# Hydrological functioning theme plan

## Restoring the hydrology of Natura 2000 terrestrial wetlands

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

**www.gov.uk/government/publications/improvement-programme-for-englands-natura-2000-sites-ipens**

# 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 have been developed. SIPs provide an overview of the issues affecting features at site level and the actions required to address them. Theme plans are high-level plans that 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 provide an over-arching direction, recommendations, or outline approaches that will help achieve target conservation status of Natura 2000 sites in England, and complement work already underway on individual sites. These plans do not have a legal status, and do not constitute a systematic evidence review, but are based on evidence and expert opinion. They aim to inform the action and initiatives of Natural England and its partners to help achieve the objectives of Natura 2000.

It is anticipated that Natural England, its stakeholders and partners, will all play a role in implementing the theme plans. In developing these plans, Natural England has approached key partners and delivery bodies to seek their input and agreement on their roles, though in some cases these discussions have not yet concluded. Recommended actions and next steps identified in the plans are not necessarily committed or resourced, but intended to inform 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

This document is the Hydrological Functioning Theme Plan. It is aimed at practitioners and decision makers dealing with the hydrology of Natura 2000 sites in England, including staff in Natural England, the Environment Agency, Defra, Internal Drainage Boards, and other stakeholders and partners.

## Scope of this theme plan and its relation with other IPENS theme plans

This document is the theme plan for hydrological functioning produced by the Improvement Programme for England's Natura 2000 Sites (IPENS) project. It focuses on the importance of hydrological restoration of SAC terrestrial wetlands in achieving the objectives of the European Habitats Directive. It provides an indication of the scale of hydrological restoration needed, summarises some key issues, and recommends the development of a strategic approach to improve the hydrological management of sites. The document is structured as follows:

- Overview of hydrological functioning issues on SAC terrestrial wetlands (section 2).
- Current approaches to hydrological restoration (section 3).
- Key issues (section 4).
- Progressing a strategic approach to the hydrological restoration of SAC terrestrial wetlands (section 5).
- Benefits, priority actions and next steps (section 6 & 7).

This theme plan focuses on the hydrological restoration of SAC terrestrial wetland habitats (i.e. upland and lowland bogs, fens, dunes, wet grasslands, valley mires, wet woodland and wet heaths) where specialised biological communities rely on a narrow range of hydrological conditions. It is intended to build on existing programmes and initiatives, such as Water Level Management Plans (WLPMs), Restoring Sustainable Abstraction (RSA) and hydrological restoration projects and actions.

The theme plan aims to initiate the development of a more holistic approach to the hydrological restoration of SAC terrestrial wetlands. It does not focus on the hydrology of SPA bird habitat, neither does it detail the management of river and lake habitats. However, the hydrological functioning of open freshwater habitats and associated wetlands are inseparable and need to viewed in an integrated way. This integration is dealt with in the plan, linking across to the theme plans on river restoration and lake restoration. These, in turn, link to other theme plans, such as that on diffuse water pollution.

The suite of IPENS theme plans focus on Natura 2000 sites in England, but the approaches and principles they identify are generally applicable to other protected sites, such as SSSIs.

# Executive Summary

Hydrological processes are central to the maintenance and restoration of Natura 2000 terrestrial wetlands such as bogs, fens, wet heaths, wet grasslands and wet woodlands. The English landscape has a long history of anthropogenic intervention in the hydrological functioning of (semi-) natural habitats through intensive land drainage, water level management and abstraction. This historic modification is one of the main causes of unfavourable condition of terrestrial wetlands on designated sites and significant conservation effort has gone into addressing it.

Most terrestrial wetlands in Natura 2000 are now in unfavourable-recovering condition, while a relatively small percentage is still unfavourable-no-change or declining. However, behind this encouraging headline lies a complex picture of outstanding actions that are still required to ensure recovery to favourable condition and achieve the full contribution of the Natura 2000 sites to the strategic objectives set out by the Habitats Directive. These strategic issues are outlined below.

Sites may be assessed as recovering where actions to remedy their impacts have been identified and their implementation has started. However, in many cases further action is still required. Sometimes these outstanding actions are currently not fully funded, or their details have not yet been agreed with partners. The IPENS Site Improvement Plans (SIPs) identify these actions and prioritise their implementation at a site level. Many outstanding actions are not new (for example, they may already be embedded in Water Level Management Plans), but progress with implementation can be slow due to a range of barriers and constraints for example associated with existing land-use interests. The actions identified in SIPs need to be further specified, agreed with delivery partners and implemented in order to achieve the target status for sites.

The target hydrological status for a SAC terrestrial wetland generally aims to restore or maintain in favourable condition the vegetation that was present at the time of the site's designation (though for the purposes of the Habitats Directive, additional habitat restoration and re-creation may be required on some sites). However, historic modifications to hydrological functioning are not always recognised as an issue, even when they impact on SAC wetland features. A factor in this can be a lack of understanding of what constitutes favourable hydrology at a site. We need to improve our understanding of eco-hydrological functioning of sites where there are gaps in our knowledge, and review long-term hydrological targets for SAC wetlands where needed in order to promote an approach to restoration that considers natural hydrological regimes and long-term sustainability.

Hydrological restoration has sometimes taken a mechanistic, managed approach to achieving the right hydrological condition for specific vegetation types. However, while some habitats and species can be maintained by artificially-managing hydrological conditions, other habitats rely on more natural processes to govern the conditions that allow them to be conserved in their full variety with all associated species. It is increasingly recognised that a long-term sustainable approach needs to focus on restoring natural hydrological processes where possible and appropriate. This can reduce the need for hydrological management in perpetuity (and its associated costs and risks) and is likely to increase resilience to climate change. The drive towards more naturally-functioning ecosystems, and to generate more sustainable ecological networks at a landscape scale, is embedded in the Lawton Principles, in Natural England's climate change adaptation manual, and in guidelines for SSSI selection. There are, however, differences between sites and habitat types with regards to the potential, and desirability, of restoring a more natural hydrology. The challenge is to establish appropriate long-term ambitions for the hydrological restoration of individual terrestrial wetland SACs.

This theme plan prioritises the need to implement the outstanding actions for SAC terrestrial wetlands identified in SIPs, and draws together the findings of these plans. It also acknowledges that a long-term approach to achieving more natural hydrological functioning is likely to be critical in reaching Favourable Conservation Status (FCS) for some habitats. The theme plan proposes to consider establishing local hydrological restoration strategies (comparable to river restoration strategies) for those terrestrial wetland SACs where the focus is on restoring, as far as possible, natural hydrological functioning. These local plans would be established with the involvement of relevant partners. The plans would analyse the potential contribution of a site to FCS based on a good understanding of a natural eco-hydrology and set appropriate hydrological targets taking account of immovable local constraints. A coordinated national programme would ensure that the hydrological restoration of SAC terrestrial wetlands is planned consistently across the network using transparent, evidence-based decision making. This theme plan proposes the development of such a programme, starting with a limited number of targeted habitats across a limited number of sites, building on work that is already underway. As a first step we would explore the value of such a programme with relevant delivery partners, particularly through the Terrestrial Biodiversity Group and the Major Landowners Group.

# Contents

# 1. Background

Hydrological processes are central to the maintenance and restoration of terrestrial wetlands designated as Special Areas of Conservation (SACs). Terrestrial wetland habitats such as bogs, fens, wet grasslands, dunes and wet heaths have specific needs in terms of groundwater and surface water availability. Changes to the eco-hydrological functioning of wetlands (i.e. where water comes from, how it moves through the site, its quantity, chemistry and nutrient status, the nature of the substrate and vegetation present) can lead to changes in vegetation composition, with consequent effects on other species that depend on the habitat. The English landscape has a long history of anthropogenic intervention in the hydrological functioning of (semi-) natural habitats through land drainage, water-level management and abstraction (Hume, 2008). The Wetland Vision for England project, developed in partnership with Environment Agency, Natural England and NGOs, articulates how the remaining wetland resource in England is impoverished and fragmented, with dependent wildlife struggling to survive. Almost all terrestrial wetland habitats are affected by a history of hydrological modification and many actions for protected sites that have been taken to address these impacts (Hume, 2008, Maltby and others, 2011). The hydrological functioning of Natura 2000 sites is often inextricably linked to the hydrological regime of the wider catchment and its legitimate interests such as flood protection, agricultural land-use and infrastructure. This can make the hydrological restoration of terrestrial wetland systems both complex and expensive. Hydrological restoration can, however, contribute to long-term sustainability, for example, with regards to climate change adaptation. It can also reduce other stressors in the landscape such as the impacts of air pollution, water pollution and habitat fragmentation. Landscape-scale management with sufficiently long-term objectives can help integrate hydrological restoration with other actions for biodiversity, climate change adaptation and enhanced ecosystem services.

Restoring the hydrological functioning of Natura 2000 terrestrial wetlands will contribute to:

- Achieving Favourable Conservation Status (FCS) for habitats and species of international importance.
- Meeting favourable condition targets for SSSIs under the Wildlife and Countryside Act (82% of SSSIs are also Natura 2000 sites).
- Meeting targets for designated sites, priority habitats and species and for ecosystem restoration under the England Biodiversity 2020 Strategy.
- Meeting objectives for protected areas and ecological status under the Water Framework Directive.
- Meeting the aims for wetlands of international importance designated under the Ramsar Convention.

# 2. Overview of Natura 2000 network in England

## 2.1 Hydrological restoration to date

Significant conservation effort has gone into tackling historic hydrological modifications on Natura 2000 terrestrial wetlands over the past decades, in recognition that this is one of the main causes of unfavourable condition of protected sites. Water abstractions have been (and continue to be) reviewed, historic drains in and around sites are being blocked, and new water-level management measures have been put in place. For example:

- Flood authorities working in conjunction with Natural England have implemented Water Level Management Plan measures on 12,750 ha of protected sites, including 11,050 ha on Natura 2000 sites as part of Natural England's national remedies programme (Data: Natural England - WLMP programme, March 2015),
- Active peat-forming conditions have been restored on some previously cut-over and drained raised bogs such as Fenns, Whixall Bettisfield, Wem and Cadney Mossess SAC (Horton 2008),
- Reductions in groundwater abstractions through the Restoring Sustainable Abstraction programme have significantly reduced hydrological risks for calcareous fen habitat, such as that at Sangey Fen (part of Norfolk valley Fens SAC) and at Blo' Norton & Thelnetham Fens (part of Waveney and Little Ouse SAC) (A. Ramsey pers. com).

These and other measures, often as part of major restoration projects, have achieved significant improvements in the hydrological condition of protected sites, preventing further deterioration and putting them on the path to recovery (see figure 1).

