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Strategic Restoration and Management (STREAM) of the River Avon SAC and Avon Valley SPA

Action A3 - Methodology for strategic planning of ditch restoration across the Avon Valley SPA

Action A2 – Review and Assessment of Methods to Protect SAC Fish Species from entrapment in the Avon Valley SPA ditch networks

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Front cover picture. *A James Coventry photograph of the Harbridge Stream and Harbridge Church, winter 1897-8. Reproduced with permission from the Hampshire Record Office (HRO 33M84/25/07).*

A modern-day view from the same spot is presented in the Appendix (Appendix Figure 16).

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1 INTRODUCTION

1.1 Background and terms of reference.

This investigation comprises Actions A2 and A3 of the Strategic Restoration and Management (STREAM) of the River Avon Special Area for Conservation (SAC) and Avon Valley Special Protection Area (SPA). The STREAM Project is a four-year partnership project funded jointly by the European Commission's LIFE-Nature programme, Natural England, Environment Agency, Wiltshire Wildlife Trust, Hampshire and Isle of Wight Wildlife Trust, and Wessex Water.

The overall objective of Action A3 is to develop a methodology for strategic planning of ditch restoration across the Avon Valley SPA, identifying:-

- Watercourses that are key to restoration of favourable condition within the SPA, without detrimental fishery impact;
- Watercourses where wetland restoration can accommodate or enhance fishery interests;
- Watercourses of particular importance for SAC fish species;
- Watercourses of particular importance to other, non-SAC fish species.

The TOR stated that the project will:-

- Carry out a published literature review relating to Avon SAC/SPA identifying habitat requirements and conflicts between fish and avian interests with appropriate reference to favourable condition tables/assessments.
- Evaluate relevant fisheries and bird data currently held by the Agency/English Nature/BTO (WeBS) for the Lower Avon , including the Somerley study area. There may be a requirement for limited survey of those watercourses where our current knowledge is inadequate.
- Arrange 'one to one' discussions with key individuals actively involved in river and floodplain management to identify issues and assessment criteria to inform a proposed scoring and prioritisation system.
- Develop a robust, objective scoring system in order to identify and prioritise sites /areas/lengths of watercourse in the Somerley project area according to the 3 categories identified described under overall objectives above.
- Make recommendations as to how the methodology may be used to evaluate the rest of the Avon SPA & SAC.
- The tenderer may propose alternatives to this approach if they believe that the alternative will provide equivalent delivery of the objectives, subject to a full justification

The overall objective of Action A2 is a review and assessment of methods to protect SAC fish species from entrapment in the Avon Valley SPA ditch networks. The TOR specified a report comprising:-

- A description of the known natural seasonal movement patterns of fish, (SAC fish species as well as other salmonids & coarse fish into and out of floodplain watercourses and the 'main channel'.

- A review of the available options, techniques and case studies for a) excluding b) facilitating migration of coarse fish & SAC fish species, in particular juvenile salmon, within small watercourses at sensitive times of year, with emphasis on low maintenance, low cost and sustainable solutions.

- The review should include an appraisal of the existing exclusion techniques currently being used on Wessex chalk rivers.

- The report will include a directory of devices and suppliers together with estimates of cost both capital and revenue (in terms of ongoing operation, deployment & maintenance).

- The report should detail the scope for and potential techniques which could be used to optimise habitat within the floodplain watercourses , minimising fish mortality as a result of the water level management regime.

- Provide 'best practice guidance' for landowners, fishery interests and river managers.

The tasks have been conducted according to the TOR with one variation. From the start it was recognised that methods to exclude fish from waterways were problematic, and in any event allowing fish unrestricted access optimised the environment in fisheries terms. This dictated that the waterways should be managed in a manner that took account of both the fishery and avian interests. It was felt that this could be done with a minimum of compromise, representing a win-win situation. Nevertheless there will be a few situations where the ideal situation cannot be achieved and ways of recognising and dealing with these must be considered.

1.2 The study area

Although the aim of this exercise is to develop a protocol for management of secondary watercourses throughout the catchment of the River Avon, much of the work was undertaken using a more limited study area. This was agreed before this work started as the Somerley estate, centred on Ibsley and Ellingham. This area was selected as it represents a large and well-managed estate with extensive wetland bird and fish interests, and a wide range of secondary channels. Some of these watercourses extend beyond the estate boundaries; where this happens the full extent of the watercourse is included as part of the study area.

1.3 The approach taken in this study

The layout of this report broadly follows the approach taken in the study as a whole. The first consideration was the formal conservation status of the study area and of the River Avon as a whole; this is covered in Section 2.

Section 3 covers the status and habitat requirements of the main bird species associated with the Avon wetlands, and section 4 the fish species in the river. Species considered in some detail are those listed as features of interest in the conservation citations, and others that occur in significant numbers or are a conservation issue.

While it is clear that some of the bird species that utilise the Avon wetlands have declined in recent years, the exact reasons are not always clear. Section 5 comprises an consideration of a wide range of environmental factors that have been changing over the past 50 years or so, in an attempt to ensure that the appropriate areas are targeted for action to attempt to restore these interest features.

Section 6 describes each of the significant secondary watercourses in the study area in turn.

Protection of fish from entrapment, and other fish passage issues, are considered in Section 7.

Development of a strategic approach to management of the secondary watercourses is described in Section 8.

While the classic chalkstream landscape is considered to be one of the most attractive natural features of the English countryside it is in fact the result of intensive human management over many hundreds, even thousands, of years. In attempting to manage and reinstate any particular interest feature it is important to bear in mind that this is an artificial environment and that its status and appearance at any particular time is the result of a wide range of past and present management actions. The history of management of the Avon and the study area in particular is a significant study in its own right but is central to this investigation. A synopsis is provided as Appendix I to this report.

2 CONSERVATION STATUS

2.1 Introduction

Much of the Avon Valley, including the Somerley study area, is covered by four conservation citations. Two are Sites of Special Scientific Interest (SSSIs) under the Wildlife and Countryside Act (1981), one is a Special Protection Area SPA) under the EU Birds Directive, and one is a special Area of Conservation (SAC) under the EU Habitats Directive.

2.2 Avon Valley SSSI

The Avon Valley SSSI is a grouping of several earlier sites notified between 1974 and 1993. It now covers the valley from Bickton to Christchurch, including the floodplain and river terraces. The citation lists the river itself, the floodplain with unimproved grassland, sand and gravel river terraces with acidic grassland and heath, and areas of woodland. Specific mention is made of, *inter alia*, salmon, trout, Bewick's swans, white-fronted geese, over-wintering wildfowl, and breeding waders.

The Natural England website gives "Views about Management" (VAM) for specific sites. These are described as:-

"a straightforward account of the basic management that is needed to conserve and enhance the wildlife or geological features of the SSSI. By giving a clear and simple statement of management principles for conservation, these views will help clarify and build upon the existing understanding between SSSI owners and occupiers and English nature about the management of their SSSIs."

Unfortunately, the VAM document for this site is not yet available.

There is a detailed assessment of the SSSI broken down into 219 units, most of which comprise single meadows. The whole of the river channel itself from Bickton to the sea comprises a single unit that is assessed as "unfavourable, no change". The reasons stated for this assessment are "drainage, inappropriate water levels, and water pollution – discharge" with the additional comments "concerns re water levels/management, prolonged flooding, weed cutting, fish populations, water quality, sediment load etc." (Natural England, 2007a). Overall, only 11% of the SSSI is considered to be in favourable condition, with a further 10% as unfavourable, recovering. Of the remainder, 41% is assessed as "unfavourable, no change", and 38% as "unfavourable, declining".

Of the 49 non-river units falling within the study area (as defined in Section 1.2), 41 (84%) are classified as "neutral grassland – lowland", 7 (14%) as "broadleaved, mixed and yew, woodland – lowland", and one (2%) as "standing open water". Regarding their condition assessment, six (12%) are ranked as "favourable", two (4%) as "unfavourable, recovering", 19 (39%) as unfavourable, no change", and 22 (45%) as "unfavourable, declining".

The reasons for the adverse assessments are varied, but “inappropriate water levels”, “undergrazing” and “inappropriate ditch management” predominate. The full breakdown is shown in Table 2.1.

Table 2.1. Reasons for adverse assessment within the 49 non-river units of the Avon Valley SSSI within the study area. Most of the 41 units assessed as in adverse condition were assigned more than one reason.

Reason	**Number of units**
Inappropriate water levels	25
Undergrazing	25
Inappropriate ditch management	20
Inappropriate scrub control	14
Drainage	10
Inappropriate weed control	7
Inappropriate cutting/mowing	7
Overgrazing	4
Agriculture - other	3
Water pollution- agricultural runoff	2
Fertilizer use	1
Forestry and woodland management	1
Vehicles - other	1
Other	1
Total	**121**

2.3 River Avon SSSI

This covers the River Avon and most of its tributaries from source to sea, along with associated wetland habitats. It was notified in 1996.

The citations lists the river channel and its associated flora and fauna (including the *Ranunculus* vegetation, salmon, sea lamprey, brook lamprey and bullhead), and wet woodland and “flood pasture” including the characteristic flora and fauna. A number of bird species are listed but they do not include Bewick’s swan, white-fronted goose or breeding waders.

The VAM for this site deals with management principles for the rivers and streams, swamp, floodplain fen, neutral pasture and marshy ground and lowland wet woodland. Under “rivers and streams” the first management principle is that the rivers natural structure and form should be maintained. This is an odd statement as the present form and appearance of the Avon is heavily modified and the result of evolving human intervention, as described in Appendix I. It is ironic that one of the very few parts of the river system that is of fairly natural character, the perennial section of the Nine Mile River, is not included in the SSSI.

The detailed assessment of the SSSI is broken down into 51 units, of which 15 cover the river and tributaries, and 36 associated wetland habitats such as fen, marsh, swamp, grassland and woodland (Natural England, 2007b). The condition assessment for the site as a whole shows only 4% is in favourable condition, with a further 4% unfavourable but recovering, 87% unfavourable no change, and 6% unfavourable declining.

All 15 riverine units are classified as “unfavourable, no change” or “unfavourable, declining”. The predominant reasons stated for this situation are inappropriate water levels, invasive freshwater species, water abstraction, water pollution – agricultural run-off, and water pollution – discharge.

The river and its side channels passing through the Somerley study area (Bickton to Ringwood) are part of a single unit, which is assessed as “unfavourable, no change”. The reasons listed are inappropriate water levels, inappropriate weirs dams and other structures, invasive freshwater species, siltation, water abstraction, water pollution – agriculture/run-off, and water pollution – discharge. The Dockens Water comprises another unit, with a similar assessment. The only non-riverine units within the study area are three small areas of broadleaved woodland (total less than 2 ha) whose condition does not appear to have been assessed.

A new condition assessment of the River Avon SSSI will be made by NE during 2008.

2.4 Avon Valley SPA

This covers much the same area as the Avon Valley SSSI and was notified in 1998. Only two species are listed, Bewick’s swan and gadwall. No specific assessment of the status of the listed interests appears to have been made.

2.5 River Avon SAC

This is an almost entirely aquatic citation. Of the nearly 500 ha included, 95% is water, with 5% bogs, marshes, fens and other wetlands. The listed features of interest are an Annex I habitat (water courses of plain to montane levels with *Ranunculus fluitans* and *Callitricho-Batrachion* vegetation) and five Annex II species (Desmoulin’s whorl snail, salmon, sea lamprey, brook lamprey and bullhead).

As the SAC covers almost the same area as the River Avon SSSI with a few additional areas from other SSSI’s, the SSSI assessments (Section 2.3) are presumed to apply.

3 THE BIRD FAUNA

3.1 Introduction

In this section the bird species of particular interest are described with particular reference to their habitat requirements during the seasons they occur in the Avon Valley. The species covered are those listed in the SPA citation, and those described in the SSSI citation that are dependent upon water levels; this includes over-wintering birds and breeding waders.

3.2 Bewick's swan (*Cygnus columbianus*)

The Bewick's swan is a winter visitor to the British Isles, breeding in the Arctic regions of Russia. At times, significant numbers have over-wintered in the Avon valley, mainly around Harbridge/Ibsley with smaller numbers in some years downstream of Ringwood. The main over-wintering areas in the UK are the Ouse Washes, and the Slimbridge area of the Severn Estuary.

The presence of this species in the valley on a regular basis is a recent phenomenon. Kelsall and Munn (1905) listed several sightings, but only one within the present Hampshire county boundary. Cohen (1963) stated that there were only five records of this species in Hampshire between the publication of Kelsall and Munn (1905) and the "long cold spell of February 1956", when there were records from several locations including the Avon Valley. Clark and Eyre (1993) state that regular over-wintering in the Avon Valley started in 1961/62, with a maximum of ten birds for the next few years. Numbers then started to build, with a maximum of 26 seen in 1970-71 (HOS 1972), peaking at over 300 in 1986/87. Numbers then declined, highest counts falling to around a hundred in the mid nineties, and to 23 in 2003/04 (HOS 2005).

There is evidence that the numbers of Bewick's in the Avon valley is influenced by the severity of the winter, with increased numbers in cold weather. This is presumably mediated by the unsuitability of habitat elsewhere under such conditions. Numbers in the UK usually peak in January "as birds arrive having exhausted food supplies in the Netherlands" (Rees *et al*, 1997). However, the continuity of numbers each successive winter indicates strongly that to a large extent the "Avon" population has represented a distinct group of birds that, having discovered the valley and found it suitable for winter feeding, return to it year after year, bringing their young with them so establishing the behaviour in successive generations. If this is correct, then once this group of birds is reduced to the level of a non-viable sub-population, recolonisation will have to await another random discovery by another group of birds. Clark (1998) suggests that in addition to factors outside the valley, local disturbance and land-use changes may have contributed to the decline.

Habitat requirements for wintering Bewick's are for a sward predominantly of soft-leaved grasses with an average height of less than 10 cm, including some wet areas with surface pools. They also require a large open area (effective field size of at least 6 ha) with unrestricted views of more than 500 m (Andrew Fielder, pers. comm.).

Although the birds spend most of the day in the meadows feeding they roost on the water, on the river itself, on the adjacent gravel pits or on the flooded meadows when water levels are very high. The development of the flooded gravel pits after WWII may well have been a factor in the birds adopting the Avon Valley as a wintering ground.

3.3 Gadwall (*Anas strepera*)

Although listed as an interest feature in the SPA, over-wintering gadwall inhabit the gravel pits in the valley and are not really dependent upon the area covered by the WLMP, though some can be found in the valley, usually around the margins of unfenced and grazed drains. Numbers have been increasing in recent years.

3.4 White-fronted goose (*Anser albifrons*)

Cohen (1963) states that the regular annual appearance of over-wintering white-fronts in the Avon Valley started in about 1940. Numbers have varied considerably, peaking at over 2,000 in very cold weather in February 1947, but with only about 100 in 1950 and 1951. Numbers were generally high during the 1960's and 70's, with many years peak counts being over 1000 birds. However, numbers fell away after about 1981/82. By 2004 the status of the species was that of "scarce winter visitor", with none over-wintering in the Avon Valley in 2001/02 and 2002/03 (HOS 2005).

Cold weather clearly influences the numbers of birds over-wintering, with the peak number recorded in the harsh winter of 1946/47. The series of mild winters in recent years may well be largely responsible for the decline seen in the Avon Valley over this period, with the birds choosing to over winter elsewhere. Clark (1998) suggests that the decline in the area mirrors that at most other British locations, and is in contrast to the overall significant increase in the north-west European wintering population as a whole. Andrew Fielder (pers. comm.) also suggests that a decline in suitable habitat in the Avon Valley is also implicated – their habitat requirements are similar to those of Bewick's swans.

3.5 Greylag goose (*Anser anser*)

The greylag became extinct as a breeding bird in England early in the 19th Century but was re-established following introductions from Scotland during the 1960's (Brown and Grice 2005). The main interest in this context is that this is a new species in this area, and its increase has coincided with the decline in Bewick's swans and white-fronted geese. This raises the possibility of the one having been implicated in the decline of the other, or at least there could be an element of the new species expanding to fill the vacant niche which might complicate recovery of the species which have declined.

Cohen (1963) cites several Hampshire sightings in the 1950's and early 60's, probably of passage migrants. A single bird was reported at Ibsley in 1971 (HOS 1972). By the early '90s many tens of birds were over-wintering in the Avon valley (eg 85 counted at Bisterne in 1992; HOS 1993; peak of 229 in 1995/6; Clark 1998) and the species is recorded as "a moderately common and increasing resident, passage migrant and winter visitor" (HOS 2005). Numbers have continued to build, with a peak count of 450 in September 2004 and numbers of birds remaining throughout the year (HOS 2005).

3.6 Canada goose (*Branta canadensis*)

This is another feral species that has increased in recent years, with possible interactions with species of interest as described for greylags. According to Cohen (1963) most records for Hampshire prior to 1955 were from a lake near Petersfield, but he mentions a flock of about 150 birds at Ringwood on January 1 1939 "most of which were Canadas with a few white-fronts". Clark and Eyre (1993) reported that numbers had been increasing since the 1950's, with the most rapid increase in the 1970's and early 80's. Clark (1998) reported that the Avon Valley population was in excess of 500 at times. The peak count for the valley in 2004 was 394, in October.

3.7 Mute swan (*Cygnus olor*)

Another possibly-introduced species that has increased in recent years, and thus possibly implicated in the fortunes of other species. Clark (1998) reported the increase in the Hampshire section of the Avon Valley from 236 birds in 1978, to 356 in 1983 and 458 in 1990. He listed "the more tolerant regime which operates within the agricultural community", fitting bird blocks on overhead power cables, and the increasing number of lakes and the restoration of carrier streams as possible contributory factors to the increase.

Table 3.1. Numbers of breeding pairs of waders recorded at a consistent group of sites in the Avon Valley, 1999-2005. No report for 2001 is available. The sites are Avon Causeway, Avon Tyrell 2, Avon Tyrell 3, Ibsley and Breamore. Data from Dorset Ecological Consultancy (1999) and Walker (2000, 2002, 2003, 2004, 2005).

Year	Lapwing	Redshank	Snipe
1999	33	13	2
2000	14	8	4
2001			
2002	12	7	0
2003	24	18	0
2004	17	15	0
2005	19	17	1

3.8 Snipe (*Gallinago gallinago*)

Clark and Eyre (1993) record the snipe in Hampshire as "a moderately common but declining breeder, common passage migrant and winter visitor". Since then, the breeding population in the Avon valley has virtually disappeared though good numbers still arrive each winter. Nationally the trend is uncertain but there has been a marked decline throughout lowland England (Baillie *et al* 2005).

Cohen (1963) stated that before 1920 the range was increasing in Hampshire and the species was constantly being found breeding in new localities, but that the range had markedly decreased more recently. A survey in 1982 located 32 breeding territories between Ringwood and Bickton, but a survey in 1990 found only six in this area of the valley (and a total of 35 between Sopley and Downton) (Clark and Eyre 1993). A series of surveys covering about 1,300 ha of the valley reported by Hoodless (2003) recorded 29 drumming males in 1990, five in 1996 and none in 2003. A similarly parlous state of the population is indicated in the result of the WLMP surveys shown in Table 3.1. Extensive surveys conducted in 1990 and 2006 indicate that the breeding population in the Avon Valley declined by 98.4% between those two years (Smart and Foley 2006).

Cramp and Simmons (1982) stated that the snipe breeds in areas “where drainage is impeded, with access to shallow water, fresh or brackish. Any tall or dense vegetation needs to be separated by more open ground with low tussocks or clumps of sedge, *Carex*, rushes, *Juncus* and tall grass. Pure sedge is associated with unsuitably deep water and pure grass with ground too hard for its bill to probe”. Cox (2003) states that snipe prefer a dense tussocky structure to the sward, in contrast to lapwing which prefer a short sward.

Green (1988) studied environmental factors that influenced the timing and success of breeding of snipe in lowland wet grassland. Of 256 nests studied, 105 failed; 60% were destroyed by predators, 19% trampled by livestock, 10% were flooded, and 10% were deserted. Birds that had nests fail in May generally produced a second nest, while those that failed in June did not. Nesting continued longest where the soil remained penetrable by the birds beaks longest. However, spring and summer floods appeared to delay nesting, and it was suggested that prolonged summer flooding reduces the population of invertebrates, especially earthworms. Thus too much water appears to be as damaging as not enough.

Equally, however, damp ground is clearly helpful if not essential for successful feeding. Jourdain (1932) reported on the situation in 1931:-

“Normally the snipe in the meadows of the Avon Valley disappear as the marshes become dry, but in 1931 owing to the continuous rainfall they remained in great numbers until the opening days of the shooting season, and no fewer that 124 were shot on the first day [August 12] *near Harbridge.”*

3.9 Lapwing (*Vanellus vanellus*)

The lapwing is described as “a common but decreasing breeder and numerous winter visitor” in Hampshire (HOS 2005). In recent years the numbers of breeding pairs has varied without obvious trend (Table 3.1) but at a lower level than formerly; a file of “MAFF Avon Valley Bird Data” held by the EA records a figure of 82 breeding pairs at Avon Tyrell alone. Hoodless (2003), describing the results of a series of surveys of around 1,300 ha of the Avon floodplain, records a decline from more than 200 pairs in 1990 to a little over 100 in 1996 and 2003. Extensive surveys if 1990 and 1996 indicate that the breeding population in the Avon Valley declined by 74.4% between these dates (Smart and Foley 2006). The national trend was for an increase in numbers between about 1965 and 1970, relatively stable numbers until about 1985, followed by a marked decline to less than half between 1977 and 2002 (Baillie *et al* 2005).

The requirements for successful breeding and rearing are similar to those for snipe, though the preference is for a shorter sward than snipe use; typically less than 10 cm in areas used for roosting, and less than 15 cm for areas used for feeding. The species requires open views of 500 m or more. There is less dependence upon water for nesting itself than for snipe, with many birds nesting in free draining sites including arable land (Cox 2003).

3.10 Redshank (*Tringa totanus*)

The current status of redshank in Hampshire is "moderately common but declining breeder, common passage migrant and winter visitor" (HOS 2005). The species appears to be at a fairly stable level in the Avon Valley. McLaughlin (2003) recorded 63 breeding pairs in a survey covering most of the Avon floodplain (1,218 ha) in 2003, compared to 55 in the same area in 1996. The numbers counted in a representative sample of the wet grasslands of the floodplain between 1999 and 2005 are shown in Figure 3.1. However, this apparently fairly stable recent situation hides a significant decrease over a longer period; extensive surveys in 1990 and 2006 indicate that the number of breeding redshank in the Avon Valley has declined by 70.6% between those two dates Smart and Foley 2006). Nationally the species has declined by about 47% between 1977 and 2002 (Baillie *et al* 2005).

The birds arrive in the valley to breed in about March, and generally leave with their young in about July, migrating fairly locally to estuaries and tidal harbours. The breeding requirements of the species lies somewhere between the short sward preferred by lapwing and the dense, tussocky structure of the sward preferred by snipe, with a mixture of short vegetation for feeding and longer vegetation for nesting. The ideal nesting habitat is a 1:3 ratio of short (less than 15 cm) and long (20-50 cm) vegetation in a mosaic, with trees or posts (Cox 2003). Other requirements for successful breeding and rearing are the presence surface pools or channels with shallow edges and an abundance of soil invertebrates, with any livestock grazing being at a low density.

