River restoration theme plan

A strategic approach to restoring the physical habitat of rivers in England's Natura 2000 sites

'Improvement Programme for England's Natura 2000 Sites – Planning for the Future'

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Preface

IPENS and theme plans

The Improvement Programme for England's Natura 2000 sites (IPENS), supported by European LIFE+ funding, is enabling Natural England, the Environment Agency, and other key partners to plan what, how, where and when to target their efforts on Natura 2000 sites and the areas surrounding them. As part of the IPENS programme, Site Improvement Plans (SIPs) and themed action plans are being developed. SIPs provide an overview of the issues affecting features at the site level and the actions required to address them. Theme plans are high-level plans which aim to improve the way in which we manage a range of key issues on the Natura 2000 site series as a whole. Theme plans can provide an over-arching direction, recommendations or outline approaches to achieve target conservation status of Natura 2000 sites in England, to complement work already underway on individual sites. The plans do not have a legal status, and do not constitute a systematic evidence review, but are based on evidence and expert opinion. They are to inform action and initiatives of Natural England and its partners to help achieve the objectives of Natura 2000.

It is anticipated that Natural England and others, working with stakeholder and partners, will all play a role in implementing the theme plans. In the process of developing the theme plans Natural England has approached key partners and delivery bodies to seek input and agreement on the roles in delivering the improvements, although in some cases these discussions have not yet been concluded. Recommended actions and next steps identified in the theme plans are not necessarily committed or resourced but aimed at informing future resource decisions. Implementation of the theme plan recommendations will be via local prioritised delivery plans and coordinated through the IPENS After-Life Steering group, working with national and local delivery partner organisations.

Audience

The river restoration theme plan covers a wide range of policy and delivery issues and so will be of relevance to a variety of audiences. It is primarily aimed at those who will play a key role in delivering the actions identified in the plan, in particular Defra, Natural England and the Environment Agency and their partner delivery organisations and major landowners who are involved as local partners, including the RSPB, National Trust, local authorities, Internal Drainage Boards, River Trusts and the Wildlife Trusts.

Executive summary

This document is the theme plan for river restoration produced by the Improvement Programme for England's Natura 2000 sites (IPENS). It describes the importance of physical restoration of rivers to the achievement of objectives set by the EC Habitats Directive and presents an overview of the general approach agreed by Natural England and the Environment Agency to implement river restoration plans on Natura 2000 sites and Sites of Special Scientific Interest (SSSIs). Issues which need to be addressed if physical restoration is to be successfully implemented across the Natura 2000 network are outlined and actions to address them are recommended. It is structured to explain:

- the key issues that need to be considered in developing a strategic approach to river restoration (Section 2);
- the way in which a strategic approach has been formulated for protected rivers in England (Section 3);
- the outstanding issues that need resolving for the approach to fully deliver its objectives (Section 4);
- recommendations for resolving outstanding issues (Section 5).

Overview

The physical restoration of rivers is fundamental to delivering improvements in the condition of riverine habitats and their characteristic biological assemblages, and to generating multiple ecosystem service benefits. Physical habitat degradation is a complex issue to address. Much of it is linked to large-scale historical damage and / or on-going uses of rivers and their floodplains eg abstraction, flood defence, agricultural use and urban development. Rivers designated as Special Areas of Conservation (SACs) and other rivers designated as Sites of Special Scientific Interest (SSSIs) under domestic legislation, suffer from the same types of physical modification that are manifest in the wider river network.

The Environment Agency and Natural England have a joint national river restoration programme in place on English rivers designated as SACs and also SSSI-only rivers that require some level of physical restoration. Addressing physical habitat degradation in protected sites will help achieve favourable condition of those sites, contribute towards achieving favourable conservation status of Habitats Directive Annex I river habitat (H3260) and river-related Annex II species across their natural range, and will also help achieve the ecological status objectives of the Water Framework Directive (WFD).

Initial implementation measures are in place on 95% of riverine SACs that were identified as requiring restoration in the first cycle of river basin management planning. Whilst this is encouraging, there is full recognition that to ensure SAC rivers contribute fully to favourable conservation status will require continued effort over long timescales (20-50 years), and will require substantial amounts of funding. Key issues that need to be addressed to ensure that strategic plans are successfully implemented include:

- perceptions of required timescales for restoration;
- delivery mechanisms and funding;
- programme governance and staffing;
- SSSI notification process;
- interactions with the hydropower agenda;
- interactions with Water Framework Directive objectives; and
- monitoring and evaluation of benefits.

Key messages

A number of key messages are highlighted in the plan:

- There are 22 SACs designated for rivers and / or freshwater species (excluding tidal sites designated for otter). Of these, 16 require restoration of physical modifications in order to bring them into favourable condition, or to maintain favourable condition.
- A focus is required on conserving naturalness and natural riverine processes as a means of conserving characteristic biological assemblages and individual species features.
- River restoration is potentially highly costly, so where possible, assisted natural recovery should be encouraged to minimise the need for high-cost intervention.
- A full range of mechanisms and funding streams need to be available and exploited in an integrated way at site-level.
- Setting tight timescales for meeting river restoration objectives is generally counter-productive, since it limits the level of restoration ambition that can reasonably be considered. A focus on short timescales leads to identification of 'quick-wins' that tend to provide selective mitigation of impacts, rather than strategic, sustainable solutions based on restoring natural processes.
- Work is ongoing to better align the process of designating protected sites with natural riverine processes to facilitate physical restoration. This includes site boundaries that can accommodate dynamic change, resulting in a functioning river corridor and more hydrologically connected floodplain land.
- There is a natural tension caused by the two sets of outcomes (under the Habitats Directive and Water Framework Directive) each with similar river restoration purposes but with different levels of requirement and ambition, (and associated costs and timescales) for restoring natural processes and holistic river ecosystem function.
- The evidence base for the importance of natural riverine processes and habitat function to characteristic biological assemblages (and hence to Habitats Directive Annex I river habitat and Annex II river-related species) is very strong. However, more effort needs to be invested in well-targeted, strategic monitoring of river restoration schemes to clearly demonstrate the benefits of restoring natural habitat function.
- A range of ecosystem service benefits can accrue from physical restoration of SAC river habitat through the restoration of natural processes, including alleviation of flooding and erosion, self-sustaining fisheries, enhancements to the local environment and contributions to tourism benefits.

Recommended actions

Strategic river restoration is a complex activity and requires a well-considered technical approach and strong dialogue with local stakeholders. A series of actions are outlined that address key constraints to progress, maintain and improve access to key funding sources, ensure that strategic plans are maintained at the centre of local decision-making, and help to improve the monitoring and evidence on which the plans are based and funds are made available. These include actions under the following headings:

- High level strategic recommendations
- Improvements to delivery mechanisms
- Improvements in funding
- Improvements to the evidence base, including scheme evaluation and monitoring

Contents

1. General background

The English river network has been extensively physically modified over many centuries. Channels have been moved, straightened, widened and deepened to reduce flooding of adjacent land, enhance land drainage and facilitate agricultural, urban and industrial development. In-channel structures (weirs, sluices, dams) have been constructed to hold water levels up for various purposes (abstraction, navigation, angling, hydropower), and banks have been stabilised to prevent movement of the river channel.

The combined effect of these changes on river ecosystems has been considerable, involving habitat simplification and loss of key habitat components, loss of marginal wetlands, interruption of coarse sediment supply, and loss of hydrological interaction with the floodplain and natural floodplain habitats (Mainstone and Hall, in draft). Very few parts of the river network have been unaffected by physical modifications; headwater streams running through ancient woodland generally provide the most natural remaining examples. Whilst selected as the best remaining examples of Annex I river habitat type (H3260), the SAC river series exhibits the full range of physical modifications that need to be addressed (albeit at lesser magnitude than other rivers).

The restoration of natural physical habitat form and function requires the restoration of natural processes (Mainstone and Hall in draft), in terms of flow and hydraulic regimes, coarse sediment delivery, lack of artificial channel constraints and inputs of large woody debris. This is not only critical for reversing historical damage, but also vital for climate change adaptation to maximise the resilience of the riverine ecosystem (Kernan and others, 2012). A whole-catchment perspective is required, making it a highly challenging task, constrained by the various legitimate uses of land and water in catchments. Strategic planning (catchment level) and long time horizons are necessary, with extensive consultation and stakeholder dialogue to clarify restoration objectives, evaluate restoration options and agree local measures. The rationale for such extensive work needs to be clear and well-articulated, to promote effective working at the site-level and to attract sufficient funding at the programme level. These statements are as true within the SAC river series as they are within the wider natural range of H3260 and river-related Annex II species, and in the English river network as a whole.

Approximately 1684 km of rivers in England are designated as SAC. This represents 67% of the forty four rivers (some 2500 km) which are legally protected as SSSI, and 1.2% of the English river network at 1:50,000 map scale (estimated by CEH as 140,173km). These rivers were selected as the best (most natural) remaining 'whole-river' examples (generally notified from source to sea) of different river types and their characteristic habitats and species.

There are 22 SACs designated for rivers and / or freshwater species (excluding tidal sites designated for otter). Of these, 16 require restoration of physical modifications in order to bring them into favourable condition, or to maintain favourable condition. Figure 1 shows English and cross-border SAC and SSSI rivers which require river restoration. Assessments of ecological status made under the Water Framework Directive (European Union directive 2000/60/EC which establishes a framework for Community action in the field of water policy and includes a headline commitment for member states to achieve good status of water bodies by 2015) reflect the impacts on river morphology in the wider English river network. Degraded morphology is a significant reason for water bodies failing to meet good ecological status. Physical modification is one of the top three pressures reported in the first River Basin Management Plans. Site improvement plans produced by the IPENS project for each Natura 2000 site include actions to address physical modification where this is not already funded and secure. These actions are generally consistent with the work identified in river restoration plans where these are in place, and in a limited number of cases recommends that river restoration plans are developed.

In addition to contributing to meeting the objectives of the Habitats Directive, the remedying of physical constraints on the SAC and SSSI river network will contribute to:

- Meeting favourable condition targets for designated sites and priority habitats and species under the England Biodiversity 2020 strategy;
- Meeting ecological status and protected area objectives under the Water Framework Directive;
- Implementing approaches to sustainable flood and coastal erosion risk management recommended by the UK Government's strategy Making Space for Water (2005) and the Pitt Review: Lessons Learned from the 2007 Floods (2008).

Physical habitat restoration is being progressed in parallel with actions to address other impacts on protected river systems, particularly abstraction, discharges, diffuse pollution, siltation and invasive non-native species (Mainstone and Clarke 2008). The combination of these actions will in the long term deliver a range of environmental improvements and benefit people that live and work along these rivers.

The SAC river series and the wider series of domestic SSSI rivers are extremely important in demonstrating and promoting a strategic approach to river restoration in the wider river network (Mainstone 2008), not only in relation to physical restoration but also the full range of artificial stressors to which rivers are exposed. They provide a valuable basis for influencing measures to secure favourable conservation status of Habitats Directive Annex I river habitat and Annex II riverine species beyond the protected area network.