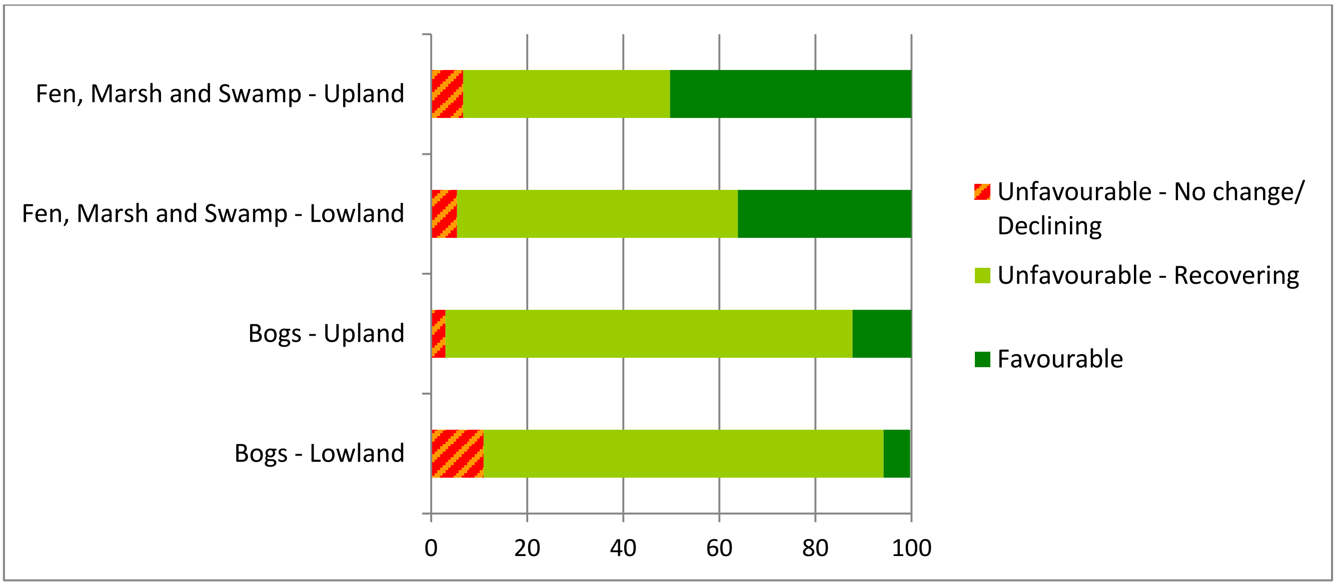



**Figure 1.Condition of relevant Natura 2000 sites. Area of Natura 2000 sites in favourable, unfavourable-recovering and unfavourable no-change or declining condition, summarised by relevant terrestrial wetland broad habitat types of underpinning SSSI units (expressed as percentage of total area of each broad habitat within England's Natura 2000 sites). Data Natural England, March 2015.**

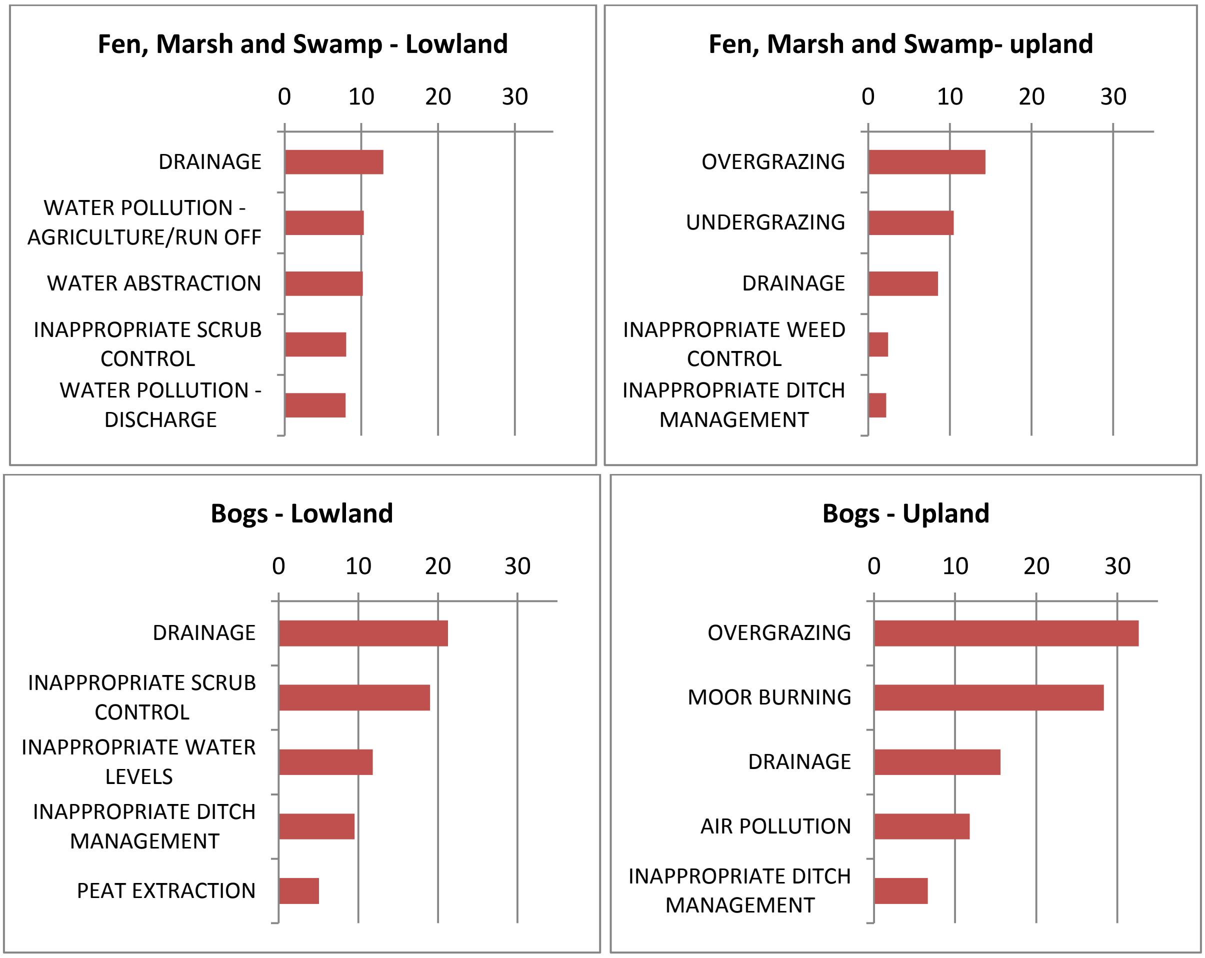



**Figure 2. Most frequent reasons for unfavourable condition within England's Natura 2000 sites, expressed as percentage of the total area of each broad habitat of SSSI units underpinning the Natura 2000 sites. The overview includes reasons why units are currently unfavourable nochange/declining and reasons why units now recovering or favourable were unfavourable. Unspecified reasons for unfavourable condition were excluded from this analysis.**

## 2.2 The need to further restore the hydrology of SAC terrestrial wetlands

The overall aim of the Natura 2000 network is to enable Favourable Conservation Status (FCS) to be reached for SAC habitats and species. The UK conservation status assessment (JNCC 2013a) shows that the European terrestrial wetland habitats considered in this theme plan (see table 1) are largely unfavourable, both in terms of habitat area and habitat structure and function. An unfavourable status for habitat area means that habitat re-creation is usually required; an unfavourable status for structure and function means that habitat restoration is usually required.

These assessments should not be surprising given that the reason why some habitats and species are afforded strong EU protection is that they have been deteriorating and are seriously threatened. Most Natura 2000 sites can therefore be seen as the 'best of what's left', rather than as examples of good habitat (the area of Natura 2000 sites in favourable condition ranges from 5% to 50% depending on the habitat, see figure 1). Unfavourable conservation status was reported when (amongst other criteria) more than 5% of a habitat is in unfavourable condition (i.e. unfavourable-declining, unfavourable-no change, unfavourable-recovering or unfavourable-unclassified, JNCC 2013c).

Sites have been classified as recovering where the need to take pro-active action was identified and implementation has started. This can mean that, although work is underway, there are outstanding actions that have been identified and still need to be put in place. Figure 1 shows that the majority of terrestrial wetland habitat within Natura 2000 sites is considered to be in unfavourable-recovering condition. Figure 2 shows that hydrology-related issues such as drainage, inappropriate water levels and ditch management are among the most frequent reasons for unfavourable condition (alongside water pollution and scrub control in the lowlands, and grazing and burning issues in the uplands). This means that hydrological issues are still relatively widespread across terrestrial wetlands in Natura 2000, even though steps are being taken across the network to address them. In England, many Natura 2000 sites with terrestrial wetlands are therefore likely to require further improvement of their hydrological functioning, rather than the maintenance of their current status.

It should be noted that UK conservation status assessments (JNCC 2013a) relate to habitat occurrences inside and outside Natura 2000 sites and indicates the need for hydrological restoration inside the relevant SACs, in the wider protected sites network (i.e. other SSSIs) and in the wider countryside. In line with the strategic objectives of the Habitats Directive, the strong role of Natura 2000 sites in achieving FCS through hydrological restoration would need to be considered. These are also the places where any achieved improvement and habitat creation is protected for the future. There is a need to identify the potential contribution of Natura 2000 sites in achieving FCS, and what more is needed outside this network.

**Table 1. List of SAC terrestrial wetland habitats considered in this theme plan.**

| Code | Habitat name |
|---|---|
| H2170 | Dunes with Salix repens ssp. argentea (Salicion arenariae) |
| H2190 | Humid dune slacks |
| H4010 | Northern Atlantic wet heaths with Erica tetralix |
| H4020 | Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix |
| H6410 | Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) |
| H6510 | Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis) |
| H7110 | Active raised bogs |
| H7120 | Degraded raised bogs still capable of natural regeneration |
| H7130 | Blanket Bogs |
| H7140 | Transition mires and quaking bogs |
| H7150 | Depressions on peat substrates of the Rhynchosporion |
| H7210 | Calcareous fens with Cladium mariscus and species of the Caricion davallianae |
| H7220 | Petrifying springs with tufa formation (Cratoneurion) |
| H7230 | Alkaline fens |
| H91D0 | Bog woodland |
| H91E0 | Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) |

The Site Improvement Plans (SIPs) developed under the IPENS programme record priority issues that are not yet fully resolved with existing mechanisms, for example, where further investigations are needed or where funding for agreed actions is not yet secured. Whilst significant progress has been reported in SIPs with regard to completed and on-going hydrological restoration measures, outstanding hydrological functioning issues have been reported in 77 SIPs. The SIPs show that issues related to the hydrological functioning of sites are particularly prevalent for SAC terrestrial wetlands and that further action is required within the scope of current programmes – and sometimes beyond (see table 2). The SIPs record the priorities and new measures for hydrological restoration needed to achieve water-dependent Natura 2000 objectives under the Water Framework Directive.
Table 2 summarises the issues and related actions in the SIPs that are relevant to SAC terrestrial wetlands. A list of the SACs relevant to terrestrial wetlands is included in Annex 5. The status of Water Level Management Plans (WLMPs) is also indicated in table 2. WLMPs typically operate in highly modified or artificial hydrological systems, so this mechanism of limited relevance to the SAC terrestrial wetlands that rely on more natural

hydrology. For most SAC terrestrial wetlands, measures are being pursued through direct engagement with landowners and managers as part of site management agreements.

