The River Adur

Knepp Estate

A Survey to Assess the Current Condition



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Ouse & Adur Rivers Trust

Version 1.1 (May 2016)

Contents:

1. Acknowledgements

Thank you to the Knepp Estate for allowing access to the river and to Amy Sefton from University of Brighton for her assistance with the survey.

2. Introduction

Since the implementation of the Water Framework Directive (WFD) (Directive 2000/60/EC), River Basin Districts, formed of multiple river catchments, are being used as the scale at which strategic planning and reporting are undertaken. There are eight such districts in England and this report is focused on the Adur & Ouse Catchment, within the South East River Basin District. The successful implementation of associated River Basin Management Plans is reliant on a greater focus directed at river catchment planning alongside stakeholder engagement and local community/stakeholder participation. However, this approach must be considered within a framework of environmental and conservation organisations working in partnership to maximise outcome benefits from projects. This catchment based approach is dependent on having clear evidence of the current issues to be addressed in order to effectively prioritise the allocation of resources.

The WFD legislation has separated river basins into a number of different water bodies and classified these according to their "ecological status" across a range of 30 criteria including assessments of water quality (levels of dissolved oxygen, ammonia, phosphates etc.) as well as ecological aspects including invertebrate population abundance and diversity and barriers to fish passage (weirs, sluices etc.). The Adur & Ouse catchment is divided into a total of 51 water bodies, of which 40 are rivers and 11 are heavily modified water bodies; 45 are currently classified as not reaching the required "good ecological status" (Environment Agency, 2009).

Walk-over surveys are a method for assessing the physical characteristics and quality of river habitats. These surveys have been developed to help the conservation and restoration of wildlife habitats along rivers and their surrounding floodplains, in effect providing the information required for river management bodies to sustain and enhance riverine habitats (Raven *et al.,* 1998). These surveys have previously been shown to be an effective method of providing ground-truthed evidence which can be used to prioritise resources to combat a wide range of river based issues (Environment Agency, 2012a).

3. Study Area

This report is focused on the western arm of the main River Adur as it flows through the Knepp Estate, near Shipley in West Sussex (TQ16414 20734 to TQ14901 21811) (Fig. 1). This section of the River Adur is within a waterbody currently classified as having "moderate" ecological status under the EU Water Framework Directive. Since 2001 the Knepp Estate has been undergoing a programme of re-wilding which has seen large areas of arable reversion, the removal of fence lines and the introduction of large herbivores to drive habitat change across the 3500 acre landholding. Part of this re-wilding has seen the diversion of the main River Adur through part of the estate combined with wetland feature creation within the floodplain. Following this river enhancement project, the Ouse & Adur Rivers Trust along with Sussex Wildlife Trust and the Wild Trout Trust undertook two phases of in-channel feature creation through the restored sections. In addition the Environment Agency removed two weir structures from within the survey area and the boards have also been removed from Bay Bridge Weir at the downstream extent of the landholding. Whilst the upstream sections have been altered and enhanced through river engineering, the lower sections have been left untouched, providing a good opportunity to monitor changes to the river as a comparison between those areas which have been enhanced and those which have not. An initial survey was undertaken in May 2015 just after the completion of the feature installation to assess the habitat quality and level of modification within the river system.

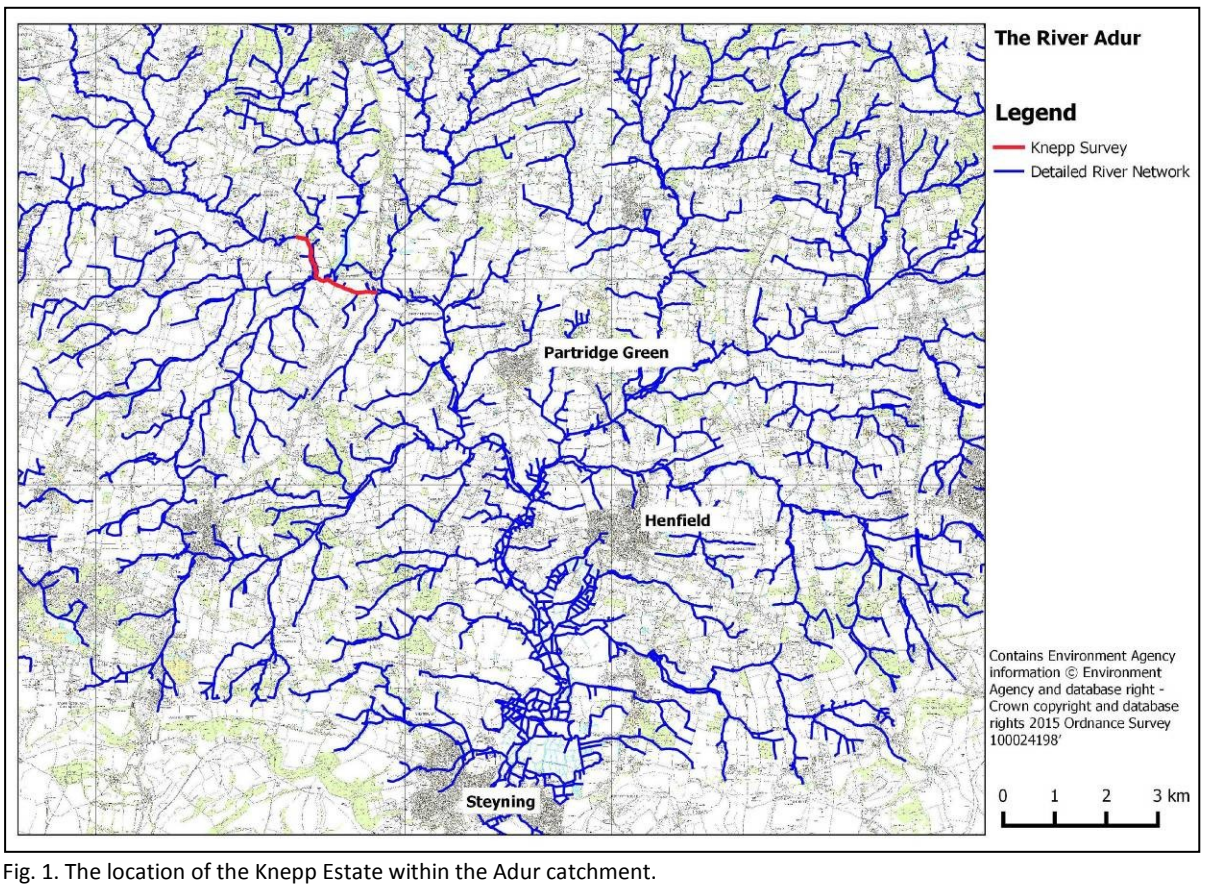

Fig. 1. The location of the Knepp Estate within the Adur catchment.