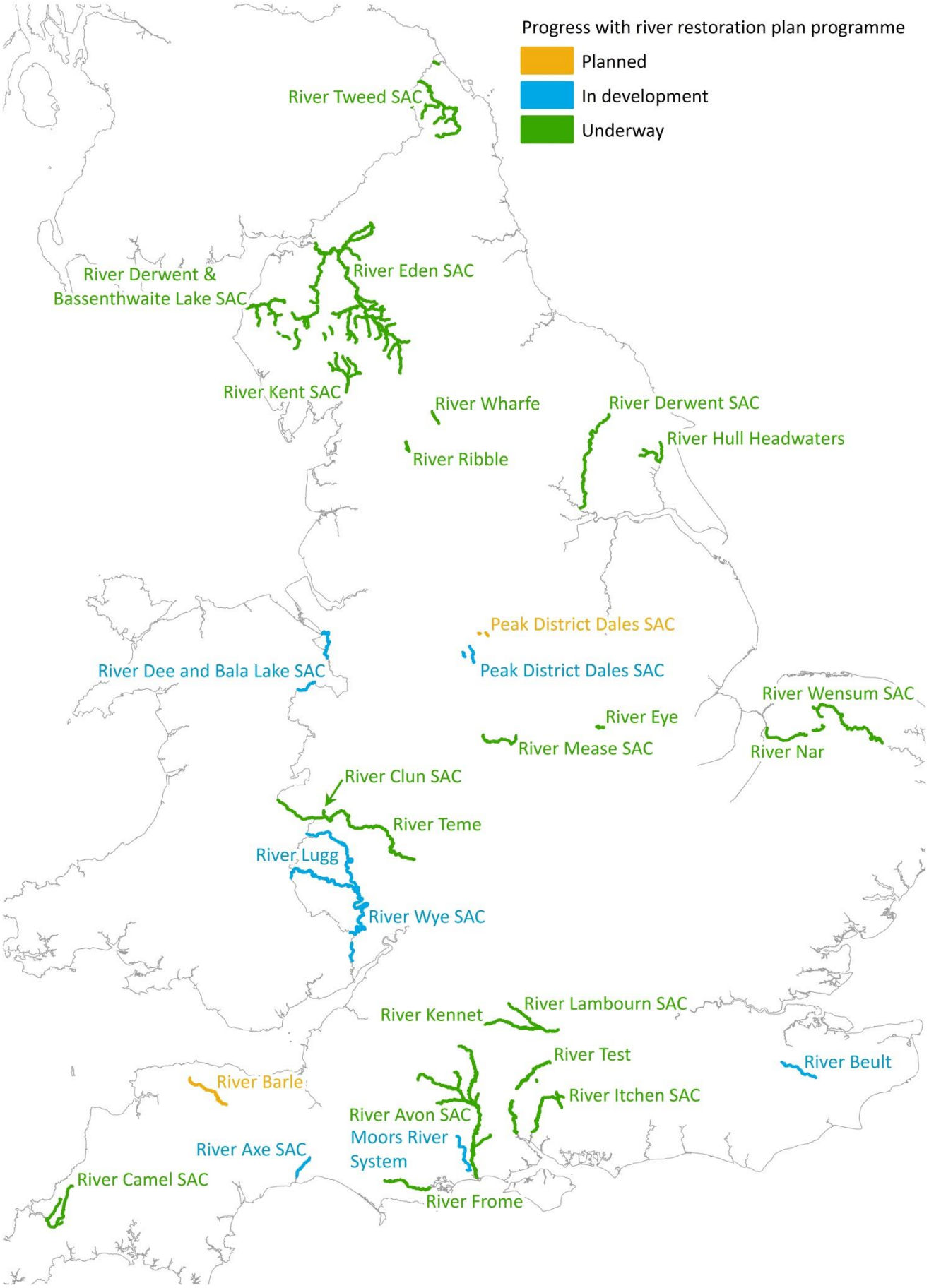


Figure 1 SAC and SSSI rivers that require a river restoration plan and implementation

2. Description of key issues

This section provides an outline of the key issues that needed to be addressed in developing a strategic approach to the physical restoration of the SAC/SSSI river series. The way in which these issues have been dealt with in the approach adopted is explained in Section 3. Outstanding issues requiring further resolution are outlined in Section 4.

2.1 Timescales and ambition

Restoring natural riverine processes to whole river systems has potential implications for a range of activities in catchments, which need to be properly considered and managed. The timescales for restoration are therefore necessarily lengthy and recovery times following the alleviation of physical modifications can also be considerable. The Habitats Directive does not set timescales for meeting SAC conservation objectives, but the Water Framework Directive does so in part, as it sets a default deadline for achieving water-related objectives on water-dependent SACs of 2015, unless site-level time extensions can be secured ('derogations'). Where ecological status objectives under the WFD differ from water-related conservation objectives on any given site, the more stringent applies (see also Section 2.8 and European Commission (2012)).

Setting tight timescales for meeting river restoration objectives is generally counter-productive, since it limits the level of restoration ambition that can reasonably be considered. A focus on short timescales leads to the identification of shorter-term solutions that tend to provide selective mitigation of impacts, rather than strategic, sustainable solutions based on restoring natural processes.

A good example of these tensions can be seen in decisions over weirs and similar structures. It is often more difficult and time-consuming to reach a decision to remove a structure than to install a fish pass. If there is pressure to deal with the structure in the short-term, mitigation through installation of a fish pass is often more expedient than removal of the structure to more fully restore natural river form and function. The fish pass does not restore the river habitat but it is often seen as the best that can be done in the time available. Technical fish passes can be very costly and such investment may act as a disincentive for subsequent more comprehensive longer term action. Lengthening the time horizons for meeting SAC objectives can therefore generate a better focus on restoration of natural processes. In order to ensure that this follows through to local delivery, there is also a need to ensure that effective local partnership steering groups are in place, and that they appreciate the need for a long term approach to decision making.

2.2 Costs

River restoration is likely to require capital works and long term management and is, therefore, potentially highly costly. It is possible to estimate unit costs per metre for capital works, based on the costs of past local restoration projects or Environment Agency cost estimates for river restoration. The effect of the type of restoration approach used on costs should be considered. In some cases, there will be considerable uncertainty in costs due to the potential for natural recovery processes to do free restoration work over time. In such cases, it is important not to over-estimate restoration costs on the basis of a worst-case scenario, involving undertaking all restoration through costly intervention measures. Costs should be identified for initial measures required to facilitate natural recovery, with a cost review milestone built in following evaluation of the extent of natural recovery.

The costs of SAC / SSSI river restoration for incorporation into the WFD River Basin Management planning process are being estimated but are difficult as they need to be derived at a very high level and so have a high level of uncertainty attached to them. The estimates for the Cumbria SAC/SSSI rivers are particularly uncertain as there

were very limited data available for upland rivers on which to base them. Recent experience on the ground in Cumbria suggests that costs may be only 30% of original estimates. For this reason, overall cost estimates are not stated here. Estimates for individual SAC rivers can be found in the Site Improvement Plans although should be used with caution, given the uncertainty described above. The joint Environment Agency and Natural England river restoration programme can provide the latest information on this issue (Wheeldon, 2013b).

Assisted natural recovery should, therefore, be encouraged wherever possible to avoid the need for high-cost intervention measures. Costs need to be estimated over short, medium and long timescales. In the short term costs to meet immediate targets, such as WFD objectives (where these are compatible with longer-term strategic restoration objectives) can be considered. Long term cost estimates should take into account potential savings from reduced channel maintenance works, associated with weed-clearing, dredging and bank stabilisations operations, which will provide some offsetting of the cost of necessary restoration interventions.

2.3 Mechanisms and funding sources

River restoration involves a range of practical measures associated with the river channel and associated riparian and floodplain land. Some of these measures are eligible for funding through agri-environment budgets whilst others (such as weir removal, gravel reintroduction etc) are not. Those that cannot be addressed by agri-environment incentives may be fundable through water-related mechanisms, such as flood risk management. What is clear is that strategic river restoration requires a full range of available mechanisms and funding streams to be available and exploited in an integrated way at site-level. Some funding sources need to be modified to allow this to happen; for instance the historical limitations of agri-environment schemes for incentivising the full range of restoration measures required have been recognised and are being addressed (see Section 4.2).

2.4 Interactions with flood risk management

Existing physical modifications to river channels can be important in current approaches to flood risk management in an area. River restoration measures either need to be flood risk neutral or be developed in harmony with flood management strategies to deliver combined benefits. Dynamic fluvial systems are often unable to adapt naturally to changes in rainfall because they are constrained by traditional flood defence structures. Conventional flood defence strategies, based on augmenting flood conveyance through defended land to downstream areas (through channel oversizing and straightening and maintenance through dredging) can represent a considerable constraint to river restoration. They can equally represent a constraint on the strategic planning of catchment-based flood risk management strategies aiming to counter the artificial enhancement of peak flows to downstream areas of flood risk. New ‘natural flood management (NFM)’ approaches are being developed which, through working with natural processes, can contribute to restoring protected rivers and their catchments whilst also delivering flood management (see section 4.2(i)).

2.5 Land loss and land management issues

The restoration of many channelized rivers requires capital works and subsequent land management to remove bank reinforcements and remove or relocate flood banks, enabling rivers to meander across at least part of the floodplain and generate natural flooding in targeted areas. Bankside reinforcements and flood banks have been established to prevent this from happening, in order to protect riparian land or essential infrastructure (eg flood banks, gauging stations, roads and bridges). The reasons for the presence of bank reinforcements and flood banks must be fully considered to ensure that they remain only where there are truly immovable constraints. In many cases approaches can be identified that are acceptable to the land managers (eg erodible corridors beyond which river movement is constrained by set-back tree planting or other means), provided the appropriate incentives are in place to support immediate and longer term land management and infrastructure change.

2.6 Local stakeholder attitudes and conservatism

The views of the local stakeholder community are often built around the recent history of a river. Since most physical modifications to rivers are long-standing (at least of the order of 40 or 50 years), and local ways of working related to the river are often based around those modifications, there is often considerable inertia to change. In many cases this can only be overcome by time, possibly generational turnover. However, good communications and articulation and demonstration of innovative solutions and their benefits can achieve considerable progress even on relatively short timescales.

River restoration can provide excellent opportunities for local communities and charities to be actively involved in decision making, working out priorities for action, implementing cost effective projects to address local issues, and protecting local resources. The Natura 2000 river restoration plans set a clear direction for all partners and stakeholders, and act as a focal point for securing and allocating resources.