**Table 2. Outstanding hydrological issues and actions reported for SAC terrestrial wetlands in SIPs**

| SAC terrestrial wetland | Scale of outstanding hydrology issues | Main outstanding hydrology issues | Main outstanding actions | Water level management Plan status |
|---|---|---|---|---|
| Active and degraded raised bogs (H7110, H7120) | All 10 SAC | Presence of historic drains in and around sites with restoration works incomplete; low water tables, drying out of the edge of bog systems; on-going effects of historic peat cutting; observed changes in hydrology that need investigation; dependence on hydrological connected land outside the site boundaries. | Raise water tables; further blocking of drains; securing favourable hydrology on surrounding land; reconsideration of SSSI boundaries; creation of marginal fen to support bog hydrology. | 8 of these 10 sites have SSSIs included the current WLMP programme. |
| Blanket Bogs (H7130) | 9 out of 10 SACs | Presence of historic drains and surface channels on sites with restoration works incomplete; dependence on hydrological connected land outside the site boundaries. | Develop and implement hydrological restoration plans; further blocking of drains; reconsideration of SSSI boundaries. | None of the 10 sites have SSSIs included in the current WLMP programme. |
| Depressions on peat substrate (H7150) | All 7 SACs | Presence of historic drains in and around sites with restoration works incomplete; lack of ditch maintenance which exacerbates water pollution; threat of drought through abstraction and climate change. | Investigate hydrological functioning; development of hydrological restoration plans; further blocking of drains; scrub removal; installation of water control structures. | 1 of the 7 sites has SSSIs included in the current WLMP programme |
| Wet mires (H7140) | 13 out of 15 SACs | Legacy of historic hydrology changes, presence of drains in and around sites, concerns about groundwater abstraction; lack of knowledge of hydrological functioning; increased evapotranspiration | Investigate hydrological functioning; reverse historic drainage impacts; develop and implement comprehensive hydrological restoration plans to re-naturalise hydrological functioning. | 5 of the 15 sites have SSSIs included in the current WLPM programme |
| Calcareous fens (H7210) | 6 out of 9 SACs | Inadequate water level management; presence of historic drains with restoration work incomplete. Winter floods with nutrient rich water; abstractions; lack of knowledge of hydrological functioning. | Review WLMPs; fully implement WLMP; update operating protocols for water management; investigate hydrological functioning; restore natural hydrological functioning | 4 of the 9 sites have SSSIs included in the current WLMP programme |
| Petrifying springs (H7220) | 3 out of 7 SACs | Presence of historic drainage systems; abstraction; hydrological changes due to caving | Hydrological investigations; prevent impact of caving; restore natural hydrological functioning. | None of the 7 sites have SSSIs included in the current WLMP programme |
| Alkaline fens (H7230) | 8 out of 16 SACs | Presence of historic drains with restoration works incomplete; inadequate water level management; lack of knowledge of hydrology; abstractions | Investigate hydrological functioning; reduce abstraction; develop hydrological restoration plans; restore natural hydrological functioning; improve water level management | 3 of the 16 sites have SSSIs in the current WLMP programme |
| Dune slacks (H2190) | 4 out of 13 SACs | Lack of knowledge of hydrology; drainage; evapotranspiration; concerns about abstraction impacts | Investigate and restore hydrological functioning | 1 of the 13 have SSSIs in the current WLMP programme |

| | | | | |
|---|---|---|---|---|
| Purple moor grassland (H6410) | 9 out of 17 SACs | Presence of historic drains with restoration works incomplete; land drainage of adjoining farmland; inappropriate water levels; inappropriate ditch management; flooding with nutrient rich water; abstraction; lack of knowledge of hydrology; | Investigate hydrological functioning; reduce impacts of drainage; grip blocking; Investigate and restore sustainable abstraction; implement WLMP; review WLMP; reinstate appropriate ditch management. | 5 of the 17 have SSSIs in the current WLMP programme |
| Lowland Hay meadows (H6510) | X out of 5 SACs | Maintenance of water control structures; prolonged flooding; WLMP out of date; suspected impacts of abstraction | Develop or update WLMP; investigate hydrological functioning; monitor flooding; investigate abstractions. | 2 of the 5 have SSSIs in the current WLMP programme. |
| Wet heath (H4010) | 12 out of 25 SACs | Presence of historic drains in and around sites restoration works incomplete; lack of knowledge of hydrology; increased evapotranspiration; suspected impact of abstraction; inappropriate ditch management; | Develop hydrological restoration plans; investigate hydrological functioning; reduce impact of drainage; implement programme of blocking drains; remove the build-up of vegetation; implement water level management; implement appropriate ditch management | 3 of the 25 have SSSIs included in the current WLMP programme |
| Bog woodland (H91D0) | 1 out of 4 SACs | Presence of historic drains with restoration work incomplete; | Develop and implement a comprehensive hydrological restoration plan | 1 of the 4 have SSSIs included in the current WLMP programme |
| Alluvial woodland (H91E0) | 5 out of 12 SACs | Presence of historic drainage with restoration works incomplete; inappropriate water level management; lack of knowledge hydrology; inappropriate ditch management; abstraction | Develop and implement hydrological restoration plans; implement water level management; investigate abstraction impacts; | 5 of the 12 have SSSIs included in the current WLMP programme |

# 3. Current approaches

A range of measures can be used to address hydrological issues on SAC terrestrial wetland sites. These involve identifying reasons for unfavourable condition and seeking appropriate solutions (‘remedies’ or ‘condition threat actions’), working with relevant authorities, site owners, occupiers and other partners. Key mechanisms for protected sites include Water Level Management Plans (WLMPs), the Restoring Sustainable Abstraction (RSA) programme, agri-environment agreements, and the funding of one-off restoration actions through LIFE, the Water Framework Directive, or private/NGO funding. An overview of drivers, delivery mechanisms, tools and processes relevant to the hydrological restoration of SAC terrestrial wetlands is included in Annex 3. The main approaches adopted to date are detailed below.

## 3.1 Approach to addressing drainage

Significant progress has been made to reduce or reverse the impact of drainage where land is owned and managed exclusively for nature conservation (for example, National Nature Reserves) and where the impacts of mechanisms on surrounding landowners are limited. In these cases the comprehensive infilling and blocking of drains has allowed the restoration of hydrological regimes to close to natural conditions on some sites (Diack, pers. com.). Much of this work has been paid for by external funding streams, such as LIFE + and Heritage Lottery Funding, as well as Grant-in Aid monies. Agri-environment schemes have also been used to fund the blocking of drains and raised water level schemes on privately-owned land. On sites that rely on the active management of water levels to maintain features, programmes such as Water Level Management Planning have provided a key mechanism (see paragraph 3.3 below). More recently, large programmes of drain blocking on blanket bog have been funded by water companies who benefit from the water quality improvements that result from the re-naturalisation of hydrological functioning. However, addressing drainage issues beyond site boundaries remains a significant challenge. Delivery mechanisms outside protected sites are more limited, mainly relying on voluntary approaches[1], and removing drainage to the extent needed is often difficult to reconcile with commercial land use.

## 3.2 Reducing the impacts of abstraction

Annex 3 outlines the way that abstraction pressures are managed to avoid or reduce, as appropriate, impacts on the environment. Between 2000 and 2010, the Environment Agency reviewed all its consents and licences that could impact on Natura 2000 sites, in particular those that were granted prior to the implementation of the Habitats Directive. The outcomes of this project, known as the Review of Consents (RoC), continue to be implemented via changes to abstraction and discharge licences where necessary, and have been incorporated into Water Company Water Resource Management Plans (WRMPS), Asset Management Plans (AMP), Catchment Abstraction Management Strategies (CAMS) and the Restoring Sustainable Abstraction (RSA) programme.

Only a limited number of terrestrial wetland Natura 2000 sites have outstanding actions with regards to abstraction (the issue is highlighted in 11 SIPs). On some of these sites abstraction is only a suspected threat, for example associated with the potential impact of climate change, and this needs further investigation. An issue with the process for changing abstraction licences has been the time it can take to complete investigations, carry out options appraisals, give notice of licence changes, and accrue adequate funds for compensation. However, since July 2014 any abstraction causing serious damage to the environment is no longer liable for compensation (Water Act 2003). The costs to water companies in changing abstractions and

[1] Regulatory approaches through notice and consent or management schemes are not applicable to land outside protected sites’ boundaries, although in principle Special Nature Conservation Orders or Flood Defence Consents may be applicable in certain circumstances.

discharges have been factored into the Price Review (PR) process. Another feature of the Water Act 2003 is the intention to bring some abstractions currently exempt from licencing (such as quarry dewatering and trickle irrigation) into the licencing regime in the near future. Overall, these changes should help ensure that remaining abstraction impacts can be dealt with more effectively.

## 3.3. Water Level Management Plans (WLMPs)

WLMPs are non-statutory site management plans for managing water levels, typically through the use of water control structures (e.g. artificial channels, sluices, pumps). Development of WLMPs is the responsibility of flood risk authorities (the Environment Agency, local flood authorities, and Internal Drainage Boards) acting in consultation with Natural England. The aim of a protected site WLMP is to identify a water level management regime that will help it achieve its conservation objectives.

Water Level Management Plans are in place for only a limited number of terrestrial wetland SACs (see table 2) because this mechanism operates in highly-modified or artificial hydrological systems, where the flood authorities have traditionally had responsibilities for flood risk management and drainage activities. Sites with WLMPs are predominantly located in lowland areas and within river floodplains. Here, flood authorities commonly own or manage water control structures that regulate water levels for the purposes of flood risk management or enhanced drainage to support agriculture. In practice, WLMPs for biodiversity benefit also need to take account of the constraints brought to bear by flood risk management and agricultural objectives.

WLMP development is funded by flood risk management grant-in-aid (Government funding) while the implementation of plan actions may be funded through grant-in-aid or agri-environment incentive schemes, depending on the nature of the measure required. The installation and maintenance of water control structures is generally funded through grant-in-aid, while agri-environment scheme agreements are used to incentivise landowners/occupiers to manage their land in ways that are compatible with wetter conditions that support the required habitats or species. In the case of Internal Drainage Boards, additional funding is also available from drainage rates levied on local landowners.

WLMPs have been implemented on 11,050 ha of Natura sites as part of the national remedies programme. However, the SIPs indicate that WLMP actions have not yet been fully implemented on some sites. In other cases, SIPs indicate the need to review WLMPs to ensure they are helping to achieve conservation objectives (see table 2).

# 4. Strategic issues

## 4.1 The relevance of natural hydrological function for Natura 2000

The SAC terrestrial wetland habitats, considered in this theme plan, are often dependent on certain hydrological conditions, such as specific water chemistry, groundwater flows, and surface water levels. Some of these habitats are highly dependent on natural or near-natural hydrological and hydrochemical processes, for example 'H7150 depressions on peat substrate' (see text box 1 below) or 'active raised bog' (see text box 4 below). Equally, some habitats might benefit from an approach to restore more natural hydrological functioning to maintain their variety and associated species in a sustainable way, although they can be (and in practice sometimes are) conserved through more artificial hydrological management, for example H7140 (see text box 2). For other habitats and in some situations, the necessary hydrological conditions may have been generated artificially, making them heavily dependent on continued human intervention, for example, some localities of Lowland Hay Meadows (see text box 4).

