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Priority river habitat in England – mapping and targeting measures

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Summary

- This paper outlines an analysis of nationally available GIS datasets to generate a new map of priority river habitat for England.

- Rivers in England were selected as priority habitat based on naturalness criteria (physical, hydrological, chemical and biological), capturing the most natural remaining examples as far as can be ascertained from nationally available data. This means that many examples of river types included in the UK BAP definition (such as chalk rivers) are excluded from the priority habitat map as they have been significantly modified and degraded over the centuries.

- In addition to explaining the development of the new priority habitat map, this paper provides advice on how the map might best be used, how to target and prioritise restoration activity on rivers that do not feature on the map, and how to identify and give recognition to any restoration works that contribute to wider priority river habitat objectives.

- **The priority habitat map** (Figure 10 in the report) - This provides a focus for preventing deterioration of our most natural remaining rivers and undertaking any limited restoration of natural processes that may be desirable (as indicated in Figure 16).

- **Priority rivers for restoration** - Figure 17 shows rivers that are of types relevant to the UK BAP definition (chalk rivers and active shingle rivers) but are not sufficiently natural to feature on the priority habitat map. These should be considered a priority for restoration of natural processes. **Action on these rivers should be considered of equal importance to the protection and enhancement of rivers on the priority habitat map.**

- Given that this national analysis is relatively coarse (particularly in respect of headwater areas), there is considerable scope for local ground-truthing and refinement. Local knowledge and interpretation have an important role to play in the use of the outputs of this work. It is recommended that a process is established for refining the priority habitat map based on more detailed local knowledge of naturally functioning rivers. The national map should subsequently be updated (a timeframe of 6 months is recommended) to reflect any local refinements. Resources need to be made available for this process.

- As part of local application, it should be recognised that the national analysis only provides a river-reach or water body perspective. Local interpretation is needed to place priorities in a whole-river and catchment management context.

Contents

1. Introduction

Streams and rivers operating under natural processes, free from anthropogenic impact and with a characteristic and dynamic mosaic of small-scale habitats that supports characteristic species assemblages (including priority species), are the best and most sustainable expression of river ecosystems (Mainstone and Hall, in draft). Key elements are:

- a natural flow regime;
- natural nutrient and sediment delivery regimes;
- minimal physical modifications to the channel, banks and riparian zone;
- natural longitudinal and lateral hydrological and biological connectivity;
- an absence of non-native species; and
- low intensity fishery activities.

These conditions provide the best defence against climate change, maximising the ability of riverine ecosystems to adapt to changing conditions. They also provide the most valuable and effective transitional links with other priority habitats, including lakes, mires and coastal habitats. In English rivers and streams, high levels of naturalness are rare.

The formal definition of priority river habitat (JNCC 2011a) includes a wide range of river types including headwater streams, chalk rivers, active shingle rivers and rivers with Ranunculion/Batrachion vegetation (the Habitats Directive Annex I river habitat type occurring in the UK). JNCC has undertaken UK-level work to provide a more explicit definition of priority river habitat that could be used for mapping purposes (JNCC 2011b). This involved generating a list of qualifying criteria and applying it to all UK rivers using GIS. Whilst useful in drawing together relevant datasets, the resulting selection of rivers was strongly driven by the occurrence of certain priority species and did not reflect the ecological importance of the rivers relative to the wider habitat resource, particularly in respect of naturalness and natural processes.

Under the England Biodiversity Strategy, the Rivers Biodiversity Integration Group (as was) agreed an approach to mapping priority river habitat (Mainstone and Moggridge 2009) based on naturalness and natural processes - one of the criteria in the list used by JNCC (2011b). The need for this work was subsequently endorsed by the Terrestrial Biodiversity Group (2012) as part of Biodiversity 2020 delivery. This work has now been done, and will be used to inform the second round of Water Framework Directive (WFD) river basin management planning and agri-environment scheme targeting processes.

The priority river habitat map that has been produced is an English interpretation of the UK definition of priority river habitat, focusing on naturalness as the principal criterion in recognition of the vital importance of natural processes in delivering sustainable riverine habitats and supporting characteristic biodiversity. Associated advice on the restoration of rivers not featuring on the priority habitat map is equally important for operational decision-making and should carry similar operational weight.

2. Rationale for priority habitat mapping

The following rationale is designed to be as compatible as possible with the principles of the WFD. Further discussion of the integration of policy drivers in river conservation and freshwater conservation more generally, and on the role of priority habitat, can be found in Mainstone and Hall (in draft).

The objective of the priority habitat map in England is to:

- help organisations protect the most natural remaining examples of rivers from further impacts on natural processes; and
- highlight any aspects of habitat integrity (hydrological, chemical, physical, biological) that could most usefully be improved.

This map provides a locus for protecting and enhancing our most natural rivers beyond what can be achieved through the Natura/SSSI series or the application of WFD ecological status objectives. The envisaged use of the priority habitat map for protecting and improving our most natural remaining examples of rivers is considered in Section 5.

Whilst the priority river habitat map will help to direct management attention at our most natural rivers, most WFD restoration measures will be focused on those rivers not attaining this level of naturalness, since the management philosophy enshrined by the WFD is to bring all waters up to a good level of ecological quality and functioning. The greatest WFD management task is therefore to work on the more impacted parts of the river network and improve these as far as is practicable. The priority habitat map will not provide the basis for directing and prioritising this wider restoration effort. For this reason, priorities for restoration action in the river network outside of the priority habitat map are explained separately in Section 6 and 7. This includes specific mapping of priority rivers for restoration as well as broader consideration of the general objective of restoring natural processes for the benefit of whole river ecosystems across the whole river network.

The implications of the mapping exercise for the monitoring and assessment of rivers in respect of the England Biodiversity Strategy (EBS) Outcome 1A (90% of priority habitats in favourable or recovering condition by 2020) need to be managed. Assessment of Outcome 1A needs to be based on the status of rivers on both the “priority habitat map” and the “priorities for restoration” map. River conservation and restoration actions carried out on the rivers which appear on both maps will therefore contribute directly to the delivery of England Biodiversity Strategy Outcome 1A, and conversely actions on other rivers will not.

3. Development of the map

3.1 Analytical methods

The naturalness classification used to map priority river habitat is based on recent work to review the river SSSI series (Mainstone *et al*. In Draft). It evaluates four main components of habitat integrity: hydrological, physical, physico-chemical (water quality) and biological. An additional classification of the naturalness of headwaters (defined as streams with a catchment area of <10km^2 to coincide with WFD typology boundaries) uses land cover data as a surrogate for direct information on river habitat condition (information which is generally lacking on headwaters).

A schematic of the naturalness classification is provided in Figure 1, whilst details of the attributes and class thresholds used are provided in Table 1. The datasets used for evaluating components of habitat integrity were resolved into WFD water bodies to provide four naturalness class values for each water body. Land cover data on headwater areas were resolved separately into individual headwater areas, maintaining a distinction between direct river-related data on water bodies and surrogate land use data for headwaters.

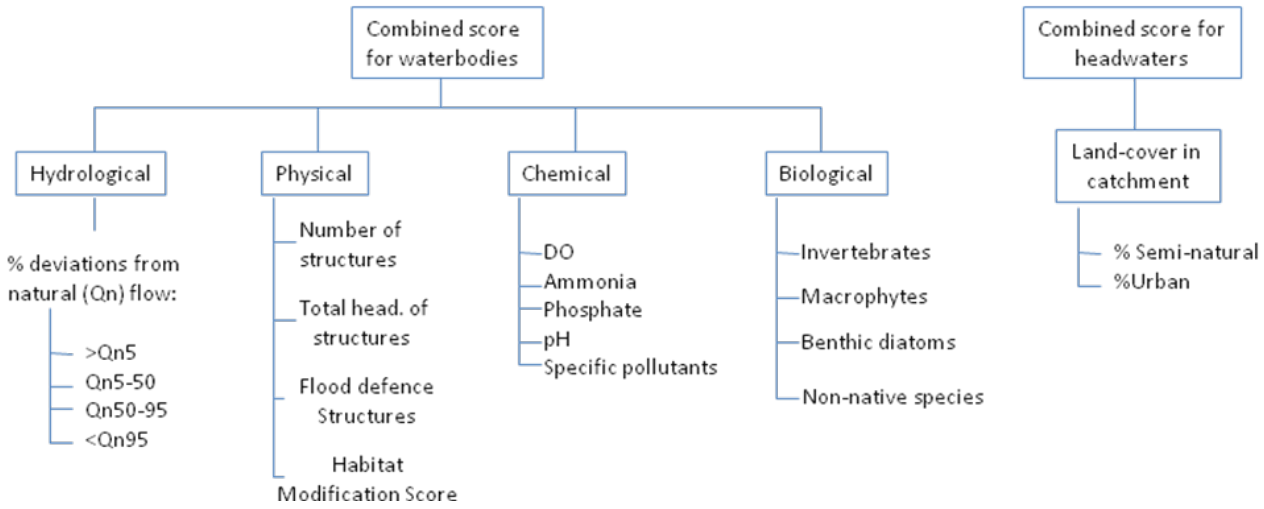

Figure 1. Structure of the naturalness analysis (from Mainstone *et al*. in draft).

This type of national analysis is necessarily relatively coarse as it draws on nationally available datasets and lacks the understanding that a more local evaluation can provide. An account of the limitations of the analysis is provided in Mainstone *et al*. (in draft), and further discussion in relation to priority habitat mapping is provided in the rest of this paper. The consequences of these limitations for how the map should be used are discussed further in Section 4. One major limitation is the spatial scale of the analysis – data largely relate to individual stretches of rivers and it has not been possible to scale information up to the consideration of whole river systems and their catchments. This has particular implications for the way in which the maps are interpreted.

It is worth emphasising that the focus of the analysis has been on natural processes and the magnitude of impacts on those processes. Some direct measurements of impacts on the biota, derived from WFD assessment, have been included where these were felt to be appropriate and available. Notably, these did not include WFD assessment of the fish community. Although fish assemblages are clearly fundamental to a healthy and naturally functioning river ecosystem, it was

felt that WFD fish community assessment data would not add value to the naturalness assessment.

3.2 Evaluation of data

The WFD river water bodies and headwater areas that are at the upper end of the naturalness range are shown in Figure 2. This figure shows all river water bodies with recorded naturalness of no less than Class 2 across all four components of habitat integrity, and any headwater area with Class 1 for urban land cover and no less than Class 4 for semi-natural land cover. Different levels of naturalness within these rivers and headwater areas are distinguished to provide a basis for deciding where the naturalness cut-off for priority habitat should lie. The figure displays all watercourses within the selected WFD water bodies, except those streams that fall within headwater areas (catchments of <10km^2). There may be considerable variation in the naturalness of the rivers within a water body, and this should be borne in mind when interpreting the map.

Table 1. Class boundaries used in the naturalness analysis.