4. Methodology

The methodology and data sheets utilised for this project have been adapted from the Environment Agency "Catchment Walkover Survey" information booklet (Environment Agency, 2012b). A digital GIS layer was used to split the course of the stream into c.500m sections (total four). These survey sections were, where possible, split according to obvious landscape features such as roads, railways and river junctions to facilitate future repetition. This means that survey sections have some variability in length. Individual A4 maps were created, using an Ordnance Survey MasterMap GIS layer, for each survey section and were annotated in the field to record land use types and in-channel features such as debris dams and structures.

Each 500m section was subdivided into 10 spot check survey points (one every 50m) where data could be collected on a variety of river characteristics. The A4 maps were used to 'in-fill' information on the presence of features which were located away from these points. Photographs were taken of each survey section and other areas of interest along the watercourse. Therefore, each 500m section had information collected during each of the ten point surveys and a "sweep up" recorded information on the section as a whole.

4.1. Analysis of Data

The data were summarised for each individual survey section and across the survey area as a whole. Land use data and locations of in-channel features were mapped using Valmiera QGIS 2.2.0 (Valmiera, 2008) and used to establish land coverage information and to highlight areas where future habitat enhancement could/should be focused. Using the criteria in Raven *et al.* (1998), each survey section was analysed to give a Habitat Quality Score (HQS) and a Habitat Modification Score (HMS). This grading system allows individual river sections to be compared against each other and indicates variation in habitat quality within the extent of the survey.

5. Results

A total of four site overviews were undertaken comprising of 40 individual point surveys across four designated site maps, equating to approximately 2.2km of river. All surveys were undertaken on 6th May 2016.

5.1 Channel Information

During the period of data collection the mean water depth within the channel was recorded as 0.47m (range 0.3m – 0.6m). In three of the four surveys the mean bank heights for both banks were recorded as being equal with section one showing the left bank to be, on average, 0.5m higher than the right. The mean bank fall width for the watercourse was recorded as 6.3m (range 4.0 – 8.0m) with the mean water width during the survey period being 2.75m (range 2.0m – 3.5m). The water width was recorded as being, on average, 40% of the bank fall width with considerable variation shown within each survey section. From the results it can be inferred that the channel is not trapezoidal for most of its length and a minimal amount of undercutting is occurring along the banks (the lines in Fig. 2 do not cross at any point) with the decreasing bankfall width through sections three and four representing the recently constructed river channel.

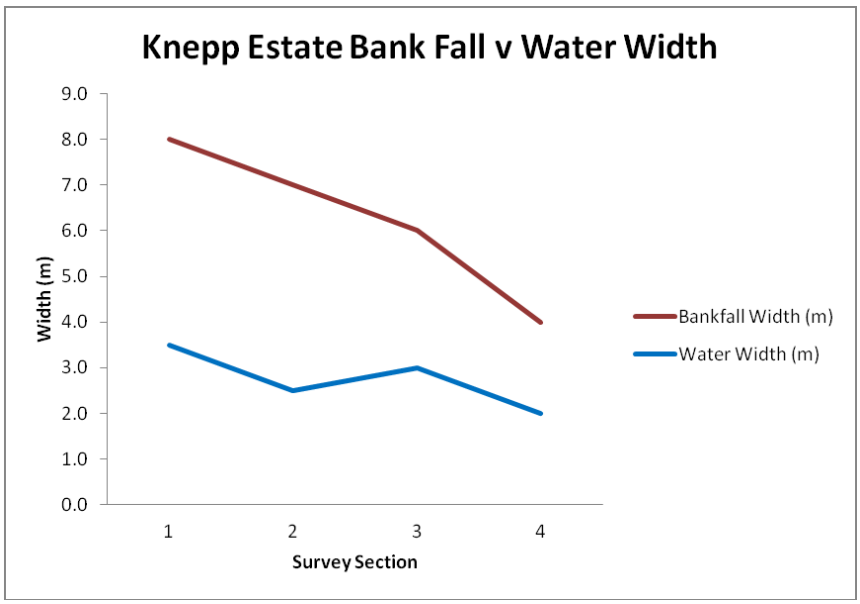

Fig. 2. The relationship between bank fall and water widths on the River Adur at the Knepp Estate.

Across all survey sections, where visible, the bed substrate was recorded as clay although it is likely that areas of silted substrate also exist, especially within section one which contains Bay Bridge Weir.

Across the survey area a total of three flow regimes were observed with 55% being recorded as having no perceptible flow, 32.5% as smooth and 12.5% as rippled (associated with glides) (Fig. 3). The number of flow regimes as an indication of diversity within each section is shown in Fig. 4. Only section one was recorded as having a >33% impoundment within it which is likely to be a result of the A24 bridge culvert and presence of Bay Bridge weir.

Fig. 3. Areas with no perceptible flow (left) and rippled flow (right) were both observed during the survey period.