**Text box 1. Depressions on peat substrate (H7150) requires a natural hydrological functioning**

In some cases, the presence and condition of Annex I habitat is wholly dependent on the integrity of the wider ecosystem in which it is embedded, for example, the habitat H7150 *Rhynchosporion* in various types of bog ecosystem. This habitat feature occurs in the wettest parts of blanket bogs, raised bogs, valley bogs and transition mires, and has been lost from many sites throughout the UK following drainage and other forms of damage. Re-establishing this habitat is only possible following the wholesale restoration of the whole bog and its supporting processes.

**Text box 2. Sustainable management of transition Mire (H7140)**

The concept of Transition Mire is widely accepted by wetland scientists as relating to the successional development of a whole wetland system, and indeed the description of the habitat makes this clear (JNCC habitat account H7140). However, in practice the feature is often narrowly interpreted as simply comprising a number of NVC communities. Although these approaches are not exclusive, a focus on the fixed presence of a particular group of plants in a particular location can ignore natural dynamic change in wetland habitats and the inevitable effects of our changing climate, leading to management that is unsustainable in the long term. A more landscape-scale and systems-based approach may be needed to the sites, their designation (features and boundaries) and an adaptive approach to their management rather than considering reasons for the presence of the high-value features in isolation. A more sustainable and eco-hydrologically robust approach would mean that the whole system supporting a range of plant communities, and the underlying processes that support them, would be mapped and assessed as 'Transition Mire' rather than just the very small areas of M14 Schoenus nigricans –Narthecium ossifragum mire or M9 Carex rostrata – Calliergon cuspidatum/giganteum mire vegetation that a narrower interpretation of 'Transition Mire' would lead to. A good example is Fen Bog in Newtondale, North Yorkshire, where a mire that shows peat stratigraphy has developed from open water through reedbed and fen to quaking valley bog (i.e. a temporal transition) whilst retaining elements of all of these habitats (spatial transition).

**Text box 3. Habitats dependent on modified hydrology**

Many important habitats have developed in hydrologically modified catchments and would be adversely impacted by restoring natural hydrological processes, as the examples below show.

Mottey Meadows SAC in Staffordshire has developed large expanses of high value MG4 and MG8 wet grassland following the partial drainage of its surrounding floodplain. Groundwater emerging from a shallow aquifer that seeps from surrounding slopes and is channelled under the SAC in pipes and discharged beyond it. Restoration of the natural hydrological regime would result in much wetter conditions and this, and high nutrient concentrations in the groundwater (AMEX 2013), would damage SAC features. Historic records suggest that the site may once have supported groundwater-fed base rich fen on the slopes with a mosaic of Molinia meadows, tall-herb fen and alluvial grassland on the floodplain. However, restoration of a more natural hydrological regime would only be possible once the water quality had been improved significantly and there was agreement that this vegetation change was desirable.

'Wetter' habitats, including examples of alkaline fen and Calcareous fen with Cladium, also occur in hydrologically modified environments. In some cases their development has been brought about by this modification, and the restoration of natural hydrological regimes is likely to be damaging. The large areas of calcareous fen in the Broads are an example of this situation.

Newham Fen supports a north-eastern example of M13 Schoenus nigricans-Juncus subnodulosus mire. It is a SAC for alkaline fen and has been the subject of various drainage schemes. Wheeler and others (2009) suggest that the presence and location of the site's high-value features are both a result of modifications to its natural hydrology as well as reflecting natural hydrological conditions such as the location of upwelling groundwater.

Malham Tarn Moss with its surrounding fens is an exceptionally rich wetland site. The water level of the tarn was raised in 1791 and the ongoing erosion of the surrounding raised bog by wave action is thought to have extended the area of alkaline fen (Wheeler and others, 2009). Obviously the extent of the tarn itself has also increased.

All of the above demonstrate how high value habitats have developed in modified environments. While changes towards more natural hydrological functions may not be considered desirable in the short-term, the impacts of modification on the long-term sustainability and integrity of sites (for example, in the face of climate change) must also be evaluated.

Much of the hydrological restoration of terrestrial wetlands to date has been achieved through the further hydrological modification of sites, rather than through the restoration of natural hydrological function, for example, by hydrological separation of some raised bog sites from surrounding land drainage, see text box 4 below. This approach is driven by a range of factors, such as the concern that restoring natural hydrological function might have adverse consequences on adjacent land uses, limitations in institutional planning horizons, and operational difficulties in changing management decision-making from a site to a landscape scale.

There is a widespread recognition (e.g. Lawton and others 2012) that a long-term sustainable approach to biodiversity conservation needs to work with natural ecological, hydrological and geomorphological processes as much as possible, rather than focusing on the maintenance of a specific vegetation type, vegetation structure or individual species alone (e.g. Hopkins and others 2007). Integrating habitat requirements at a landscape scale using natural environmental processes as a template would enable the full ecological variation of habitats to be expressed, maximise opportunities for climate change adaptation and ecosystem services, and build resilience and flexibility into the system. Restoring natural hydrological functioning may also reduce or remove on-going management costs, though it might require significant initial funding. An approach that focuses on natural hydrological processes could therefore provide the most sustainable approach to restoring large–scale wetland habitat complexes in the long-term (see also Mainstone 2014; Mainstone, Clarke & Crosher 2014; Olmeda and others 2014).

The reliance of SAC terrestrial wetland habitats on natural hydrological processes is also relevant to achieving and maintaining Favourable Conservation Status (FCS) as defined by the Habitats Directive because the assessment of conservation status includes considerations related to the functioning of a habitat, as well as the future prospects of maintaining FCS. The restoration of SAC terrestrial wetlands should be based, where feasible, on natural hydrological functioning where this delivers better habitat functioning and more secure future prospects than artificial hydrological management in perpetuity.

The drive towards more naturally functioning ecosystems, to generate more sustainable ecological networks at a landscape scale is embedded in the Lawton principles (Making Space for Nature, Lawton 2010), in Natural England's climate change adaptation manual (Natural England and RSPB 2014), and in the SSSI selection guidelines (JNCC 2013b). It provides a significant challenge to conventional approaches to the hydrological management of sites, and is likely to encounter significant barriers arising from land use interests, budget limitations and societal concerns. Ways need to be found to meet this challenge so that natural hydrological function can be achieved wherever it is practical and feasible, whilst accepting that in some cases it is not possible, even in the long-term, and that habitat restoration can only be achieved through artificial hydrological management.

**Text box 4. Raised bogs – the importance of hydrological restoration**

A raised bog is a morphological feature in its own right, comprising various structural components and different types of wetland vegetation, including communities referable not only to 'Active Raised Bog', but also 'Depressions on peat of the *Rhynchosporion'* around bog pools and 'Transition Mire and Quaking Bog' in the lagg. The separate features of a bog are co-dependent and rely on an intact hydrological regime across the whole system. All English raised bogs, including SACs, are hydrologically damaged, and many have suffered from peat extraction, afforestation and development of secondary woodland on drained peat surfaces, all with associated drainage. The designation of raised bogs has focused on remnant areas where actively peat-forming vegetation still occurred. However, many sites were designated without securing the land area necessary to sustain and restore the entire bog ecosystem, making it difficult to ensure their long-term sustainability. Some bog sites fall under flood authority Water Level Management Plans, while at other sites, water level management arrangements are pursued directly with the relevant landowners. However, many measures required to achieve hydrological integrity have not been implemented because of the likely impacts of hydrological restoration on surrounding undesignated land. In some cases these shortfalls have been met with short-term engineering solutions, such as surrounding the active bog with plastic piling to prevent water loss. Restoration of natural hydrological processes is usually more difficult to achieve than simply accepting existing modifications and attempting habitat enhancements within the constraints of the damaged system. This means however that the typical variety of vegetation that would be associated with an intact bog system, including the lagg habitats, is not sustained.

The primary focus for restoring this habitat has been the infilling of drainage ditches or grips within sites, and the restoration of appropriate hydrological regimes. While spectacular progress has been made with raising and stabilising water levels on a number of SACs (e.g. Fenns, Whixall Bettisfield, Wem and Cadney Mossess SAC, South Solway Mosses SAC), much less progress has been achieved with securing sympathetic hydrological regimes on surrounding areas. This is essential to both reduce marginal hydraulic gradients and to restore peripheral lagg fen systems.

## 4.2 Remaining gaps in knowledge of the current and historic hydrological functioning of sites

The eco-hydrological characterisation of sites over the last decades has improved both our understanding of wetland development and function, and the impacts of human modification on natural hydrological function

(See Annex 3 tools and processes). While significant progress has been made in applying this knowledge at a site scale and using it to plan restoration and assess likely impacts of potential pressures, e.g. groundwater abstraction, there are still many water-dependent sites for which there is no full understanding of their 'ecological potential', based on the site's natural eco-hydrological functioning and modifications to the hydrological regime.

The impact of drainage on site integrity is inconsistently assessed. In some cases, drainage infrastructure is still maintained (or, at best, not disabled) even where there is evidence of impacts on interest features. For example, many valley mire systems within heathland complexes have artificially deepened axial drains with associated ditch networks. The damage done by these systems has been recognised on some sites (such as the New Forest, where it is being comprehensively addressed, see text box 7) but on many sites with active drainage (see SIPs) there is no planned action to restore the natural hydrological regime (Diack pers. com.) Several publications (e.g. Wheeler and others, 2004; Wheeler and others, 2009) provide tools to assess sites and understand how they developed, and a number of accounts of eco-hydrological function of individual sites have been produced. However, few of these are complete, and many water-dependent habitats (other than lowland raised bogs and fens) are barely covered. This means that it is still difficult to recognise sites and features with modified or sub-optimal hydrological regimes, and to identifying the related impacts on the biological features. This can lead to the under-reporting of hydrological issues and a tendency to classify modified hydrology as a favourable reference. See also paragraph 4.3

## 4.3 The historic approach to setting objectives for hydrology on protected sites

The hydrology of most, if not all, Natura 2000 terrestrial wetlands has been modified by historic drainage both within sites and in the wider landscape. Many of the declines in wetland wildlife can be directly related to drainage schemes (Purseglove 1988), and even on protected sites the effects of drainage may still be apparent. Much of this modification may have been carried out prior to designation of sites and the remnants, although with degraded hydrology, still qualified for designation. Historically, the hydrological restoration targets for designated terrestrial wetlands have aimed to maintain the vegetation present at the time of designation in favourable condition[2]. It did not aim to restore a site to its full potential. Site conservation objectives tend to be framed and achieved within the parameters allowed by artificial management of surface water through control structures. This means that modifications to the hydrology of terrestrial wetlands tend to be maintained (e.g. Harding and others, 2014). For example, at many fen sites, artificial drainage networks have been retained because they've 'always been there' (Natural England and RSPB, 2014).