2.7 Built heritage / landscape - competing environmental receptors

River restoration plans for SAC rivers identify existing in-channel structures (e.g weirs) where their removal would benefit river ecology and natural processes. However, a range of physical modifications (but particularly damming structures such as weirs) can have historical significance, and may have legal protection. Identifying historic environment assets when developing the restoration plan means that advice from local authority archaeologists can be sought early on in project development, enabling historic environment considerations to be fully integrated into project design. The following principles are applied when considering SSSI river restoration proposals and the historic environment:

- The significance of designated and non-designated assets and landscapes will be assessed and appropriate mitigation agreed with local authority archaeologists.
- Mitigation options may include design modification to minimise impacts, consolidation/ enhancement of surviving heritage features, or archaeological recording in advance of or during removal/modification of a structure.

This approach helps to reduce potential conflicts between river restoration and the historic environment, although there will remain instances where agreement on how to proceed is difficult to reach. Physical modifications can also become part of the aesthetic appeal of the landscape (for instance water mills). However, such landscape issues normally have workable technical solutions, and generally river restoration based on natural processes is in harmony with landscape objectives.

2.8 Interactions with WFD ecological status/potential objectives

The WFD has its own set of decision-making rules for meeting ecological status objectives, which can lead to decisions about river restoration that are different to those made to meet the objectives of river SACs and SSSIs. Restoration plans for SAC and SSSI rivers typically go further in restoring naturalness than planned measures to address physical impacts on other rivers under the general provisions of the WFD. In theory this is not a problem, since restoring greater levels of naturalness to a river than required to meet good ecological status or potential is not generally in conflict with WFD objectives. The most stringent objective (ie the one requiring greatest restoration of naturalness) should be applied in any given situation, and indeed for SACs this approach is a requirement laid out by the WFD. The potential tension caused by the generation of two sets of outcomes for similar purposes (ie river restoration) but with different levels of ambition, (and associated costs and timescales) for restoring natural processes needs to be addressed through the strategic approach to river restoration. These interactions between objectives relate to different levels of ambition and planning timescales for protected sites compared to the wider river network, so are highly relevant to Section 2.1 above.

2.9 Interactions with objectives for other Natura habitats and species

Restoration of natural processes within river SACs and SSSIs can come into conflict with the protection of nature conservation interest that has developed within or survived in the intensively managed floodplains generated by historical land drainage and flood defence activities. This interest may be semi-natural grasslands that are under threat from lateral river movement, drainage ditches with high biodiversity interest that would be damaged by inundation with nutrient-rich floodwaters, or bird interest on areas with carefully engineered water levels. These conflicts can act as further obstacles to restoring natural riverine processes. We need decision-making processes that evaluate these conflicts in a strategic way and develop solutions that take all biodiversity interests into account at suitable spatial and temporal scales. This issue is considered further in the IPENS theme plan on hydrological functioning (see Annex 1). There is great potential for integrated landscape-scale solutions based on a template of long-term natural hydrological functioning of river and floodplain habitat mosaics.

Within the river itself, a management focus on individual SAC species may cause conflict with the restoration of natural river habitat function if not approached in the right way. For instance, cases can be made for retaining artificial banks and in-channel structures because of the additional habitat provided for white-clawed crayfish (an Annex II species), even though the river would provide abundant suitable crayfish habitat following restoration. An approach is needed that is focussed on natural habitat function but transparently addresses the resolution of perceived habitat/species conflicts.

2.10 Ecosystem service benefits

A range of ecosystem service benefits can accrue from physical restoration of SAC river habitat through the restoration of natural processes, to benefit society in a range of ways, including:

- helping to reduce the risk of flooding and erosion;
- improving the aesthetic quality of river corridors;
- restoring habitat quality for characteristic fish species, thereby encouraging natural, self-sustaining fisheries;
- contributing to urban regeneration by providing a river corridor that enhances the local environment, and providing attractive green space for recreation and leisure;
- contributing to tourism benefits;
- helping to better link agriculture and the natural environment; and
- improving sediment management.

The synergies with catchment-based flood risk management and landscape restoration have already been mentioned. However, river restoration also has the potential to reduce certain ecosystem services that are currently drawn from river-floodplain systems, such as in the area of food production on floodplains. A full understanding of the effects of river restoration on ecosystem services can only be achieved at site-level.

Hydropower generation is an ecosystem service that has considerable potential to conflict with natural habitat function, since it is dependent on physical modification of the river channel and interferes with natural channel morphology, sediment dynamics, flow regimes and hydraulic character. A strategic approach is required to hydropower development to ensure that impacts on natural habitat function are properly controlled and do not conflict with SAC/SSSI river restoration objectives (see Section 4.5).

2.11 Evaluation of ecological benefits

The ecological benefits of physical river restoration have been questioned in the scientific literature, due to a general lack of pre- and post-project appraisal. This is a complex debate (Mainstone and Holmes 2010) where

criticism is directed more towards restoration methods based on re-creating habitat features rather than methods that restore underlying natural river processes (the latter being more generally accepted as being of ecological benefit). The issue does however hamper efforts to restore natural riverine processes and needs to be addressed as part of any strategic restoration strategy.

3. General approach to SAC/SSSI river restoration

3.1 Introduction

Natural England and the Environment Agency have a joint national programme of physical restoration on river SACs and SSSIs in England, involving the development and implementation of long-term whole-river restoration plans. The plans set out actions to move each river towards a more natural, self-sustaining state that supports a greater diversity and abundance of characteristic wildlife, whilst taking into account legitimate uses of the river.

A national SSSI river restoration project officer post, jointly funded by Natural England and the Environment Agency, has been in place since mid-2009 (see recommendation in Section 5 for continuation of this post). The officer oversees the full roll-out of a set of Restoration Planning Guidelines (Wheeldon and others 2010 and associated help notes on key issues) across all affected protected rivers. The aims of the post have evolved over time, but recently have focussed on getting river restoration underway for SAC rivers and supporting strategic implementation of river restoration measures. SAC rivers are treated as a top priority for restoration within the overall national programme. At the time the post was set up, strategic restoration plans and initial implementation was in place on just 71km of the SAC river length that requires restoration. This has now increased to 1335km, (81% of the length that requires restoration) which is a significant achievement albeit that the vast majority of the task of physical restoration lies ahead.

This work forms part of a wider strategic approach to restoring natural habitat function within the SAC and SSSI river series and the freshwater habitat series as a whole (Mainstone and Clarke 2008), which is in line with climate change adaptation priorities for river ecosystems. (Natural England/RSPB, 2014). The approach splits habitat integrity into key components: hydrological, physical, physico-chemical and biological (the latter in terms of biological stressors such as non-native species). These components are directly related to key pressures on freshwater habitats, which are then directly related to key remedies for managing those pressures at acceptable levels in relation to natural habitat function. This framework is embedded in the assessment of site condition, providing a direct link between site condition and required remedies. Figure 2 summarises the approach, and places the strategic programme of physical river restoration in context. Other IPENS theme plans deal with issues around resolving other key pressures: issues with hydrological integrity are dealt with in the theme plan on hydrological functioning; issues with physico-chemical integrity are dealt with (in part) in the theme plan on diffuse water pollution; and issues with biological integrity are dealt with (in part) by the theme plan on invasive species (see Annex 1 for links to all IPENS theme plans).

Fundamental to this general approach is the principle that naturally functioning river habitat, free of artificial modifications, provides the best expression of the habitat and its characteristic biological assemblages, including individual priority species that may form part of a SAC notification. From a species perspective, the requirements of an individual species are expressed in the context of natural river habitat function, so that the species is conserved as part of the characteristic biological community. This avoids any tendency for management to become focused on optimising the habitat for a given species, or on protecting existing (modified) conditions, in ways that work against natural habitat function (Mainstone and Hall In Draft). Shifts in the distribution and abundance of priority species resulting from restoration of natural river habitat function will occur and have to be transparently managed at site-level. Wherever possible and where consistent with the aims for wetland designated sites, the principle of natural habitat function extends to floodplain habitats, so that naturally functioning river/floodplain habitat mosaics can be promoted. However, this is more complicated to achieve in practice and requires a strongly site-specific approach (see the theme plan on hydrological functioning for further detail).

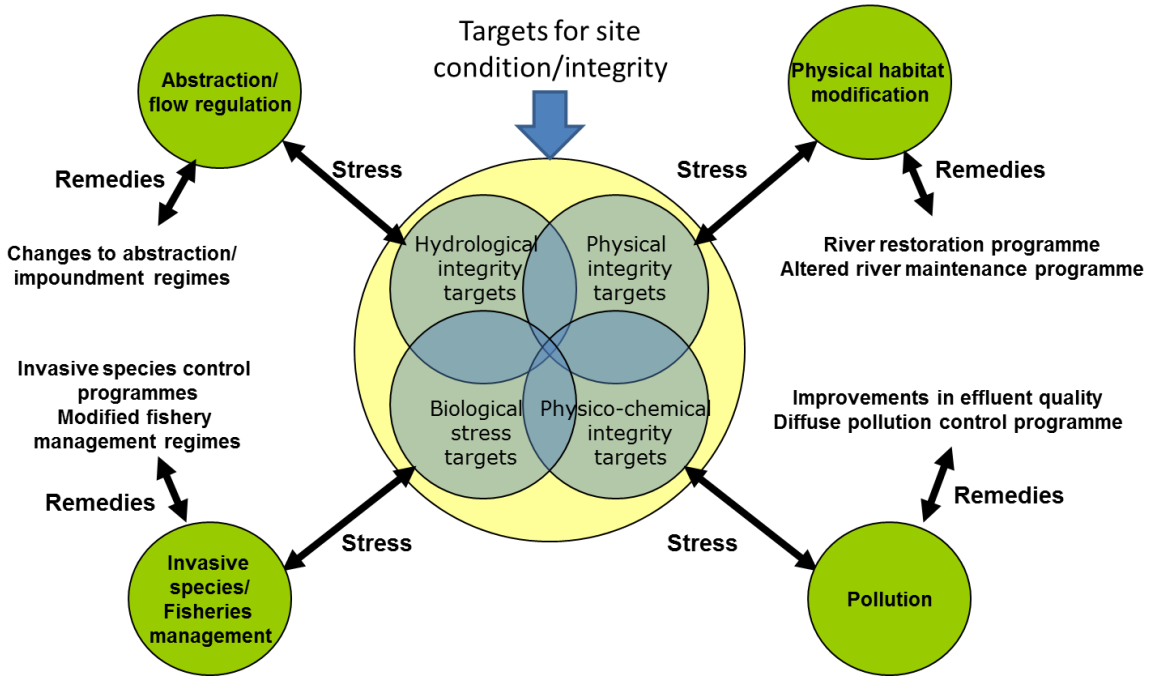


Figure 2. The relationship between the assessment of components of freshwater habitat integrity, key pressures and remedies to resolve those pressures (from Mainstone and Clarke 2008).

3.2 Scale of restoration activity

Of the 1684km total length of SAC rivers in England, 1653 km (98%) requires some assessment of river restoration needs eg a whole river restoration plan is required (which will assess restoration needs), and subsequent implementation of actions identified to physically restore river channels in order to bring them into 'favourable condition' (ie adequately conserved and able to support characteristic flora and fauna, and therefore meeting the objectives of the SAC), though not all of this river length will require active restoration measures. Figure 1 shows the river SACs and SSSIs in England (including cross-border sites) with those requiring restoration highlighted. Table 1 lists the SAC and SSSI rivers affected and summarizes latest progress. There should be no doubt that physical restoration of these rivers is a major undertaking.

