	to	Whittington	North East	Ridings	Don	Rother	K40874	K39474	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
71	Whittington	to	Chesterfield	North East	Ridings	Don	Rother	K39474	K38872	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
72	Adwick upon Dearne	to	Wath	North East	Ridings	Don	Dearne	SE481018	SE436022	5	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	3645	29
73	Wath	to	Darfield	North East	Ridings	Don	Dearne	SE436022	SE423048	5	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	3645	29
74	Darfield	to	Little Houghton	North East	Ridings	Don	Dearne	SE423048	SE418054	5	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	3645	29
75	Little Houghton	to	Barnsley	North East	Ridings	Don	Dearne	SE418054	E35007	6	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	No	4374	21
76	Barnsley	to	Low Barugh	North East	Ridings	Don	Dearne	E35007	E31609	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
77	Low Barugh	to	Riverside Farm	North East	Ridings	Don	Dearne	E31609	SE30111	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	Yes	No	3024	37
78	Riverside Farm	to	Bretton Park	North East	Ridings	Don	Dearne	SE30111	SE29112	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1944	62
79	Bretton Park	to	Scissett	North East	Ridings	Don	Dearne	SE29112	SE25110	6	2	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	2592	51
80	Scissett	to	Bagden Bridge	North East	Ridings	Don	Dearne	SE25110	SE24409	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
81	Bagden Bridge	to	Denby Dale	North East	Ridings	Don	Dearne	SE24409	SE23809	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	No	1296	94
82	Chapel Haddlesey	to	Beal	North East	Ridings	Aire	Aire	SE581260	SE535256	5	2	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	7290	10
83	Beal	to	Knottingley	North East	Ridings	Aire	Aire	SE535256	SE493242	5	2	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	7290	10
84	Knottingley	to	Castleford	North East	Ridings	Aire	Aire	SE493242	SE427260	5	3	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	10935	6
85	Castleford	to	Lemonroyd	North East	Ridings	Aire	Aire	SE427260	E38228	6	3	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	13122	3
86	Lemonroyd	to	Fleet	North East	Ridings	Aire	Aire	E38228	E38128	6	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	4374	21
87	Fleet	to	Rothwell	North East	Ridings	Aire	Aire	E38128	E34730	6	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	4374	21
88	Rothwell	to	Skelton Grange	North East	Ridings	Aire	Aire	E34730	E33430	6	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	4374	21
89	Skelton Grange	to	Thwaites Mill	North East	Ridings	Aire	Aire	E33430	E32631	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
90	Thwaites Mill	to	Knostrop	North East	Ridings	Aire	Aire	E32631	E32331	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
91	Knostrop	to	Crown Point	North East	Ridings	Aire	Aire	E32331	E30733	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
92	Crown Point	to	Granary Wharfe	North East	Ridings	Aire	Aire	E30733	E29733	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
93	Granary Wharfe	to	Armley Mills	North East	Ridings	Aire	Aire	E29733	E27434	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
94	Armley Mills	to	Kirkstall (lower)	North East	Ridings	Aire	Aire	E27434	E26534	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
95	Kirkstall (lower)	to	Kirkstall (upper)	North East	Ridings	Aire	Aire	E26534	E26634	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
96	Kirkstall (upper)	to	Kirkstall (allotments)	North East	Ridings	Aire	Aire	E26634	E26435	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39

Table 7 – cont.

Stretch number	d/s boundary		u/s boundary	Region	Area	Catchment	River	Lower NGR	Upper NGR	Eel stock status	Eel habitat quantity (riverine)	Eel habitat quantity (stillwater)	Eel habitat quality	Salmonids present?	Lamprey present?	Bullhead present?	Spined loach present?	White-clawed crayfish present?	Non-native crayfish present?	Impediments to d/s migration?	**Eel stocking score**	**Priority**
										1 to 6	1 to 5	1 to 5	1 to 5	F/O/R	F/O/R	F/O/R	F/O/R	F/O/R	y/n	y/n		
97	Kirkstall (allotments)	to	Kirkstall Abbey	North East	Ridings	Aire	Aire	SE26435	SE26135	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
98	Kirkstall Abbey	to	Newlay Locks	North East	Ridings	Aire	Aire	SE26135	SE24436	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
99	Newlay Locks	to	Rodley	North East	Ridings	Aire	Aire	SE24436	SE23536	6	1	1	3	Occasion	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	2916	39
100	Rodley	to	Baildon	North East	Ridings	Aire	Aire	SE23536	SE15137	6	3	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	5832	18
101	Baildon	to	Saltaire	North East	Ridings	Aire	Aire	SE15137	SE13838	6	1	1	4	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	2592	51
102	Saltaire	to	Hirstwood	North East	Ridings	Aire	Aire	SE13838	SE13038	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	YES	648	117
103	Hirstwood	to	Bingley	North East	Ridings	Aire	Aire	SE13038	SE10439	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	YES	648	117
104	Bingley	to	Crossflatts	North East	Ridings	Aire	Aire	SE10439	SE09840	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
105	Crossflatts	to	Marley	North East	Ridings	Aire	Aire	SE09840	SE09540	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
106	Marley	to	Gargrave	North East	Ridings	Aire	Aire	SE09540	SD93753	6	5	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	Yes	YES	2340	59
107	Gargrave	to	High Mill Cottages	North East	Ridings	Aire	Aire	SD93753	SD92453	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
108	High Mill Cottages	to	New Brighton	North East	Ridings	Aire	Aire	SD92453	SD92253	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
109	New Brighton	to	Aqueduct	North East	Ridings	Aire	Aire	SD92253	SD91853	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
110	Aqueduct	to	Coniston	North East	Ridings	Aire	Aire	SD91853	SD90854	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
111	Coniston	to	Bell Busk	North East	Ridings	Aire	Aire	SD90854	SD90756	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
112	Bell Busk	to	Newfield	North East	Ridings	Aire	Aire	SD90756	SD90858	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
113	Newfield	to	Scosthrop Manor	North East	Ridings	Aire	Aire	SD90858	SD90259	6	1	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	432	141
114	Scosthrop Manor	to	Aire Head	North East	Ridings	Aire	Aire	SD90259	SD90267	6	2	1	4	Frequent	Occasion	Frequent	Rare/abs	Rare/abs	No	YES	864	113
115	Methley	to	Kirkthorpe	North East	Ridings	Aire	Calder	SE383253	SE357213	5	2	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	7290	10
116	Kirkthorpe	to	Wakefield	North East	Ridings	Aire	Calder	SE357213	SE336204	6	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	4374	21
117	Wakefield	to	Horbury	North East	Ridings	Aire	Calder	SE336204	SE31918	6	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	4374	21
118	Horbury	to	Calder Grove	North East	Ridings	Aire	Calder	SE31918	SE30217	6	1	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	4374	21
119	Calder Grove	to	Saville	North East	Ridings	Aire	Calder	SE30217	SE24121	6	2	1	3	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	8748	8
120	Saville	to	Dewsbury	North East	Ridings	Aire	Calder	SE24121	SE23520	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1944	62
121	Dewsbury	to	Ravensthorpe	North East	Ridings	Aire	Calder	SE23520	SE21819	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1944	62
122	Ravensthorpe	to	Mirfield	North East	Ridings	Aire	Calder	SE21819	SE20219	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1944	62
123	Mirfield	to	Bracken Hill	North East	Ridings	Aire	Calder	SE20219	SE18520	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1944	62
124	Bracken Hill	to	Cooper Bridge	North East	Ridings	Aire	Calder	SE18520	SE17620	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1944	62
125	Cooper Bridge	to	Old Corn Mill	North East	Ridings	Aire	Calder	SE17620	SE16922	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1944	62
126	Old Corn Mill	to	ADT Car Auctions	North East	Ridings	Aire	Calder	SE16922	SE15921	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	Yes	YES	3024	37
127	ADT Car Auctions	to	Brighouse (Snakehill)	North East	Ridings	Aire	Calder	SE15921	SE14722	6	1	1	3	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1944	62
128	Brighouse (Snakehill)	to	Brighouse (Sugden's	North East	Ridings	Aire	Calder	SE14722	SE14522	6	1	1	4	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	2592	51

Table 7 – cont.

Stretch number	d/s boundary		u/s boundary	Region	Area	Catchment	River	Lower NGR	Upper NGR	Eel stock status	Eel habitat quantity (riverine)	Eel habitat quantity (stillwater)	Eel habitat quality	Salmonids present?	Lamprey present?	Bullhead present?	Spined loach present?	White-clawed crayfish present?	Non-native crayfish present?	Impediments to d/s migration?	**Eel stocking score**	**Priority**
										1 to 6	1 to 5	1 to 5	1 to 5	F/O/R	F/O/R	F/O/R	F/O/R	F/O/R	y/n	y/n		
129	Brighouse (Sugden's	to	Lillands	North East	Ridings	Aire	Calder	SE14522	E13723	6	1	1	4	Occasion	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	2592	51
130	Lillands	to	Elland	North East	Ridings	Aire	Calder	SE13723	E12422	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1296	94
131	Elland	to	Standard Wire	North East	Ridings	Aire	Calder	SE12422	E07223	6	2	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	2592	51
132	Standard Wire	to	Sowerby	North East	Ridings	Aire	Calder	SE07223	E06923	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1296	94
133	Sowerby	to	High Royds	North East	Ridings	Aire	Calder	SE06923	E05324	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1296	94
134	High Royds	to	Boulder Clough	North East	Ridings	Aire	Calder	SE05324	E04324	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1296	94
135	Boulder Clough	to	Sagar Richards	North East	Ridings	Aire	Calder	SE04324	E03924	6	1	1	4	Frequent	Rare/abs	Occasion	Rare/abs	Rare/abs	No	YES	1296	94
136	Sagar Richards	to	Brearley	North East	Ridings	Aire	Calder	SE03924	E02925	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	YES	648	117
137	Brearley	to	Hebden Bridge	North East	Ridings	Aire	Calder	SE02925	D99327	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	YES	648	117
138	Hebden Bridge	to	Eastwood	North East	Ridings	Aire	Calder	D99327	D97226	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	YES	648	117
139	Eastwood	to	Todmorden	North East	Ridings	Aire	Calder	D97226	D96425	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	YES	648	117
140	Todmorden	to	Todmorden (Castle S	North East	Ridings	Aire	Calder	D96425	D95324	6	1	1	4	Frequent	Rare/abs	Frequent	Rare/abs	Rare/abs	No	YES	648	117
141	Swinefleet	to	n/a	North East	Ridings	Ouse	Swinefleet W	SE765217	n/a	4	1	1	2	Rare/abs	Rare/abs	Rare/abs	Rare/abs	Rare/abs	No	YES	1944	62
142	Naburn	to	Linton	North East	Dales	Ouse	Ouse	SE594445	SE494600	3	5	1	4	Occasion	Frequent	Occasion	Rare/abs	Rare/abs	No	YES	2160	61
143	Linton	to	Boroughbridge	North East	Dales	Ouse	Ouse	SE494600	SE397671	4	5	1	4	Occasion	Frequent	Occasion	Rare/abs	Rare/abs	No	YES	2880	50
144	Boroughbridge	to	Westwick (Newby)	North East	Dales	Ure	Ure	SE397671	SE356670	4	2	1	5	Occasion	Frequent	Frequent	Rare/abs	Occasion	No	YES	480	140
145	Westwick (Newby)	to	West Tanfield	North East	Dales	Ure	Ure	SE356670	SE276787	4	4	1	5	Occasion	Frequent	Frequent	Rare/abs	Occasion	Yes	YES	1080	110
146	West Tanfield	to	Mickley	North East	Dales	Ure	Ure	SE276787	SE25176	4	1	1	5	Frequent	Frequent	Frequent	Rare/abs	Frequent	Yes	YES	90	157
147	Mickley	to	Kilgram	North East	Dales	Ure	Ure	SE25176	SE19086	4	3	1	5	Frequent	Frequent	Frequent	Rare/abs	Frequent	No	YES	180	152
148	Kilgram	to	Danby Low Mill	North East	Dales	Ure	Ure	SE19086	SE15287	4	2	1	5	Frequent	Frequent	Frequent	Rare/abs	Frequent	No	YES	120	156
149	Danby Low Mill	to	The Batts	North East	Dales	Ure	Ure	SE15287	SE14687	4	1	1	5	Frequent	Frequent	Frequent	Rare/abs	Frequent	No	YES	60	160
150	The Batts	to	Redmire Force	North East	Dales	Ure	Ure	SE14687	SE04490	4	3	1	5	Frequent	Frequent	Frequent	Rare/abs	Frequent	No	YES	180	152
151	Redmire Force	to	Aysgarth Falls	North East	Dales	Ure	Ure	SE04490	SE01888	5	1	1	5	Frequent	Frequent	Frequent	Rare/abs	Frequent	No	YES	75	158
152	Aysgarth Falls	to	Nappa Mill	North East	Dales	Ure	Ure	SE01888	D96090	5	2	1	5	Frequent	Frequent	Frequent	Rare/abs	Frequent	No	YES	150	154
153	Barmby Barrage	to	Elvington	North East	Dales	Derwent	Derwent	SE681286	SE705475	3	4	1	4	Rare/abs	Frequent	Occasion	Rare/abs	Frequent	No	YES	864	113
154	Elvington	to	Stamford Bridge	North East	Dales	Derwent	Derwent	SE705475	SE713557	3	3	1	4	Rare/abs	Frequent	Occasion	Rare/abs	Frequent	No	YES	648	117
155	Stamford Bridge	to	Buttercrambe	North East	Dales	Derwent	Derwent	SE713557	E73158	3	1	1	4	Occasion	Frequent	Occasion	Rare/abs	Frequent	No	YES	144	155
156	Buttercrambe	to	Howsham	North East	Dales	Derwent	Derwent	SE73158	E73062	4	2	1	4	Occasion	Frequent	Occasion	Rare/abs	Frequent	No	YES	384	150
157	Howsham	to	Kirkham Abbey	North East	Dales	Derwent	Derwent	SE73062	E73565	4	1	1	4	Occasion	Frequent	Occasion	Rare/abs	Frequent	No	YES	192	151
158	Kirkham Abbey	to	Low Marishes	North East	Dales	Derwent	Derwent	SE73565	E83377	5	5	1	4	Frequent	Frequent	Occasion	Rare/abs	Frequent	No	YES	600	139
159	Low Marishes	to	West Ayton	North East	Dales	Derwent	Derwent	SE83377	E99085	5	5	1	5	Frequent	Frequent	Occasion	Rare/abs	Frequent	No	YES	750	116
160	West Ayton	to	Forge Valley	North East	Dales	Derwent	Derwent	SE99085	E98985	5	1	1	5	Frequent	Frequent	Frequent	Rare/abs	Frequent	No	YES	75	158

elver stocking due to the existence of an established eel population and the presence of substantial lamprey populations (Table 7). Indeed, the Yorkshire Ouse catchment is believed to support one of the most important river lamprey populations in the UK (Jang & Lucas, 2005). Nonetheless, **the area considered most appropriate for stocking is the stretch from Boroughbridge (~102 km from estuary) downstream to Naburn (~60 km from estuary)** (Table 7). However, there are a number of potential impediments to downstream migration of eel. For example, before mitigation measures were implemented, impingement of lamprey ammocoetes was known to occur at Moor Monkton water abstraction works (Frear & Axford, 1991), and eel are occasionally impinged at Acomb (A. Leighton, pers. comm.). Eel may also be impinged/entrained at the power station on the tidal Ouse at Drax, although no surveys appear to have been conducted. Note that eel leaving most of the rivers draining into the Humber Estuary may also be at risk of impingement at the power station on the estuary at Stallingborough (Proctor & Musk, 2001; Dawes *et al*., 2005).

6.2 Yorkshire Derwent

Eel are present throughout the Yorkshire Derwent (Section 5.3; Whitton & Lucas, 1997), and form an important part of angler catches (EA, unpublished data). Similarly, lampreys have been recorded throughout the Derwent (Fig. 21; Jang *et al*., 2003, 2004; Masters *et al*., 2004; Vesey, 2004; Bradbury, 2005; Jang & Lucas, 2005), with high densities of ammocoetes present in many areas (Harvey *et al*., 2006; Nunn *et al*., 2007a). Indeed, the Derwent is designated as a Special Area of Conservation (SAC) due to its population of river lamprey[1]. Brown trout and bullhead are also found throughout much of the Derwent, although populations are greatest in the upper reaches (Figs 22 & 23). There is only one record for salmon and none for spined loach (EA, unpublished data).

White-clawed crayfish are widespread in the upper reaches of the Yorkshire Derwent, including the River Rye, but there are few records downstream of the Rye confluence (Fig. 24). There are a few records for signal crayfish (*Pacifastacus leniusculus* (Dana)) in Settrington Beck, a tributary of the Derwent, but not for the Derwent itself (Fig. 25). Thus, **the Yorkshire Derwent is designated as LOW PRIORITY for elver stocking due to the existence of an established eel population and the presence of substantial lamprey populations** (Table 7). Indeed, as mentioned previously, the Yorkshire Ouse catchment, which includes the Derwent, is believed to support one of the most important river lamprey populations in the UK (Jang & Lucas, 2005), and brook lamprey are widespread in the upper reaches of the Derwent (Whitton & Lucas, 1997). Nonetheless, **the area considered most appropriate for stocking is the stretch from Stamford Bridge (~63 km from estuary) downstream to Barmby Barrage** (Table 7). However, there are a number of potential impediments to downstream migration of eel. For example, impingement of lamprey ammocoetes is known to occur at Elvington and Loftsome Bridge water treatment works (Dawes *et al*., 2004), and eel are found occasionally (A. Leighton, pers. comm.). Eel may also be impinged/entrained at the power station on the tidal Ouse at Drax, although no surveys appear to have been conducted.

[1] see http://www.jncc.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030253