While maintaining a modified hydrological system may be the only practical approach for some sites (for example, because of the constraints of surrounding land use), at other sites this approach may underplay the potential for a feasible restoration of natural hydrology. However, fully restoring the hydrology of some sites may actually change the habitats they are able to support. For example, the change from woodland to bog and mire habitats on sites such as Wybunbury Moss (see text box 5). The scope for implementing management actions at protected sites can also be restricted by organisational timescales, such as 5-year site management plans or the yearly allocation of budgets. This means that where sites don't have strategic long-term visions, management interventions tend to be directed at short-term solutions to maintain specific vegetation types, rather than working towards long-term restoration goals (for example, creating scrapes to reach an artificially low water table rather than restoring a higher water table).
Where a site's conservation targets do not reflect an ambition to restore or recreate habitats, the available delivery mechanisms (such as the regulation of abstraction, drainage or management of water levels – see

[2] See guidance for common standards monitoring,  11 Setting targets (http://jncc.defra.gov.uk/page-2275)

annex 3) are unlikely to work towards the hydrological improvements that would support this ambition. Conservation objectives are the key way by which management objectives for sites are communicated to other regulators. It is therefore important that any long term vision for restoring the more natural hydrological functioning of a protected site is reflected in its conservation objectives (where this target is agreed as being both feasible and appropriate - see section 5.5). In setting long-term ambitions, accepting more engineered solutions may be appropriate for some sites (for example, to maintain habitats or balance different land-use needs), but on other sites, it may be feasible to aim for the long-term restoration of more natural hydrological regimes, similar to the setting of long-term SAC and SSSI objectives for rivers (JNCC 2014, Mainstone and Hall in draft). This would provide much needed synergy with the philosophy of natural habitat function that has been adopted for open freshwater SSSIs and SACs (see Section 4.6) and address many of the perceived habitat management conflicts that are apparent at site-level.

## 4.4 Reliance on short-term and mostly voluntary measures

In designating sites, the boundaries of a protected area have often been drawn tightly around the qualifying habitats. For many terrestrial wetlands this has meant that areas of land that are hydrologically connected to a site (and critical to its functioning) are located outside the protected site. As a consequence, the range of potential mechanisms to ensure that this land is managed sympathetically (e.g. in terms of drainage and water level management) is mainly limited to agri-environment schemes, agreements through Water Level Management Plans and other contractual arrangements, which are usually time-limited but would need to continue in perpetuity[3]. This means that hydrological improvements to sites are sometimes made on an incremental and opportunistic basis. The effort and cost required by this approach can be high compared to the often limited benefits these improvements entail.

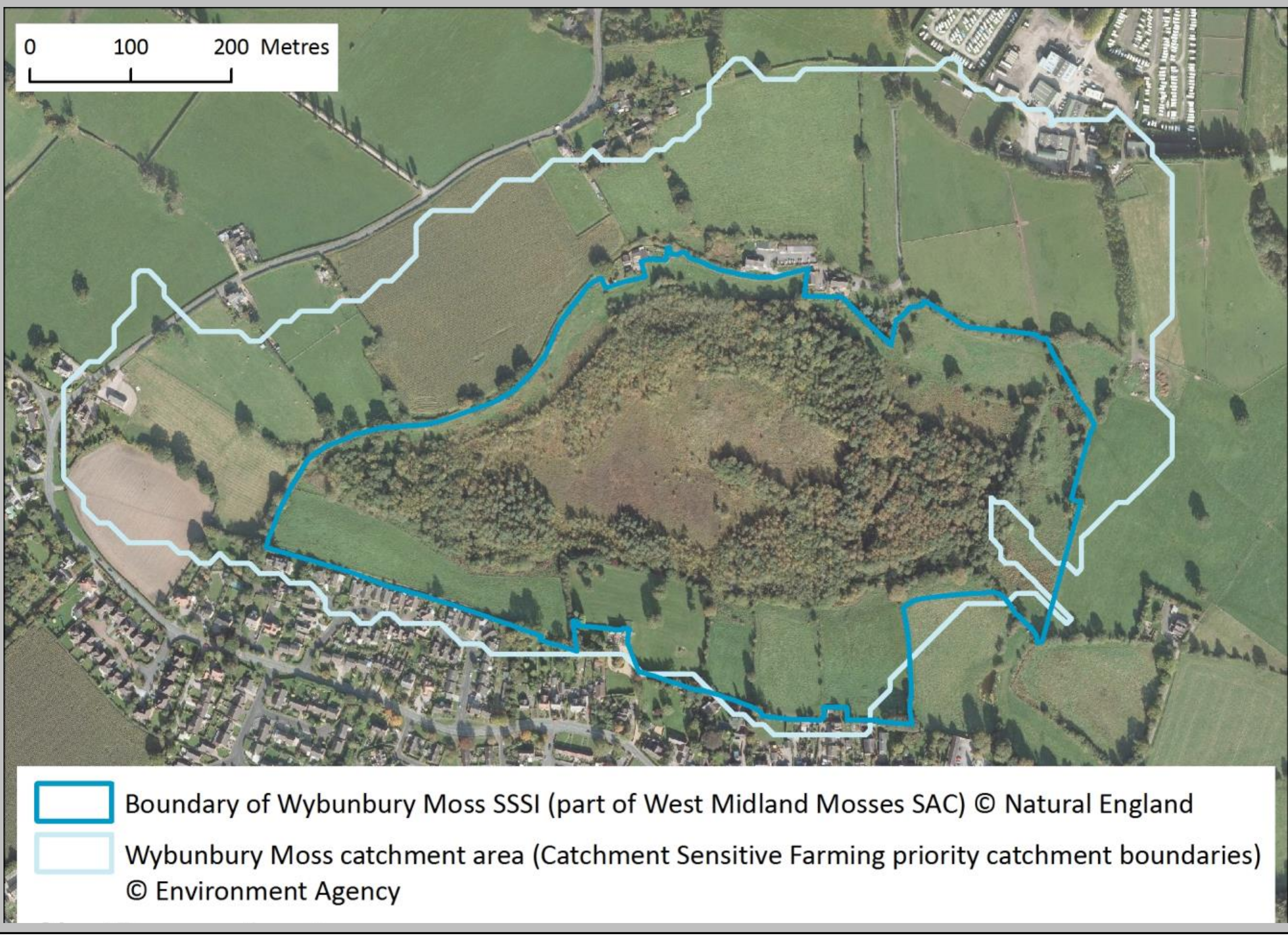
Including hydrologically connected land within the designation can help to provide more levers to secure sympathetic land use and management. However, site designation needs to be complemented by other mechanisms, and with the funding necessary to achieve improved management, such as land management agreements or, potentially, land acquisition. Guidance on wetland SSSI boundary setting (e.g. JNCC, 1998) has always recognised the importance of including land necessary to support hydrological function, however, the implementation of this guidance has not always been consistent. More recent guidance developed in support of Natural England's review of SSSIs further emphasises the importance of these issues in boundary setting (Natural England, 2013b), and these principles have been applied in the recent notification of Bolton Fell Moss and Walton Moss SSSI.

[3] Regulatory approaches through notice and consent or management schemes are not applicable to land outside protected sites' boundaries, although in principle Special Nature Conservation Orders or Flood Defence Consents may be applicable in certain circumstances.

**Text box 5. Example - Basin mire**

The aerial photograph below shows Wybunbury Moss,part of West Midlands Mosses SAC. This site is a basin mire with a small, discrete water catchment area that extends to the surrounding fields – only part of which is included within the boundary of the SSSI/SAC. The site's ecohydrology is complex, with several water supplies, including base-rich groundwater from the shallow sand and gravel aquifer to the west and north, groundwater from a deep aquifer emerging under the site, and rainwater directly feeding the bog vegetation on the central floating raft. The quality and condition of the site's interest features are largely determined by activities in the wider catchment, including agriculture and development. The condition of the transition mire and quaking bog feature for which the site is designated is currently unfavourable largely due to poor water quality (high N in the shallow groundwater – agriculturally derived – and high phosphate from domestic run-off). Catchment Sensitive Farming advice has been provided and a Diffuse Water Pollution Plan has been produced for the site. However, the measures needed to adequately resolve the agricultural pollution have not all yet been fully completed.

A programme of hydrological restoration has been underway for over ten years (largely through the blocking of internal drains that were dug in the 19th century) and the benefits to the transition mire are already being seen. The historic drainage led to the establishment of relatively dry woodland over much of the site in the later 20th century and, as this was present at the time of the SSSI's notification, there has been some reluctance to regard it as a negative habitat feature (see also section 4.3). Under a restoration of natural hydrological process, it is expected that much of this woodland would revert to bog vegetation, with true fen woodland developing in swampy marginal areas. It is important that this ecological potential is recognised and that these objectives are considered in site planning. The eco-hydrological functioning of the site is well understood (including the importance of the wider catchment in supporting the transition mire) but favourable condition will be achieved only if the entire catchment is managed sensitively.




## 4.5 Constraints of existing land use and budgets

Where sites are currently under active hydrological management, surrounding land-use is often dependent on the continuation of artificial interventions. Making changes to those regimes, by removing drainage or raising local (sometimes regional) water tables, to restore more natural hydrological functioning is frequently constrained by flood risk management issues, the presence of infrastructure, or agricultural land use objectives. The restoration of natural hydrological regimes is often difficult to reconcile with current farming systems, even with the added incentive of agri-environment scheme payments.

One example of a fundamental barrier to in hydrological restoration that can be encountered is the duty of riparian landowners to let water flow through their land without obstruction, pollution or diversion that might affect the rights of others. (Environment Agency, 2014). This means that any changes to historic modifications of the hydrological functioning of a watercourse needs to be agreed with all the land owners affected by the change. Given legitimate concerns about the potential effects of hydrological restoration on land productivity, land value etc., gaining agreement to major interventions can be a formidable challenge. This explains why the most significant hydrological restorations have been achieved on sites that are owned and managed for the primary purpose of nature conservation.

The costs of large-scale hydrological restoration (and associated compensation to landowners for damages or income foregone) can be prohibitive. Additionally, there can be strong cultural objections to changing hydrological functioning. In some cases, land purchase is the most cost-effective and mutually satisfactory way of resolving these issues. However, for many sites, reconciling divergent land-use interests by balancing user requirements may still be the only viable approach.

## 4.6 Comparison with the approach to the hydrological restoration of open freshwaters

In comparison to SAC terrestrial wetlands, Natural England has adopted a more strategic and programmed approach to restoring the hydromorphological functioning of designated freshwater habitat (rivers and lakes). For rivers, Natural England and the Environment Agency have a joint national river restoration programme in place. For lakes, Natural England and the Environment Agency jointly fund an officer to oversee and help implement a series of lake restoration remedies enabled by WFD Grant in Aid.

For terrestrial wetlands there is currently no strategic national programme for restoring, where possible, natural hydrological function that covers drainage, abstraction and water level management in a more holistic way. The hydrological restoration of terrestrial wetlands relies on a range of remedies being put in place. Some of these are embedded in nationally coordinated programmes (e.g. Water Level Management Plans, Restoring Sustainable Abstraction), while others are instigated on a site-by-site basis with only limited national coordination (e.g. drain blocking).

The river restoration programme puts a natural habitat function at the heart of the hydrological restoration of rivers (Mainstone and Clarke 2008, Mainstone and Hall in draft), which is in-line with climate change adaptation priorities for freshwater ecosystems (Natural England/RSPB 2014. See also the IPENS river restoration theme plan). The approach to river restoration splits habitat integrity into four key components: hydrological, physical, physico-chemical and biological (the latter in terms of biological stressors, such as invasive 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 3 summarises the approach.

