Cyfoeth Naturiol Cymru
Natural Resources Wales

River Habitat Survey in Wales: analysis for Area Statements 2018

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1. Crynodeb Gweithredol

Cyfoeth Naturiol Cymru (CNC) yw'r sefydliad sydd wedi mabwysiadu swyddogaethau datganoledig Cyngor Cefn Gwlad Cymru, Comisiwn Coedwigaeth Cymru ac Asiantaeth yr Amgylchedd Cymru. Mae Adran 11 o Ddeddf yr Amgylchedd (Cymru) 2016 yn mynnu bod Cyfoeth Naturiol Cymru yn paratoi ac yn cyhoeddi 'datganiadau ardal' er mwyn helpu i weithredu'r polisi adnoddau naturiol cenedlaethol. Caiff yr amgylcheddau daearol a dŵr croyw eu rhannu'n chwe ardal fel a ganlyn: gogledd-orllewin Cymru, gogledd-ddwyrain Cymru, canolbarth Cymru, de-ddwyrain Cymru, de-orllewin Cymru a chanol de Cymru.

Er mwyn cefnogi a llywio'r gwaith o ddatblygu'r datganiadau ardal, bydd Cyfoeth Naturiol Cymru yn llunio proffiliau ecosystem sy'n cwmpasu prif ddosbarthiadau'r cynefinoedd ar gyfer pob ardal y datganiadau. Bydd y proffiliau hyn yn crynhoi'r wybodaeth ar sail maint, ansawdd ac amrywiaeth, a byddant yn darparu crynodeb o'r prif faterion a chyfleoedd ar gyfer gwella ansawdd, gwydnwch a chysylltedd y cynefin. Mae'r prosiect hwn yn canolbwyntio ar ddadansoddi data Arolwg Cynefinoedd Afonydd er mwyn llywio'r proffiliau o ecosystemau dŵr croyw.

Rhwng 1994 a 1996, cwblhawyd Arolwg Cynefinoedd Afonydd sylfaenol ledled Cymru a Lloegr er mwyn llunio sylfaen ar gyfer ansawdd cynefinoedd afonydd. Ym mhob 10km sgwâr yng Nghymru a Lloegr, dewiswyd tri safle Arolwg Cynefinoedd Afonydd ar hap er mwyn cynnal arolwg arnynt, sef 4,555 o safleoedd i gyd (613 yng Nghymru). O 2007 i 2008, ailadroddwyd yr arolwg sylfaenol cenedlaethol hwn i asesu'r newid mewn ansawdd ac amrywiaeth hydromorffolegol (704 o safleoedd yng Nghymru allan o 4,848).

Mae'r adroddiad presennol yn cyflwyno dadansoddiadau o ddata'r ail Arolwg Cynefinoedd Afonydd sylfaenol yn 2007–08 er mwyn cymharu (a) safleoedd yng Nghymru a Lloegr a (b) safleoedd yn chwe ardal ddaearol y datganiadau yng Nghymru. Mae canlyniadau'r dadansoddiadau yn dangos y canlynol:
a) Yn gyffredinol, mae gan Gymru lefelau uwch o ansawdd, naturioldeb ac amrywiaeth cynefinoedd, yn ogystal â dangos lefelau uwch o ansawdd cynefinoedd (yn y sianel ac ym mharth y glannau) a lefelau is o beirianneg nag sy'n amlwg yn Lloegr. Canlyniadau'r dadansoddiad
b) Mae gan ardaloedd y canolbarth, y de-orllewin a'r gogledd-orllewin ansawdd a naturioldeb cynefin cyffredinol uwch a lefelau is o bwysau o'u cymharu ag ardaloedd y gogledd-ddwyrain, canol y de a'r de-ddwyrain. Roedd amgylcheddau afonydd yn y tair ardal olaf wedi'u nodweddu gan bresenoldeb a chyfradd uwch o nodweddion peirianyddol, yn ogystal â phwysau yn sgil arferion defnydd tir ym mharth y glannau a'r cyffiniau, sy'n arwain at amrywiaeth a naturioldeb is ac asedau naturiol is cyfatebol. Tynnwyd sylw at blanhigion goresgynnol fel problemau ychwanegol posibl ar draws yr holl ardaloedd. Sgoriodd yr holl ardaloedd yn uchel o ran asedau naturiol hefyd, gyda phresenoldeb nodweddion prin a gwlyptiroedd.

Mae'r dull a ddefnyddiwyd yn dangos sut y gellir defnyddio data'r Arolwg Cynefinoedd Afonydd o'r ail arolwg sylfaenol i lunio ystadegau cryno er mwyn cymharu ansawdd amgylcheddol ac asedau naturiol Cymru a nodi cyfleoedd ar gyfer amddiffyn, gwella ac adfer. Gellid cyfuno'r dadansoddiadau hyn â dadansoddiad o setiau data biolegol, ansawdd dŵr, defnydd tir a pheirianyddol eraill. Mae potensial mawr ar gyfer cyfuno

setiau data o'r fath ac mae'r adroddiad hwn yn darparu fframwaith dadansoddol syml trwy ddefnyddio tablau a graffiau sy'n hawdd ei ddehongli.

Mae'r dadansoddiadau hyn hefyd yn dangos defnyddioldeb y gwaith o sefydlu arolygon sylfaenol o gynefinoedd. Yn wreiddiol, y bwriad oedd i arolygon o'r fath gael eu cynnal bob deg mlynedd ac argymhellir y dylid cynnal arolwg yn 2019 er mwyn diweddaru'r asesiad yn 2007–08.

Gwneir yr argymhellion canlynol:

- Ymgorffori canlyniadau'r dadansoddiadau hyn yn y datganiadau ardal ledled Cymru er mwyn nodi cyfleoedd ar gyfer amddiffyn, gwella ac adfer.
- Defnyddio allbynnau'r tablau a'r adroddiadau ardal yn y gronfa ddata gysylltiedig i gynhyrchu dadansoddiadau ar bwysau, effeithiau ac asedau amgylcheddol ym mhob ardal.
- Ystyried potensial yr Arolwg Cynefinoedd Afonydd i ddarparu sail dystiolaeth strwythuredig ar gyfer effaith strwythurau artiffisial, gan gynnwys gwrthgloddiau, cwlfertau a choredau (sy'n bresennol mewn cyfrannau uchel mewn rhai ardaloedd), ar gynefinoedd a phrosesau hydromorffolegol. Gellid defnyddio hyn er mwyn asesu addasiadau cynlluniedig a gwaith adfer.
- Croesgyfeirio canlyniadau'r Arolwg Cynefinoedd Afonydd gyda setiau data eraill ledled Cymru, gan gynnwys dosbarthiadau o dan y Gyfarwyddeb Fframwaith Dŵr.
- Ystyried y potensial i Cyfoeth Naturiol Cymru ddefnyddio data'r Arolwg Cynefinoedd Afonydd i lywio'r elfen hydromorffolegol o dan y Gyfarwyddeb Fframwaith Dŵr.
- Cwblhau trydydd Arolwg Cynefinoedd Afonydd yn 2019 ar amlder tebyg i'r ail arolwg yn 2007–08 ledled Cymru er mwyn asesu cyfeiriad a dwysedd y newid.
- Ystyried y ffyrdd eraill o gymhwyso'r Arolwg Cynefinoedd Afonydd yng Nghymru, megis y canlynol:
  Y Gyfarwyddeb Fframwaith Dŵr ac asesiadau geomorffolegol
  Asesiadau hydromorffolegol a geomorffolegol o ddalgylchoedd ac afonydd
  Cynllunio, darparu a monitro gwaith adfer afonydd
  Asesiadau manwl o gyflwr cynefinoedd rhywogaethau
  Rheoli gwaddod mân
  Rheoli pysgodfeydd (e.e. eogiaid a brithyllod y môr)

2. Executive Summary

Natural Resources Wales (NRW) is the organisation that has adopted the devolved functions of the Countryside Council for Wales, Forestry Commission Wales and Environment Agency Wales. Section 11 of the Environment (Wales) Act 2016 requires NRW to prepare and publish 'Area statements' for the purpose of helping to implement the national natural resources policy. The terrestrial and freshwater environment will be divided into the following six areas: North-west Wales, North-east Wales, Mid Wales, South-east Wales, South-west Wales and South-central Wales.

To support and inform the development of Area Statements, NRW is producing ecosystem profiles covering the main habitat groupings for each statement area. These profiles will summarise information on extent, condition and diversity, and provide a synopsis of the key issues and opportunities for improving habitat condition, resilience and connectivity. This project focuses on analysis of River Habitat Survey (RHS) data to feed into the freshwater ecosystem profiles.

From 1994 to 1996 a baseline River Habitat Survey was carried out across England and Wales in order to produce a baseline of river habitat quality. In every 10km square in England and Wales, three RHS sites were randomly selected to be surveyed, totalling 4555 sites (613 in Wales). In 2007 to 2008, this national baseline survey was repeated to assess change in hydromorphological quality and diversity (704 sites in Wales out of 4848).

The present report presents analyses of the 2007-2008 repeat baseline RHS data to compare (a) sites in England and Wales and (b) sites in the six terrestrial statement areas in Wales. Results of analyses shows that:
a) Wales generally has higher levels of habitat quality, naturalness and diversity and also exhibits higher levels of habitat quality (both in-channel and within the riparian zone) and lower levels of engineering than are evident in England.
b) Mid, South-west and North-west areas have higher overall habitat quality and naturalness and lower levels of pressure compared to North-east, South-central and South-east areas. River environments in the latter three areas were characterised by a higher presence and extent of engineering features, and pressures from land use practice near and in the riparian zone, resulting in lower diversity and naturalness, with corresponding lower natural assets. Invasive plants were highlighted as potential additional issues across all areas. All areas also scored high in terms of natural assets with the presence of rare features and wetlands.

The approach taken demonstrates how RHS data from the repeat baseline survey can be used to produce summary statistics to compare the environmental quality and natural assets of Wales and identify opportunities for protection, enhancement and restoration. These analyses could be combined with an analysis of other biological, water quality, land use and engineering datasets. There is great potential for using such datasets in combination and this report provides a simple analytical framework using tables and graphs that are easy to interpret.

These analyses also show the usefulness of establishing random baseline surveys of habitats. Such surveys were originally planned to occur every 10 years and it is recommended that a survey is carried out in 2019 to update the 2007-8 assessment.

Recommendations are made as follows:

- Incorporate the outcomes of these analyses into the Area Statements across Wales in order to **identify opportunities for protection, enhancement and restoration**.
- Use the tabled outputs and the area reports in the associated database to produce analyses of pressures, impacts and environmental assets **within each area**.
- Consider the potential of RHS to provide a structured evidence base for the impact of artificial structures including bank revetment, culverts and weirs (which are present in high proportions in some areas) on habitats and hydromorphological processes. This could be used both to assess **planned modifications and restoration work**.
- **Cross-reference** the outcomes of RHS with other datasets across Wales including classification under the Water Framework Directive (WFD).
- Consider the potential for Natural Resources Wales to use RHS survey data to inform the **hydromorphology element under WFD**.
- Carry out a repeat RHS survey in 2019 at similar frequency to the 2007-8 repeat survey across Wales to **assess the direction and intensity of change**.
- Consider other applications of RHS in Wales such as:
  WFD and geomorphological assessments;
  Catchment and river hydro- and geomorphological assessments;
  River restoration planning, delivery and monitoring;
  Detailed species habitat condition assessment;
  Fine sediment management;
  Fisheries management (e.g. salmon and trout).

3. Introduction

Natural Resources Wales (NRW) is the organisation that has adopted the devolved functions of the Countryside Council for Wales, Forestry Commission Wales and Environment Agency Wales. These functions include the management and monitoring of the freshwater environment including protected sites designated under UK and European legislation (SSSIs and SACs) and environmental monitoring for the Water Framework and Nitrates Directives.

Section 11 of the Environment (Wales) Act 2016 requires NRW to prepare and publish statements ('Area statements') for the areas of Wales that it considers appropriate, primarily for the purpose of helping to implement the national natural resources policy. Area statements represent an evidence base to assist in the delivery of the sustainable management of natural resources (SMNR) at a local level across Wales; they will bring together data, information and ways of engaging others to help forge a better understanding of the state and trends of natural resources in an area, the pressures on them, and the benefits they provide.