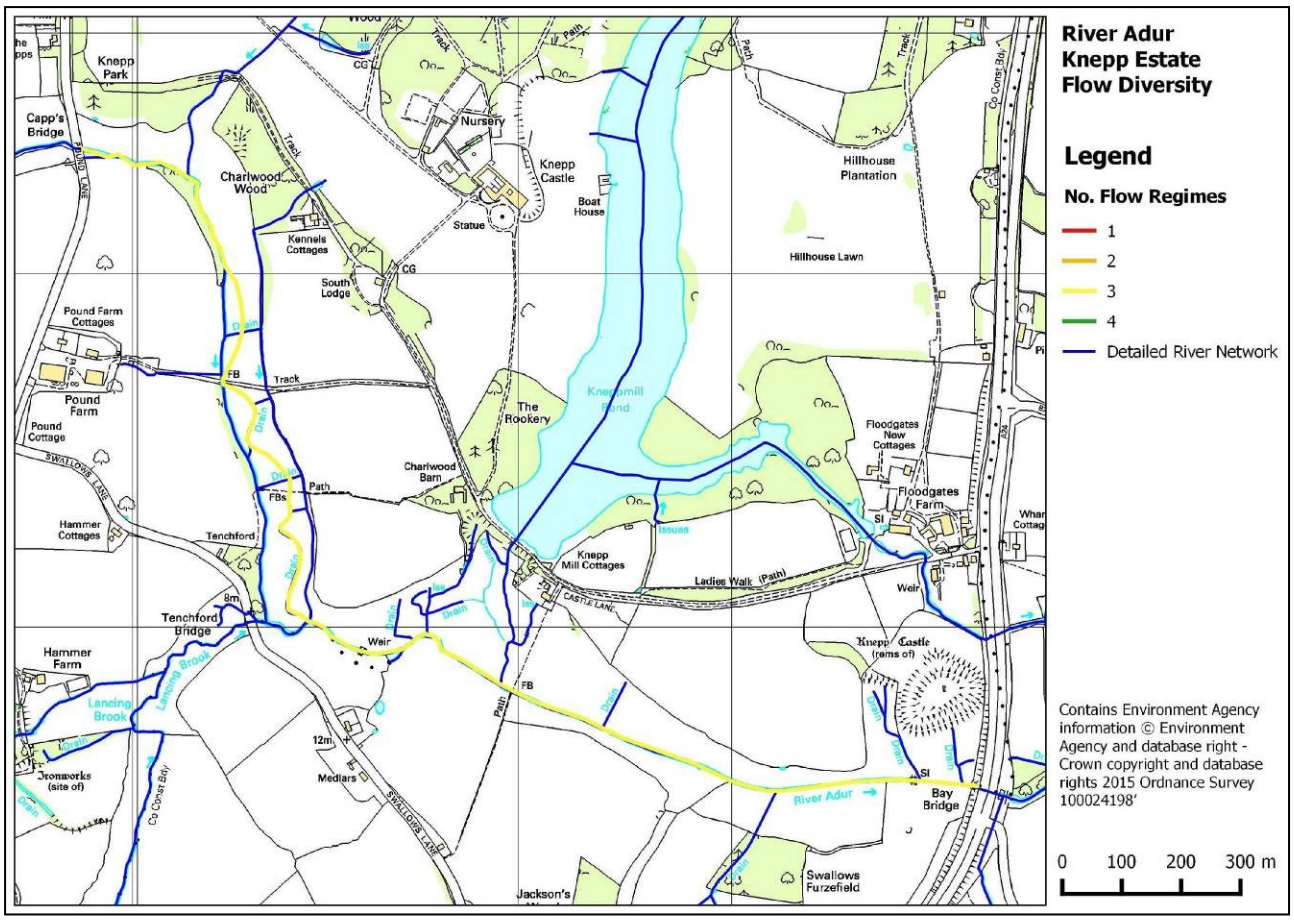

Fig. 4. Number of flows, as an indication of flow diversity, within each survey section of the Knepp Estate.

5.2 In-Channel Modifications

At the downstream extent of the survey area two modifications to the river system are present, the bridge culvert under the A24 and Bay Bridge Weir approximately 100m upstream (Fig. 5). At the time of survey the boards were removed from Bay Bridge Weir and in this state and from observation these are not preventing the movement of fish species within the survey area, however, should the boards be returned to the weir structure then coarse fish passage would be impeded during the majority of flow conditions. . The upstream section also recorded a culvert as the river passes under Capps Bridge but again this is not thought to be causing any barrier to fish passage (Fig. 6).

There are a number of bridges which cross the river through the Knepp Estate which allow for either public access or vehicular movements across the landholding (these do not constitute a modification to the channel) and none of these were observed to be a potential barrier to fish passage. Whilst no in-channel modifications were recorded on the channel bed, 3.7% of the banks were observed to have been reinforced although these are generally associated with the presence of Bay Bridge Weir and the culverted sections.

Fig. 5. Looking downstream to Bay Bridge Weir, one of three in-channel modifications on the River Adur through the survey area.

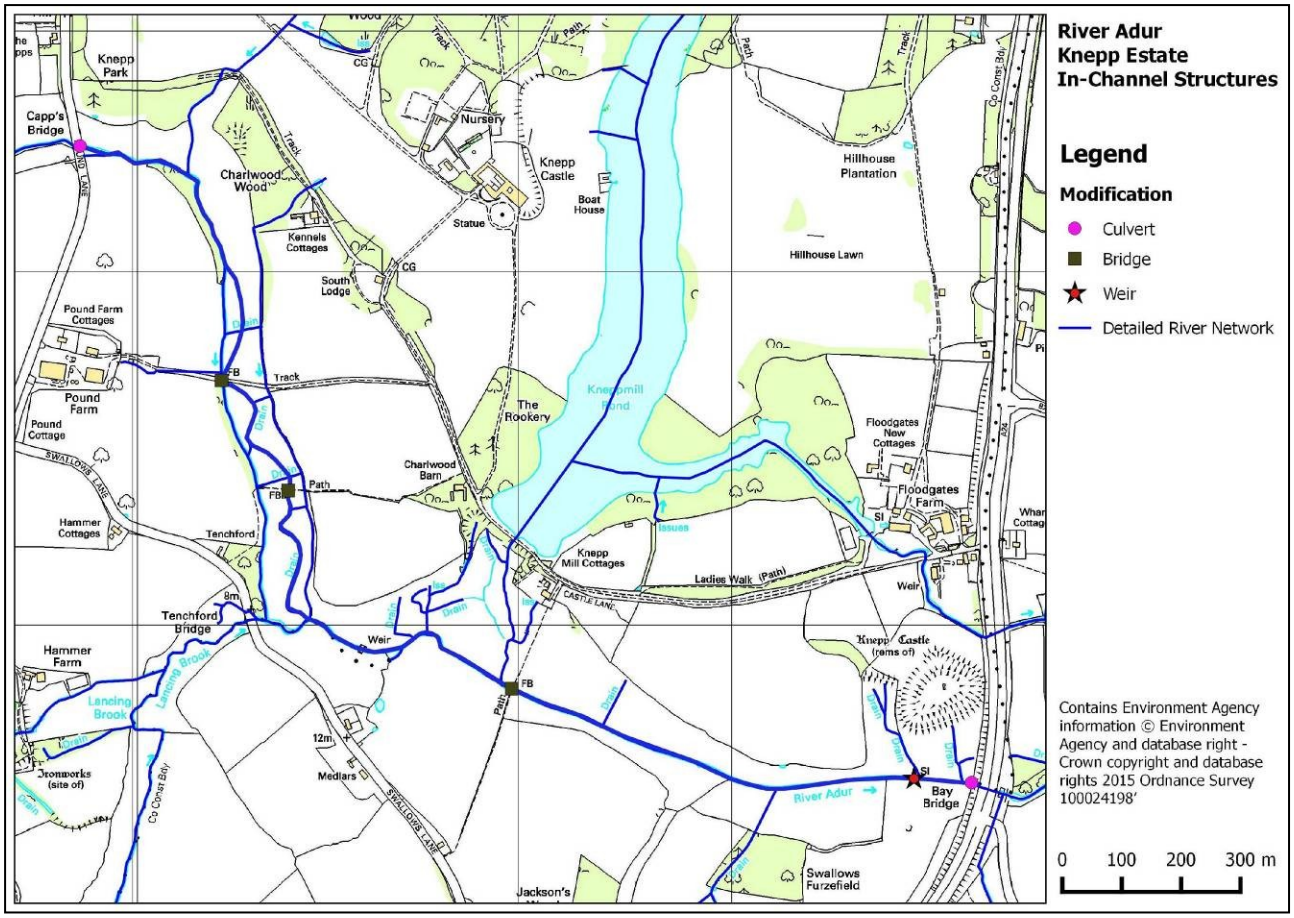

Fig.67. Locations of in-channel structures and bridges on the River Adur as it flows through the Knepp Estate.

5.3 In-channel Features

A total of 60 in-channel features were recorded across six categories (riffles, berms, side bars, point bars, mid-channel islands and large woody debris) (Fig. 7). This gives an average of 12.5 features per survey section or, on average, one feature every 33m for the course of the river. The presence of riffles was recorded in one of the survey sections.