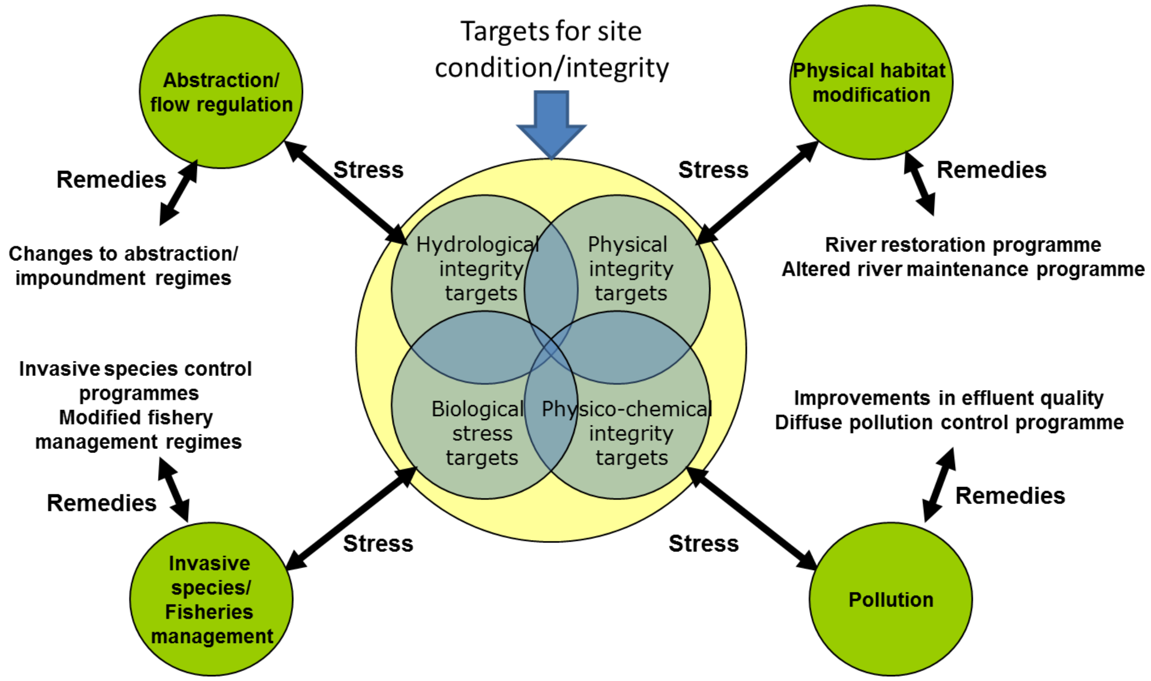



**Figure 3. The relationship between the assessment of components of freshwater habitat integrity, key pressures and remedies to resolve those pressures (from Mainstone and Clarke 2008).**

Fundamental to this approach is that naturally-functioning freshwater habitat, free of artificial modifications, caters appropriately to its characteristic biological assemblages and individual species (including those that form part of a SAC notification). From a species perspective, the requirements of an individual species are expressed in the context of natural 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 artificially optimising habitat for a given species, or protecting existing (modified) conditions that work against natural habitat function (Mainstone and Hall, in draft).

In respect of hydrological regimes, the site objectives for designated rivers and lakes include hydrological targets that are based on acceptably small deviations from the natural hydrological regime (flows targets for rivers; targets for water levels and residence times for lakes). These targets form part of the assessment of site condition and are used to drive management decisions to protect or restore natural hydrology. See text box 6 for details on river flow targets.

Wherever possible, and where consistent with the conservation objectives for such habitats, river restoration plans apply the principle of natural habitat function (and particularly natural hydrological function) to adjacent terrestrial wetland habitats so that naturally functioning freshwater/wetland habitat mosaics can be promoted.

The approach to SAC/SSSI river and associated wetland restoration, using natural hydrological functioning as a template, could provide a useful model for the hydrological restoration of SAC terrestrial wetlands. However, the applicability of this model to SAC wetlands needs to be further considered and developed in discussion with relevant partners (see section 5).

**Text box 6. River flow targets and Water Framework Directive**

It is important to note that Natural England's approach to flow targets in SAC and SSSI rivers, whilst superficially similar to the approach adopted for protecting ecological status under the WFD, is fundamentally different in that it treats the natural flow regime as part of the habitat feature, and is therefore protected in its own right as a critical element in shaping the habitat and the characteristic biological assemblage. Under the WFD, the natural flow regime is seen as a supporting element, and the focus of monitoring and management is on the condition of the standard biological quality elements. The extent to which the natural flow regime is protected under the WFD is therefore critically dependent on the ability of WFD biological monitoring to detect flow-related impacts. This monitoring is not necessarily geared to the detection of such impacts on Natura 2000 objectives (see Mainstone and Hatton-Ellis 2011 for further explanation). Work is ongoing with the UK Technical Advisory Group, Environment Agency and Natural England, towards more aligned flow targets for the third River Basin Management Plans.

The evidence base for using the natural flow regime for managing the impacts of flow modifications on SAC and SSSI river habitat is provided by Mainstone (2010a), whilst the implications of the evidence base for how flow targets are framed for SAC and SSSI rivers are discussed in Mainstone (2010b). Mainstone and others (2012) provide more detailed explanation of the UK conservation agencies approach to the use of flow targets in protecting river SACs and SSSIs.

# 5. Improvement strategy for the Natura 2000 network

## 5.1 Implement priority actions for Natura 2000 sites identified in SIPs

While significant improvements have been made in reversing historic changes to the hydrological functioning of SAC terrestrial wetlands, the full implementation of actions identified in existing plans and programmes remains a substantial task. These actions, as identified in the SIPs, should be implemented as a priority to ensure further progress is made towards the objectives of the Habitats Directive. These actions include:

- Continuation of the hydrological restoration of bog, mire and wet heath systems, through:
  - raising water levels
  - removal of drains
  - ditch/grip blocking
  - bunding
  - gully reprofiling
  - tree and scrub removal and re-vegetation (as appropriate).
- Reduction of on-going peat cutting within Natura 2000 sites along agreed timescales through modification of permissions.
- Ensuring that hydrologically connected areas surrounding designated sites are managed sympathetically and the inclusion within site boundaries is considered where possible.
- Implementing actions in existing agreed Water Level Management Plans (which should be reviewed as necessary).
- Implementing outstanding actions to reduce abstraction pressure, and investigate cases where impacts are suspected.

Wherever possible, measures that work towards restoring natural hydrological functioning should be prioritised, rather than measures that contribute to a more artificial hydrology. However, critical measures for artificially managed sites, where further deterioration in condition is likely over the short term, should also be prioritised.

Section 4 outlines some strategic issues that could benefit from a more programmed approach to the longer-term hydrological restoration of SAC terrestrial wetlands, alongside the implementation of priority restoration actions for individual sites.

This theme plan proposes to consider developing a programme of hydrological restoration for SAC terrestrial wetlands along the principles indicated in sections 5.2 to 5.9 below. These sections are not meant to signal a shift in Natural England's approach with immediate effect or without further discussion; instead, value of the approach should be further explored with key delivery partners and stakeholders, initially through the Terrestrial Biodiversity Group and the Major Landowners Group.

## 5.2 Restoring natural hydrological functioning where possible

Conservation efforts have not always focused on achieving natural hydrological functioning where this would be desirable. This has been due to strategic barriers such as knowledge gaps in hydrological functioning, the historic approach to setting targets, the need to rely on short term and voluntary measures, and constraints arising from land use and budget limitations. The importance of restoring, as far as possible, natural hydrological function on terrestrial wetland sites needs to be duly considered in relation to the long-term ambition to achieve Favourable Conservation Status (FCS). It can enable additional habitat creation and can ensure that hydrological requirements are maintained in a long-term sustainable manner, so increasing resilience to climate change (see also section 4.1). However, resolving all hydrological issues at all sites, particularly through restoring natural hydrological functioning, is not likely to be feasible. Appropriate ambitions for further hydrological restoration at sites, and the targeting of effort, needs to be considered carefully in light of other legitimate demands on land and water, constraints on resources, and the potential implications of changing climate.

It is therefore proposed that the benefit of a long-term, programmed approach to the sustainable hydrological restoration of SAC terrestrial wetlands is further explored with stakeholders. The approach would focus on restoring natural hydrological functioning as far as possible, analysing the potential of a site based on a good understanding of a natural eco-hydrology, and setting appropriate hydrological targets that take account of both local constraints and the need to maximise a site's contribution to FCS. Generating a reference hydrological template for the landscape (to understand how habitat mosaics would occur naturally) can provide an assessment of the potential for habitat restoration and re-creation within a site and in the wider catchment. This subsequently informs a decision-making process for setting appropriate hydrological ambition for sites. The appropriate long-term hydrological ambition should be embedded in the site's conservation objectives to provide clarity to stakeholders and partners, and to ensure that the available mechanisms work towards these targets in a coordinated manner. This programme is probably best implemented in an approach comparable to that for river restoration i.e. establishing local strategic hydrological restoration plans with stakeholders and partners, and placing them within a coordinated and prioritised national programme. A national programme can also provide the direction needed to take advantage of the best potential restoration locations.

What constitutes a 'natural' hydrology for a site catchment or region can be difficult to define. It is clear though that the extent to which natural hydrological processes can be restored is usually heavily constrained. The term 'restoration' needs to be conditioned with 'as far as possible', without undermining the principle that restoring natural processes by addressing anthropogenic modifications is likely to provide the most sustainable approach to restoring large-scale habitat mosaics. In line with the approach taken to natural river functioning, hydrological targets for terrestrial wetlands could, for the relevant sites, be based on acceptably small deviations from the natural hydrological regime due to immovable constraints. This approach needs to be further developed and tested for terrestrial wetland hydrology.

Whilst many physical and hydrological modifications are effectively immovable (e.g. flood defences protecting urban areas), others have the potential to be reversed if a sufficiently strategic and long-term view is taken (see also work by Mainstone 2014 and others). Hydrological restoration potential must be assessed at a landscape or catchment scale, taking a sufficiently long-term view with respect to what habitats could develop in a hydrologically-restored landscape (taking into account constraints such as climate change, natural variability and other strategic conservation objectives). It will be necessary to consider constraints and assess feasibility and cost of overcoming these when translating a long-term vision to appropriate hydrological targets.

In focusing on natural processes, allowances need to be made for the re-positioning of high-value existing habitats, and supported species within the landscape according to restored hydrological processes, factoring in adequate connectivity to allow species to sustain viable populations, and time to allow movement of species to newly suitable conditions. The assessment of the potential for restoring natural hydrological functioning may result in identifying potential for restoring habitats that are currently not present and for which a site is currently not designated. As there can be conflicts with maintenance objectives in the short term, including the 'no deterioration' requirement of the Habitats Directive, these shifts need to be duly justified in terms of achieving FCS and need to be reflected in the site's conservation objectives through the appropriate process for changing site's objectives. Some flexibility in conservation objectives is needed to allow redevelopment of habitats in a restored landscape, which might include modifications to site notifications.