Area statements will cover all parts of Wales; there will be six covering the terrestrial and freshwater environments, namely North-west Wales (Gwynedd, Ynys Môn and Conwy), North-east Wales (Denbighshire, Flintshire and Wrexham), Mid Wales (Ceredigion and Powys), South-east Wales (Newport, Monmouthshire and the Gwent Valleys Unitary Authorities), South-west Wales (Pembrokeshire, Carmarthenshire, Swansea, Neath-Port Talbot) and South-central Wales (Vale of Glamorgan, Bridgend, Rhondda Cynon Taf, Merthyr, Cardiff, Caerphilly and the southern part of the Brecon Beacons).

To support and inform the development of area statements, NRW is producing ecosystem profiles covering the main habitat groupings for each area. These profiles will summarise information on extent, condition and diversity, and provide a synopsis of the key issues and opportunities for improving habitat condition, resilience and connectivity.

This report focuses on analysis of River Habitat Survey (RHS) data to set Wales into context and feed into the freshwater ecosystem profiles.

4. Methods

4.1. River Habitat Survey (RHS)

RHS is a CEN-compliant (CEN 2004) standard methodology for hydromorphological assessment under the WFD and feature condition assessment under the Habitats Directive that is widely used in the UK and across Europe (Raven et al. 1997). RHS has been applied to more than 25,000 sites in the UK since 1994.

The RHS field method is designed to yield reliable information on the physical structure of a 500m stretch of river in a format suitable for statistical analysis (Fox, Naura & Scarlett 1998). The survey is organised in two major sections: 'spot-checks' and 'sweep-up'. The spot-checks are a series of ten 1m wide transects across the channel at 50m intervals, where bank and channel physical structure, as well as man-made modifications, land use and vegetation structure are recorded in a replicable manner. The 'sweep-up' section, is used to note other habitat components like trees and associated features, flow features, and bank structure. In addition, background map-based information on altitude, slope, distance from source, height of source, solid and drift geology, flow category and water quality class are also collected.

RHS data collected at spot-checks and during the sweep-up are used to calculate the following series of quality scores and indices (Table 1 and Fig. 1):

- **Habitat Modification Score** (HMS) quantifies the extent, potential impact and persistence of engineering structures on river channels, banks and riparian zones (Walker 2005). It is categorised into five classes representing increasing levels of engineering impact, from semi-natural to severely modified (Appendix 1). The HMS is split into sub-scores describing different engineering structures: culverts; bridges; outfalls and deflectors; bank and bed reinforcement; bank and bed resectioning; berms and embankments; weirs, dams and sluices; fords; poaching.
- **Habitat Quality Assessment** (HQA) scores the occurrence and diversity of natural habitat features, land uses and floodplain features, such as channel substrate types, riffles, pools, woodland and wetland (Raven et al. 1998). The score provides an overall site assessment of habitat diversity and conservation value. To be meaningful, HQA scores need to be interpreted within the context of sites of similar type.

  HQA scores are classified into five quality bands following a '**context analysis**'. A context analysis consists of comparing a site HQA to the distribution of HQA scores for sites of similar type using a nearest neighbour approach. The method, approved by the Environment Agency, uses a statistical recombination of map-derived attributes representing known drivers of geomorphological change (i.e. specific stream power and shear stress; Jeffers, 1998) to select 150 sites of similar type. A site is then assessed according to its position within the distribution of HQA scores for the 150 sites. The bottom quintile of the distribution represents very low habitat quality and the top quintile very high quality (all relative).

- **River Habitat Quality** (RHQ) index combines HQA and HMS classes into one index representing the overall quality and integrity of river habitats (Appendix 1) (Walker 2005).
- **Channel Substrate Index** (CSI), **Flow Regime Index** (FRI), **Channel Vegetation Index** (CVI) and **Geomorphic Activity Index** (GAI) are derived using RHS spot-check data on channel substrate, flow-types, channel vegetation structure, erosion and deposition features, riffles and pools (Naura et al. 2016), (Appendix 2). The indices represent natural hydromorphological dimensions in British rivers.
- **Hydromorphological Impact Ratio** (HIR) combines individual HIRs for four hydromorphological indices/dimensions (CSI, FRI, GAI and CVI) to assess departure from natural condition and impact. The composite HIR varies from 1 (no impact/semi-natural condition) to 5 (very high impact), see Appendix 3.
- **Riparian Quality Index** (RQI) combines information on bankface and banktop vegetation structure, bank material and modification in an assessment of riparian vegetation complexity, naturalness and continuity (Appendix 4).

Figure 1. Examples of Welsh sites with index values. Top left: Unnamed river on the Dyfi catchment; Top right: Afon Clarach; Bottom left: tributary of Afon Camlad; Bottom right: Afon Dwyfor.

Table 1. RHS derived indices.

Indices	RHS index	Range	Description
Habitat quality indices	Habitat Modification Score (**HMS**)	0 to 6000+	Quantifies the extent, potential impact and persistence of engineering structures
	HMS class	1 (semi-natural) to 5 (severely modified)	Classification of HMS score into 5 categories using set boundaries
	Habitat Quality Assessment score (**HQA**)	0 to 100	Quantifies the diversity and naturalness of habitat features
	HQA class	1 (very low) to 5 (very high)	Classification of HQA score by comparing to sites of similar types using a context analysis.
	River Habitat Quality (**RHQ**) index	I (excellent) to V (very poor)	Classification combining HMS and HQA classes and representing overall habitat quality and conservation value
	Riparian Quality Index (**RQI**)	1 (very low) to 5 (very high)	Quantifies the complexity, continuity and naturalness of the riparian vegetation
Hydromorphological indices	Channel Substrate Index (**CSI**)	-2 (silt) to 1 (boulders)	Represents the average substrate size
	Flow Regime Index (**FRI**)	-1 (glide) to 2 (waterfall)	Represents the average flow-type
	Channel Vegetation Index (**CVI**)	-2 (free floating vegetation) to 1 (mosses and lichens)	Represents the dominant vegetation types
	Geomorphic Activity Index (**GAI**)	-1 (no activity sign) to 1.6 (high activity)	Represents the level of geomorphic activity (i.e. erosion and deposition)
	Hydromorphological Impact Ratio (**HIR**)	1 (low impact) to 5 (very high impact)	Quantifies the level of departure from natural state of CSI, FRI, CVI and GAI combined

4.2. RHS baseline survey

From 1994 to 1996 and from 2007 to 2008, RHS sites in England and Wales were selected using a stratified random sample design. The stratification of the sample was done to enable a good spatial coverage of the countries and meaningful comparisons between geographical areas and regions (EA, 2011).

In 1994-1996, the basis for the sampling was the 250k scale river network and sites were selected using the Ordnance Survey (OS) 10km grid. Three RHS sites were selected randomly using a smaller 2km grid within each 10km square resulting in a total of 4555 sites. In 2007-8, the same process was repeated but only two sites were selected on the 250k network and one site was selected on river stretches from the 50k network outside the 250k network boundaries. The split in the sampling strategy was done so as to account for headwater streams which were under-represented in the previous sample. In 2007-8, sites from the Isle of Man and from small coastal areas were added to the survey. The 2007-8 survey therefore represents a combination of sampling strategies carried out at different scales and stratified per 10km squares. It resulted in a slightly larger sample of 4848 sites.

4.3. Data collation and analysis

The data used were sourced from the NRW and EA databases. They were analysed and summarised to provide a range of Indices on habitat quality, natural assets, features, pressures and impacts.

Data in this report are presented either as pie charts, graphs or tables. Tables were colour-coded using conditional formatting procedures in Excel so as to represent **differences between areas** using colour gradients (Fig. 2). Different colour gradients were used for pressures and impacts (green-yellow-red for tables 2 to 5) and natural assets features (yellow-green for tables 6 to 10).

Figure 2. Example of interpretation of colour-coded tables (Tables 2 to 5). Records for weirs (in the black frame) are coloured according to the relative occurrence of the structure across areas, from low relative occurrence in green (North-west and South-east Wales) to high relative occurrence in red (South-central Wales).

Welsh areas	N	Weirs	Bridges	Culverts	Realigned	Deepened	Re-sectioned	
Mid Wales	220	6%	3%	20%	14%	14%	27%	4
North-east Wales	55	7%	4%	27%	18%	18%	33%	6
North-west Wales	161	4%	5%	27%	27%	22%	33%	6
South-east Wales	47	4%	13%	19%	45%	36%	55%	4
South-central Wales	47	13%	17%	30%	53%	23%	62%	7
South-west Wales	174	7%	6%	22%	30%	22%	47%	5

5. Wales in Context

During the repeat baseline survey of 2007-2008, a total of 4848 sites were surveyed in England, Wales and the Isle of Man (Fig. 3).

Figure 3. Location of sites in England and Wales from the 2007-8 RHS baseline survey of English and Welsh rivers.

Levels of modification were shown to be lower in Welsh rivers compared to England with 16% of sites in the 'semi-natural' class in Wales compared with nearly 8% in England (Fig. 4). The proportion of sites with high HQA was also significantly higher in Wales (47%) compared to England (35%, Fig. 5). It follows that overall River Habitat Quality was higher in Welsh rivers compared to those in England, with 21% of sites falling within the 'Excellent' and 'Good' categories in Wales compared to 11% in England denoting lower levels of engineering and greater structural diversity (Fig. 6). The proportion of sites falling into the lowest category in England (41.7%) was more than double that of Wales (17%).

Figure 4. Habitat Modification class distribution in Wales and England (2007-8 RHS baseline survey).

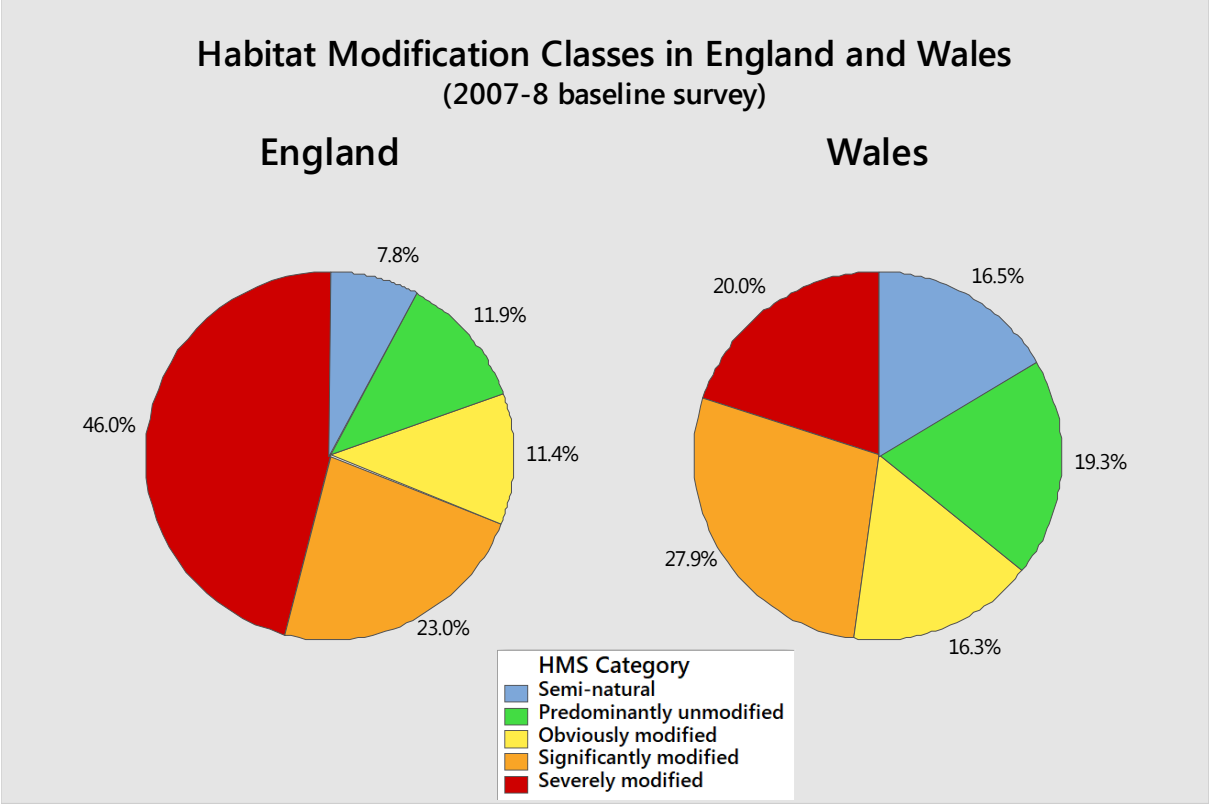


Figure 5. Habitat Quality Assessment (HQA) class distribution in Wales and England (2007-8 RHS baseline survey).