Table 1 English SAC river and riverine SSSI units that require a river restoration plan and implementation

River SSSI Name	SAC	River Basin District	SAC river length (KM)	Max to restore (KM)	Strategy in place	Implementation under way
Avon system	River Avon	South West	217	310	Yes	Yes
Axe (lower)	River Axe	South West	12	12	Pending	Pending
Camel Valley and tributaries	River Camel	South West	74	74	Yes	Yes
Teme (unit 6)	River Clun	Severn	5	5	Yes	Yes
Derwent and tributaries	River Derwent and Bassenthwaite Lake	North West	133	77	Yes	Yes
Derwent	River Derwent	Humber	86	68	Yes	Yes
Dee (England)	River Dee and Bala Lake	Dee	35	35	Pending	No
Dove Valley and Biggin Dale (3 units)	Peak District Dales	Humber	9	9	Pending	Pending
Eden and tributaries	River Eden	Solway Tweed	410	207	Yes	Yes
Hamps and Manifold Valleys (2 units)	Peak District Dales	Humber	5	5	No	No
Itchen	River Itchen	South East	33	33	Yes	Yes
Kent and tributaries	River Kent	North West	87	50	Yes	Yes
Lambourn	River Lambourn	Thames	25	25	Yes	Yes
Lathkill Dale (2 units)	Peak District Dales		7	7	No	No
Mease	River Mease	Humber	25	25	Yes	Yes
Tweed catchment rivers - England: Till catchment	River Tweed	Northumbria	169	129	Yes	Yes
Wensum	River Wensum	Anglian	71	75	Yes	Yes
Wye	River Wye	Severn	250	250	Pending	Pending
		Total SAC	1653	1396	1335	

The English approach to river restoration on protected sites has proved very successful and as of February 2015 a total of 12 SACS have plans in place (out of 16 that need them), covering approximately 1335km (81%) of the 1653km of SAC that require them). Initial implementation measures are in place on 95% by length of Natura 2000 sites that had a river restoration measure assigned to them in the first River Basin Management Plans. The remaining 318km (1653km – 1335km) is made up of the River Axe, Dee, Wye and river units of the Peak District Dales SAC (Dove, Lathkill and Hamps/Manifold). Restoration plans are in development for the Axe, Wye and Dove, and in place for the Dee; implementation is required on these rivers. Plans for Lathkill Dale and the Hamps / Manifold will be developed in the future. Whilst these figures are encouraging, there is a clear need to ensure the river restoration remedy continues to progress. This will require continued effort over long timescales, including seeking to maintain the joint project officer role and adequate funding for river restoration.

The emphasis of the national programme is increasingly moving to implementing the restoration strategies, in order to meet Water Framework Directive, Habitats Directive and SSSI commitments. Implementation of river restoration is likely to be expensive and requires being funded over long timescales from a range of sources. A range of funding sources is available and opportunities exist to find synergies with other work areas in order to fund improvements. Sections 3.3 and 3.4 go on to explain how different mechanisms and funding sources may be brought together.

3.3 River restoration planning

Development of the strategic restoration plans involves geomorphological appraisal to assess the current physical state of the river, and an accompanying ecological appraisal to interpret the impact on river ecology. This helps to establish a 'restoration vision' for the river, identify and prioritise restoration measures, and set out how they can be delivered in partnership with key interested parties.

River restoration planning has been applied consistently across the protected river network. It is based on evidence-based information, clear and transparent decision-making and the involvement of those interested in, or impacted by, the proposals.

Principles of river restoration planning

The decision-making process applied to protected rivers recognises that river restoration action:

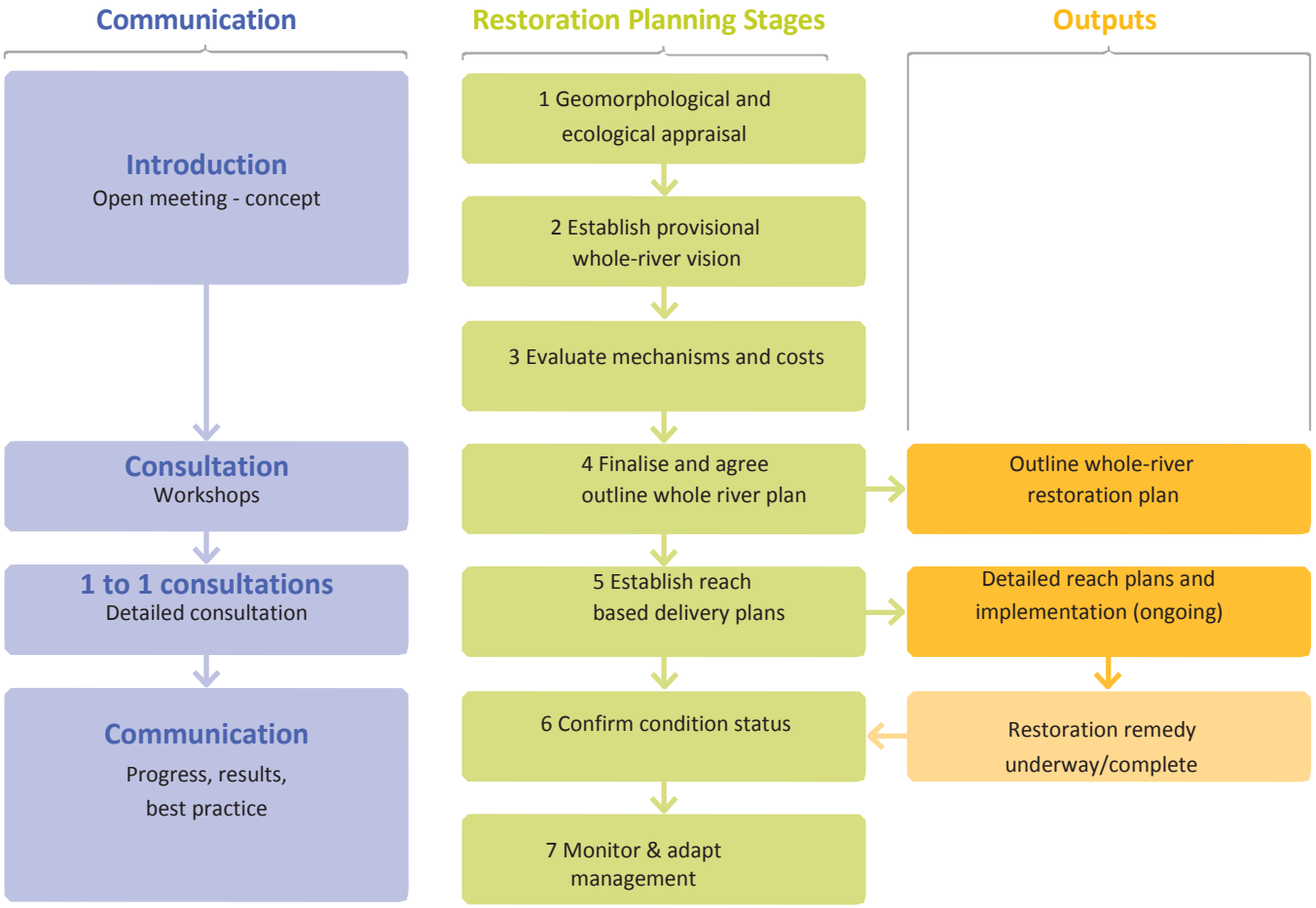
- requires strategic planning at the catchment scale if it is to be targeted and cost effective;
- is potentially highly costly and needs to maximise the use of assisted natural recovery;
- is rectifying damage caused by a range of historical activities, many of which were state-endorsed and/or state-funded at the time;
- is the joint responsibility of organisations and land owners involved in water and land use;
- has a range of potential benefits beyond ecological/conservation objectives that need to be maximised, including catchment flood risk management, water resources management, fishery improvement and landscape and recreational value, ecosystem services provision, and increasing resilience to climate change;
- has a range of potential dis-benefits that need to be minimised, including increased flood risk, fishery modifications that are undesirable to local anglers, abstraction difficulties, and impacts on the historic built environment and land use potential;
- is likely to take considerable time to achieve in its entirety;
- needs to be taken into consideration in reactive evaluation of proposals to maintain or add to existing physical modifications, particularly those concerning in-channel structures and proposals for hydropower schemes;
- needs to draw on the full range of available funding and resourcing mechanisms appropriate to the measures needed;
- needs to take climate change into account.
- needs to have clearly identified ecological success criteria;
- can be delivered using an adaptive management approach, supported by monitoring.

The principles outlined above are broadly similar, and complement approaches, to morphological restoration in the wider river network. The Environment Agency has also developed guiding principles for morphological restoration to deliver Water Framework Directive environmental objectives (Environment Agency, 2011). Restoration work on Natura 2000 and SSSI sites can therefore be regarded as demonstration projects for similar work that may be needed in the wider river network.

The river restoration plan is necessarily high-level as it covers the whole river. It results in the broad identification of appropriate restoration measures for each river reach (a reach may be a few hundred metres to several kilometres long), taking into account immovable constraints (essential infrastructure that cannot be removed even in the long-term). The reach-level measures defined should be challenging but realistic in terms of the constraints imposed by land management, particularly immovable constraints imposed by flood risk to people and the built environment and public water supply.

The aim of the restoration planning process is to develop a technically sound restoration plan, but equally importantly to build consensus, establish a local delivery partnership (which may involve working with a catchment partnership established under the WFD), and to embed the restoration plan into delivery mechanisms such as agri-environment schemes, flood risk management maintenance and capital works and regulation of activities that affect the river system such as land drainage, development planning and environmental permitting. The local decision-making process for developing a restoration strategy is summarised in Figure 3.

Figure 3 Local decision-making in river restoration planning



3.4 Delivery phase

The delivery phase involves the detailed planning of measures with individual landowners at the river reach level. This is a long-term, on-going activity and is now the main focus of the SAC/SSSI river restoration programme, with projects being implemented with owner-occupiers and other partners. Local partnerships for main rivers involve the Environment Agency, whilst for smaller river sections requiring restoration Lead Local Flood Authorities (ie unitary authorities, county councils, Internal Drainage Boards) play a key role.

River restoration plans allow Environment Agency, Natural England and local partnerships to take a long term approach to securing funding from a range of sources. Using restoration plans to prioritise the individual reach-level projects, rolling bids are being made by the Environment Agency, Natural England and others to Defra Water Framework Directive funding streams, Environmental Stewardship, and Woodland Grant Schemes. These bids sit alongside opportunistic bids to a range of other funding sources. Work in-kind from partners, including the River Trusts, Wildlife Trusts and angling clubs is a critical part of implementing restoration actions. Increasingly funding is being secured from private sources including charitable trusts, private companies and landowners. Table 2 below summarises the types of restoration measure and related funding options most commonly used to deliver physical habitat restoration for protected rivers.