**Text box 7. The New Forest**
The New Forest represents one of the best examples of the restoration of a range of water-dependent Annex I habitats through an approach that wholly embraces the restoration of natural hydrological functioning. Here, the drainage of mires and channel deepening is being reversed, and natural drainage patterns encouraged, with major benefits to stream and river habitat, standing waters, transition mires and wet heath, and associated Annex II species, including southern damselfly. This work has been funded through a LIFE programme, and is now receiving agri-environment funding (LIFE02NAT/UK/8544).

## 5.3 Establishing long-term local restoration plans in partnership

As wetland hydrological restoration is complex and costly it requires a planned approach. Any restoration project needs to contribute to the overall vision for the hydrological restoration of its catchment. Engaging effective local partnerships is key in translating an understanding of natural eco-hydrological processes to a local restoration strategy.

A programme for SAC terrestrial wetland restoration could be developed that uses an approach similar to the river restoration programme. This means developing a technically sound hydrological restoration plan for terrestrial wetlands, building consensus, establishing a local delivery partnership, embedding the restoration plan into delivery mechanisms (such as agri-environment schemes, flood risk management and capital works) and regulating any activities that affect the wetland system, such as land drainage, development planning and environmental permitting. The stages of a local decision-making process for developing a hydrological restoration strategy, linked to national priorities, are shown in the figure 4 below (adapted from the approach for river restoration plans, Wheeldon 2013).

Taking this approach means that hydrological restoration can be planned consistently across the Natura 2000 network, using evidence-based and transparent decision making that involves those interested or impacted by restoration proposals. National coordination also means that relative priorities between sites can be considered in developing a series of restoration plans across the country, ensuring cost-effective effort and a joined-up ambition to achieve FCS. A degree of national coordination is also needed to ensure that the delivery mechanisms required are effectively embedded in relevant national programmes, such as the water company AMP programmes and future rounds of River Basin Management Planning.

Good local communications and the articulation and demonstration of need and benefits are essential to the local decision-making process. They provide opportunities for local stakeholders to be actively involved in decision making, working out priorities for action, implementing cost effective projects to address local issues, and protecting local resources. Long-term hydrological restoration plans with well-articulated priorities can set a clear direction for all partners and stakeholders, and act as a focal point for securing and allocating resources.

## 5.4 Focus on achieving Favourable Conservation Status (FCS)

The role of restoring natural hydrological processes to help achieve FCS should be considered for the reasons given in section 4.1, and may be required where practicable, at as many sites as possible for a habitat to be in FCS. The extent to which natural hydrological processes can be restored will vary between different sites. Sites where the restoration of natural hydrological functioning can be achieved with relatively modest effort have a great potential for contributing to FCS, but for other sites it may only be possible to maintain their current level of contribution. The challenge is to target most efforts for hydrological restoration at the best potential locations, something that will require a degree of national coordination. This approach will also help ensure that the balancing of different local interests does not compromise work to achieve the wider-scale objectives of the Habitats Directive. A focus on FCS means that site ambitions are not only set from a single site's perspective, but that account is taken of the overall objectives of the Habitats Directive to achieve FCS and the potential contribution of a site. A coordinated programme approach will need to compare hydrological restoration potential between sites and link local-level decision making with national priorities to help inform the appropriate level of ambition for each site. See figure 4 below for the envisaged local decision making process. The outcome should be a well-evidenced set of targets that is appropriate for each site, as well as for the wider network as a whole. These targets would need to be linked to the conservation objectives for the sites (see section 5.4).

## 5.5 Rationalising conservation objectives

Natural England's approach to the setting of conservation objectives of European sites recognises that the Natura 2000 network should contribute to FCS. This includes restoring habitats, where necessary, to turn the current unfavourable conservation status to favourable. Over time, the conservation objectives for European sites will be refined to better outline their contribution to the strategic aims of the Habitats and Birds Directives. The importance of hydrological functioning to the conservation objectives of terrestrial wetland habitats is likely to feature in future supplementary advice produced by Natural England in due course (see Natural England Standard: conservation objectives for European Sites in England). Natural hydrological functioning may be taken as a starting reference when analysing the potential of sites to contribute to the FCS of SAC features.

The appropriate level of ambition identified in local restoration plans (see 5.4) should be clearly translated into the site's conservation objectives. In this way, available delivery mechanisms can start to work towards a site's full contribution to FCS. Explicitly specifying hydrological ambitions linked to conservation objectives can also give clarity to stakeholders and partners on which future investments can be based, and can prevent expensive artificial water management structures being put in place unnecessarily. The value of setting detailed hydrological targets for terrestrial wetlands needs to be further discussed when developing the strategic approach set out in the theme plan with stakeholders and partners.

## 5.6 Managing potential biodiversity conflicts

In England, most wetland habitats and species assemblages have developed in landscapes that have been hydrologically modified for many years. As such, the restoration of natural wetland function can have major implications for a site's current biodiversity interest. These implications need to be properly explored and managed. Consideration of such conflicts is not new – they are frequently encountered in the development and implementation of strategic physical restoration plans for SAC and SSSI rivers (see also river restoration theme plan). Conflicts may be between different habitat types, for example, between restoring natural river/floodplain hydrological connectivity, and the potential loss of standing waters that have developed within the floodplain because of flood defence structures. Water level management conflicts may also arise between habitat and species interests, for example the removal of in-channel structures from rivers might impact on areas of wet grassland (used by wading birds) that are maintained by those structures. It is important to identify these existing high-value features and ensure that their needs are met within restored landscapes. For example, the recent development of targeting maps for important breeding wader populations (RSPB/Natural England, 2014) will allow more informed decisions about the timing and scale of restoration of more natural hydrological regimes to be made in those areas identified, alongside planning of suitable habitat conditions within the restored landscape.
A general approach based on restoring natural water and wetland ecosystem function at landscape scale wherever possible, and nesting species requirements as much as possible in that natural ecosystem function,

provides the means by which all such conflicts can be rationalised, minimised and managed. This does not imply that conflicts can be resolved with no consequences for current management, but it does imply that an evaluation and decision-making framework can be followed that transparently identifies such conflicts, determines the best approach to addressing them based on principles of landscape-scale consideration of natural hydrological processes, and agrees the strategic changes required to management objectives that need to be adopted. Externalising the issues and approaching them in a structured way with appropriate time horizons is key to viewing potential biodiversity conflicts in an appropriate context.

Recent thinking on the conservation of coastal and floodplain grazing marsh in England provides optimism that the necessary integration of restoration philosophy can be achieved across biodiversity interests (Crosher and others 2013). Proposals are being developed to reconceptualise grazing marsh based on a more natural hydrological function, so that in the long-term management and restoration objectives can be aligned with wider water and wetland restoration objectives.

## 5.7 Making use of available mechanisms in a holistic manner

Achieving FCS will require significant restoration efforts at some sites. Where the outcome of a local–to-national decision-making process is agreement that a site should achieve a (more) natural hydrological functioning, the measures necessary to achieve this may have significant implications for current land use. Mechanisms to put these measures in place (such as designating buffer zones, land acquisition and compensation for damage) are available, but budget limitations will require them to be strictly prioritised. The benefit of establishing a programmed approach to hydrological restoration is that these mechanisms can be deployed where they are most needed and steered towards sites where they will deliver the greatest good. Similarly, a programmed and prioritised approach means that external funding sources, such as LIFE, can also be better targeted. A national programmed approach therefore has the potential to break through the barriers to delivery identified in section 4.

Successful hydrological restoration of terrestrial wetlands often means that multiple stresses to the hydrological functioning of a site need to be addressed in a comprehensive approach in order to achieve biodiversity objectives. There are examples where significant effort has gone into relieving groundwater abstraction, but where historic drains are still present which prevent hydrological restoration. Similarly, water flows and levels are sometimes not restored due to the threat of water pollution. Restoring hydrological functioning therefore needs to be set in the context of general site restoration which also considers aspects of land management, its place in the landscape and the potential impacts of climate change, using a holistic, rather than a single-issue approach.

## 5.8 Improving our knowledge

The approach set out in this theme plan relies on a good understanding of the ecological potential as well as consideration of the likely costs and the benefits of restoring natural hydrological processes. Building on our substantial existing knowledge base of the hydrological functioning of sites, (e.g. built up through Review of Consents and subsequent further investigations for groundwater dependent terrestrial wetlands under WFD), a targeted programme of investigations should be undertaken to address remaining knowledge gaps. This would inform further development of site and landscape-scale restoration plans. Some work to better understand the eco-hydrological functioning of SAC terrestrial wetlands and identify potential for more natural hydrological functioning has been done as part of IPENS (see text box 8).

National strategic documents such as the England Wetland Vision can be used to help identify areas of good potential for hydrological restoration and terrestrial wetland creation.
Principles developed through the investigation of the functioning of open waters, fens and bogs should also be applied to other water-dependent habitats e.g. alluvial woodlands, wet heath, dune slacks. More consistent

long-term monitoring of the results of restoration projects is also needed to inform future work and evaluate the effectiveness of interventions.

**Text box 8. IPENS Evidence projects**

The need to improve our understanding of the hydrological functioning of 18 sites was reported as a major issue in SIPs. IPENS-funded evidence projects have contributed to a better understanding of the hydrological functioning of some terrestrial wetlands SACs:

- Norfolk Valley Fen SAC (IPENS Evidence Project 044) provided an eco-hydrological characterisation and investigation of the hydrological function of the SAC. The project reviewed existing information, identified pressures and threats, recommended critical short-term management actions (e.g. drain in-filling). It considered the longer-term actions necessary to sustain the wetland features, and identified where further investigation is required (Shaw and Trat, 2014).
- Border Mires, Kielder- Butterburn SAC (IPENS Evidence Project 070) mapped remaining active drains within specific mires in the SAC. This will help inform any future ground works delivered by the Border Mires partner organisations (Lee, 2015).
- West Midlands Mosses SAC (IPENS Evidence Project 073) reviewed the eco-hydrological status of Chartley Moss SSSI, part of the SAC, through a review of existing reports, mapping of surface drainage and other hydrological features, re-development of a conceptual model, a review of impacts on an unmodified state, and the likely necessary restoration measures needed to achieve something approaching pre-modification state (Low, 2015).

## 5.9 Trialling the approach to example habitats and sites

It should be recognised that the strategy proposed in this section is a long-term approach that needs to be further developed with stakeholders and partners. It is not meant to signal a shift in Natural England's approach with immediate effect or without further discussion. Instead, the value of the approach should be further explored with key delivery partners and stakeholders. However, there may be benefit in trialling this approach on a limited set of habitats and key sites where restoring a natural hydrological functioning is likely to be most feasible and beneficial.