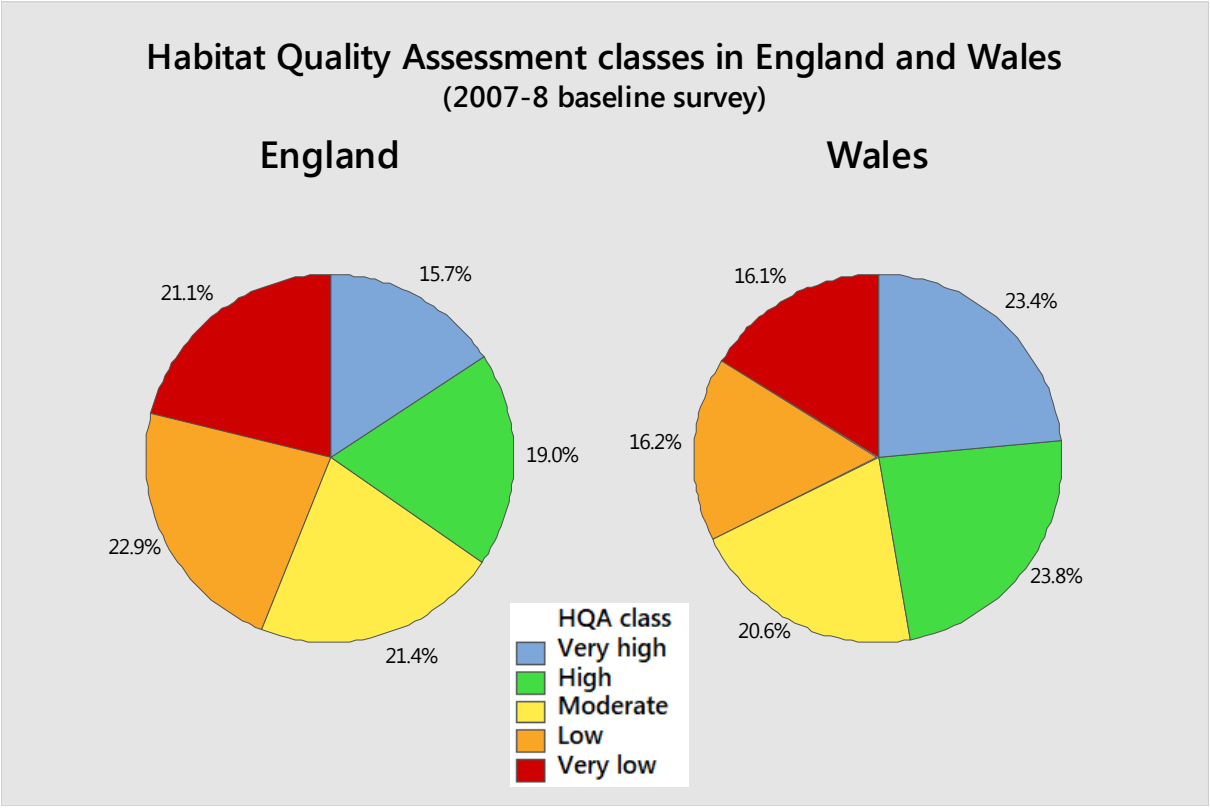
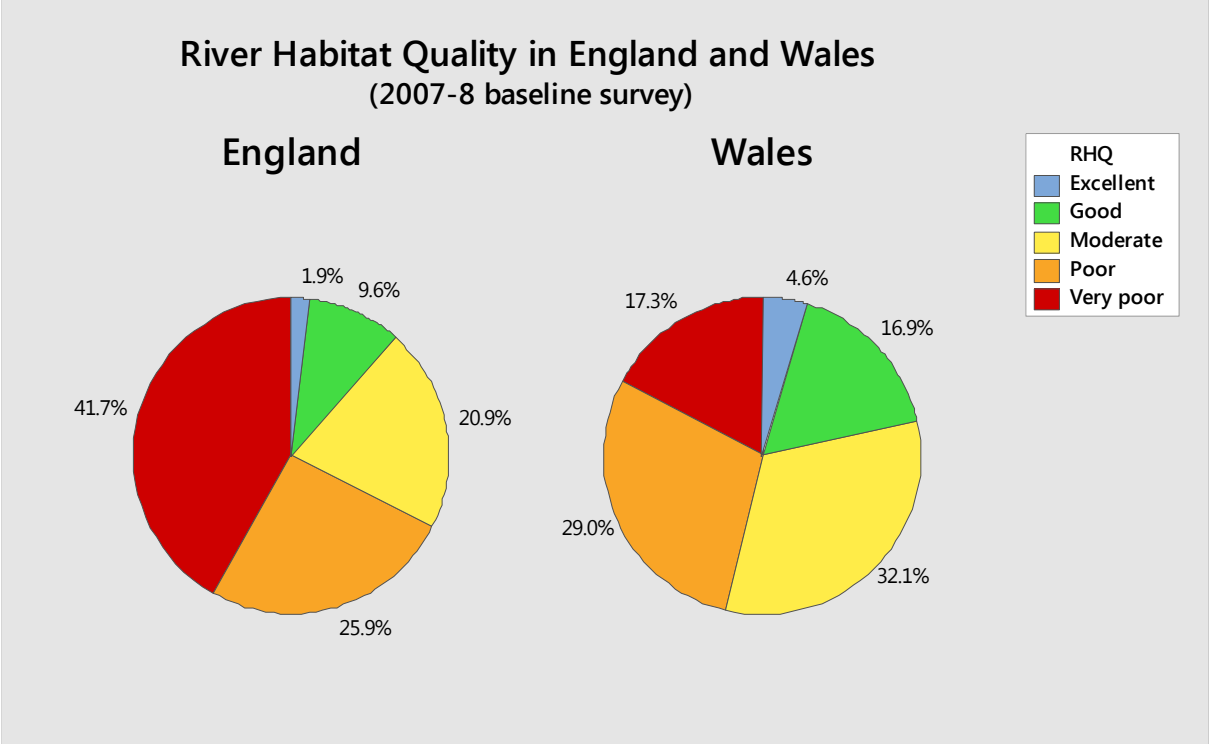


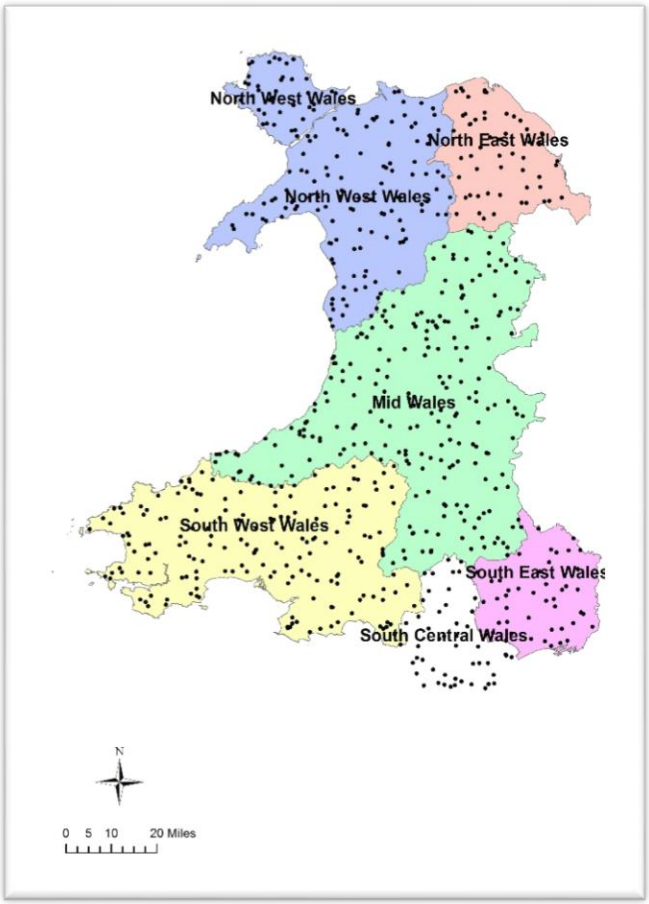
Figure 6. River Habitat Quality (RHQ) class distribution in Wales and England (2007-8 RHS baseline survey).



6. Hydromorphological quality assessment in six terrestrial statement areas in Wales

There were 704 sites surveyed in Wales in the 2007-8 baseline survey out of 4848 surveyed sites covering England, Wales and the Isle of Man (Fig. 7).

Figure 7. Location of sites in Wales from the 2007-8 RHS baseline survey of English and Welsh rivers alongside the area statement boundaries.



6.1. River Habitat Quality

River Habitat Quality differed between Welsh areas. South-east, South-central and North-west Wales had the highest proportions of poor quality sites (between 49% and 65%), combined with low proportions of high quality sites (between 4% and 14%; Fig. 8). This was due to high levels of engineering and high proportions of heavily modified sites (Fig. 9).

North-west and South-west Wales had a higher proportion of high RHQ sites (Fig. 8) despite high levels of engineering (Fig. 9) because of a higher proportion of sites with high diversity and naturalness (Fig. 10).

Mid Wales had the highest and lowest proportions of sites with high and low RHQ (Fig. 8) attributable to low recorded levels of engineering; nearly half of all sites were predominantly unmodified or semi-natural (Fig. 9).

Figure 8. River Habitat Quality (RHQ) class distribution in the Welsh statement areas in the 2007-8 RHS baseline survey of rivers.

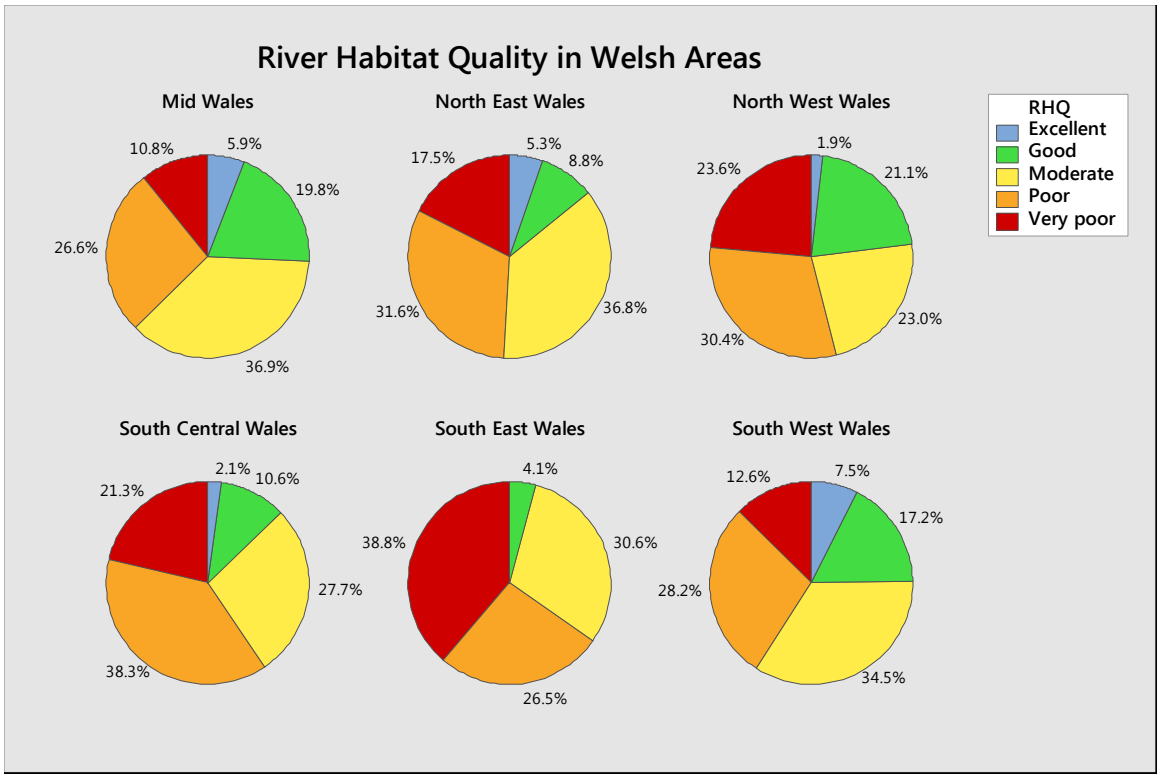


Figure 9. Habitat Modification Score (HMS) class distribution in the Welsh statement areas in the 2007-8 RHS baseline survey of rivers.