The highest number of features observed in any one survey section was 17 (sections 1 and 3). Whilst section three has been enhanced through the creation of a new channel and the introduction of a number of woody features, the features in section one appear to be occurring naturally through bank slumping as a result of the removal of the weir boards at Bay Bridge. Large woody debris was recorded at four locations along the length of the stream mainly concentrated in the central area (Fig. 8).

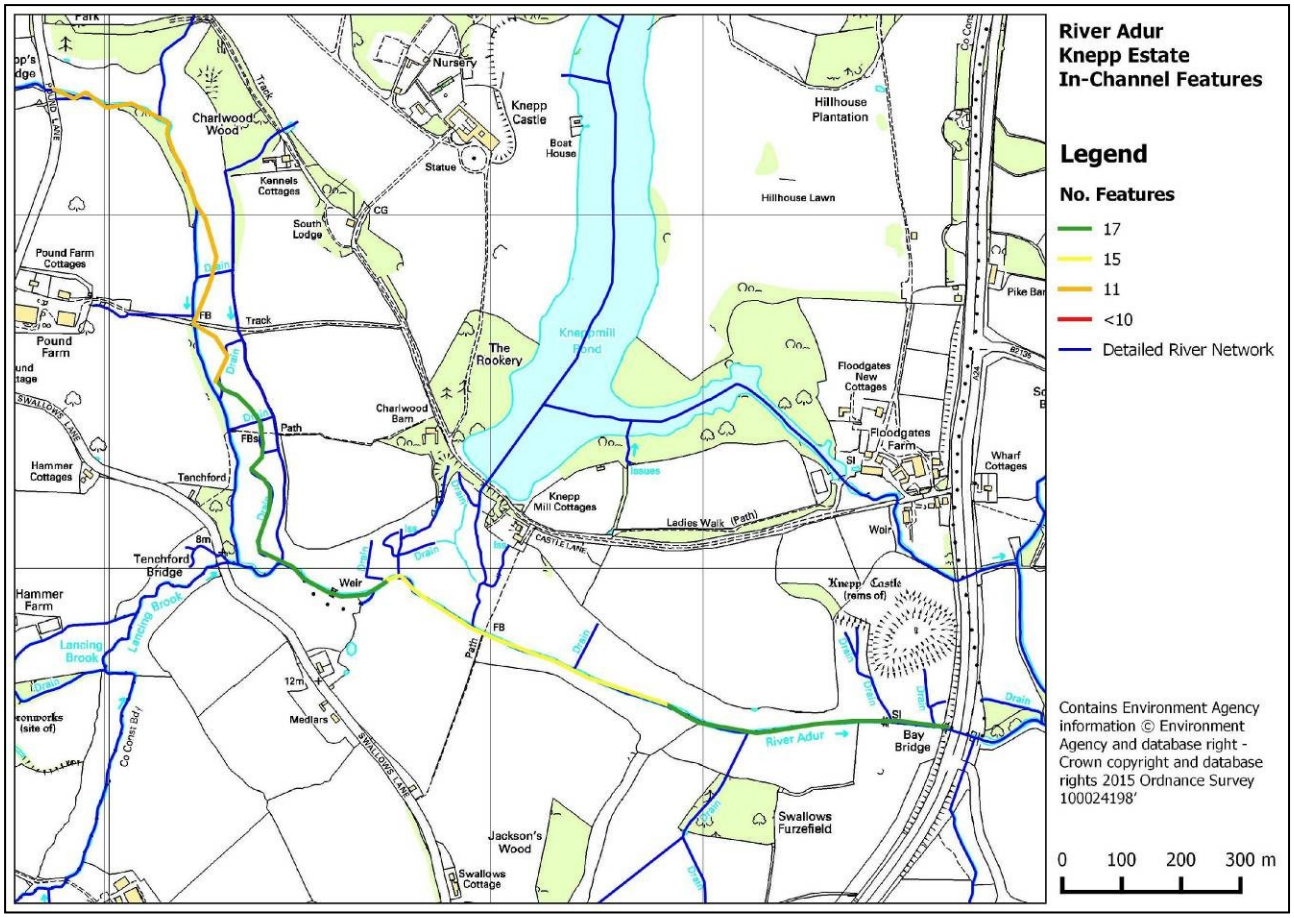

Fig. 7. Number of features per survey section on the River Adur as it flows through the Knepp Estate.