3.11 Over-wintering wildfowl

In addition to the Bewick's swans and geese species already covered, a wide range of species of ducks and waders utilise the valley in winter, especially when extensive areas are flooded. Clark (1998) provides a useful description of over-wintering birds in the Lower Avon Valley between 1977 and 1997. Typical winter peaks for the valley are of the order of 14,000 wildfowl and waders, but these numbers, and the species composition, vary considerably with conditions. Numbers of widgeon, pintail, shoveler, black-tailed godwit, teal, golden plover and lapwing increase considerably in wet winters with extensive flooding. Bewick's swans, white-fronted geese, wigeon and lapwing are all increased during very cold winters.

The relationship between the valley and the expanding area of Blashford Lakes is complex, with some species shifting their balance towards the lakes. However, there appears to be far fewer Wigeon in the study area in more recent years; overall they are usually the most abundant duck species in the valley in winter. Clark (1998) lists disturbance by water-skiers, disturbance by anglers, wildfowl shooting , changes in meadow management and milder winters as possible contributory factors.

Even in very wet winters there are areas particularly favoured by wintering wildfowl and waders, which may render the populations vulnerable to future loss of habitat.

In the extensive period of high water levels in February 2007 the following counts were made in the Hucklesbrook/Harbridge area; more than 2200 black-tailed godwit, 1000+ lapwing, 4 curlew, 3 ruff, 215 pintail, 190 shoveler, 22 shelduck and 4 Bewick's swans (John Levell, pers. comm.). The figures for godwit, shoveler and pintail are higher than any peaks reported by Clark (1998) for the period 1977 to 1997.

4 THE FISH FAUNA

4.1 Introduction

This section describes the main species of fish present in the Avon, including all those that are listed in the SAC citation ("Annex II species"). Particular attention is paid to habitat requirements and movements and migrations.

4.2 Salmon (*Salmo salar*)

The salmon is an Annex II species under the Habitats Directive. Salmon have occurred in the Avon for hundreds, probably thousands, of years, but their distribution within the river and their life-cycle has undergone some radical changes. What their distribution was within the catchment before man started to interfere with the environment is uncertain and in any case really only of academic interest. What is certain is that head-retaining structures have had a fundamental impact upon the species for many hundreds of years, both in terms of obstruction to free movement and the drowning-out of potential spawning and nursery habitats. From the viewpoint of free access the situation has been better in recent years than at any time since mediaeval times, with a considerable proportion of the spawning distribution in the upper river and tributaries upstream of Salisbury, in non-drought years at least. This has by no means always been the case; Aubrey (1847), originally written between 1656 and 1691, records that salmon "are sometimes taken in the upper Avon, rarely, at Harnham Bridge juxta Sarum". A footnote in the same publication (added in 1847) states that "I know of no person now living who has ascertained its having ascended the Avon so far as Salisbury". Berry (1933) recorded a number of redds in the Britford water below Salisbury "which marked the highest limit of their run". The annual report of the River Board for 1962 stated that until a fish pass was installed at the Ringwood HEP station it was a rare event to catch a salmon upstream of there. The present distribution of spawning has been achieved through a programme of installation of fish passage facilities at all the major obstructions to migration.

There have been major changes in the seasonal run-timing of salmon in the Avon, reflecting changes throughout much of the range of the species. For at least 80 years up to about 1980 most of the fish returned in the spring (February to May) and were large fish having spent two or three years at sea feeding and growing. These fish entered and ascended the river as they arrived, and spent several months laid up in suitable areas until the Autumn, when they undertook a secondary migration to the spawning areas. This meant that they avoided having to negotiate the estuary and lower river at times of low flow and high temperatures, and that there was generally a good flow to allow them to migrate over weirs. More recently there has been a strong trend towards younger sea age, with one-sea winter fish (grilse) occurring in similar numbers to 2 SW fish, and 3SW fish having almost disappeared. Most fish now return to the river in May to August, leaving them more vulnerable to the effects of low flows and high temperatures in the estuary and lower river.

Numbers of salmon returning to the Avon fell markedly between 1988 and about 1992, and have so far only partially recovered (Solomon and Lightfoot 2007). To some extent this reflects a decline throughout the British Isles, but the effect has been particularly marked and long-lasting in the chalk streams.

Salmon spawn in gravelly areas with a good flow of water. The main river in the study area offers limited spawning, mainly at the tail of the weirpools and in shallow “ford” areas. There is often good spawning in the Dockens Water and some spawning in other tributaries and side streams; the presence of young salmon in electric fishing surveys (Tables 4.1, 4.2 and 4.3) is indicative of successful spawning nearby. Young salmon live in shallow, fast-flowing water with suitable cover, which may be hundreds of metres from the spawning areas. There is some suitable rearing habitat in the main river, but perhaps rather more in the tributaries and side streams.

4.3 Sea trout and brown trout (*Salmo trutta*)

Sea trout ascend the Avon to the Fordingbridge area, spawning mainly in the New Forest stream such as the Linford Brook, Hucklesbrook and the Dockens Water. They do not occur in any numbers further upstream probably because of the good growth potential there means that a non-migratory habit is advantageous and the fish remain in the river as brown trout. Sea trout have similar spawning requirements to salmon, though they may make use of much smaller watercourses. The requirements of the juveniles are also similar, though small trout have a wider distribution than young salmon.

Brown trout occur in a number of the smaller tributaries (Tables 4.1, 4.2 and 4.3), but it is impossible to distinguish between young brown and sea trout until the latter turn silver to become smolts.

4.4 Bullhead (*Cottus gobio*)

The bullhead is an Annex II species in the Habitats Directive. It occurs in large numbers wherever conditions are suitable, viz shallow water with a substrate of stones or cobbles which provide shelter. Studies reported by Mills and Mann (1983) indicated that the fish showed a preference for stones of 40 to 120 mm diameter. Spawning takes place close to the area where the adults live, and the male builds a “nest” under a suitable stone and protects the fertilised eggs until they hatch. The spawning season is protracted, from February to June. This appears to be one of the most sedentary of the British freshwater fish fauna, with measured migrations of just tens of metres in contrast to the tens of km for most other freshwater species (Peter 1998). Quantitative assessments of bullhead abundance are difficult due to their small size and they were often ignored in earlier electric fishing surveys. For this reason they are not shown in Tables 4.1, 4.2 and 4.3. In the most recent surveys a logarithmic abundance estimate is attempted (numbers estimated at 1-10, 10-100, 100-100 etc per 100m^2).

4.5 Brook lamprey (*Lampetra planeri*)

This is another Annex II species in the Habitats Directive. They live in streams with a medium gradient (fall of 1.9 to 5.7 m/km) and spend much of their life as larvae in burrows in sediment (Hardisty 1986 a). After three to seven years of larval life the ammoecoete larva metamorphoses to the adult form, and feeding ceases. The adults may live in burrows is somewhat coarser sediment for a while before emerging in early spring to migrate upstream to spawn among stones or sand in shallow water (5-30 cm) with a flow of 0.2 – 3 m/sec. In most situations the migrations are thought to be very restricted but Malmqvist (1980) describes a directed upstream migration pre spawning in April-May in a Swedish stream. He suggested that this served to correct for downstream drift in younger stages. Pre-spawning brook lamprey have been recorded moving in both an upstream and downstream direction on the Avon (Dr G Lightfoot, pers. comm.). As with bullheads quantitative assessments are problematic largely due to the burrowing habit of the ammoecetes and the short duration of the adult phase; they are thus not included in Tables 4.1, 4.2 and 4.3.

Johns (1996, 1997, 1998) undertook surveys of the distribution of lampreys in the Avon, and found that brook lampreys were widely distributed throughout most of the catchment, though they were more abundant in the tributaries than in the main river.

4.6 Sea lamprey (*Petromyzon marinus*)

Although the sea lamprey is listed as an interest feature in the River Avon SAC it appears to limit its penetration of the river to the lowermost reaches, and is rarely if ever recorded as far upstream as Ringwood. Johns (1996) found no direct evidence of the presence of the species in the river though he found unidentified ammocoetes in side channels in the lower river where the species would be expected to be present. Wheeldon (2003) reported anecdotal evidence of the presence of the species in the lower river, and the author of this report has also seen adult sea lamprey in the lower reaches on many occasions.

Although it is believed that this species does not ascend the river as far as the study area, it is likely to be a factor in management of watercourses further downstream. Spawning takes place in relatively deep (0.4-0.6 m) and fast-flowing (1-2 m/sec) water (Hardisty 1986 b). On hatching, the juveniles drift downstream until they find areas with a slower flow and abundant silt, where they burrow and remain for some years as ammocoetes. Free access to side channels may be important so that they can exploit suitable habitat.

4.7 Roach (*Rutilus rutilus*)

The Avon has long been famous for its stocks of roach which gained a large size. However, numbers appear to have declined in recent decades, with viable angling stocks now largely dependent on the occasional stronger yearclass. A general decline in a number of coarse fish was reported by anglers between the mid 1960’s and mid 1970’s, with roach considered to have suffered to the greatest extent (Huggins *et al* 1977). Two factors were suggested as most likely contributory causes; heavy weedcutting, and the loss of side channels associated with the decline of the watermeadow systems. To date, there has been no general recovery of the roach population to former levels.

Roach inhabit a wide range of freshwater habitats from still waters to relatively fast-flowing rivers such as chalk streams. They spawn in late spring laying their adhesive eggs on submerged vegetation.   Mills (1981) noted them spawning among *Fontinalis antipyretica* growing on vertical piles and banks on the River Frome. Most of the eggs were laid within 0.2 m of the surface, even where the depth was a metre or more; such behaviour is likely to leave the eggs vulnerable to falls in water level. In the year of study (1980) spawning took place within a day or so of May 14. Fifty percent hatch was achieved in 11-12 days, and the newly hatched fry remained close to the incubation site for a day or two; virtually all had gone by May 28. The young fish then move to areas of relatively slow-flowing water. Lightfoot and Jones (1979) found that the young fry were able to maintain swimming speeds of up to 10 body-lengths per second, but sought out areas where the flow was about 40 % of that. Thus they were to be found in flows of the order of 2-6 cm/sec in mid-June, gradually colonising slightly faster water as they grew. Lightfoot and Strevens (1984) observed a significant downstream movement of 0+ roach on the Avon in late summer, starting in early August, peaking about the end of September, falling to low levels by early November. These fish averaged around 30 mm in length. Later observations by these authors were reported in Solomon (1992), and are illustrated in Figure 4.1; these indicate a slightly earlier timing of downstream movement, indicating some level of inter-annual variation. Lightfoot and Jones (1979) also noted that roach became scarce in their study area on the river Hull (a Yorkshire chalkstream) at a length of around 30 mm and suggested that a functional redistribution had taken place. These authors also noted a compensatory upstream migration of 0+ roach corresponding with the first lift in flow in the Autumn, after which little movement of juveniles took place over winter. Brown (1979) also reported an upstream movement of 0+ cyprinids between August and October in East Anglian rivers.

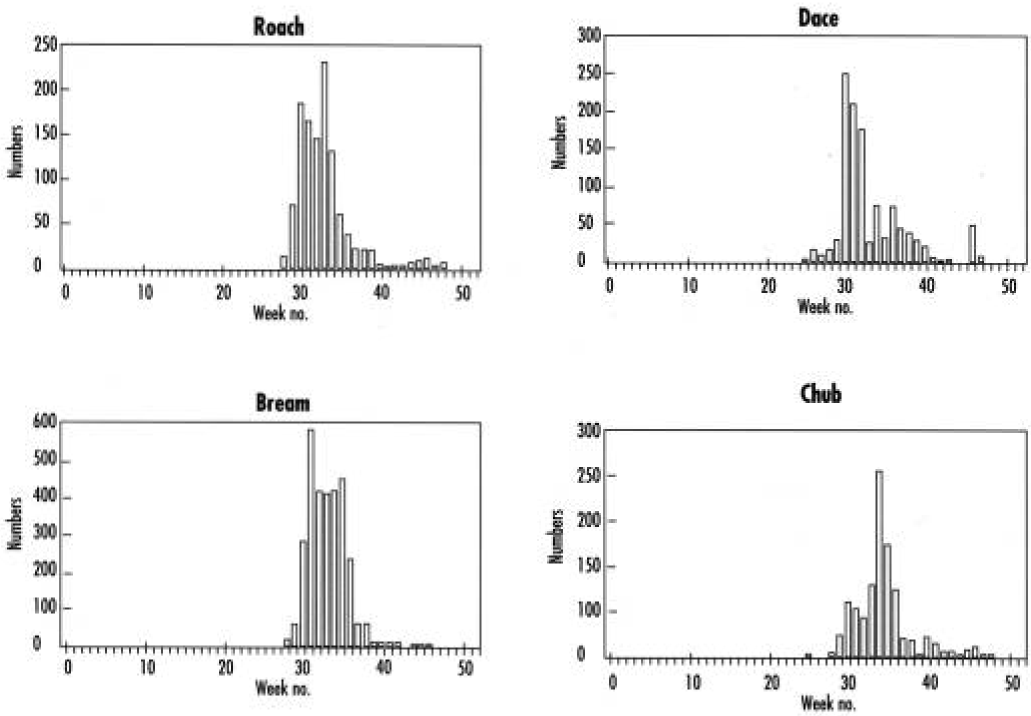

Figure 4.1. Weekly numbers of 0+ cyprinids recorded in downstream traps at a fish farm intake on the Avon in 1986. From Solomon (1992). Week 30 is centred on July 25.

Observations on the movement of adult roach are rather varied. Champion and Swain (1974) observed movements of adult fish through a fixed trapping facility on the River Axe (Devonshire) and noted peaks in upstream migration in September to December, and downstream in March to May. Conversely, observations of roach movement through a fish pass on the River Meuse in Belgium indicated that 90% of upstream migration was in the spring, from early April to the end of May (Prignon *et al* 1998). Roach may migrate considerable distances. Linfield (1985) observed a differential length distribution of roach over a 35 km length of the River Witham in Lincolnshire that indicated that adult fish may migrate upstream throughout the reach. Peter (1998) reported migrations of the species of up to 72 km in large European rivers.

4.8 Dace (*Leuciscus leuciscus*)

The dace is also a characteristic species of the Avon which, it is claimed, also suffered a decline in the 1970's (though not perhaps as sharp as that of roach) from which it has never fully recovered. Dace are more a species of flowing water than roach, and it does not naturally occur in still waters. They spawn on stones in shallow riffles, generally in March and April, a month or two before roach spawn. Lobon-Cervia *et al* (1996) observed dace moving upstream from a main river into small shallow tributaries to spawn. In a study of the movements of adult dace in the River Frome Clough *et al* (1998) radio tracked spent fish from the shallow spawning areas in a side-stream, down into the main river, and into the slow-flowing lower reaches of tributaries. They suggested that the fish had sought out areas of low flow to recover from the exertions of spawning. Clough and Ladle (1997) radio-tracked adult dace and noted that they spent most of the daylight hours in a small side channel, but each night migrated 245 to 680 m upstream into the main river, returning to the daytime areas at dawn.

Dace in their first months of life undergo similar migrations to roach, though with a tendency towards a month or so earlier (Lightfoot and Strevens 1984). This is further supported by the data presented in Figure 4.1, where the peak in downstream movement is in week 30 (about July 26).

4.9 Barbel (*Barbus barbus*)

Barbel are well-distributed through the river as far upstream as Salisbury, and are an important sport fish. They are not native to the river, however, and are believed to have arrived in the lower river through colonisation from the lower River Stour where they were introduced from the Thames early in the 20th Century. Berry (1933) suggests that the earliest capture of a barbel in the Avon took place in about 1915, but Sheringham (1928) does not mention barbel in the list of species available for capture in the Christchurch area. However, Tryon (1988) describes a days barbel fishing on the Avon at Christchurch (Royalty Fishery) in 1934 that culminated in a fish of 14lb 6oz, equalling the then British record, so the species must have been well-established by then. From there they gradually spread upstream, appearing at Somerley by the 1950's. Their upstream progress was enhanced by, and may have been almost entirely effected by, stocking; Clower (1965) recorded that 47 fish to 8 lb were introduced at Downton in January 1964, and there are a number of anecdotal records of introductions throughout the river. They are now a major feature of anglers catches from Britford to the sea.

4.10 Bream (*Abramis brama*)

Bream are also a relatively new species in the Avon, and like the barbel are well-spread through the river from Salisbury to the sea. They are not mentioned by any of the early authors of works describing the river, the first reference found (Clower 1965) being to “silver” bream in the Royalty Fishery:-

“Surprisingly, for such a fast-flowing river, silver bream are fairly common in some of the pools – particularly in the Garden Pool”.

Williams (1980) records the earliest record of a bream further upstream on the Longford Estate around the late 1970’s. The same author also reported the first records of carp and tench in this area of the river.

Bream demonstrate a similar pattern of downstream movement as roach and dace in their first months of life (Figure 4.1).

4.11 Chub (*Leuciscus cephalus*)

Chub are a major part of the fish fauna of the Avon from well above Salisbury to the lowermost reaches. There is some uncertainty regarding their history in the river. Aubrey (1685) does not list the species as being present in the Wiltshire part of the river. A detailed list of fish caught at Somerley during the tenancy of the Baron d’Erlanger in 1895-96 makes no mention of chub, and Turner-Turner (1914) claimed that the species was introduced to the river “in recent times” by an angler releasing live-bait brought from elsewhere. Whatever their origin they have clearly found the river to their liking. Although the angler survey reported by Huggins *et al* (1977) claimed that there had been a decline in this species, it was not as sharp as that for dace and in particular roach, and the species appears to have made a full recovery.

The adult fish occur throughout the river with a strong association with cover created by trees and bushes. Spawning takes place on stones or vegetation typically in May and June. The species undergoes migrations of similar timing and function to those of roach, but perhaps up to a month later.

Chub show a similar pattern of movement as roach and dace in their first months of life (Figure 4.1).

4.12 Electric fishing surveys

A number of the secondary waterways within the study area have been surveyed by electric fishing over a period of over 20 years. The basis of these has varied; some are quantitative estimates of numbers per 100 m^2 based upon multiple catches; a second group are numbers per 100 m of stream based on a single catch; and the results of a third group are given as catch per unit effort. While these results are comparable within these three groupings no valid comparison can be made between the groupings. They do provide a most valuable semi-quantitative picture however, and the results for the three groups are shown in Tables 4.1, 4.2, and 4.3.

Table 4.1. Numbers of fish per 100 m^2 of seven species estimated from electric fishing sites in secondary waterways in the study area.

			Numbers per 100m^2						
Stream	**NGR SU**	**Date**	**Salmon**	**Trout**	**Roach**	**Dace**	**Chub**	**Barbel**	**Pike**
Harbridge S.	1470010500	20/10/05	0.25	0.25	0	13.70	8.12	0.51	1.52
Woodside C.	1420008100	04/08/05	1.02	0.82	0.20	2.65	12.85	0.20	0.41
Ashley Str.	1370006300	08/08/05	0.23	0	3.84	0.45	35.91	0.68	1.81
King Stream	1433804322	11/10/05	1.28	0	0	3.99	5.10	0.32	0
King Stream	1433804322	10/10/06	2.37	0.45	0	2.15	6.10	0.57	0.11
Linford Br.	180070	10/08/05	0	0.33	0.33	0.33	2.00	0	0
Dockens W.	1558808277	13/09/01	0.65	6.66	0.81	2.27	4.87	0	0.16
Dockens W.	1558808277	?	0	4.31	0	0	1.72	0	0
Dockens W.	1558808277	31/08/05	0	5.68	0	0	1.46	0	0
Dockens W.	1558808277	24/08/06	0	3.75	0	0	0.97	0	0
Dockens W.	1470906979	31/08/05	0	0.372	0.372	1.486	1.486	0	0.186
Dockens W.	1470906979	24/08/06	0.198	6.349	0	0	0.198	0	0.198

Table 4.2. Numbers of fish caught per 100 m of stream in a single electric fishing in secondary waterways in the study area.

			Numbers per 100m length						
Stream	**NGR SU**	**Date**	**Salmon**	**Trout**	**Roach**	**Dace**	**Chub**	**Barbel**	**Pike**
Harbridge Str.	1458110138	30/11/83	1	0	16	31	4	0	5
Harbridge Str.	1458510238	30/11/83	0	0	11	93	6	0	4
Harbridge Str.	1459510290	30/11/83	0	0	4	42	2	0	10
King Stream	1401805574	07/11/83	0	0	9.0	5.5	14.5	0	7.5
King Stream	1394105727	07/11/83	0	0	0.5	1.5	15.5	0	7.5
King Stream	1379905836	07/11/83	0	0	71.0	152.0	35.0	0	10.0
King Stream	1377105926	07/11/83	1.0	1	2.0	2.0	1.0	0	6.0
King Stream	1381605981	07/11/83	0	2	13.0	5.0	20.0	0	14.0
King Stream	1390805983	07/11/83	0	0	39.0	5.0	7.0	0	15.0
King Stream	1395006066	07/11/83	0	0	2.0	0	3.0	0	4.0
King Stream	1385306193	07/11/83	0	0	51.0	49.5	66.0	0	10.0
King Stream	1389706314	07/11/83	0.5	0.5	2.0	1.5	5.5	0	5.0
King Stream	1381306426	07/11/83	0	0	3.5	60.5	40.5	0	4.0
King Stream	1379506552	07/11/83	0	0	17.0	49.0	38.0	0	9.0
King Stream	1378906676	07/11/83	0	0	28.0	117.5	13.5	0	6.5
Linford Br.	1482006040	04/06/85	0	1.5	2	33.5	3.5	0	0
Linford Br.	1494606161	04/06/85	0	0	0	15	0.5	0	0
Linford Br.	1509206288	04/06/85	0	0	0	20	0	0	0
Linford Br.	1525306385	04/06/85	0	2.5	0.5	12	3	0	0
Linford Br.	1531606567	04/06/85	0	1.5	0.5	38	0.5	0	0
Linford Br.	1535506761	04/06/85	0	0	0.5	68	3	0	0
Linford Br.	1551406925	04/06/85	0	0	0.5	228	1	0	0
Linford Br.	1572407011	04/06/85	0	0	2	207.5	0.5	0	0
Linford Br.	1598807010	04/06/85	0	0	0	9.5	0	0	0
Linford Br.	1622006938	04/06/85	0	0.5	0	77	0.5	0	0
Linford Br.	1648306901	04/06/85	0	1	0	117	1	0	0
Linford Br.	1672406958	04/06/85	0	0.5	0	45	0	0	0
Linford Br.	1786906823	04/06/85	0	3	0	150	1	0	0
Linford Br.	1798406967	04/06/85	0	8.5	0	0	1	0	0
Linford Br.	1815007131	04/06/85	0	3.5	0	0	0.5	0	0
Linford Br.	1821407324	04/06/85	0	2.5	0	0.5	0.5	0	0
Linford Br.	1843807460	04/06/85	0	1	0	0	0.5	0	0

Table 4.3. Numbers of seven species of fish captured in a unit effort electric fishing exercise in secondary waterways in the study are, 1999-2000.