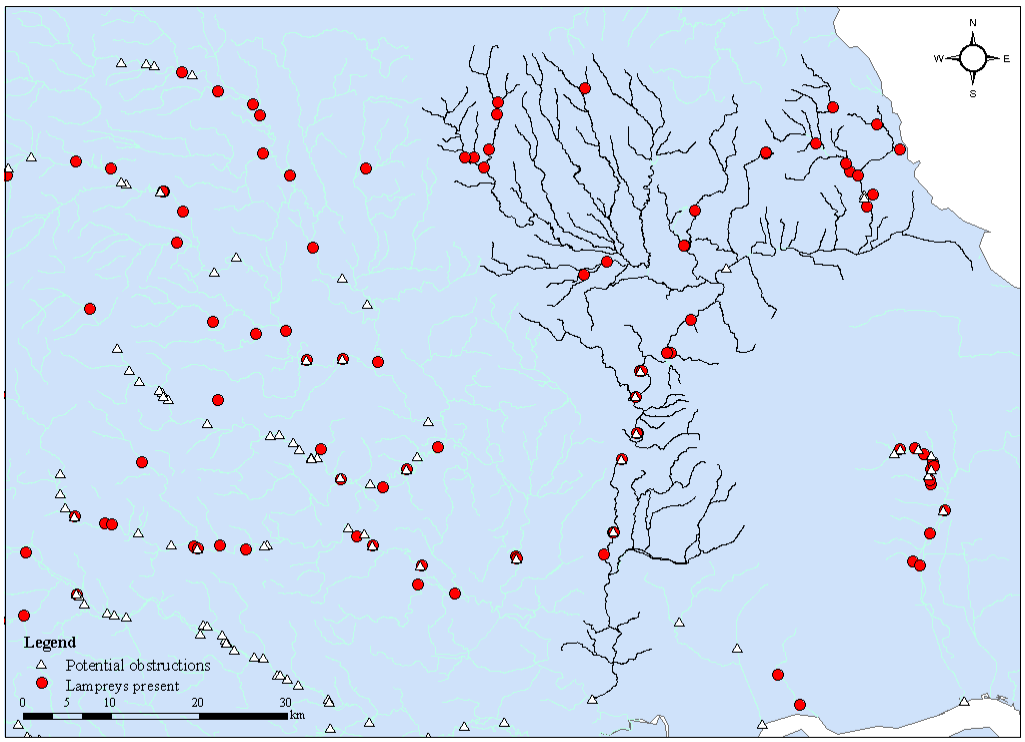

Fig. 21 The Yorkshire Derwent catchment, showing distribution of lampreys

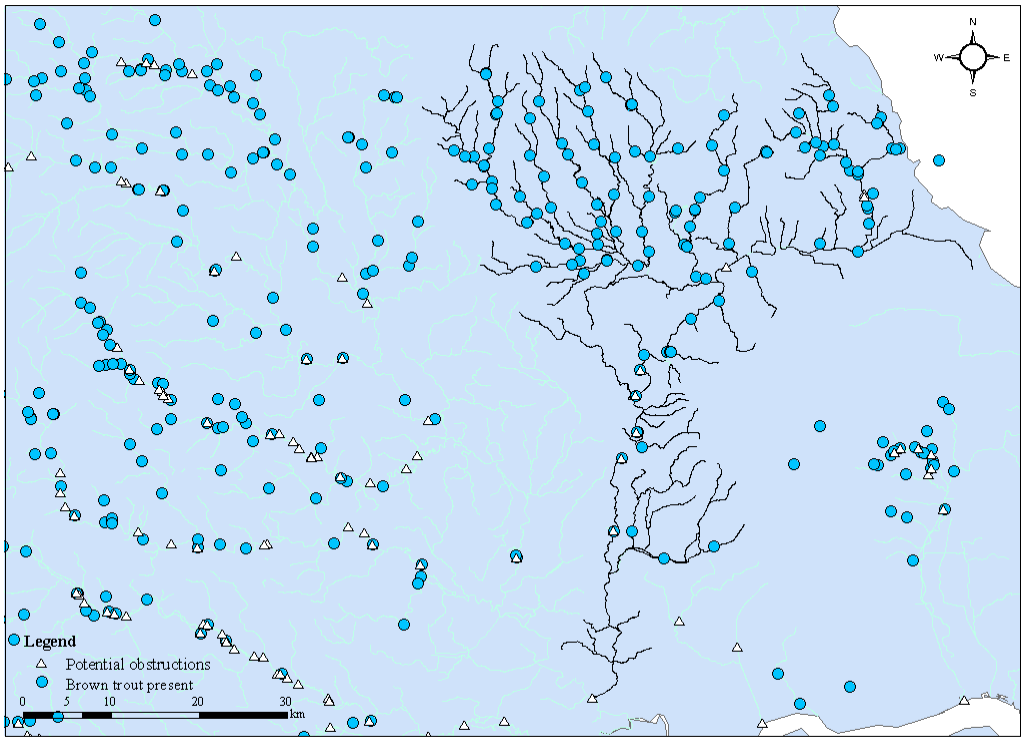

Fig. 22 The Yorkshire Derwent catchment, showing distribution of trout

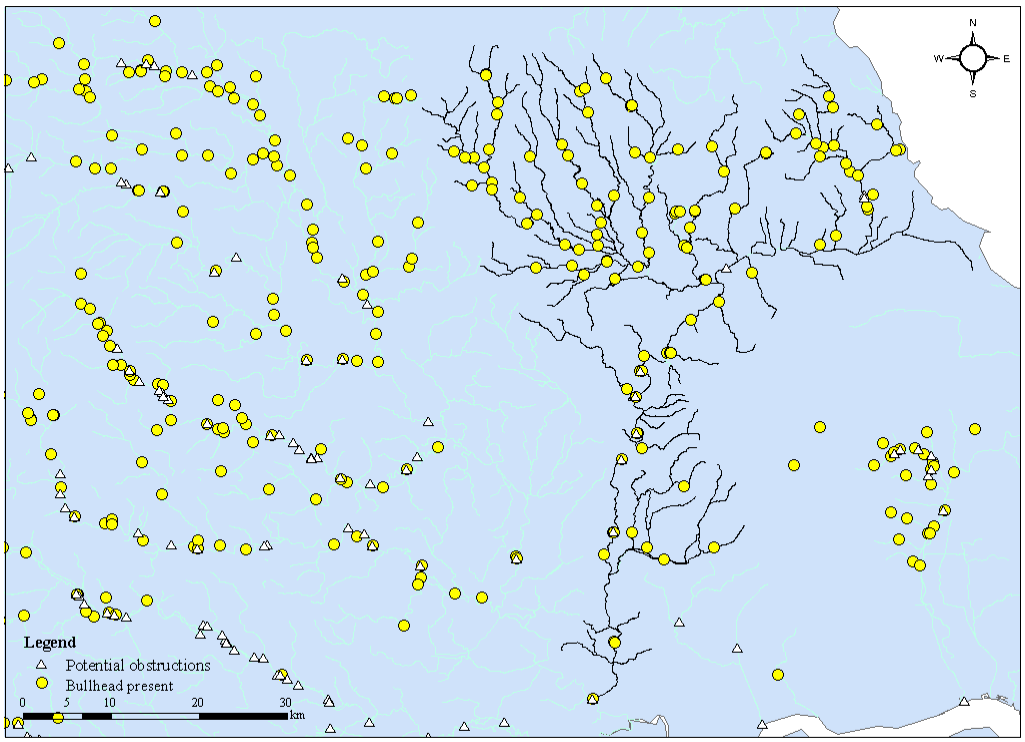

Fig. 23 The Yorkshire Derwent catchment, showing distribution of bullhead

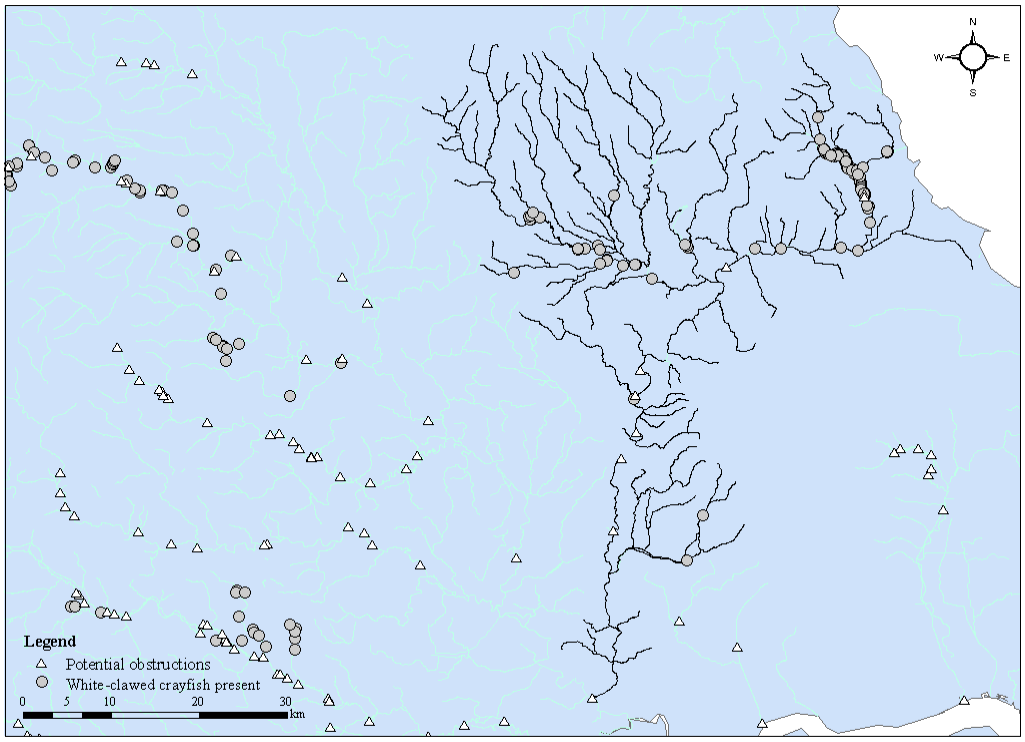

Fig. 24 The Yorkshire Derwent catchment, showing distribution of white-clawed crayfish

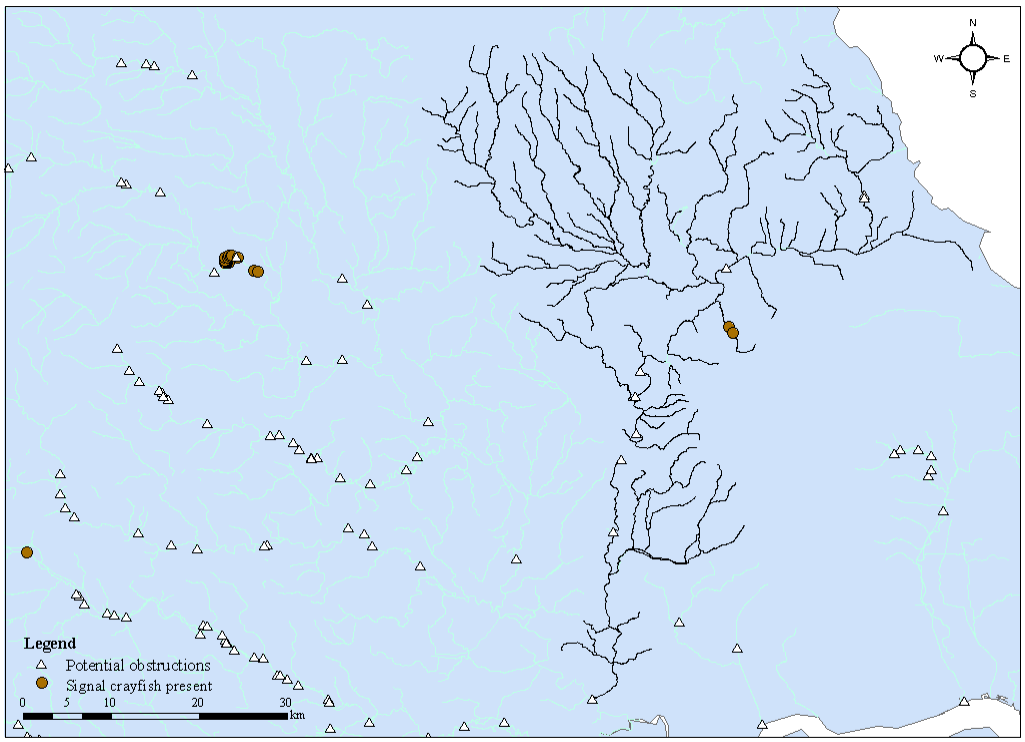

Fig. 25 The Yorkshire Derwent catchment, showing distribution of signal crayfish

6.3 River Ure

Eel are present in the River Ure as far upstream as Aysgarth (Bishopdale Beck), although population densities appear to be greatest in the lower reaches (Section 5.4). Similarly, lampreys are present throughout the Ure (Fig. 26; BEST, 2003, 2004; Vesey, 2004; Bradbury, 2005), with high densities of ammocoetes present in many areas (Harvey *et al*., 2006; Nunn *et al*., 2007a). In addition, brown trout, salmon (including eggs and juveniles) and bullhead are found throughout much of the Ure, especially the middle and upper reaches, but there are no records for spined loach (Figs 27-29).

White-clawed crayfish are present throughout the middle and upper Ure (Fig. 30), while signal crayfish are present in the middle reaches around West Tanfield (Fig. 31; Bubb *et al*., 2002). Thus, **the River Ure is REJECTED for elver stocking due to the existence of an established eel population and the presence of substantial populations of salmonids, lampreys, bullhead and white-clawed crayfish** (Table 7). Indeed, as mentioned previously, the Yorkshire Ouse catchment is believed to support one of the most important river lamprey populations in the UK (Jang & Lucas, 2005), and brook lamprey are widespread in the upper reaches of the Ure (Whitton & Lucas, 1997). In addition, there are a number of potential impediments to downstream migration of eel, although these are mostly on the Ouse (see Section 6.1) rather than the Ure itself.

6.4 River Trent

The distribution of eel in the Trent catchment is skewed towards the tidal reaches and the upper catchment, with comparatively few records for the middle reaches and the rivers Dove, Derwent, Soar and Erewash (Section 5.8). Moreover, densities are

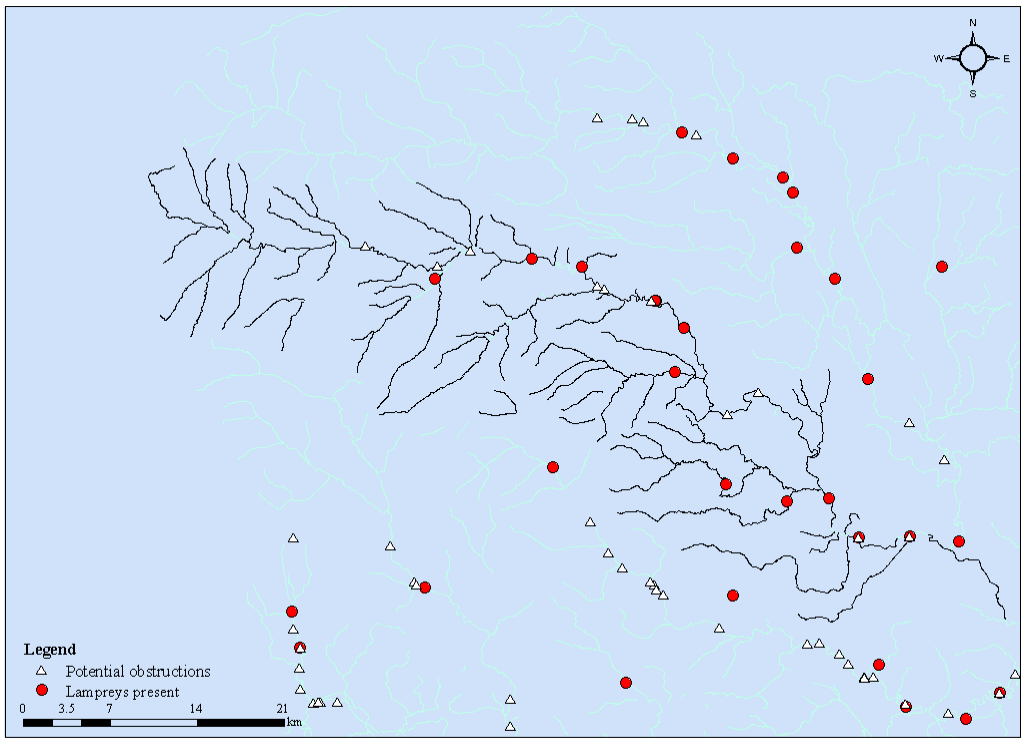

Fig. 26 The River Ure catchment, showing distribution of lampreys

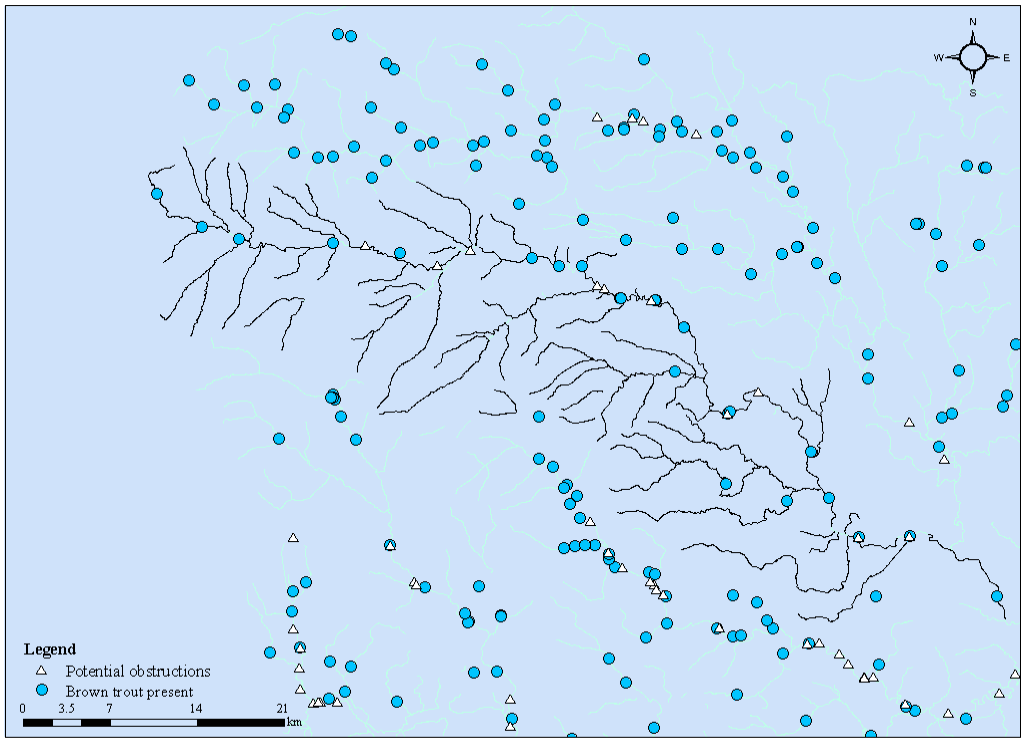

Fig. 27 The River Ure catchment, showing distribution of trout

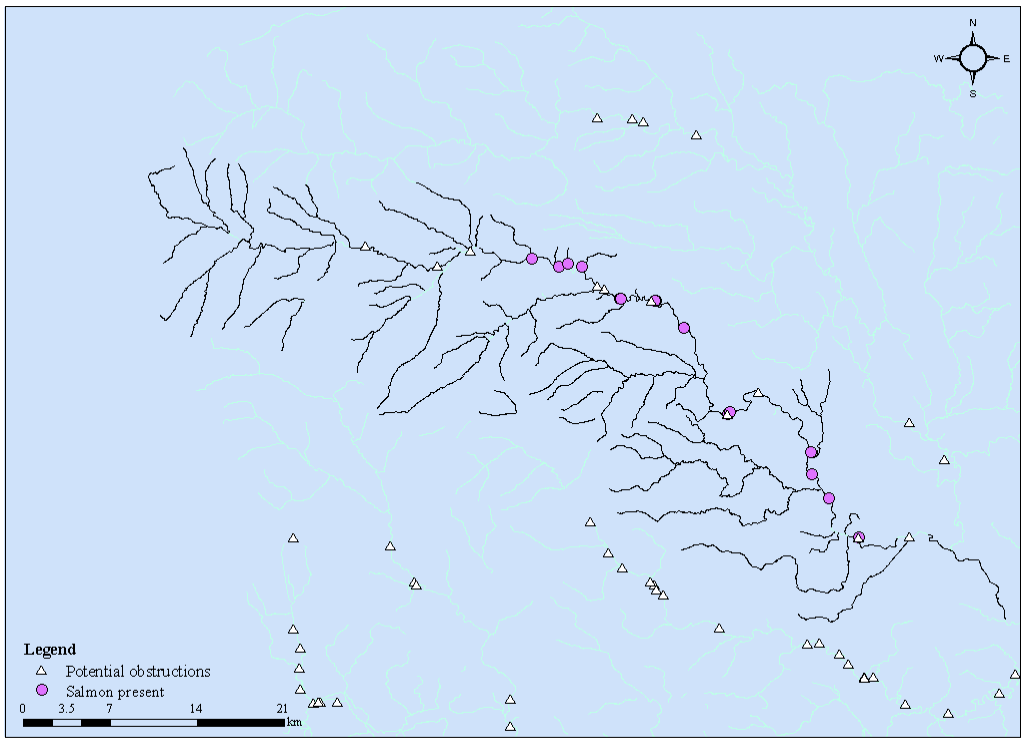

Fig. 28 The River Ure catchment, showing distribution of salmon

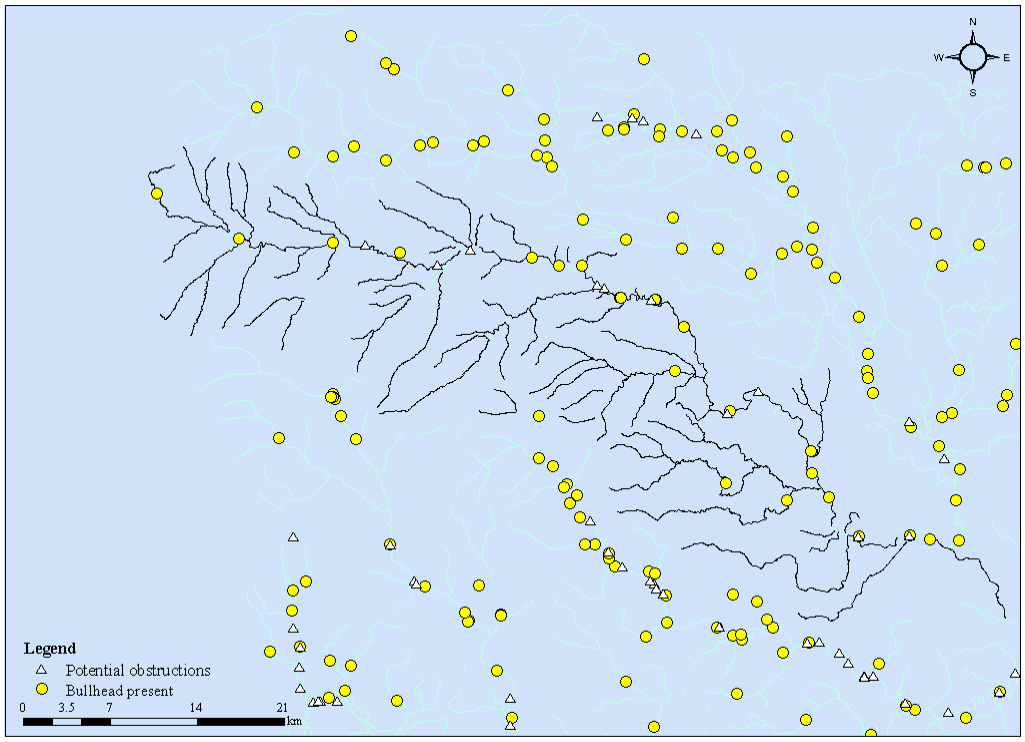

Fig. 29 The River Ure catchment, showing distribution of bullhead

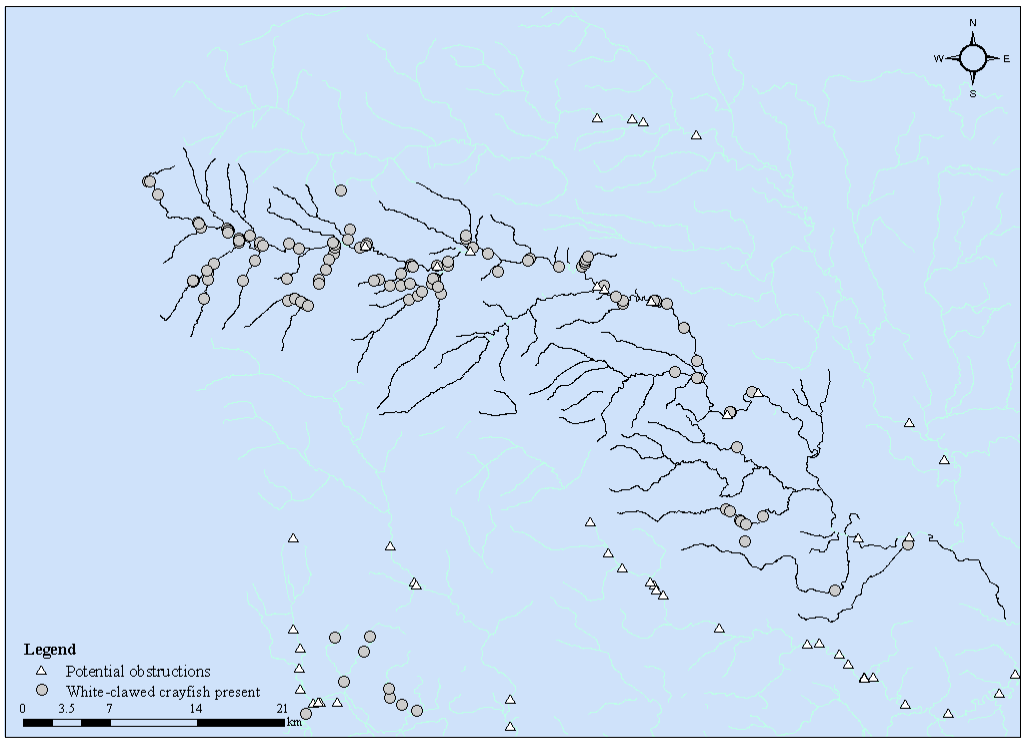

Fig. 30 The River Ure catchment, showing distribution of white-clawed crayfish

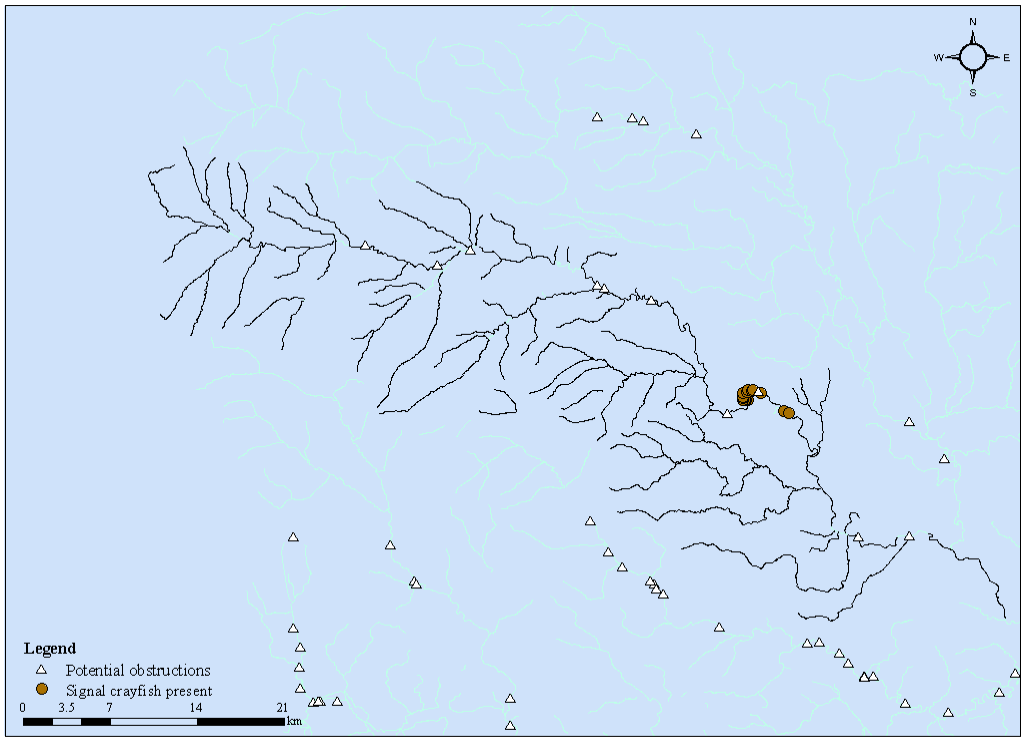

Fig. 31 The River Ure catchment, showing distribution of signal crayfish

substantially lower than historically (see Mann, 1989; Jacklin, 1996), although little information is available concerning abundances in the lower tributaries. Similarly, lampreys were formerly abundant in the Trent, but anadromous species (i.e. river and sea lamprey) are now almost exclusively limited to the tidal river, with very few records upstream of Cromwell Weir (Jacklin, 2006). By contrast, brook lamprey are present in a number of major tributaries (e.g. the rivers Dove and Derbyshire Derwent), and also some minor tributaries in the upper catchment (Fig. 32). Indeed, the species is a qualifying feature of the Peak District Dales SAC[2]. However, there are few records from the Trent itself (Fig. 32; Vesey, 2004; Bradbury, 2005; Jacklin, 2006), although no specific surveys have been conducted.