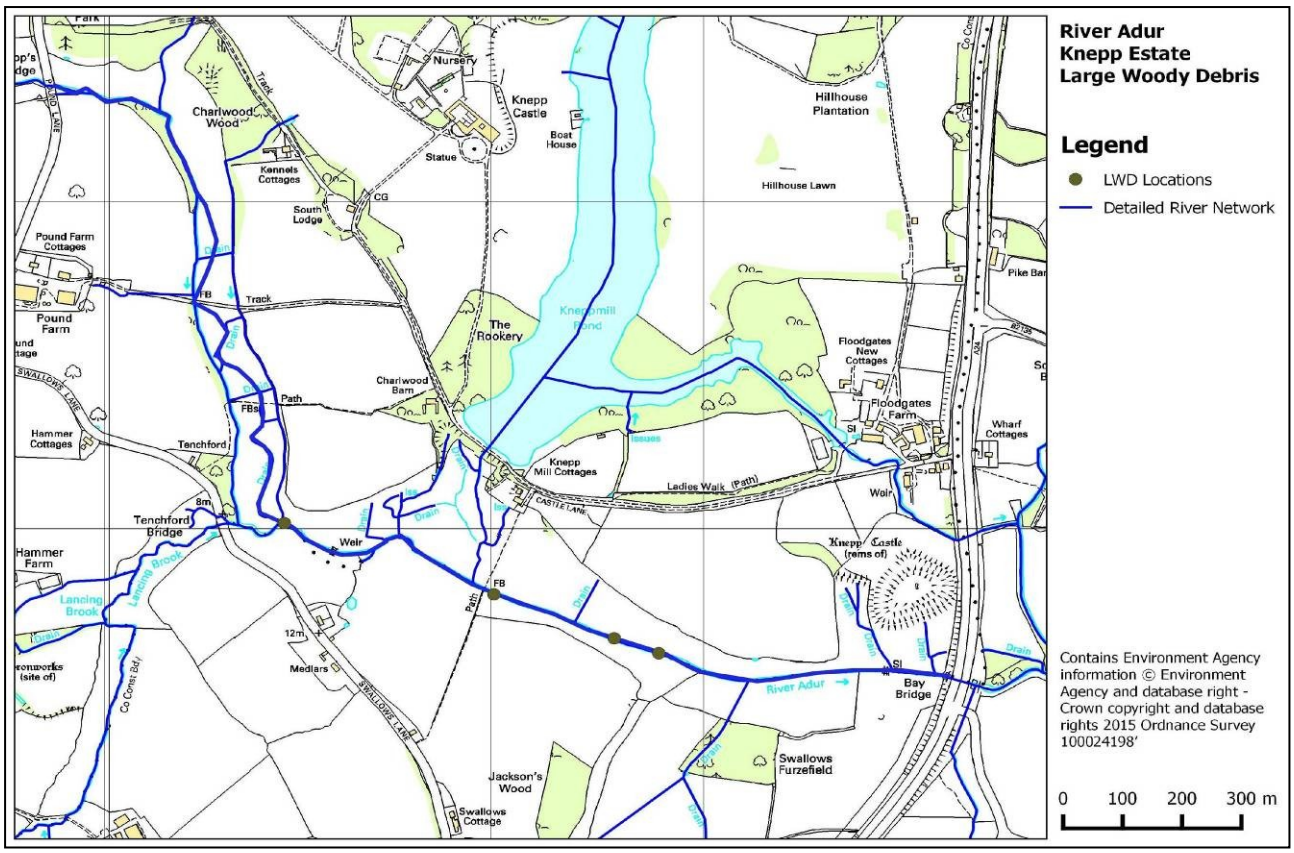

Fig. 8. Locations of large woody debris on the River Adur as it flows through the Knepp Estate.

5.4 River Banks

The main bank substrate was recorded as clay/earth at over 99% of spot checks with concrete being recorded as part of other in-channel structures. Whilst bank slumping was observed through section one there was no recorded eroding banks (used as a measure of current and possible future bank erosion) with none considered to be at substantial risk of erosion in the near future. In addition erosion areas were highlighted through the presence of bare bank faces which were recorded at 42% of left bank spot checks and 60% of those on the right hand bank.

5.5 Bankside Trees

The river survey has shown an absence of continuous or semi-continuous bankside tree cover through any survey section. Isolated tree cover was recorded across 50% of the survey area (when both banks are considered together), with occasional at 25% and no tree cover at 25% (Fig. 9).

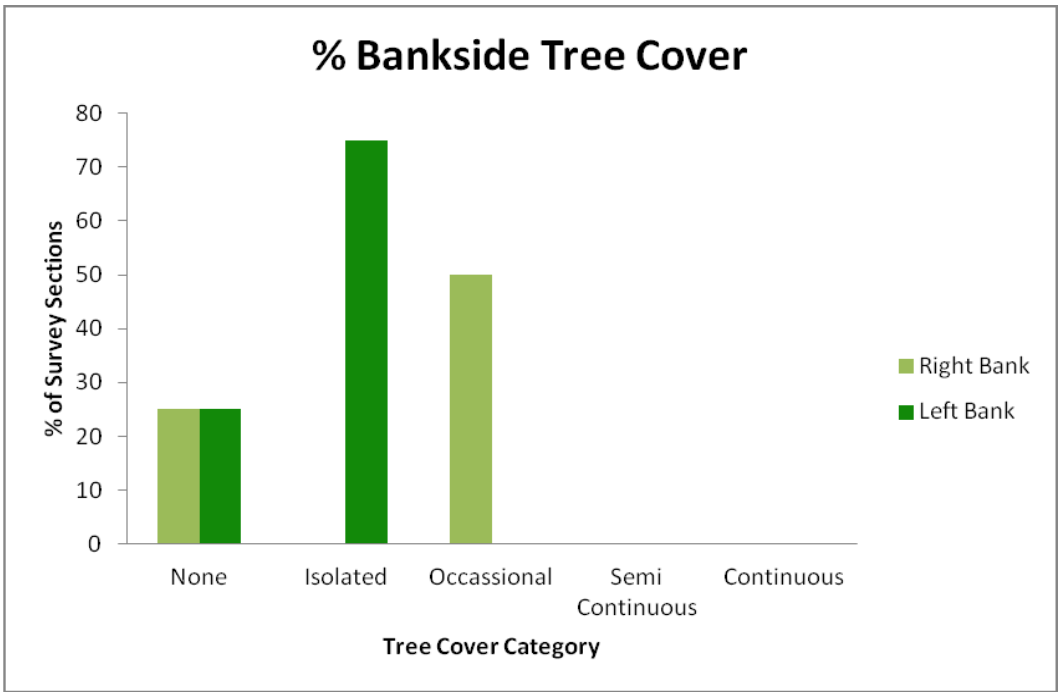

Fig. 9. Percentage bank side tree cover for left and right banks.

5.5.1 Alder

The common alder (*Alnus glutinosa*) is a riverine tree important due to its deep roots which provide protection against bank erosion. Although alder was recorded in all survey sections, none of the sections surveyed recorded >33% alder. The presence of the disease *Phytophthora alni* was not detected in any survey section.

5.6 Bankside Woody Features

Survey section one was the only to record no channel shading for its entire length whilst section two recorded >33% channel shading. As a result of this the same pattern was observed for the presence of overhanging boughs. Exposed bankside roots were recorded in sections two and three as was the presence of large woody debris. Fallen trees were observed in section three and had began to transform into a large woody debris dam.

5.7 Land Use (5m from bank) and Vegetation Structure

The dominant land use on both sides of the river is improved grassland for grazing which has, for the length of the survey, been enhanced to contain a number of scrapes as part of a wetland creation and floodplain connection project. Whilst some trees lined the banks on occasion there was no woodland cover on the land along the river corridor. By utilising the presence of certain vegetation types along the bank edge it is possible to infer which areas contain buffer strips. A >50% presence of one or a combination of the following vegetation types has been taken to represent an area which has a buffer of approximately 5m between the bank edge and the surrounding landscape: Broadleaf Woodland, Tall Herb/Rank Vegetation, Scrub/Shrubs, Wetland/Heath and Rough Unimproved Grassland. None of the survey area had suitable vegetated buffer strips to either bank although it is understood these are hard to establish as part of the wider project to re-wild the estate and allow livestock to roam free. All bank tops were recorded as having a uniform (1 plant community) vegetation structure which is in line with the absence of buffer strips along the river's edge (Fig. 10).


Fig. 10. Bare bank faces and uniform bank top vegetation structure dominate the River Adur through the Knepp Estate.

5.8 Invasive Species

No invasive species were observed during the survey.

5.9 Habitat Quality Score

The Habitat Quality Scores (HQS) for the watercourse ranged from 32 to 45 with an average of 38. This indicates limited variation in habitat quality across the survey area. The highest scoring area is within the newly constructed river channel where a number of in-channel features, such as berms and deflectors, have been installed. Interestingly the fourth survey section also incorporated parts of the new channel which had also seen features installed but less frequently and many of these will take some time before providing benefits to the habitat of the river. The overall picture of riverine habitat quality for the River Adur as it flows through this section of the Knepp Estate is shown in Fig. 11. This scoring system is relative and a result of this is that there will always be sections ranked low in comparison to others regardless of the actual score received. However, with a recorded highest score of 45 (whilst categorized as high in terms of the survey, this is some way below the potential "top scores" for HQS in lowland rivers which can reach in excess of 100 (Raven *et al.*, 1998) and surveys within the Adur & Ouse catchment realising top scores of 70) it is, in this case, assumed that those areas ranked in the bottom half would benefit from immediate remedial action to improve both in-channel and bankside conditions but all sections could be further improved to maximise the riverine habitat potential.