			Catch per unit effort (CPUE) x 100						
Stream	**NGR SU**	**Date**	**Salmon**	**Trout**	**Roach**	**Dace**	**Chub**	**Barbel**	**Pike**
Ellingham Car.	141082	Spring	7.22	2.58	6.19	15.98	32.47	0.52	3.61
Ellingham Car.	141082	Summer	8.21	2.24	9.70	16.42	18.66	2.24	1.49
Ellingham Car.	141082	Autumn	13.39	4.72	39.37	52.76	29.92	0.79	0
Ellingham Car.	141082	Winter	3.7	1.85	8.80	6.94	22.22	0.93	1.85
Woodside Dr.	144072	Spring	0	1.06	12.17	16.93	8.47	0	7.94
Woodside Dr.	144072	Summer	0	0.76	0	0	0.76	0	5.30
Woodside Dr.	144072	Autumn	0	0	4.8	2.4	7.2	0	17.6
Woodside Dr.	144072	Winter	0	0	5.33	27.81	7.69	0	13.02
Ibsley Stream	150116	Spring	0	1.04	7.29	17.19	17.19	0	0.52
Ibsley Stream	150116	Summer	0	2.99	1.49	0	0	0	1.49
Ibsley Stream	150116	Autumn	0	1.65	5.79	0	7.44	0	0
Ibsley Stream	150116	Winter	0	1.49	7.43	23.27	22.77	0	0.99

4.13 Conclusions on fish and side channels

From the above brief review it is clear that many fish species make use of side channels for a wide range of purposes, including spawning, nursery areas, living areas and shelter from high flows in the main river. The detailed patterns of seasonal and diurnal movements into, out of and within these waterways is relatively poorly studied but from the information that is available it is clear that such movements may be both extensive and complex, and involve fish of all ages. The electric fishing results for three of the minor water courses over a period of a year shown in Table 4.3 demonstrates numbers of fish of different species changing quite markedly between seasons. This reinforces the desirability of maintaining longitudinal connectivity of waterways wherever possible.

5 THE CHANGING ENVIRONMENT AND THE STATUS OF CONSERVATION INTERESTS

5.1 Introduction

While there have undoubtedly been declines in some of the interest features of the Avon Valley, especially birds and salmon, identifying the exact causes is complicated. As already discussed, this is an important issue as only by careful analysis of the drivers of change can the most effective action be taken to halt and reverse any such declines – if indeed it is possible to do anything about them at all. There have been significant changes in both the physical environment and the other fauna that may have had direct or indirect impact upon the interest features. The aim of this section is to examine these changes and to put them into context.

5.2 Temperature

Whether or not long-term climate change is responsible, there have been significant fluctuations and trends in climatic conditions over the past 60 years. In Figure 5.1 the winter Central England Temperature (Manley 1974) is shown for each winter period (December to February inclusive) from 1940 to present. There is an upward trend with an increase of 0.1^{o}C every 5.2 years.

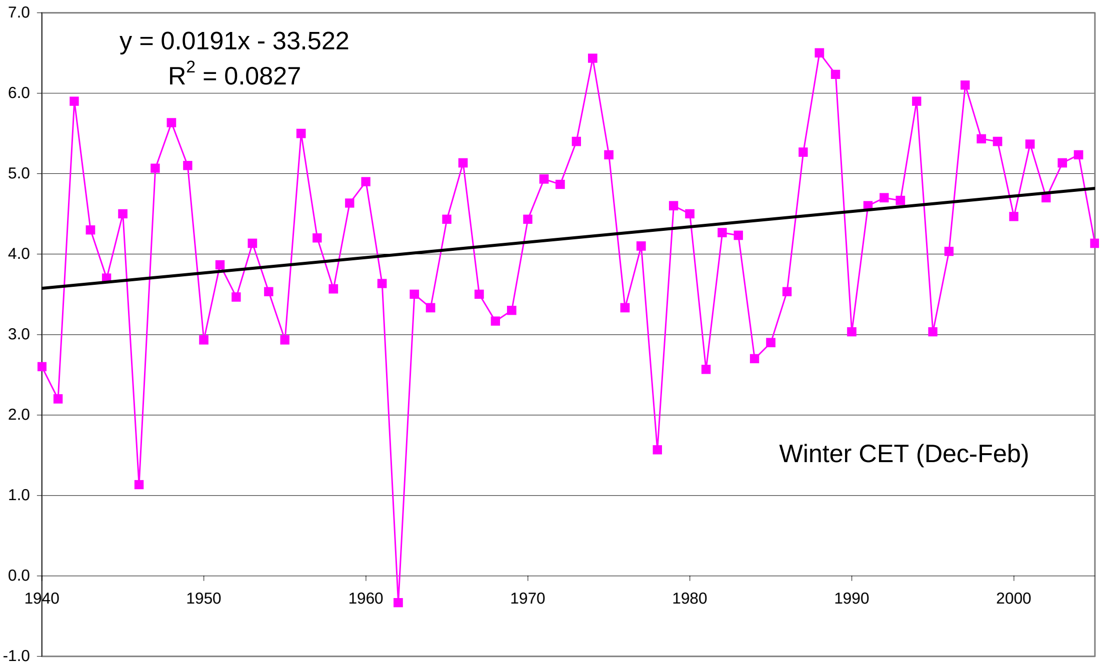

Figure 5.1. Winter (December-February) mean Central England Temperature, 1940 to date. Each point applies to the three month period starting with December in the year shown –thus the 2005 figure covers December 2005 to February 2006.

As discussed in Sections 3.1 and 3.2, the presence and abundance of Bewick's swans and white-fronted geese in the Avon valley appears to have been associated with cold winters. Water temperatures in the Avon are now marginal for salmon at times (Solomon and Sambrook 2004, Solomon et al , and the decline in recent years may well be mediated by climatic factors (Solomon and Lightfoot 2007).

5.3 Gravel extraction

Extraction of gravel from the Avon Valley started in a small way in the 1930's, but increased after the war and is still continuing. Flooded gravel pits have become a major habitat feature of the valley, reducing the area of grassland and increasing the area of open water. The total area of still surface water in the valley between Bickton and Ringwood is now of the order of 250 ha, compared to perhaps a tenth that for the river itself. The main impact of this development in terms of the interests being considered here is the great increase in habitat for aquatic birds. The Bewick's swans over-wintering in the valley have generally used the flooded gravel pits for roosting each night, though when the valley is flooded they may remain in the meadows and sometimes roost on the river. It is likely that the development of the flooded pits contributed to the establishment of the over-wintering populations in the 1950's, and they are undoubtedly responsible for the development of the local populations of gadwall. It is more difficult to see how they could be implicated in the decline of various bird species unless their presence favours a direct competitor.

5.4 River flow and water levels

There is little evidence of a major change in medium to high river flows over the past 60 years, though there are of course marked variations between years. The nearest gauging station to Somerley is at East Mills, Fordingbridge. This provides a good idea of flows at Somerley, though the latter are likely to be a little more variable due to a greater proportion of the flow being derived from surface flow from the New Forest streams. Gauging started in the mid 1960's, but we can extend the series back in time using a relationship with a modelled historic flow series for the River Itchen. The Itchen flow record is available as gauged flows back to the 1960's, but Agency-funded R&D (Jones *et al* 2004) has extrapolated monthly mean flows back a further 100 years based upon groundwater and rainfall records. Figure 6.2 shows a modelled series for East Mills, based upon the relationship between East Mills and Itchen flows for the period for which gauged records of both are available. This shows no obvious trends over this period.

One way in which Avon flows appear have changed in recent years is that the incidence of very high winter flows has increased since the late 1980's compared to the previous thirty years (Dr G Lightfoot, pers. comm.). It is uncertain whether this a truly new phenomenon, a return to a situation that existed before the earlier period, or random chance.

There is no evidence of a systematic change in management of low water levels over the past 50 years either in the Avon Valley as a whole or in the Somerley study area. While there is clearly scope for levels to be influenced by hatch operation, weed cutting and flood defence works, examination of old photographs of Ibsley Bridge does not indicate any noticeable change; images from throughout the past 100 or more years were accessed, including ones dated as 1898, 1904, 1905, 1909, 1910, 1930, 1945 and 1950.

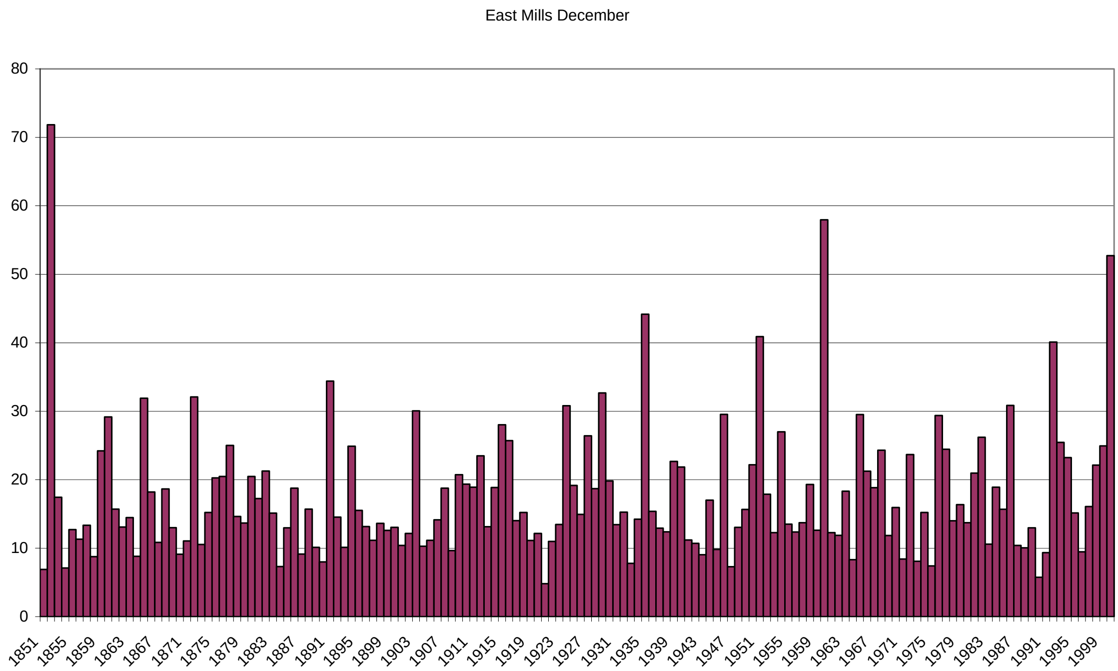

Figure 6.2. Modelled monthly mean flows for December for the Avon at East Mills, based upon the relationship between MMF at East Mills and Highbridge and Albrook (River Itchen) and a modelled series for the Itchen.

5.5 Land drainage, river dredging and weed cutting

These activities all have scope to affect hydrological characteristics and water levels.

Land drainage has been undertaken extensively since Victorian times, through surface water drainage (ditches) and land drains. Large-scale maps of the Somerley area held at the Hampshire Record Office show extensive networks of land drains covering much of the estate. The impact of this activity on river flows and levels is uncertain. There is a widespread perception that the Avon is “spatier” than it used to be within living memory, and that high levels that used to hold now fall more quickly. This was also a view held nearly a hundred years ago. In considering reasons for the decline in fish stocks in the Avon, Turner-Turner (1914) wrote “as far as salmon are concerned, a conspicuous reduction in its water level through universal drainage seems worthy of consideration. Floods that formerly remained for weeks two feet above the meadows now subside in a few days, and the average river level is perhaps nine inches less than formerly”. Unfortunately few records survive of land drainage activities such as main-river dredging, ditch clearance and field drainage. However, apart from main-river dredging, little land drainage work has been carried within the Somerley study area in the past 50 years so this activity is unlikely to have contributed to the recent changes in the fortunes of wetland birds there; however, it is possible that the neglect and decline of former land-drainage works, including the ditch network, is implicated.

The river has been periodically dredged over the past hundred years, mainly as a flood-defence measure. A request for information from the Environment Agency produced the surprising response that they had no information about historical dredging between Bickton and Ringwood in the post-war period. Huggins *et al* (1977) present some information on dredging between 1950 and 1975 indicating that there was activity in most years, including the Bickton to Ringwood reach in 1958 and 1970. The reach above Ibsley Bridge was also dredged in the 1980's, and the spoil was dumped on the west bank to form an access drive (John Levell, pers.comm.). One likely result of this last activity is to reduce the frequency of bank overtopping into the meadows above Ibsley Bridge.

Weed cutting has been undertaken in most years since the 1950's. Upstream of Salisbury this has been undertaken by the riparian owners, but downstream of Salisbury it has been the responsibility of the Environment Agency and its predecessors, as it has a flood defence function. The weed is cut using specially-designed machinery and the cut material is removed from the river using dragline machines at a series of booms set across the river to retain the weed. Without cutting, the channel becomes so choked with weeds that levels rise throughout the summer, despite falling flow, and in some years flooding would otherwise occur in late summer. The extent of weed-cutting activity before the 1950's is uncertain. Weed cutting activity must have a major impact on the river ecosystem and was listed as one of the two main factors thought to be implicated in the decline of coarse fish stocks by Huggins *et al* (1977) – see section 4.7.

5.6 Land use and agricultural practices

Although no detailed records have been accessed during this study, agricultural land use appears to have changed relatively little in the Somerley study area over the past 75 years, apart from the decline in the operation of traditional water meadows. Grazing of cows and sheep remains the predominant agricultural activity, though use of fields for producing silage hay has increased. There has been a recent trend towards production of suckler herds rather than dairy herds. It has been suggested that worming treatment of livestock may reduce the production of invertebrates in animal droppings or even in the meadows as a whole, but no further information was gathered on this.

One area adjacent to the Somerley study area has been changed pasture to arable farming, just to the west of the Ashley Stream (Figure 6.6). The timing of this change is not known.

One factor associated with agriculture that has changed is the level of undergrowth on the floodplain. Historically the area was kept largely clear of undergrowth presumably to maximise agricultural production, and as a result of cropping for firewood. A photograph of the land beside the Harbridge stream taken in 1897-98 is shown on the front cover of this report and in Appendix Figure 14. In Appendix Figure 15 the same scene is shown in November 2006. There has clearly been considerable colonisation of the area by willow and other trees and shrubs.

5.7 Disturbance

With increasing population in the South of England, increased numbers of road vehicles and aircraft, and increased leisure time it is almost inevitable that the Avon Valley and its wildlife are experiencing increased levels of disturbance. The overall effect is unknown.

5.8 Factors responsible for the decline in bird interests

Many of the wetland birds of conservation interest are in decline, though a number of other species, generally of less conservation interest, have increased. Clearly, in planning actions to try and halt and reverse these declines (including management of water levels) it is important to identify the primary drivers.

In the case of the Bewick's swan and white-fronted goose the factors are likely to be mainly outside the area under consideration. Peaks in abundance of both species coincide with cold winters. There is no evidence that there have been systematic changes in the frequency and extent of winter flooding that could explain the development and decline of the wintering populations in the Avon Valley. There have however been a number of other changes that might be implicated in the decline, or at least may complicate any recovery. These include land-use changes, disturbance (by anglers and wildfowlers) and increases in several other species utilising the same areas and resources.

Good numbers of migratory wildfowl and waders still occur in the valley during wet winters, and again there is no evidence that changes in frequency, duration and extent of flooding have occurred.

However, the decline in breeding waders may be at least in part due to a gradual long-term decline in the secondary waterway systems in the valley, with the loss of extensive wetted margins and marshy areas (although ironically Clark (1998) lists restoration of carriers as one possible contributory factor in the increase in populations of mute swans). Other factors that could be implicated include increase in disturbance, increase in fencing and overhead cabling, and changes in land use - all suggested by Clark (1998) as possible factors for the decline in some wintering bird populations - and a general increase in growth of trees and undergrowth on the floodplain. Although the species vary in their detailed requirements most of the breeding waders prefer wide open areas with a clear view of any approaching dangers. From an examination of aerial photographs taken over the past 50 years it is clear that cover has increased.

However, another possible factor in the decline in breeding waders is the increase in populations of potential predators, particularly corvids. In the two survival studies described in Section 3.5 above, 23% (Green 1988) and 31% (Mason and Macdonald 1976) of eggs or chicks of snipe were killed by predators, predominantly carrion crows (*Corvus corone*). Populations of this species have been increasing in the UK for the past 40 years at least, more than doubling in the 35 years between 1967 and 2002 (Baillie *et al* 2005). Other corvids likely to predate on wader eggs and chicks have also greatly increased in recent years; eg jackdaws (*Corvus monedula*) up 82% in the 25 years from 1977 to 2002, and magpie (*Pica pica*) up 108% in the 35 years 1977 to 2002 (Baillie *et al* 2005). Populations of corvids are likely to have increased in the Somerley area to a greater extent than these national figures suggest due to a change from a rigidly keepered environment to one with virtually no avian management. It is also likely that mink, which are now established in the valley in significant numbers as a result of escapes from mink farms, are also significant predators of eggs and chicks of ground-nesting birds.

Overall, it is clear that the bird fauna and indeed the whole environment of the Avon floodplain are in a state of dynamic flux. As described in the appendix the appearance and environment of the Avon Valley at present, and at any time in the past thousand years, is a reflection of the stage of management of the valley that prevails at the time. In the long term there have been enormous changes in land use (including agriculture and gravel extraction), and levels of disturbance and management of the river. There has been a warming trend over the past 100 years or so, which has been particularly marked in the past 30 years. The balance of bird species has also shown significant changes, with two of the species of greatest conservation interest (Bewick's swans and white-fronted geese) effectively appearing, thriving and disappearing within a period of 70 years. It is difficult if not impossible to identify the critical factors involved in the changing fortunes of the different species. The very fact that many species are increasing while others decline suggest that the environment is changing rather than deteriorating, and the interactions between the species in flux complicates the picture further. It may prove very difficult to manage the environment for the benefit of one or a few species of particular conservation interest.

5.9 Factors responsible for the decline in salmon in the Avon

There is considerable debate regarding the factors that are predominant in the decline in stocks of salmon in the Avon. There are many pressures on the population but to account for the decline that took place between the late 1980's and early 1990's we must seek some factor that has also changed over the same period. Within-river factors such as sedimentation of spawning gravels and changes in the sediment cycle associated with changes in flow regime, breakdown in the *Ranunculus* cycle and water temperature , and marine conditions which are apparently responsible for low marine survival throughout the British Isles are likely candidates (Solomon and Lightfoot 2007).

6 CLASSIFICATION AND ASSESSMENT OF WATERWAYS

6.1 The approach taken

The TOR require that the waterways in the study area are assessed and prioritised in fishery terms, and are considered in conjunction with WLMP actions to benefit floodplain conservation interests. The first step is to identify and list all channels of potential interest within the study area. This process was conducted using a number of inputs including examination of recent and historical maps, walkover surveys, discussion with Agency and Natural England Staff, discussion with John Levell (Somerley Estate), and examination of survey reports. Only channels with an actual or potential fisheries interest were included.

Figure 6.1. Aerial view of the flooded valley upstream of Ibsley Bridge, January 5 2003. This view is looking North (upstream), with Ibsley Bridge off the bottom of the picture, and Bickton at the top. The white dotted line indicates the approximate centre-line of the river. Note that the West bank of the river is higher than the fields behind it, probably as the result of dredging spoil dumped on the bank. In the centre foreground the two hatchpools on side stream leading to the Harbridge Stream are visible. In the middle right the Huckles Brook enters across a raised delta, created by gravel being washed down the stream. Most of the trees on the floodplain are along the banks of the main river and side streams. Photo by Stills Photography, on behalf of the Environment Agency.

Figure 6.2. The next river reach downstream from Figure 4.1 taken on the same day, with Ibsley Bridge near the top of the picture. The white dotted line indicates the approximate centre-line of the river. Note again that most of the trees and scrub in the floodplain are along the river. Also note that the watermeadows in the left foreground are higher than the flooded area of the valley. Photo by Stills Photography, on behalf of the Environment Agency.

Many of the watercourses do not have names so a hierarchical numbering system was developed, based upon the WLMP area classification. This not only provides compatibility with the wider WLMP process, but is also valid in ecological terms as the WLMP areas are divided by significant drops in water level such as major weirs. The main river channel, including reaches around the back of islands in the main stream, are allocated designation 1 within each WLMP area, for example the main river through the Ellingham (WLMP area 6) is designated 6.1. Other watercourses, including tributaries, within this WLMP area are numbered 6.2, 6.3 etc. Side branches off these second-order waterways are given a third number eg 6.6.1. In a few instances a channel crosses a WLMP boundary without any obvious structure, and such stream have two numbers; for example, the Harbridge Stream is 7.2 upstream of Harbridge Causeway, and 6.2 downstream.

Only water courses entirely or partly within the Somerley Estate (the study area) were allocated a number in this exercise. This includes the whole of WLMP Area 6 (Ellingham) but only parts of Area 5 (Ringwood) and Area 7 (Harbridge Green). If this exercise is extended additional water courses will require numbering within these last two Areas.

Figure 6.3. Aerial view of the watermeadows at Ellingham, December 1986. The picture is taken looking SW, with Ellingham Drive in the foreground. The lower part of the Ellingham Carrier (Channel 6.5.1) runs close to the river, and the gently-curved Woodside Carrier (Channel 6.5.2) and the more sinuous Woodside Drawn (Channel 6.6) can be seen on the left. The low angle of the sun shows up the individual channels well. Some grazing swans can be seen on the right centre but it is not known if they were mute or Bewick's.

6.2 Water courses on the Somerley Estate

The watercourses identified are shown in Figures 6.4 – 6.6. Each is now described in turn.

Channel 7.1. Main river between Bickton Weir and Ibsley Weir. This channel runs between Bickton Upper Weir (SU14721310) and Ibsley Weir (SU14950958) and the millstream as far down as the head-loss structure at SU14850945. This represents about 4500 m of main channel plus a further 250 m of channel behind mainstream islands. The head-loss structures at the upper and lower ends of this reach represent little barrier to the movement of adult salmon and downstream migrants of most species, but are likely to be serious obstacles for upstream migrant coarse fish. Thus to a large extent the coarse fish populations of this reach are isolated from reaches upstream and downstream.