Table 2 Types of restoration measure and related funding options most commonly used (alone or in combination) to deliver physical habitat restoration for protected rivers.

Further detail can be found in Wheeldon (2012). Red indicates where no mechanism currently covers an item adequately. The "Making Space for Water" option in the proposed new Rural Development Programme (RDP) Countryside Stewardship scheme for England aims to address some of these gaps.

Category of restoration works	Management measure	RDP (Environmental stewardship and CSF)	NE Conservation Enhancement Scheme (non-RDP)	FCERM partnership funding	Defra GiA WFD funding	European Fisheries Funding	Major donors and trusts e.g SITA	Private landowners and angling interests
Preparation and construction	Professional help with design and implementation plans (may require major engineering design costs)	?	?	*	*	*	*	*
	Loss of Basic Payment Scheme (BPS) on productive land for preparatory work and during construction, eg storage, compounds etc.						*	*
Small scale in-channel and riparian measures	Introduction of coarse woody debris in channel				*		*	*
	Current modification (localised narrowing, log weirs etc.)		*		*		*	*
	Soft engineered bank re-enforcement/repair/ re-profiling		*		*		*	*
	Breaking up of concreted substrate				*		*	*
	De-silting (gravel jetting/mudding boards etc.)				*		*	*
	Cutting of river bank vegetation	*			*		*	*
	Removal of hard bankside defences		*	*	*		*	*
	Remove, re-locate or stop maintenance of flood defence banks		*	*	*		*	*
	Compensation for land loss due to increased river Area				*		?	*
	Loss of BPS on land lost to the river				*		*	*
Major channel/ bank measures	Restore appropriate substrate		*		*		*	*
	Removal/modification of artificial barriers		*	*	*	*	*	*
	Removal of hard bankside defences		*	*	*		*	*
	Large-scale modification – narrowing, bank re-profiling etc.				*		*	*
	Re-meandering		*	*	*		*	*
	Remove, re-locate or stop maintenance of flood defence banks		*	*	*		*	*
	Compensation for land loss due to increased river area				*		*	*
	Loss of BPS on land lost to the river				*		*	*
Major change in riparian land use	Stock exclusion	*			*		*	*
	Establishment of riparian margin/buffer zone	*			*		*	*
	Establishment and/or management of riparian trees	*			*		*	*
	Conversion from arable to semi-natural habitat	*					*	*

Category of restoration works	Management measure	RDP (Environmental stewardship and CSF)	NE Conservation Enhancement Scheme (non-RDP)	FCERM partnership funding	Defra GiA WFD funding	European Fisheries Funding	Major donors and trusts e.g SITA	Private landowners and angling interests
	Establishment of appropriate riparian grazing	*					*	*
	Control of invasive non-native plants	*			*		*	*
	Temporary loss of recreational fishing rights				*		*	*
	Infrastructure replacement (footpaths, tracks, bridges, stock shelters)	?			?		*	*
	Removal from agricultural use		*	*	?		*	*
	Devaluation of business- area is large proportion of business land, may not be viable (diminishing returns)				*		*	*
	Reduction in fodder, bedding, pasture and over-wintering area availability	?			?		*	*
	Reduced productivity of in-filled channels	?			?		*	*
Other	Management plan (land, but also includes stock management in flood events)	?					*	*

The table highlights gaps in funding for certain measures and these are discussed further in Section 4.

3.5 Progress to date

The joint national river restoration programme for protected rivers has made good progress (see section 3.1) and this needs to be maintained over long timescales. A "Restoring Designated Rivers" information hub has been created in order to share information about the programme, including the strategic plan for each river and material outlining practical progress on the ground. Examples of implementation activity are briefly given below.

The River **Wensum** geomorphological appraisal (2006) and 2009 River Wensum Restoration Strategy (RWRS) were developed as a pilot for the national approach to whole-river restoration planning. Implementation has drawn together Statutory Agencies, professional advisors and local partners to deliver major improvements to the river. Work to restore the River Wensum SSSI was recently named the winner of the England River Prize and features as a case study on the European river restoration wiki pages.

On the Hampshire **Avon**, development of the River Avon Strategy (2009) was funded by Wessex Water and the Environment Agency Flood and Coastal Risk Management (FCRM) Grant in Aid (GiA), and developed by a partnership of statutory, voluntary, landowners, fishing clubs and private industry. River restoration projects on the ground have been taken forward - between 2011 and 2015 a programme of approximately £4 million is being undertaken by a dedicated Environment Agency team using FCRM GiA, with additional funds and projects being delivered by Natural England Conservation and Enhancement Scheme (CES) agreements with fishing clubs, WFD Catchment Restoration Fund funding and volunteers.

In **Cumbria** restoration plans for the Eden, Derwent and Kent were developed in 2010, using Environment Agency flood risk management and Natural England SSSI funding. Delivery is being taken forward by a partnership of the Eden Rivers Trust, West Cumbria Rivers Trust, South Cumbria Rivers Trust and the Wild Trout Trust in partnership with Natural England and the Environment Agency. Significant landowners such as the National Trust are also closely involved. River restoration on mobile gravel rivers such as those in Cumbria has not previously been

undertaken in England and presents significant challenges both technically and in terms of securing the long term changes in land management required. A mixture of funding from the Environment Agency and Natural England, EU Interreg, and agri-environment budgets is being used to develop and implement projects on the ground including reconnection of an old meandering channel on the River Leith. New Countryside Stewardship options for "Making Space for Water" and riparian strips to support the land use change required have been developed using Cumbria as an example.

In addition to the implementation work on the ground, the advent of the catchment based approach in England has made it easier to work in partnership with charitable organisations such as River and Wildlife Trusts. Partnership working has helped to build capacity within these organisations, resulting in an increase in their ability to deliver large scale river restoration projects effectively.

A further important development is the establishment of the Environment Agency geomorphology technical service. Geomorphology advisors play a crucial and increasing role in helping to develop restoration projects and ensuring that proposed river management activities are compatible with the restoration of riverine protected areas.

4. Addressing outstanding issues

The experience of the river restoration programme has helped to identify common strategic and operational issues influencing restoration of protected rivers that require further action.

4.1 Timescales

There is a clear need to ensure river restoration on SACs is adequately resourced and progressed in the short to medium term. This needs to be coupled with an appreciation that decision making and delivery of all the actions in an SAC river restoration plan in order to meet SAC objectives must be viewed over long time frames (typically 20-50 years). The generation and auditing of strategic plans for river restoration, and regular reporting to Europe on progress with plans, should provide the necessary drive to implement necessary measures in the short to medium term whilst providing reassurance that restoration efforts on SAC rivers progress as quickly as possible at site-level.

Clarification is needed over the interaction between the dual requirements to meet 1) shorter term WFD timescales for ecological status objectives and 2) the generally longer timescales required to fully deliver restoration objectives for SAC (and SSSI) rivers. The rationale for longer timescales, to allow greater restoration of natural processes and habitat function in designated rivers, is based on the conservation needs of river ecosystems and their associated priority species and is compatible with the principles of the Habitats Directive. However, the procedural complexities this generates with the WFD need to be discussed and managed. In respect of SAC rivers, it should be possible to apply relevant measures according to the most stringent objective applicable to a site, as required by the WFD, and to clarify what this means for compliance with the less stringent objective over shorter timescales. In some cases, short-term measures to meet ecological status objectives will be compatible with the strategic plan for the protected site, and in other cases they may not be. This issue is part of the wider consideration of interactions between WFD and Habitats Directive implementation discussed in Section 4.6.

4.2 Delivery mechanisms

The main delivery mechanisms currently used to deliver river restoration on protected sites in England are summarised in Table 2. These mechanisms are often used in combination with each other- for examples several schemes have been funded using RDP funds to secure the land management aspects whilst Flood and Coastal Risk Management (FCRM) funds are used for the capital aspects. Originally these were the two main sources of funding available but recently there has been a gradual shift towards wider partnership working and associated funding e.g DEFRA WFD Grant in Aid (GiA) for catchment partnership projects, and also for landowners to fund work themselves.

Figure 4 shows a range of mechanisms for delivering river restoration, indicating whether they are under development, being increasingly used, or are new approaches that need further development. The various mechanisms are grouped according to whether they primarily relate to delivering capital works or longer term land management change. In addition further work may potentially be funded via research councils (eg NERC) and academic partnerships. Where processes can be better integrated and synergies identified, such as delivery of River Basin Management Plans and Flood Risk Management Plans, it may be possible to bring in additional funding.

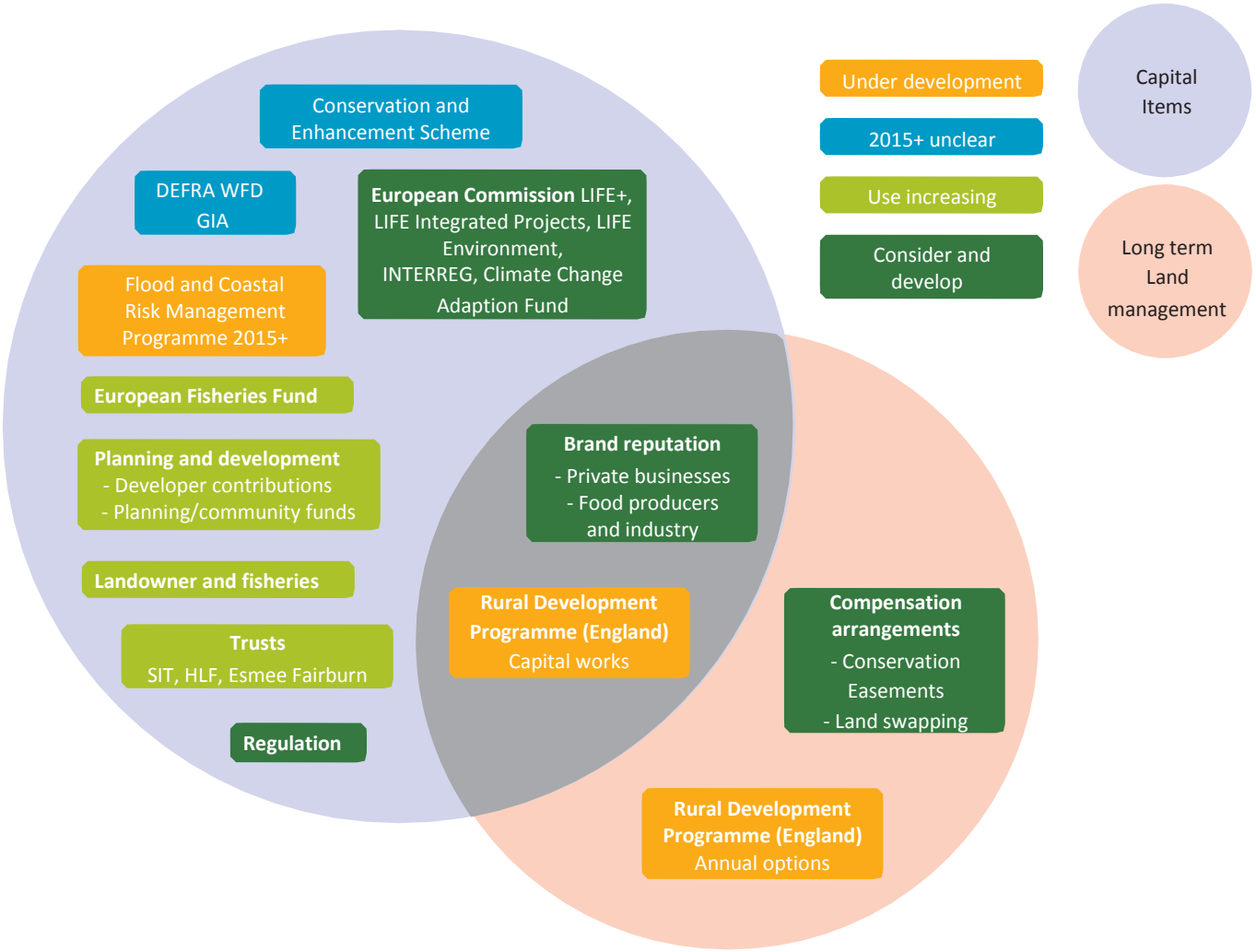


Figure 4. Analysis of existing and potential river restoration delivery mechanisms.