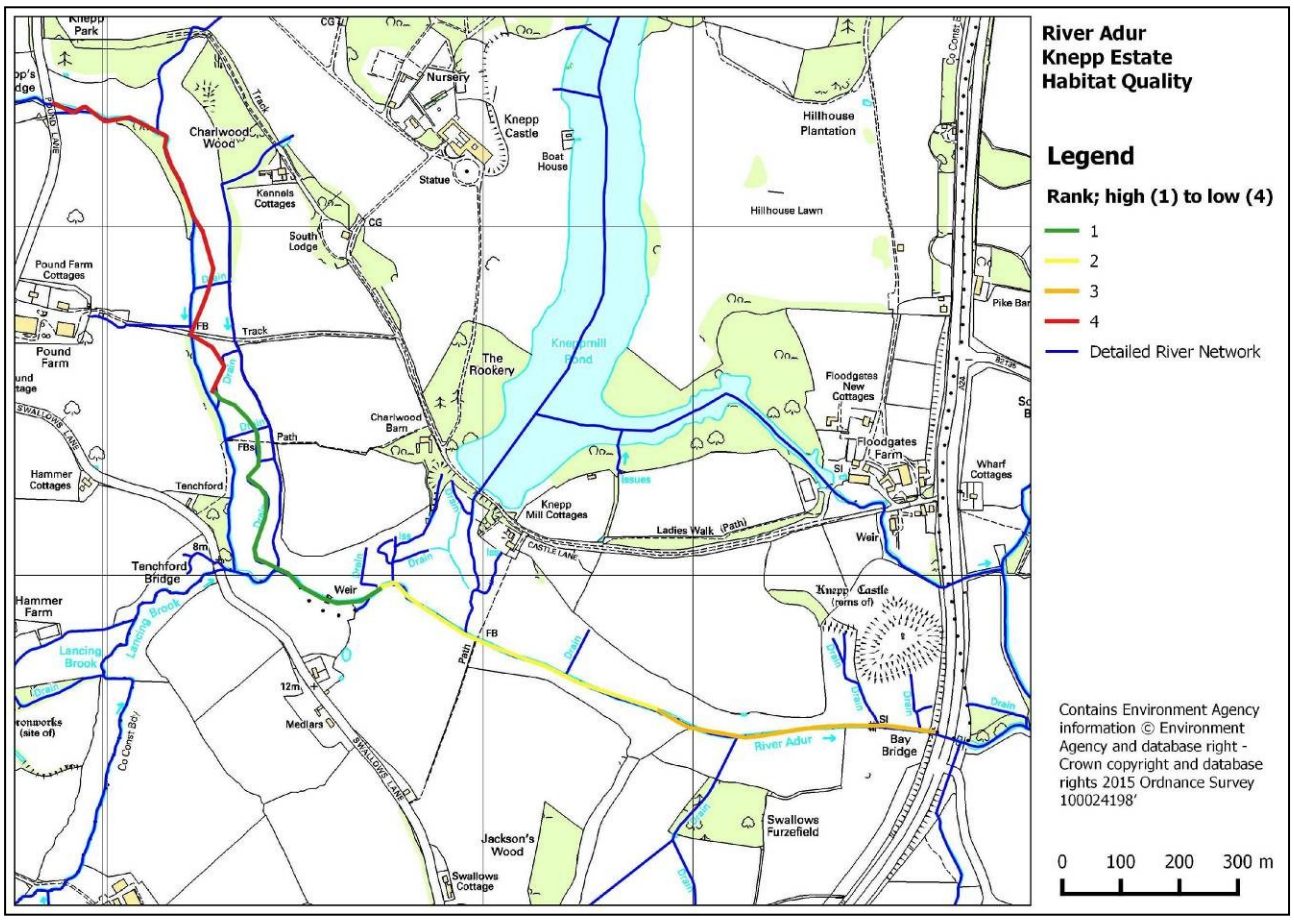

Fig. 11. Habitat Quality Scores ranked from high (1) to low (4).

When compared against the results of the survey undertaken in May 2015 there appears to have been some alteration in survey section rankings for habitat quality (Fig. 12). In 2015 section four received the second highest score for HQS with section two being the lowest, these two sections have reversed in their ranking. This appears to be as a result of the bank vegetation structure and presence of in-channel vegetation scoring higher through section two along with the natural build up of large woody debris and higher presence of bankside tree cover within this section.

Interestingly section one has seen the largest increase in HQS despite remaining ranked third. This is likely to be the result of the removal of the boards at Bay Bridge Weir which is allowing natural river processes to form sinuosity, increased flow dynamics, in-channel vegetation and a number of in-channel features.