(hes, ges, mes, pes and bes = high, good, moderate, poor and bad ecological status respectively)

Naturalness component and attribute	Naturalness class				
	1	**2**	**3**	**4**	**5**
Physical					
1. Habitat Modification – HM Class of mean score for water body	1	2	3	4	5
2. In-channel structures					
a) Number of structures in water body	0-2	3-5	6-10	11-20	>20
b) Total vertical drop (metres) of structures in water body	0-2	3-5	6-10	11-20	>20
3. Flood defence structures – total length (km)	0-2	3-5	6-10	11-20	>20
2. Hydrological					
% deviation from monthly naturalised flow					
a) Flows <Qn95	<5%	5-10%	10-25%	25-40%	>40
b) Flows Qn95-50	<5%	5-10%	10-25%	25-40%	>40
c) Flows Qn50-5	<5%	5-10%	10-25%	25-40%	>40
d) Flows >Qn5	<5%	5-10%	10-25%	25-40%	>40
3. Physico-chemical					
1. Dissolved oxygen	hes	ges	mes	pes	bes
2. Total ammonia	hes	ges	mes	pes	bes
3. Phosphate	hes	ges	mes	pes	bes
4. pH	hes	ges	mes	pes	bes
5. Specific pollutants	hes	ges	mes	pes	bes
4. Biological					
1. Macroinvertebrates	hes	ges	mes	pes	bes
2. Macrophytes	hes	ges	mes	pes	bes
3. Benthic diatoms	hes	ges	mes	pes	bes
4. Non-native species (aggregate weight score of species)	<5	5-10	10-20	20-30	>30
5. Headwaters					
Land cover in headwater catchment in water body					
a) % semi-natural vegetation	>90%	70-90%	50-70%	25-50%	<25%
b) % urban	<2%	2-5%	5-10%	10-25%	>25%

The aim of the priority habitat map is to capture a limited subset of the most natural examples of rivers in England, with a reasonable representation across geographical regions. This is particularly difficult in a country where anthropogenic pressures are distributed unevenly, with lowland areas being subject to far greater overall pressure than upland areas (though certain pressures are more acute in the uplands). Some attributes and targets (WFD environmental standards and also biological metrics used to assess ecological status) allow greater levels of anthropogenic pressure in lowland rivers than upland rivers, reflecting a perceived higher tolerance to some pressures – this potentially helps to capture lowland examples in the mapping exercise.

An alternative approach that has been considered is to identify the best (most natural) examples of different river types, so that we can select rivers in a stratified way that achieves a clear balance of representation across river types. This type of stratified approach has been used in the past to notify SSSI rivers and is the basis of the current river SSSI review (Mainstone *et al.* in draft). Through the course of this analysis it was decided not to adopt a stratified approach for the reasons discussed in Section 3.3 below.

Figure 2 includes a relatively large number of rivers with a widespread distribution across England. There is an inevitable skew towards upland areas, but there are still plenty of examples in lowland England. Semi-natural land cover in headwater catchments is much more prevalent in upland areas; however, land cover is only a coarse proxy for river habitat naturalness, and headwater streams flowing through semi-natural habitat will not necessarily exhibit high levels of naturalness. Many of the streams in the upland headwater areas shown on the map are heavily degraded by a combination of moorland gripping and burning, practices which damage habitat structure and generate heavy loads of organic particulates that smother the stream bed. Some of these upland areas also suffer from a legacy of acid pollution and from metal ore mining.

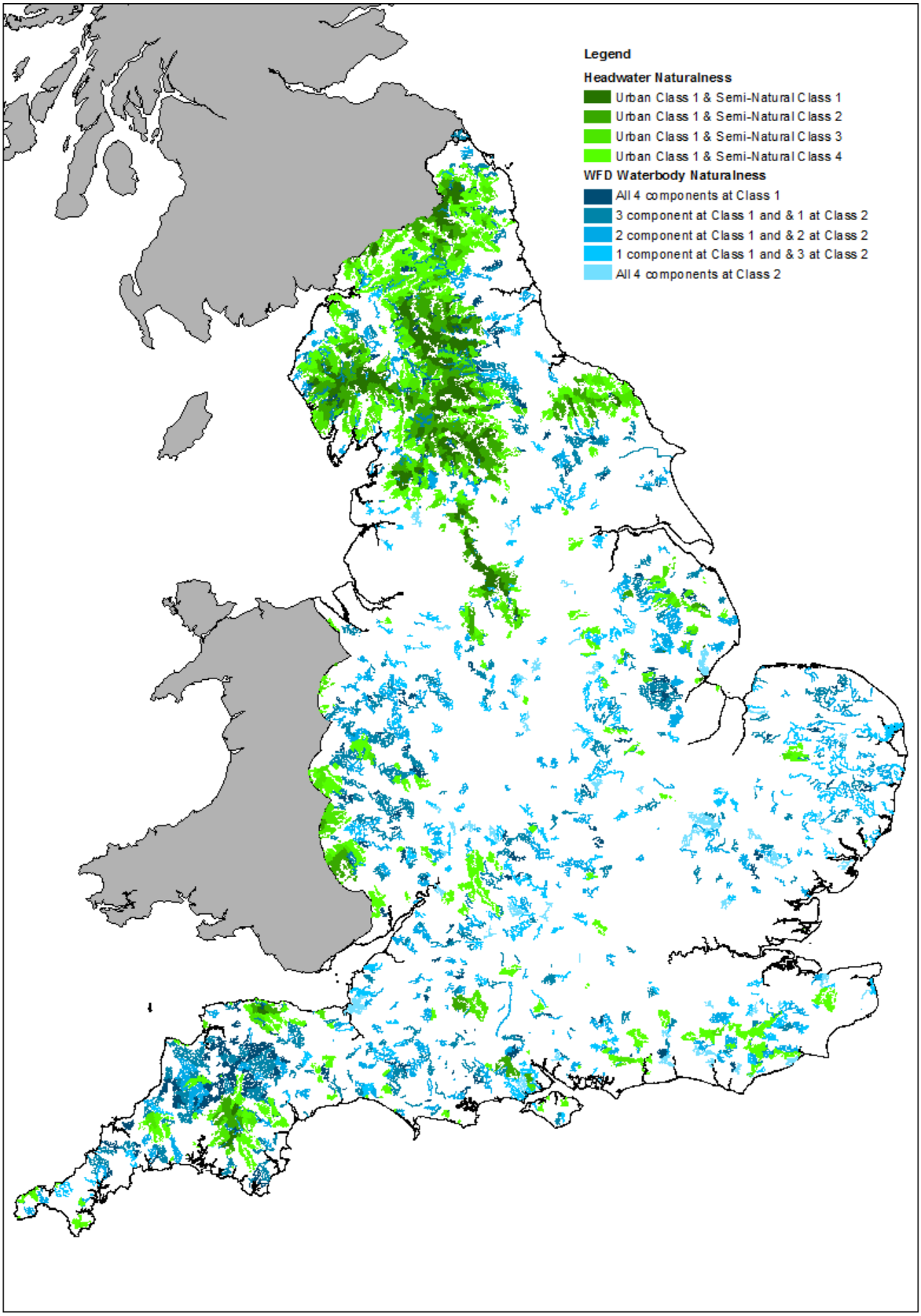

Figure 2. WFD river water bodies and headwater areas exhibiting relatively high levels of naturalness according to the analysis undertaken.

The relationships between the rivers/headwater areas included in Figure 2 and the spatial distribution of river SSSIs, chalk rivers, active shingle rivers, headwaters, rivers at WFD high morphological status (hms) and high ecological status (hes) overall, and priority species 'hotspots' are shown in Figures 3 to 8 respectively. It was not possible to provide a robust comparison with the distribution of rivers with Ranunculion/Batrachion vegetation, since our current understanding (encapsulated by the dataset included in JNCC 2011b) is based on macrophyte survey data which is only available on a limited subset of rivers. Rivers of this type are widely distributed in England, and occur in many upland areas (to an extent dependent on the interpretation applied to the definition in the Habitats Directive). Predictive modelling is needed to gain a robust understanding of the spatial distribution of this habitat in England – all that can be said currently is that it is a widely distributed and relatively common type of river.

a) Comparison with the river SSSI series

As might be expected, there is a reasonable amount of association with the river SSSI series (Figure 3). Complete overlap would not be expected since the river SSSI series comprises a set of whole-river designations that represent the best examples of the natural variation in river habitat in England. Some types of river are more impacted than others, and no whole river (i.e. source-to-sea) has minimal impacts along its entire length. The current analysis of priority habitat evaluates rivers on a water body basis, and individual water bodies may be relatively unimpacted even though other water bodies within the catchment are under major anthropogenic stress. Main river stems are often more heavily impacted than their tributaries, and these main stems often constitute a large proportion of a SSSI notification.

b) Comparison with the chalk river resource

There is a significant amount of association with the chalk river habitat resource (Figure 4), but it is not surprising that a considerable proportion of the resource falls outside the rivers and headwater areas highlighted as most natural by the analysis. Chalk river systems have been extensively physically modified down the centuries, and exploited for their clean water. As noted in Section 2, the relatively low naturalness of many of our chalk rivers does not mean that they are not a priority for restoration action (this is discussed further in Section 6).

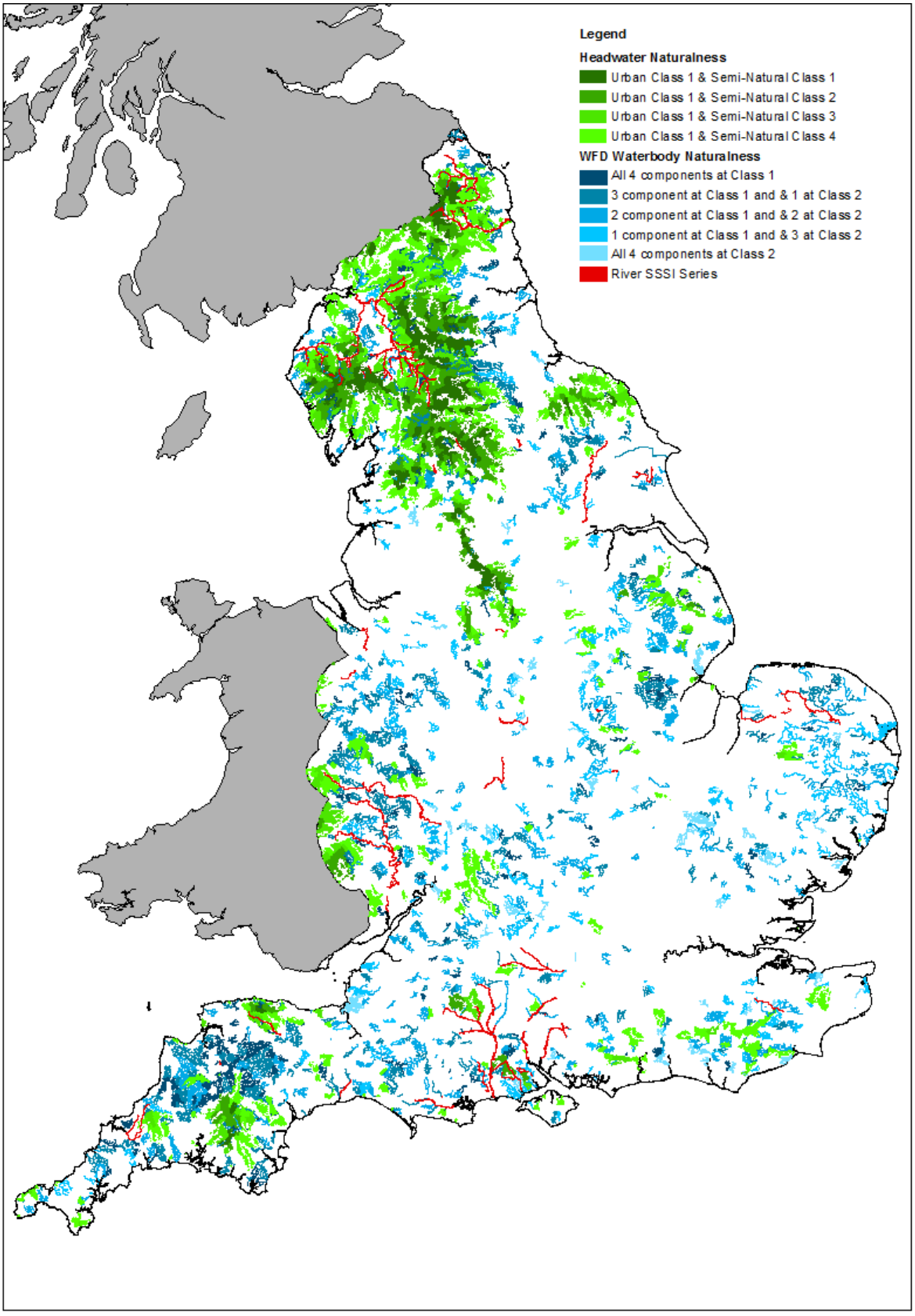

Figure 3. Associations between relatively natural river water bodies/headwater areas and the river SSSI series.