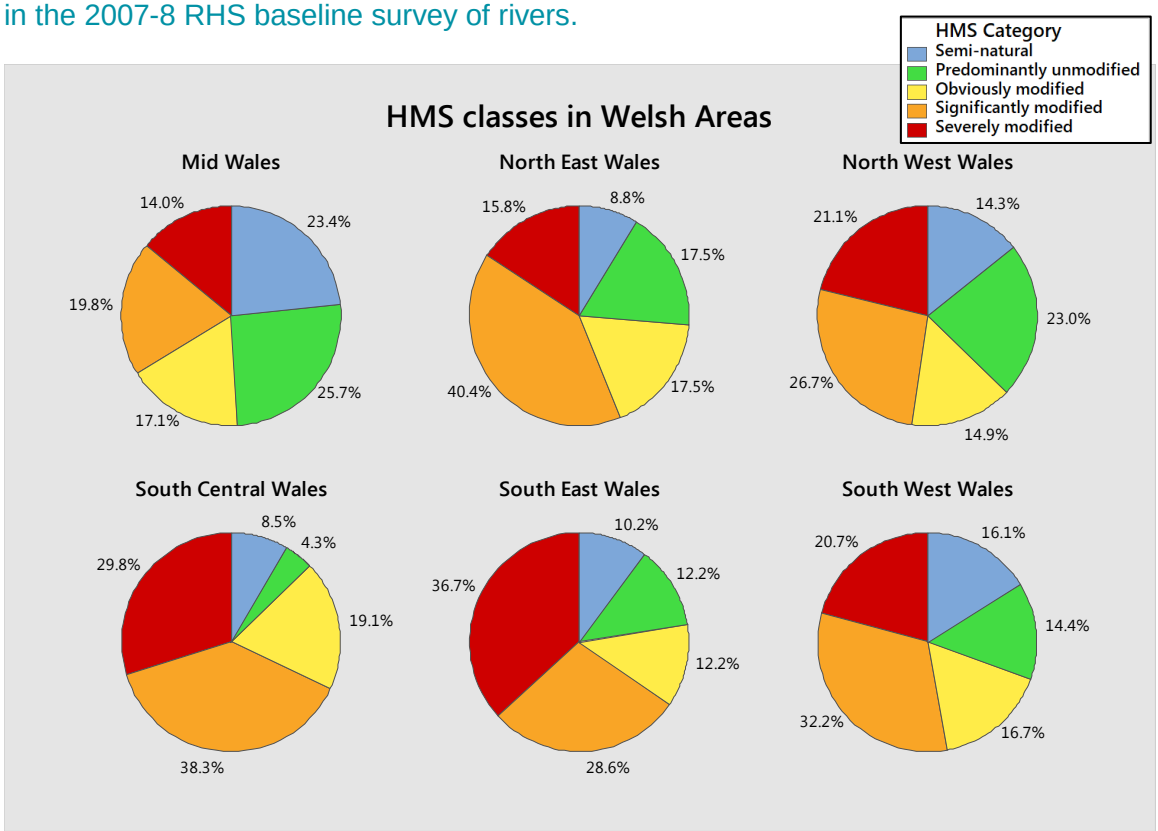
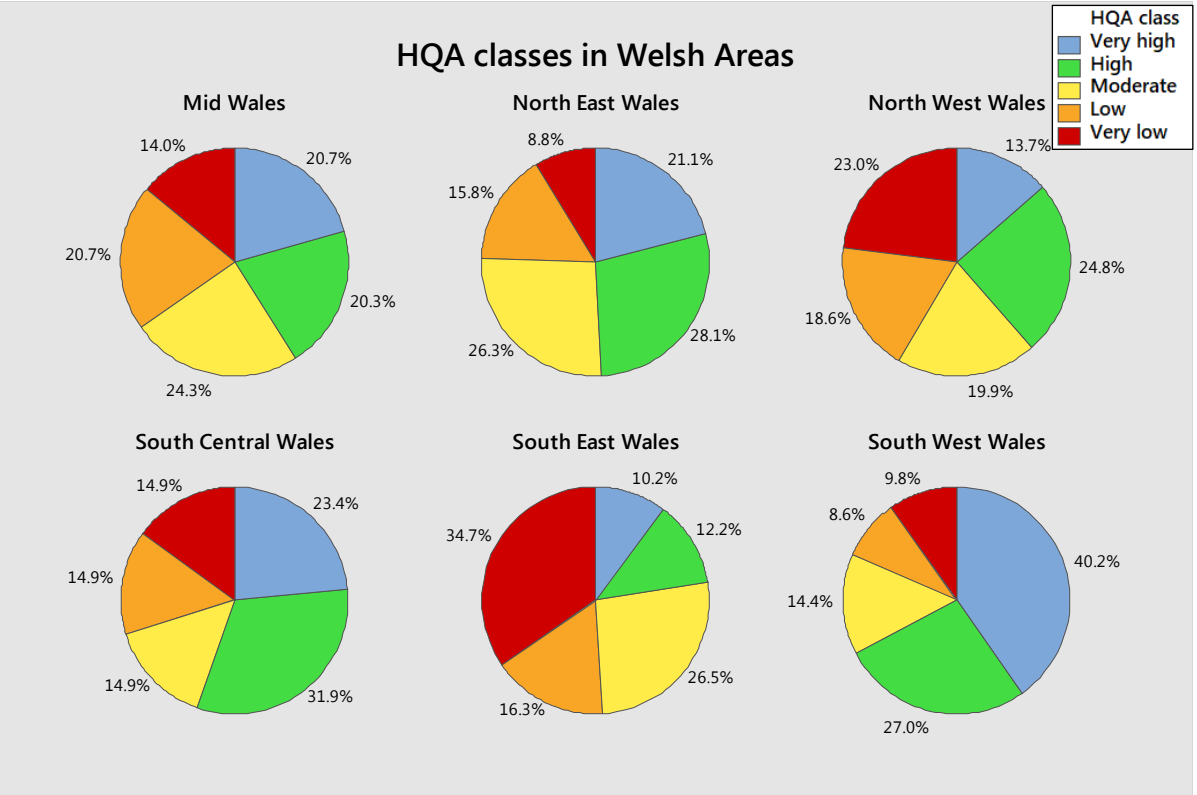


Figure 10. Habitat Quality Assessment (HQA) class distribution in the Welsh statement areas in the 2007-8 RHS baseline survey of rivers.



6.2. Pressures

6.2.1. Engineering Pressures

Channel and bank resectioning explained a significant proportion of the HMS in most areas (Fig. 11). Channel planform (i.e. sinuosity) and cross-sectional modifications were evident in all areas and predominant in South Wales (Fig. 12).

The distribution of pressures showed a higher occurrence of engineering structures and resectioning in South compared to North Wales (Table 2). South-central Wales had the highest occurrence of major bridges and weirs, culverts, resectioning and reinforcement. North Wales was characterised by a higher occurrence of reinforcement, embankments and poaching.

Figure 11. Relative contribution of different types of engineering pressures in the Welsh statement areas. The charts show the relative contribution of HMS sub-scores to overall HMS scores for sites from the 2007-8 RHS baseline survey.

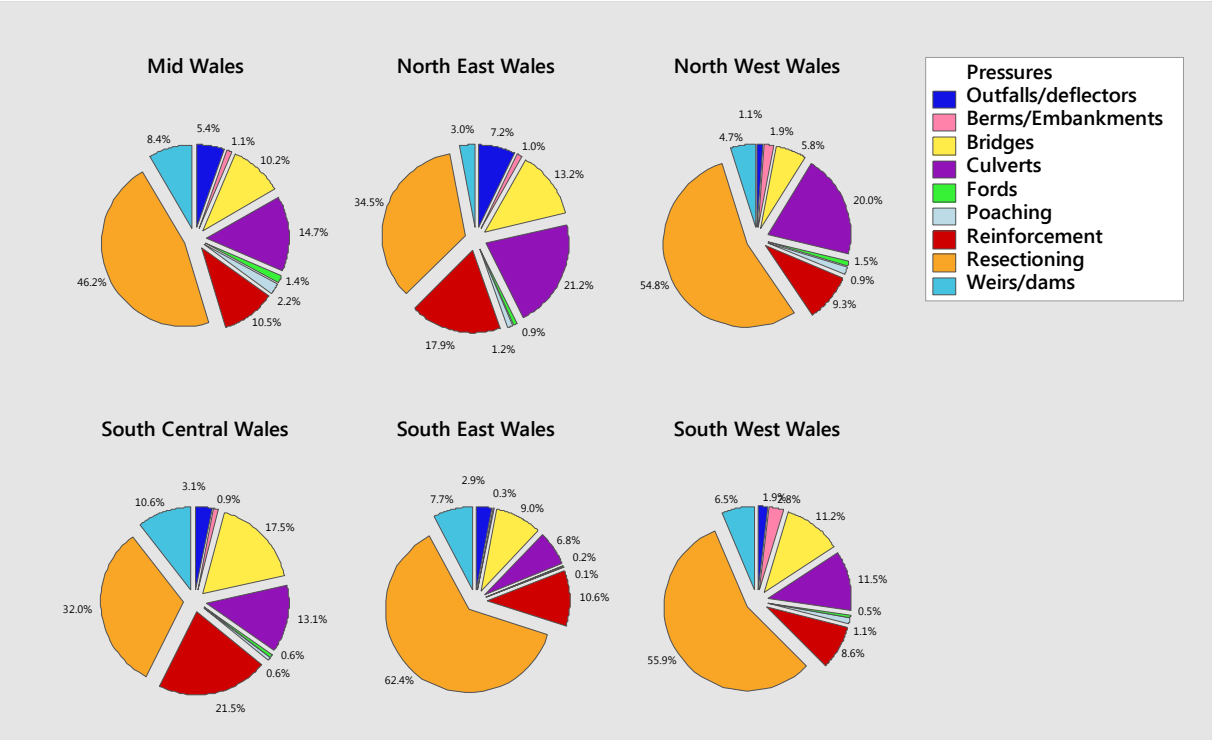


Figure 12. Cross-sectional and planform modifications in rivers in the Welsh statement areas based on data from the 2007-8 RHS baseline survey (using sweep-up data).