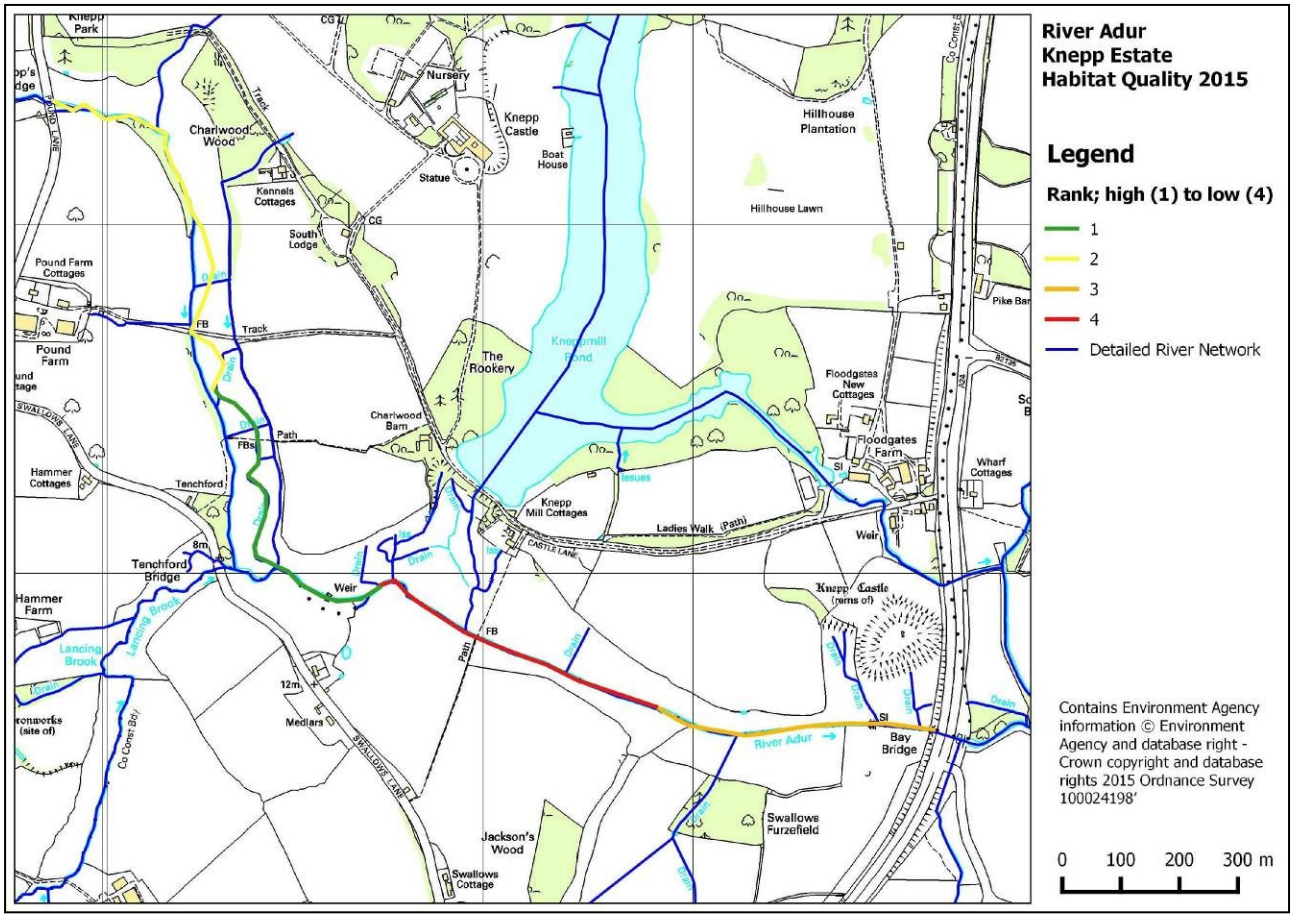

Fig. 12. Habitat Quality Scores from May 2015 ranked from high (1) to low (4).

These scores may, however, be biased by flow conditions and river levels at the time of survey which may drown out features which are present but not visible. As such further repeat surveys are recommended on an annual basis to assess changes to the river system over a longer period of time.

5.10. Habitat Modification Score

Habitat Modification Scores (HMS) were calculated for each survey section using guidance in Raven *et al*, (1998). Scores within the sub-catchment ranged from zero to 13. The watercourse is shown to be obviously modified (range, 9-20) within 25% (equal to one) of the survey sections, which is a result of the A24 road culvert and Bay Bridge Weir within section 1 (Fig. 13). Whilst there has been a large scale river restoration project undertaken on the site which has seen two weirs removed and the channel re-directed these have not been classed as modifications as the purpose has been to restore the river to its natural functioning condition.

HMS scores have been ranked and entered into a GIS format to indicate those areas which have undergone the greatest/least amount of modification (Fig. 14). The HMS rankings, as would be expected, have not changed since the last survey in May 2015.

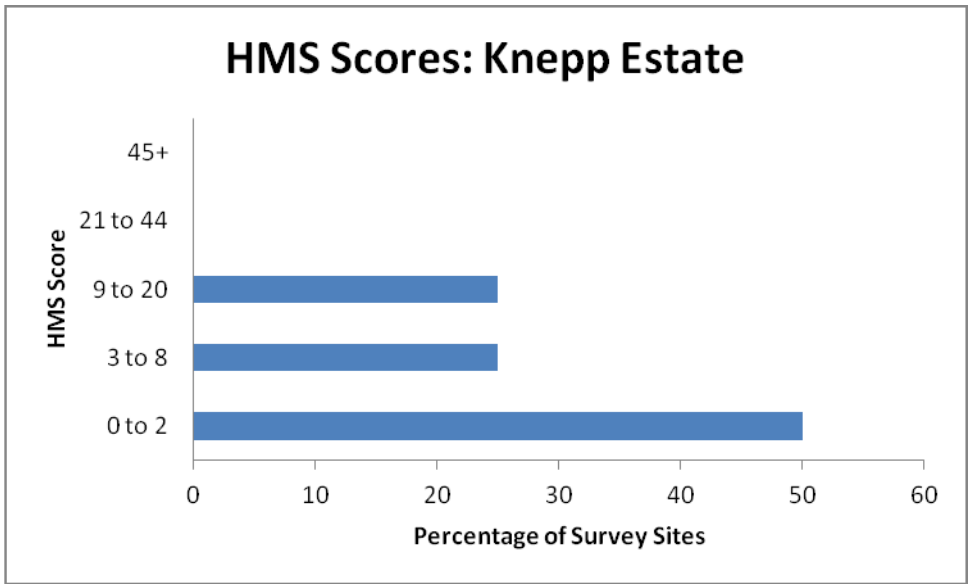

Fig. 13. Habitat Modification Score ranges as a percentage of sites surveyed.