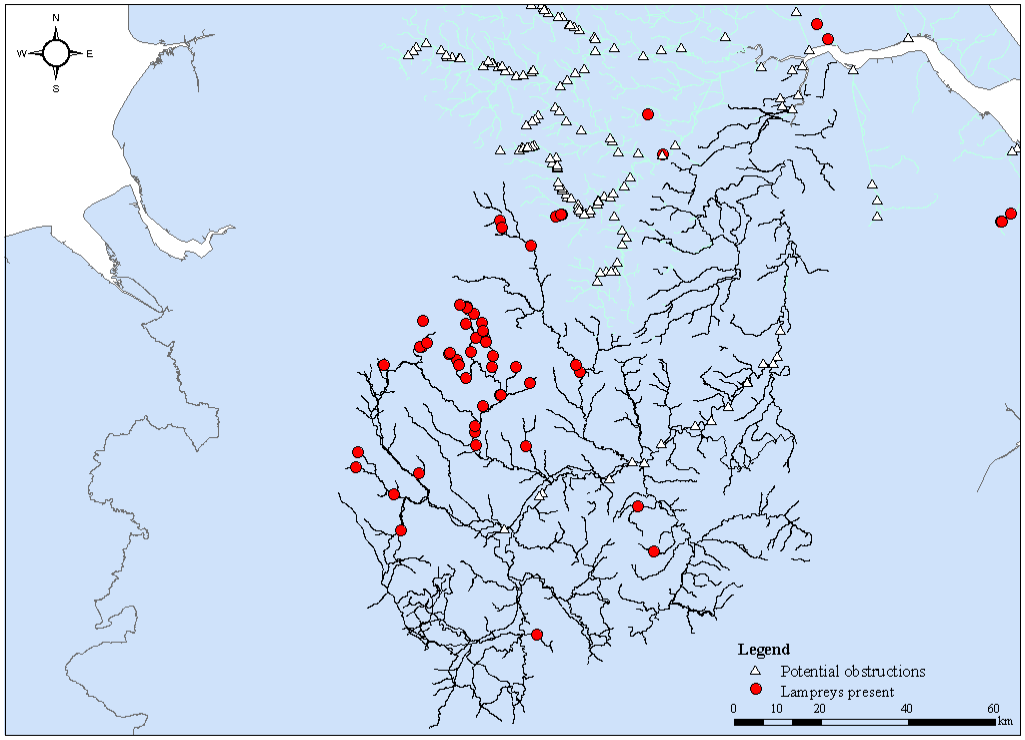

Fig. 32 The River Trent catchment, showing distribution of lampreys

Bullhead and trout are present in the middle and lower reaches of the Trent, but are only minor members of the fish community in the main stem of the river (Harvey, 1996; Britton, 1999; Harvey *et al*., 1999; Nunn *et al*., 2007b). Both species are, however, common in the upper reaches of the river and many tributaries of the Trent (Figs 33 & 34). There appear to be no records for juvenile salmon in the Trent itself, although adult fish need to migrate through the river to reach spawning and nursery areas in the Dove and Derwent if self-sustaining populations are to become established (see Anon., 1986; Cowx & O'Grady, 1995; Sykes, 2004). Spined loach are present throughout much of the Trent (Fig. 35; Nunn *et al*., 2003; Davies *et al*., 2004; HIFI, unpublished data), although their full distribution is uncertain as no targeted surveys have been conducted. Although they are generally only minor members of the fish community, the Trent is of national importance regarding the conservation of the species (Nunn *et al*., 2003).

[2] see http://www.jncc.gov.uk/protectedsites/sacselection/sac.asp?EUcode=UK0019859

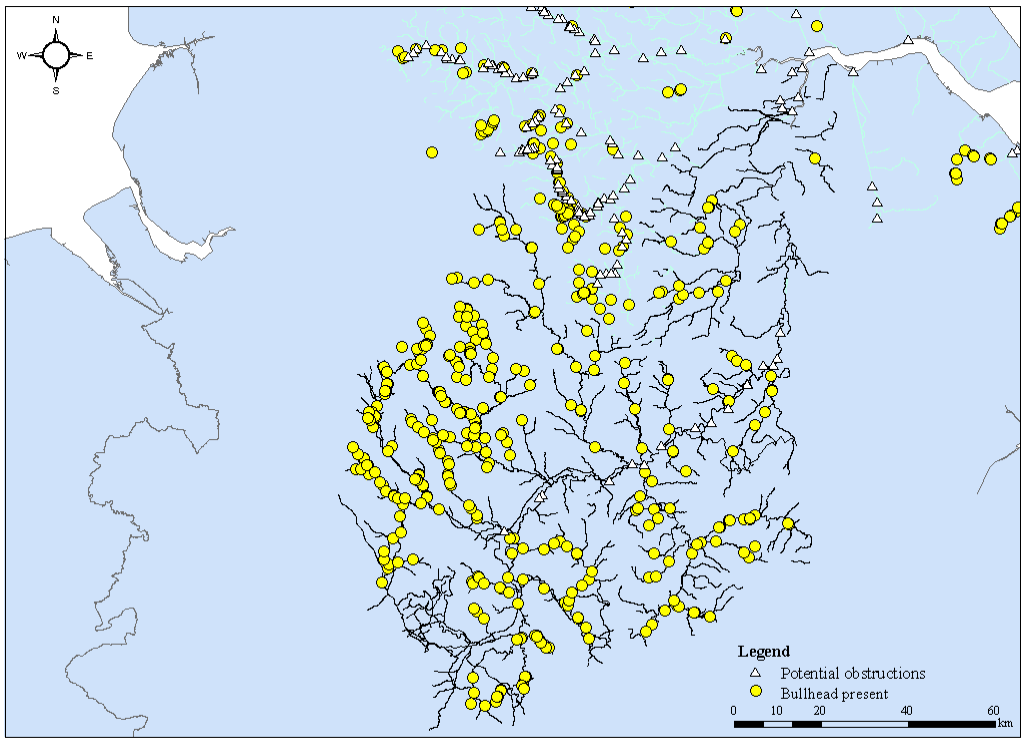

Fig. 33 The River Trent catchment, showing distribution of bullhead

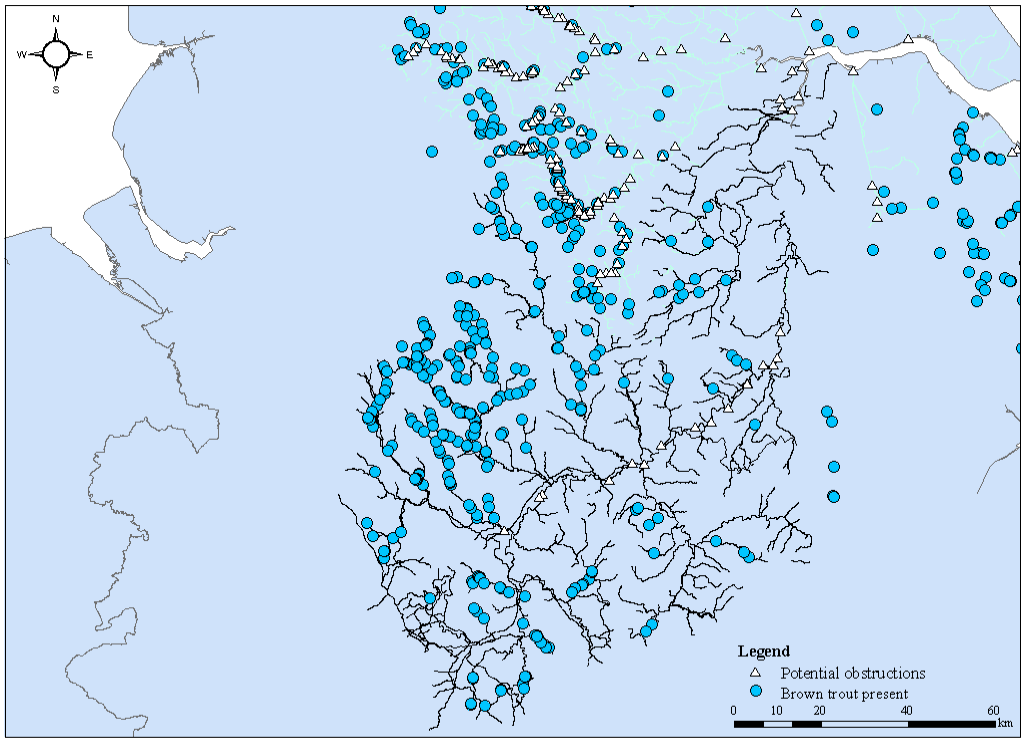

Fig. 34 The River Trent catchment, showing distribution of trout

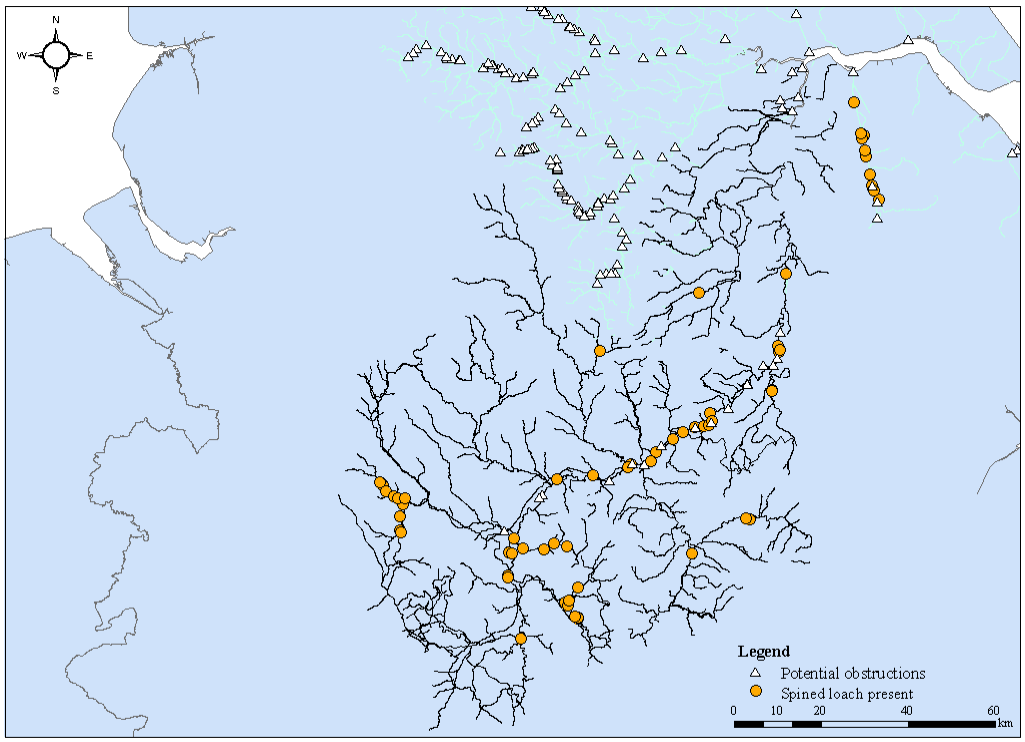

Fig. 35 The River Trent catchment, showing distribution of spined loach

Indeed, the River Mease, a tributary of the Trent, is designated as a SAC due to its populations of spined loach (and bullhead)[3].

There appears to be only one record of white-clawed crayfish from the Trent itself (downstream of Stafford, 1988), while there are three records of signal crayfish; one at Farndon, another at Kelham (both near Newark) and the third downstream of the Tame confluence (EA, unpublished data). In addition, a population of non-native spiny-cheek crayfish (*Orconectes limosus* (Rafinesque)) is present in Attenborough gravel pits (Holdich & Black, 2007), adjacent to the confluence of the River Erewash with the Trent. However, the Peak District Dales, notably the River Dove, are designated as a SAC for their populations of white-clawed crayfish[2], and the species is also a qualifying feature of the River Mease SAC[3]. Notwithstanding, the full distribution of crayfish in the Trent is unknown as few targeted surveys have been conducted.

Although eel stocks are substantially lower than historically, the Trent appears to provide an abundance of suitable habitat for the species, and should be a major contributor to the eel stocks of the Humber Estuary. Thus, **the middle and lower reaches of the River Trent are designated as MEDIUM PRIORITY for elver stocking due to the low densities of eel present and the general absence of conservation species** (Table 7). The main exception is spined loach, for which the Trent is of national importance. It is recommended, therefore, that surveys are undertaken to establish the full distribution of spined loach in the Trent, so that stocking areas and strategies can be selected to minimise potential harm to the conservation status of the species. Ideally, stocking should be conducted in addition to, not instead of, mechanisms to increase natural immigration into the river.

[3] see http://www.jncc.gov.uk/protectedsites/sacselection/sac.asp?EUcode=UK0030258

The area considered most appropriate for stocking is the stretch from Alrewas (~200 km from estuary) downstream to Holme Sluices (~125 km from estuary) (Table 7), due mainly to the greater quantity of habitat compared with other stretches. In particular, the stretch from Thrumpton to Holme Sluices includes a large area of on-line stillwaters (e.g Attenborough Nature Reserve, Colwick Park) and the confluence of the River Erewash, which may provide suitable habitat for eel. Although outwith the scope of the present study, a number of major tributaries, such as the River Soar, may also be suitable for stocking. It is recommended that stocking is undertaken at a series of locations within this stretch and, ideally, on a number of occasions (i.e. trickle stocking). There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel, although power stations may be an exception. For example, fish are entrained/impinged at the power stations at Ratcliffe-on-Soar and Keadby, although few eel have been reported from the former site (Carter & Reader, 2000; Jacklin, 2006), and there are plans to restore a number of decommissioned power stations (Drakelow, High Marnham, Staythorpe and West Burton) by 2015 (T. Jacklin, pers. comm.). There is also a hydropower scheme on the weir at Beeston, although there is a fish pass and a navigation lock, but the deflector screens are poor and could impact upon downstream migrating eel (T. Jacklin, pers. comm.). Monitoring programmes should be instigated to investigate the impacts of such potential impediments on the eel populations of the Trent catchment.

6.5 River Don

Eel are present in the middle and lower reaches of the River Don (Section 5.9), but densities are substantially poorer than in many of the other major rivers in the Humber catchment. Much of the upper Don catchment is characterised by brown trout and bullhead (Amisah & Cowx, 2000a, b; Harvey & Cowx, 2004a, b), and so was not considered for stocking of elvers, but these species are uncommon in the middle and lower reaches of the river (Figs 36 & 37; Harvey *et al*., 2004; Nunn *et al*., 2007c), offering the potential for stocking. Lampreys (probably brook lamprey) are present in small numbers in the River Rivelin and Ea Beck, tributaries of the Don, but there is only one record for Don itself (Sprotbrough Weir) (Fig. 38; Vesey, 2004; Bradbury, 2005). It is possible, however, that lampreys may be more widely distributed than realised as no targeted surveys have been conducted. Similarly, there are few records for salmon and none for spined loach (EA, unpublished data).

Populations of white-clawed crayfish exist in some tributaries of the upper River Don (e.g. the River Sheaf), although there appear to be no records for the Don itself, and there is a single record for signal crayfish downstream of Sprotbrough Weir (Figs 39 & 40). Thus, **the lower and middle reaches of the River Don are designated as HIGH PRIORITY for elver stocking due to the low densities of eel present and the general absence of conservation species** (Table 7). **The area considered most appropriate for stocking is the stretch from Blackburn Meadows (~76 km from estuary) downstream to Crimpsall (~46 km from estuary)** (Table 7), due mainly to the low abundance of conservation species compared with upstream. It is recommended that stocking is undertaken at a series of locations within this stretch and, ideally, on a number of occasions (i.e. trickle stocking). Before a final decision is made on the stocking areas, however, the likelihood of pollution incidents must be assessed. If periodic water quality problems are prominent, the possibility of stocking being