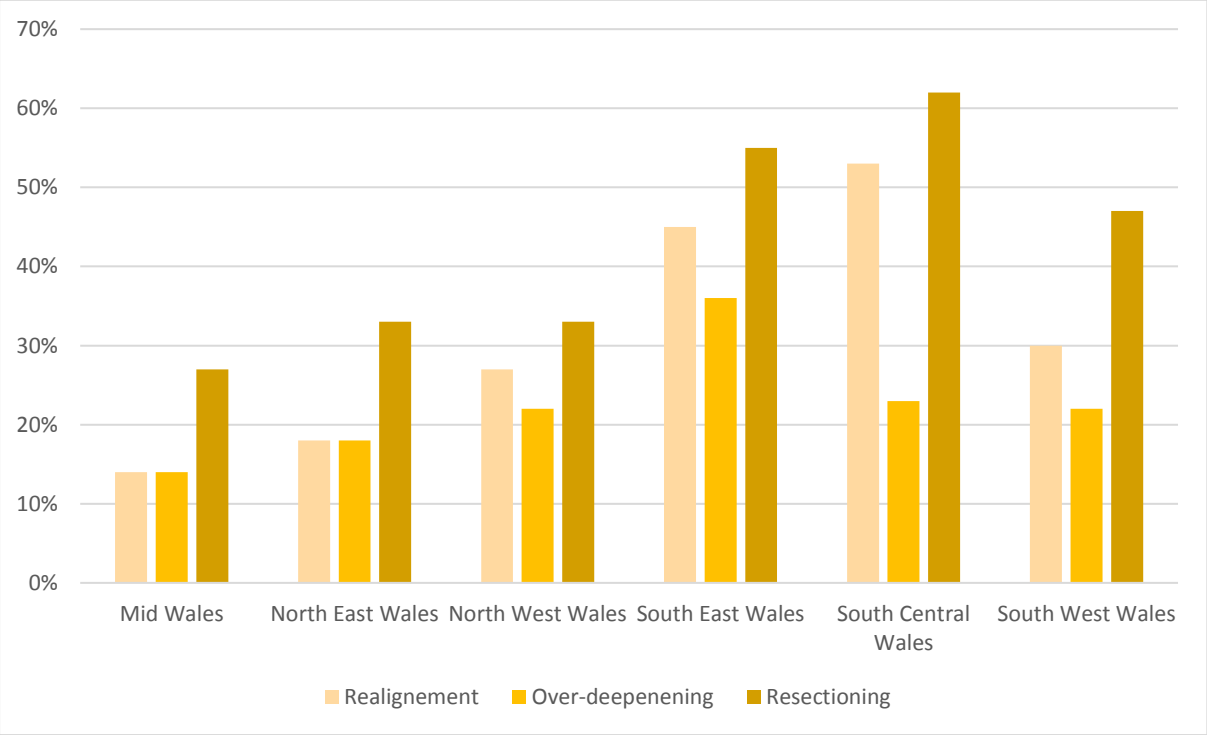


Table 2. Occurrence of major bank and channel structures on rivers in the Welsh statement areas. Data derived from sites in the 2007-8 RHS baseline survey of Welsh rivers. See Fig 2 for interpretation of colour coding.

Welsh areas	N	Weirs	Bridges	Culverts	Realigned	Deepened	Resectioned	Reinforced	Embanked	Poached
Mid Wales	220	6%	3%	20%	14%	14%	27%	42%	10%	45%
North-east Wales	55	7%	4%	27%	18%	18%	33%	65%	15%	47%
North-west Wales	161	4%	5%	27%	27%	22%	33%	65%	20%	47%
South-east Wales	47	4%	13%	19%	45%	36%	55%	45%	2%	9%
South-central Wales	47	13%	17%	30%	53%	23%	62%	74%	4%	30%
South-west Wales	174	7%	6%	22%	30%	22%	47%	55%	22%	40%

6.2.2 Land use pressures on floodplain

Each RHS area was characterised by different dominant land usage and associated potential floodplain pressures (Table 3). South-central Wales had the highest occurrence of engineering structures and the highest proportion of suburban and urban land-use across all Welsh regions. South-west and mid Wales had a very high occurrence of improved grassland with coniferous plantations also common in the Mid Wales area. The South-east area featured the highest occurrence of tilled land and the North-east area had a strong predominance of suburban land use, parklands and gardens. This indicates different origins of pressures, impacts and potential mitigation measures for each area.

Table 3. Occurrence of non-natural land use types on the floodplain 50m from the banktop on rivers in the Welsh statement areas. Data derived from sites in the 2007-8 RHS baseline survey of Welsh rivers. See Fig 2 for interpretation of colour coding.

Welsh areas	N	Coniferous Plantations	Improved Grassland	Suburban Urban	Tilled Land	Parkland or Gardens
Mid Wales	220	18%	53%	34%	5%	15%
North-east Wales	55	5%	38%	47%	7%	45%
North-west Wales	161	10%	49%	42%	7%	18%
South-east Wales	47	4%	19%	34%	23%	26%
South-central Wales	47	6%	26%	77%	2%	28%
South-west Wales	174	6%	57%	43%	11%	14%

6.2.3 Land use pressures on banks and riparian zones

The spatial distribution of different land-use pressures showed a similar pattern for banks and riparian zones indicating a variety of potential impacts on riparian quality, in-channel habitats and hydromorphology across areas (Table 4).

Table 4. Occurrence of non-natural land use types in the riparian zone in the Welsh statement areas. Data derived from sites in the 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	N	Coniferous Plantation	Improved Grassland	Suburban Urban	Tilled Land	Parkland or Gardens
Mid Wales	220	4%	27%	3%	1%	1%
North-east Wales	55	1%	11%	7%	1%	5%
North-west Wales	161	1%	17%	4%	1%	2%
South-east Wales	47	1%	9%	10%	6%	5%
South-central Wales	47	2%	10%	13%	0%	7%
South-west Wales	174	1%	20%	5%	1%	2%

See Fig 2 for interpretation of colour coding.

6.2.4 Invasive plants

Invasive non-native plant species were present in all regions (Table 5) with an increase in distribution evident since the 1994-96 survey (Environment Agency, 2011). Occurrence of giant hogweed, Japanese knotweed and Himalayan balsam were highest in the South Wales areas and particularly prevalent in and around urbanised areas.

Table 5. Occurrence of three invasive plant species associated with river banks in the Welsh statement areas. Data derived from 2007-8 RHS baseline survey of Welsh rivers.

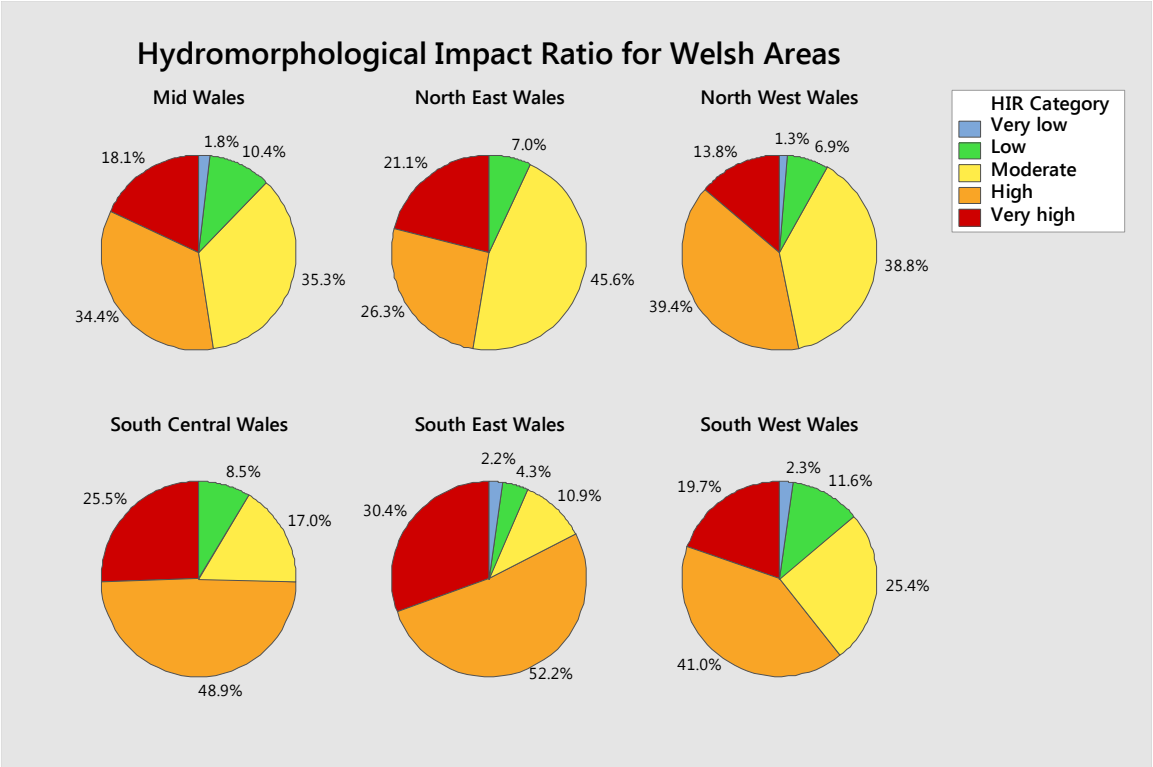
Welsh areas	N	Giant Hogweed	Japanese Knotweed	Himalayan Balsam
Mid Wales	220	3%	7%	12%
North-east Wales	55	2%	0%	22%
North-west Wales	161	1%	9%	9%
South-east Wales	47	6%	11%	30%
South-central Wales	47	6%	26%	32%
South-west Wales	174	2%	22%	31%

See Fig 2 for interpretation of colour coding.

6.3. Naturalness

The naturalness of hydromorphological dimensions are described by the HIR and showed some correlation with the level of engineering and land use pressures across areas. South-east Wales and South-central Wales had the highest levels of departure from naturalness amongst all areas (Fig. 13). Both were characterised by very high levels of habitat modification through planform and cross-sectional modifications linked to urban areas (Table 2 and 4). South-west Wales showed high impacts linked to the presence of resectioning and reinforcement in more agricultural settings. Mid Wales and North Wales areas displayed higher levels of naturalness associated with lower levels of planform and cross-sectional modifications, generally in more rural settings.

Figure 13. Comparison of Hydromorphological Impact Ratio (HIR) categories by area. Data derived from 2007-8 RHS baseline survey of Welsh rivers.



6.4. Hydromorphological and habitat features

The following tables (Tables 6-9) provide a comparative description of natural feature distribution across Welsh areas. They were based on RHS sweep up data (unless stated otherwise) on the occurrence of various habitat and land use features. They contribute to the natural capital of resources available to freshwater and terrestrial ecosystems around rivers and to the quality of life and well-being of communities.

6.4.1. Natural land uses

Broad-leaved woodland and rough pasture were the dominant natural land use types recorded in Welsh river floodplains, with each dominating in half of the areas (Table 6). Wetlands and moorland heath were also present in a significant number of sites, especially in North-west, Mid and South-west Wales.

Table 6. Occurrence of natural land use types on the floodplain (within 50m of the banktop). Data derived from 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	N	Broadleaved Woodland	Scrubs and Shrubs	Wetland	Moorland Heath	Rough Pasture	Tall Herbs
Mid Wales	220	66%	43%	20%	15%	62%	49%
North-east Wales	55	67%	53%	13%	4%	82%	62%
North-west Wales	161	47%	54%	50%	16%	73%	45%
South-east Wales	47	45%	21%	2%	0%	81%	30%
South-central Wales	47	72%	57%	17%	2%	66%	70%
South-west Wales	174	76%	73%	28%	4%	65%	75%

See Fig 2 for interpretation of colour coding.

6.4.2. Tree features

Trees occurred in the vast majority of sites with few sites showing no treeline on both banks. All associated features occurred extensively across all regions with the exception of North-west Wales which had the lowest occurrence of trees and associated features, potentially linked to the presence of wetlands, moorland and pasture (Table 7).

Table 7. Occurrence of trees and associated features across areas. Data derived from 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	N	Continuous Tree Line	Extensive Shading	Over-hanging Boughs	Exposed Tree Roots	Underwater Tree Roots	Fallen Trees	Large Wood
Mid Wales	220	31%	51%	79%	68%	47%	50%	57%
North-east Wales	55	29%	53%	89%	84%	50%	71%	65%
North-west Wales	161	16%	29%	57%	34%	18%	25%	27%
South-east Wales	47	21%	40%	70%	66%	51%	45%	45%
South-central Wales	47	30%	47%	85%	68%	34%	38%	28%
South-west Wales	174	32%	53%	80%	67%	45%	55%	59%

See Fig 2 for interpretation of colour coding.