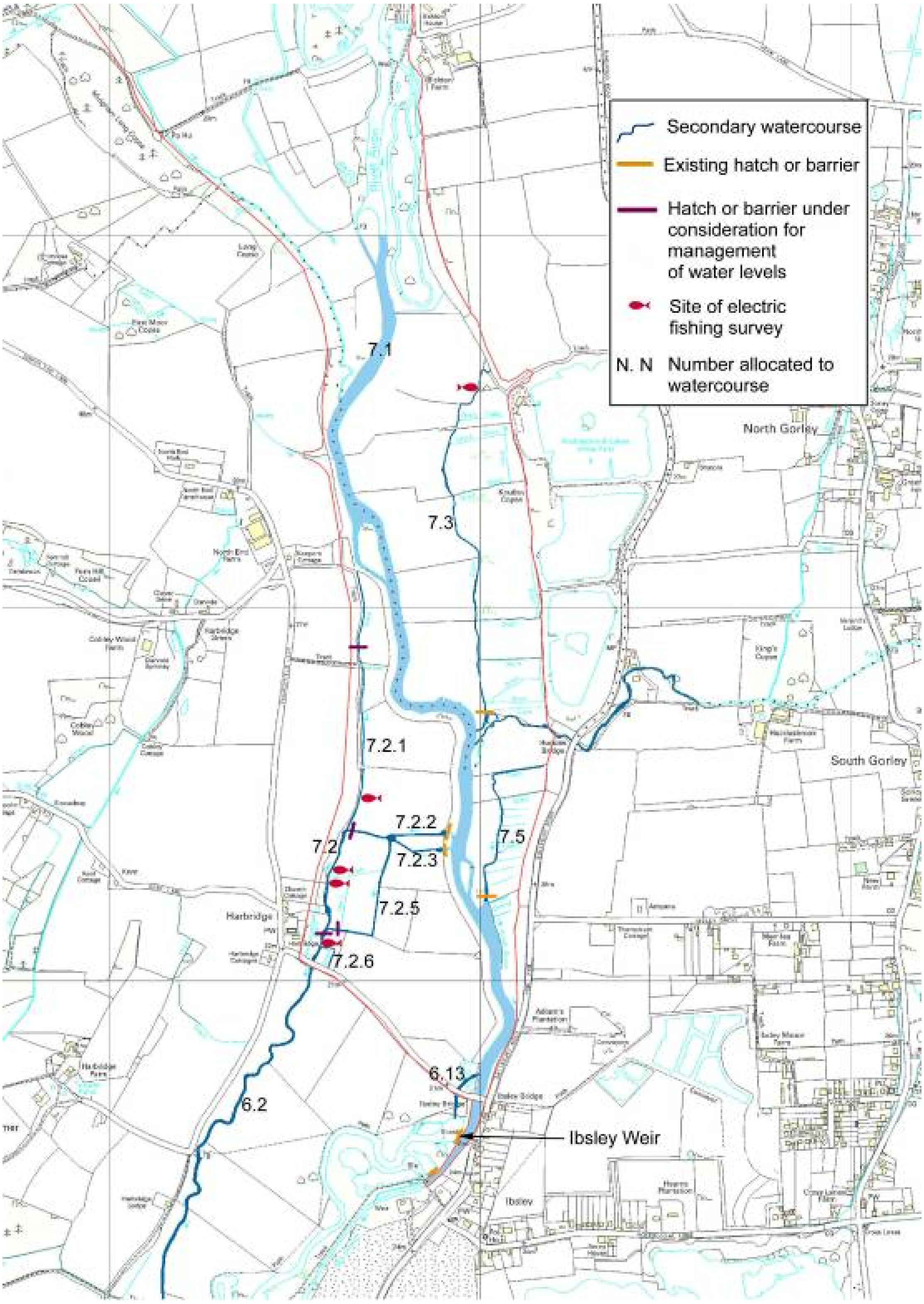

Figure 6.4. The Ibsley/Harbridge part of the study area, showing the secondary watercourses of existing or potential fisheries interest. The red line indicates the boundary of the WLMP area. Crown Copyright. All rights reserved Environment Agency, 100026380,2006.

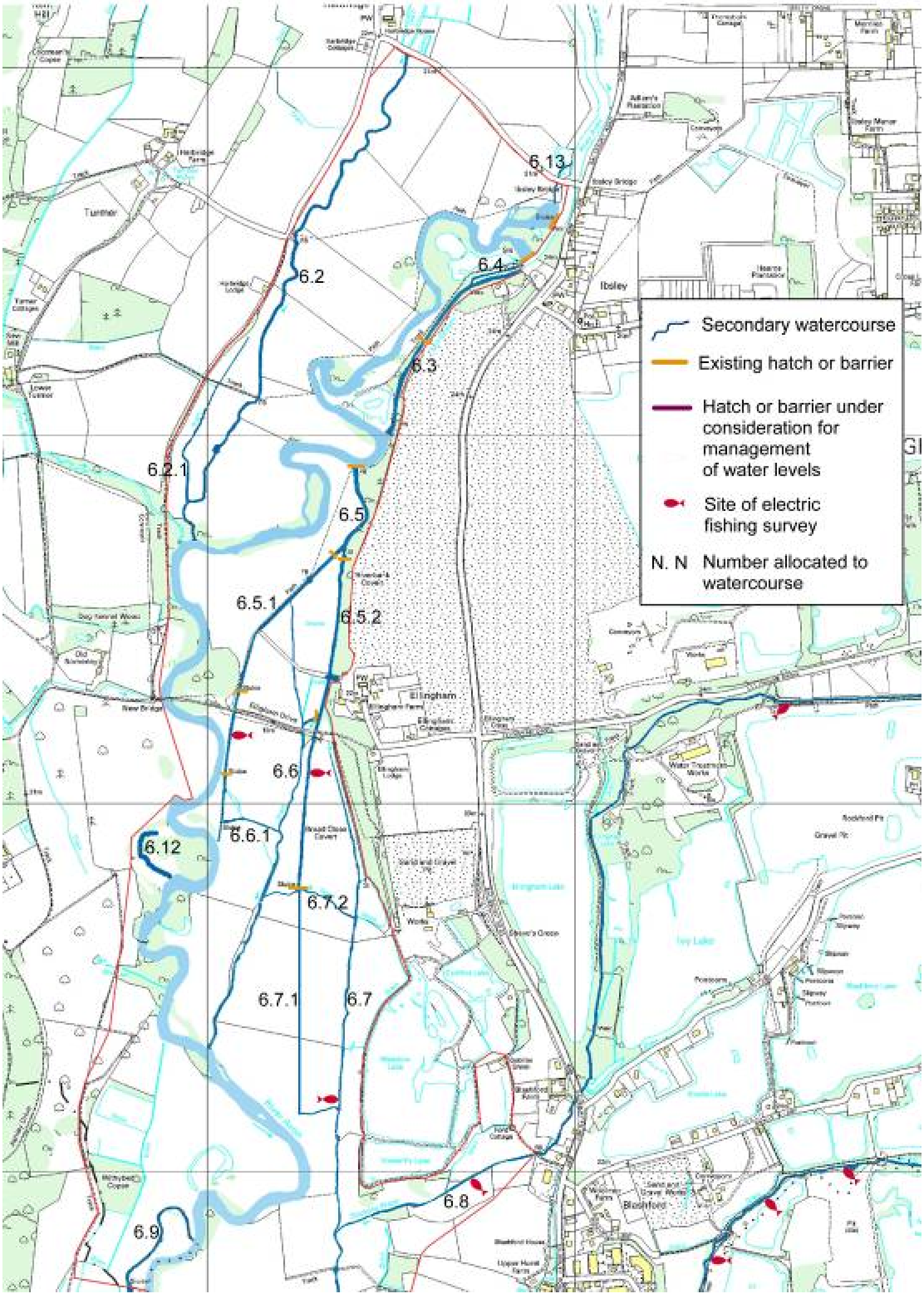

Figure 6.5. The Ellingham part of the study area, showing the secondary watercourses of existing or potential fisheries interest. The red line indicates the boundary of the WLMP area.

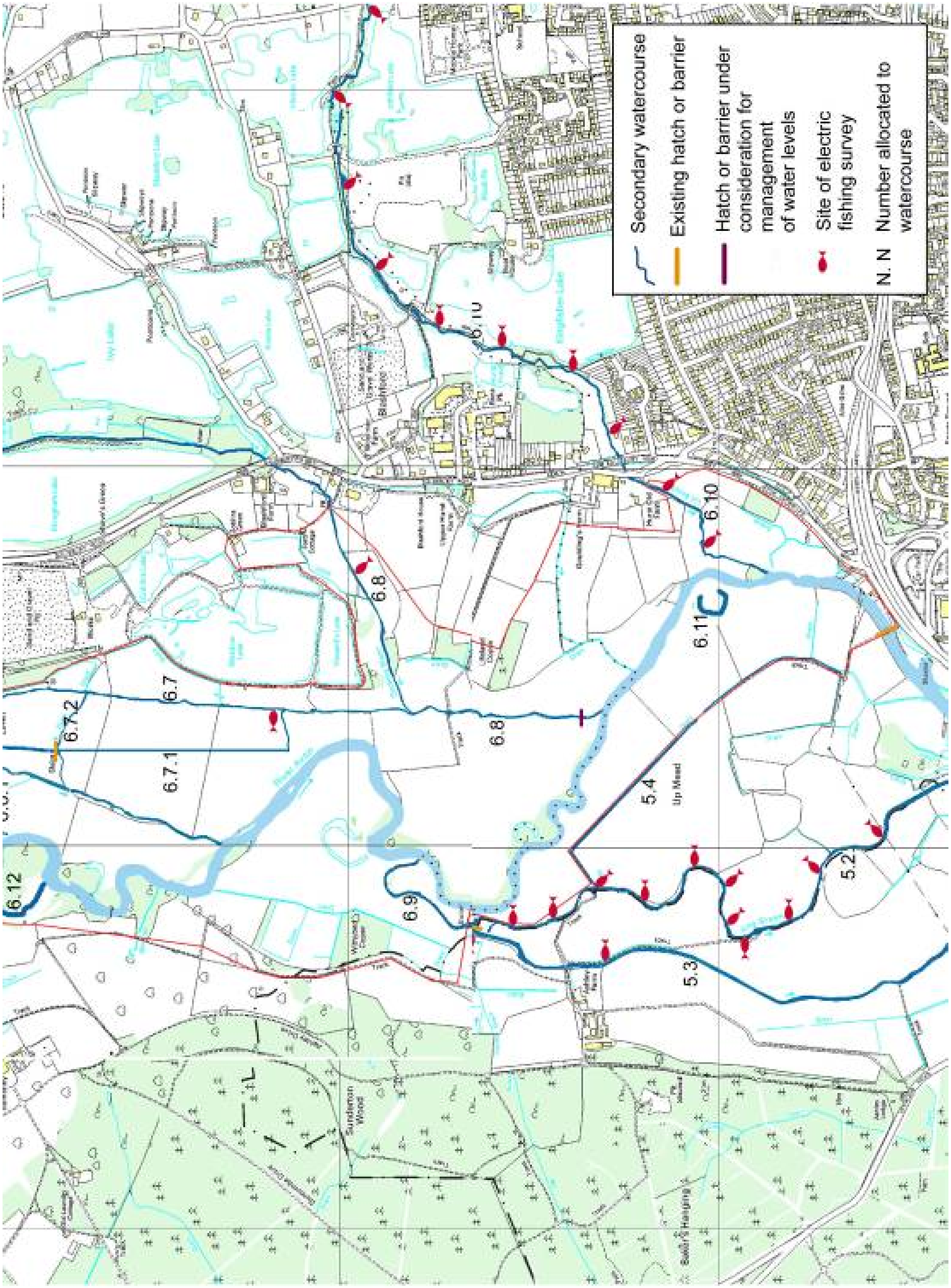

Figure 6.6. The Blashford part of the study area, showing the secondary watercourses of existing or potential fisheries interest. The red line indicates the boundary of the WLMP area. Crown Copyright. All rights reserved Environment Agency, 100026380,2006.

Channel 7.2/6.2. Harbridge Stream. This stream system has a total length of the order of 3000 m between its "source" (leakage through from the main river at SU14761112) and the point where it rejoins the main river at SU13960872. In addition there are of the order of 700 m of subsidiary channels (7.2.2 to 7.2.6). The flow in the upper part of the stream (7.2.1) is minor, but is greatly enhanced by flow drawn from two undershot sluices from the main river, flowing through the side channels 7.2.2, 7.2.3 and 7.2.4 and 7.2.5 to join the stream a short distance upstream of Harbridge Causeway.

Figure 6.7 Hatch pool where Channel 7.2.2 leaves the main river to feed the Harbridge Stream. October 2006.

Figure 6.8. Harbridge Stream, looking downstream at the junction of channels 7.2.4 and 7.2.1. Photograph from Mike Porter, EA.

The Harbridge Stream is of considerable importance in fishery terms. It has a natural channel form throughout most of its length, and contains significant populations of both salmonids and coarse fish. It is protected from damaging high flows when the main river is in flood, and the lower reaches are likely to represent an important sheltered area for fish seeking refuge from very high flows. Some angling is carried out on the stream, the “hole” immediately below Harbridge Causeway being a popular spot when the main river is high and dirty.

Fish population information is available from Agency records of electric fishing operations (Tables 4.1 and 4.2). Dace, roach, chub and pike were the dominant species (in that order), with small numbers of juvenile salmon recorded.

Channel 7.3. Ibsley Stream. A short spring-fed stream that runs from about SU14951155 to join the main river at SU14981067. The total length is of the order of 1200 m, plus a number of short side ditches that are too small to justify separate consideration. Water velocities are generally low, and the stream has a typical depth of the order of 0.5 m. Electric fishing surveys conducted in 1999-2000 (Carter 2000; Table 4.3) showed bullhead, three-spined sticklebacks, dace and chub to be the most abundant species. A lack of 0+ cyprinids between March and November in a series of three-weekly spot samples taken by electric fishing indicated a lack of spawning within the stream, and a lack of colonisation by such fish from the main river. Continuous observation of fish entering and leaving the stream was undertaken using fine-mesh (1 mm) traps between early November and late December 1999, and between late January and late February 2000 (Copp *et al* 2000). Daytime movements into and out of the stream were at a relatively low level, and effectively cancelled each other out. However, at night there was a significant net movement into the stream from the river, mainly of 0+ fish. Chub predominated, followed by roach, dace, three-spined stickleback and bullhead. A head-retaining structure (Figure 6.9) was installed some years ago by the Estate but has not been used because of possible fishery conflicts. However, commissioning of this structure or an equivalent is now being proposed for this stream to raise water levels in the adjacent meadows.

Channel 7.4. Huckles Brook (Latchmore Brook). This is a sizeable tributary stream draining about 17 km^2 of the New Forest. It is used by spawning sea trout, and contains resident trout and probably a range of other species. This stream is unlikely to be affected by any of the WLMP proposals.

Channel 7.5. Small side stream upstream of Ibsley Bridge. The 500 m channel drains a small area of meadowland to the east of the main river. Little is known of its fishery interest. A head-retaining structure was installed some years ago by the Estate but has never been used because of possible fishery conflicts. However, commissioning of this structure or an equivalent is now being proposed for this stream to raise water levels in the adjacent meadows.

Channel 6.1. **Main river between Ibsley Weir and Ringwood Weir**. This is a main-river reach of the order of 6600m.


Figure 6.9. Unused hatch structure on Ibsley Stream.


Figure 6.10. Main river just downstream of Ibsley, October 2006.


Figure 6.11. Ibsley Mill Stream (Channel 6.3), October 2006.

Channel 6.2. Harbridge Stream. Included in 7.2 above.

Channel 6.3. Ibsley Mill Stream. This is a continuation of the main river line after most of the flow feeds over Ibsley Weir. It starts at Ibsley Lower Weir (SU1489309497) and runs for 700m to rejoin the main river at SU1447309002. There is some doubt as to whether this channel ever was a mill stream. It currently houses the sub-gravel intake for the Blashford Lakes scheme. It is a sizeable and important channel, and salmon spawn here on occasions. It provides some good riffle areas for such fish as young salmon, bullhead and dace.

Channel 6.4. Old Hatchery Channel, Ibsley. This is a delightful small waterway, just 200m in length running from the mill stream at SU1487309492 and rejoining it at SU1473309387. It supports juvenile salmonids as well as bullheads, dace and chub.

Channel 6.5. Ellingham watermeadow feeder system. Channel 6.5 itself is considered to be the 250 m watercourse between the intake structure form the main river (SU14400891) and the split to form the Ellingham Carrier (6.5.1) and the Woodside Carrier (6.5.2). The Ellingham Carrier runs from this point, gradually losing water when the meadows are being watered, to rejoin the main river via a pipe at SU 14020788. It has a length of about 1000m. There are two head-retaining structures (hatches) which are used to control the flow and the water level for meadow drowning; these are situated about 50 and 500 m downstream from the split with the Woodside Carrier. The Woodside Carrier also runs for about 1000m. There is a control structure at the downstream end that regulates the flow into the drawn system (Channel 6.7).

Figure 6.12. Old hatchery channel (Channel 6.4), October 2006.

Figure 6.13. Looking upstream to the hatch where the Ellingham watermeadow system leaves the main river in Channel 6.5.

Figure 6.14. Ellingham Carrier (Channel 6.5.1) looking upstream from a point close to Ellingham Drive. December 2006.

Figure 6.15. Woodside Carrier (Channel 6.5.2) a short distance upstream of Ellingham Drive.


Figure 6.16. Lower end of the Woodside Carrier (Channel 6.5.2), looking upstream towards Ellingham Drive. January 2007.

Electric fishing surveys (Tables 4.1 and 4.3) show these carriers to be important in fisheries terms, with juvenile salmon, trout, roach, dace chub, barbel and pike present in good numbers. Some angling takes place in these channels, especially when the main river is in spate.

It is likely that channels 6.5, 6.5.2 and 6.7 originally represented a part of the Avon Navigation and were constructed in around 1675 – see Appendix for more details.

Channel 6.6. Ellingham watermeadow drawn system. Channel 6.6 starts in the meadows at about SU1423308517 and runs 1200m south, increasing in size at it gathers water from the meadows, to join the main river at SU1400307327. It gains considerable flow from a channel cut through from Channel 6.5.2 just upstream of Ellingham Drive. It also receives flow from the bottom of the Ellingham carrier via a 180m side channel, 6.6.1.

Channel 6.7. Woodside watermeadow drawn system. This drawn system starts in the meadow at about SU1433308087 and flows 1300m south to join the Dockens water (Channel 6.8) at SU1435806857. It is joined by two side channels; 6.7.1 which runs 700m from SU1425807817 to join Channel 6.7 at SU1435806857; and 6.7.2 which runs 250 m from where it separates from Channel 6.6 to join 6.7 at SU1438307772. An electric fishing survey (table 4.3) showed roach, dace, chub and pike to be the main species present.

Figure 6.17. Ellingham Drawn (Channel 6.6) looking upstream; Channel 6.7.2 visible on the right.

Figure 6.18. Lower end of the Woodside Drawn (channel 6.7) looking upstream from the confluence with the Dockens Water. January 2007.

Figure 6.19. Channel 6.7.2 running between the Ellingham Drawn and the Woodside Drawn.

Figure 6.20. The Dockens Water (Channel 6.8, flowing from the right) at its confluence with the main river. January 2007.

Figure 6.21. King Stream (Channel 5.2). January 2007.

Channel 6.8. Dockens Water. A sizeable tributary draining of the order of 20 km^2 of the New Forest. In its lowermost 1200 m it has been dredged and straightened but is a natural channel upstream of there. It joins the main river at SU14360631, and is itself joined by the Woodside drawn system channel at SU14350685, about 600 m from the confluence with the main river. The Dockens Water is an important salmon spawning and nursery stream; a survey site at SU147070, about 1100 m above the confluence with the main river, often has the highest densities of juvenile salmon in the Avon catchment. Other species recorded at this and a site further upstream are trout, bullhead, chub, dace, eel, minnow, perch and stone loach (Table 4.1).

Channel 6.9/5.2. King Stream. The King Stream was probably the main river in earlier times, occupying as it does the lowest part of the floodplain (see Appendix). It starts where it leaves the main river at SU13960682 and flows along a meandering course of the order of 3000 m to rejoin the river at SU14150460. There is a major head-loss structure about 300 m from the top of the stream, with the Ashley Stream (Channel 7.3) remaining at the higher level. There is a connection with the main river at about 2000 m where it receives flow during spates via the flood relief weir. There is also a connection to the main river via hatches about 250 m above the bottom end, but these are not currently in commission. The Ashley Stream rejoins the King Stream at about 2300 m.

The King Stream is a varied habitat with pools and riffles, and this is reflected in a wide range of fish species including salmon, trout, roach, dace, chub, barbel and pike (Tables 4.1 and 4.2).

Channel 6.10. Linford Brook. This tributary draining the New Forest joins the main river at SU14730587. The lower reaches can dry completely in a drought but clearly there are suitable refuges further upstream as the fish fauna is well represented (Tables 4.1 and 4.2), though salmon, barbel and pike appear to be absent. Electric fishing surveys have revealed some relatively enormous numbers of dace present on occasions (Table 4.2).

Channel 6.11. Refurbished oxbow lake. This old cut-off meander (centred on SU13800785) was dug-out and reconnected to the main river via a pipe by John Levell (Somerley Estate) during 2006 to provide coarse fish fry habitat. It is recommended that this highly commendable initiative is monitored to assess its effectiveness. As it is also likely to prove of benefit for birds (waders and wildfowl) the scope for future similar initiatives (such as Channel 6.12 below) looks positive.

Channel 6.12. Silting oxbow lake. This cut-off meander centred on SU14600600 is silted and choked with rush and other emergent vegetation, and of no fisheries interest in its present state. However, NE are interested in the possibility of restoring at least part to open water for bird interests, and with appropriate re-connection to the river this could be of significant interest in terms of a refuge for juvenile coarse fish.

Channel 6.13. Ibsley Weir by-pass. There is a culvert under the Ibsley-Harbridge causeway a little west of the main bridge. Although there is no obvious channel associated with it this could be used for a bypass channel running from a little upstream of Ibsley Bridge into the weirpool. The main function of this would be to act as a natural-style pass for coarse fish and possibly salmonids. It would also represent an interesting habitat in its own right (a high gradient small stream) and could be incorporated into any works that are undertaken to allow the river to spill into the meadow above the causeway at lower height than the existing raised bank allows.

Such nature-like passes have been much used in Austria (Parasiewicz *et al* 1998; Mader *et al* 1998) and Germany (Gebler 1998) and have proved very successful.

Channel 5.1. Main river from Ringwood Weir to Avon Castle. This main river reach of about 4200 m runs from Ringwood Weir (SU14570555) to "The Leam" at Avon Castle (SU141803517).

Channel 5.2 Kings Stream. Already considered as extension of channel 6.9.

Channel 5.3. Ashley Stream. This stream runs from SU14770667 where it leaves the King Stream, to where it rejoins the King Stream at SU13980514. It has a length of about 1700 m and was probably constructed as the millstream for Ashley Mill, which was situated close to the downstream end of the channel. An electric fishing survey showed that chub and dace are the dominant species, but salmon, roach, barbel and pike are also present (Table 4.1).

Channel 5.4. Up Mead Drain. This overgrown channel runs for about 1300 m from the King Stream at SU13893 to the main river at SU1436305477. It is currently of no fisheries interest except perhaps the lowermost few metres which may provide a refuge for fish from the main river at times of flood. There are proposals in the

WLMP to use this watercourse to raise water levels in the adjacent meadows. This would probably be done by closing off the connection with the King Stream and feeding the channel via a pipe from the main river, with levels maintained at the appropriate level within the channel by one or more structures. The channel may become of fisheries interest if appropriate levels for fish can be maintained throughout the year.

Channel 5.5 Bickerley Mill Stream. This major sidestream leaves the main river below Ringwood weir and is outside the study area. It rejoins the main river a little distance upstream of the lower boundary of the Ringwood Unit at Avon Castle.

Channel 5.6. Flood relief channel. This short (200 m) channel centred on SU14260533 acts to carry flood water from the main river to the King Stream. This is probably required because the capacity of the bridge on the present-day main river is of limited capacity compared to both the old and the existing bridges on the King Stream (See Appendix). It has a weir at the King Stream end which only spills when the river is high, so for much of the time this channel is virtually still water.

7 PROTECTION OF FISH FROM ENTRAPMENT

7.1 Consideration of the issues

The TOR for Task A2 are listed in Section 1.1 and include an assessment of the seasonal patterns of movements of fish, and a review of options for excluding fish from the ditch systems or facilitating movement as appropriate. The requirement for a review of fish exclusion methodologies pre-supposes that exclusion of fish is desirable or beneficial. It is suggested that in the great majority of situations under consideration this is not so.

As has already been discussed, the preferred approach to management of secondary waterways is to allow free access in and out for all fish species as long as the benefits of doing so outweigh the risks of losses by entrapment and stranding. Other factors in the decision-making process is the practicability and cost of providing effecting screening, and the potential adverse impact of the screening itself.