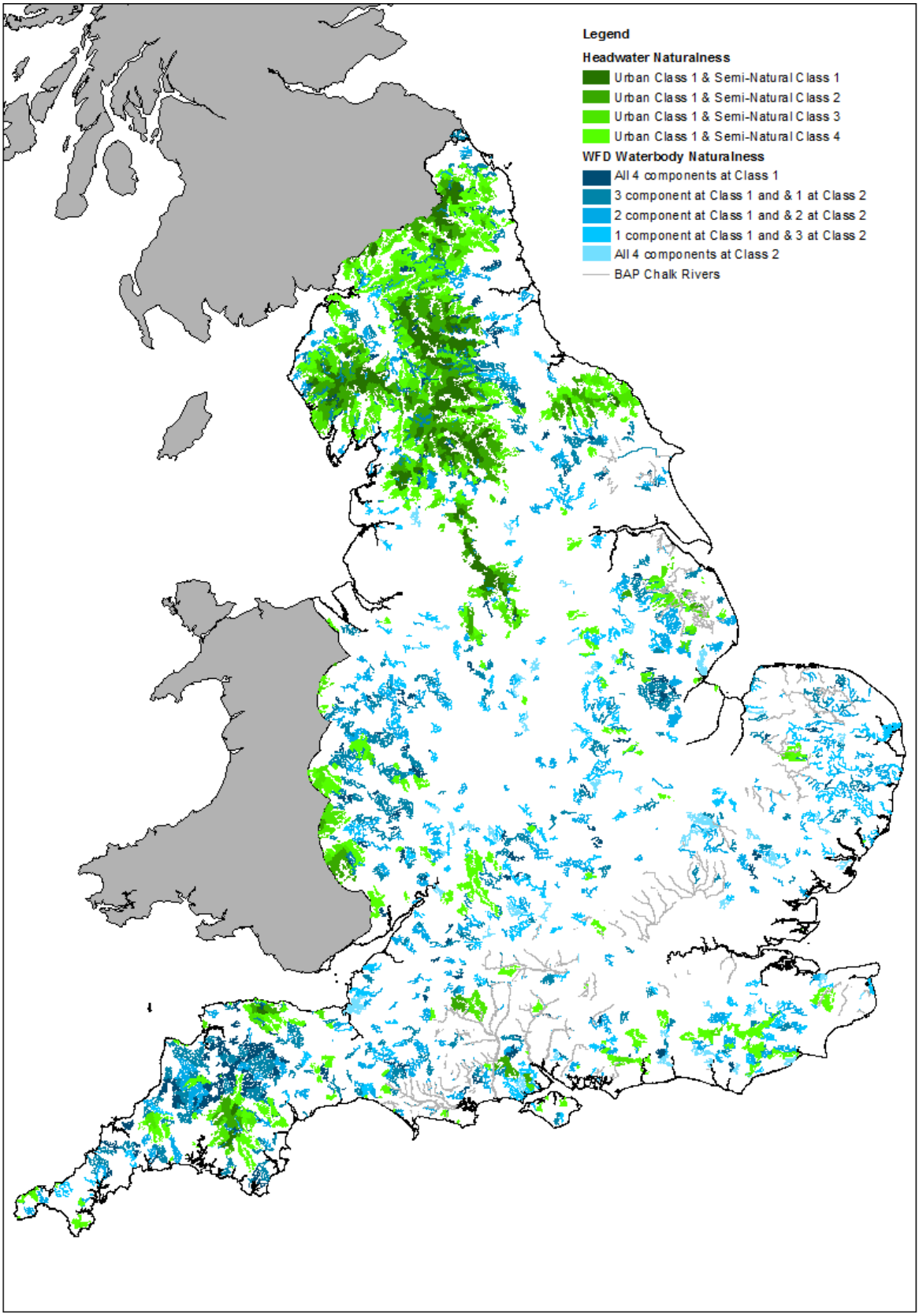

Figure 4. Associations between relatively natural river water bodies/headwater areas and the chalk river resource.

c) Active shingle rivers

The level of association with the distribution of active shingle rivers is highly variable (Figure 5), with best associations in upland areas most noted for such rivers. The JNCC dataset (JNCC 2011b)was based on an interrogation of the River Habitat Survey (RHS) database, which screened RHS survey sites for the presence of a gravel-dominated riverbed in combination with features such as point and mid-channel bars and eroding cliffs. The RHS analysis produced an unexpected distribution in many ways, showing considerable numbers of sites in lowland areas perhaps not normally thought of as active shingle rivers but exhibiting indicators of active river processes - it is mainly in these lowland areas where the lack of association with relatively natural rivers occurs. This may be due to the coarse resolution of the naturalness analysis – a relatively natural tributary with active shingle may be present in a river water body that does not have a high naturalness score overall. This might be addressed through local interpretation of the priority habitat map (see Section 4). It may also be that many lowland rivers with active shingle are relatively modified (e.g. in relation to water quality or flow), suggesting a need for improvement.

d) Headwaters

Under the UK BAP definition all headwaters potentially form part of the priority habitat definition and so are shown in Figure 6. This map emphasises the sheer scale of the headwater resource as a proportion of the river habitat network, accounting for the large majority of total river length. The headwater areas selected as most natural by land cover comprise a relatively large proportion of the upland headwater resource but a very small proportion of the lowland resource.

The headwater analysis is the least certain component of the naturalness analysis – for example, highly natural headwater streams running through very small catchment areas, often wooded, would not be detectable by the analysis that has been undertaken. Equally, land cover is a crude measure of naturalness and various types of impact on river habitat are not well correlated with it (e.g. abstraction pressure, point source pollution). These issues can only be addressed through local interpretation of the final priority habitat map (see Section 4).

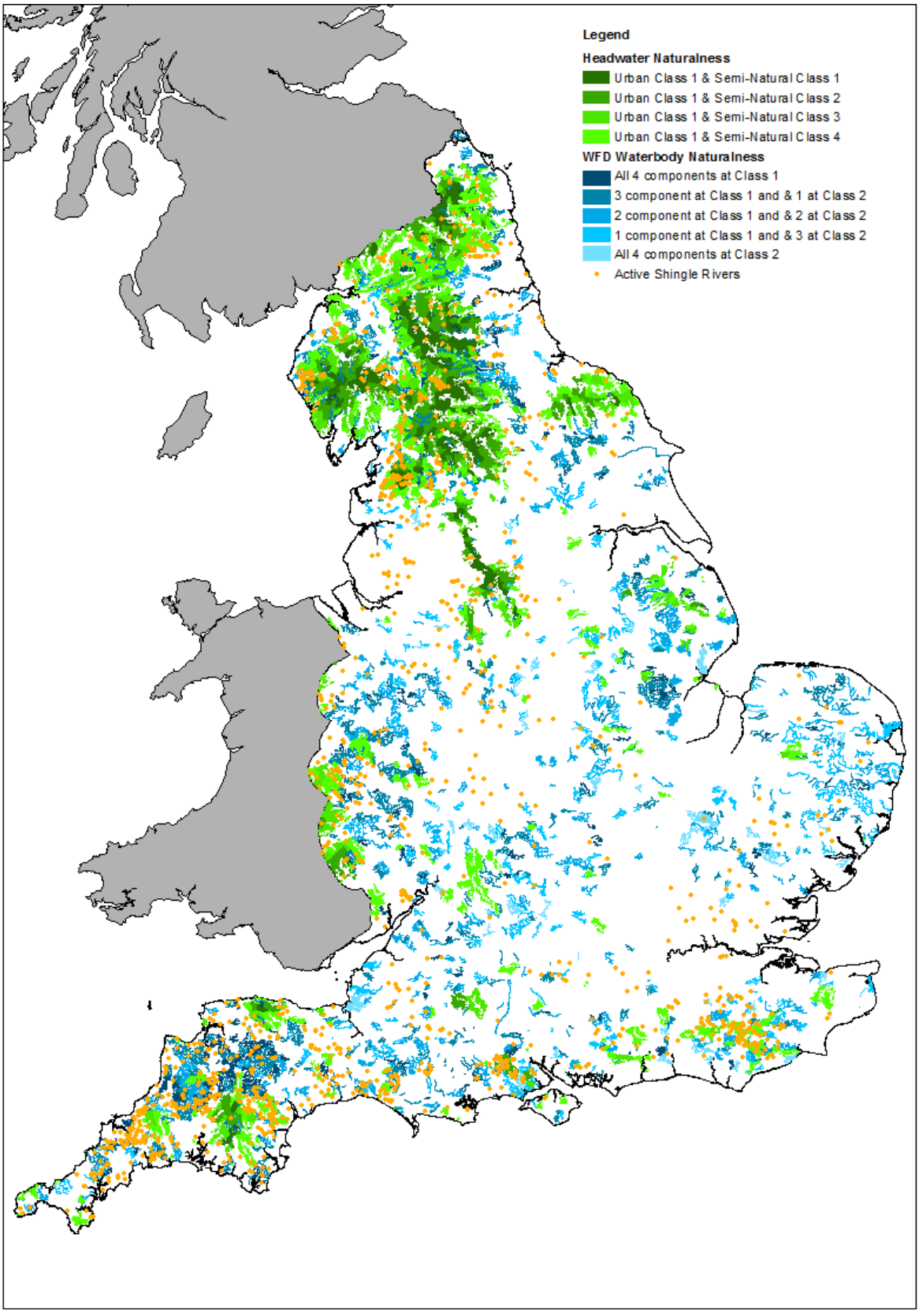

Figure 5. Associations between relatively natural river water bodies/headwater areas and River Habitat Survey sites exhibiting characteristics of active shingle rivers.

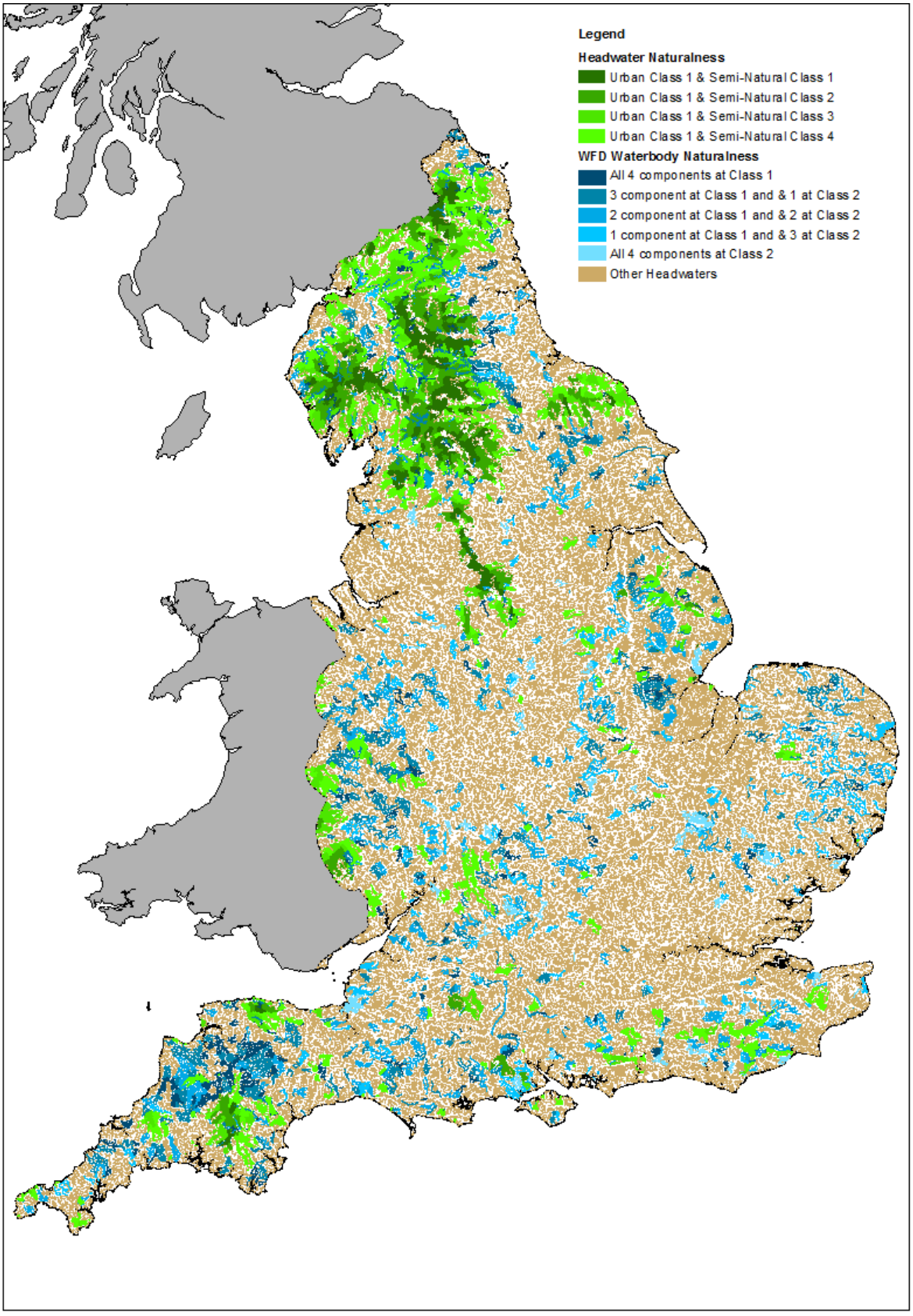

Figure 6. Associations between relatively natural river water bodies/headwater areas and the wider headwater resource.