Currently it is very difficult to deliver river restoration schemes fully using existing DEFRA funding streams (Environmental Stewardship, WFD budgets, flood risk management budgets and the Conservation and Enhancement Scheme). In particular, restoring river movement requires landowners to accept a high degree of uncertainty and potential loss of value to their assets, and current funding mechanisms do not last long enough, provide sufficient incentives, or contain suitable options.

Figure 4 illustrates the importance of the new Rural Development Programme Countryside Stewardship scheme in helping to deliver the longer term land management change associated with restoration of protected rivers. In considering and developing potential new land management options suitable for incentivising river restoration and natural fluvial process, there are a number of useful parallels from managing coastal change that can be drawn on, including for designated sites. These include old agri-environment scheme options that supported managed retreat and which are helpful in thinking about a suitable approach to supporting restoration of natural process and associated land management.

The need for mechanisms to support the physical restoration of rivers, riparian corridors and floodplain connectivity has been highlighted in recommendation 17 of the 'Synergies Project' (Cathcart and Hardiman 2013), which considered the integrated delivery of outcomes across DEFRA's Biodiversity 2020, Water Framework Directive and Flood and Coastal Risk Management programmes. It proposes that alternative mechanisms for river restoration need to be developed where it is not possible to fund the required measures through traditional land management incentive agreements.

Approaches that aim to “make room for the river” and encourage more natural river processes are increasingly being implemented in continental Europe and North America (Piégay and others, 2005; Dutch ‘room for the river’ initiative). The driver is usually flood and erosion risk management but often has other benefits, including habitat restoration. There may be delivery mechanisms used in other countries that can be adapted for use in the UK such as options to explore include conservation easements in the USA (Smith and others, 2012a; Smith and others, 2012b) and land swapping in Denmark (RESTORE, 2013). The following sections discuss various delivery mechanisms in greater detail.

a) Incentives

Landowner resistance to allowing natural river processes to occur or be restored is high, due to the associated long term land use change and varying loss of land eligible for the single farm payment (rivers are ineligible). In addition, in upland farming systems, the limited floodplain grazing land can be critical to the viability of the farm business.

The new “Making Space for Water “ option in the new Rural Development Programme for England (Countryside Stewardship), incentivising the re-establishment of lateral river movement (Wheeldon 2014), is likely to greatly improve the rate of progress in removing bank reinforcements. It is clear however that RDP alone is unlikely to be able to deliver the more complex large scale schemes required.

b) Land Purchase or Compensation and Payment for Alternative Beneficial Land Use

The current approach to SAC river restoration is based on the funding of capital works and subsequent on-going payments for appropriate land management associated with the restored river. An alternative option is public purchase of required land and the leasing of management to others (eg NGOs). This may be a more sustainable option in the long-term, at least in some cases.

An example of this approach is the use of flood risk management funds to purchase or lease land in order to compensate landowners for land loss associated with managed realignment schemes for coastal flood risk management or Natura 2000 site habitat creation. DEFRA guidance and funding rules set out basic principles, which are then used to negotiate on a scheme-by-scheme basis.

Section 2.2 of the DEFRA guidance sets out principles that suggest that FCRM GiA might be used to fund capital elements of schemes with joint Natural Flood Management (NFM) / river restoration aims, but the associated longer term land use change has to be funded using other mechanisms eg RDPE Countryside Stewardship options.

c) Payments for Ecosystem Services

The term Payments for Ecosystem Services (PES) is often used to describe a variety of schemes in which the beneficiaries of ecosystem services provide payment to the stewards of those services. PES schemes can involve a continuing series of payments to land or other natural resource managers in return for a guaranteed or anticipated flow of ecosystem services. The basic idea behind PES is that those who are responsible for the provision of ecosystem services should be rewarded for doing so, representing a mechanism to bring historically undervalued services into the economy (The River Trusts 2012).

The WATER project (River Trusts, 2012) considered the potential for PES schemes to pay for ecosystem services such as provision of adequate quality and quantity of drinking water, and flood peak attenuation using NFM approaches, and produced basic guidance on how to develop a scheme. The potential development of a PES scheme to support projects with Natural Flood Risk Management and river restoration aims needs to be considered and tested.

d) Conservation covenants and easements

Conservation easements have been widely used in the United States to restrict developments in return for positive tax benefits for land owners. Covenants are a contractual agreement between parties covering all sorts of activities; they cannot generally be handed on to successive owners and are often limited to impacts upon neighbouring land.

An analysis of legal delivery frameworks (Smith, L. (2012)) on the use of restrictive covenants (such as those being used by West Country Rivers Trust in piloting PES) with conservation easements found the following;

- Easements have been used for a variety of environmental purposes in the United States to protect wetlands, scenic views or to establish state parks and are generally entered into by state and federal governments and NGOs. There have been some issues in the United States partly due to people seeking the associated tax benefits and as a result the benefits are gradually being closed off.
- Whilst covenants are common in the UK (perhaps 79% of land is subject to at least one covenant), conservation easements are not currently an option. Easements might prove a useful tool in the UK and could be better than covenants for long-term safeguard and where actions needed to be spatially targeted. The Law Commission has recently recommended the introduction of conservation covenants (easements) in England, following extensive consultation.

The potential use of covenants and easements to support projects with Natural Flood Risk Management and river habitat and species restoration aims needs to be considered and tested.

e) Land banking and swapping

In Denmark, the government Forestry and Nature Agency buys land in advance and then makes it available for projects such as the Houting LIFE project to swap with landowners who will be adversely affected by the restoration of river movement. Increasingly this type of approach is being used in The Netherlands in order to improve standards of flood risk protection for farms in polders.

Land ownership patterns differ in Denmark and The Netherlands compared to the UK. Nevertheless, this policy of land swapping and land purchase to facilitate restoration is a powerful tool and would be useful in the UK, particularly when looking to restore on a catchment scale.

f) Developer Contribution Schemes

Natural England, the Environment Agency and three local planning authorities in the East Midlands have set up a 'Developer Contributions Scheme' (DCS) which will enable development to proceed in the catchment of the River Mease SAC whilst ensuring that such development does not contribute to deterioration in water quality. The scheme will pay for projects to offset the phosphate contribution made by the new development.

The Mease river restoration plan incorporates a range of restoration measures, some of which can be directly linked to associated benefits in terms of reducing levels of phosphorous. The different categories against which actions are listed have been considered by relevant specialists and those which provide benefits in terms of phosphorous reductions have been identified. Developer contributions can be used to fund implementation of these measures.

Details of the scheme are available at
http://www.nwleics.gov.uk/files/documents/river_mease_sac_developer_contribution_strategy1/River%20Mease%20DCS.pdf

g) Working with food producers and suppliers

Consumers have the power to influence the level of biodiversity focus in land management through the purchasing decisions they make, as long as the relationship between food products and their environmental benefits are clear. Supermarket marketing and supply chain advisors are increasingly looking at biodiversity delivery as a means of:

- enhancing brand reputation;
- responding to changing customer shopping habits by sourcing food with a biodiversity story behind it;
- improving traceability and transparency of supply chains;
- addressing the supply chain insecurity that results from declining ecosystem services, through investment in biodiversity strategies with agricultural suppliers; and
- complying with international standards on environmental management (ISO 14001).

[URL references accessed 30/04/2015]

The link between marketing or brand reputation initiatives and their biodiversity benefits can vary significantly depending on the scale of the initiative. National initiatives are more difficult to establish and are typically less demonstrably linked to biodiversity benefits. Local initiatives based around the delivery of a strategic restoration plan could be more demonstrably linked to the biodiversity benefits of river restoration.

There are already number of local initiatives in place where food suppliers and private industry have focussed on their funding of biodiversity delivery as a selling point eg Coca Cola and Wessex Water both invest in projects that deliver biodiversity gain on protected rivers.

There is a need to explore opportunities more strategically where companies seeking enhanced brand reputation could help deliver biodiversity benefits to protected rivers. There is scope to trial an approach to working with local food producers on specific designated rivers. Case studies could be developed looking at food production on land adjacent to protected rivers in prime food production locations eg potato production on land adjacent to the Rivers Wye and Lugg, whilst upland SACs may be linked to key lamb production locations.

The evidence base for the ecological and ecosystem service benefits of riparian and river habitat restoration needs strengthening in order to enable engagement with food suppliers, and to provide quality assurance for consumers.

h) Partnership funding

The advent of the DEFRA catchment approach has increased partnership working with non-governmental organisations such as River Trusts. This has resulted in a gradual shift towards wider partnership working and associated funding as these groups can often secure funds from major donors such as the charitable trusts, industry, and landowners and combine it with DEFRA funding to maximise value for money. Increasingly landowners are willing to fund work themselves as they see the benefits it can bring to their landholding, including fisheries and potentially tourism.

Further development of non-governmental implementation mechanisms for river restoration is needed however, as governmental organisations still often lead on the development and management of multi-million pound project bids. A national strategic approach to securing funds from sources such as the European Commission LIFE Integrated Projects and Climate Change Adaption funds should be developed in order to maximise uptake of these funds for delivery of river restoration on protected areas.

i) Interaction with Natural Flood Management

As acknowledged by the UK Government's strategy "Making Space for Water" (2005) and the Pitt Review (2008), traditional flood management solutions will continue to have a key role but alone may not always be effective or sustainable in the face of increasing flood and erosion risk over the next century.