The seasons and timing of movements of the SAC and other main fish species present in the Avon have been discussed in Section 4.

There would appear to be no advantage in preventing upstream passage of any life-history stage of any fish species in any situation being considered in this report, and every reason to facilitate it wherever feasible.

Prevention of downstream passage from the main river into secondary waterways may be desirable if the fish are likely to experience a greater risk of death by such passage, or if migration is significantly delayed. This must be balanced by consideration of the benefits of allowing access to possible extensive areas of habitat. This justifies consideration on a species by species basis.

7.2 Bullhead and brook lamprey

Bullhead and brook lamprey have generally restricted migrations and preventing passage into ditch systems is simply not an issue. Indeed, smaller waterways are likely to favour them and free passage is to be encouraged.

7.3 Cyprinids

Cyprinids (roach, dace, chub, barbel, bream etc) undertake rather more extensive migrations than bullheads and brook lamprey, over distances of the order of kilometres.

There have been two extensive reviews of techniques to exclude fish from water intakes, by Solomon (1992) and by Turnpenny and O'Keeffe (2005). There are basically two approaches to preventing or reducing the downstream passage of fish into secondary waterways. These are physical exclusion by meshes too fine to allow passage; and exploitation of behavioural reactions to encourage passage via an alternative route. These are now considered in turn.

Figure 7.1 A Johnson Passive Wedge Wire Cylinder (PWWC) Screen on a water intake on the River Tamar, dewatered. This is one of the few practical screen types for utilising fine mesh and small gaps. The slot size in this case is 3mm, which would exclude cyprinids of 50 mm and larger. The screens are kept clear of debris by bursts of compressed are released inside the screen cylinder, triggered automatically by a pressure drop across the screen. The costs of supply, installation and operation make the deployment of such screens quite impractical in the situation being considered in this report.

a) Physical screens. The mesh required, and the approach velocity that will allow fish to escape from the influence of the intake, will of course depend upon the size and to some extent the species of fish. Turnpenny and O'Keeffe (2005) suggest that a screen with a slot width of 3mm with an approach velocity of 22 cm/sec would prevent the passage of, and would allow the escape of, 50 mm cyprinids with the possible exception of bream which have a more restricted swimming ability. Exclusion of cyprinids as small as 20 - 30 mm (such as comprise much of the population of 0+ fish at the time of their late summer migration) would by extrapolation require a mesh with gaps of 1.2 mm and an approach velocity of 8.8 cm/sec. As far as the author is aware no such screens have ever been installed in the UK for the protection of such small fish. The costs would be prodigious and there would be a requirement for constant cleaning to keep the mesh clear.

The Jacobs Babtie group at Fawley have extensive experience with intake screening and are currently investigating the performance and suitability of a range of screen types for small cyprinids in a two-year project funded by Thames Water Utilities and Veolia Ltd. They have used three Passive Wedgewire Screens (see Solomon 1992) with compressed air backwash (to automatically keep the mesh clean) with mesh slots of 1, 2 and 3 mm continuously pumped at 25 l/sec. They are currently looking also at two other screen types, both travelling belt screens with 3 mm mesh of different types. All water drawn through the screens is then passed through plankton mesh to recover all entrained material, including fish. The study is also examining the implications of any loss of fish in terms of the overall population. The results of these trials should be available shortly, and will add considerably to our knowledge of suitable approaches for preventing entrainment of juvenile cyprinids. Again, however it is stressed that the costs of installing and operating such screens are likely to render them out of the question for the applications being considered here.

b. Behavioural screens. Some behavioural diversion systems may be suitable for small cyprinids; Turnpenny and O'Keeffe (2005) list acoustic, light and bubble diversion systems as being in their "second division" of options for juvenile cyprinids, as "being suitable in some applications". Perhaps the most appropriate for consideration here is the "Bio-acoustic fish fence" (BAFF) system, which uses an acoustic deterrent largely contained within a curtain of air bubbles. Figures of 56 to 92% efficiency at excluding cyprinids are quoted, varying between sites and species, though details such as the approach velocity, volumes abstracted and bypass arrangements are not provided. Although they do not involve a mesh that requires cleaning these electro-mechanical devices do require a source of electrical power, and regular maintenance. This involves periodic removal of the underwater units, and thus some provision for lifting them.

It must be stressed that all the equipment involved in both physical and behavioural screening represents major capital and running costs, frequent maintenance and major engineering for installation. Turnpenny and O'Keefe (2005) Installation of such facilities may be justified for large-scale abstractions where any entrained fish are lost to the system. However, it is suggested as inappropriate for the situation under consideration here, where the majority of the fish entrained, far from being lost to the system, are afforded access to prime habitat with only minor risk. What risk remains is that of becoming stranded in flooded meadows when they are drained. The timing of proposed meadow flooding, winter through to early summer, avoids the main season of downstream movement of juvenile cyprinids (Section 4).

Another factor to consider is that any screens to prevent downstream passage are also likely in addition to prevent or restrict upstream passage. In most situations this is undesirable.

Overall, it is suggested that installation of screening to restrict the passage of juvenile cyprinids in the context of ditch management on the Avon is not necessary, desirable or practicable, subject to adoption to the guidelines listed in Section 8.3.

7.4 Salmonid smolts

The other main class of downstream migrants is the smolts of salmon and sea trout, and these represent a rather different issue to juvenile cyprinids for several reasons:-

- They are obligate migrants and safe and timely passage to the sea is essential for their survival;

- The timing of their downstream migration, roughly from March to May, lies within the season when meadow flooding is proposed;

- By this stage of their life the scope for compensatory survival of a reduced population is past and loss of (say) 10% of the run of smolts will result in a 10% reduction in the stock or returning adults;

- They are larger and the technology of excluding them from entrainment is better established and more practicable.

However, even here routine screening is not recommended. In most cases, the diversion of significant flows of water into secondary watercourses (for example the Harbridge Stream) represents an appropriate and safe route downstream, and most fish will be able to rejoin the main river with minimal risk and delay. The take-off for meadow flooding generally represents a minor proportion of the water being diverted, with the flooding being maintained by level rather than flow. Smolts are adept at finding the main flow downstream and are unlikely to venture into areas of shallow flooding unless there is a significant velocity of flow involved. This is of course in sharp contrast to traditional water-meadow flooding where large volumes of water were taken down channels of increasing number and decreasing size such that there was no readily-found safe route back to the main river, and large numbers of fish became stranded and were killed (See Appendix 1).

Figure 7.2. A bar screen on the intake for a trout farm on the Avon. The gap between the bars, around 10 mm, is sufficient to exclude salmon smolts. Although the screen material itself is fairly cheap there are major engineering costs associated with effective and safe installation on intakes handling sizeable flows, and maintenance is required at least daily to keep the screen clear of debris.

It is therefore suggested that smolt screens are considered only where and when EA fisheries staff perceive a significant threat to the safety of smolts. This assessment will require site visits when meadow-flooding is in operation under conditions that are representative of the smolt season. Practicability is an issue; it is unlikely to be realistic to exclude smolts from the Ellingham Carrier for example without extensive and very costly engineering, but it may be so at the draw-off points from the carrier for flooding individual areas.

Screening is relatively straightforward where a limited flow is being drawn through a discrete channel. A simple mesh screen, with a maximum gap between vertical bars of 12 mm, can be set into a rectangular channel with slots to receive it. The channel can be formed of concrete, brick or timber and needs only be of short length – perhaps 0.3 – 0.6 m. Arranging for the mesh screen to be sloped so that the top edge is downstream of the lower edge affords some level of self-cleaning and facilitates manual cleaning. Even so, daily inspection and cleaning are likely to be required. The location of the screen is important, in that a safe alternative route should be readily available. Thus the screen should be sited where the water is drawn-off from the larger channel, rather than some distance along the intake channel. Such screens will only be required from about mid-March to the end of May for the effective protection of the smolt runs. They should be removed as the flooded areas are drained by reducing the retained head, so that any fish that have entered the area can leave.

Figure 7.3. A simple bar screen on an intake to a single pond on a trout farm on the Avon. In contrast to the situation shown in Figure 7.2 installation costs for intakes handling such a limited flow can be modest. Regular maintenance is required to clear the screen of debris, but this is less of an issue if the effectiveness of the wetland being supplied is not dependent on a constant flow.

Further design and operating criteria are provided by Solomon (1992) and Turnpenny and O'Keeffe (2005), but it is stressed that there may in practice be little or no justification for screening even for smolts.

7.5 Fish exclusion installations elsewhere on the Avon

All major intakes for potable and industrial water supply, and fish farms, are fitted with screens to exclude salmonid smolts. The fish farms at Britford, Trafalgar and

Bickton have physical mesh screens with minimum gaps between vertical bars of 10 or 12 mm. These are likely to exclude all salmonid smolts and cyprinids of 100 mm or more, but offer little or no protection for juvenile cyprinids. In contrast to the situation being considered in this report, few small cyprinids drawn into the fish farms are likely to survive.

7.6 Cost of intake screening

The TOR require that indicative costs of installing and operating intake screens are provided. This is problematic as indicated in a review of screening technology by Turnpenny and O'Keeffe (2005) who stated:-

"The costs of installing fish screens are highly site-specific and will depend on whether the application is a new-build or a retrofit, what existing structures are present, what ground conditions are like, the degree of exposure to flood and other damage, whether power is available and many other factors."

They do provide some cost estimates for a range of intake sizes and screen types, but point out that these are only supply costs and do not cover installation. In most cases the site engineering costs greatly exceed the cost of supply of the hardware.

The range of supply costs provided by Turnpenny and O'Keeffe (2005) for a $1m^3$/sec intake include 12 mm flat mesh panel (£24 k), 3mm PWWC screen (£50 k), and a raked bar screen (£40 k). Again it must be stressed that these costs do not include site engineering and installation.

Much smaller intakes that might be approachable with low-tech solutions are likely to cost very much less. A screen to exclude smolts from a small draw-off into a scrape, for example, where the flow may be 1 Ml/d or less, using simple mesh held in a timber frame driven into the ground, may be installable for little more than the costs of materials – perhaps just a few tens of pounds.

7.7 Approaches to upstream fish passage

As already discussed, it is recommended that all head-retaining structures are designed and managed to allow effective fish passage in both directions whenever practicable. Detailed design of hatches and associated fish passage facilities are beyond the scope of this report, but suggestions on general principles are appropriate. The following approaches are suggested as being worthy of further consideration:-

- Arrange for structures to be low-head so that they are ascendable by the fish of interest. Even where higher heads are required this may be achieved by the use of two or more structures a little distance apart.

- Reduce the retained head at times, for example during seasons when wetting of meadows and scrapes is not required. As already discussed, from the perspective of maintaining good conditions for fish it is recommended that the retained level is only reduced enough to achieve appropriate conditions for birds and other interests rather than by just "pulling the plug", but the lower retained level may render the structure passable by many fish.

- Bed raising may be a viable option at some sites, especially where past dredging has lowered the levels. For example, addition of large volumes of gravel could generate some valuable riffle habitat as well as achieving an increase in upstream water level. As a general sustainable approach it is to be strongly recommended as it requires little if any maintenance and it uses the head loss to create habitat rather than uselessly, even damagingly, dissipating it in one fall. The main limitation of this approach is that it does not allow active management of levels by season, which could be an issue in terms of flood defence.

- It may be possible to devise and install a fish pass at some structures. The science of design of fish passes for cyprinids, especially small fish, is not well developed in the UK and further examination of possible approaches is required. Possibilities include pool and traverse passes with low head loss between pools, baffle passes and possibly fish locks. This approach will require some level of flow volume and may not be realistic in many smaller channels. In practice, channels with such low flows that retaining all to achieve wetting of the target area are likely to be of only minor fishery significance.

- By-pass channels are an option well worthy of consideration where land and flow are available to accommodate them. The concept is that they lose the retained head over a length of the order of tens to hundreds of metres, allowing fish passage and indeed creating some interesting habitat in their own right. The principles and practice ate described by Gebler (1998), Mader *et al* (1998) and Parasiewicz (1998).

- The situation is less critical where the channel is fed from the main river and rejoins it some way downstream. Fish can colonise the stream from both upstream and downstream, and the main issue becomes ensuring effective and rapid downstream passage for smolts entrained from the main river.

It is strongly recommended that these options are actively researched and trialled in field situations.

8 TOWARDS A METHODOLOGY OF STRATEGIC PLANNING

8.1 Introduction

In this section the information gathered so far is used to develop a practical and sustainable approach to strategic planning of development and management of secondary watercourses based upon sound ecological principles. While this is based upon the study area between Bickton and Ringwood it is hoped that the approach will be equally practicable for the whole of the Avon catchment and indeed other groundwater-fed rivers throughout the UK and beyond. However, before we can develop a high-level process it is necessary to consider a number of practical issues.

8.2 What do the birds and bird interests want from the waterways?

The bird interests being considered here are of two main groups; breeding waders, and over-wintering swans, geese, wildfowl and waders. The main requirement of the waterways is management of water levels to create and maintain shallow flooded areas and wet ground at specific times of year. One factor that greatly reduces potential conflict with fishery interests is that maintaining water levels does not necessarily require significant volumes of water to be continually flowing from the river or sidestreams over the ground. This is in contrast to the operation of traditional watermeadows, where large volumes are required to maintain exchange of water over the ground to maintain temperature and to allow deposit of suspended solid material for soil enrichment. Losses of fish associated with traditional watermeadow operation can be considerable and screening to prevent such losses is problematic.

The documentation associated with restoration of breeding waders through the High Level Scheme (HLS) of the ESA provisions for the Avon Valley spells out targets for ideal habitat (Andrew Fielder, *pers. comm*.). These include, *inter alia*, managing low sward height, low livestock densities between March 1 and May 31, 25% of the field should have soil damp enough for a 6-inch nail to be pushed into the ground with ease between April 1 and June 30, 5-10% of the field should have standing water between March 1 and June 15, subject to weather and ground conditions, in hollows/scrapes and stream edges.

With regard to wintering wildfowl and waders, it would appear that the greater the extent of flooding in space and time, the greater the numbers of birds. While it may not be practicable (or indeed desirable) to engineer extensive flooding in winters of low or average flow there may well be scope for creating limited areas of wetland. This is already done to some extent on the Somerley Estate in the form of scrapes and old watermeadow channels to attract wildfowl for shooting; water level is managed using hatches on the old watermeadow carriers and drawns. Although the requirements for breeding waders outlined above only specify a requirement for water level conditions from March 1 to June 30, operating any head-retaining mechanisms throughout the winter will not only ensure that conditions are optimal for breeding waders from March 1 but will also be of benefit to wintering wetland birds in dry or average seasons.

An important issue to resolve is the extent to which water levels, and changes in water levels in recent decades, have been contributory to the perceived decline in wetland bird numbers. As discussed in Section 5.8, while it is clear that appropriate water levels and management thereof are important for wetland birds, there is evidence that a number of other factors may have been partly or even predominantly responsible for the decline. It is clearly important to be sure that changed management of water levels will be effective in reversing, or in helping to reverse, the declines and whether other, alternative or additional, actions are indicated.

8.3 What do the fish and fishery interests want from the waterways?

The secondary waterways of the Avon valley represent a most important resource in fisheries terms, providing several habitat features for a range of species.

First, they simply increase the area of habitat available. Although generally of limited width they do represent a major part of the overall wetted area of the Avon system; in the case of the Somerley Estate, they represent a greater area of river bed that the main river itself. They increase the length of bankside, with cover for small fish, to an even greater extent.

They also increase the habitat diversity greatly. The main river represents a rather uniform habitat, whereas the secondary waterways provide a wide range of depths, current speeds and cover. Some provide areas of fast flow over riffles, suitable for spawning and rearing of salmonids, while other provide deep slow water which acts as a refuge for small cyprinids from the faster current of the main river. The two main requirements in terms of fish interests in the secondary channel are habitat diversity, and longitudinal connectivity. As described in Section 4.13 even the supposedly non-migratory species of fish often make significant movements on a daily or seasonal basis, and to avoid damaging conditions in the main river during times of flood.

Generally, the proposed actions to raise water levels in some secondary waterways is to be welcomed in fisheries terms as long as the following fishery considerations are taken into account wherever possible:-

- The action of raising water levels does not “drown out” or otherwise reduce the ecological value of any riffle areas;

- As far as possible, any head-retaining structures are passable to all age classes and species of fish that wish to pass in either direction at all times, or at least frequently enough to represent no significant degradation in fisheries terms.

- Variation in retained water levels should be appropriate for optimising fisheries as well as avian habitat; in particular a two-state situation of either high or low water levels, with no intermediate state, should be avoided.

- Water level changes should be achieved gradually, especially when levels are being lowered, to avoid stranding fish. This applies particularly to juvenile brook lampreys, which spend up to several years living in silt banks. While they are able to move slowly through silt banks to adjust to changing water levels, rapid changes are likely to leave them fatally stranded.

- The situation of a large volume of flow passing through the grass sward should be avoided wherever possible, as it can lead to fish becoming stranded or vulnerable to avian or mammalian predators. This is particularly important during the salmon and sea trout smolt season (roughly mid-March to the end of May). Although such stranding of fish can occur naturally during floods there is little need for it to occur as a result of actions to improve the habitat for wetland birds.

- Flooding of scrapes and wetting of meadows should be achieved wherever possible through maintaining water levels rather than by having an active flow over the land. Scrapes and temporary ponds should, where possible, be connected to one watercourse through a single channel or pipe, so that the area fills and empties through the same orifice that allows complete draining of the area as levels in the feeder fall. There is thus little or no flow through the area to carry and trap fish, and any fish that do find their way into the area do not become trapped as levels fall. If a continuous flow is necessary through the area the volume should be minimised, and wherever possible the outflow should be a discrete channel through which fish can pass, rather than a dissipated flow through the sward. This may require some minor bunding works.

In most cases, it is felt that these fisheries requirements can be incorporated into the proposals for water level management for bird interests as long as they are taken into consideration from the earliest planning stages. It is of course recognised that it will not always be possible to achieve the ideal situation of satisfying all these fisheries considerations, and where it is not it is to be hoped that discussion between all interests will reach acceptable compromise. For example, it is likely that it is desirable in bird terms that some wetland “scrapes” are maintained as wet as possible, with the maximum area of damp ground for wader feeding, well after the river level has fallen away. Thus the scrape would not be drained back into the channel, but would be isolated from it through deployment of a bund in a culvert, or by virtue of the bed of the scrape sloping away from the river. Although some fish may become trapped in such scrapes this could be minimised by ensuring that the scrapes were flooded, and had their levels maintained while channel level is high, without significant volume of flow through them (i.e. it is basically only filled once). This is likely to minimise the numbers of fish entering the scrape.

8.4 The scoring system

The TOR require development of a scoring system to identify and prioritise sites with respect to their vulnerability to impact for SAC and non-SAC fish species from water level management. Developing a scoring system proved to be more of a challenge that initially envisaged. This was largely because of what is presumed to lie behind the proposal, that is the idea that there are some side streams that might be selected for “sacrifice” in fisheries terms. While some watercourses are clearly more important or more vulnerable than others for fish stocks, all play an important and integral role is some aspect of fish life history. For example, even the most unprepossessing ditch that may dry out in the summer may play an important role as a shelter from flood flows in the winter, especially if it is connected with a reach of main river where such shelter is limited. The Somerley study area is well-endowed with side channels in comparison with much of the Avon upstream and downstream, but even here all those accessible to fish are considered important. It is also clear that the vulnerability of individual watercourses will vary along its length. For shelter from floods, it may be the short length closest to the confluence with the river that are most valuable, whereas vulnerable riffle areas may be located at any point along the course.

It is felt that a more satisfactory approach is to classify the attributes of each length of each side stream so that appropriate steps can be taken to protect those features as far as possible when considering WLMP actions. For example, it may be important to protect riffles that represent important habitat for salmonid spawning and rearing, and dace spawning, from inundation by head retaining structures. On the other hand there may be no harm (and even net benefit) in raising water levels in areas occupied by most cyprinids as long as connectivity is retained.

Vulnerability of different situations, species and life-history stages is also an important issue. A small tributary may be greatly reduced in value for 0+ cyprinids by a relatively minor head-retaining structure at or near the confluence to the main river, unless fish spawn upstream of the barrier. Side channels which divide from and rejoin the main river are much less vulnerable to reduction in value in this respect as colonisation by 0+ fish may take place by downstream drift, even if there are a number of structures on the channel. On the other hand, there is often little or no risk to smolts migrating downstream from meadow-flooding by operation of structures on small tributaries without salmonid spawning. The risk is in this case greater with side channels deriving their flow, and perhaps part of the run of smolts, from the main river.

Sidestreams are vulnerable to fisheries impact through two quite separate effects; obstruction to passage and drowning-out of shallow habitats.

In Figures 8.1, 8.2 and 8.3 the streams are colour-coded according to the sensitivity of the fish populations likely to be using them to obstruction to passage by head-retaining structures. The lowermost 50 m of all stream joining/rejoining the main river are shown highlighted in purple. Wherever feasible, access to these lengths should be possible for all species and sizes of fish as shelter from flood conditions in the main river. This effectively means that no structures should be sited here as 0+ cyprinids will be barred by even the lowest of structures. Lengths of stream that are utilised by older cyprinids and into which access is not possible from the main river from upstream shown highlighted in red. Colonisation in these cases has to be from downstream and head structures on these lengths should be restricted where possible to 25 cm at maximum, or alternative passage facilities should be provided – see Section 7.7. Areas believed to be frequented by spawning salmonids, and which are accessible from upstream for colonisation by cyprinids, are shown highlighted in yellow. Structures on these streams should be passable by adult trout and salmon; guidelines are available in the Environment Agency Fish Pass Manual (available on CD).

Table 8.1 Summary of classification of secondary channels in Figures 8.1, 8.2 and 8.3.

Colour	Description	Importance	Optimal situation
Purple	Lowermost 50 m of all channels joining or rejoining main river	Shelter for all species and sizes of fish from flood conditions on main river	No head-retaining structures
Red	Lengths of stream that are utilised by older cyprinids and into which access is not possible from the main river from upstream	Spawning and rearing area for cyprinids.	Head retaining structures limited to head of 25 cm where possible, not drowning-out any riffles
Yellow	Areas believed to be frequented by spawning salmonids, and which are accessible from upstream for colonisation by cyprinids	Spawning and rearing areas for salmonids and cyprinids	Head-retraining structures passable to adult salmon and trout, not drowning out any riffles
Not colour coded	Areas which can be colonised by cyprinids from upstream, and not utilised by salmonids	Spawning and rearing areas for cyprinids	Not drowning-out any riffles

Channels that are listed in Section 6 but which are not colour-coded in Figures 8.1, 8.2, and 8.3 are nonetheless important for fish, but are deemed to be less sensitive to the installation of head-retaining structures. Colonisation by juvenile coarse fish will be possible from upstream where the channel leaves the main river, so upstream colonisation is less critical. The channels are not considered important for salmonids spawning. Nonetheless, the fishery potential of these streams will be optimised by allowing reasonable access up and downstream at times, and design of head-retaining structures should bear this in mind where possible. The main potential fishery impact of head-retaining structures in these channels lies in the effects upstream, especially with respect to drowning-out of shallow areas.