e) Water bodies at high morphological status and high ecological status

A few English WFD water bodies have been classified at hes overall (i.e. across all criteria making up the hes assessment) or at least for their morphology (hms). It is important to understand how these water bodies have been classified in the naturalness analysis and ensure that they are properly recognised in the priority habitat mapping exercise.

Figure 7 shows the catchments of the water bodies involved. There are 3 water bodies judged to be at hes and a further 11 judged to be at hms but failing at least one other hes criterion. Unusually for WFD water bodies, all 14 of these water bodies are almost exclusively in headwater areas. They all score highly on the headwater naturalness classification; however, due to the lack of WFD monitoring sites in headwaters there is little direct data on their status. Of these 14 water bodies, 5 (1 hes water body and 4 hms water bodies) had sufficient data for an overall water body naturalness score to be assigned - these water bodies all scored in the top two classes of combined naturalness shown on Figure 7. The other 9 water bodies had insufficient data to be classified and therefore only appear on Figure 7 by virtue of being hes or hms water bodies.

f) Priority species

The overlap with 'hotspots' for river-related priority species (from Section 41 of the CROW Act) is shown in Figure 8. This map is limited by the records that were available for the analysis (see Mainstone *et al*. in draft for further detail) and will under-estimate the distribution of many species. It is difficult to interpret this map since there is no simple relationship between the naturalness of a river and the number of priority species it contains. Some types of river have naturally low biodiversity and may therefore contain fewer priority species. Each species has its own habitat preferences - some will be naturally absent from a particular river exhibiting natural functioning, some will be naturally present, and others may be artificially present due to deliberate introduction or anthropogenic impacts making conditions more favourable.

The best outcome for habitat and species conservation is where a river with high levels of naturalness is supporting a wide range of priority species as part of the characteristic community. In the map, some overlap is evident between the highlighted rivers/headwater areas and the grid cells with the highest numbers of species. However, the map is difficult to interpret for the reasons given above, exacerbated by the differential levels of recording effort across England and the relatively small amount of variation in the number of priority species between grid cells (as indicated by the slight variation in intensity of shading of grid cells).

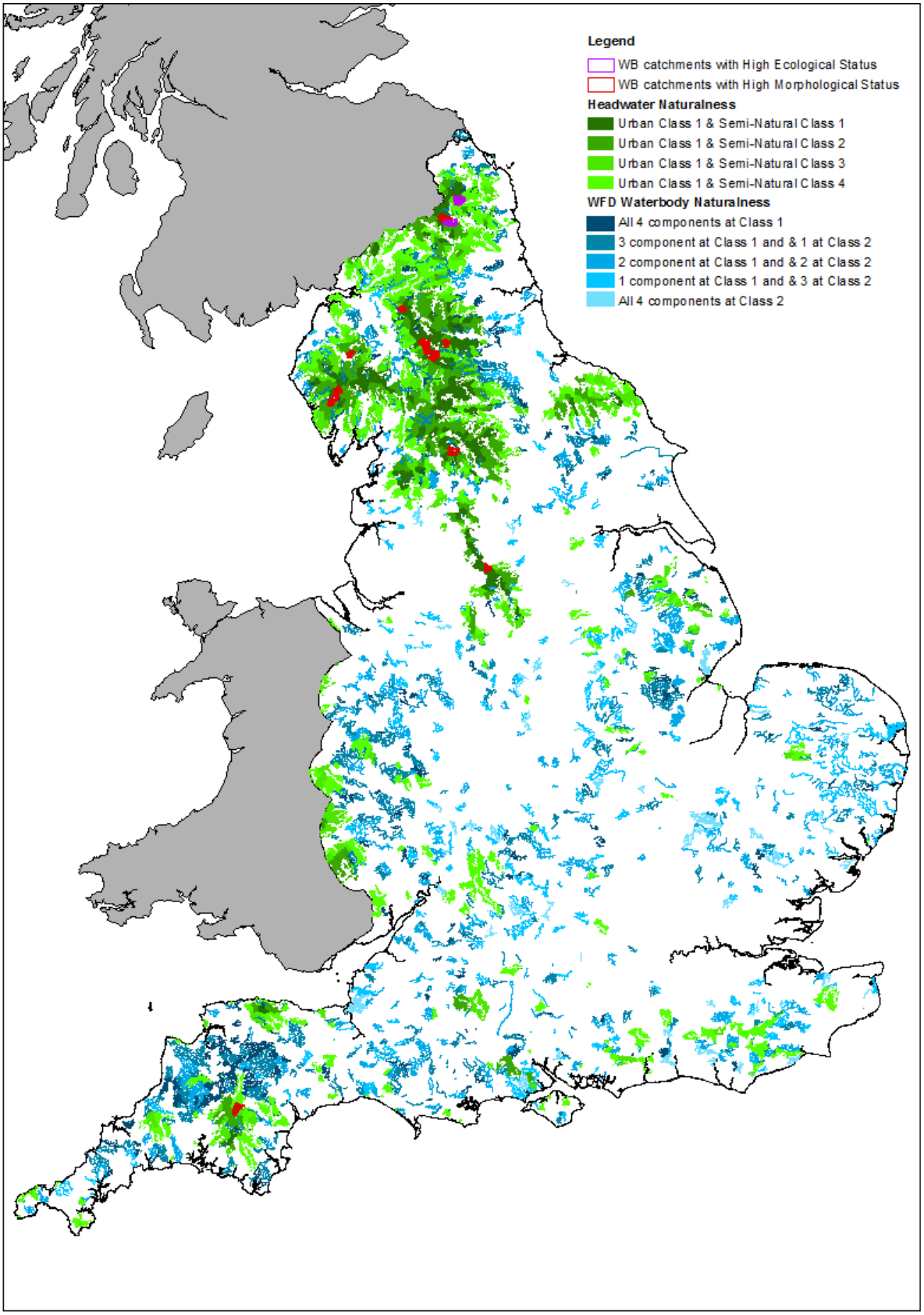

Figure 7. Associations between relatively natural river water bodies/headwater areas and water bodies assessed as high morphological status or high ecological status overall.

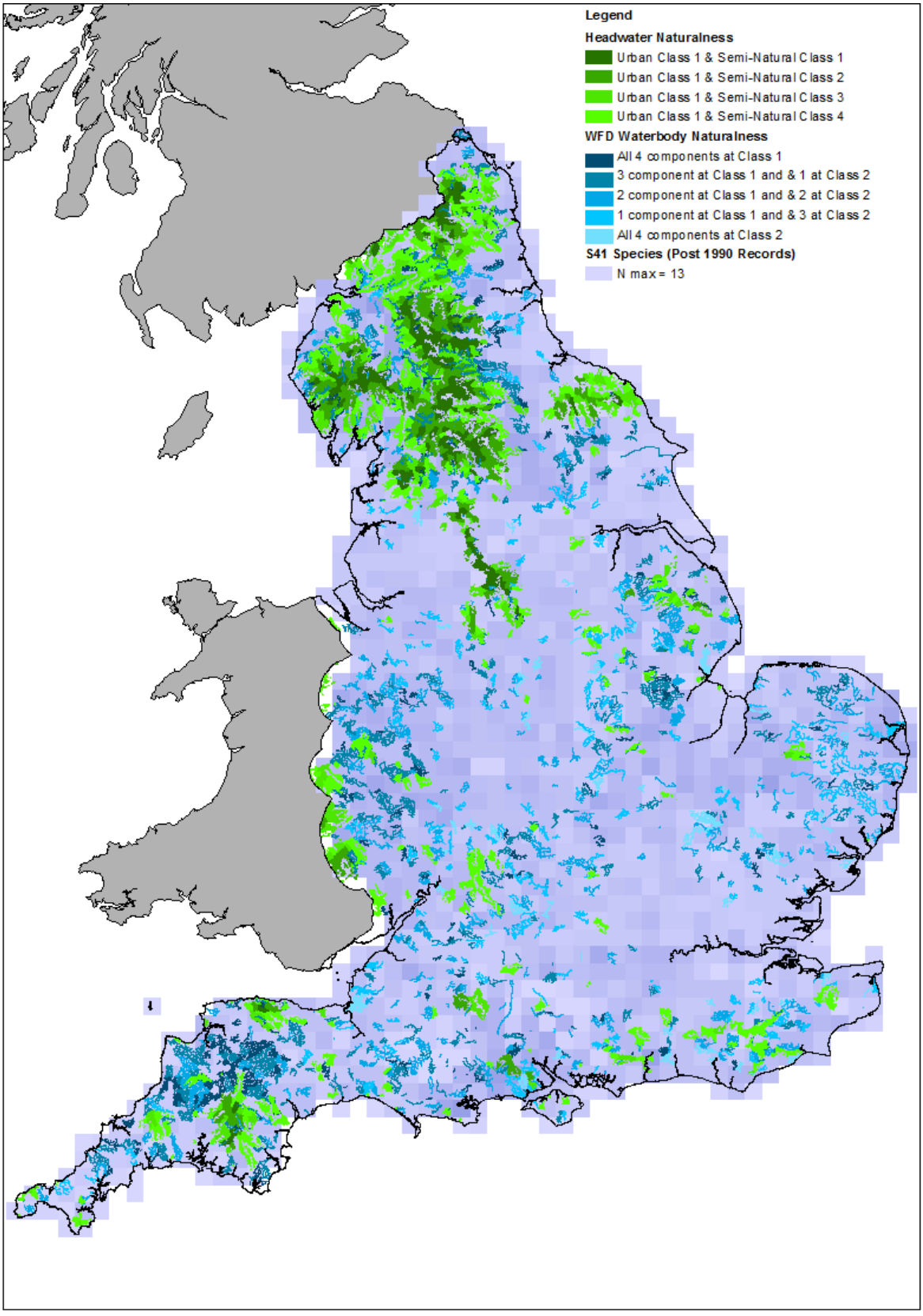

Figure 8. Associations between relatively natural river water bodies/headwater areas and recorded numbers of river-related priority species (on Section 41 of the CROW Act).