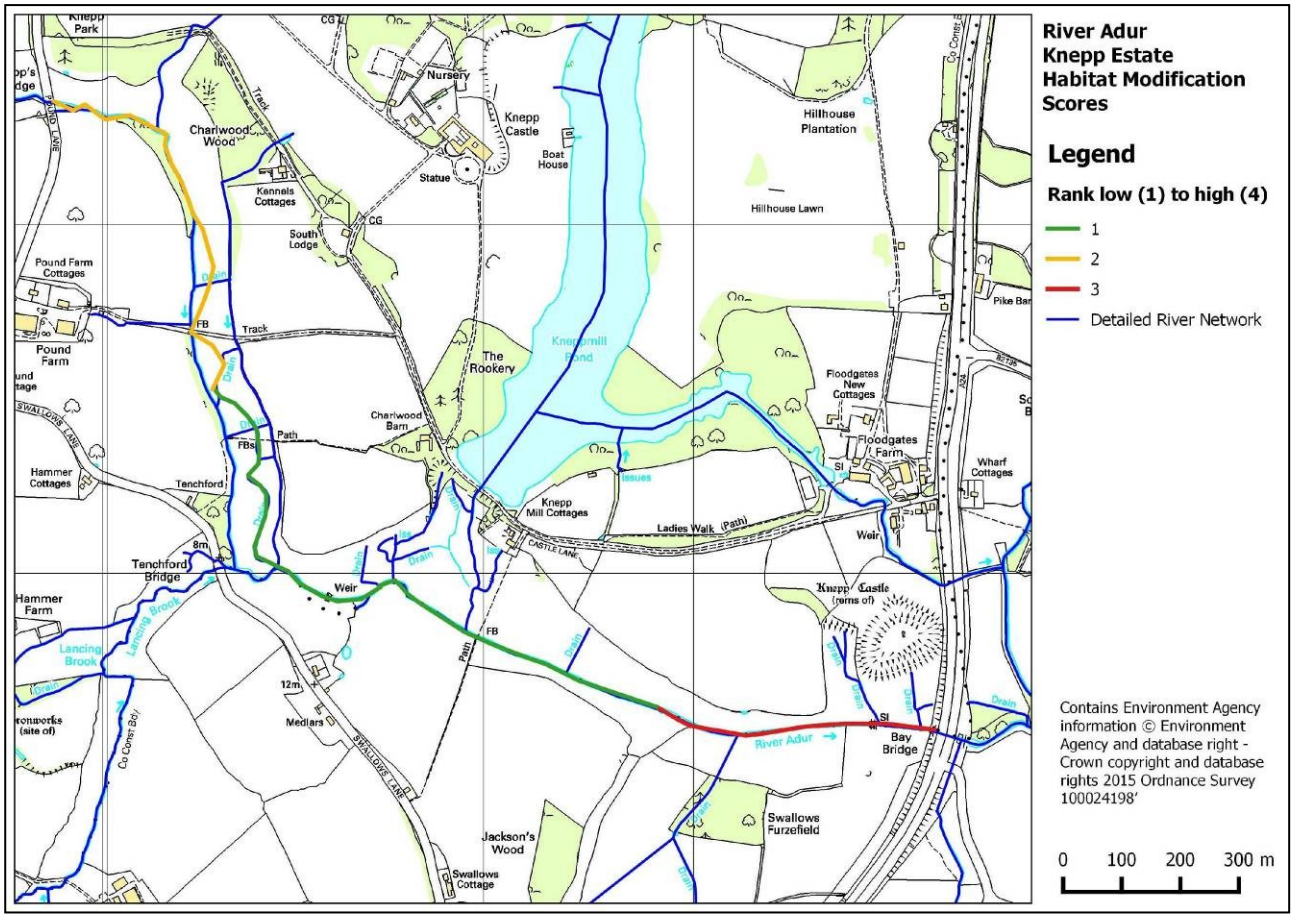

Fig. 14. Habitat Modification Scores ranked from least modified (1) to most modified (3).

6. Discussion

This section of the River Adur is part of a waterbody currently classified as having “moderate” ecological status under the EU Water Framework Directive. The results of this survey indicate that there is room for improvement to the river system although it is appreciated that the necessary measures may be difficult under the regime of re-wilding being undertaken.

The channel bed characteristics have been shown to be dominated by a clay substrate although there are also likely to be areas of heavy silt loading which were not visible at the time of survey. The low levels of in-channel vegetation and apparent lack of a diverse substrate within the channel will be limiting spawning opportunities for a number of fish species as well as limiting the establishment of invertebrate communities which, combined with possible high levels of silt accumulating through the still water sections could be a limiting factor in the establishment of naturally sustainable, multi-species fish populations.

No high risk areas for bank erosion were observed through the survey, mainly due to the bank profiles and heavy clay substrate. However, a lack of bank face vegetation along much of the river combined with

limited tree cover and the lack of riparian buffer strips are contributing to the relatively low habitat quality scores being realised along the course of the river. However, it is understood that the management regime of the landholding makes it difficult to create buffer strips or plant young trees without providing exclusion zones from livestock to allow trees to establish. However, the introduction of trees in the downstream sections would provide shading to the river along with natural recharge of woody debris, both important to the creation of a naturally functioning river system (Fig. 15). In addition bankside trees provide shelter for fish and invertebrates in exposed root systems and help to bind banks together, limiting any future increase in erosion risk. The establishment of buffer strips would also act as a filter to sources of pollution which would be washed into the river as flood water subsides (e.g. animal faeces).

Fig. 15. Bank side tree cover, buffer strips and in-channel vegetation establishment would all help in raising the habitat quality and ecological condition of the River Adur.

The observed flow diversity within the stream shows three different regimes of which rippled will be providing some oxygenation to the water whilst those areas with no perceptible flow will be adding to any silt loading which is occurring. However, this is likely to change over time as increased flow velocity as a result of the removal of weir structures should make the system more dynamic. There are no obviously impounded sections and those recording no perceptible flow are likely to be as a result of a lack of gradient within the river bed as it has levelled out through silt deposition when the structures were in place. All survey sections recorded the presence of in-channel features with sections one and three providing the highest number (17). Whilst section three has been enhanced through the placement of woody debris, section one is seeing the occurrence of natural bank slumping which is creating a series of berms, resulting in sinuosity and the establishment of in-channel, emergent, vegetation (Fig. 16).

There are numerous opportunities to increase the amount of in-channel features, specifically berms, deflectors and large woody debris, throughout the surveyed sections. Further investigation should also be undertaken as to the suitability of introducing sections of gravel substrate throughout the survey area. Although present, there is the potential to increase the amount of woody debris within the channel to increase the available habitat for fish and invertebrates. In the short term this could be placed in the river

at strategic locations where woody debris is absent from survey sections. However, it is suggested that the planting of trees along the bank edges would, once established, begin to naturally recharge the river with woody debris, eliminating the need for hands on management.

Fig. 16. Section one of the survey area which appears to be re-naturalising as a result of the removal of the boards at Bay Bridge Weir. Bank slumping is creating berms and side bars which are adding to sinuosity and allowing emergent vegetation to establish.

No evidence of invasive species was observed during the survey period. It was not possible to assess the presence/absence of signal crayfish (*Pacifastacus leniusculus*) or other in-channel invasive fish/invertebrate species and as such it is not possible to indicate a complete absence of invasive species from the site.

In a natural state with semi-natural land use, lowland rivers (such as the River Adur and its tributaries) which are connected to their floodplains would have extensive areas of wetland associated with them (Raven *et al*, 1998). The local and national loss of wetland habitats has been well documented (e.g. O'Connell, 2003; Southgate, 2012) and the results of this survey indicate that the River Adur, as it flows through the Knepp Estate has regained its connectivity with the floodplain and a number of scrapes have been constructed to provide wetland habitat. As such there is no need to establish wetland areas or re-connect the river with its floodplain.

Using HQS and HMS to allocate individual scores to river sections is a useful tool in establishing focal areas for further investigation or future work programmes. Lowland rivers can show scores of 100+ (Raven *et al,* 1998). This implies there is potential to increase overall scores across all river sections. However, the fact that very few areas provide continuous land use of broadleaf woodland, heath/moorland or wetlands will be a limiting factor in achieving higher scores (the continuous presence of one or more of these habitat types on both banks would increase scores by up to 14 points per section). Although the upper range of scores will always be constrained by the surrounding land use and the fact that this section of river does not have any of the special features listed from lowland rivers by Raven *et al*, (1998), it is not unrealistic to expect higher scores than those currently being seen, even at the top end of the range. The predominant reasons for the lower scoring areas were the lack of riparian buffer strips, bank faces/tops not having

complex vegetation structure, the limited tree cover and as a result a limited amount of features associated with this.

There does not appear to be any major obstruction to fish passage within the river system and those modifications which remain are unlikely to be altered/removed due to their importance to local infrastructure.

7. Recommendations

- Investigate the potential to introduce gravel substrate if historically present across the site.
- Introduce woody debris to more locations throughout the survey area, specifically within sections one, two and the upper reaches of section four.
- Establishment and enhancement of bankside and back face vegetation cover as well as strategic planting of trees would provide multiple benefits to the river and the species associated with it.
- Continue to monitor the river over time as further, natural enhancement is likely to occur within the channel

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