It is not feasible to indicate on maps of this scale the areas of riffle that are likely to be important for spawning and rearing salmonids, bullheads and spawning dace. Such reaches will usually represent only a part of the overall length, though they will often be intermittently spaced along the stream. The scope for head retaining structures to be installed and operated without adverse impact on fish will be site specific, depending upon the proximity of shallow areas upstream, the gradient of the stream, and the height of the structure. Site surveys will be an essential part of planning works in any streams with shallow reaches, to avoid or minimise the degradation of shallow riffle areas.

8.5 Design and operation of head-retaining structures.

In order to manage water levels, head-retaining structures will be required in a number of watercourses. Detailed design of such structures is beyond the scope of this report but there are a number of design and operating criteria that can be suggested. In developing this list it is hoped that all relevant criteria have been borne in mind, but it is inevitable that some have been missed. This list should therefore be considered as a draft for consultation. It must also be stressed that the list represents the ideal from the viewpoint of fisheries and that it must be recognised that, in some instances at least, it may not be realistic to satisfy all these issues. The criteria identified so far are now listed.

- The structure should be low cost to install and maintain, and constructed of appropriate materials taking account of its location. Most will be required in areas of considerable natural beauty and natural or mellow materials are most appropriate, for example timber, brick or stone rather than concrete and bright metal.

- Facilities should be designed to require the minimum of maintenance and adjustment.

- The design must take account of H&S issues with respect to the operation and maintenance, and safety of the public, especially children, even on private land. Operational safety may dictate that a walkway bridge is incorporated in sizeable structures.

- Water levels should only be required to be changed a few times a year, so stop-logs are likely to be a viable option as long as appropriate equipment is available to manipulate them safely. Achieving the head through use of a number of stop-logs each of limited height will increase the ease and safety of their manipulation as well as allowing for fine adjustment of retained head (see below).

- Flexibility should be incorporated to allow subtle management; for example, use of small stoplogs will allow careful adjustment and manipulation of level; and incorporation of a vertical slot 30 cm wide, closed off for the time-being with stoplogs, would allow simple retro-fitting of a fish pass.

- Water level changes should be achieved gradually, especially when levels are being lowered, to avoid stranding fish. This will be simple if a series of small-height stop-logs are used, which can be removed one at a time to effect a gradual change. This may require the site to be visited on a number of occasions each time a water level change is required, unless the overall adjustment is small.

- Channels and scrapes that will become untenable for fish when levels are lowered should be constructed to drain progressively without sumps, to allow fish to escape as levels are reduced.

- When high water levels are no longer required for birds, the level should be lowered only as far as is required to maintain appropriate conditions for avian interests and agriculture, in order to maintain conditions suitable for fish.

- Head loss structures should take account of fish passage requirements, and include fish passage structures where necessary. This is discussed further in Section 7.5 above.

8.6 Dredging/watercourse maintenance

In some situations ditches or other watercourses have become silted or choked with undergrowth. It has been suggested that this may interfere with maintaining high water levels (though it is a little difficult to see how; blocked ditches are more likely to impede drainage than to lower water levels). However, an effective ditch system is important for managing variations in water level, and the open water and wetted bankside areas are important avian habitat features.

Where slow-flowing or static water ditches require clearing by use of machines there is likely to be some adverse effect on fish in the area but this is perhaps unavoidable. Undertaking such work in the Autumn and Winter will minimise the effects upon very small fish which may be unable to move away from the area affected.

Disposal of dredged material is an issue. In the past there has been a tendency to dump the spoil alongside the channel, creating a raised bank which interferes with movement of water onto and off the floodplain; for example this is an issue upstream of Ibsley Bridge, as described in Section 5.5. Ideally the spoil material should be removed from the floodplain, spread thinly over a wide area of floodplain, or used to create features that enhance rather than degrade the floodplain habitat.

8.7 Fencing and cover

One area where there is potential for a conflict of interest between bird and fish interests is the issue of fencing alongside streams, and development of riparian trees and bushes. Generally, the waders and wildfowl of particular conservation interest prefer a habitat with no trees, bushes or hedges. Trees and bushes naturally develop alongside stream and provide cover and food for the fish. Streamside fencing keeps grazing livestock from damaging the banks of secondary waterways (and indeed prevents the animals from falling into the stream). However, they also prevent any grazing of the banks, allowing shrubs to develop rapidly. Even barbed-wire fences may quickly become overgrown with creeping vegetation, giving them a hedge-like appearance.

The solution here has to be a reasonable accommodation on both sides. Probably the most valuable vegetation in fisheries terms is the low scrub, such as bramble, which is not the main offender in avian terms. Any flora more than a few metres from the waterway is of no consequence for fish, so can be removed without impact on fish interests. Removal of trees and cover across the floodplain may cause other conflicts of interests with those with wider conservation interests (including tree-nesting birds such as the Cetti's warbler), and indeed with landscape interests. However, this is beyond the terms of reference of this report.

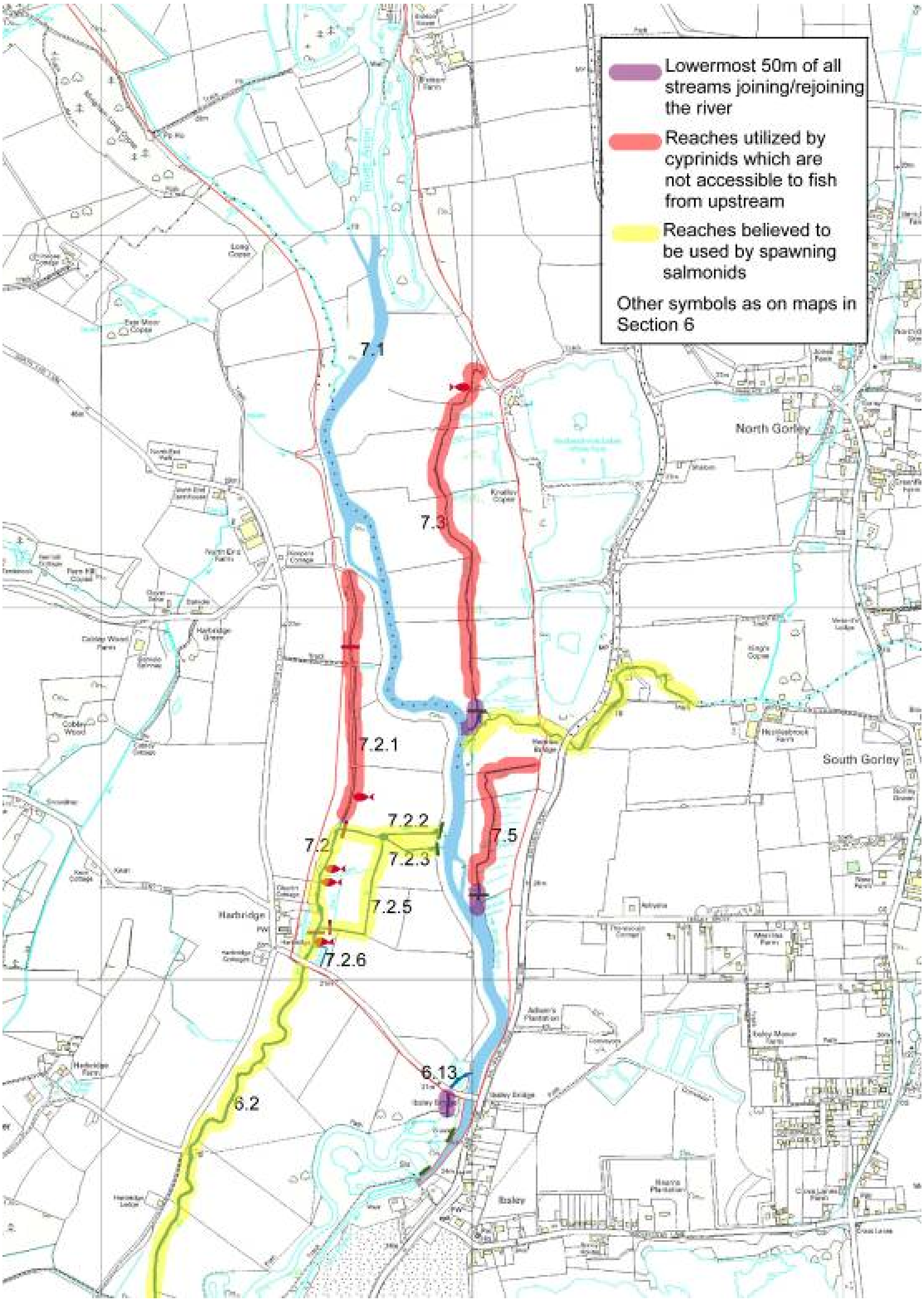

Figure 8.1. The secondary watercourses of the Harbridge/Ibsley part of the study area highlighted according to their fisheries sensitivity to the impact of head retaining structures. The thin red line indicates the boundary of the WLMP area. Crown Copyright. All rights reserved Environment Agency, 100026380,2006.

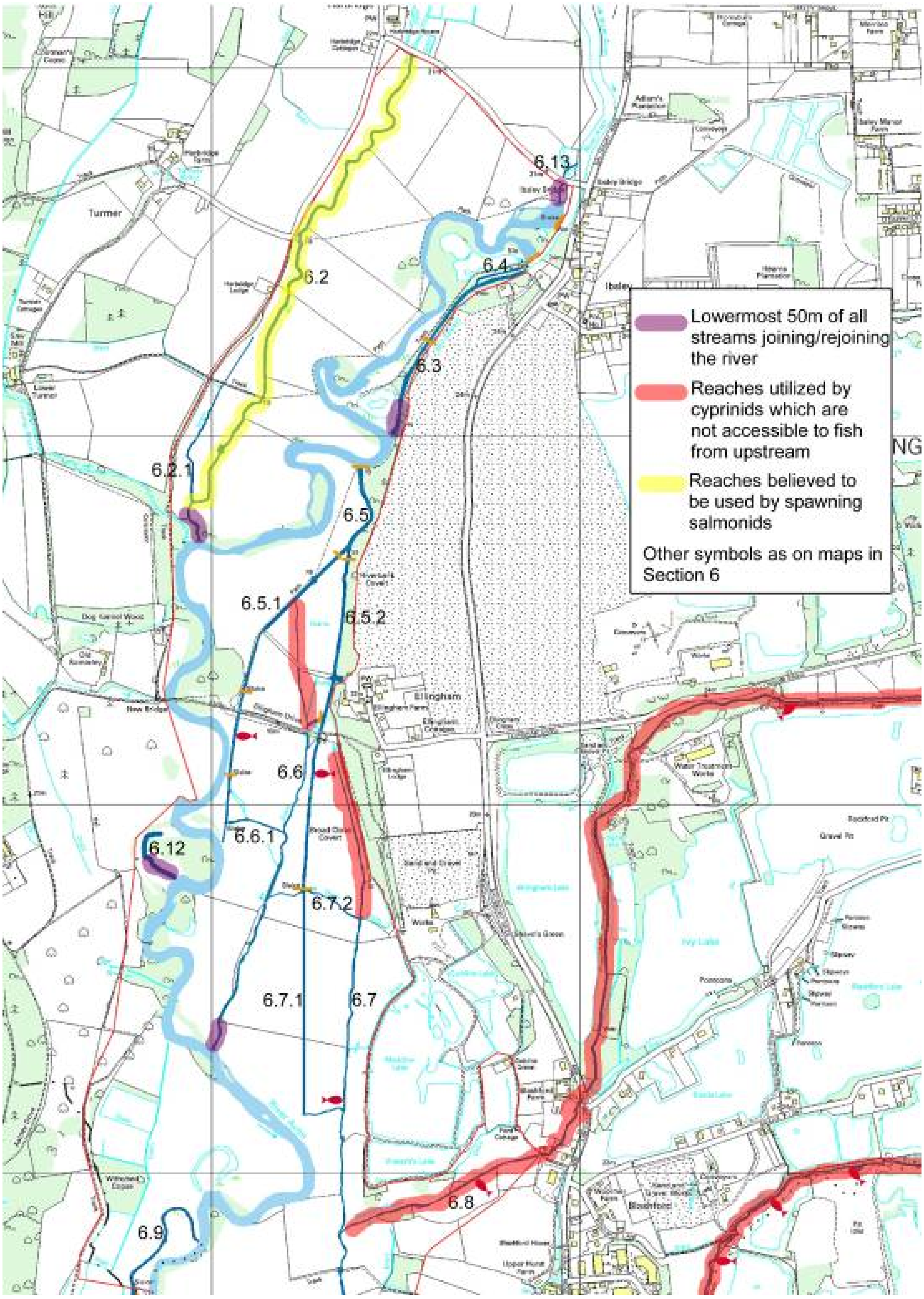

Figure 8.2. The secondary watercourses of the Ellingham part of the study area highlighted according to their fisheries sensitivity to the impact of head retaining structures. The thin red line indicates the boundary of the WLMP area.

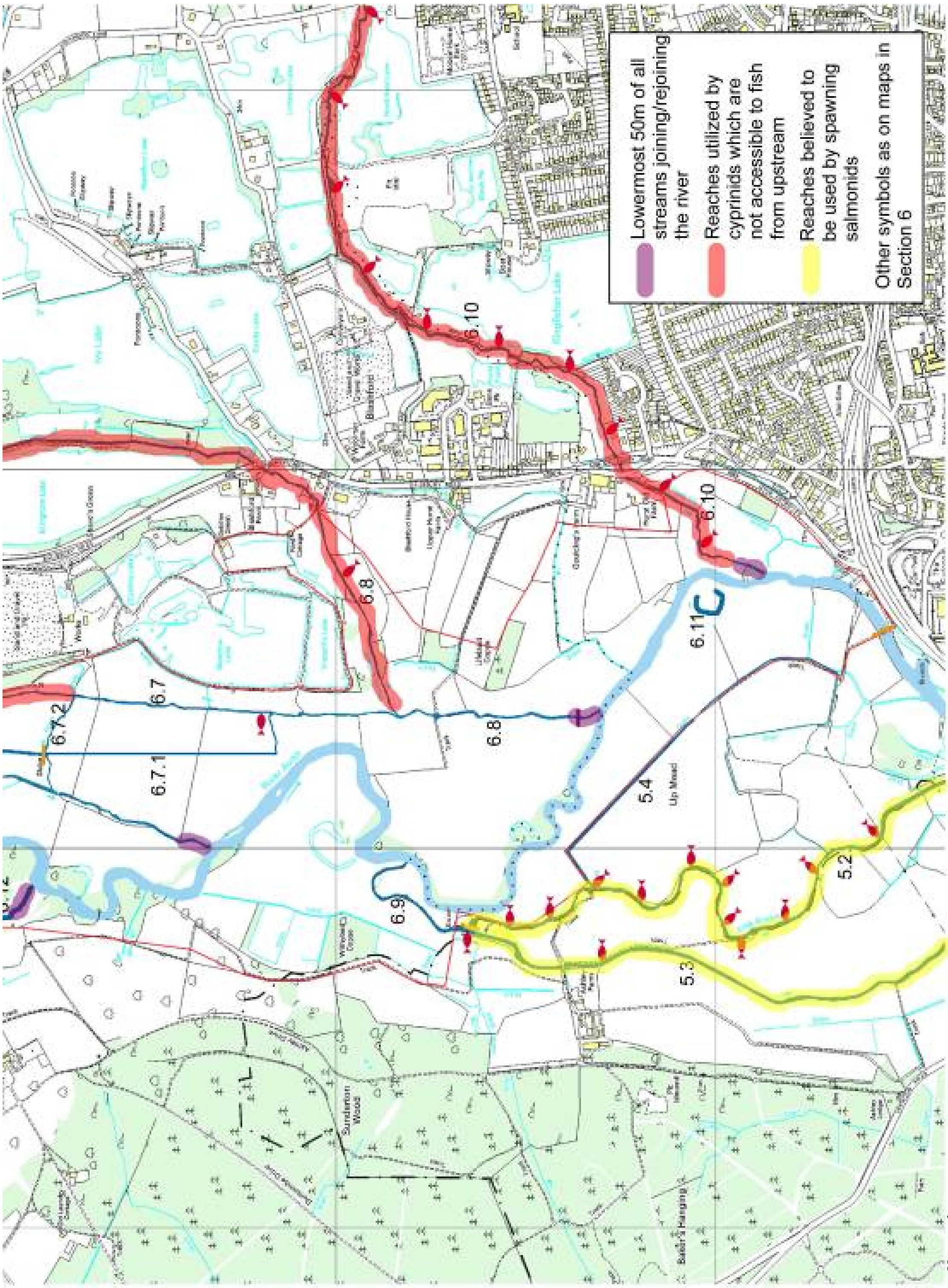

Figure 8.3. The secondary watercourses of the Blashford part of the study area highlighted according to their fisheries sensitivity to the impact of head retaining structures. The thin red line indicates the boundary of the WLMP area. All rights reserved Environment Agency, 100026380,2006.

8.8 Developing a Process

To ensure that all interests to be considered at the appropriate time there is a need for an agreed process , with steps undertaken in the right order. This will need to be agreed between the relevant parties (EA, NE and possibly others). To ensure that avian and fishery interests are properly involved the following draft process list is proposed:-

1. Identify areas that are considered to be unfavourable with respect to wetland bird interests.

2. Consider full range of factors that may be causing unfavourable status.

3. If water level is a significant issue, develop broad proposals for WLM including identifying which watercourses might be involved.

4. Consult fisheries interests (EA Fisheries Department, fishery owners).

5. If proposals are considered to be neutral or potentially beneficial in fisheries terms, develop detailed plans in connection with fisheries interests to try and maximise both avian and fisheries benefits.

6. If proposal is considered to be harmful in fisheries terms, explore variations/modifications that may reduce, remove or reverse fisheries impact.

7. If resolution of fisheries impacts cannot be achieved, consider alternative options to achieve avian benefits such as alternative approaches or locations.

8. If no acceptable alternatives can be identified consider proceeding, considering how a balancing fishery enhancement could be achieved nearby. It must be accepted by all interests that just occasionally there is no “win-win” option and that compromise will be needed.

It is recommended that a process flow-chart is developed based upon the above list, for trial and consultation.

It must be stressed that, as required in the TOR of this project, only avian and fisheries interests are being addressed in this list. It is likely that a wider range of interests will have a valid viewpoint on the issue; these will include other terrestrial and aquatic ecology interests, the landowners, and agricultural interests. It is therefore suggested that the above process should be reviewed by the relevant groups to ensure that all valid interests are involved at the appropriate time.

8.9 The current WLMP proposals for the study area

Proposals for management of water levels in the Avon Valley under the WLMP are being developed jointly by Natural England (Andrew Fielder) and the EA (Mike Porter). There are three main current proposals for the study area, on the Harbridge Stream (Channel 7.2, and 7.2.1-6), on the Ellingham and Woodside Carrier system (Channels 6.5.1 and 6.5.2) and on the artificially-raised bank of the main river upstream of Ibsley Bridge (channel 7.1). These proposals and the investigation being covered in this report developed together to a large extent, with joint meetings and site visits to discuss details and establish principles. It is not surprising therefore that the proposals are generally consistent with the guidance presented here, but it is nonetheless of interest to consider the proposals in some detail.

For the Harbridge Stream proposals the SSSI target features are breeding wader assemblages (lapwing and redshank) and wintering birds (primarily Bewick's swans). The target condition is partial flooding in winter (November to March inclusive) and maintaining a high field water table with muddy ditch margins or occasional shallow pools from April to June inclusive. This will involve first the modification of the two off-take structures from the main river, replacing the stop-log arrangements with undershot gates. This will allow better control of flow into the stream. Second, bed-raising is proposed at two points, as indicated in Figure 8.4. This would be done by keying large stones into the bed and covering them with gravel, with the aim of raising upstream water level by about 0.5 m. Care would be taken in siting the work so that any shallow riffle areas upstream were not drowned-out, in liaison with EA fisheries staff.

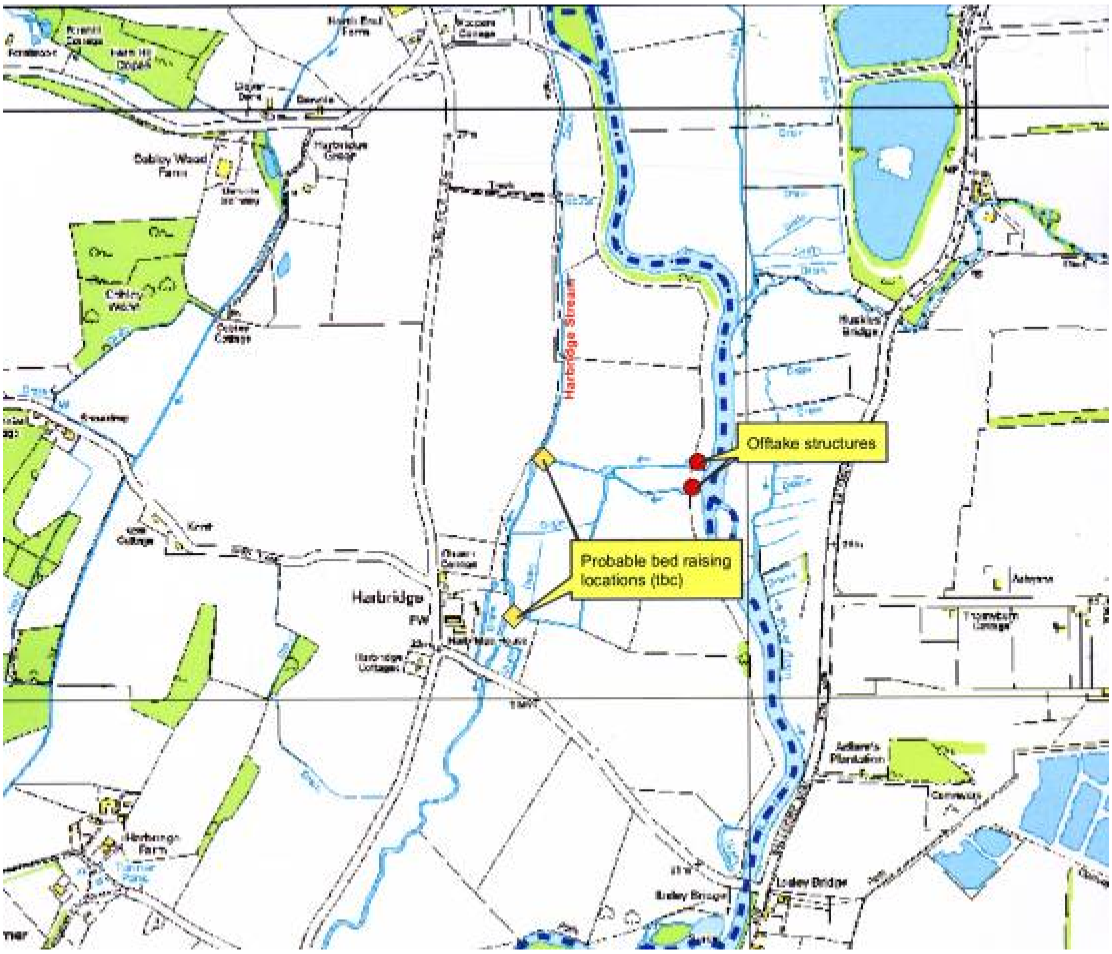

Figure 8.4. Location of proposed WLMP works on the Harbridge Stream. Crown Copyright. All rights reserved Environment Agency, 100026380,2006.