6.4.3. Special features (channel)

Special features are features and habitats that have specific visual or conservation interest and that tend to be rare at a national/UK scale. Welsh rivers support an abundance of special features. Mid Wales and North-west Wales showed the highest occurrence of in-channel features of landscape and visual quality such as natural waterfalls, cascades, and multiple channels. Mid Wales, North-east and South-west Wales featured a high proportion of sites with debris dams and leafy debris.

In terms of natural assets, Mid Wales had the highest proportion of special features in the country.

Table 8. Occurrence of special features in channel. Data derived from 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	N	Side Channels	Natural Waterfalls >5m	Natural Waterfalls < 5m	Cascades	Backwaters	Debris dams	Leafy Debris
Mid Wales	220	9%	3%	27%	28%	7%	30%	27%
North-east Wales	55	5%	2%	7%	5%	4%	35%	15%
North-west Wales	161	12%	3%	22%	27%	6%	11%	2%
South-east Wales	47	4%	0%	13%	9%	4%	19%	2%
South-central Wales	47	6%	2%	6%	11%	9%	13%	9%
South-west Wales	174	13%	1%	9%	20%	5%	34%	19%

See Fig 2 for interpretation of colour coding.

6.4.4. Special features (wetlands)

Wetland types are also recorded as special features due to their decline since the 19th century, making them valuable from both conservation and ecological perspectives. South-west Wales had the highest occurrence and diversity of wetland types including wet woodland, marshes and flushes (Table 9). North-west Wales had a high occurrence of marshes, bogs and natural open waters, whilst mid Wales supported relatively high occurrence of flushes, bogs and wet woodland. In contrast, South-east, South-central Wales and North-east Wales had some of the lowest occurrences of natural wetlands.

Table 9. Occurrence of wetlands on the floodplain 50m from the banktop. Data derived from 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	N	Wet Woodlands	Marshes	Flushes	Natural Open Water	Bogs	Water Meadows
Mid Wales	220	10%	9%	19%	3%	9%	0%
North-east Wales	55	4%	5%	4%	2%	0%	0%
North-west Wales	161	8%	24%	7%	3%	12%	0%
South-east Wales	47	2%	0%	2%	2%	0%	2%
South-central Wales	47	6%	4%	6%	0%	4%	2%
South-west Wales	174	14%	19%	24%	1%	5%	1%

See Fig 2 for interpretation of colour coding.

6.4.5. Riparian vegetation

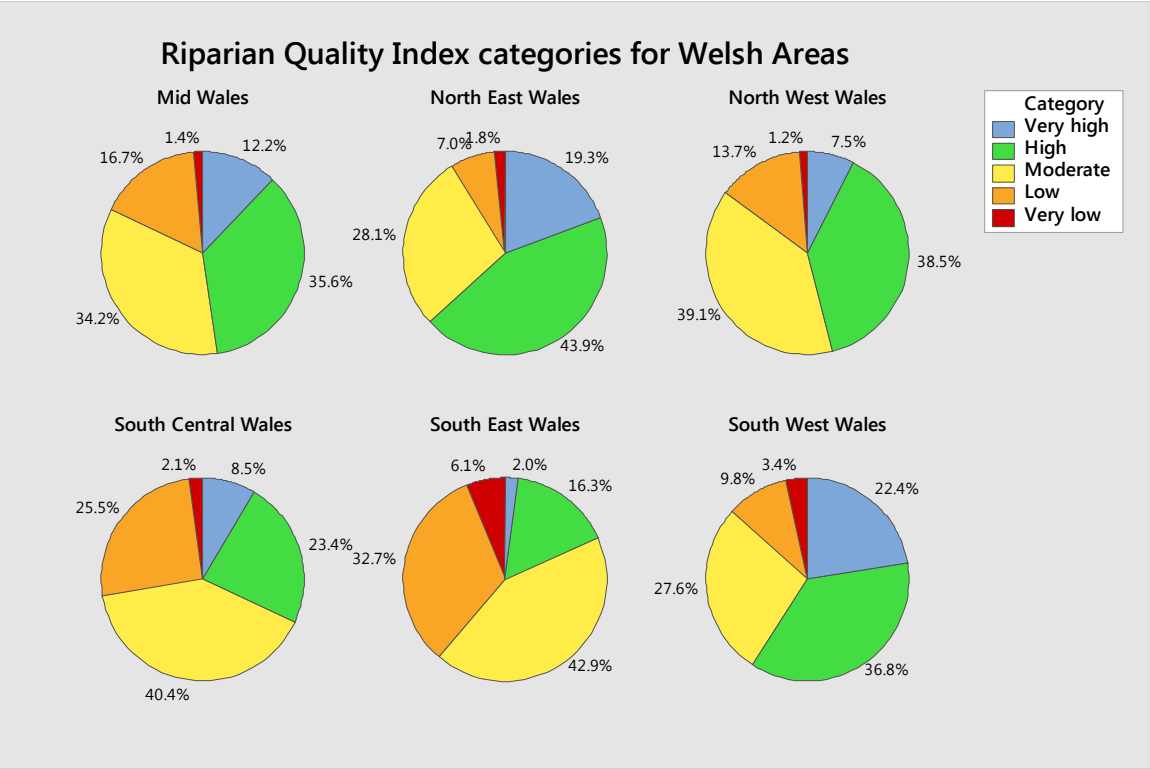
Riparian vegetation is recorded in RHS spot-checks and sweep-up sections. We present here a new index, the Riparian Quality Index (RQI) along with data on natural riparian land uses.

6.4.6. Riparian Quality

Riparian Quality, as expressed by the RQI, was typically relatively high across Welsh areas (Fig. 14). North-east Wales had the highest levels of riparian quality and the lowest proportion of sites with poor RQI, followed by South-west, North-west and Mid Wales. South-east Wales and South-west Central had the lowest levels of riparian

complexity, naturalness and continuity in comparison. These areas also have the highest levels of suburban and agricultural influence.

Figure 14. Comparison (by area) of the proportion of sites in various Riparian Quality Index (RPI) categories. Data derived from 2007-8 RHS baseline survey of Welsh rivers.



6.4.7. Riparian land use

Riparian land use generally followed floodplain land use distribution (Tables 4 and 10). The comparison of these two tables shows a predominance of natural land use types (e.g. rough pasture and broadleaved woodland) over artificial influences (e.g. improved grassland and suburban). In all areas, natural land use types represented no less than 64% of all land use types associated with river banks.

Table 10. Occurrence of natural land use types on the riparian zone (5m from the banktop, spot-checks). Data derived from 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	N	Broadleaved Woodland	Scrub and Shrubs	Wetland	Moorland Heath	Rough Pasture	Tall Herbs
Mid Wales	220	18%	4%	2%	10%	23%	7%
North-east Wales	55	22%	3%	1%	2%	28%	16%
North-west Wales	161	11%	7%	9%	7%	36%	5%
South-east Wales	47	15%	2%	0%	0%	46%	7%
South-central Wales	47	23%	7%	2%	0%	24%	11%
South-west Wales	174	28%	12%	3%	2%	16%	9%

7. Discussion

In comparing hydromorphological quality, natural assets, features, pressures and impacts, the indices and summary data extracted from the baseline survey show some interesting and sometimes contrasting patterns across Welsh areas and between Wales and England.

Wales tended to exhibit higher levels of hydromorphological quality, naturalness and diversity than England. This also corresponded with Wales having higher levels of habitat quality (in-channel and in the riparian zone) and lower levels of engineering.

The following three tables help to summarise the information in relation to the Welsh statement areas:
Quality, naturalness and pressure indices (Table 11)
Natural assets indices and statistics for key elements (Table 12)
Pressures and potential restoration actions (Table 13)

Quality, naturalness and pressure indices were ranked and ordered between areas using expert judgment (Table 11). Table 12 was ordered in the same way as Table 11 to facilitate comparisons. The main issues and management actions were listed with a prioritisation for river and floodplain restoration in Table 13. The tables are given as an example of how the previous statistics may be combined and ranked so as to identify different issues and prioritise management actions between areas. Table 11 also includes an element of within area analysis and highlights issues that are prominent at area level (shaded squares).

Mid, South-west and North-west areas stood out as having the highest overall quality and the lowest levels of pressures (Table 11). However, the areas showed potential for improvement in habitat diversity (Mid and North-west Wales) and habitat modifications (South-west Wales). All areas scored high in terms of natural assets with the presence of rare features and wetlands (Table 12). Mid Wales had fewer natural land uses compared to other areas and North-west Wales had fewer bankside trees. Potential recommended actions are to protect existing natural assets and naturalness and enhance/restore highlighted aspects such as habitat diversity, modifications and fine sediment input.

North-east Wales, South-central Wales and South-east Wales seemed to have comparatively lower levels of habitat quality, naturalness and higher levels of pressure.

Compared to other areas, North-east Wales, South-central Wales and South-east Wales had the lowest levels of habitat quality and naturalness as a result of higher levels of pressure. River environments in these areas were characterised by higher frequency and extent of engineering features (e.g. bank revetment, culverts and weirs) and additional pressures from land use practice near and in the riparian zone potentially increasing the risk of fine sediment supply/accumulation and the establishment of invasive non-native plant species. Based on these statistics and analyses, recommendations for management action are to restore the natural environment within the limits defined by land use constraints and improve diversity where this is not possible through enhancement schemes.

Table 11. Quality, pressures and impacts indices ranked across Welsh statement areas with a rating taking account of all indices (Index based rating column), a description of main issues, restoration actions and priorities. Ranking only offers a comparison between areas and it does not always represent the levels of impact of specific issues within an area. Shaded cells represent indices and issues of concern within individual areas. Data derived from 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	RHQ	HMS	HQA	HIR	RPI	Index based rating	Issue description	Restoration action	Priority for river restoration
Mid Wales	1	1	5	1	4	**1**	River and riparian diversity	Riparian management, in-stream diversity	Moderate
South-west Wales	2	3	1	2	2	**2**	Engineering	Constraints removal	Moderate
North-west Wales	3	2	4	3	3	**3**	Habitat diversity and naturalness	Restoration and sediment management	Moderate
North-east Wales	4	4	3	4	1	**4**	Engineering, habitat diversity and naturalness	River restoration, enhancement	High
South-central Wales	5	6	2	5	5	**5**	Engineering, in-channel and riparian habitat naturalness, land-use pressures	River restoration, enhancement	High
South-east Wales	6	5	6	6	6	**6**	Engineering, in-channel and riparian habitat quality, diversity and naturalness, land-use pressures	River restoration	High

Table 12. Natural asset indices ranked across Welsh statement areas with a rating taking account of all indices (natural asset rank) and recommended management actions. Data derived from 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	Trees and features	Special features (channel)	Special features (wetlands)	Natural riparian land use	Natural land use	Natural asset rank	Management action
Mid Wales	3	1	3	5	5	**3**	Protect and enhance
South-west Wales	2	3	1	1	1	**1**	Protect
North-west Wales	6	2	2	2	2	**2**	Protect
North-east Wales	1	4	4	3	4	**4**	Enhance
South-central Wales	4	5	6	4	3	**5**	Restore
South-east Wales	5	6	5	6	6	**6**	Restore

Table 13. Summary of pressures and potential restoration actions across Welsh statement areas. Data derived from 2007-8 RHS baseline survey of Welsh rivers.

Welsh areas	Index based rating	Engineering pressure	Land use pressures	Restoration actions
Mid Wales	1	Culverts	Coniferous plantations	De-culverting, fencing, buffering
South-west Wales	2	Resectioning, culverts, embankments	Improved grassland	De-culverting, re-meandering, fencing
North-west Wales	3	Reinforcement, culverts, embankments	Improved grassland	De-culverting, re-meandering, fencing, buffering
North-east Wales	4	Reinforcement, culverts	Improved grassland and parkland	De-culverting, two-stage channels, fencing
South-central Wales	5	Reinforcement, resectioning, realignment, culverts, bridges, weirs	Urban	De-culverting, re-meandering, two-stage channels, green infrastructure, buffering
South-east Wales	6	Resectioning, realignment, deepening, culverts, bridges	Urban and tilled land	De-culverting, re-meandering, two-stage channels, green infrastructure, buffering

8. Conclusion

The approach applied to this project demonstrates how RHS data from baseline surveys and associated indices can be used to produce summary statistics to compare the environmental quality and natural assets of Wales and its respective areas.