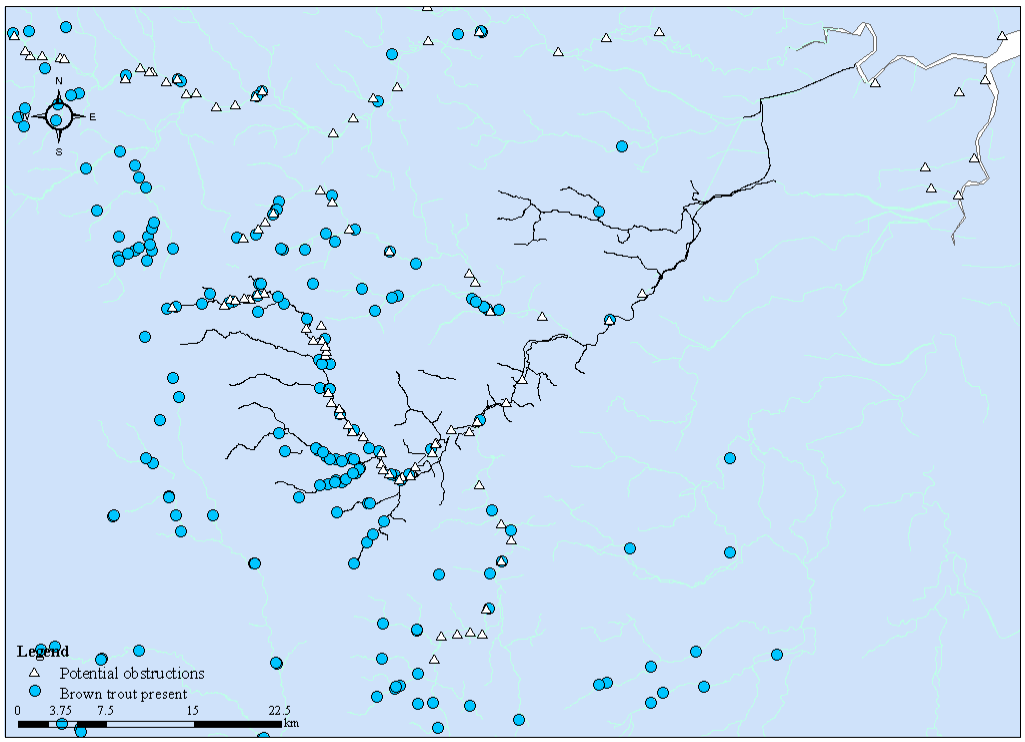

Fig. 36 The River Don catchment, showing distribution of trout

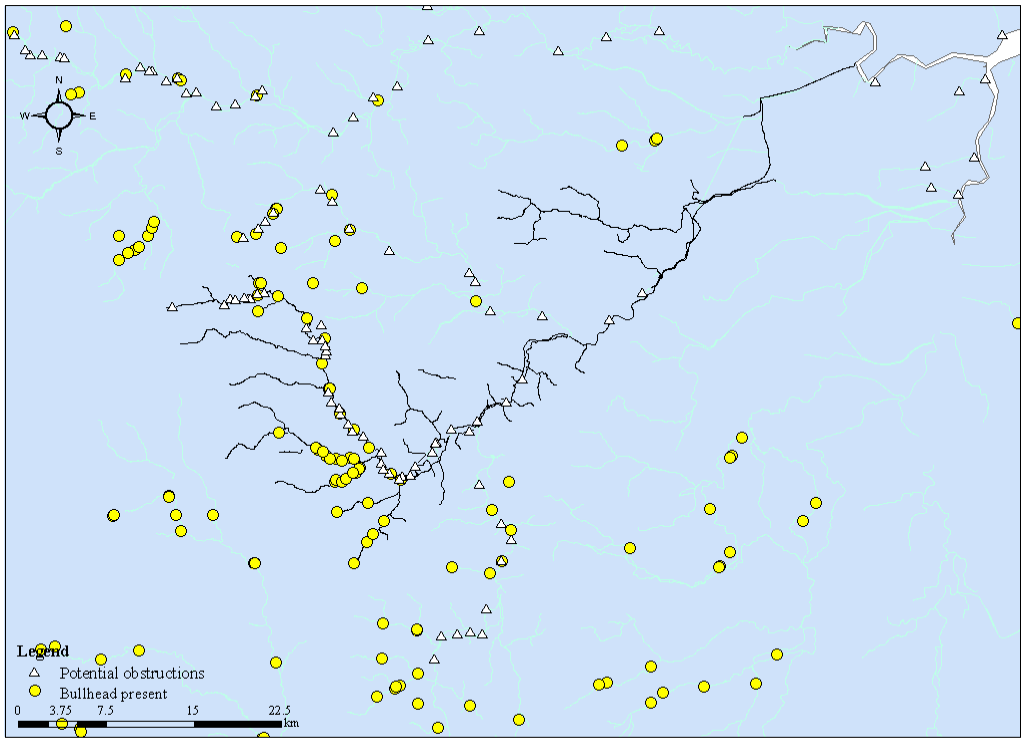

Fig. 37 The River Don catchment, showing distribution of bullhead

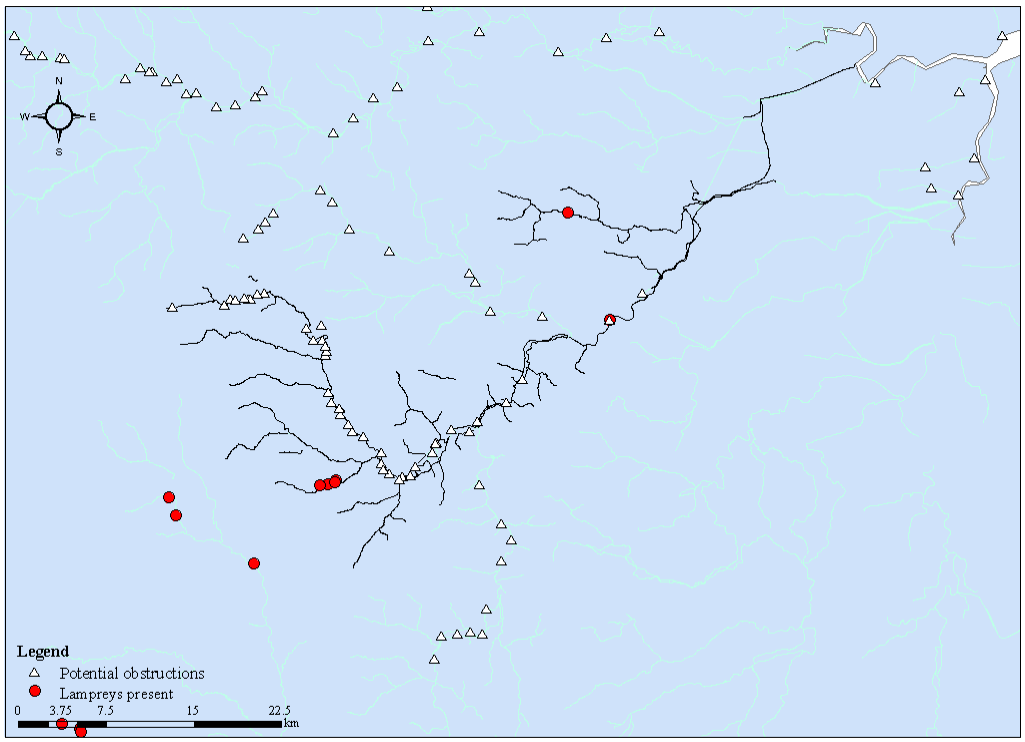

Fig. 38 The River Don catchment, showing distribution of lampreys

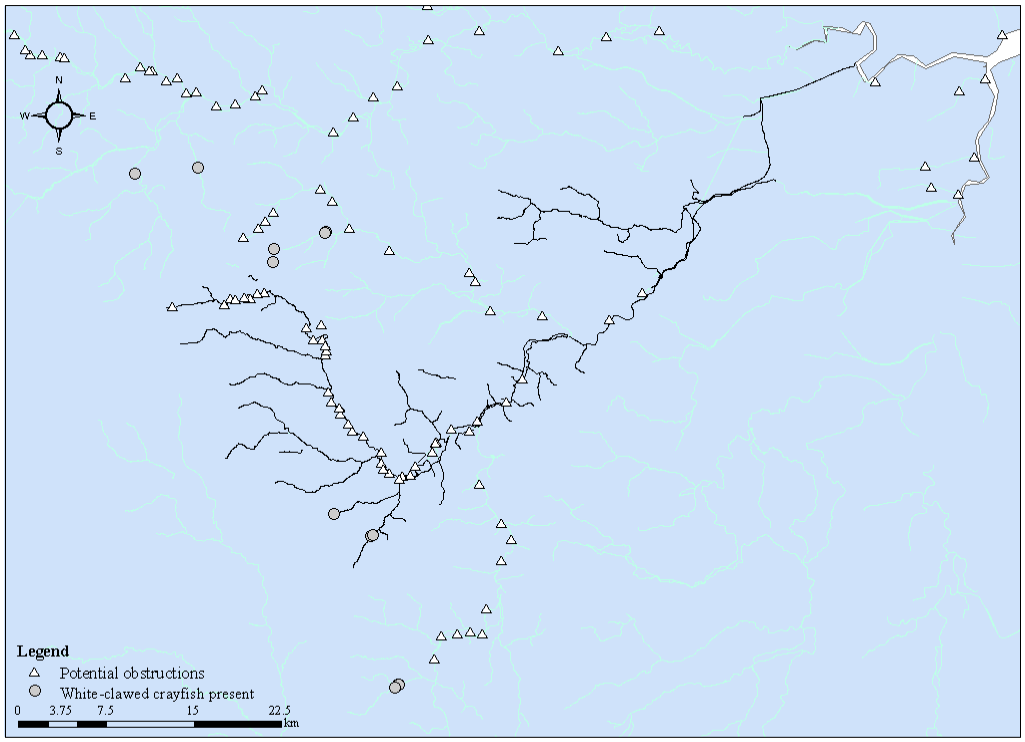

Fig. 39 The River Don catchment, showing distribution of white-clawed crayfish

successful is reduced and may be a waste of valuable stocking material that could be used more successfully elsewhere. There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel, with most obstructions passable either over weir sills or through navigation locks.

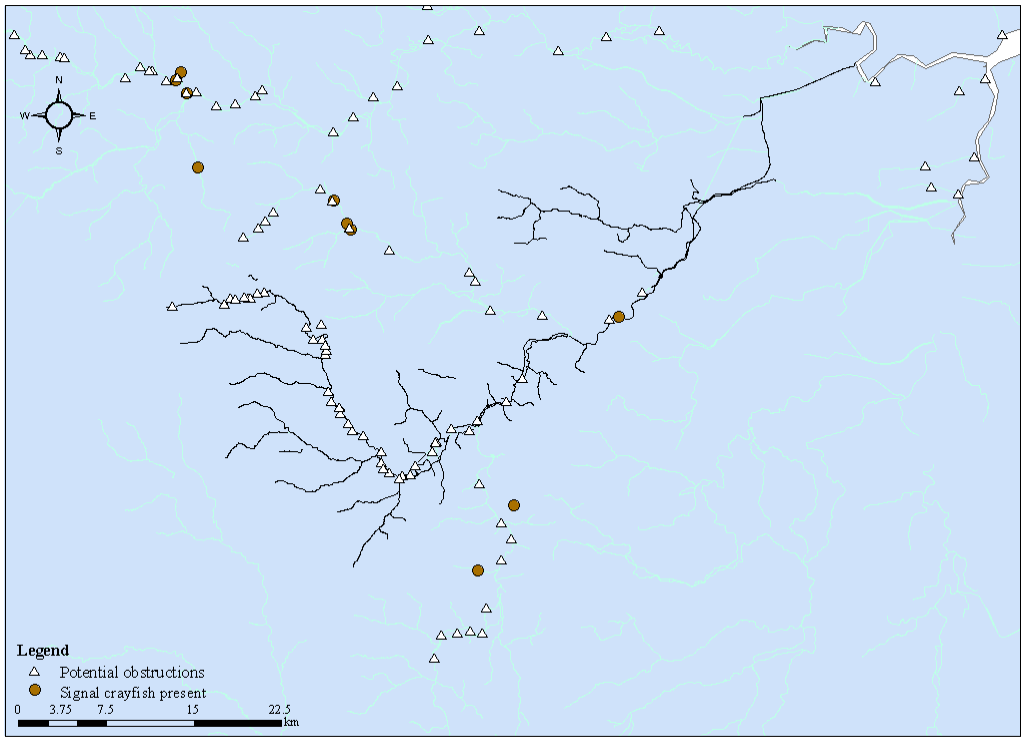

Fig. 40 The River Don catchment, showing distribution of signal crayfish

6.6 River Rother

Eel appear to be absent from the River Rother (Section 5.10). Much of the upper Rother catchment, especially the tributaries, is characterised by brown trout and bullhead (Figs 41 & 42; Amisah & Cowx, 2000a, b; Harvey & Cowx, 2004b), and was therefore not considered for stocking of elvers. However, despite these species also occurring in the middle and lower reaches of the main stem of the Rother, they are generally only minor components of the fish community, and there are no records for salmon and spined loach (EA, unpublished data). Similarly, there appear to be no records of lampreys in the Rother (Vesey, 2004; Bradbury, 2005; EA, unpublished data), although no targeted surveys have been conducted.

Populations of white-clawed crayfish exist in some tributaries of the upper River Rother, such as the River Hipper, but there appear to be no records for the Rother itself (Fig. 43), and there are no records for non-native crayfish (EA, unpublished data). Thus, **the middle and lower reaches of the River Rother are designated as HIGH PRIORITY for elver stocking due to the low densities of eel present and the general absence of conservation species** (Table 7). **The area considered most appropriate for stocking is the stretch from Stavely (~99 km from estuary) downstream to Killamarsh (~90 km from estuary)** (Table 7), due to the superior quality of habitat compared with other stretches. It is recommended that stocking is undertaken at a series of locations within this stretch and, ideally, on a number of

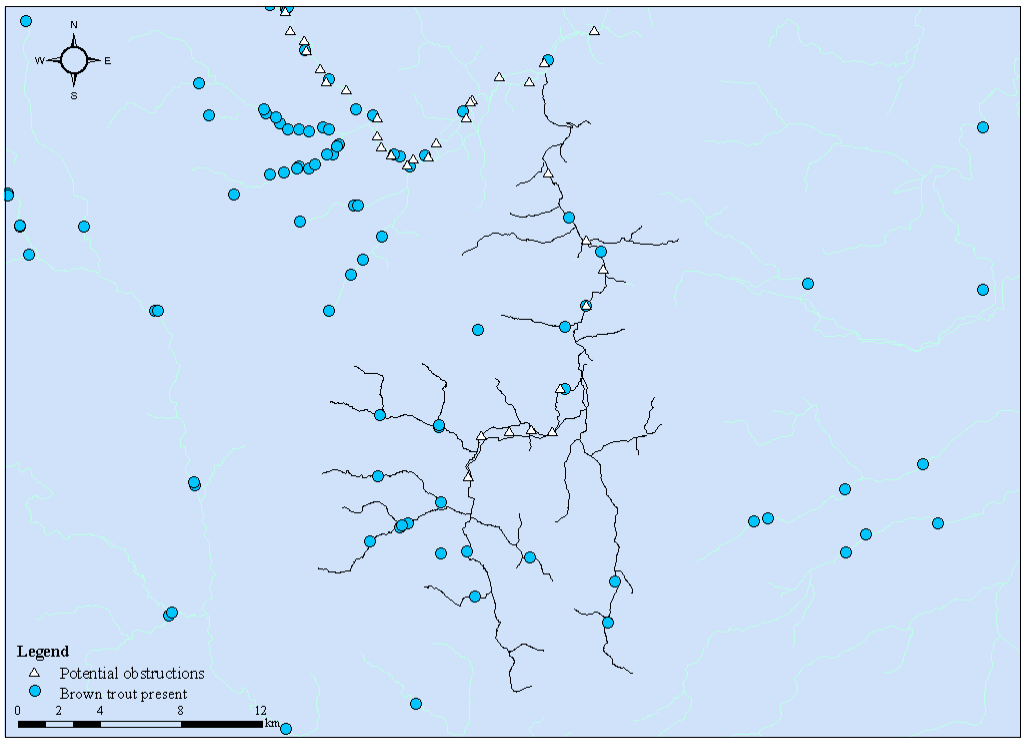

Fig. 41 The River Rother catchment, showing distribution of trout

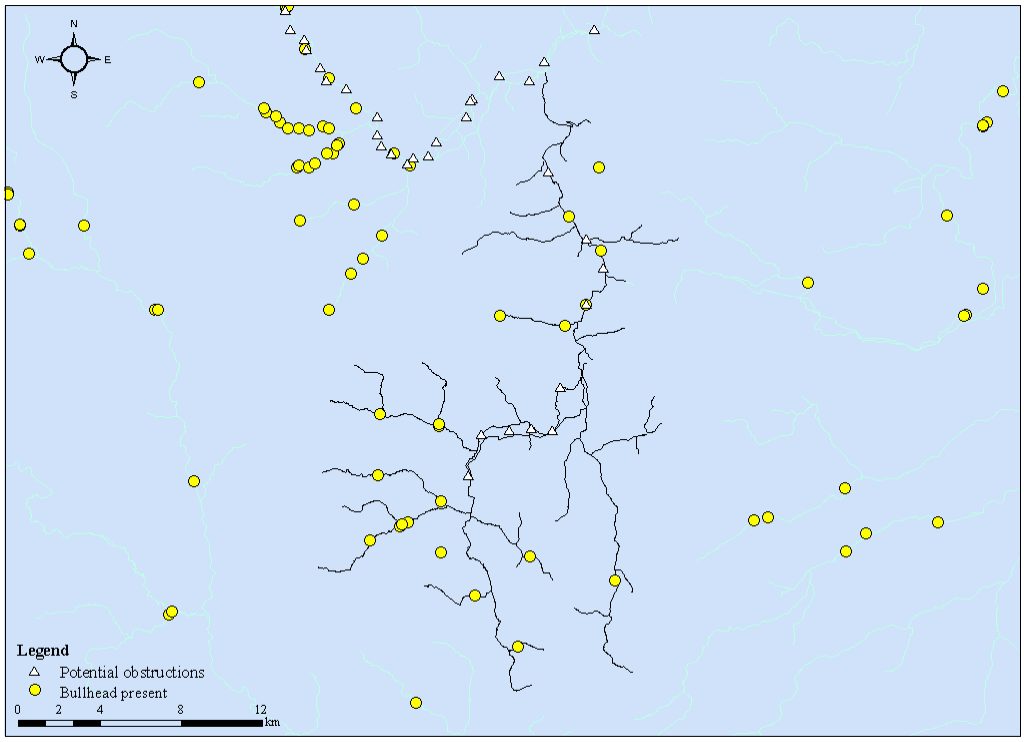

Fig. 42 The River Rother catchment, showing distribution of bullhead

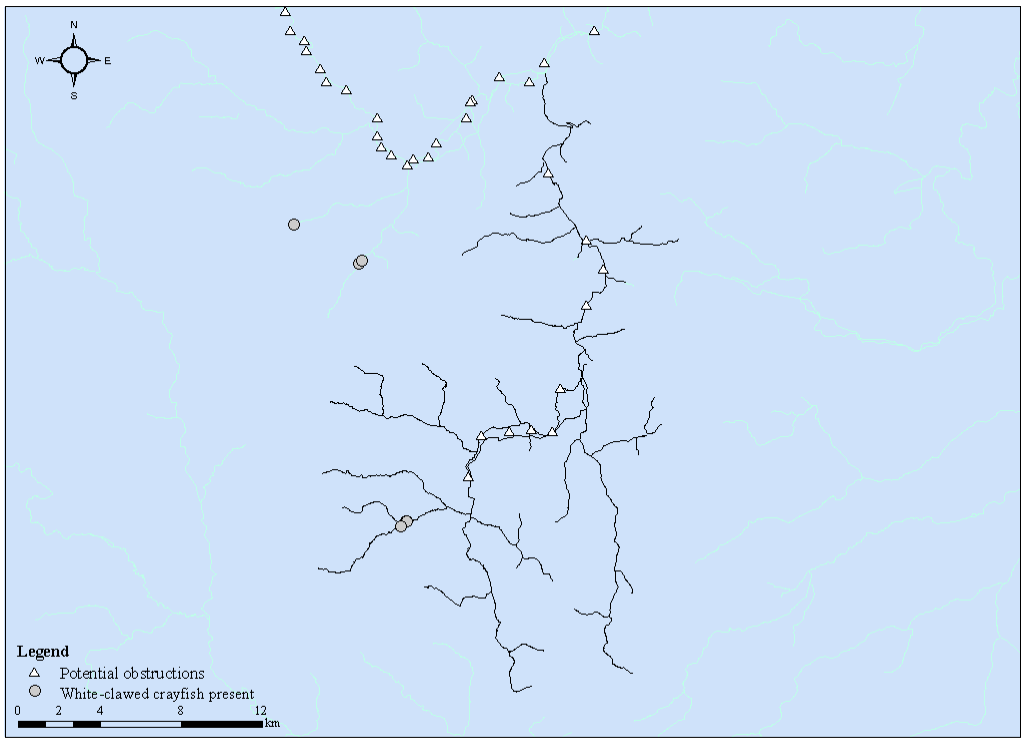

Fig. 43 The River Rother catchment, showing distribution of white-clawed crayfish

occasions (i.e. trickle stocking). As with the River Don, due consideration should be given to water quality issues that may impact upon stocking success before sites are finalised. There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel, with most obstructions passable either over weir sills or through navigation locks.

6.7 River Dearne

Eel appear to be present in only very small numbers in the River Dearne (Section 5.11). Much of the upper Dearne catchment, especially the tributaries, is characterised by brown trout and bullhead (Figs 44 & 45; Amisah & Cowx, 2000a, b; Harvey & Cowx, 2004b), and was therefore not considered for stocking of elvers. However, despite these species also occurring in the middle and lower reaches of the main stem of the Dearne, they are generally only minor components of the fish community, and there are no records for salmon and spined loach (EA, unpublished data). Similarly, there appear to be no records of lampreys in the Dearne (Vesey, 2004; Bradbury, 2005; EA, unpublished data), although no targeted surveys have been conducted.