With climate change likely to mean more intensive rainfall, resulting in increased river flooding and changes in patterns of erosion there is an increasing drive to make use of more "Natural Flood Management" (NFM) approaches. The modern concept of "making space for water" is associated with a catchment-based approach to flood risk management, based on natural processes, and is highly compatible with river restoration.

The challenges in delivering a range of NFM approaches using current implementation mechanisms, and potential alternatives, are explored in the recently published DEFRA report on The Economics of Climate Resilience Natural Environment Theme: Natural Flood Management CA0401 (Frontier Economics and others, 2013). The findings show there are many common difficulties shared between the implementation of NFM and restoration approaches involving "making space for water".

j) Regulation and enforcement

The approach to river restoration outlined in section 3 above is based on a voluntary, incentivised approach. No compulsory action has yet been taken to implement river restoration plans. The amount of pressure to apply compulsory mechanisms is related to the required timescales for meeting SAC objectives. As long as a long-term approach is taken where appropriate and acceptable progress is being made with plans, there should be little need for enforcement procedures. However, it may be required in some instances (eg for the removal of key structures), so there is a need to ensure that the relevant measures or objectives in river restoration plans carry sufficient weight to inform the current regulatory decision making process (development control and environmental permitting). Thought needs to be given to how to better integrate restoration plans into operational decision making for Natural England and Environment Agency permitting and the planning system, to ensure that they are taken into account as material considerations. Ideally, decisions should not be made which conflict with long-term plans.

4.3 Programme governance

The success of the national programme as a whole has been critically dependent on the role of the national project officer, jointly funded by Natural England and the Environment Agency and reporting to a national steering group consisting of relevant Natural England and Environment Agency staff. The long-term sustainability of this post is fundamental to keeping the programme on track and focused on long-term strategic outcomes. It has proved difficult to secure the long-term funding for this post that the programme requires, which puts at risk the considerable investment that has so far been made and the ability of the programme to meet its long-term objectives.

At the site-level, there is currently variation in the extent to which the strategic restoration plan is driving long-term, strategic decision-making. Where the plan for the site is new and local governance arrangements are not yet mature, there is a tendency for some stakeholders to continue with small-scale mitigation works without strategic context, and to secure delivery funds for such work by referencing the strategic plan rather than contributing effectively to delivery of its longer term aims. These instances highlight the critical importance of an effective local partnership steering group, which agrees the ethos and content of the plan and ensures that proposals for individual schemes are properly planned and make effective progress with its implementation. To aid-site level planning and governance, it is recommended that specific actions are included within future editions of the Site Improvement Plans produced by the Improvement Programme for England's Natura 2000 Sites (IPENS project), to set out the requirements for river restoration planning, implementation and governance (see Section 5.1).

4.4 Notification process

Some elements of the SSSI notification process for river habitat (on which UK terrestrial SAC notification is based in England), are not consistent with the restoration of natural processes on SAC rivers, as set out in Mainstone (2011). The following issues are particularly relevant.

- River SSSI/SAC boundaries are focused on the extant alignment of river channel(s) at the time of designation. The SSSI boundary does not allow for natural river movement, which is a particular problem in energetic upland river systems. In many cases, the river channel has moved well out of the original

mapped location of the SSSI (eg Figure 5). Having such a static basis for defining river SSSI boundaries creates considerable difficulty in promoting natural riverine processes and their associated ecological benefits.

- Current river SSSI/SAC notifications in England are focused particularly on the river channel and do not adequately address the functional river corridor or river-floodplain habitat interactions.

- Greater emphasis needs to be given to conserving naturalness and natural riverine processes as a means of conserving characteristic biological assemblages and individual species features.

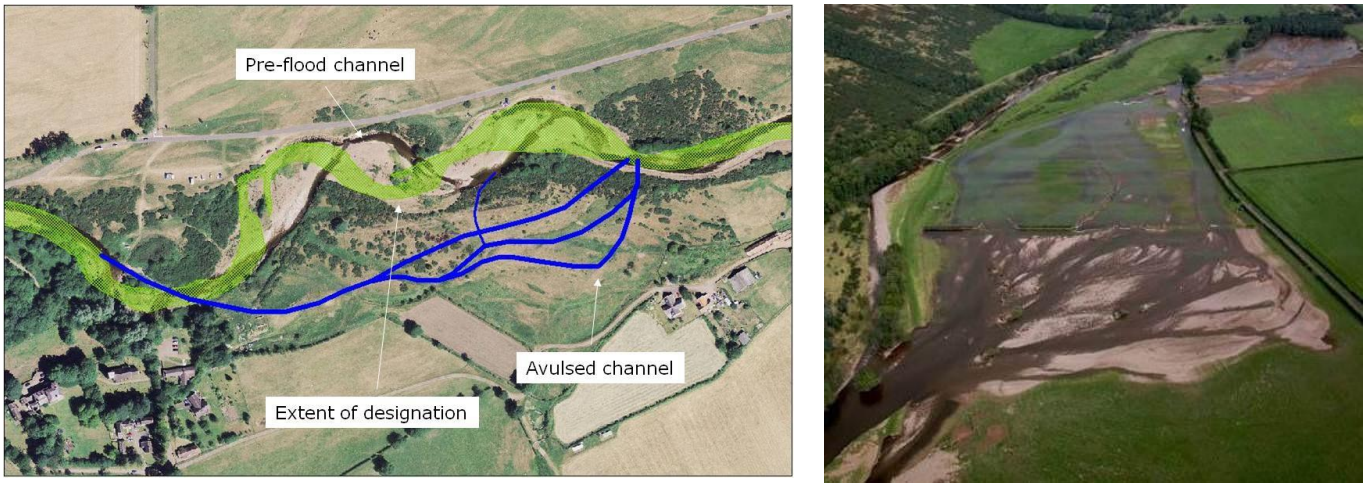


Figure 5. Channel movement in relation to mapped SSSI boundary on the River Breamish, Northumbria (part of River Tweed SAC) in 2008 flood event. Left: SSSI in green, newly formed channel in blue. Right: aerial picture showing channel change.

Work is currently being undertaken on the national (Great Britain) SSSI selection guidelines and under Natural England's notification strategy to better align the river SSSI notification process with natural riverine processes and habitat function, which will facilitate (inter alia) physical river restoration (Mainstone and others, in draft). This includes the use of site boundaries that accommodate dynamic change and the inclusion of appropriate river corridors within the site boundary. The intention is that sites will be re-notified on a rolling basis over a period of time to incorporate a functioning river corridor, more hydrologically connected floodplain land, lateral channel movement within the site boundary and with species features explicitly protected through maintenance and restoration of natural processes.

4.5 Interactions with the hydropower agenda

There are estimated to be around 26,000 in-channel structures (dams, weirs, sluices) in rivers across the UK, with the large majority being located in England. Over the past decade there has been an increasing trend for these structures to be considered for use in small-scale hydropower schemes, fuelled by the push for renewable energy sources to combat climate change. The need to reconcile objectives for river restoration with the demand for green energy from hydropower generation has become acute. Since restoring natural habitat function is the key climate change adaptation measure for freshwater ecosystems, (Kernan and others, 2012), and in-channel structures generate major loss of natural function in English rivers, this can be viewed as a conflict between two climate change priorities. The issue affects the SAC and SSSI river network as much as it affects the wider river network.

The SAC/SSSI river restoration planning framework is clear about how to make decisions about existing in-channel structures, and this has been reinforced in a joint regulators' statement on hydropower (Environment

Agency/Natural England/Countryside Council for Wales, 2012). Natural England's climate change adaptation manual (Natural England/RSPB 2014) provides support for the approach specifically in the context of climate change. Further work is needed to explain this position clearly to hydropower developers.

4.6 Interactions with WFD and other ecological objectives

Strategic plans to restore SAC and SSSI rivers generally go considerably further than planned measures to restore good ecological status (or potential) to river waterbodies under the WFD. Generally, there is a regular operational need to highlight Article 4.1 of the WFD, relating to the application of the most stringent objectives, which would ensure that measures for SAC river restoration should, where more stringent, be applied over and above the baseline requirements of the WFD. The European Commission's Frequently Asked Questions document (EC 2012) on the relationship between the WFD and Habitats Directive does provide the necessary direction to implement Article 4.1. However, there are areas where further guidance would be useful, for instance in the operational handling of timescales for achieving objectives across the two Directives (see Section 4.1). It would also be valuable to develop further detailed approaches to improving synergies between the Directives, and indeed to reconciling potentially conflicting requirements within the Habitats Directive (Rekhlau and others, 2010), based on the promotion of natural processes and integrating species needs within naturally functioning habitat wherever possible. Some further information on decision making can be found in the Hydrological Functioning Theme Plan (Annex 1). Critically, further guidance also needs to address conflicts between restoring natural river habitat function and conserving floodplain habitats that have evolved as a result of damaging physical modifications to rivers.

4.7 Evaluation of benefits

a) Ecological benefits

Whilst the general ecological case for restoring natural riverine processes to conserve river habitat is strong, strategic evaluation of case studies within the SAC river restoration programme would be valuable in improving the evidence base. The monitoring strand of the SAC restoration programme is under-developed; now that strategic restoration plans have been produced and implementation is underway, it is a good time to make progress with this. The quality of monitoring is considerably more important than the quantity – a small but strategic programme of research across the SAC/SSSI river network, based on carefully selected sites investigating key restoration issues on key river types, would generate the most beneficial results. Linkage with local universities would improve the likelihood of long-term monitoring activity on these sites.

An IUCN river restoration project is currently underway, the aim of which is to promote best practice in river restoration for supporting biodiversity conservation, for enhancing ecosystem services, and for developing a more consistent approach to meeting the aims of the Habitats Directive, the EC Water Framework Directive and the Floods Directive. One of the main objectives is to gather evidence of the benefits of restoring natural processes for river, riparian and floodplain biodiversity, and to provide a platform for raising funds for practical restoration. This project should help to establish strategic research on a range of carefully selected restoration sites, which should be sufficiently robust and well-planned to make significant enhancements to the evidence base for river restoration.

Robust monitoring results from good case studies in other parts of the world are also becoming more available, which will help to alleviate this evidence issue (eg Lorenz and others 2013, Luderitz and others 2011).

b) Ecosystem service benefits

Allied to ecological evidence, there is a growing interest in techniques to assess the wider ecosystem service benefits from river restoration (eg flood risk management, landscape and recreation). Use of these techniques on the

SAC/SSSI river series alongside ecological monitoring techniques would help to promote the wider case for river restoration.

An increasing number of restoration projects are being planned and evaluated with ecosystem services in mind, but standard tools for assessing ecosystem services are not widely available. The evaluation of specific projects tends to rely on adapting and interpreting a range of assessment approaches and applying them to river restoration projects. There is no one list setting out how to value the natural assets associated with rivers, no standard approach, and assessments rely on interpretation so are unlikely to be done consistently.

A data driven method for assessing elements of ecosystem service benefits of river restoration using Google earth has recently been proposed (Large and Gilvear 2014). The approach is currently being considered further as part of the "Automated mapping of river networks for ecosystem service assessment" project. There is a need to develop this and other approaches in order to establish consistent and widely applicable ways to evaluate the ecosystem service benefits of river restoration.