Due to the spatial resolution of the baseline survey being carried out using a random sampling strategy over a 10km grid square stratification, it has been possible to produce assessments which we consider to be meaningful and representative at area as well as at national scales. These spatial analyses could be further compared to the 1994-1996 baseline survey to explore potential temporal trends in quality, pressures and impacts.

Quality indices have provided a useful summary of essential dimensions of diversity, naturalness, pressure, impacts and natural assets (e.g. rare natural features) enabling comparison and prioritisation of management action.

The statistics produced for this report were automatically generated in a database allowing ease of ordering in Excel using in-built conditional formatting functionality. The final summary of indices and assets can easily be carried out by local staff with an understanding of local and national issues.

The analytical approach can also be repeated using the same material and tables to identify issues and priorities within areas. Instead of colour-coding indices and features across areas, the same approach could be applied within areas to enable the identification of dominant pressures, issues and features, to inform intelligent management actions.

Another step in the analyses would be to consider issues and features in greater detail. To facilitate this, area reports have been produced as part of a database provided with this report with additional details on feature distribution and associated indices. Further analyses could also incorporate data from other sources, such as biological data, Natural Flood Management opportunity maps, Flood Protection assets, land use maps, diffuse pollution, pesticides, water quality etc.

The potential for using such datasets in combination are endless and this report provides a simple analytical framework using tables and graphs that are easy to interpret. These analyses show the usefulness of establishing random baseline surveys of habitats and the following recommendations are made:

- Incorporate the outcomes of these analyses into the Area Statements across Wales in order to **identify opportunities for protection, enhancement and restoration**.
- Use the tabled outputs and the area reports in the associated database to produce analyses of pressures, impacts and environmental assets **within each area**.
- Consider the potential of RHS to provide a structured evidence base for the impact of artificial structures including bank revetment, culverts and weirs (which are present in high proportions in some areas) on habitats and

hydromorphological processes. This could be used both to assess **planned modifications and restoration work**.

- **Cross-reference** the outcomes of RHS with other datasets across Wales including classification under the Water Framework Directive (WFD).
- Consider the potential for Natural Resources Wales to use RHS survey data to inform the **hydromorphology element under WFD**.
- Carry out a repeat RHS survey in 2019 at similar frequency to the 2007 repeat survey across Wales to **assess the direction and intensity of change**.
- Consider other applications of RHS in Wales such as:

WFD and geomorphological assessments;

Catchment and river hydro- and geomorphological assessments;

River restoration planning, delivery and monitoring;

Detailed species habitat condition assessment;

Fine sediment management;

Fisheries management (e.g. salmon and trout).

9. References

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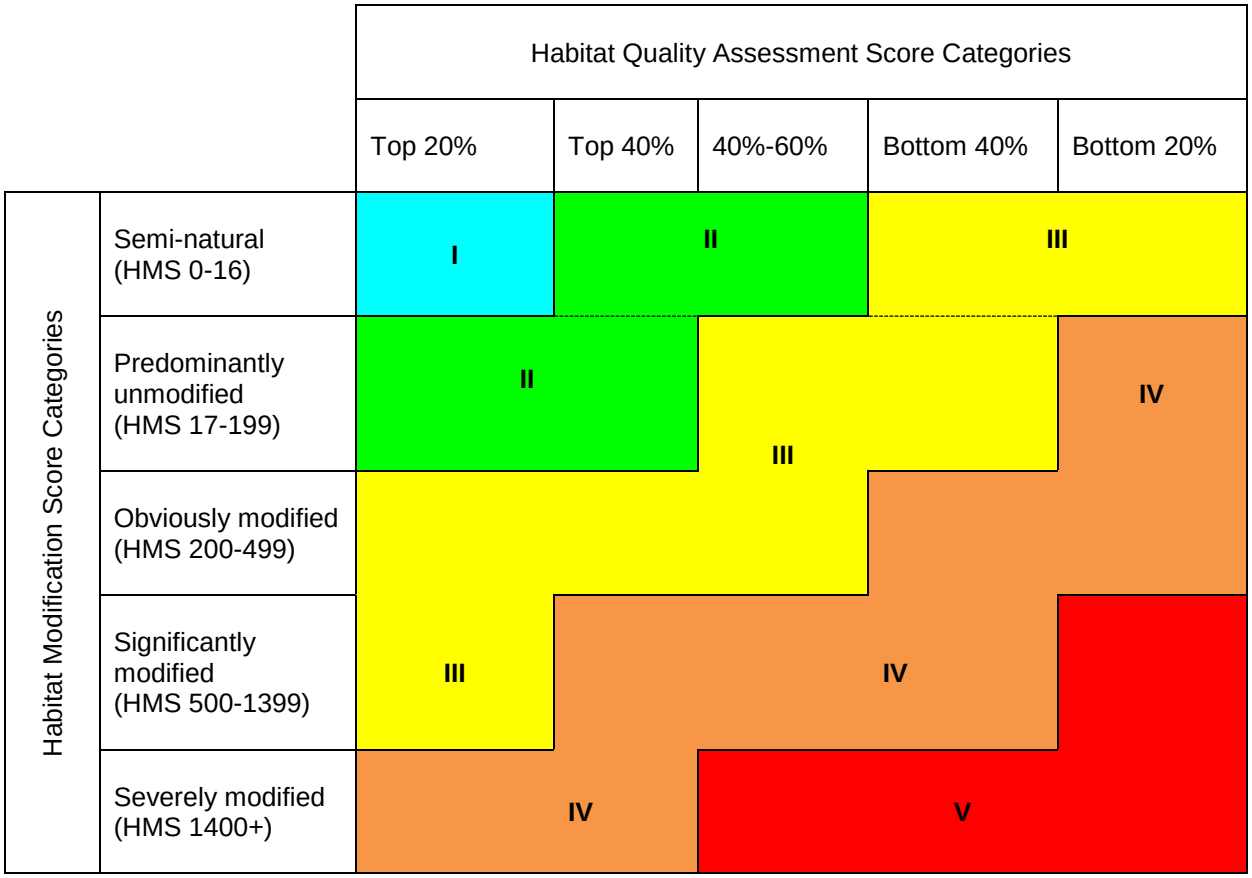
10. Appendices

Appendix 1: Habitat quality assessment

River Habitat Quality index derivation using the Habitat Quality Assessment and Habitat Modification Score categories.



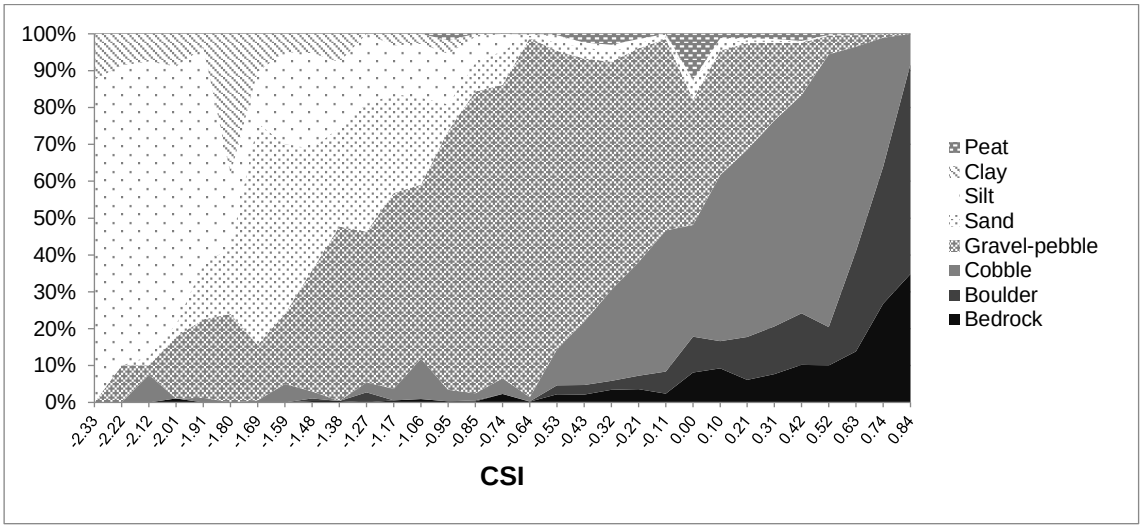
RHQ index description and management prioritisation

River Habitat Quality Categories	Description	Management
I	Excellent	Protect
II	Good	Maintain and Improve
III	Moderate	Enhance
IV	Poor	Rehabilitate
V	Extremely Poor	Restore

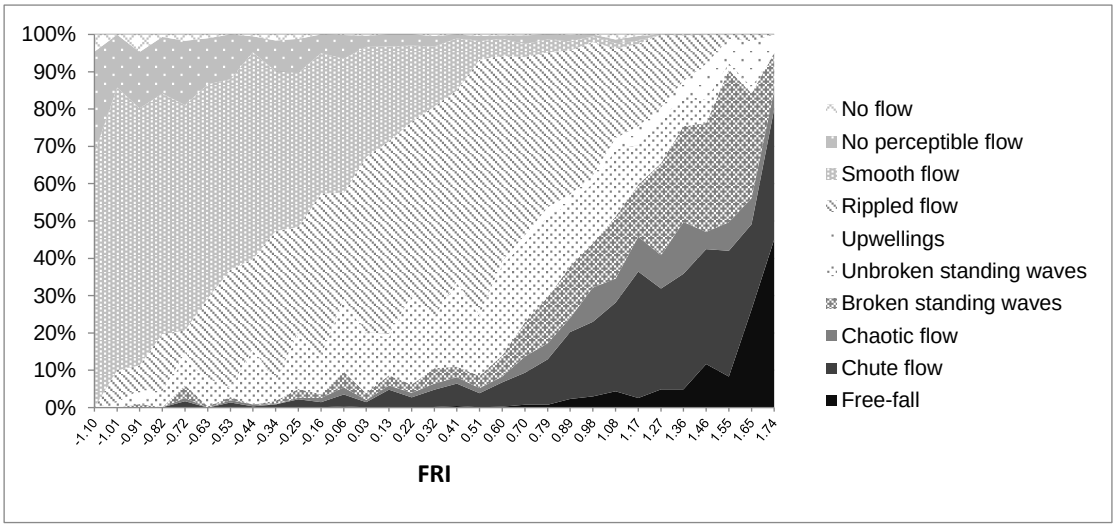
Appendix 2: Hydromorphological indices

The four hydromorphological indices represent major dimensions in the distribution of hydromorphological features derived from RHS data. The following figures illustrate, for each index, the relative occurrence of constituting morphological features along the indices scales. The indices and figures were built using RHS semi-natural sites with little or no signs of channel/bank modification.

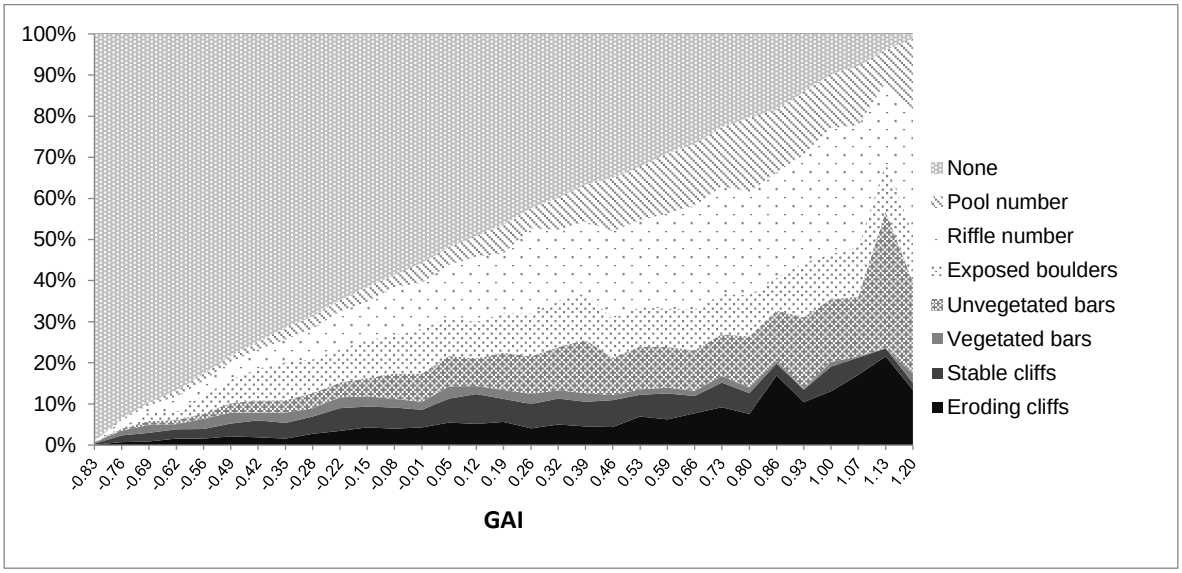
- The **Channel Substrate Index** represents a gradient in average channel substrate size. The gradient is correlated with measures and attributes relating to stream power, shear stress, climate and sediment supply. At the lower end of the scale, sites are dominated by fine substrate. As we progress through the scale, we see a gradual increase in average sediment size and a shift towards coarser substrate types.