Populations of white-clawed crayfish exist in some tributaries of the upper River Dearne, although there appear to be no records for the Dearne itself (Fig. 46), but there are a few records for signal crayfish (Fig. 47). Thus, **the middle and lower reaches of the River Dearne are designated as HIGH PRIORITY for elver stocking due to the low densities of eel present and the general absence of conservation species** (Table 7). **The area considered most appropriate for stocking is the stretch from Barnsley (~78 km from estuary) downstream to Adwick upon Dearne (~59 km from estuary)** (Table 7), due mainly to the low abundance of conservation species compared with upstream. It is recommended that stocking is undertaken at a series of locations within

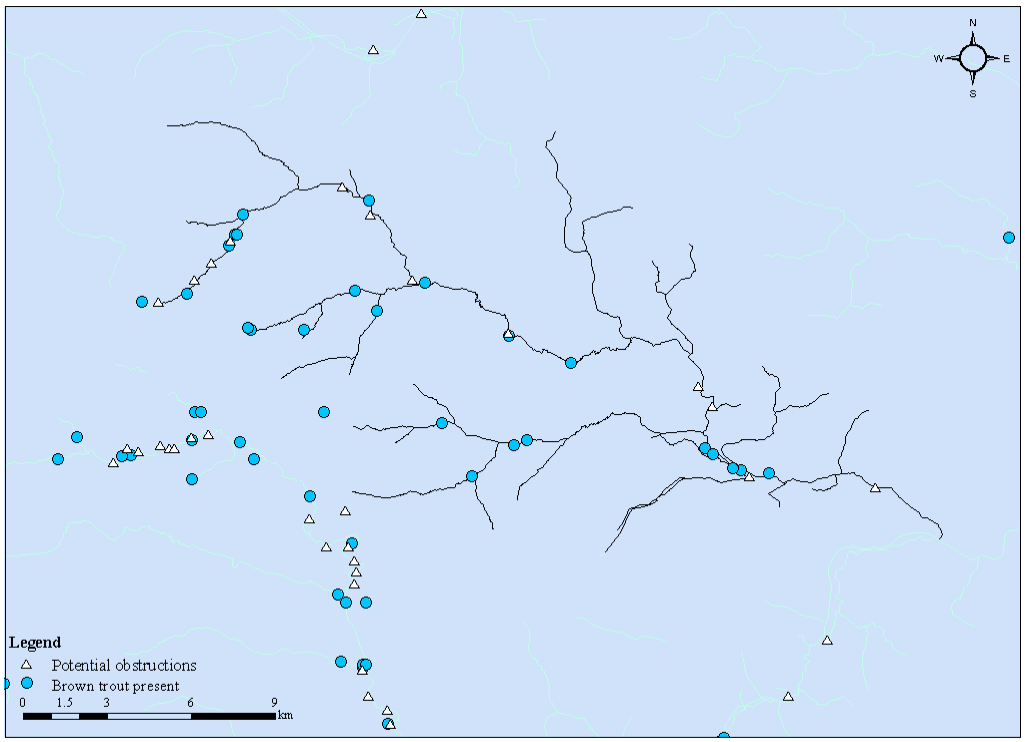

Fig. 44 The River Dearne catchment, showing distribution of trout

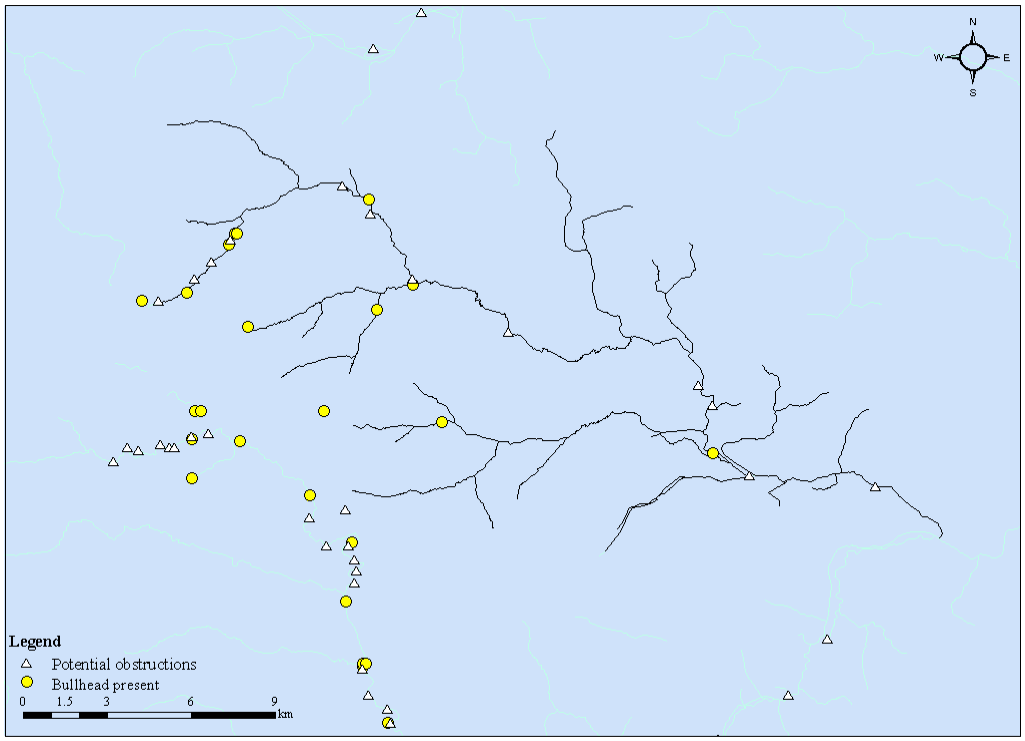

Fig. 45 The River Dearne catchment, showing distribution of bullhead

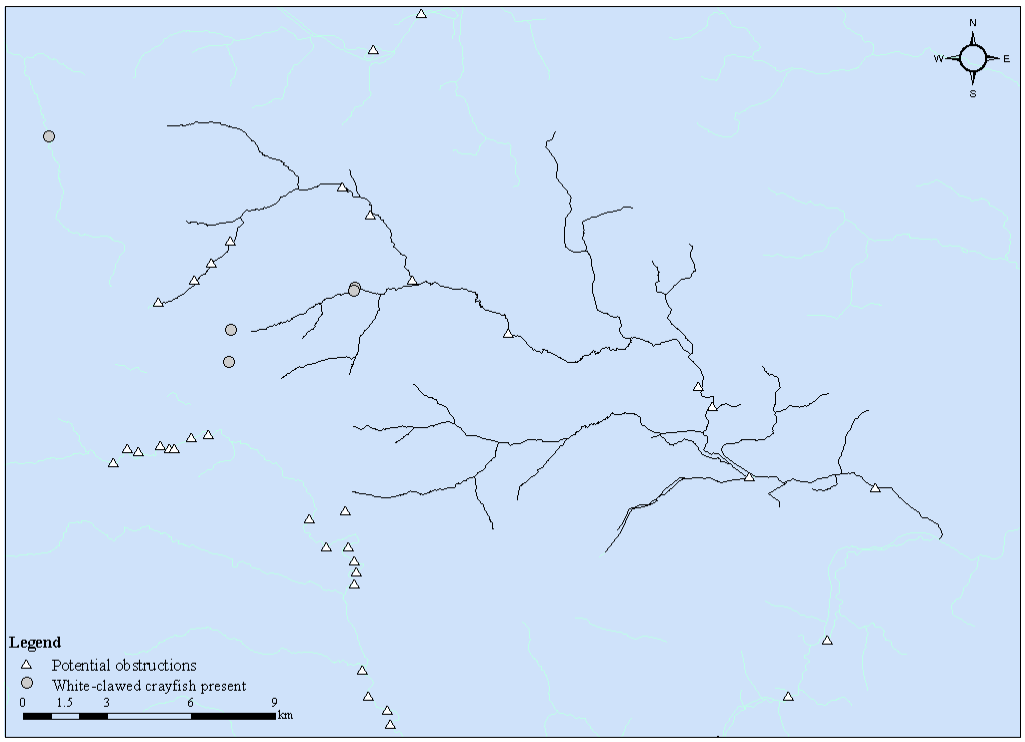

Fig. 46 The River Dearne catchment, showing distribution of white-clawed crayfish

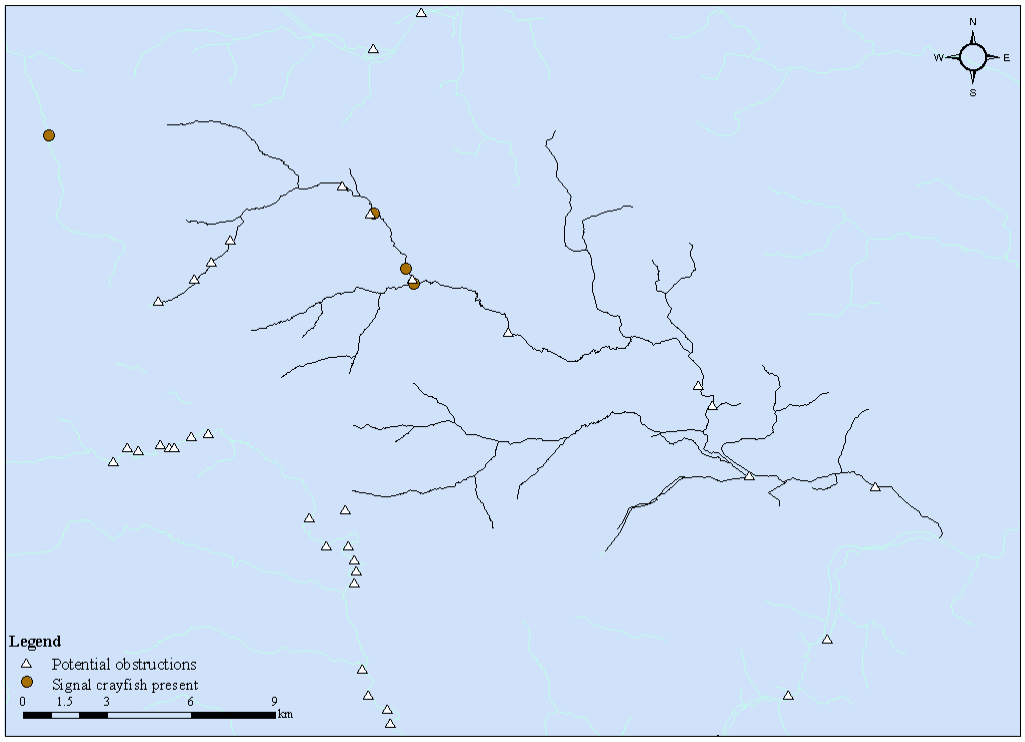

Fig. 47 The River Dearne catchment, showing distribution of signal crayfish

this stretch and, ideally, on a number of occasions (i.e. trickle stocking). As with the rivers Don and Rother, due consideration should be given to water quality issues that may impact upon stocking success before sites are finalised. There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel, with most obstructions passable either over weir sills or through navigation locks.

6.8 River Aire

Very few eel have been recorded from the River Aire, with a number of the records probably originating from small-scale stocking events (Section 5.12). Much of the upper Aire catchment, particularly the tributaries, is characterised by brown trout and bullhead (Figs 48 & 49; Harvey & Cowx, 2004b), and so was not considered for stocking of elvers. However, although these species also occur in the middle and lower reaches of the main stem of the Aire, they are generally only minor components of the fish community, and there are no records for salmon or spined loach (EA, unpublished data). Lampreys (probably brook lamprey) are present in the River Aire from Malham downstream to at least Bingley, and also in a number of tributaries of the upper reaches (e.g. River Worth and Winterburn Beck) (Fig. 50; Vesey, 2004; Bradbury, 2005; Harvey & Cowx, 2006). It is possible, however, that lampreys may be more widely distribution than realised as no targeted surveys have been conducted.

White-clawed crayfish are present in a number of tributaries of the upper (e.g. Winterburn Beck) and lower reaches (e.g. Meanwood Beck) of the River Aire, but there are few records from the Aire itself (Fig. 51). However, there are two records of signal crayfish from the main stem of the Aire; both between Skipton and Keighley (Fig. 52). Thus, **the middle and lower reaches of the River Aire are designated as HIGH PRIORITY for elver stocking due to the low densities of eel present and the general absence of conservation species** (Table 7). **The area considered most appropriate for stocking is the stretch from Baildon (~111 km from estuary) downstream to Chapel Haddlesey (~48 km from estuary)** (Table 7), due mainly to the low abundance of conservation species compared with upstream. In addition, there is a large area of stillwaters in the floodplain of the lower reaches, which may provide suitable habitat for eel, although connectivity with the river is limited. It is recommended that stocking is undertaken at a series of locations within this stretch and, ideally, on a number of occasions (i.e. trickle stocking). Before a final decision is made on the stocking areas, however, the likelihood of pollution incidences must be assessed. In addition, it is recommended that surveys are undertaken to establish the full distribution of lampreys in the Aire, so that stocking areas and strategies can be selected to minimise potential harm to the conservation status of the species. There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel, although power stations may be an exception. For example, eel may also be impinged/entrained at the power stations on the Aire at Eggborough and Ferrybridge, although no surveys appear to have been conducted.

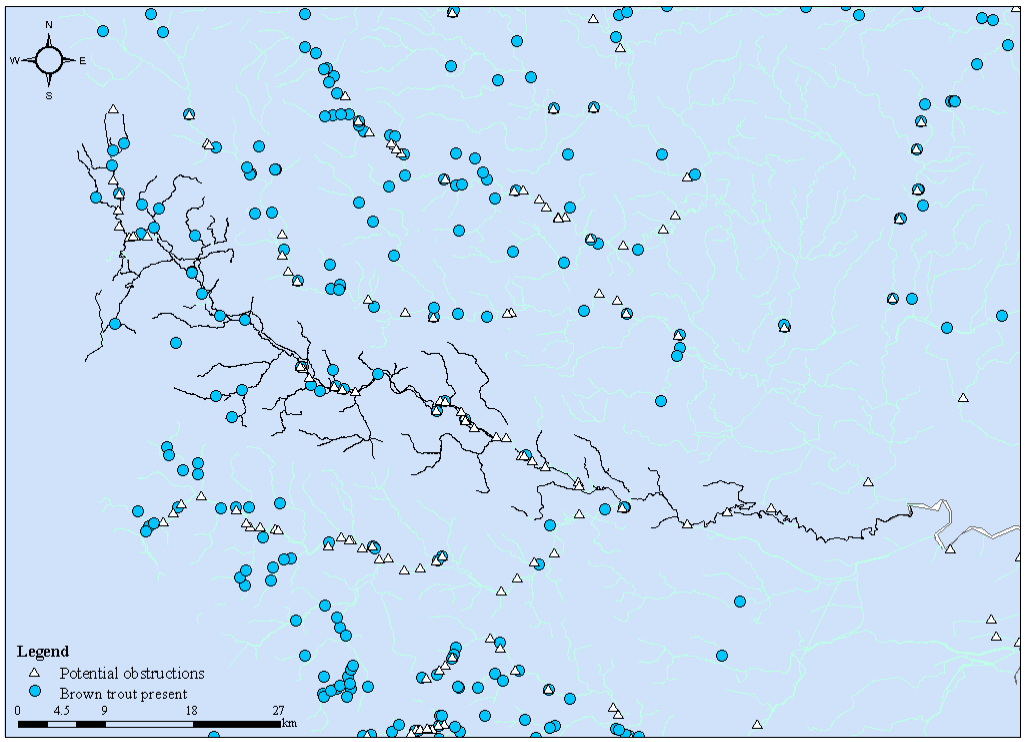

Fig. 48 The River Aire catchment, showing distribution of trout

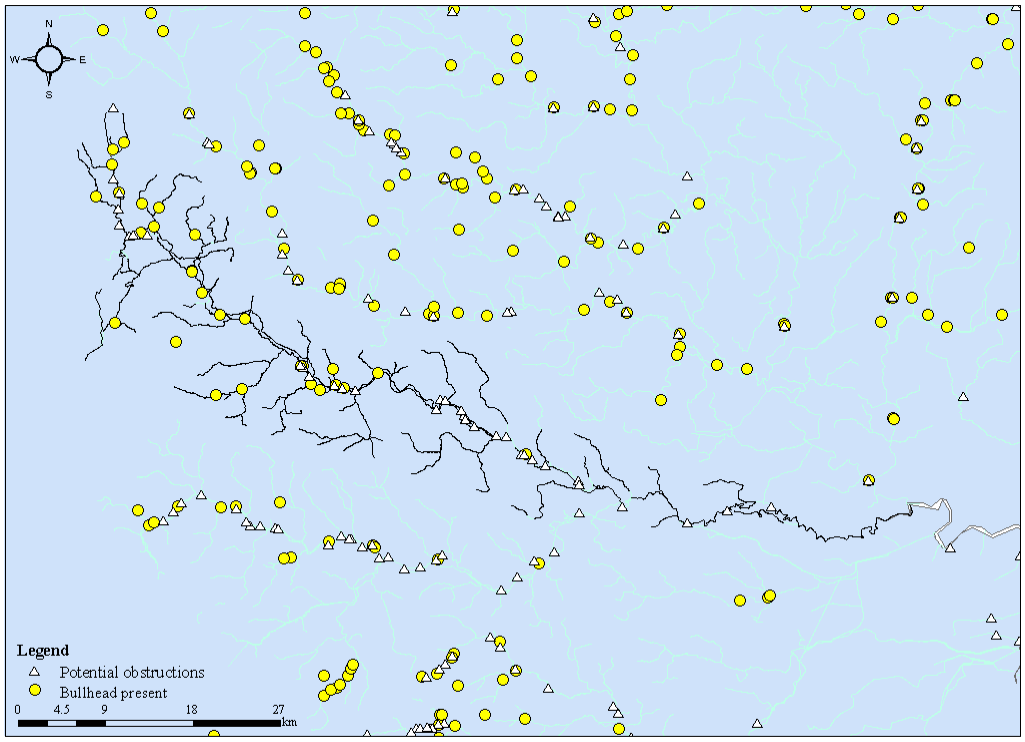

Fig. 49 The River Aire catchment, showing distribution of bullhead

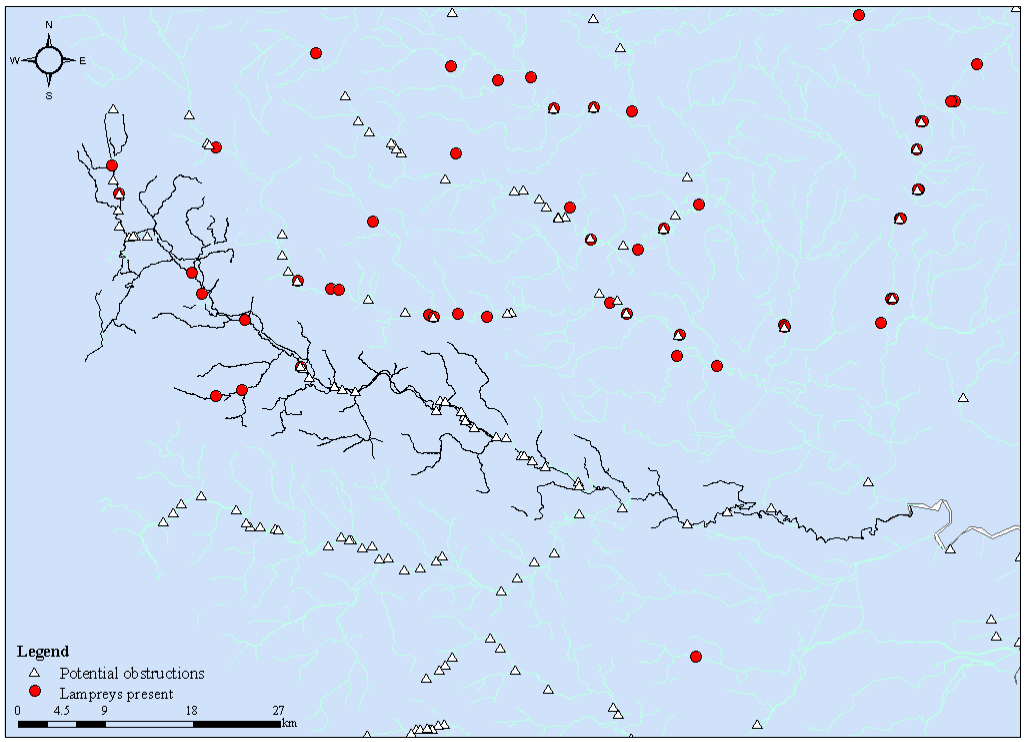

Fig. 50 The River Aire catchment, showing distribution of lampreys

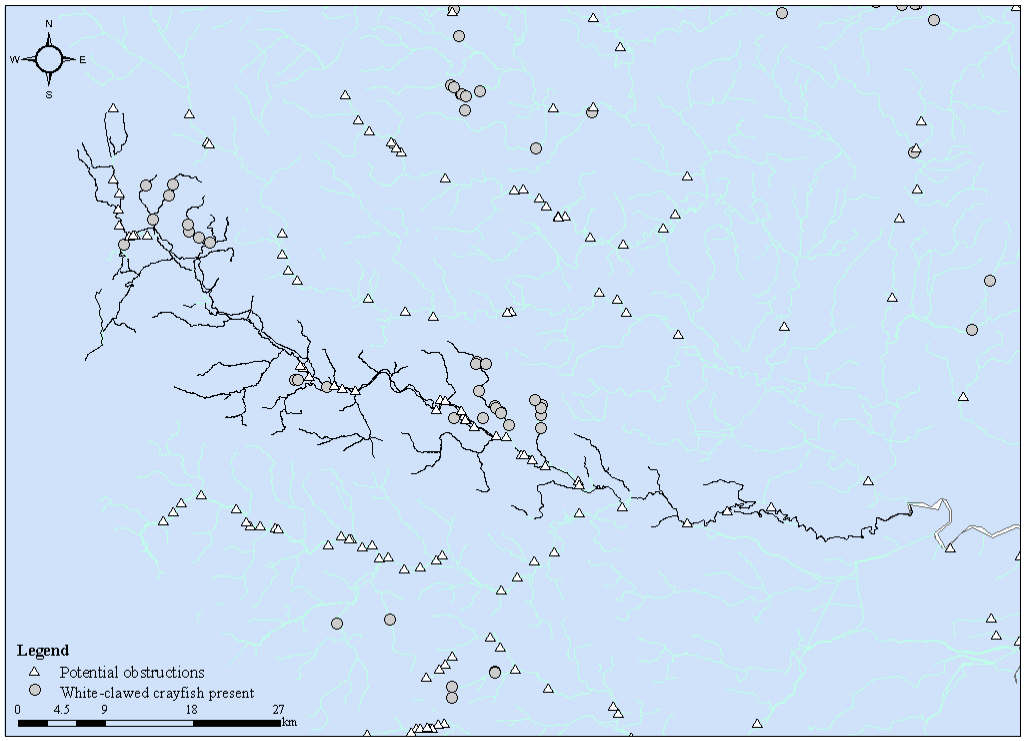

Fig. 51 The River Aire catchment, showing distribution of white-clawed crayfish

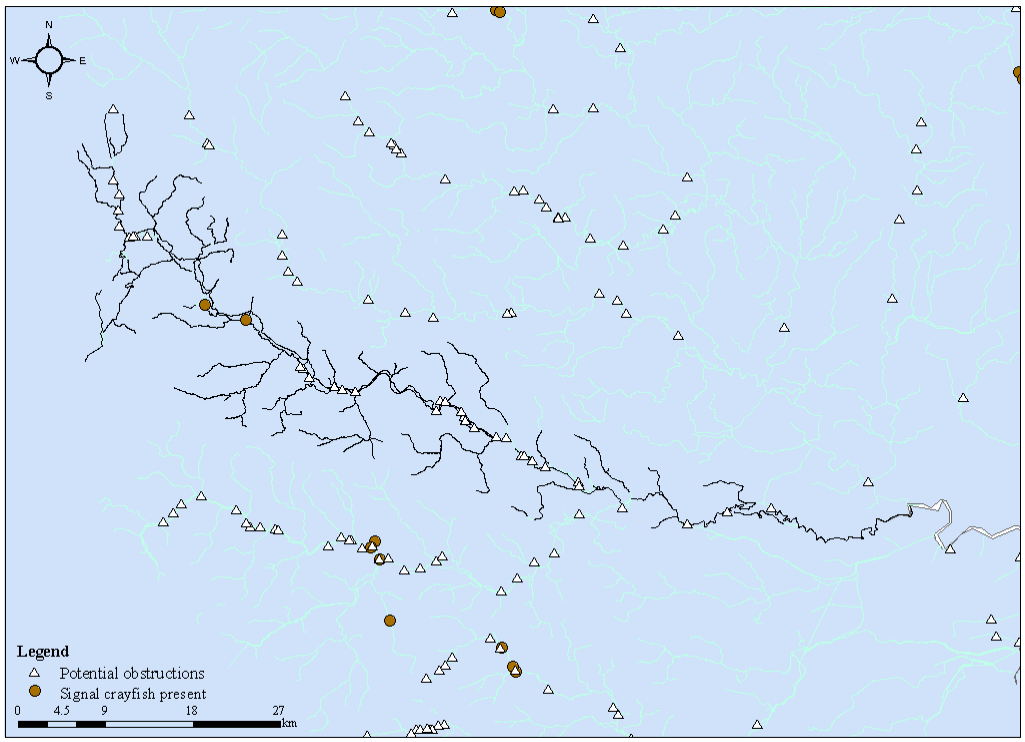

Fig. 52 The River Aire catchment, showing distribution of signal crayfish

6.9 River Calder

Very few eel have been recorded from the River Calder, with the only record restricted to a single fish probably originating from small-scale stocking events (Section 5.13). Much of the upper Calder catchment, particularly the tributaries, is characterised by brown trout and bullhead (Figs 53 & 54; Harvey & Cowx, 2004a, b), and so was not considered for stocking of elvers. However, although these species also occur in the middle and lower reaches of the main stem of the Calder, they are generally only minor components of the fish community, and there are no records for salmon, spined loach or lampreys (Vesey, 2004; Bradbury, 2005; EA, unpublished data). It is possible, however, that lampreys may be present in the catchment, but no specific surveys have been conducted.