Managing flood risk by working with natural processes can include a range of "natural flood management (NFM)" approaches that can contribute to restoring protected rivers and their catchments. A comprehensive programme of research (Working with Natural Processes, WwNP, Research Framework) to assess how flood and coastal erosion risk management could be carried out sustainably, improving the environment for people and wildlife was launched in July 2014. The project will specifically consider the potential flood risk and ecological benefits of NFM approaches. Aspects under consideration include effects on sediment supply and transport, potential for "blue-green" infrastructure, managing woody debris and fisheries.

Stages 1, 2 and 3 of the WwNP programme are complete and have established what research had been completed to date, gaps in our knowledge and future research needs. The 14 highest priority research projects have now been identified and the business cases written to form a basis for future R&D project proposals. The next steps are to publicise the framework; obtain funding for the projects; carry out the research projects; and monitor progress of the framework.

5. Implementation and priority actions

5.1 Implementation

The English approach to river restoration on protected sites has proved very successful so far and as of August 2014 a total of 13 SACS have plans in place (out of 18 that need them), covering approximately 1100 km of SAC). Whilst this is encouraging, there is full recognition that to ensure SAC rivers contribute fully to favourable conservation status will require continued effort over long timescales (20-50 years). The actions outlined in this theme plan need to be implemented by Natural England, the Environment Agency and partners and are summarised in section 5.2. Implementation of all theme plans will be overseen by an ongoing 'After LIFE' process after the conclusion of the IPENS project itself.

Update Site Improvement Plans

The Site Improvement Plans (SIPs) produced by the IPENS project for each Natura 2000 site are live documents, and where necessary will be updated annually to reflect new understanding about issues affecting the sites. River restoration actions are already included in SIPs for SACs which are part of the national programme. Natural England staff should ensure that these and any actions added in future editions of the SIPs are consistent with the recommendations outlined in Table 3 below.

Table 3. Recommended approach for SIP actions

Number	SIP section	Recommendation
1	Delivery partner	River restoration plans are jointly owned, therefore the joint delivery partners of 'Natural England / Environment Agency' should be included for all actions relating to the implementation of river restoration plans
2	Timescales	Timescales and any descriptive text relating to implementation of river restoration plans should be realistic about the timescales required for full delivery of the plan, and make this clear in responding to extensions of Water Framework Directive / River Basin Management Plan deadlines 2015/2027.
3	Mechanisms	Consideration should be given to inclusion of a broad range of delivery mechanisms for river restoration plan implementation, with reference to available information sources
4	Funding	Consideration should be given to a wide range of funding options for river restoration plan implementation, with reference to available information sources
5	Governance	Need to ensure effective local partnership steering groups are in place and that they retain a focus on long term strategic decision making, ensuring that individual delivery schemes contribute towards long-term restoration of natural processes and natural habitat function.

5.2 Recommended actions

Table 4 below outlines the priority actions for implementing this theme plan. It indicates the next steps required to progress the approach outlined. The priority actions table should not be seen as a fully funded, committed-to implementation plan. It is aimed at informing future resource decisions of the delivery bodies involved. Implementation of the theme plans will be coordinated through the IPENS After-Life programme and its steering group. It summarises those actions identified in earlier sections of this document, which are recommended to address outstanding issues for implementation of the SAC/SSSI river restoration programme developed by Natural England and the Environment Agency. Actions are mainly strategic rather than site specific and are subdivided into

themes as follows:

- High level strategic recommendations
- Delivery mechanisms
- Funding
- Site level implementation – Evidence base, evaluation and monitoring.

Actions in Table 4 are not presented in a priority order. A wider prioritisation of actions identified by the IPENS project will be undertaken in due course to inform decision making about funding and implementation during the delivery phase after the IPENS project has closed.

Table 4 Priority actions

Action no.	Action description	Timescale	Delivery mechanism and funding option	Lead body
HIGH LEVEL STRATEGIC RECOMMENDATIONS				
1	Seek the view of the European Commission regarding general recognition of the need for longer timescales for meeting SAC objectives in relation to complex freshwater issues.	2015	EU Expert group on Birds and Habitats Directives	Natural England / Environment Agency
2	Make recommendation to the Commission that further work is undertaken on aligning the Water Framework Directive and Habitats Directive targets, based around restoring dynamic natural processes at landscape/catchment-scale and applying climate change adaptation principles, to secure greater synergies and increase the efficiency of decision-making across the biodiversity and water agendas.	2015	IPENS closure reports	Natural England / Environment Agency
3	Finalise strategic review of river SSSI series in England and implement findings to provide better underpinning of the restoration of natural riverine processes for both habitat and species conservation, including on Natura 2000 sites.	2015 and beyond as a rolling programme	SSSI Detailed Notification Review Implementation	Natural England
DELIVERY MECHANISMS				
4	Strategic analysis of current use of available delivery mechanisms e.g LIFE, HLF, Trusts etc: identification of opportunities to develop new delivery mechanisms across all SAC rivers, and by individual designated river.	2015		Collaborative research by Defra, Natural England and the Environment Agency
5	National feasibility study assessing the potential to use land purchase, land banking, covenants and payments for ecosystem services for delivery of river restoration on designated rivers. Study to also consider synergies with Natural Flood Risk Management.	2015-2016		Collaborative research by Defra, Natural England and the Environment Agency

Action no.	Action description	Timescale	Delivery mechanism and funding option	Lead body
6	Clarify the status of river restoration plans in regulatory decision making, and fully embed river restoration plans into Environment Agency environmental permitting and Natural England consenting processes, including hydropower and flood defence permitting	2015 onwards	Natural England /Environment Agency National project officer for the SAC/SSSI river restoration programme	Natural England regulatory services and legal and Environment Agency environmental permitting
7	Explore opportunities where companies seeking enhanced brand reputation could help deliver biodiversity benefits to protected rivers. Local case studies could be developed looking at food production on land adjacent to protected rivers in prime food production locations.	Ongoing, but useful to develop case studies by 2017/2018	SAC/SSSI river restoration programme	Natural England / Environment Agency / NGOs
8	Track progress with the River Mease SAC developer contribution scheme, and promote as a case study for delivery of river habitat restoration	2017/18	River Mease Developer Contribution Scheme	Natural England, Local Authority
9	Ensure effective local partnership steering groups are in place and that they retain a focus on long term strategic decision making	2015 onwards	Natural England /Environment Agency National project officer for the SAC/SSSI river restoration programme	Natural England / Environment Agency`
FUNDING				
10	Seek to secure resources for the continuation of the national project officer post that has been fundamental to the success of the national programme of SAC/SSSI river restoration.	2015 onwards	Defra Grant-in- aid	Natural England, Defra
11	Create a national funding strategy and action plan to identify, prioritise and secure major funding for restoration of SAC and SSSI rivers from sources such as the European Commission. LIFE Integrated Projects and Climate Change Adaption funds should be developed in order to maximise uptake of these funds for delivery of river restoration on protected areas.	2015/16 onwards	IPENS / Natural England External Funding Team. LIFE +, INTERREG, Climate Change Adaption, the Heritage lottery fund, charitable trusts, food producers, and developer contribution schemes.	A partnership of Environment Agency, Natural England, River Trusts, Wildlife Trust, major landowners such as the National Trust and RSPB.
SITE LEVEL IMPLEMENTATION - EVIDENCE BASE, EVALUATION AND MONITORING				
12	Ensure actions within future revisions of IPENS Site Improvement Plans for river SACs are consistent with recommendations in Section 5.1 of this plan.	2015 onwards	Natural England core work	Natural England Area Teams / site responsible officers
13	Improve the evidence base on the importance of natural processes to riverine ecosystems and the ecological/biodiversity benefits of physical restoration, including - review the available evidence and generate an accessible report - collaborate over a programme of strategic research to provide further underpinning. - Promote use of SSSI series for monitoring success of practical restoration	Review in 2015; Implementation 2016 onwards	Development of Natural England evidence paper. IUCN project on river restoration in the UK, Progress the monitoring work strand of the river SSSI/SAC restoration	IUCN project, Natural England Environment Agency, River Restoration Centre, Academics
14	Review available evidence on the ecosystem service benefits of rivers and the benefits of physical restoration, and use the SSSI/SAC network to improve evidence base, thereby contributing to development of generic methods.	Review 2015; Implementation 2016 onwards	IUCN project, application of ES techniques to selected SAC/SSSI river restoration strategies	IUCN project Natural England, Environment Agency, RRC Academics

Action no.	Action description	Timescales	Delivery mechanism and funding option	Lead body
15	Review available evidence on the Natural Flood Management benefits of catchment restoration including physical habitat restoration, and implement programme of strategic research to improve evidence base if required.	2015/16 onwards	DEFRA, Environment Agency FCRM GiA. (This action is a subset of action 13 but can utilise a specific Defra/EA research budget)	DEFRA, Environment Agency, Natural England
16	Develop monitoring protocol and strategy for SAC/SSSI river restoration on a strategic and project scale and apply to the designated rivers network. Seek collaborative funding, linked to IUCN project and Working with Natural Processes framework as appropriate.	2015	Natural England /Environment Agency National project officer for the SAC/SSSI river restoration programme and NE river habitat senior specialist	Natural England (with support from Environment Agency)

Annex 1. IPENS Theme Plans

The table below provides hyperlinks to the suite of IPENS theme plans, which are available on the Natural England publication catalogue.

Theme plan	Hyperlink
Atmospheric nitrogen deposition	http://publications.naturalengland.org.uk/publication/6140185886588928?category=5605910663659520
Climate change	http://publications.naturalengland.org.uk/publication/4954594591375360?category=5605910663659520
Diffuse water pollution	http://publications.naturalengland.org.uk/publication/5848526737113088?category=5605910663659520
Grazing	http://publications.naturalengland.org.uk/publication/4839898496368640?category=5605910663659520
Habitat Fragmentation	http://publications.naturalengland.org.uk/publication/5004101806981120?category=5605910663659520
Hydrological functioning	http://publications.naturalengland.org.uk/publication/6400975361277952?category=5605910663659520
Inappropriate coastal management	http://publications.naturalengland.org.uk/publication/6371629661683712?category=5605910663659520
Invasive species	http://publications.naturalengland.org.uk/publication/6130001713823744?category=5605910663659520
Lake restoration	http://publications.naturalengland.org.uk/publication/5583022327857152?category=5605910663659520
Public access and disturbance	http://publications.naturalengland.org.uk/publication/6621454219083776?category=5605910663659520
River Restoration	http://publications.naturalengland.org.uk/publication/5478339747774464?category=5605910663659520

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This work has been financially supported by LIFE, a financial instrument of the European Community

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Natural England is here to secure a healthy natural environment for people to enjoy, where wildlife is protected and England's traditional landscapes are safeguarded for future generations.

ISBN 978-1-78354-197-3

Catalogue Code: IPENSTP023

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