3.3 Selecting naturalness cut-offs for the priority habitat map

Given that Figure 2 contains a large number of rivers including many with significant losses of naturalness, it was decided to screen out the least natural to reduce the subset of rivers encompassed by the priority habitat map. It was concluded that restricting the priority habitat map to rivers with no or only one component of habitat integrity at naturalness class 2 (i.e. the rest being at Class 1) would capture an appropriate amount of the most natural parts of the resource whilst retaining a reasonable geographic spread across England. In addition, it was decided to retain headwater areas from naturalness classes 1 to 4, since there would otherwise be little representation in lowland England (but local verification of highly natural headwaters needs to play a major role in taking the map forward - see Section 4). Water bodies at hes or hms that have insufficient data for a water body naturalness score have been added to the map, since a lack of data on these water bodies was not considered sufficient justification for their exclusion - **this means that the priority habitat map includes all water bodies judged to be at hes or hms**.

It was decided not to force a balance of representation of different river types in the final map by stratifying the selection of rivers by type. Such an approach would have complicated the evaluation and made cut-offs more difficult to understand. It would also risk losing focus on the most natural remaining examples of lowland rivers, since it would mean accepting more impacted rivers into the priority habitat map. The primary focus of the priority river habitat map is to avoid deterioration from highest levels of naturalness - inclusion of more impacted rivers would dilute this focus. The restoration map in Section 6 provides an additional means of recognising the importance of rivers that do not feature on the priority habitat map.

Feedback on the draft priority habitat map produced using the above cut-offs highlighted that some of the water bodies are designated as heavily modified or artificial under the WFD. This is because in some of the datasets used for the naturalness analysis, particularly the physical habitat assessment, data availability is very patchy. Water bodies designated as heavily modified or artificial are not appropriate for inclusion and were therefore omitted at this stage. Figure 9 shows heavily modified or artificial water bodies that were removed from the draft priority habitat map. Exclusion of these water bodies still leaves a reasonable spread of rivers in lowland England. Interestingly, it has a significant impact in upland areas, due to the heavily modified status of rivers downstream of headwater reservoirs (as a result of impacts on the natural flow regime).

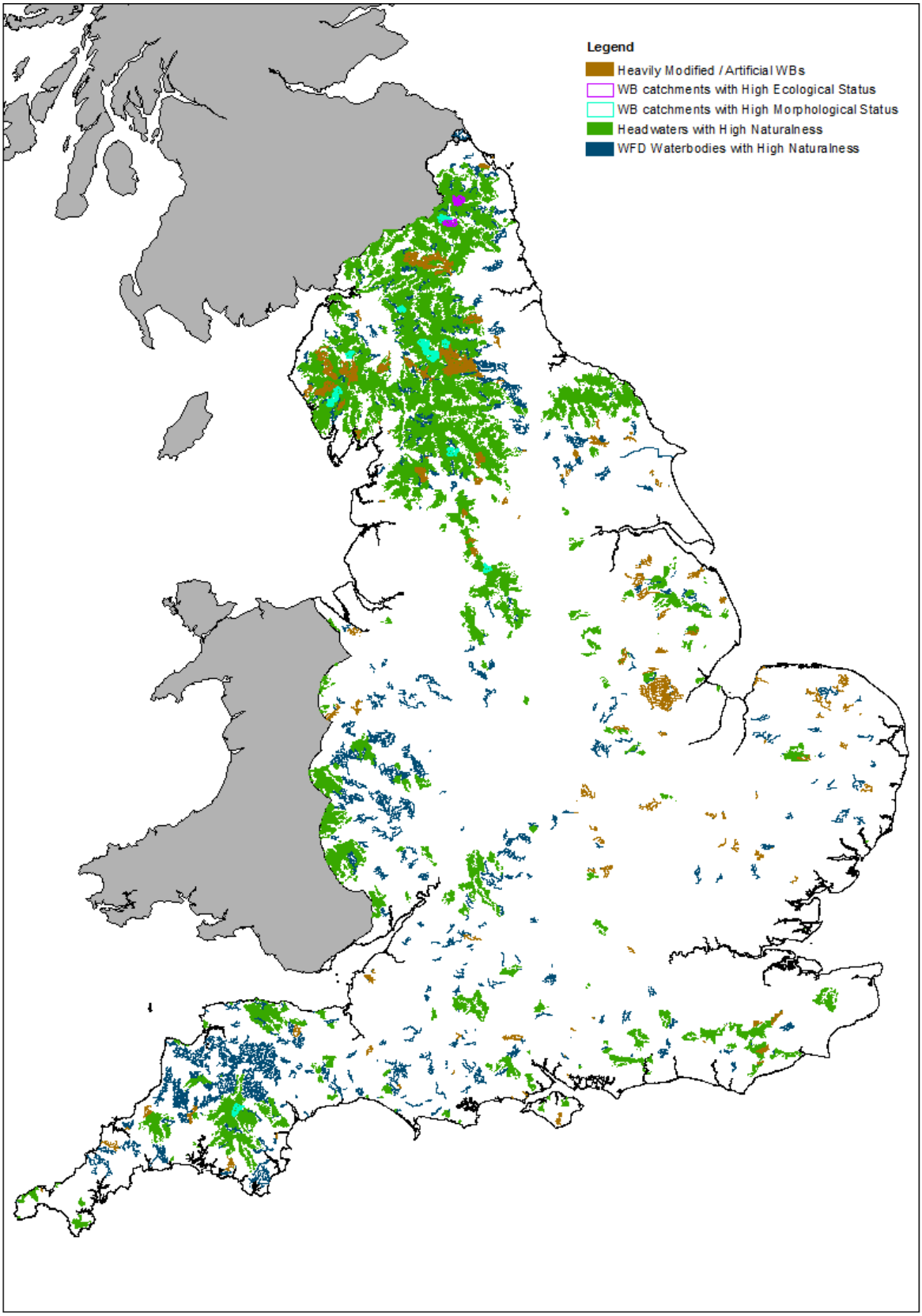

Figure 9. The occurrence of water bodies designated as heavily modified or artificial in the draft priority river habitat map.

The decisions on cut-offs for the priority habitat map have reduced the level of overlap with the river SSSI series and the river types included in the UK definition of the priority habitat. The implications of this are discussed in subsequent sections.

4. The priority habitat map

The final priority habitat map, using the chosen cut-off points for naturalness and adjustments to include hes/hms water bodies but exclude WFD heavily modified and artificial water bodies, is shown in Figure 10. The relationships between the priority habitat map and the spatial distribution of river habitat SSSIs, chalk rivers active shingle rivers and headwaters are shown in Figures 11 to 14 respectively. Figure 15 shows the relationship with recorded ‘hotspots’ of priority species.

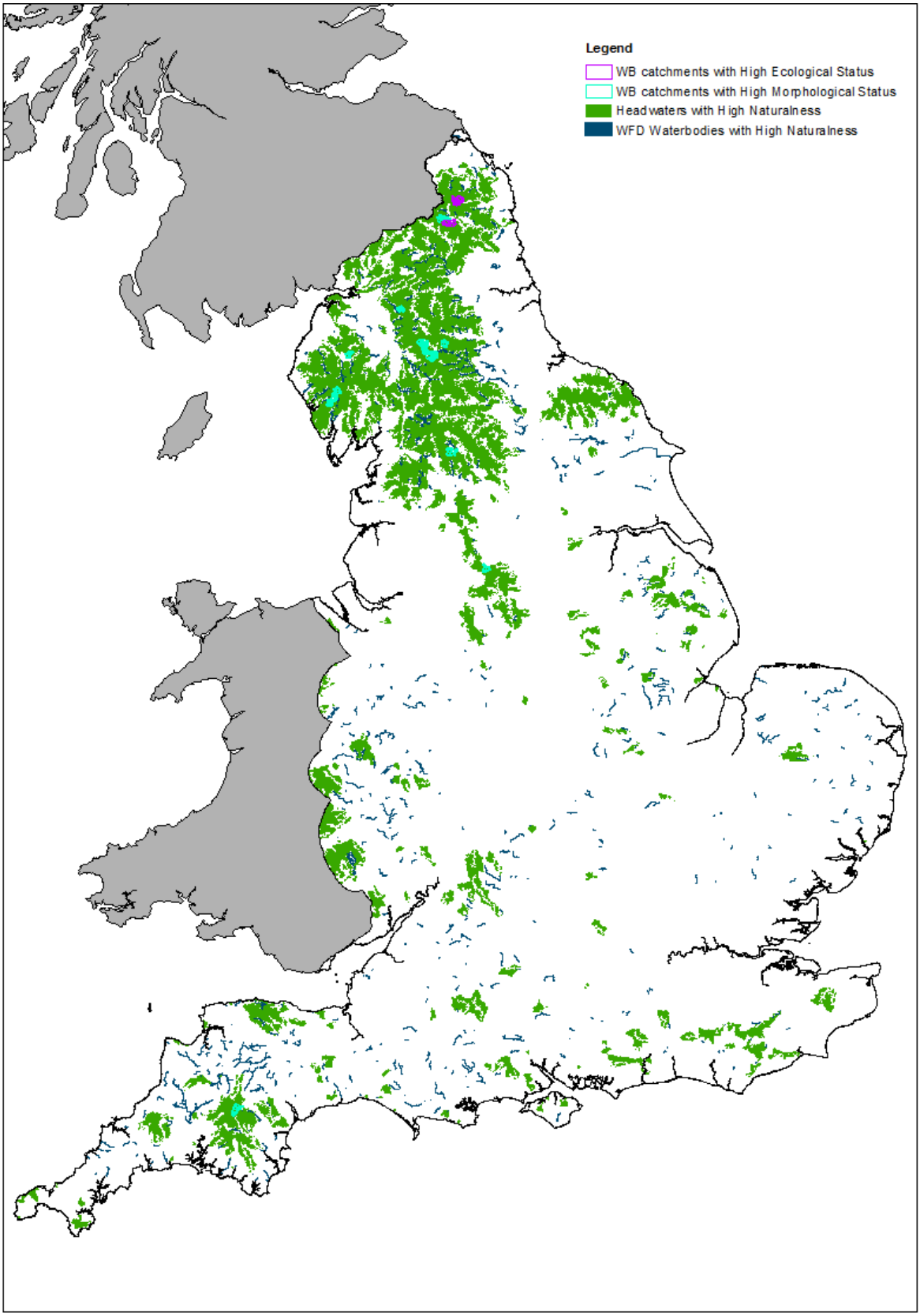

Figure 10. The final version of the priority river habitat map, showing river water bodies and areas with potentially highly natural headwater streams (see separate high resolution version for more detail).

A high resolution version of Figure 10 is provided separately for more accurate inspection and interpretation of the map, and a shapefile has been produced for operational use. Given the limitations of this national analysis, it is important that the map as it stands is not seen as definitive at the local scale. It is a first attempt to identify our most natural rivers using nationally available data, and its use must be sufficiently flexible to incorporate other rivers with high levels of naturalness identified by local staff.

There is still a reasonable amount of association with SSSI rivers (Figure 11), mainly in the undesignated tributary network of SSSIs (e.g. Wye, Teme and southern chalk rivers) where extensions to existing notifications would boost SSSI representation of our most natural rivers (see Mainstone *et al*. in draft for a more detailed analysis of river SSSI notifications).

There is relatively little association with the chalk river resource (Figure 12), which is somewhat disappointing but not particularly surprising. Some of this will be due to physical modifications but flow modifications from abstraction will also be important. Some of the most important associations are in headwaters areas highlighted as most natural by the priority habitat map, most notably (in respect of chalk rivers) areas of the North and South Downs and Lincolnshire Wolds.

Associations with active shingle rivers (Figure 13) are again arguably strongest in headwater areas marked on the priority habitat map, rather than the water bodies marked on the map. This is likely to be mainly a topographical issue rather than a naturalness issue *per se*, with active shingle rivers often occurring downstream of higher gradient headwaters. Impacts on naturalness in rivers downstream of these headwater areas is likely to account for the lack of strong association with waterbodies on the priority habitat map.