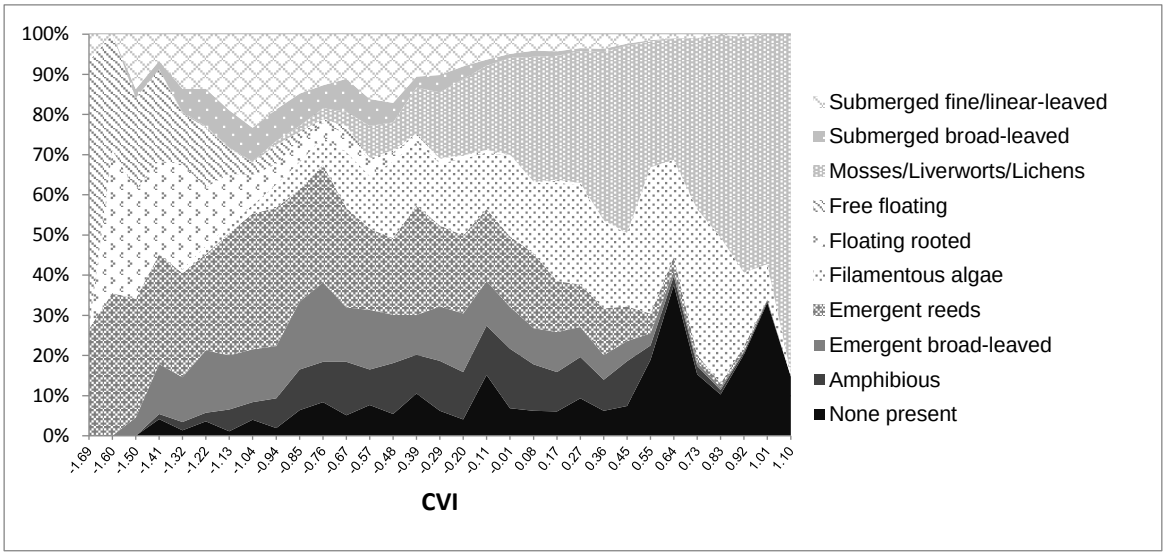
- The **Flow Regime Index** represents a gradient between slow tranquil and fast turbulent flow-types. The index ranges from sites dominated by slow flowing less turbulent features such as glides and pools to sites dominated by fast flowing features such as waterfalls, cascades and rapids. The gradient is strongly correlated to measures of discharge and slope as well as altitude and geology.



- The **Geomorphic Activity Index** represents a gradient of increased activity. It is based on the relative occurrence of erosion and deposition features such as bars, cliffs, riffles and pools. Sites at the bottom of the scale display few or no signs of activity whilst sites at the upper-end of the scale are dominated by active erosion and deposition features. The index is not simply a representation of the number of eroding/depositing features, it also differentiates between types of activity. The lower end of the scale displays a higher proportion of stable erosion and deposition features (i.e. stable cliffs and vegetated bars) compared to the upper end of the scale which is dominated by more active features (i.e. eroding cliffs and unvegetated bars). The GAI was correlated to measures of stream power, shear stress as well as attributes relating to climatic, land-use and geological controls.



- The **Channel Vegetation Index** follows a gradient of flow velocity, energy and channel condition. The lower end of the scale is dominated by floating vegetation typical of slow flowing environments with stable hydrographs. As we progress along the scale, submerged and emergent vegetation types become dominant followed by filamentous algae, mosses, liverworts and lichens. The CVI gradient is strongly correlated with stream energy, geology and altitude.



Appendix 3: Hydromorphological Impact Ratios

Hydromorphological Impact Ratios (HIR) are indices describing departure from natural condition and impact for four hydromorphological indices (CSI, FRI, GAI and CVI) using the following equation:

$$HIR_{Index} = (Index_{semi\text{-}natural\ prediction} - Index_{observed}) / (Index_{semi\text{-}natural\ prediction} - Index_{maximum\ possible\ difference})$$

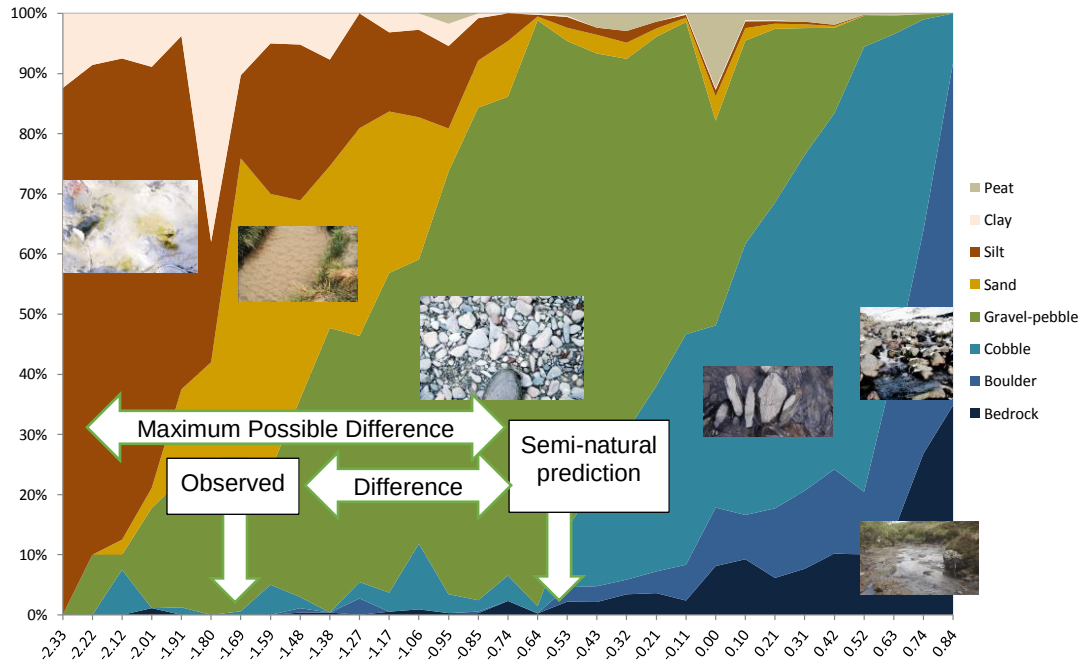
Semi-natural index values were predicted using map-derived data on stream power, shear stress, geology, etc for a subset of semi-natural RHS sites (Naura et al, ms).

The HIR is a ratio between **observed** over **maximum possible** departure from natural state/impact. It varies from 0 (no impact/semi-natural condition) to 1 (maximum impact). For example, following a survey, we find that a site is dominated by sand and gravel with a CSI value of -1.8 (Figure A3.1). Using the predictive model, we find that the semi-natural CSI should be 0.64 indicating a gravel-dominated stream. The HIR_{CSI} will be calculated as:

$$HIR_{CSI} = (0.64 - (-1.8)) / (0.64 - (-2.33))$$
$$= 2.44/2.97$$
$$= 0.82\ (82\%)$$

The calculated HIR_{CSI} value (0.82) means that the observed difference of 2.44 between semi-natural and observed CSI values represents 82% of the maximum possible difference (2.97) for a silt-dominated stream. The site can be considered as heavily impacted.

Figure A3.1: Channel Substrate Index (CSI) and HIR_{CSI} calculation. The chart represents the substrate composition of RHS sites with increasing CSI values (x-axis). The HIR_{CSI} is calculated as the ratio between 'observed' and 'maximum possible' departure from semi-natural state or impact.



1

HIR_{index} values are calculated for FRI (HRI_{FRI}), GAI (HRI_{GAI}) and CVI (HRI_{CVI}). The indices are categorised into five quintiles representing 'Very Low' (HIR_{index} between 0 and 20%) to 'Very High' impacts (HIR_{index} between 80 and 100%).

A **composite HIR** index can then be derived for each site using the highest impact value amongst all four indices. Thus, a site with a HRI_{CSI}, HRI_{FRI}, HRI_{GAI} and HRI_{CVI} of 2, 3, 3 and 5 would have an overall HIR or 5 (Very High Impact).

Appendix 4: Hydromorphological Riparian Quality Index calculation

The Riparian Quality Index (RQI) represents the **complexity**, **naturalness** and **continuity** of the riparian zone The riparian zone is defined as the zone comprising the bank face, bank top and a buffer from 5m of the bank top assessed as part of the River Habitat Survey (RHS).

The RQI features three sub-scores for **complexity**, **naturalness** and **continuity** that are calculated separately for each bank and added to yield a final site score between 0 and 120. The final RQI is classed into five equal quintiles to represent increasing riparian quality from 'Very Low' (1st quintile) to 'Very High' quality (Last quintile).

Complexity sub-score (maximum: 60)
Score each bank separately. For each spot-check, score the bank face and bank top vegetation structure using the following table and add the scores for both banks.

Bank top vegetation structure	Bank face vegetation structure	Score
Complex or Simple	Complex	3
Complex	Complex or Simple	3
Simple	Simple	2
Complex or Simple	Uniform or Bare	1
Uniform or Bare	Complex or Simple	1
Uniform or Bare	Uniform or Bare	0

Naturalness sub-score (maximum: 40)
Score each bank separately. For each spot-check:

- **score 1** if the bank material is **natural** and **no modifications** were recorded.
- **score 1** if the 5m land use is **natural**

Add the scores for both banks

Continuity sub-score (maximum: 20)
Score each bank separately. Count the number of spot-checks with **simple or complex** vegetation structure on the bankface **OR** on the banktop that are **contiguous**. Add the scores for both banks.

Examples: Left bank vegetation structure B = Bare; U = Uniform; S = Simple; C = Complex. In grey are highlighted valid scoring spot-checks.

Spot-check	1	2	3	4	5	6	7	8	9	10	Score
Bank face	**S**	U	B	U	**S**	B	U	**S**	**S**	U	**7**
Bank top	**S**	**S**	U	**C**	**C**	**S**	U	**S**	**S**	U	

Spot-check	1	2	3	4	5	6	7	8	9	10	Score
Bank face	**S**	**S**	U	**S**	**C**	B	**S**	B	**S**	U	**4**
Bank top	**S**	**C**	U	U	**S**	B	**U**	U	**S**	U	

Spot-check	1	2	3	4	5	6	7	8	9	10	Score
Bank face	**S**	U	**S**	U	**C**	B	**C**	B	**S**	U	**0**
Bank top	**S**	U	**S**	U	**C**	B	**C**	U	**S**	U	

Data Archive Appendix

The data archive contains:
[A] Digital versions of the contract report: Microsoft Word document(s); and an equivalent Adobe Portable Document Format version.

[B] Excel spreadsheet of 704 River Habitat Surveys across Wales from 2007-8 analysed by Welsh statement areas.

[C] Access database of 704 River Habitat Surveys across Wales from 2007-8 analysed by Welsh statement areas.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue https://libcat.naturalresources.wales (English Version) and https://catllyfr.cyfoethnaturiol.cymru (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no 121648.

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