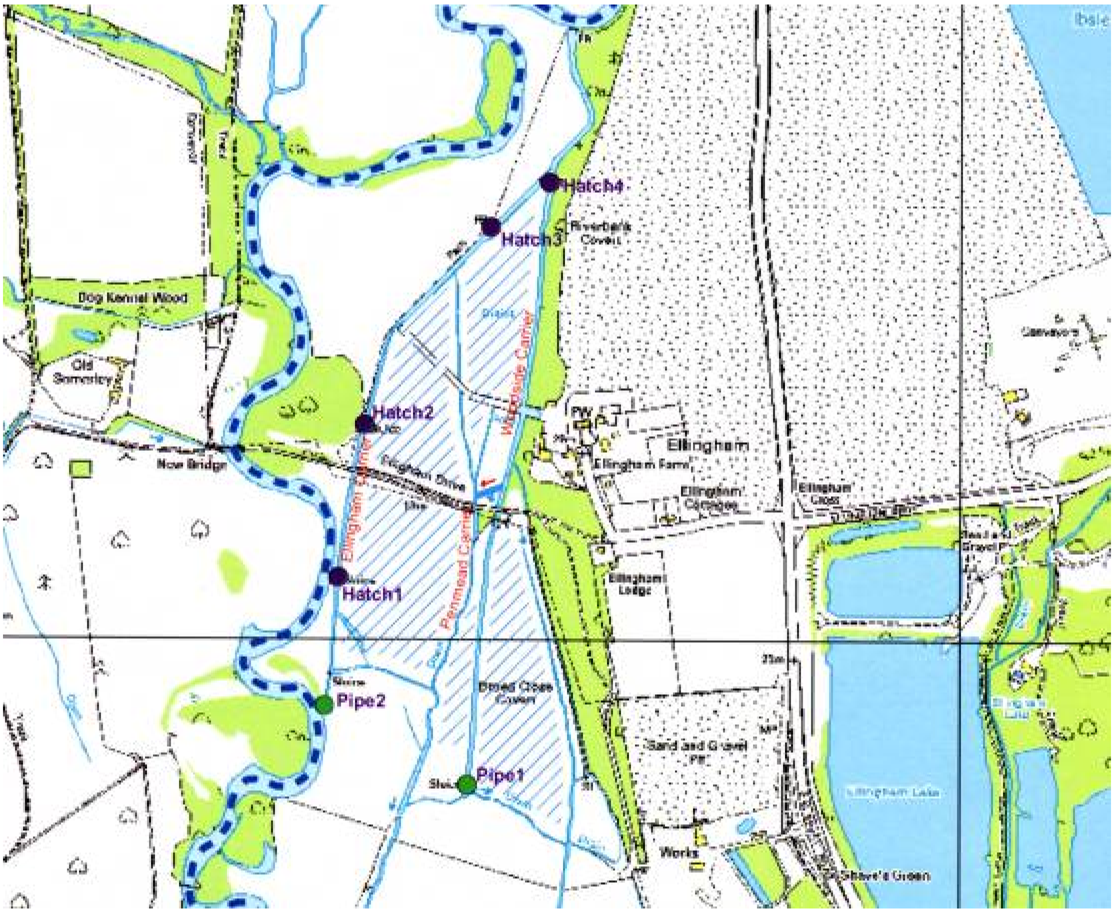

Figure 8.5. Location of proposed WLMP works on the Ellingham and Woodside carriers. Crown Copyright. All rights reserved Environment Agency, 100026380,2006.

These proposals appear to be benign in fisheries terms, as long as the situation is managed so that only limited volumes of water actually flow through the meadow. The raising of water level in the upper reach of the Harbridge Stream, coupled with the undershot sluices, should enhance fish passage and in any event will not detract from present conditions. The creation of a new riffle, utilising some of the head loss currently uselessly spent at the off-takes from the main river, will be a gain in fish habitat terms. It is important however that all works are monitored to check that the intended benefits are achieved and that there are no unforeseen adverse impacts.

For the Ellingham and Woodside Carrier work the target features and conditions are the same as for the Harbridge Stream work (above). The work required is the reinstatement of four old water-meadow hatches (locations shown in Figure 8.5) and the installation of control structures on two pipes; in recent years flows and levels through these pipes has been controlled by the Estate using fairly crude blocking devices. It is stressed that there is no intention to operate the meadows as traditional water meadows, just to regulate water levels to allow the appropriate degree of inundation. Flooding will be achieved by virtually static water, with minimal flow through the sward. Flow will be maintained through the carriers at all times, so that fish will have safe routes through the channels.

These proposals are generally neutral in fisheries terms, representing neither an adverse impact nor an enhancement. Again, the operation of the new works will justify monitoring to check that there are no unexpected adverse impacts on fisheries interests, and any operating agreement should be arrived-at in conjunction with EA fisheries staff.

Finally, the target conditions for the proposed work upstream of Ibsley Bridge is to allow the western floodplain to flood and drain at an earlier opportunity, and to relieve the pressure on the right-hand bank immediately downstream of the bridge which is in danger of failure. This bank upstream was built-up using dredging spoil about 20 years ago, and the intention is to re-instate the situation to how it was before that. These proposals are generally neutral in fisheries terms, though preventing the failure of the bank below Ibsley Bridge is a distinct benefit. There is the intention to separate any gravel in the material to be removed and to use this for fishery enhancement work; the remaining material would be spread thinly over the floodplain.

8.10 Monitoring and future management

The processes proposed in this document are aimed to help ensure that the optimal decisions are taken regarding management of the secondary watercourses in the Avon Valley. However, there will be significant uncertainty as to whether the aims of each action are fully achieved, and whether there may be unforeseen effects (either good or bad) on habitats and biota. It is therefore important that the effectiveness of each programme of actions is monitored and reviewed on an appropriate timescale. It is suggested that a report is made on the effectiveness and effect of each action after one and five years, and if appropriate at five year intervals thereafter.

Such monitoring will allow consideration of modification or even reversal of the action, and will provide an important input into future planning.

9 ACKNOWLEDGEMENTS

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Finally I am very grateful to the Somerley Estate for allowing frequent access to the river and secondary waterways on their land, and to the Hampshire Record Office for allowing the use of copies of photographs and documents in their collection to be reproduced in the report.

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Appendix 1. A little history

11 THE AVON VALLEY IN GENERAL

The history of development of the river and its catchment are important to this study as they have a fundamental impact upon the aquatic environment. Although considered a most attractive natural feature, the classic chalkstream surrounded by chalk downland is in fact a man-made and highly-managed environment. Man first appeared in Southern Britain about 700,000 BP, with Palaeolithic artefacts dating from around this time have been found in the area (Hughes 1984). However, our ancestors probably made little impression on the scenery until Neolithic times (4500 – 2600 BC) when the hunter-gatherer lifestyle began to give way to agriculture. Fields were cleared in the natural forest of oak, elm, lime, ash, field maple, hazel and alder. However, limited tools meant that this process was slow until the Iron Age (750 BC-43 AD). The Romans introduced towns to the landscape and virtually completed the clearance of the natural woodland; however, some remnants of woodland remained and were managed for production of fuel and building materials. Since that time the whole catchment has been managed for agriculture, urban development, transport etc and hardly a vestige of the pre-historic natural environment remains. Williams-Freeman (1915) describes the pre-historic status of the Hampshire chalkstreams:-

> "Two points he must thoroughly grasp – the impenetrable character of the natural forests, and the swampy, impassable nature of the river valleys. There was in the old days no tidy undergrowth of the ten-year-old hazel, but a tangled mass of every shrub that is native to a wet climate, with fallen trees and decaying branches all bound together, living and dead, by brambles, woodbine and wild clematis – a jungle so thick that only along the tracks made by wild beasts, or up the narrow gravelly beds of the higher reaches of the streams, could it be pierced by man…"

Control of the river and its riparian vegetation would have started with the dawn of agriculture in the area, as the valley floor would have represented the most fertile land. The Romans had water mills, and many mill sites were recorded in the Domesday Book (1086). Although the buildings associated with these mills have long gone many recent mills are built on the same sites, which were in continuous use for at least a thousand years. Cross (1964) gives details of more than a hundred existing and recently abandoned mill sites in the Avon catchment. Development of milling would have involved extensive channelisation work to concentrate the river into a single channel, generally along one side of the floodplain so that the head could be retained and exploited. Further channelisation would have been involved in the development of agriculture, to help drain swampy areas. Development of water meadows arrived in the area during the 17th century, and these dominated the valley floor from the uppermost reaches to Knapp Mill for the next three hundred years. The organised flooding of riverside land began on the Wylye and Ebble in about 1635 and on the main Avon in the Salisbury area about 1645 (Aubrey 1847). Water meadows spread to cover about 20,000 acres on the Avon and its tributaries in Wiltshire alone (Fry 1937). At first they were operated as part of a complex cycle of sheep grazing and hay production, and flooding took place primarily in the spring and autumn.

However, by the middle of the 19th century they were being used mainly for cattle, and flooding took place on a discontinuous basis throughout much of the year.

Figure 1. An un-managed reach of chalkstream, the Bere Stream in Dorset. This picture was taken in January; in summer, the river is effectively completely overgrown.

Traditional flooding of water meadows involved large volumes of water being spread over large areas of land, and was a major hazard for downstream migrant fish, including salmon parr and smolts, and juvenile coarse fish. Berry (1933) describes how fish may become stranded among the grass of the meadow, "a deservedly popular resort for several herons as well as a host of other feathered foe". Even those fish that managed to survive to pass on down the drawns (drainage channels) would be caught in special traps (called hullies or bunnies) set there by the drowners; the fish so caught were considered a perk of the job. As long ago as Victorian times angling interests on the Test paid £75 to two watermeadow operators to limit watering to three days a week during the smolt migration (Grimble 1913).

Water meadow operation involved retaining structures to create the head for flooding of fields a little further downstream. A head of water was such a valuable asset for milling and water meadows that virtually the whole fall of the river was exploited and many disputes broke out between neighbours. Many of these head-retaining structures still exist and much of the natural head of the river is lost in steep steps at these places. This has played a fundamental part in destroying the natural features of the river.

Another development that occurred at about the same time as the start of watermeadow operation was the development of the Avon for navigation (Willans 1937). An Act of Parliament was passed in 1664/5 to make the river navigable from the sea to Salisbury but there is significant doubt regarding how much engineering was actually undertaken. There is clear evidence in the Britford area where the remains of a navigation cut and locks are still visible. Cross (1970a) states that two 25 ton barges ascended to Salisbury in 1684, but that floods around 1690 damaged the works to the extent that the navigation never re-opened. The fact that barges ascended to Salisbury does not prove that extensive works had been undertaken; Willans (1937) quotes an ascent by John Taylor by boat as early as 1623, well before any work was commenced. The extent of possible work within the study area is discussed below.

More recent developments such as dredging of much of the river for land drainage and flood defence have completed the metamorphosis from a natural river system to a highly artificial and managed one.

12 HISTORY OF THE STUDY AREA.

In common with the rest of the river, the nature of the study reach through the Somerley Estate is the result of centuries of human management. It is clear that the main river channel has been moved to the edge of the floodplain above Ibsley Bridge and above Ringwood, as the channel no longer occupies the lowest part of the valley. This was presumably done to generate head for milling or water meadow operation. The exact line of the earlier channel is difficult to judge, and in any event the river is likely to have migrated across the valley floor to some extent, forming meanders and then cutting-off ox-bow lakes, as it still does today downstream of Ibsley.

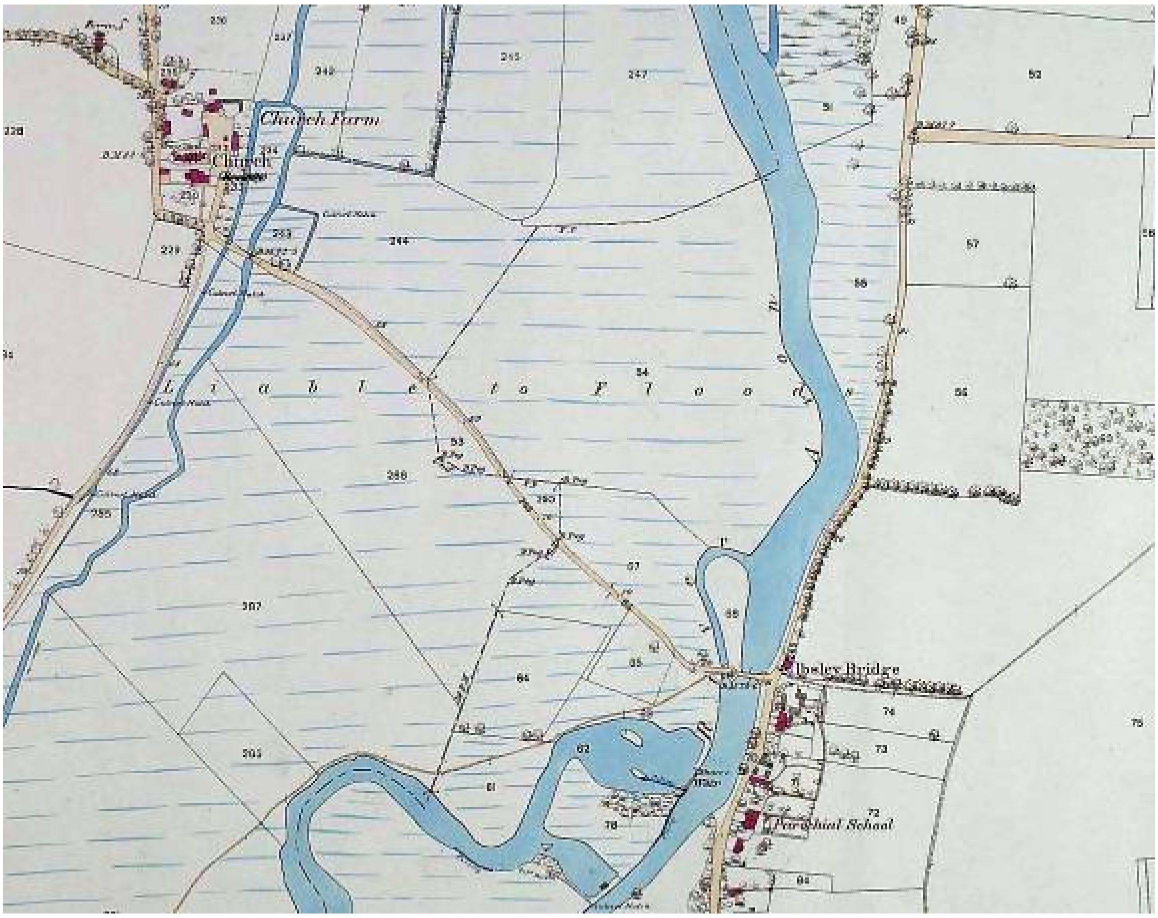

Figure 2. Extract from OS First Edition 25" map of Ibsley area, produced in about 1870. The topography shown is much as it is today, but the line of the Parish Boundary, deviating from the mid-line of the river at the top and bottom of the map, shows how the course of the river was once very different.

An idea of the line of the channel at one period in the past can be obtained from examination of parish boundaries on old OS maps; parish boundaries were originally established about 900 years ago and often followed rivers for obvious reasons. While they may have moved to some extent as the river shifted, they tend to have been "fixed" at some indeterminate time in the past. The OS 25" map of the Ibsley area (Figure 2) shows the parish boundary following the centre of the river channel down past Hucklesbrook, and then swinging out across the meadows towards Harbridge, crossing the line of the causeway three times before rejoining the present main river below Ibsley Weir.

Figure 3. Extract from a pre-inclosure map of the Parish of Harbridge by John Charlton, dated 1793. Again note that part of the meadow on the Harbridge side of the river is marked as "Part of Ibsley Parish", indicating a change in the course of the river. Reproduced with permission from the Hampshire Record Office (HRO 21M57/MP13).

A pre-enclosure map of Harbridge Manor (Figure 3) shows a similar line as the division between the Parishes of Harbridge and Ibsley. This map also gives us a fascinating insight into the methods of agriculture in the C18th. The area between the river and the Harbridge Stream is divided into a number of fields with names such as Lane Ditch Furlong, Kent Ham Furlong, Horse Leys and Ibsley Piece. The Shorter Oxford English Dictionary defines a furlong as "an area of land a furlong each way, containing ten acres", or "an indefinite division of a common field". Naming of one field in Harbridge as "Seven Acre Furlong" suggests the latter definition was being used here! Each of the furlongs or fields was divided into many strips of land under different tenants, each tenant holding one or more strips in each furlong. Chapman and Seeliger (1997) suggest that there was substantial advantages to subsistence farmers in having land spread over a wide area to reduce the risk of total crop failure. This is likely to have been particularly so in here as different patterns of flooding in different years would mean that the furlongs were likely to vary considerably in productivity. It is probable that these strips were marked but not fenced, and that once the hay or other crop had been taken the whole would be turned over to shared grazing. This pattern of land management was swept away by the enclosure process; the Parliamentary Order for enclosure in Harbridge was enacted in 1817. It is clear that this area of land that appears rather wild and desolate nowadays was once under intensive agricultural management. One last observation on this fascinating map is the “furlong” named “Mill Lands”, with a border onto the old river line as indicated by the parish boundary. This might indicate the general location of the mill at Ibsley mentioned in the Domesday Book.

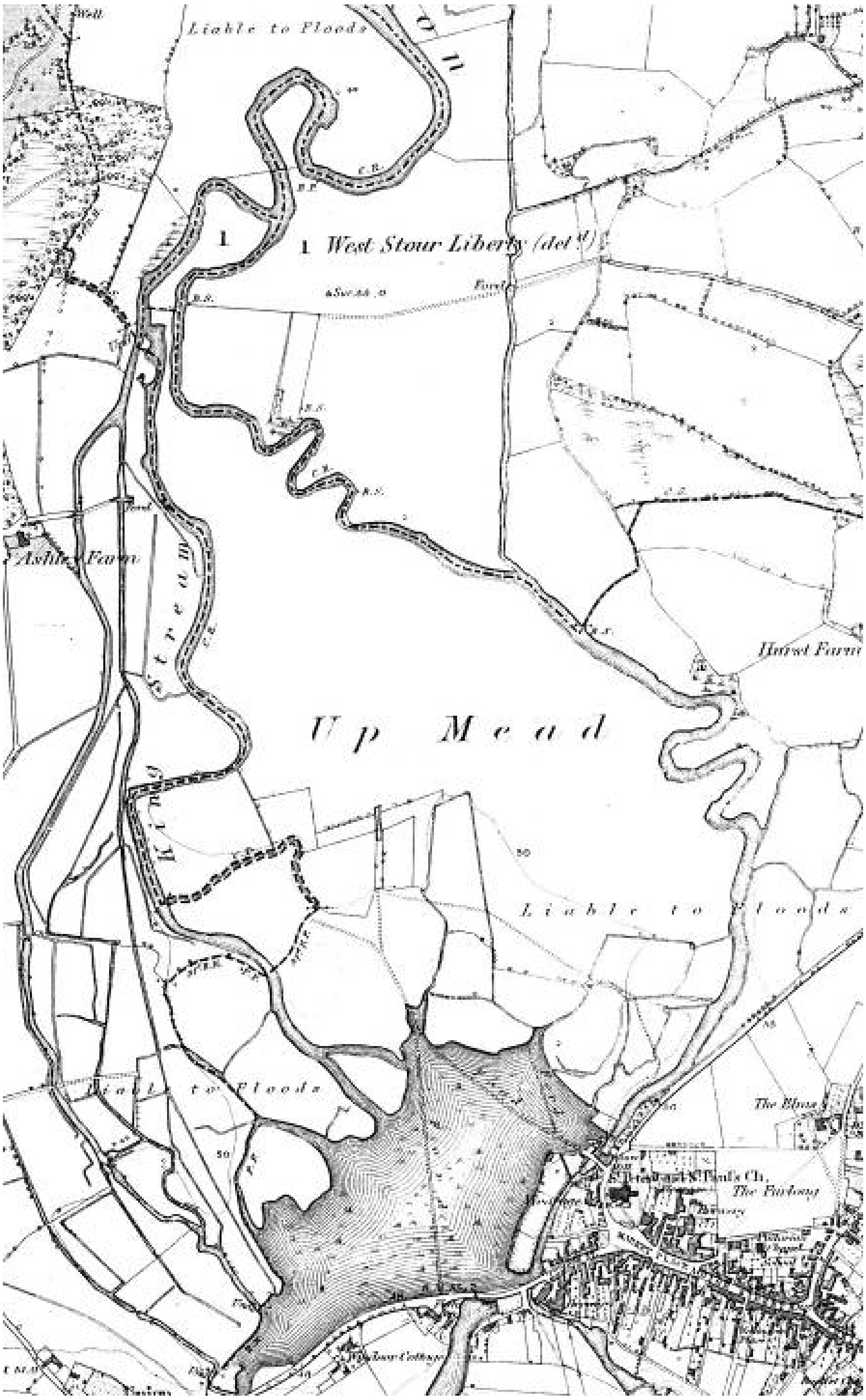

Figure 4. Extract from the OS First Series 6" map of the river upstream of Ringwood, dated 1875. Note the Parish Boundary following the King Stream, deviating round old meanders, indicating that this was once the main river.

In the area upstream of Ringwood (Figure 4) one parish boundary follows the existing main (easternmost) channel part way, but then veers off to the east to follow the course of the Lin Brook. Another boundary follows the line of the King Stream, swinging off into long-lost meanders in its lower part. It is likely that this represents a former line of the main river, and this certainly appears to be the lowest part of the valley.

Further evidence that the King Stream approximates to the old main river channel comes from a manuscript map (Figure 5) showing the extent of fishing rights of the Squire of Ringwood, Mr Morant, who was in dispute with the Somerley Estate over the extent of rights. This marks the King Stream as “The River Avon”, and the modern main channel as the “Ringwood Mill Stream”. Finally, the old King Stream Bridge (Figure 6, now demolished) was larger than one over the “main river” (Figure 7), once again indicating that the King Stream was once the main river.

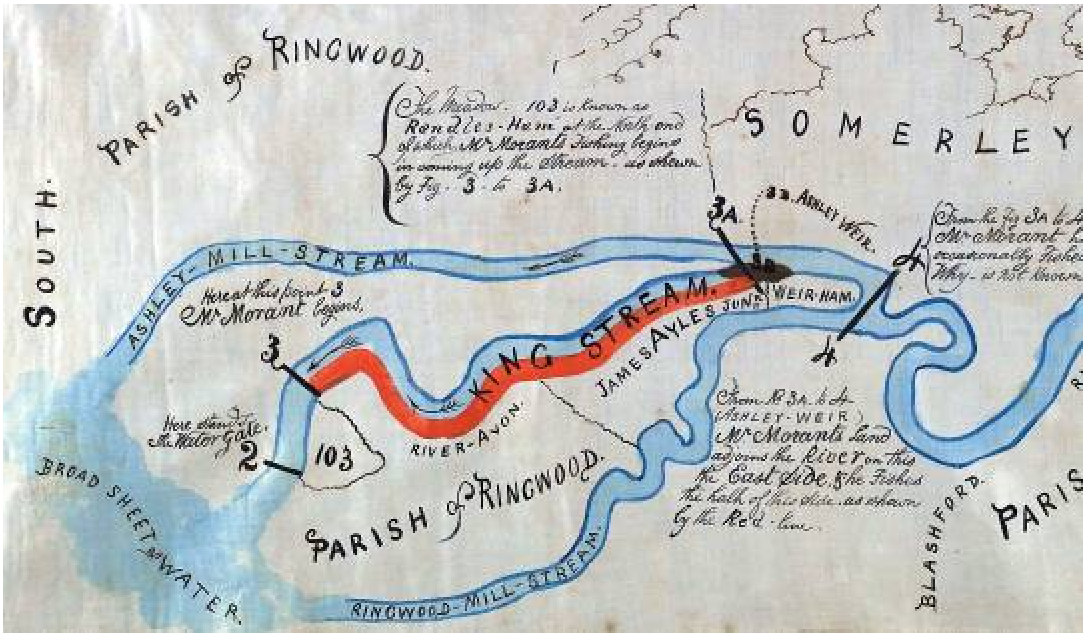

Figure 5. Extract from C19th manuscript map showing fishing rights, indicating that the King Stream was the main river. Reproduced with permission from the Hampshire Record Office (HRO107M86/50).