Associations with headwaters (Figure 14) are impossible to discern due to their ubiquitous nature. All waterbodies on the priority habitat map will have headwaters, and there is a good case for particular management consideration of these.

Some associations with higher recorded numbers of priority species are apparent from Figure 15. However, as discussed in Section 3.2 the significance of any apparent associations is not clear. A new initiative by the Freshwater Habitats Trust, on the identification of Important Freshwater Areas for biodiversity, should provide a more sophisticated basis for characterising relationships between priority species and priority river habitat. It should allow better understanding of where river biodiversity hotspots are related to habitat naturalness and therefore compatible with priority habitat objectives. Equally, it should highlight any instances where such hotspots are related to impacts on habitat naturalness and where more thought needs to be given about how to accommodate existing biodiversity interest in planning restoration of natural habitat function.

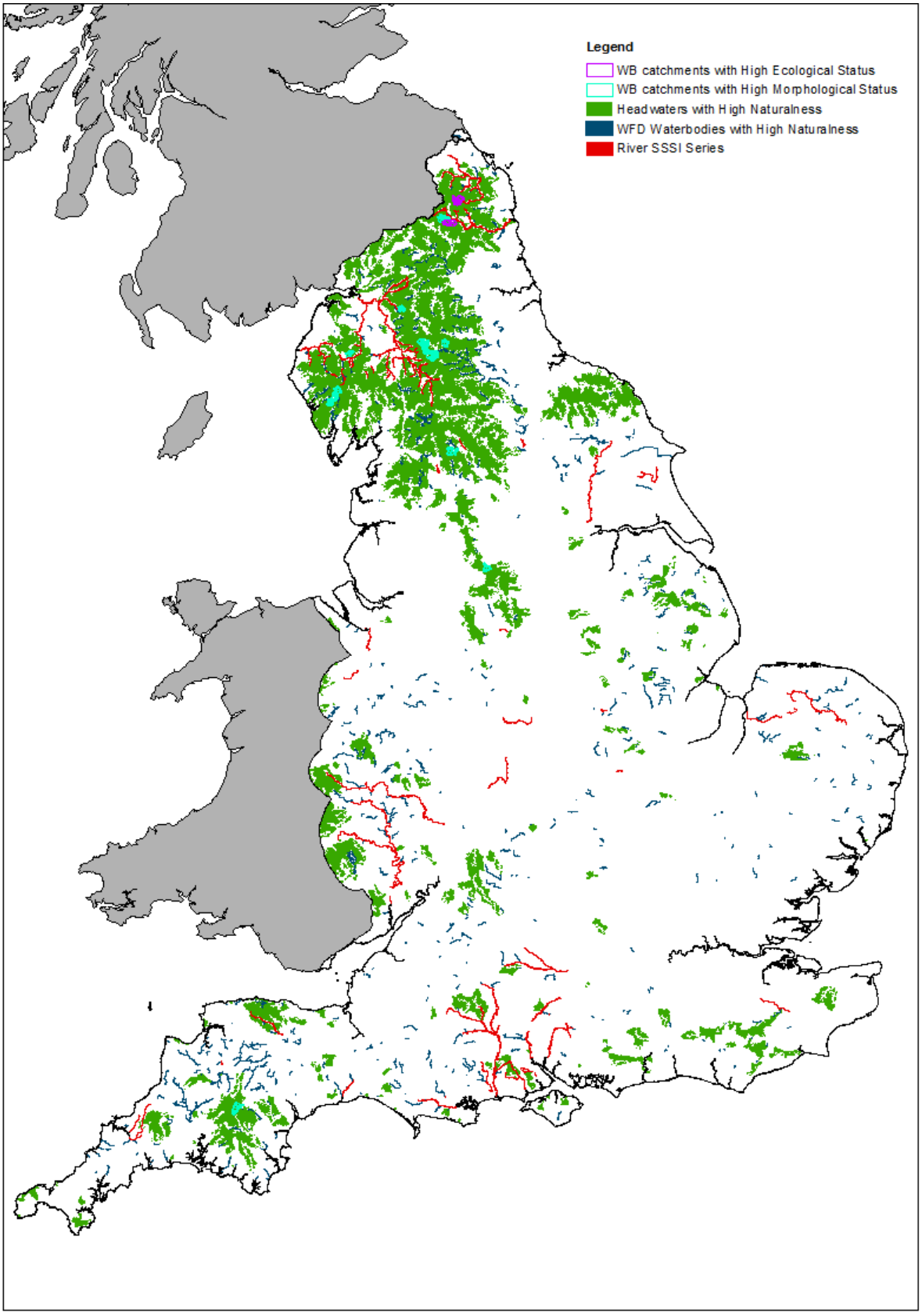

Figure 11. Overlaps between the priority river habitat map and the river SSSI series.

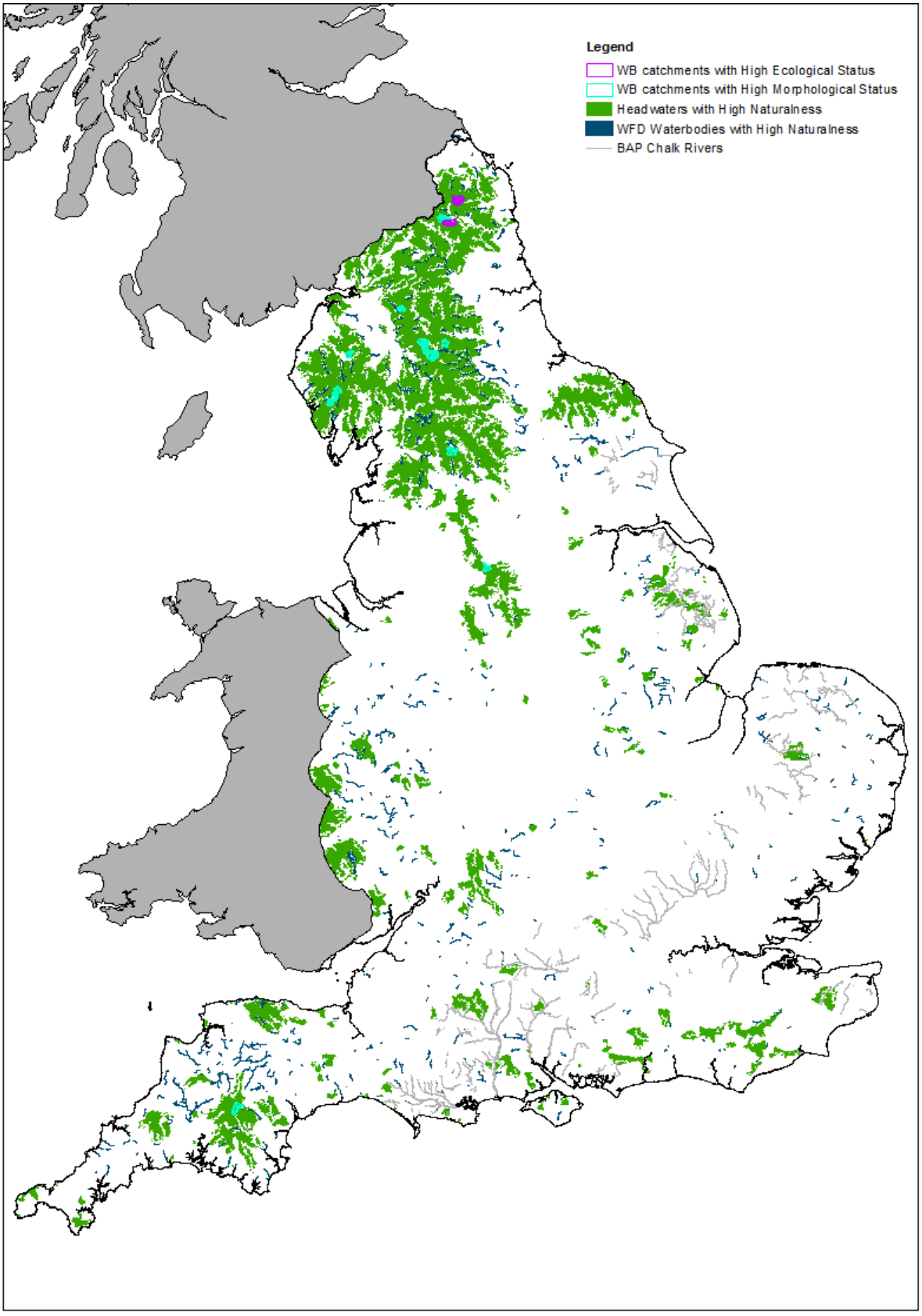

Figure 12. Associations between the priority river habitat map and the chalk river habitat resource.

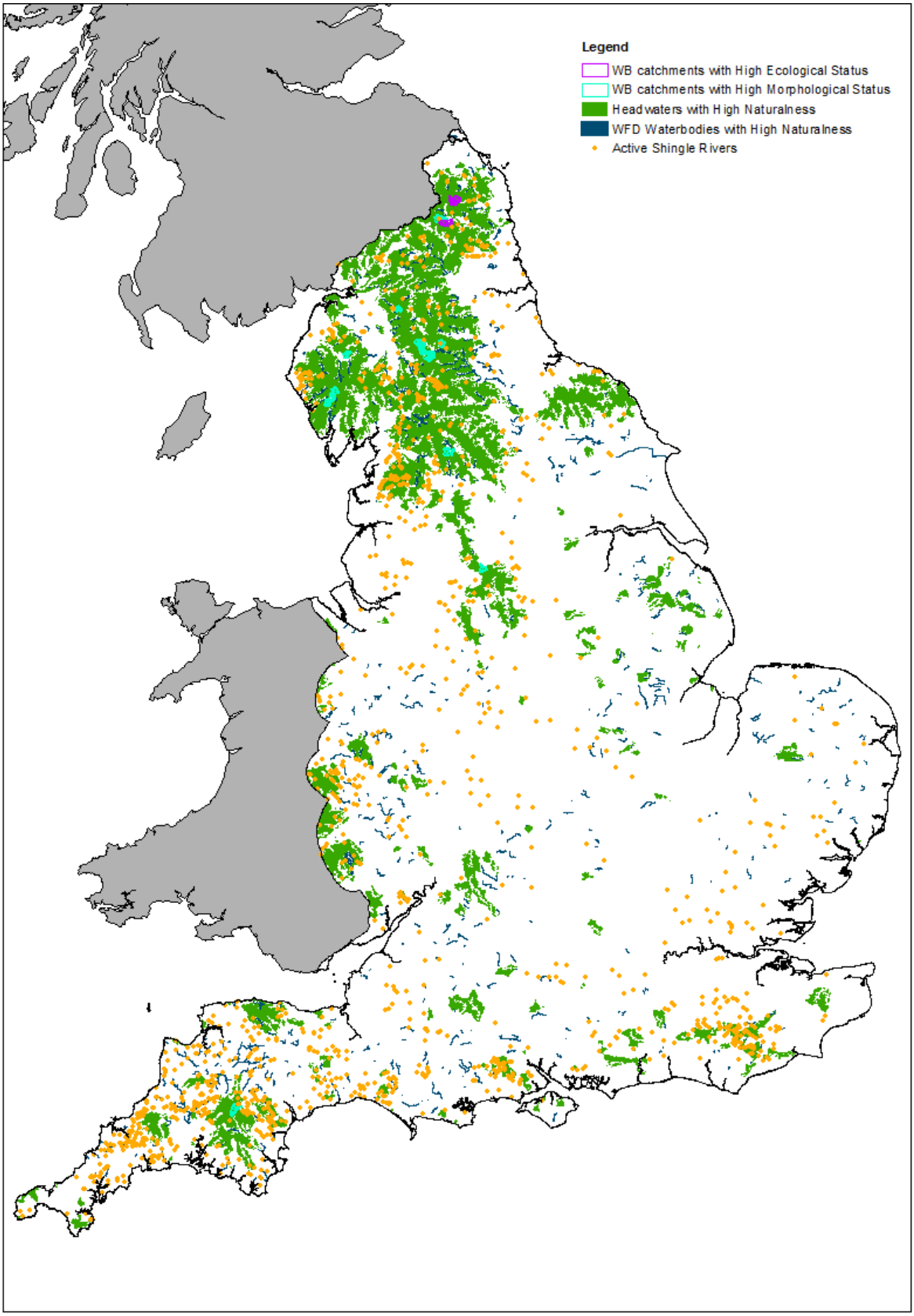

Figure 13. Associations between the priority river habitat map and River Habitat Survey sites exhibiting characteristics of active shingle rivers.