White-clawed crayfish are present in a small number of tributaries of the middle reaches of the River Calder (e.g. Fenay Beck and Dean Brook), but there are no records for the Calder itself (Fig. 55). However, there are a number of records of signal crayfish in the main stem of the Calder around Brighouse (Fig. 56). Thus, **the middle and lower reaches of the River Calder are designated as HIGH PRIORITY for elver stocking due to the low densities of eel present and the general absence of conservation species** (Table 7). **The area considered most appropriate for stocking is the stretch from Brighouse (~120 km from estuary) downstream to Methley (~77 km from estuary) (downstream of Saville in particular)** (Table 7), due mainly to the low abundance of conservation species compared with upstream. In addition, there is a large area of stillwaters in the floodplain of the lower reaches, which may provide suitable habitat for eel, although connectivity with the river is limited. It is recommended that stocking is undertaken at a series of locations within this stretch and, ideally, on a number of occasions (i.e. trickle stocking). Before a final decision is made on the

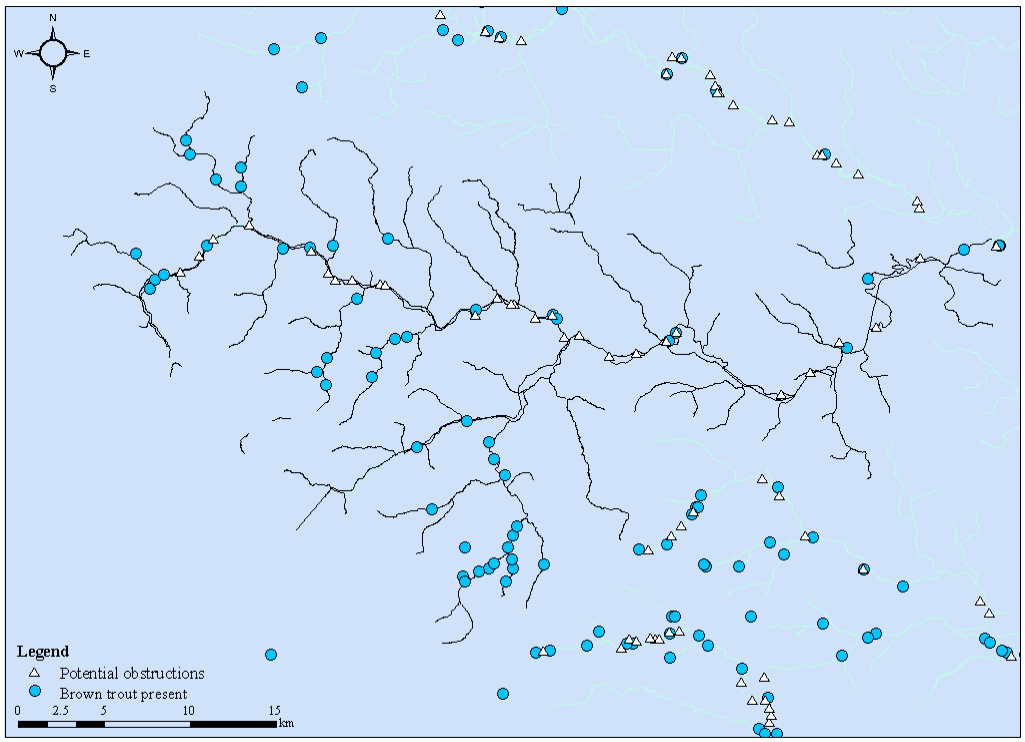

Fig. 53 The River Calder catchment, showing distribution of trout

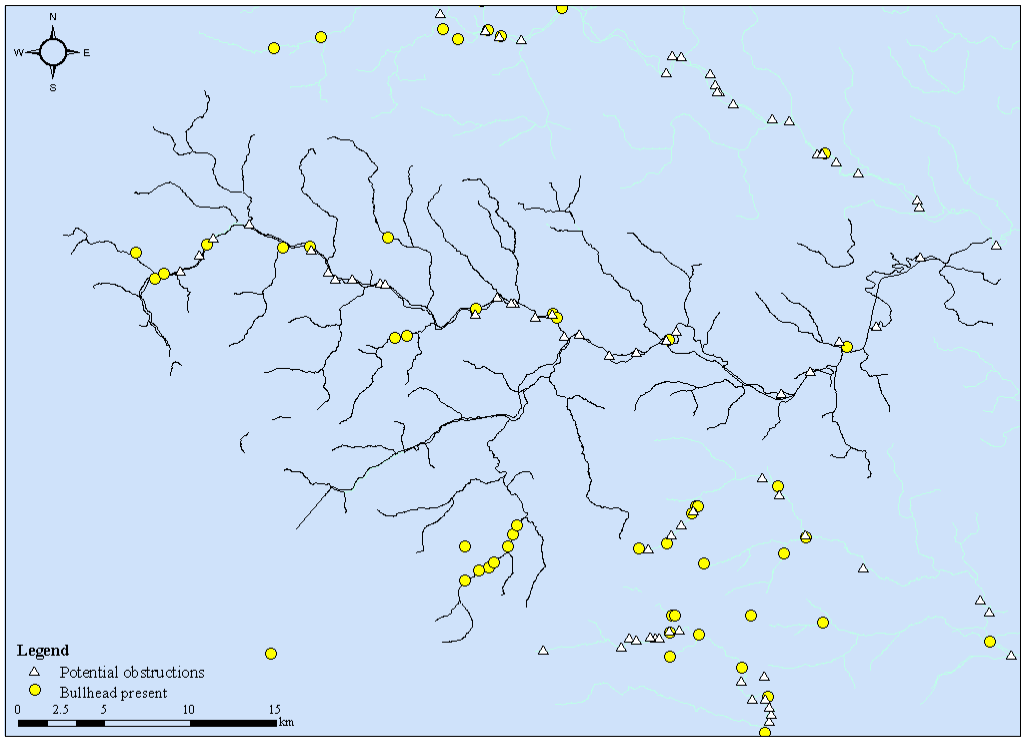

Fig. 54 The River Calder catchment, showing distribution of bullhead

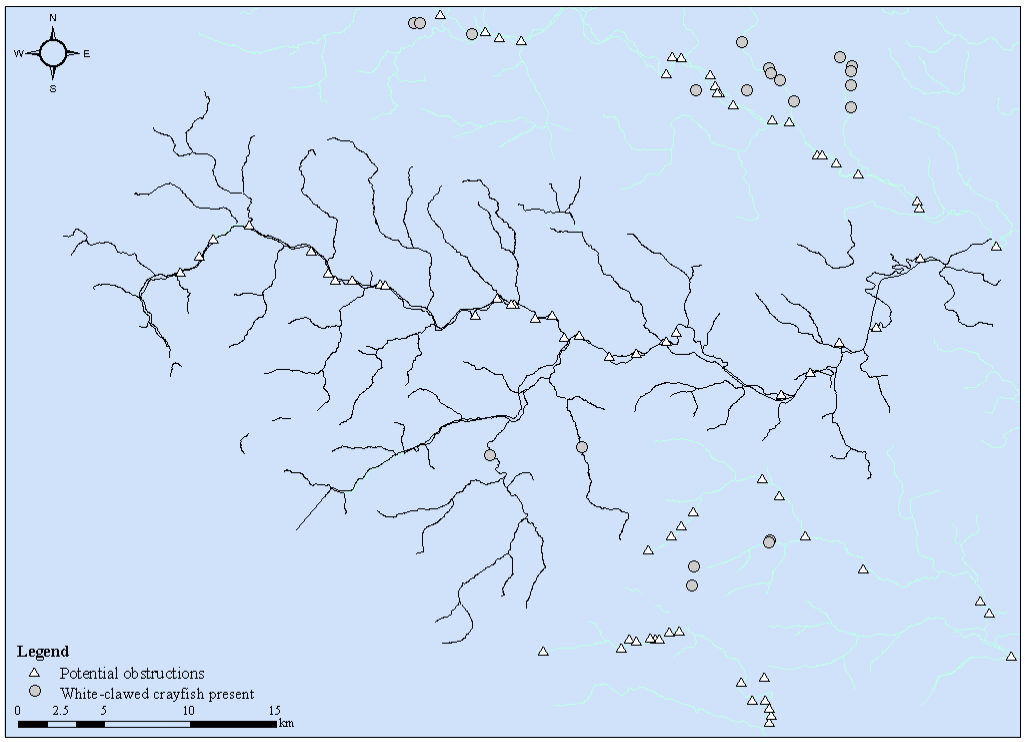

Fig. 55 The River Calder catchment, showing distribution of white-clawed crayfish

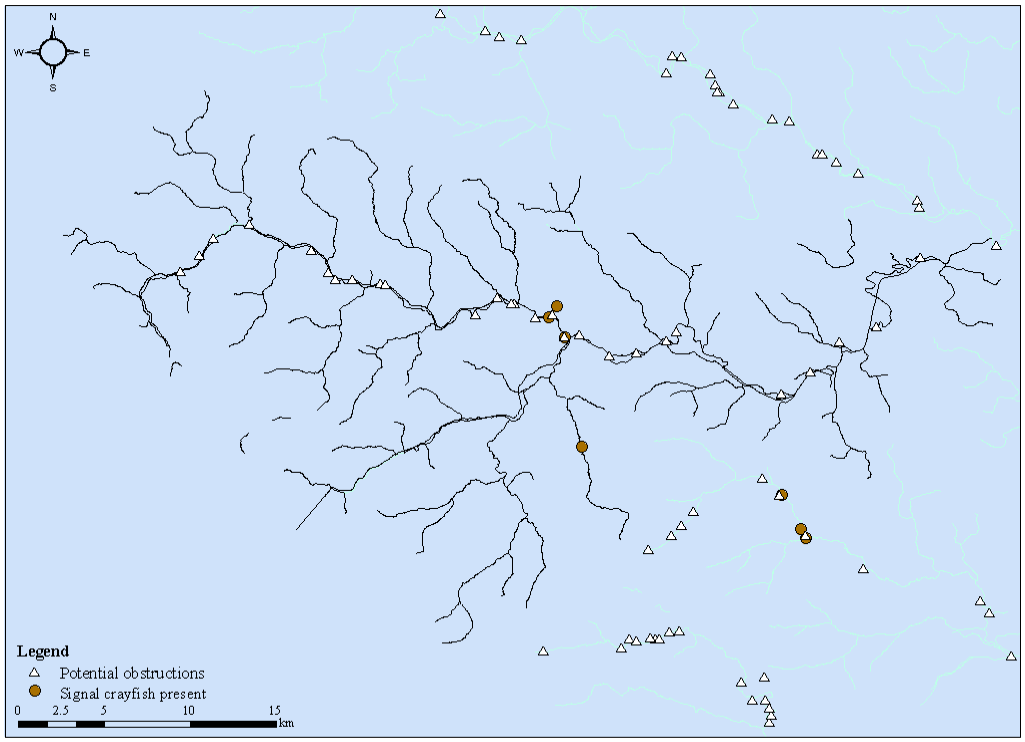

Fig. 56 The River Calder catchment, showing distribution of signal crayfish

stocking areas, however, the likelihood of pollution incidences must be assessed. There are a number of potential impediments to downstream migration of eel, although these are mostly on the Aire (see Section 6.8) rather than the Calder itself.

6.10 River Ancholme

Eel are present throughout most of the River Ancholme (Section 5.14) and, indeed, there is a licensed eel fishery on the lower reaches (Firth, 2001). There are records of brown trout in a small number of tributaries of the upper Ancholme catchment (Fig. 57), but none for the Ancholme itself, and there are no records for salmon or bullhead (EA, unpublished data). Similarly, there are no records of lampreys in the Ancholme (Vesey, 2004; Bradbury, 2005; EA, unpublished data), although no targeted surveys have been conducted. Although not indigenous to the catchment, spined loach now occur throughout the Ancholme (Fig. 58; P. Thornton, pers. comm.) as a result of a water transfer scheme (Davies *et al*., 2004).

Despite occasional anecdotal records of both white-clawed and signal crayfish, there are no confirmed records of either species in the Ancholme catchment (R. Page, pers. comm.), although no targeted surveys have been conducted. Thus, **the River Ancholme is designated as MEDIUM PRIORITY for elver stocking due to the general absence of conservation species** (Table 7). The main deliberation to whether stocking should take place is spined loach, for which the Ancholme could be, or may become, of importance. It is recommended, therefore, that surveys are undertaken to establish the full distribution of spined loach in the Ancholme, so that stocking areas and strategies can be selected to minimise potential harm to the conservation status of the species. Although eel appear to be relatively abundant in the Ancholme, stocking may increase escapement of silver eel from the Humber catchment. Consideration should also be given to restricting the exploitation of silver eels to aid recovery of the stocks in the long term. **The area considered most appropriate for stocking is the stretch from Harlam Hill Weir (~27 km from estuary) downstream to Ferriby Sluice** (Table 7), due mainly to the greater quantity of habitat compared with other stretches. It is recommended that stocking is undertaken at a series of locations within this stretch and, ideally, on a number of occasions (i.e. trickle stocking). However, there are a number of pumping stations (NGRs: SE 979 127, SE 982 117, SE 995 052, SE 997 040), which could interfere with downstream migration of silver eel, that require consideration.

6.11 Swinefleet Warping Drain

There are no records of eel, trout, salmon, bullhead, lampreys, spined loach or crayfish in Swinefleet Warping Drain, although no surveys appear to have been conducted. Similarly, no RHS surveys have been undertaken on the drain, although habitat quality is considered suitable for eel (Firth, 2001). Thus, **Swinefleet Warping Drain is designated as MEDIUM PRIORITY for elver stocking due to the probable low densities of eel present (due to the flapped outfall) and the likely absence of conservation species** (Table 7). There may, however, be some water quality issues (Firth, 2001), which should be investigated before stocking is undertaken. **It is recommended that stocking is undertaken at a series of locations along the length of the drain and, ideally, on a number of occasions** (i.e. trickle stocking). It is recommended, however, that surveys are undertaken to establish the presence/absence

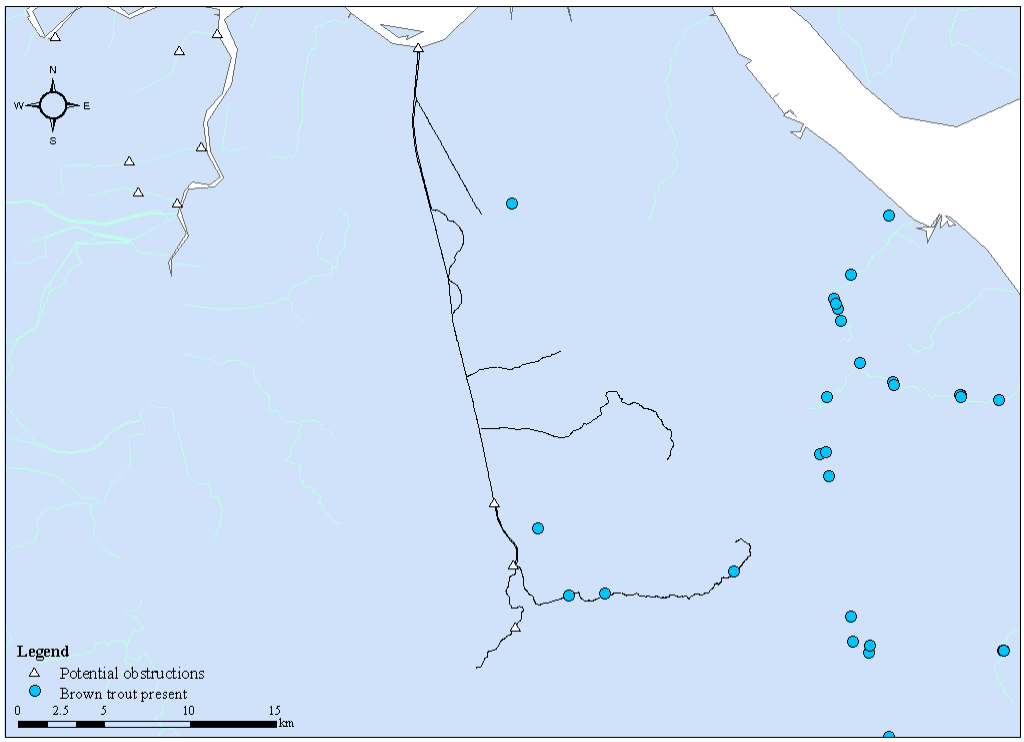

Fig. 57 The River Ancholme catchment, showing distribution of trout

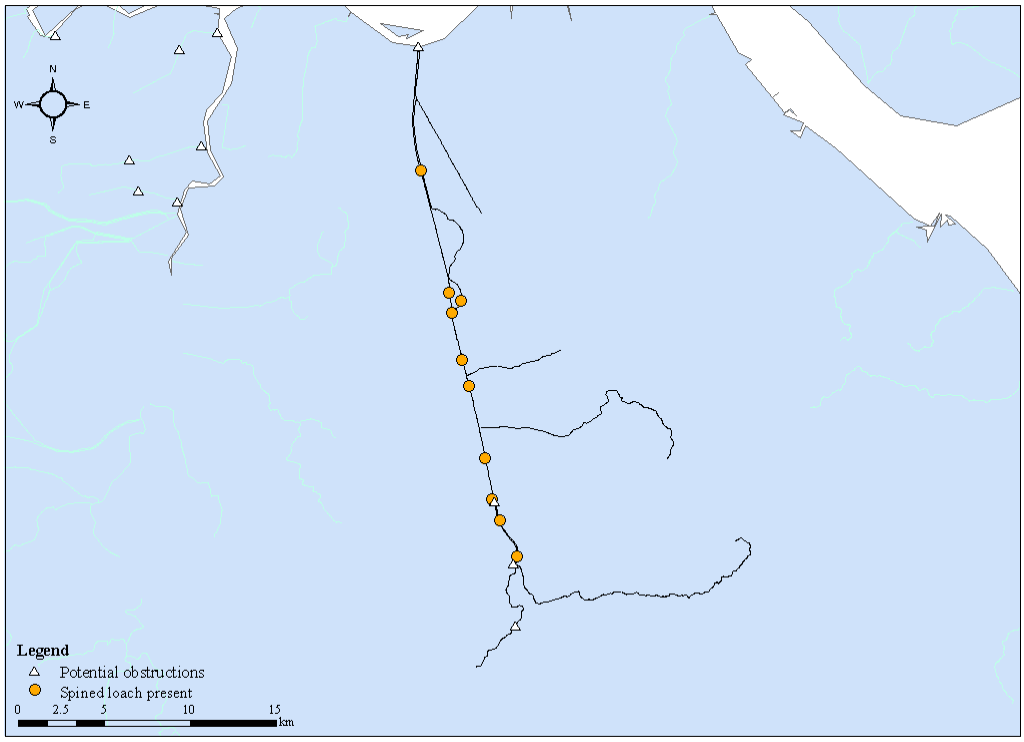

Fig. 58 The River Ancholme catchment, showing distribution of spined loach

and distribution of eel and conservation species in the system prior to stocking. There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel; the outfall at Swinefleet has a cantilever system, which reduces the pressure required to lift the flap, so escapement should be possible under all but very low flow conditions.

6.12 Tetney Haven

Eel are present throughout the Tetney Haven catchment, including Tetney Drain and the Louth Canal (Section 5.17). Brown trout are present in a number of locations in the upper catchment, including Waithe Beck (Cowx *et al*., 2006), a tributary of Tetney Drain, and the Louth Canal (Fig. 59). Similarly, bullhead and lampreys (probably brook lamprey) are present in a number of tributaries of the Louth Canal, with the former species also present in some tributaries of Tetney Drain (Figs 60 & 61). Despite occasional anecdotal records of both white-clawed and signal crayfish, there are no confirmed records of either species in the Tetney Haven catchment (R. Page, pers. comm.), although no targeted surveys have been conducted. Thus, **the Tetney Haven catchment is designated as MEDIUM PRIORITY for elver stocking due to the general absence of conservation species** (Table 7), **although the abundance of eel should be fully evaluated before a final decision is made.** Irrespective, despite eel being present throughout the catchment, it is likely that there is potential for larger populations than exist at present. **The area considered most appropriate for stocking is the stretch from Alvingham (~12 km from estuary) downstream to Tetney Lock (~1 km from estuary)** (Table 7), due mainly to the greater quantity of habitat compared with other stretches. It is recommended that stocking is undertaken at a series of locations within this stretch and, ideally, on a number of occasions (i.e. trickle stocking). There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel.

6.13 Adlingfleet Drain

There are no records of eel, trout, salmon, bullhead, lampreys, spined loach or crayfish in Adlingfleet Drain, although no surveys appear to have been conducted, but habitat quality is considered suitable for eel (Firth, 2001). There may, however, be some water quality issues (Firth, 2001); indeed, there were signs of poor water quality (i.e. discolouration of the water due to the presence of ochre) on a site visit in March 2007. In addition, the pumping station at Cow Lane would be a major impediment to downstream migration of silver eel. Thus, **Adlingfleet Drain is designated as LOW PRIORITY for elver stocking, despite the probable low densities of eel present (due to the flapped outfall) and the likely absence of conservation species, due to water quality issues and impediments to downstream migration** (Table 7). Even if water quality issues can be addressed, **stocking should be restricted to downstream of the sluice and pumping station at Cow Lane**, unless mitigation measures are implemented. However, surveys should be undertaken to establish the presence/absence and distribution of eel and conservation species in the system prior to stocking.