Figure 6. The old bridge over the King Stream in about 1898, demolished when the dual carriageway was built in the 1970’s.   Reproduced with permission from the Hampshire Record Office (HRO 33M84/25/25)

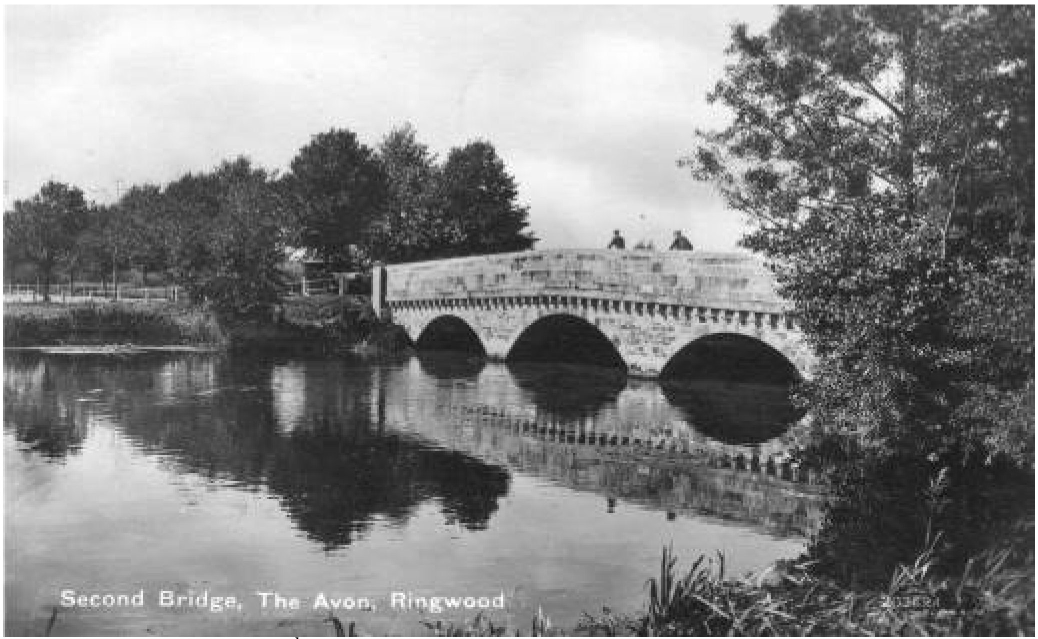

Figure 7. An early 20th Century postcard of the bridge over what is now the main channel at Ringwood. This is a smaller structure than that over the King Stream. This bridge is still there; the fish Inn is off to the right of the picture.

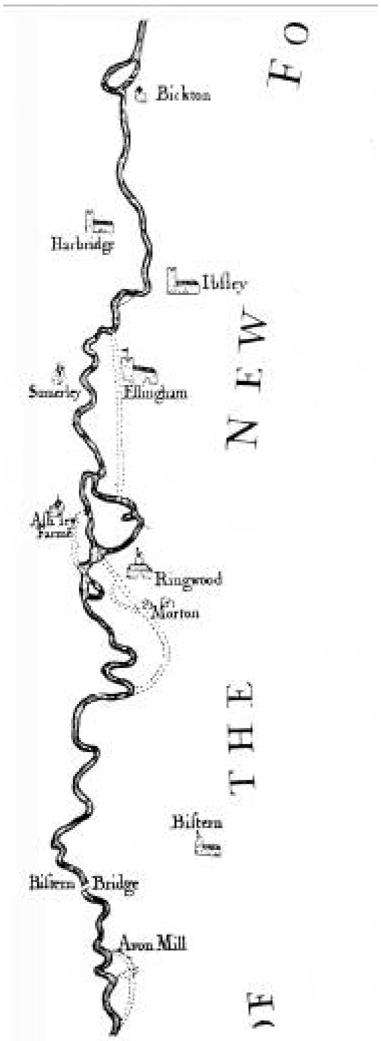

Figure 8. Extract from Naish's map of the River Avon, in about 1675.

Figure 9. Extract from Isaac Taylor's 1759 map of Hampshire.

Figure 10. A view of Ringwood from the west dated 1724. Note the sheet of water to the left of the causeway.

A map of the Avon from Salisbury to the sea is attached to a map of Salisbury produced by William Naish in 1751. The river map was surveyed in 1675 by Thomas Naish (presumably a relative of William's) and James Mooring. The section showing the study area is shown in Figure 9.

Cross (1970b) included a map that showed the channels from the Naish map as "navigation cuts" as part of the Avon Navigation (see section 1 above), but there must be some doubt about this. Notes on Naish's map produced by the Geography Department at Portsmouth University state that "the intention behind the use of solid and dotted lines is not properly understood". The date of the survey (1675) is the same year that Cross (1970a) says the work on the navigation was begun, in the Salisbury area. Perhaps the dotted channels indicated proposed works (that may or may not have been completed), or existing side channels for other purposes such as mills and watermeadows. However, if the interpretation by Cross (1970a, 1970b) is correct then a navigation channel was constructed through the Ellingham area. The dotted line on the Naish map appears to follow the line of present-day watermeadow carriers and drawns (Channels 6.5, 6.5.2 and 6.7, and including the lowermost reach of the Dockens Water, 6.8; see main report).

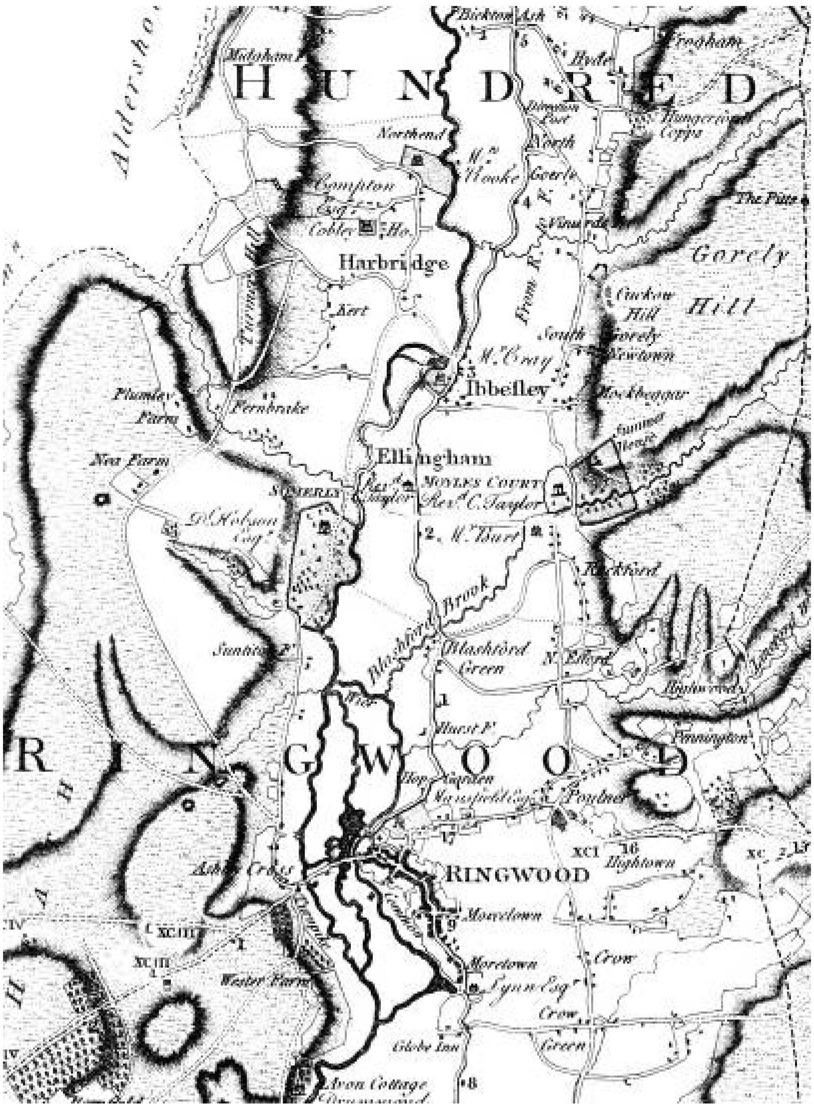

Figure 11. Extract from Thomas Milne's 1791 map of Hampshire

The earliest detailed map available covering the whole study area, published in 1759 (Figure 9), shows the main channels much as they are today, including the weir streams at Ibsley, and the separation into the three streams upstream of Ringwood.

Mills are shown near where the Ashley Stream rejoins the King Stream, and close to the present site of Ringwood Weir. No mill is shown at Ibsley; although some maps mark one of the streams there as the "Mill Stream", a mill is listed for Ibsley in Domesday, and Cross (1964) suggests that there was a mill there until around 1800.

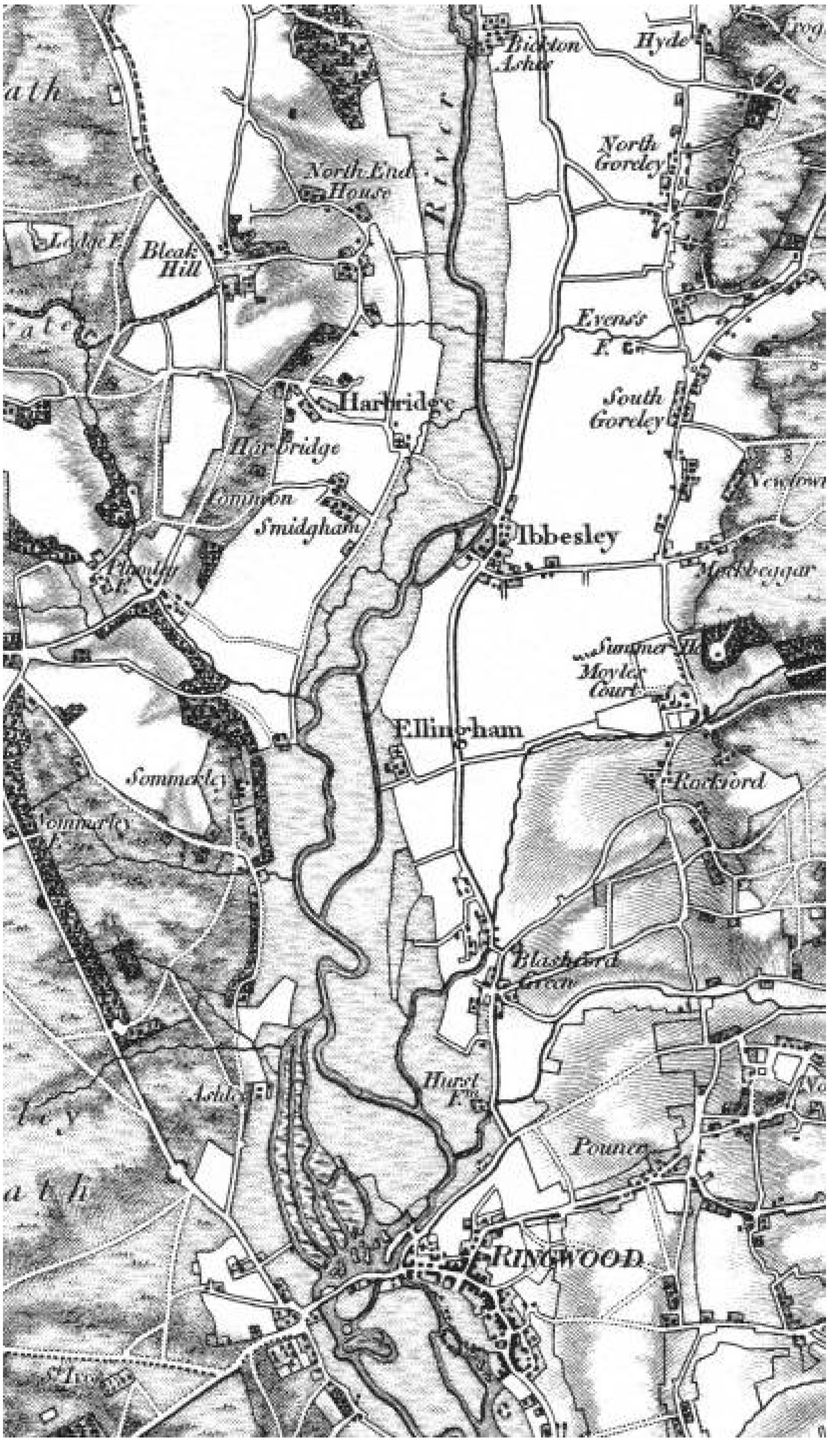

Figure 12. Extract from the OS First Edition 1" map surveyed in about 1808.
Dating from a somewhat earlier time (1724) is a view of Ringwood from the southwest (Figure 10). On the left of the picture is the causeway carrying the Wimborne road (approximately on the line of the present-day A31), with a large sheet of water to the north through which the river runs, which is well indicated on later maps.

Thomas Milne's map of 1791 shows the Ringwood lake and the two mills (Figure 11). It also shows the Ibsley weir streams swinging further across the valley than the present-day channels, perhaps occupying the old channel indicated by lines of trees still present NW of the current weir stream.

Interpretation of all these early maps must be undertaken with care, as the surveying was rudimentary and greater detail was included for property belonging to those who had subscribed to the maps production. However, with the advent of the Ordnance Survey early in the 19th Century we can rely on the maps to be reliable.

The First Edition OS 1" map (Figure 12) surveyed in about 1808 does not mark mills but again indicates the Ringwood lake, and a multiplicity of channels upstream of Ringwood. It also shows the Woodside Carrier at Ellingham, and the Harbridge Stream emanating from the main river a short distance upstream of Ibsley Bridge, perhaps in the same place as the two hatches today. Much greater detail is shown in the larger-scale OS maps; the first 6" (1:10,560) and 25" (1:2500) maps of this area appearing around 1870.

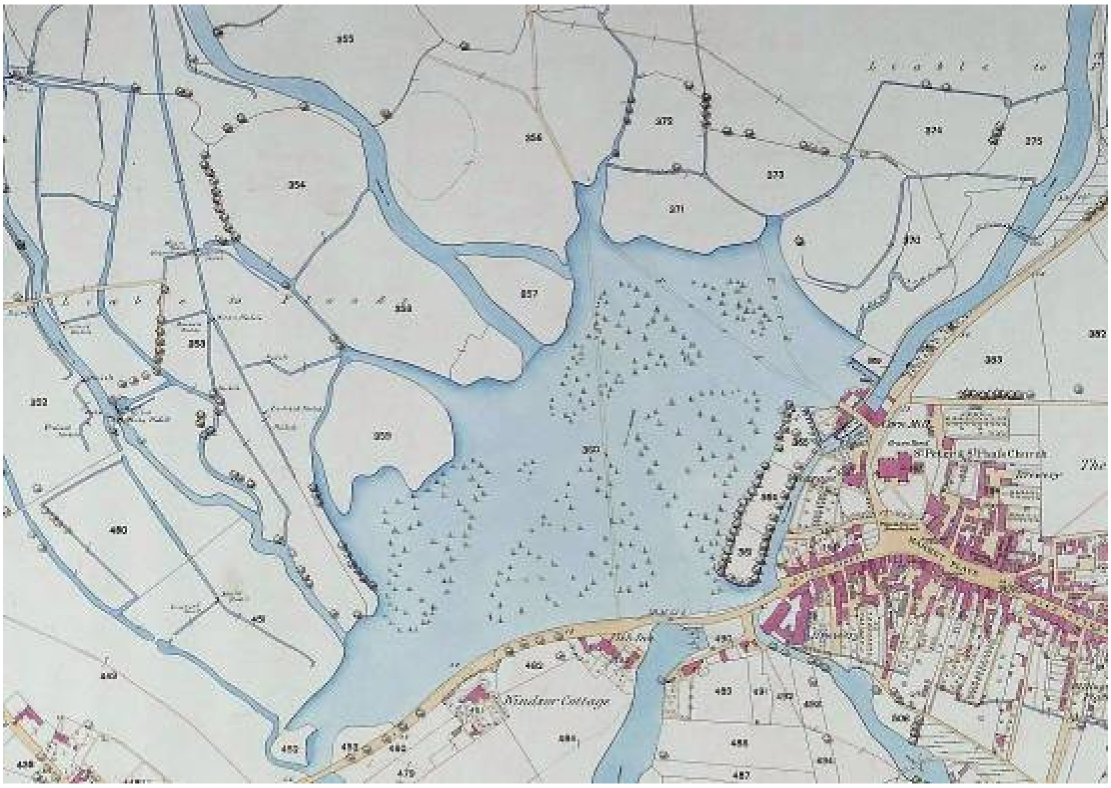

Figure 13. Extract from the OS First Edition 25" map showing the lake and other waterways at Ringwood in about 1870.

The upper (Ibsley) and middle (Ellingham) parts of the study area and their channels have changed relatively little over the past 120 years or so. However, the area around Ringwood and in particular the "lake" has been very much modified mainly in connection with successive road schemes. It is likely that the lake was created as a result of the construction of the road causeway between Ringwood and Ashley Heath. It is likely to have always been shallow, and the situation around 1870 is shown in the First Edition 25" map (Figure 13), which indicates fords through the lake. By the time of the first road bypass scheme in 1936-37 the lake appears to have silted up further, with many islands now apparent (compare the maps in Figures 13 and 14).

PLAN OF THE MORASS AT RINGWOOD SHOWING ALTERATIONS, 1936-1937

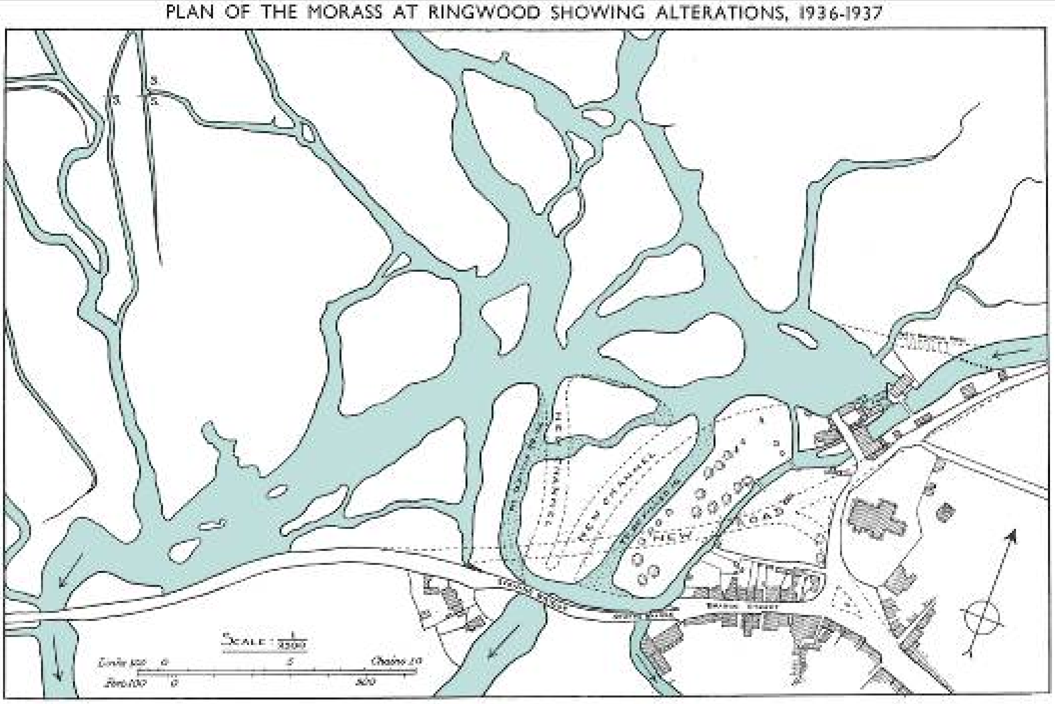

Figure 14. Map of the "Ringwood Morass" based on Berry (1936). This shows the extent of the waterways in 1936, and the changes made during construction of the first bypass.

Figure 15. A view from early in the C20th from the King Stream Bridge towards Ringwood. The "Lake" is clearly visible to the left of the causeway, with reed beds projecting well out into it.

The road scheme involved the demolition of the mill, already in decline (Cross 1964), though the mill house survived for another 40 years as the Avon Hotel. It also involved filling-in of some channels and excavation of others – see Figure 14.

Figure 16. A James Coventry photograph of the Harbridge Stream and Harbridge Church, winter 1897-8. Reproduced with permission from the Hampshire Record Office (HRO 33M84/25/07).

Figure 17. Harbridge Stream and Harbridge Church viewed from the same spot as Figure 16, November 2006.

The second road scheme, carried out in the 1970's, created the existing A31 dual carriageway. This used the existing bypass as the southern carriageway, with a new multi-lane northern carriageway added. This involved shifting the river channel northwards in the area of the old mill, and the demolition on the Avon Hotel (the old mill house).

Further siltation of the Ringwood lake has occurred since then and now little sign remains, with the exception of small areas of swampy woodland. Sadly, there appear to be very few photographs of the lake in earlier years. The best that could be located in this study was a postcard from the early 20th Century (Figure 15).

There were extensive water meadows in the study area, on the east side of the river upstream and downstream of Ellingham. These are still intentionally flooded at times, but the method of operation is nothing like as damaging as was the traditional approach described in Section 1 of this Appendix. Flooding is only practised in winter, when fish movement is very limited, and most water remains in the channels and there is minimal volume of flow through the grass sward itself.

There are disappointingly few descriptions or photographs of the floodplain in earlier times to give us a general idea of its management or appearance. When photography was an expensive business, pictures generally limited to portraits, grand houses, churches and views of beauty spots. A refreshing exception to this rule was the work of James Coventry, who lived at Burgate House (now occupied by the Game Conservancy Trust) and took thousands of high-quality photographs between about 1892 and 1902. Most of his work has been lost but around 270 of the original plates are held by the Hampshire Record Office. Many of these are reproduced by Light and Ponting (1999), and they provide a fascinating picture of life in the Avon Valley at that time. Coventry was just as interested in bridges, weirs and watermeadows as he was in churches and posed portraits. The picture of the King Stream Bridge (Figure 6) is one of Coventry's, and another, of the Harbridge Stream and surrounding meadows, is shown in Figure 16. Figure 17 is taken from the same spot in December 2006. The area was very much less overgrown formerly, probably reflecting the need in those days to press all available land into useful agricultural production. This is likely to have been reflected throughout the valley.

In conclusion, the topography of the Avon Valley has undergone major changes due to human activity over a period of a thousand years or more. The present appearance of the valley is just a snapshot in a still-changing, heavily-modified, landscape.