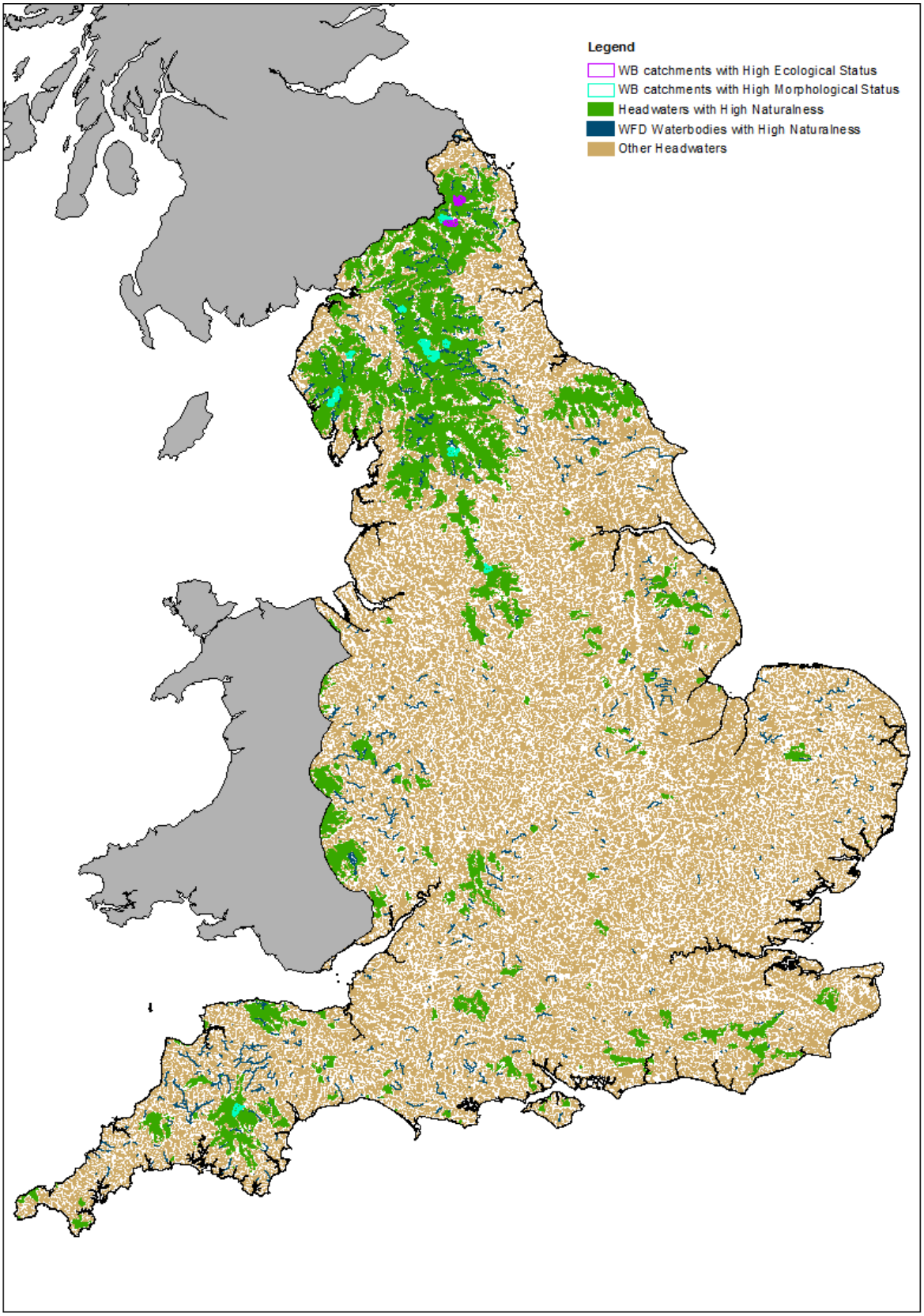

Figure 14. Associations between the priority river habitat map and the headwater habitat resource.

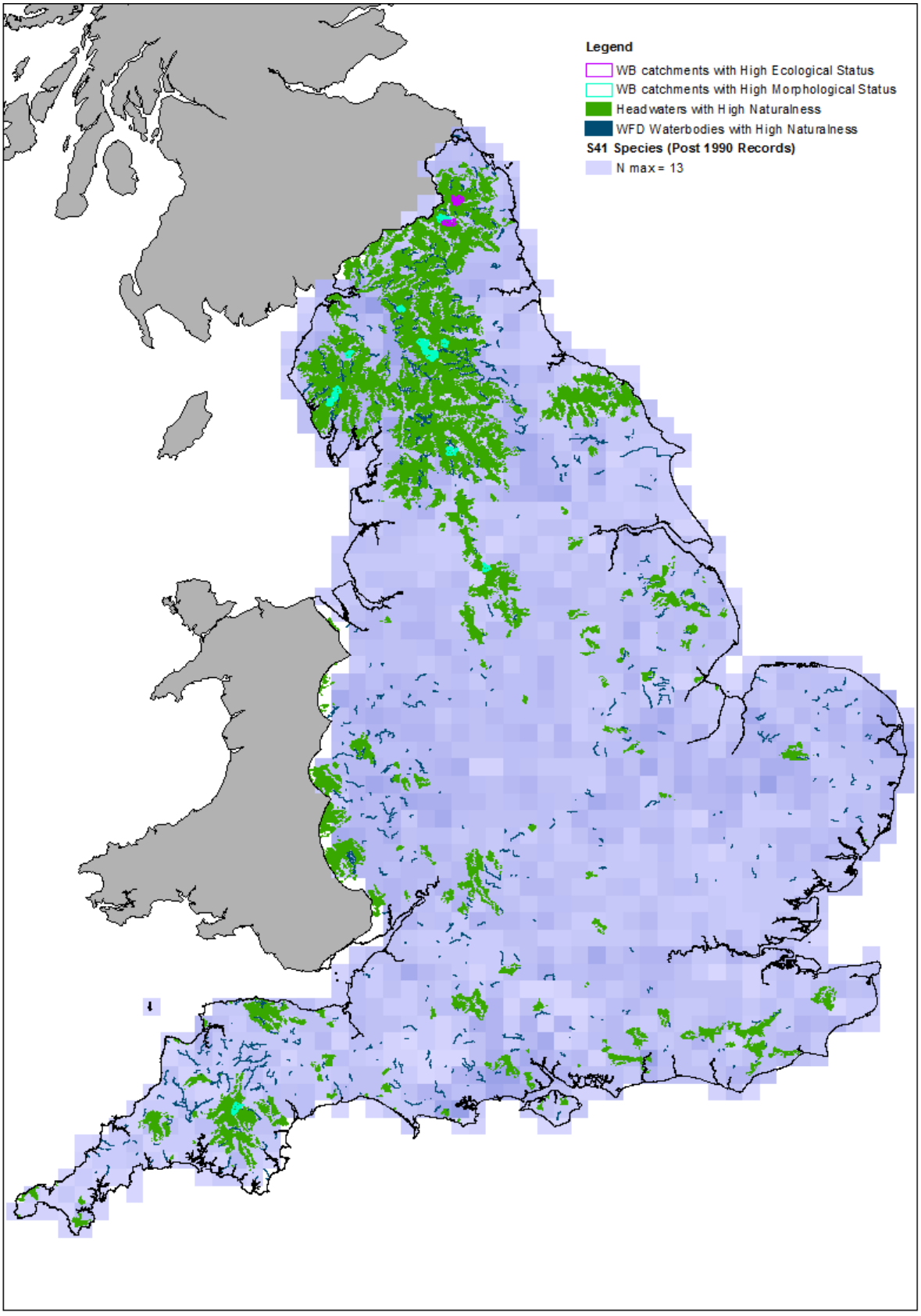

Figure 15. Associations between the priority river habitat map and recorded numbers of river-related priority species (on Section 41 of the CROW Act).

5. Using the priority habitat map in decision-making

The map should be used to identify where preventative measures are needed to protect river systems against losses of naturalness. This is particularly relevant to local planning authorities and EA and NE staff involved in relevant consenting activities, particularly those connected with the WFD. In WFD terms, very few rivers are considered to be at high ecological status in England, since one or more of the criteria used to define hes (physical habitat condition, flow regime, water quality status, absence of non-native species) are not compliant. This means that very few English rivers receive the added protection against deterioration that hes provides. The priority habitat map adds value to the WFD by providing additional recognition of our most natural rivers.

Figure 16 is a version of the priority habitat map that can help with deciding where highly targeted and appropriate restoration measures might be taken to address impacts on natural processes and restore these rivers to the most natural expressions of river habitat possible. It shows the single component of habitat integrity that is preventing each water body from attaining high levels of naturalness overall (NB this cannot be used in headwaters because suitable data do not exist). This provides an important basis for maximising the benefits of restoration measures, since effort is focused on removing specific constraints to a river that is otherwise functioning relatively naturally. This information is relevant to EA and NE staff, local NGOs and other stakeholders seeking to identify and implement suitable restoration measures on these rivers (for instance through agri-environment funding or other mechanisms).

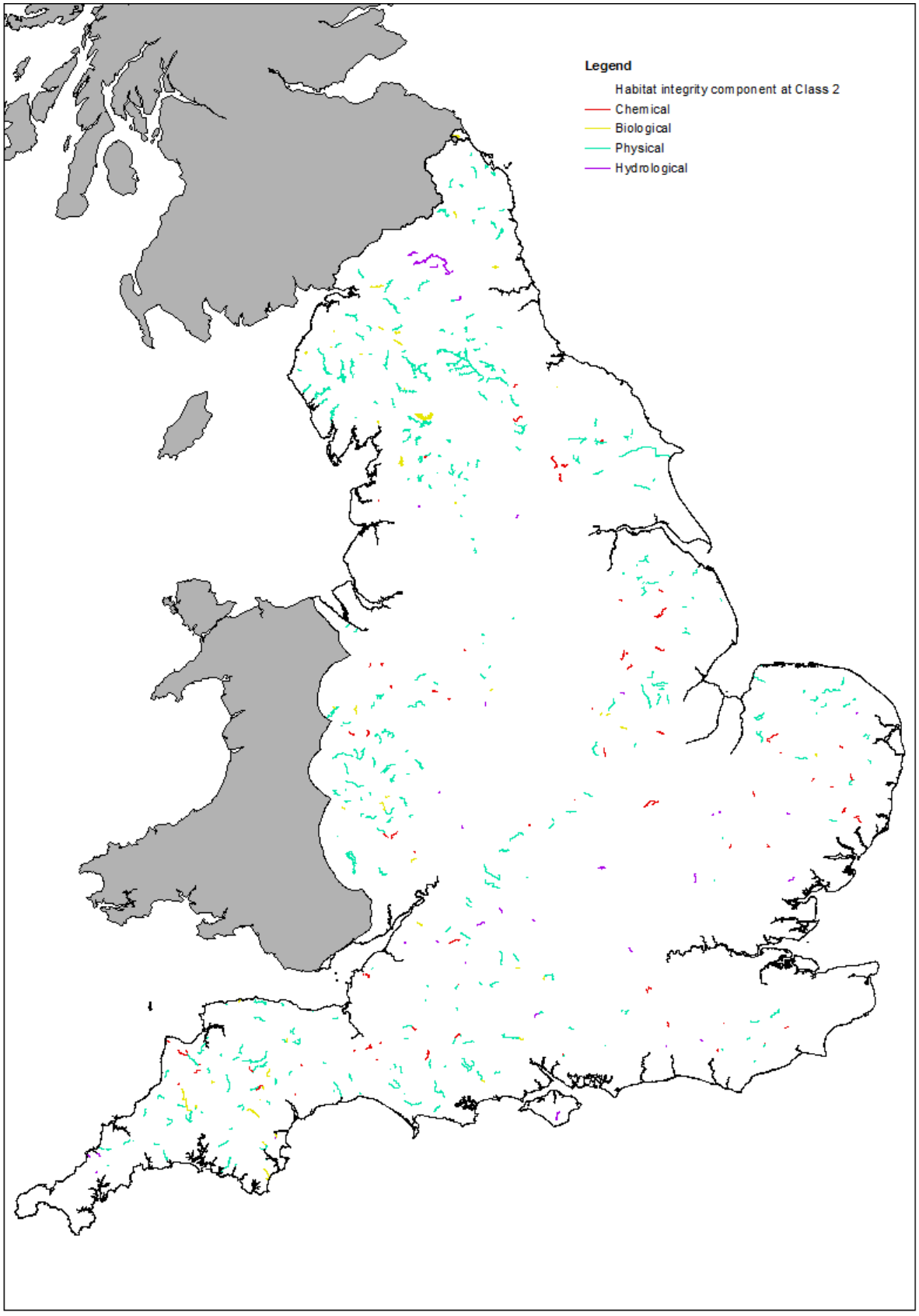

Figure 16. A version of the priority river habitat map showing waterbodies coloured to indicate components of habitat integrity that might be targeted for improvement.