6.14 Pauper's Drain

There are no records of eel, trout, salmon, bullhead, lampreys, spined loach or crayfish in Pauper's Drain (EA, unpublished data), although few fisheries surveys appear to have

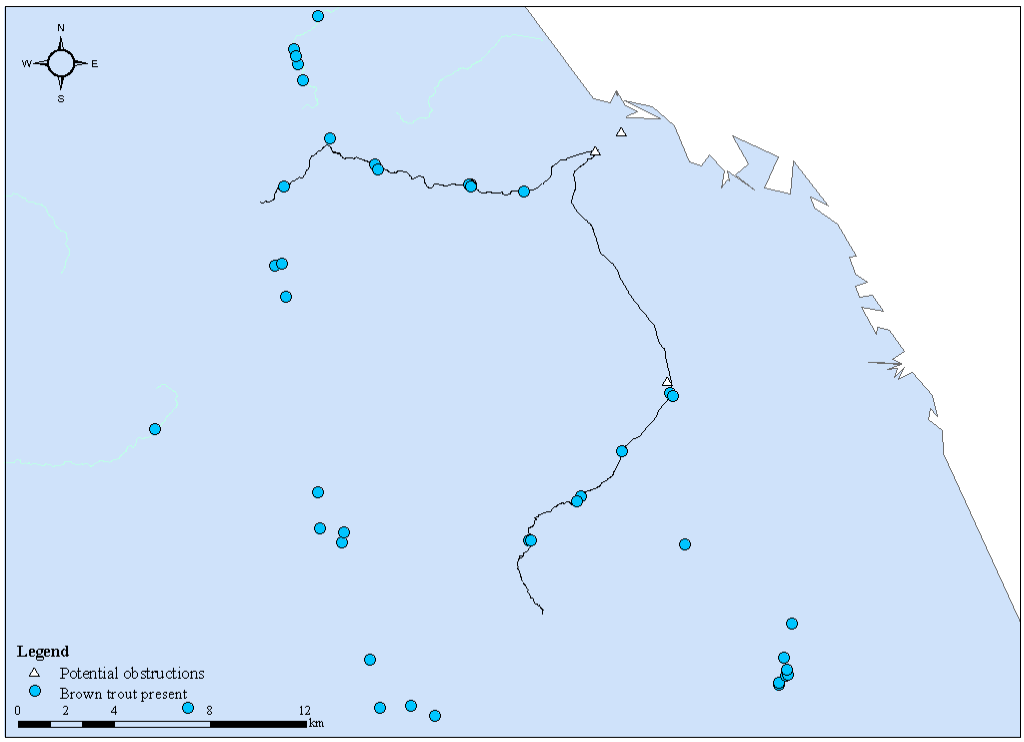

Fig. 59 The Tetney Haven catchment, showing distribution of trout

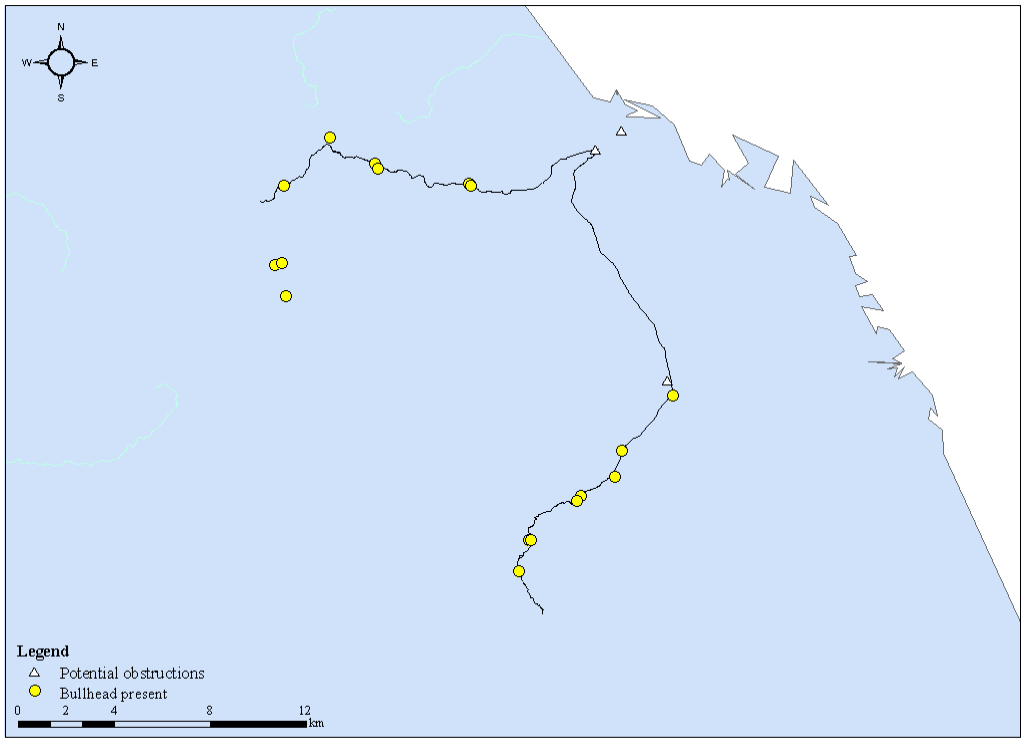

Fig. 60 The Tetney Haven catchment, showing distribution of bullhead

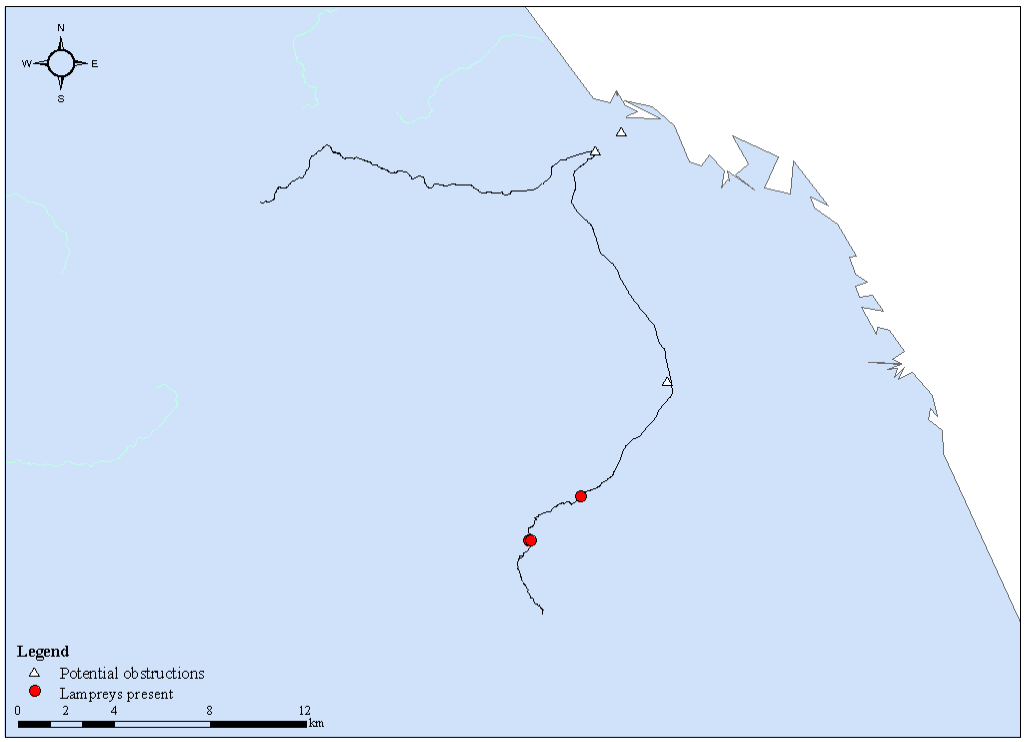

Fig. 61 The Tetney Haven catchment, showing distribution of lampreys

been conducted. However, RHS surveys have been undertaken on the drain, and habitat quality is considered suitable for eel (Firth, 2001). Thus, **Pauper's Drain is designated as MEDIUM PRIORITY for elver stocking due to the probable low densities of eel present (due to the flapped and pumped outfall) and the likely absence of conservation species** (Table 7). There may, however, be some water quality issues (Firth, 2001), which should be investigated before stocking is undertaken. **It is recommended that stocking is undertaken at a series of locations along the length of the drain and, ideally, on a number of occasions** (i.e. trickle stocking). There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel; escapement through the outfall at Luddington should be possible under all but low flow conditions.

6.15 Bosky Dyke (Keadby Warping Drain)

Eel were present in reasonable numbers in Bosky Dyke (Keadby Warping Drain) in the early 1980s (Carpenter, 1982), but no surveys have been conducted since, and there are no records of trout, salmon, bullhead, lampreys, spined loach or crayfish. Similarly, no RHS surveys have been undertaken on the drain. Nonetheless, **Bosky Dyke (Keadby Warping Drain) is designated as MEDIUM PRIORITY for elver stocking due to the probable below potential densities of eel present (due to the flapped outfall) and the likely absence of conservation species** (Table 7). **It is recommended that stocking is undertaken at a series of locations along the length of the drain and, ideally, on a number of occasions** (i.e. trickle stocking). There appear to be no major impediments (e.g. hydropower or pumping stations) to downstream migration of silver eel; escapement through the outfall at Keadby should be possible under all but low flow conditions.

7. CONCLUSIONS AND RECOMMENDATIONS

Barriers to migration have been identified as one of the factors potentially contributing to the decline in eel recruitment across Europe over the last three decades (White & Knights, 1997; Feunteun, 2002; Briand *et al*., 2003; Dekker, 2003), and there is some evidence to suggest that migration barriers are also having an impact on eel distribution within the Humber catchment (Table 6). **It is recommended that measures to overcome the barrier effects at each obstruction (e.g. installation of elver passes) are identified and installed to facilitate immigration of elvers into the watercourses of the Humber catchment.** The benefits of eel passes are reviewed by Knights & White (1998). Briand *et al*. (2005) and Laffaille *et al*. (2005a) demonstrated the potential benefits of eel passes in France, with recruitment increasing from negligible to 0.2-2.4 million elvers per year after installation of an eel pass. Installation of elver passes, and other methods of improving upstream migration of eel, should follow the guidance of Solomon & Beach (2004).

Data on the eel populations of the Humber catchment are patchy and, often, inaccurate, as the routine electric fishing surveys conducted by the Environment Agency (targeting salmonids and cyprinids) are inefficient for the species (Knights *et al*., 2001). This is particularly the case for the larger rivers, such as the Trent, which are difficult to sample in the middle and lower reaches (where eel may be most abundant) due to extreme river widths and water depths. As such, the eel populations of the Humber catchment are likely to have been underestimated. The only information routinely collected for eel is their presence/absence or approximate abundance (on a logarithmic scale), which does not allow density or biomass to be determined. **It is recommended, therefore, that data on the numbers, lengths and weights of yellow and silver eel are collected in future surveys, to assist in the assessment of the populations of the catchment.** Inherent with such surveys should be the use of sampling methods and techniques specifically for the efficient capture of eel (see Knights *et al*., 2001). To this end, guidance has recently been produced by the Environment Agency on the sampling and data collection of eel populations in rivers (Taylor & Aprahamian, 2006). Density or biomass data should permit a more accurate assessment of the key barriers to eel migration, and provide information on spatial variations in eel population structure.

The stocking of elvers above impassable barriers was found to increase eel production in the River Thames (Knights, 2005), and the practice has also been identified as a potential tool for enhancing eel populations in the Humber catchment. To ensure that maximum benefits accrue, it is important that stocking is targeted towards areas where eel production potential is highest. There is comparatively little information on the habitat requirements of eel, rendering it difficult to identify optimal stocking areas. Although the eel is generally regarded as a eurytopic (generalist) species, there is some evidence for ontogenetic or size-related shifts in habitat use, with small (<30 cm) eel preferring shallower water with more abundant aquatic vegetation than larger individuals (Laffaille *et al*., 2005b; Domingos *et al*., 2006). **It is recommended, therefore, that studies are instigated to identify key habitat requirements for all life stages of eel, so that habitat availability can be enhanced and stocking can be targeted towards the most appropriate areas.** Such information could also be used to assess the availability of suitable eel habitat in the Humber catchment. Until then, it has been suggested that stocking sites should be upstream of major migration barriers and

where eel density is likely to be below than the carrying capacity of the habitat (Williams & Aprahamian, 2004). Ideally, stocking sites should have a high degree of physical heterogeneity, providing a large amount of cover and a diverse food supply. All stocking activities should follow the guidance of Williams & Aprahamian (2004).

It is possible that stocking of eel may increase competition with or predation on resident fauna (Diamond & Brown, 1984; Mann & Blackburn, 1991; Blake & Hart, 1995; Dörner & Benndorf, 2003). This may be particular importance should the receiving waterbodies support populations of designated species. **It is recommended, therefore, that surveys are undertaken to establish the full distribution of eel and conservation species in the Humber catchment, so that stocking areas and strategies can be selected to maximise success, while minimising potential harm to the status of conservation species.** At the very least, surveys should be undertaken to establish the status of eel and conservation species in areas selected for stocking.

There are some concerns regarding the impacts of impediments (e.g. hydropower schemes and pumping stations) on the downstream migration of silver eel. For example, Behrmann-Godel & Eckmann (2003) and Winter *et al*. (2006) reported increases in mortality, due to injuries acquired when passing through hydropower turbines, and alterations in eel behaviour (i.e. a delay in migration past the structure) associated with the downstream migration of silver eel at hydropower schemes. Although outwith the scope of the current study, an example in the Humber catchment is the power station on the estuary at Stallingborough, where large numbers of eel are sometimes impinged (Proctor & Musk, 2001; Dawes *et al*., 2005). **It is recommended, therefore, that suitable mitigation measures, such as screens or fish passes, are installed at structures known to impinge or entrain large numbers of eel.** For example, impingement of eel was known to occur at Moor Monkton water abstraction works on the Yorkshire Ouse (Frear & Axford 1991), but this has now been ameliorated by the installation of a screen. Similarly, Boubée & Williams (2006) demonstrated the benefits of passes at hydropower schemes to downstream migrating silver eel in the Mokau River in New Zealand.

There is some evidence to suggest that stocking of elvers from outside of the immediate area can have little or no positive impact on the escapement of silver eel (Westin, 1998; Shiao *et al*., 2006). For example, Westin (1998) demonstrated that eel stocked into the rivers in the Baltic drainage area (but which had never been in the Baltic Sea) could contribute little to recruitment as they were unable to find their way out of the Baltic Sea. He suggested that olfaction is essential for orientation, with stocked eel having no opportunity to imprint this orientation cue. **It is recommended, therefore, that the elvers for stocking the Humber catchment should be sourced from the UK, if possible from the Humber Estuary.** It is recognised, however, that the Humber Estuary may not be a practical source due to the comparatively low recruitment of elvers that naturally occurs on the east coast of the UK and, as such, the Severn Estuary is likely to be the source. However, elvers are still abundant in the Severn Estuary and have been successfully used to stock waters elsewhere in the UK. Transfer of eel from outside of the Humber catchment will require health checks and possibly a period of quarantine before stocking, thereby increasing costs. This is particularly important because of the potential for transfer of *Anguillicola crassus* Kuwahara, Niimi & Itagaki, which has been implicated in the decline in recruitment of the European eel (Kennedy & Fitch, 1990; Evans & Matthews, 1999; Kirk, 2003). *A. crassus* has been recorded in the

River Trent (Kennedy & Fitch, 1990) and a number of Yorkshire rivers (Dolben, 1991; D. Hopkins, pers. comm.), but the full distribution and status of the parasite in the Humber catchment is unknown; the location of areas affected with *A. crassus* would be considered as part of the Section 30 protocol. Guidance on the stocking of eel is currently being produced by the Environment Agency (Barnard, in prep.).

In some situations, but especially in rivers, there are concerns that an unknown proportion of stocked fish either disperse from the target area or die, thereby contributing little to the recovery or enhancement of the fishery. For example, Berg & Jørgensen (1994) observed that although only minor movements of 0+ eel occurred in the first 2-3 months after stocking, there was some evidence for density-dependent mortality. **It is recommended, therefore, that post-stocking monitoring is conducted, to ascertain the survival and/or dispersal of stocked eel.** Thorough evaluation of stocking activities should permit effective stocking strategies for eel to be formulated based upon sound scientific information, and allow an assessment of the contribution of stocking to the recovery or enhancement of the fishery.

Notwithstanding the above issues, a number of obstructions and stretches of river have been prioritised for mitigation action and stocking, respectively (Table 8). **The obstructions prioritised for action are Naburn and Linton (Ouse), Barmby (Derwent), Topcliffe (Swale), Cromwell and Averham (Trent), Sprotbrough (Don), Chapel Haddlesey and Beal (Aire), and Luddington and Pademoor (Pauper's Drain), and attention and resources should focus on these in the first instance.** Thereafter, attention should focus on medium and then low priority obstructions. In some circumstances, however, it may prove more beneficial to focus on further obstructions on heavily regulated systems (e.g. the rivers Trent, Don and Aire) rather than low priority barriers on less regulated systems. Note that the obstruction scores are a function of eel stock status, the degree to which migration barriers and other factors are limiting eel populations *in the watercourse*, the passability at *each barrier* by eel, and the quality and quantity of habitat upstream of each obstruction, up to the next obstruction (Section 4.1). As such, the obstructions ranked as highest priority are not necessarily the most significant migration barriers. For example, although Boroughbridge Weir appears to be a major barrier to upstream migration of eel, it is only a relatively short distance (~6 km) to the next obstruction at Westwick, so is ranked as medium priority.

The areas prioritised for stocking are Blackburn Meadows to Crimpsall (Don), Stavely to Killamarsh (Rother), Baildon to Chapel Haddlesey (Aire) and Brighouse to Methley (Calder), and attention and resources should focus on these in the first instance. Thereafter, attention should focus on medium priority areas. In some circumstances, it may prove more beneficial to focus on further areas in systems with the poorest eel stocks (e.g. the rivers Trent, Don, Rother, Aire, Calder) rather than low priority areas. These prioritisations should ensure that maximum benefits accrue from the limited resources available to the Environment Agency for enhancing stocks to meet EU obligations for eel conservation.

Table 8 Priority obstructions and elver stocking areas in the Humber catchment

Watercourse	Priority obstructions	Priority ranking	Priority stocking area	Priority ranking
River Hull	Hempholme	M	n/a	n/a
	Cleaves Farm	L		
Yorkshire Ouse	Naburn	H	Boroughbridge-Naburn	L
	Linton	H		
Yorkshire Derwent	Barmby	H	Stamford Bridge-Barmby	L
	Elvington	M		
River Ure	Boroughbridge	M	n/a	R
	West Tanfield	M		
River Swale	Crakehill	M	n/a	n/a
	Topcliffe	H		
River Nidd	Skip Bridge	M	n/a	n/a
	Hunsingore	M		
River Wharfe	Tadcaster	M	n/a	n/a
	Boston Spa	M		
River Trent	Cromwell	H	Alrewas-Holme Sluices	M
	Averham	H		
River Don	Sprotbrough	H	Blackburn Meadows-Crimpsall	H
	Thrybergh	M		
River Rother	Beighton	M	Stavely-Killamarsh	H
	Rother Valley CP	M		
River Dearne	Adwick	L	Barnsley-Adwick	H
	Darfield	L		
River Aire	Chapel Haddlesey	H	Baildon-Chapel Haddlesey	H
	Beal	H		
River Calder	Kirkthorpe	M	Brighouse-Methley	H
	Wakefield	M		
River Ancholme	South Ferriby	M	Harlem Hill-South Ferriby	M
	Harlam Hill	L		
River Foulness	Weighton Lock	M	n/a	n/a
	Holme House	M		
Swinefleet Warping Drain	Swinefleet outfall	M	Whole drain	M
Tetney Haven	Stonebridge Farm	L	Alvingham-Tetney Lock	M
	Tetney Lock	M		
Adlingfleet Drain	Adlingfleet outfall	M	Cow Lane-Adlingfleet	L
	Cow Lane	M		
Pauper's Drain	Luddington	H	Whole drain	M
	Pademoor	H		
Bosky Dyke	Keadby outfall	M	Whole drain	M
	Keadby sluice	M		

H = high priority, M = medium priority, L = low priority, R = rejected, n/a = not applicable

8. REFERENCES

Amisah, S. (1998). Impacts of anthropogenic activities on the fisheries of the Don, Rother and Dearne catchments. Unpublished PhD thesis, University of Hull.

Amisah, S. & Cowx, I. G. (2000a). Impacts of abandoned mine and industrial discharges on fish abundance and macroinvertebrate diversity of the upper River Don in South Yorkshire, UK. *Journal of Freshwater Ecology* **15**, 237-250.

Amisah, S. & Cowx, I. G. (2000b). Response of the fish populations of the River Don in South Yorkshire to water quality and habitat improvements. *Environmental Pollution* **108**, 191-199.

Anon. (1986). The case for the re-introduction of salmon into the River Derwent. Report to Derbyshire County Angling Club.

Armstrong, G. (1994). NRA experience with freshwater fish passes. In *Fish Passes in Barrage and Weir Design*. Hydraulics Research, Wallingford, Report MIS3.

Axford, S. N. (1991). Some factors affecting catches in Yorkshire rivers. In *Catch Effort Sampling Strategies: Their Application in Freshwater Fisheries Management* (ed. I.G. Cowx), pp. 143-153. Fishing News Books, Blackwell Scientific Publications, Oxford.

Baras, E., Philippart, J. C. & Salmon, B. (1996). Estimation of migrant yellow eel stock in large rivers through the survey of fish passes: a preliminary investigation in the River Meuse (Belgium). In *Stock Assessment in Inland Fisheries* (ed. I. G. Cowx), pp. 82-92. Fishing News Books, Blackwell Scientific Publications, Oxford.

Behrmann-Godel, J. & Eckmann, R. (2003). A preliminary telemetry study of the migration of silver European eel (*Anguilla anguilla* L.) in the River Mosel, Germany. *Ecology of Freshwater Fish* **12**, 196-202.