6. Priorities for restoring rivers that do not feature on the priority habitat map

Under the Water Framework Directive, there are many factors to take into consideration when prioritising rivers for action. A cost-benefit analysis of measures is undertaken within the river basin management planning process, using a scoring system to evaluate the benefit of each measure from a number of different objectives. A similar process exists for evaluating potential schemes for agri-environment funding. Advice on prioritising rivers that do not feature on the priority habitat map needs to be compatible with these scoring processes.

The priority habitat map was constructed from a water body-scale evaluation of naturalness. However, it is more appropriate to look at the naturalness of whole river systems with a view to prioritising restoration actions at a catchment-scale. Taking this catchment-based approach, it would be sensible to prioritise degraded water bodies that sit within river systems containing water bodies on the priority habitat map. This could maximise the potential for recolonisation from the least impacted parts of the river network.

In the context of WFD and agri-environment scheme targeting, a score might be assigned to water bodies that are adjacent to a water body or headwater area shown on the priority habitat map.

It makes sense for the river types that form part of the UK BAP priority habitat definition but do not feature on the priority habitat map to be a focus for restoration action. This would mean, for example, that much of the chalk river resource would be a priority for action. Difficulties arise when considering headwater streams, since these form the majority of the river network – not all of these can be a priority for action, but at the same time they generally need to receive much more protection (they are not monitored under the WFD and their condition is not generally considered in WFD decision-making).

In the context of WFD and agri-environment scheme targeting, a score might be assigned to water bodies that do not feature on the priority habitat map but are chalk river, active shingle river or headwater stream, or naturally support Ranunculion/Batrachion vegetation. Figure 17 indicates chalk rivers and active shingle rivers (as far as we can identify them with available data) that do not feature on the priority habitat map. Given the high conservation value attached to chalk rivers in particular, this map is an important tool for targeting restoration activity for priority river habitat objectives and should be considered of equal importance to the priority habitat map itself.

There are considerable numbers of rivers on this map, indicating the widespread occurrence of river types included in the priority habitat definition (of which chalk and active shingle rivers are only two) – other operational considerations will be important in prioritising actions within these rivers. The map shows headwater areas containing rivers with active shingle characteristics, which goes some way to highlighting priority headwater streams for restoration. However, as mentioned in Section 4, headwaters occurring upstream of rivers featuring on the priority habitat map should also be considered a particular priority for restoration where needed.

River SSSIs have their own programme of remedies to address impacts as far as possible, irrespective of whether they feature on the priority habitat map. Required measures are flagged up through the SSSI remedies programme and do not require reiteration here.

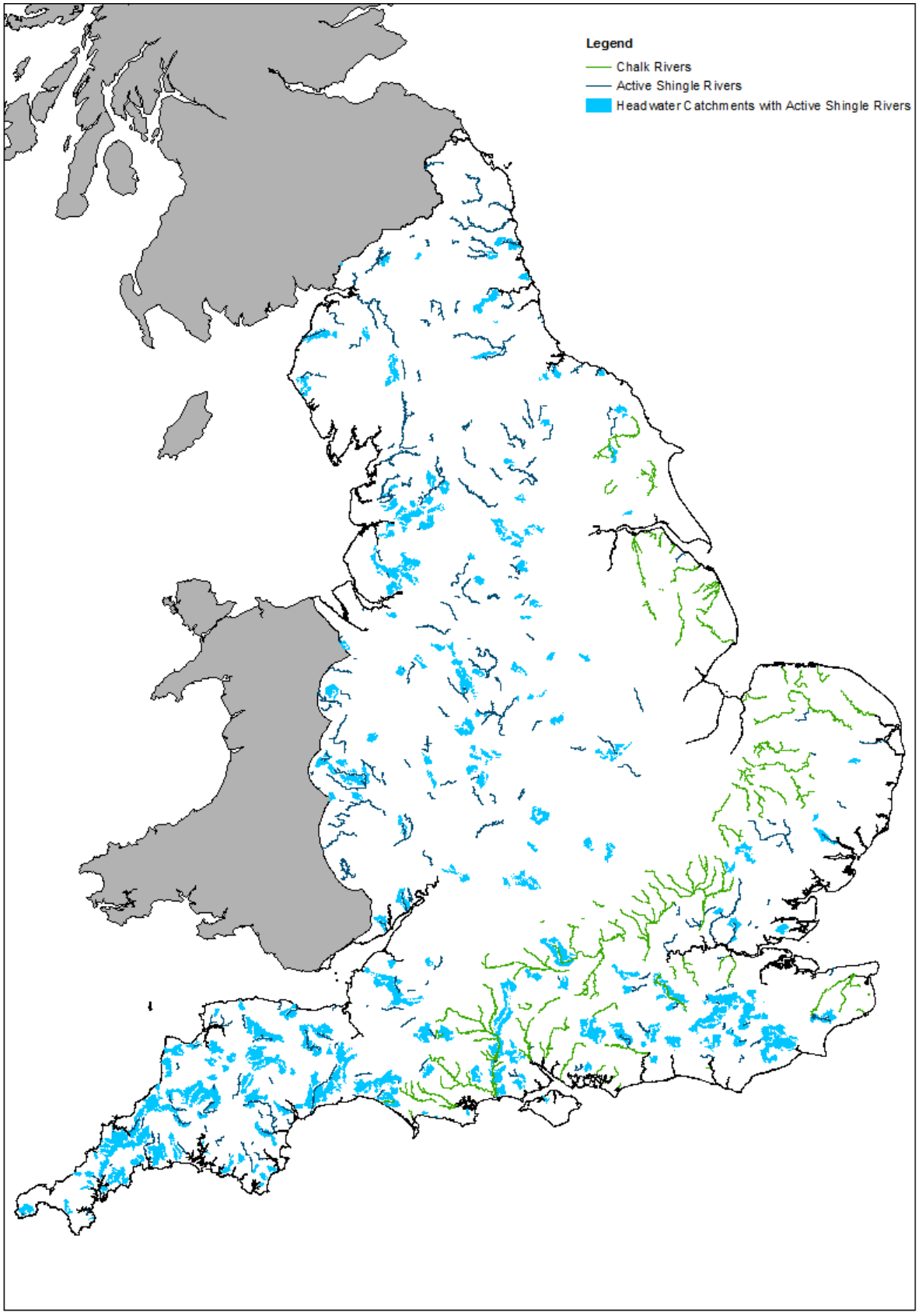

Figure 17. Chalk rivers and active shingle rivers that do not feature on the priority river habitat map and which should be considered a priority for restoration action.

7. Recognising the value of measures in the wider river network

In practical terms, there are socio-economic constraints on the extent to which natural processes can be restored in rivers. These vary widely depending on population density and the spatial distribution of different human activities. Some are immovable for example urban areas and essential infrastructure (major roads and railways). The extent to which any river can operate to natural processes will depend on site-specific circumstances.

For the purposes of prioritising activities in relation to Biodiversity 2020, any measures that seek to restore natural riverine processes should be considered as a contribution to restoring rivers towards the levels of naturalness associated with the priority river habitat. Table 2 provides examples of measures that restore natural processes and those that do not. This can be used to help identify measures that would contribute to the objectives of priority river habitat.

In the context of WFD and agri-environment scheme targeting, a score might be assigned to any measure that is based on restoring natural riverine processes. In addition, a negative score may be assigned to any measure that does not work with natural processes.

Table 2. The relationship between key restoration measures and natural processes.

Measures restoring natural processes	**Measures not restoring natural processes**
Removal of in-channel structures (weirs, dams)	Construction of fish passes
Removal of bank revetments to restore lateral channel movement	Flow augmentation
Measures to restore natural river channel dimensions and flooding of the floodplain, associated with restoration/re-creation of floodplain habitats	Reducing the width/depth of the river channel to fit impacted flows
Restoration of the natural flow regime by land use/land management change (e.g. restoration of drained upland peat areas) and reducing abstraction/flow modifications	Increasing tree shading to mask eutrophication effects
Restoration of more natural nutrient and sediment regimes by controlling problems at or near source (e.g. restoration of drained upland peat areas, reduced fertiliser use, nutrient reductions in effluents)	Establishment of new in-channel control structures to manage flooding or generate power
Restoration of a diverse semi-natural riparian zone, including patchy cover of trees, shrubs and herb-rich swards of varying heights	Close bankside fencing
Restoration of ephemeral in-channel habitats, including naturally intermittent headwater streams and natural areas of intermittently exposed riverine sediments (shoals, shallow margins)	Dredging
Restoration of wetlands, backwaters and oxbow lakes in the floodplain, in hydrological connectivity with the river.	
Retention of large woody debris in the channel	Removal of fallen trees.
Control of non-native species associated with rivers	

8. Recommendations for further national analysis

a) Local refinements

It is recommended that local staff use the shapefile version of the priority habitat map to generate a local map of priority habitat, adding in suitable rivers and potentially excluding those deemed insufficiently natural based on local knowledge. This would sensibly be led by local EA biodiversity staff, in liaison with local stakeholders. The national version of the map should be updated following this local exercise, which might take 6 months to conclude, and would require some staff resource to finalise and disseminate.

Local screening for highly natural streams (particularly within headwater areas featured on the priority habitat map) is also strongly recommended, as there is no other way to reliably identify such streams. This would require dedicated survey, of the type undertaken in Sussex (Holmes 2010). Such work would contribute to both the SSSI notification strategy and the refinement of the priority habitat map.

b) National analysis

The spatial distribution of some of the river types mentioned in the UK BAP definition of priority river habitat, namely active shingle rivers and rivers with Ranunculion/Batrachion vegetation, is not well defined. Available datasets are based on patchy survey data, and such surveys do not identify degraded examples of type that should be highlighted for restoration purposes. A national modelling approach to predicting the reference distribution of these river types would provide a more robust foundation for habitat mapping. This should use predictor variables such as catchment topography, distance from source and stream gradient that are not affected by anthropogenic impacts, and the model should be based on sites that are not impacted to an extent that obscures their type-specific characteristics. Further work to refine our understanding of the spatial distribution of the chalk river resource, to capture chalk headwater streams (including winterbournes) would also be beneficial, particularly in the light of recent headwater surveys in the South Downs.

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