Berg, S. & Jørgensen, J. (1994). Stocking experiments with 0+ eels (*Anguilla anguilla*) in Danish streams: post-stocking movements, densities and mortality. In *Rehabilitation of Freshwater Fisheries* (ed. I. G. Cowx), pp. 314-325. Fishing News Books, Blackwell Scientific Publications, Oxford.

BEST (2003). Survey of adult river and sea lamprey spawning and habitat availability in the Rivers Ure, Swale, Wharfe and Nidd, 2003. Report to Environment Agency.

BEST (2004). Survey of adult river and sea lamprey spawning and habitat availability in the Rivers Ure, Swale, Wharfe and Nidd, 2004. Report to Environment Agency.

Blake, M. A. & Hart, P. J. B. (1995). The vulnerability of juvenile signal crayfish to perch and eel predation. *Freshwater Biology* **33**, 233-244.

Boubée, J. A. T. & Williams, E. K. (2006). Downstream passage of silver eels at a small hydroelectric facility. *Fisheries Management and Ecology* **13**, 165-176.

Bradley, D. C. (2005). Review of information on lamprey populations in the Humber basin. Report to Environment Agency.

Briand, C., Fatin, D., Fontenelle, G. & Feunteun, E. (2003). Estuarine and fluvial recruitment of the European glass eel, *Anguilla anguilla*, in an exploited Atlantic estuary. *Fisheries Management and Ecology* **10**, 377-384.

Briand, C., Fatin, D., Fontenelle, G. & Feunteun, E. (2005). Effect of re-opening of a migratory pathway for eel (*Anguilla anguilla*, L.) at a watershed scale. *Bulletin Français de la Pêche et de la Pisciculture* **378-379**, 67-86.

Britton, J. R. (1999). The impact of cormorant predation on inland fisheries in the UK. Unpublished PhD thesis, University of Hull.

Bubb, D. H., Lucas, M. C. & Johnson, C. (2002). Dispersal and distribution of signal crayfish *Pacifastacus leniusculus* in the River Ure, West Tanfield. Environment Agency R&D Technical Report W1-074/TR.

Carpenter, A. C. (1982). A study of the biology of the eel, (*Anguilla anguilla* L.) in the tributaries of the lower River Trent. Unpublished PhD thesis, University of Hull.

Carter, K. L. & Reader, J. P. (2000). Patterns of drift and power station entrainment of 0+ fish in the River Trent, England. *Fisheries Management and Ecology* **7**, 447-464.

Casellato, S. (2002). European eel: a history which must be rewritten. *Italian Journal of Zoology* **69**, 321-324.

Clay, C. H. (1995). *Design of Fishways and other Fish Facilities*. CRC Press, Boca Raton, 256 pp.

Cooper, M. J. & Wheatley, G. A. (1981). An examination of the fish population in the River Trent, Nottinghamshire using angler catches. *Journal of Fish Biology* **19**, 539-556.

Cowx, I. G. (1991). The use of angler catch data to examine potential fishery management problems in the lower reaches of the River Trent, England. In *Catch Effort Sampling Strategies* (ed. I. G. Cowx), pp. 154-165. Fishing News Books, Blackwell Scientific Publications, Oxford.

Cowx, I. G. & Broughton, N. M. (1986). Changes in the species composition of anglers' catches in the River Trent (England) between 1969 and 1984. *Journal of Fish Biology* **28**, 625-636.

Cowx, I. G. & O'Grady, K. (1995). The reintroduction of salmon in the River Dove via the River Trent. Report to the National Rivers Authority.

Cowx, I. G., Harvey, J. P., Nunn, A. D., Noble, R. A. A., Taylor, R. & Rollins, D. J. (2006). Sutton Estate ecological surveys 2006. Report to Environment Agency.

Daemen, E., Cross, T., Ollevier, F. & Volckaert, F. A. M. (2001). Analysis of the genetic structure of European eel (*Anguilla anguilla*) using microsatellite DNA and mtDNA markers. *Marine Biology* **139**, 755-764.

Davies, C. E., Shelley, J., Harding, P. T., McLean, I. F. G., Gardiner, R. & Peirson, G. (2004). *Freshwater Fishes in Britain*. Harley Books, Colchester.

Dawes, O. J., Musk, W. A. & Proctor, N. V. (2004). Derwent impingement study: investigation into the impacts of transfer/treatment operations on the integrity of a European status species. Report to Yorkshire Water plc.

Dawes, O. J., Musk, W. A. & Proctor, N. V. (2005). Assessment of lamprey impingement at South Humber Bank Power Station: interim report. Report to Humber Power Ltd.

Dekker, W. (2003). Did lack of spawners cause the collapse of the European eel, *Anguilla anguilla*? *Fisheries Management and Ecology* **10**, 365-376.

Diamond, M. & Brown, A. F. (1984). Predation by the eel, *Anguilla anguilla* (L.), on the eggs and spawning population of the roach, *Rutilus rutilus* (L.). *Fisheries Management* **15**, 71-73.

Dolben, I. P. (1991). First occurrence of *Anguillicola crassus* in the Yorkshire region. National Rivers Authority report.

Domingos, I., Costa, J. L. & Costa, M. J. (2006). Factors determining length distribution and abundance of the European eel, *Anguilla anguilla*, in the River Mondego (Portugal). *Freshwater Biology* **51**, 2265-2281.

Dörner, H. & Benndorf, J. (2003). Piscivory by large eels on young-of-the-year fishes: its potential as a biomanipulation tool. *Journal of Fish Biology* **62**, 491-494.

Evans, D. W. & Matthews, M. A. (1999). *Anguillicola crassus* (Nematoda, Dracunculoidea); first documented record of this swimbladder parasite of eels in Ireland. *Journal of Fish Biology* **55**, 665-668.

Feunteun, E. (2002). Management and restoration of European eel population (*Anguilla anguilla*): an impossible bargain. *Ecological Engineering* **18**, 575-591.

Firth, C. (1997). 900 years of the Don fishery: domesday to the dawn of the new millennium. Environment Agency, Leeds.

Firth, C. (2001). Humber outfalls: fish access report. Environment Agency report.

Frear, P. A. & Axford, S. N. (1991). Impingement and mortality of fish associated with the R. Ouse abstraction scheme. National Rivers Authority Fisheries Science Report 62/91.

Gray, M. & Mee, D. (2002). Inventory of trout stocks and fisheries in England and Wales. Environment Agency R&D Technical Report W2-062/TR.

Harvey, J. P. (1996). The evaluation and development of electric fishing gears and sampling strategies for the assessment of fish stocks in large water bodies. Unpublished PhD Thesis, University of Hull.

Harvey, J. P. & Cowx, I. G. (1999). Appraisal of the impact of fisheries management on the conservation status of the Leven Canal, East Yorkshire. Report to English Nature.

Harvey, J. P. & Cowx, I. G. (2000). Appraisal of the impact of fisheries management on the conservation status of the Leven Canal, East Yorkshire. Report to English Nature.

Harvey, J. P. & Cowx, I. G. (2002). Appraisal of the impact of fisheries management on the conservation status of the Leven Canal, East Yorkshire. Report to English Nature.

Harvey, J. P. & Cowx, I. G. (2004a). Ridings surveys: compensation release project. Report to Environment Agency.

Harvey, J. P. & Cowx, I. G. (2004b). Ridings surveys: water resources project. Report to Environment Agency.

Harvey, J. P. & Cowx, I. G. (2006). Winterburn compensation flow reduction trials fisheries assessment. Report to British Waterways.

Harvey, J. P., Cowx, I. G. & Nunn, A. D. (1999). A study to assess primary and secondary production in the River Trent and their role in food availability and growth of 0+ cyprinids. Report to Environment Agency.

Harvey, J. P., Mazik, K., Cowx, I. G. & Elliott, M. (2004). Water quality, sediment, benthos and fisheries baseline survey: River Don Water Injection Dredging. Report to British Waterways.

Harvey, J. P., Nunn, A. D. & Cowx, I. G. (2006). Survey of larval lamprey (ammocoetes and transformers) in the Yorkshire Ouse and Derwent catchments, 2004. Report to Environment Agency.

Holdich, D. & Black, J. (2007). The spiny-cheek crayfish, *Orconectes limosus* (Rafinesque, 1817) (Crustacea: Decapoda: Cambaridae), digs into the UK. *Aquatic Invasions* **2**, 1-16.

Jacklin, T. E. (1996). The River Trent: is it too clean? *Proceedings of the Institute of Fisheries Management Annual Study Course, York, 1996*, pp. 129-142.

Jacklin, T. E. (2006). The status of lamprey species in the River Trent with particular regard to the Humber Estuary SAC. Environment Agency report.

Jang, M. H. & Lucas, M. C. (2005). Reproductive ecology of the river lamprey. *Journal of Fish Biology* **66**, 499-512.

Jang, M. H., Ha, K., Bubb, D. H. & Lucas, M. C. (2003). Habitat use and migration of adult anadromous lampreys in the tidal Yorkshire Ouse and Derwent in relation to environmental conditions. Report to Environment Agency and English Nature.

Jang, M. H., Ha, K. & Lucas, M. C. (2004). Habitat availability, distribution and abundance of spawning lampreys in the Yorkshire Derwent system. Report to Environment Agency.

Kennedy, C. R. & Fitch, D. J. (1990). Colonization, larval survival and epidemiology of the nematode *Anguillicola crassus*, parasitic in the eel, *Anguilla anguilla*, in Britain. *Journal of Fish Biology* **36**, 117-131.

Kirk, R. S. (2003). The impact of *Anguillicola crassus* on European eels. *Fisheries Management and Ecology* **10**, 385-394.

Knights, B. (2003). A review of the possible impacts of long-term oceanic and climate changes and fishing mortality on recruitment of anguillid eels of the Northern Hemisphere. *Science of the Total Environment* **310**, 237-244.

Knights, B. (2005). A review of the status of eel populations in the River Thames and its tributaries. Report to Environment Agency.

Knights, B. & White, E. M. (1998). Enhancing immigration and recruitment of eels: the use of passes and associated trapping systems. *Fisheries Management and Ecology* **5**, 459-471.

Knights, B., Bark, A., Ball, M., Williams, F., Winter, E. & Dunn, S. (2001). Eel and elver stocks in England and Wales – status and management options. Environment Agency R&D Technical Report W248/MAFF R&D Project SFO307.

Laffaille, P., Acou, A., Guillouët, J. & Legault, A. (2005a). Temporal changes in European eel, *Anguilla anguilla*, stocks in a small catchment after installation of fish passes. *Fisheries Management and Ecology* **12**, 123-129.

Laffaille, P., Feunteun, E., Baisez, A., Robinet, T., Acou, A., Legault, A. & Lek, S. (2005b). Spatial organisation of European eel (*Anguilla anguilla* L.) in a small catchment. *Ecology of Freshwater Fish* **12**, 254-264.

Lucas, M. C. & Frear, P. A. (1997). Effects of a flow-gauging weir on the migratory behaviour of adult barbel, a riverine cyprinid. *Journal of Fish Biology* **50**, 382-396.

Mann, R. H. K. (1989). The management problems and fisheries of three major British rivers: the Thames, Trent and Wye. *Canadian Special Publication of Fisheries and Aquatic Sciences* **106**, 444-454.

Mann, R. H. K. & Blackburn, J. H. (1991). The biology of the eel *Anguilla anguilla* (L.) in an English chalk stream and interactions with juvenile trout *Salmo trutta* L. and salmon *Salmo salar* L. *Hydrobiologia* **218**, 65-76.

Masters, J. E. G., Jang, M. H., Ha, K. & Lucas, M. C. (2004). Migration, exploitation and spawning of adult river lamprey in the tidal Ouse and Derwent (NE), September 2003 to May 2004. Report to Environment Agency.

Masters, J. E. G, Jang, M. H, Ha, K., Bird, P. D., Frear, P. A. & Lucas, M. C. (2006). The commercial exploitation of a protected anadromous species, the river lamprey (*Lampetra fluviatilis* (L.)), in the tidal River Ouse, north-east England. *Aquatic Conservation: Marine and Freshwater Ecosystems* **16**, 77-92.

Nunn, A. D. (2005). The dynamics of larval and 0+ juvenile fish populations in lowland rivers. Unpublished PhD thesis, University of Hull.

Nunn, A. D., Cowx, I. G. & Harvey, J. P. (2003). Note on the ecology of spined loach in the lower River Trent, England. *Fisheries Management and Ecology* **10**, 117-121.

Nunn, A. D., Harvey, J. P., Noble, R. A. A. & Cowx, I. G. (2007a). Condition assessment of lamprey populations in the Yorkshire Ouse catchment, north-east England, and the potential influence of physical migration barriers. *Aquatic Conservation: Marine and Freshwater Ecosystems* (in press).

Nunn, A. D., Harvey, J. P. & Cowx, I. G. (2007b). Benefits to 0+ fishes of connecting man-made waterbodies to the lower River Trent, England. *River Research and Applications* (in press).

Nunn, A. D., Harvey, J. P. & Cowx, I. G. (2007c). The 0+ fish populations of the lower River Don, and the potential impacts of an extreme storm event. Report to Environment Agency.

Proctor, N. V. & Musk, W. A. (2001). Fish impingement assessment: South Humber Bank Power Station. Report to Humber Power Ltd.

Russell, I. C. & Potter, E. C. E. (2003). Implications of the precautionary approach for the management of the European eel, *Anguilla anguilla*. *Fisheries Management and Ecology* **10**, 395-401.

Schmidt, J. (1922). The breeding places of the eel. *Philosophical Transactions of the Royal Society of London (Series B)* **211**, 179-208.

Shiao, J. C., Ložys, L., Iizuka, Y. & Tzeng, W. N. (2006). Migratory patterns and contribution of stocking to the population of European eel in Lithuanian waters as indicated by otolith Sr:Ca ratios. *Journal of Fish Biology* **69**, 749-769.

Soloman, D. J. & Beach, M. H. (2004). Manual for provision of upstream migration facilities for eel and elver. Environment Agency Science Report SC020075/SR2.

Starkie, A. (2003). Management issues relating to the European eel, *Anguilla anguilla*. *Fisheries Management and Ecology* **10**, 361-364.

Stone, R. (2003). Freshwater eels are slip-sliding away. *Science* **302**, 221-222.

Sykes, A. J. A. (2004). Feasibility study for the revival of migratory salmonid stocks within the rivers of the Humber catchment. Unpublished MSc thesis, University of Hull.

Taylor, A. A. L. & Aprahamian, M. W. (2006). Sampling yellow eel populations in rivers. Environment Agency management system document.

Tesch, F. W. (1977). *The Eel: Biology and Management of Anguillid Eels*. Chapman & Hall, London.

van Ginneken, V. J. T. & Maes, G. E. (2005). The European eel (*Anguilla anguilla*, Linnaeus), its lifecycle, evolution and reproduction: a literature review. *Reviews in Fish Biology and Fisheries* **15**, 367-398.

Vesey, M. (2004). Distribution of lampreys in the Humber system. Report to Environment Agency.

Westin, L. (1998). The spawning migration of European silver eel (*Anguilla anguilla* L.) with particular reference to stocked eel in the Baltic. *Fisheries Research* **38**, 257-270.

White, E. M. & Knights, B. (1997). Dynamics of upstream migration of the European eel, *Anguilla anguilla* (L.), in the Rivers Severn and Avon, England, with special reference to the effects of man-made barriers. *Fisheries Management and Ecology* **4**, 311-324.

Whitton, B. A. & Lucas, M. C. (1997). Biology of the Humber rivers. *Science of the Total Environment* **194/195**, 247-262.

Williams, B. & Aprahamian, M. W. (2004). Management guidelines for the stocking of eel and elver (*Anguilla anguilla* L.). Environment Agency report.

Wilson, B. (2006). Prioritising fish passage improvement projects. Environment Agency report.

Winter, H. V., Jansen, H. M. & Bruijs, M. C. M. (2006). Assessing the impact of hydropower and fisheries on downstream migrating silver eel, *Anguilla anguilla*, by telemetry in the River Meuse. *Ecology of Freshwater Fish* **15**, 221-228.

Wirth, T. & Bernatchez, L. (2001). Genetic evidence against panmixia in the European eel. *Nature* **409**, 1037-1040.

APPENDIX – Plates of potential eel migration obstructions

Plate 1 The tidal barrage at the mouth of the River Hull (source: Environment Agency)

Plate 2 Hempholme Weir (at high tide) on the River Hull (source: Environment Agency)

Plate 3 Whinhill Fish Farm Weir on the River Hull (source: Environment Agency)

Plate 4 Naburn Weir on the Yorkshire Ouse (source: Environment Agency)

Plate 5 Linton Weir on the Yorkshire Ouse (source: Environment Agency)

Plate 6 Barmby Barrage on the Yorkshire Derwent (source: HIFI)

Plate 7 Elvington Weir on the Yorkshire Derwent (source: HIFI)

Plate 8 Stamford Bridge Weir on the Yorkshire Derwent (source: HIFI)

Plate 9 Buttercrambe Weir on the Yorkshire Derwent (source: HIFI)

Plate 10 Howsham Weir on the Yorkshire Derwent (source: HIFI)

Plate 11 Kirkham Abbey Weir on the Yorkshire Derwent (source: HIFI)

Plate 12 Boroughbridge Weir on the River Ure (source: HIFI)

Plate 13 Westwick (Newby) Weir on the River Ure (source: HIFI)

Plate 14 West Tanfield Weir on the River Ure (source: http://www.ukriversguidebook.co.uk/)

Plate 15 Crakehill Weir on the River Swale (source: Environment Agency)

Plate 16 Topcliffe Weir on the River Swale (source: Environment Agency)

Plate 17 Catterick Bridge on the River Swale (source: Environment Agency)

Plate 18 Skip Bridge Weir on the River Nidd (source: Environment Agency)

Plate 19 Kirk Hammerton Weir on the River Nidd (source: HIFI)

Plate 20 Hunsingore Weir on the River Nidd (source: Environment Agency)

Plate 21 Goldsborough Weir on the River Nidd (source: HIFI)

Plate 22 Tadcaster Weir on the River Wharfe (source: HIFI)

Plate 23 Boston Spa Weir on the River Wharfe (source: HIFI)

Plate 24 Flint Mill Weir on the River Wharfe (source: Environment Agency)

Plate 25 Wetherby Weir on the River Wharfe (source: HIFI)

Plate 26 Cromwell Weir on the River Trent (source: Environment Agency)

Plate 27 Nether Lock Weir on the River Trent (source: HIFI)

Plate 28 Averham Weir on the River Trent (source: Environment Agency)

Plate 29 Newark Weir on the River Trent (source: HIFI)

Plate 30 Hazelford Weir on the River Trent (source: HIFI)

Plate 31 Gunthorpe Weir on the River Trent (source: Trent Rivers Trust)

Plate 32 Stoke Bardolph Weir on the River Trent (source: Trent Rivers Trust)

Plate 33 Holme Sluices on the River Trent (source: Trent Rivers Trust)

Plate 34 Beeston Weir on the River Trent (source: Trent Rivers Trust)

Plate 35 Thrumpton Weir on the River Trent (source: Trent Rivers Trust)

Plate 36 Sawley Weir on the River Trent (source: Trent Rivers Trust)

Plate 37 Crimpsall Sluice on the River Don (source: HIFI)

Plate 38 Sprotbrough Weir on the River Don (source: HIFI)

Plate 39 Thrybergh Weir on the River Don (source: HIFI)

Plate 40 Aldwarke Weir on the River Don (source: HIFI)

Plate 41 Masbrough Weir on the River Don (source: HIFI)

Plate 42 Orgreave Weir on the River Rother (source: HIFI)

Plate 43 Beighton Weir on the River Rother (source: HIFI)

Plate 44 Rother Valley Country Park Weir on the River Rother (source: HIFI)

Plate 45 Killamarsh Weir on the River Rother (source: HIFI)

Plate 46 Adwick upon Dearne Weir on the River Dearne (source: HIFI)

Plate 47 Darfield Weir on the River Dearne (source: HIFI)

Plate 48 Little Houghton Weir on the River Dearne (source: HIFI)

Plate 49 Chapel Haddlesey Weir on the River Aire (source: HIFI)

Plate 50 Beal Weir on the River Aire (source: HIFI)

Plate 51 Knottingley Weir on the River Aire (source: HIFI)

Plate 52 Castleford Weir on the River Aire (source: HIFI)

Plate 53 Methley Weir on the River Calder (source: HIFI)

Plate 54 Kirkthorpe Weir on the River Aire (source: HIFI)

Plate 55 Wakefield (Chantry Bridge) Weir on the River Calder (source: HIFI)

Plate 56 Ferriby Sluice on the River Ancholme (source: HIFI)

Plate 57 Harlam Hill Weir (d/s) on the River Ancholme (source: HIFI)

Plate 58 Harlam Hill Weir (u/s) on the River Ancholme (source: HIFI)

Plate 59 Bishopbridge Weir on the River Ancholme (source: HIFI)

Plate 60 Toft Newton Weir on the River Ancholme (source: HIFI)

Plate 61 Weighton Lock on the River Foulness/Market Weighton Canal (source: HIFI)

Plate 62 Sodhouse Lock on the River Foulness/Market Weighton Canal (source: HIFI)

Plate 63 Holme House Weir on the River Foulness (source: HIFI)

Plate 64 The outfall of Swinefleet Warping Drain at Swinefleet (source: HIFI)

Plate 65 The tidal barrage on Tetney Haven near Stonebridge Farm (source: HIFI)

Plate 66 The weir at Tetney Lock on Tetney Haven (source: HIFI)

Plate 67 Alvingham Weir on Tetney Haven (source: HIFI)

Plate 68 The outfall of Adlingfleet Drain at Adlingfleet (source: HIFI)

Plate 69 The sluice at Cow Lane on Adlingfleet Drain (source: HIFI)

Plate 70 The outfall of Pauper's Drain at Luddington (source: HIFI)

Plate 71 The outfall of Bosky Dyke (Keadby Warping Drain) at Keadby (source: HIFI)

Plate 72 The sluice on Bosky Dyke (Keadby Warping Drain) near Keadby (source: HIFI)