The following three habitats are considered to be most suitable for trialling and developing this long-term approach:

- Raised bogs (H7110 Active raised bogs and H7120 degraded raised bog)
  Active raised bog is a European priority habitat for which eight SACs in England have been designated (including degraded raised bogs would add two more sites to the programme). Significant progress has already been made in restoring more natural hydrological functioning on some of these sites, and a programmed approach, particularly in relation to off-site hydrology, has the potential to add benefit.
- Calcareous Fen (H7210)
  This European priority habitat has a restricted range in England. The close relationship of fen habitat with floodplain hydrology means that trialling the approach on this habitat is likely to help develop links with the approaches to river and lake restoration. An initial assessment of the potential for hydrological restoration is provided in annex 4.
- Transition mire and quaking bog (H7140)
  The habitat is designated at fifteen SACs and there is already a substantial evidence base for its eco-hydrological functioning. As the habitat occurs in a range of landscapes, its hydrological restoration has the potential to benefit several other Annex I habitats (including alkaline fen, wet heath, raised

bog and blanket bog). Equally, comprehensive restoration of hydrology on these other habitats also presents opportunities for the restoration of transition mire.

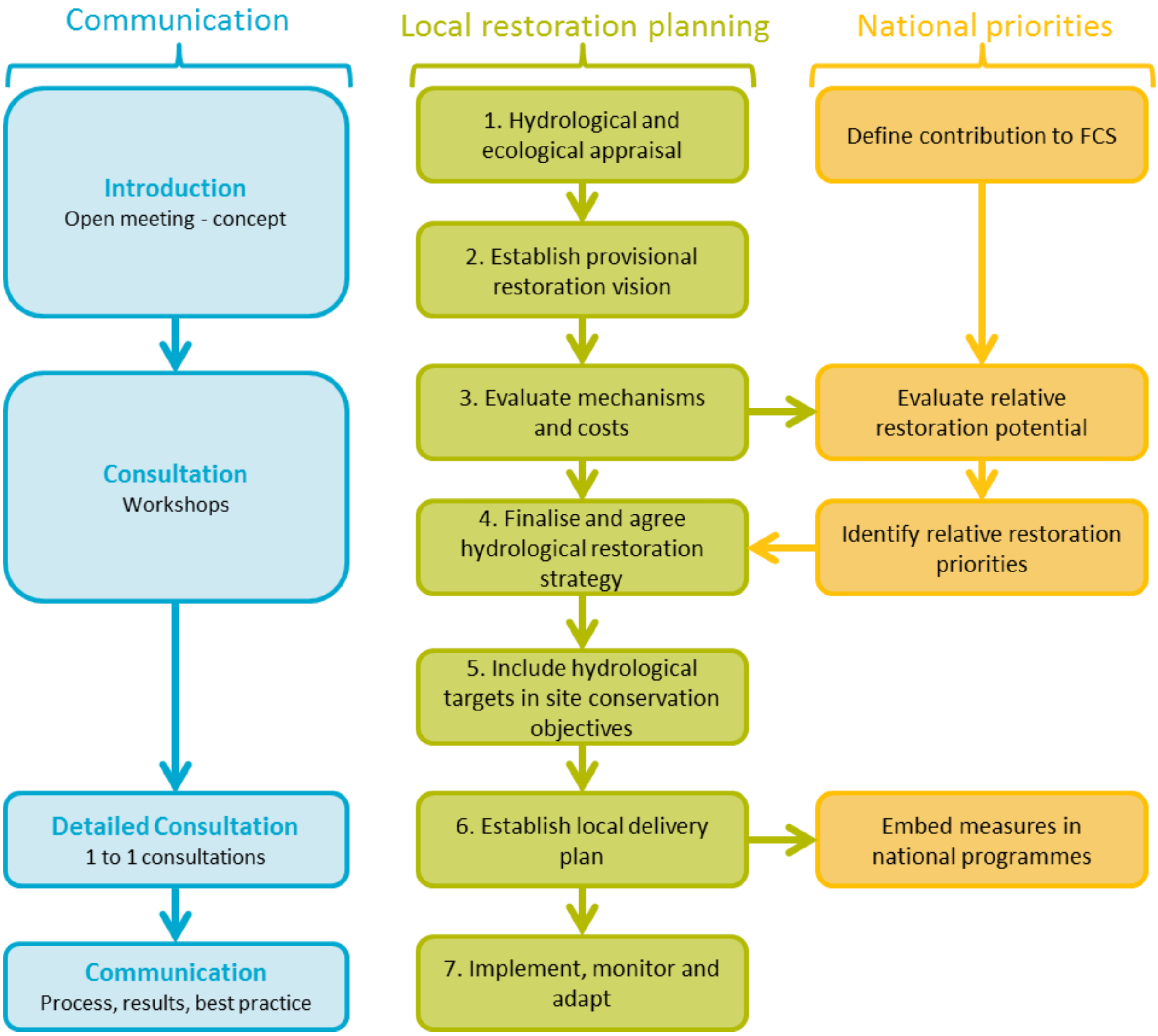



**Figure 4 envisaged decision-making process in hydrological restoration planning**

# 6. Wider benefits of hydrological restoration

The hydrological restoration of SAC terrestrial wetlands is likely to have benefits beyond immediate nature conservation interests. These potential wider benefits will vary from site to site. A full understanding can only be achieved at a local or catchment level.

Ecosystem service benefits can include:

- Helping to improve water quality by reducing run-off.
- Improved carbon storage, e.g. through the restoration of upland deep peatland.
- Supporting drinking water supply.
- Synergies with large-scale flood-risk management and water resource management by slowing or storing flood waters and recharging groundwaters.
- Opportunities for climate change adaptation by increasing the capacity of the natural environment to regulate impacts of extreme weather events.
- Increased amenity and recreation value.

The approach envisaged in this plan also contributes to implementing the recommendations of the Lawton Review for a more joined-up and resilient network of protected sites and wider environmental delivery mechanisms at a landscape-scale. The Wetland Vision stipulates the wider benefits of wetland restoration, including synergies with preserving the historic environment. Benefits of wetland restoration are also highlighted in the UK National Ecosystem Assessment (NEA 2014, NEA 2011) and the publications of the Natural Capital Committee (NCC 2014, NCC 2015).

# 7. Actions

Table 3 (below) outlines the priority actions for implementing this theme plan. It indicates the next steps envisaged to progress the outlined approach and these will be explored further with the suggested stakeholders and partners. The priority actions table should not be seen as a fully funded, committed-to implementation plan. It is aimed at informing the future resource decisions of the delivery bodies involved. Implementation of this theme plan and others will be coordinated through the IPENS After-Life programme and its steering group.

The table summarises those actions identified in earlier sections of this document. Actions are mainly strategic, rather than site specific, and are subdivided into themes as follows:

- Implementing priority actions for sites.
- Establishing a programmed approach.
- Improving the evidence and knowledge base.

Actions in Table 3 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.

**Table 3 Priority actions for implementing this theme plan**

| Action no. | Action description | Suggested Lead bodies and partners |
|---|---|---|
| **Implement priority actions for Natura 2000 sites identified in SIPs**<br>Wherever possible, measures that work towards restoring natural hydrological functioning should be prioritised, rather than measures that contribute to a more artificial hydrology. However, critical measures for artificially managed sites, where further deterioration in condition is likely over short timescales, should also be prioritised. | | |
| 1 | Continue the hydrological restoration of bog, mire and heath systems, through raising water levels, removal of drains, ditch/grip blocking, bunding, gully reprofiling, sometimes assisted with tree and scrub removal and revegetation. | Natural England, partners |
| 2 | Reduction of on-going peat cutting within Natura 2000 sites along agreed timescales through modification of permissions. | Local authority |
| 3 | Ensure hydrologically connected areas surrounding sites are managed sympathetically. Consider including these zones in the site boundaries for sites with bogs and mires. | Natural England |
| 4 | Implement actions in existing agreed Water Level Management Plans. Review Water Level Management Plans where necessary. | Flood authorities |
| 5 | Implement outstanding actions to reduce abstraction pressure and investigate cases where remaining impacts are suspected. | Environment Agency, Natural England |
| **Develop hydrological restoration programme** | | |

| | | |
|---|---|---|
| 6 | Discuss with stakeholders and partners the value of developing a programmed approach to the hydrological restoration of SAC terrestrial wetlands through the Terrestrial Biodiversity Group (TBG) and the Major Landowners Group (MLG). | Natural England, TBG, MLG |
| 7 | Agree the nature, scope and timescales as well as the process and who is involved in developing a programmed approach. | Natural England, TBG, MLG |
| 8 | Develop a business case for a national project officer and establish programme coordination, guidance, audit, etc. | Natural England |
| 9 | Further develop with key partners and stakeholders the approach and framework for setting appropriate hydrology targets for sites. | Natural England |
| 10 | Starting with a limited number of sites, develop long-term hydrological restoration strategies and plans with local stakeholders and partners, assessing the potential for hydrological restoration, taking near-natural hydrological functioning as a reference. | Natural England, Environment Agency, local partners |
| 11 | Establish the hydrological restoration priorities for Natura 2000 terrestrial wetland sites and include the appropriate hydrological targets in the site's conservation objectives. | Natural England |
| 12 | Develop a funding strategy for implementing prioritised hydrological restoration measures to secure funding for major restoration of SAC and SSSI terrestrial wetlands. Bids for sources such as the EU LIFE and Climate Change Adaption funds should be developed. | Natural England, Partners |
| **Improving the evidence and knowledge base** | | |
| 13 | Targeted investigations into the hydrological functioning of sites and their wider natural hydrological landscapes where evidence gaps have been identified. | Natural England |
| 14 | Starting with a limited number of priority habitats, clarify what Favourable Conservation Status means for terrestrial wetlands and what the role of England's Natura 2000 network is in achieving this, through FCS work under the Chief Scientist Group. | Natural England, JNCC |
| 15 | Improve awareness and understanding of the role of (natural) hydrological functioning in assessing site condition. | Natural England |

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# Annex 3. Overview of drivers and delivery mechanism for hydrological restoration of terrestrial wetlands

## Key Drivers

### Water Framework Directive (WFD)

The WFD requires the River Basin Management Plan (RBMP) programme of measures to become operational by December 2012, and aims for Natura 2000 Protected Areas to achieve compliance by December 2015. Extensions may be permitted under the specific conditions.

RBMPs set out the actions, known as the 'programme of measures', that are necessary to ensure that inland and coastal waters achieve WFD 'good ecological status or potential' status (or an alternative objective) and that there is no deterioration from their current status, along with the specific requirements for protected areas described above. Abstraction licensing is one of several mechanisms in place to support River Basin Planning objectives.

The first set of RBMPs were published in December 2009 by the Environment Agency; the competent authority for the WFD in England. These river basin management plans (RBMPs) included a summary (in 'annex D') of the measures needed for water dependent Natura 2000 sites to meet their conservation objectives. Since then, new information has emerged on risks or impacts to Natura 2000 sites and some new measures have been identified which are being included in the update to the plans. A fundamental and new approach to capturing the priority and new measures for water dependent Natura 2000 sites is through the publication of IPENS Site Improvement Plans (SIPs). The SIPs contain priority actions for all habitats on these sites. The SIPs include the priorities and new measures needed to achieve water-dependent Natura 2000 objectives under the WFD.

Groundwater body assessment: A groundwater body can be classed as either Good or Poor based on its chemical status and groundwater abstraction pressures. The WFD requires that all groundwater bodies achieve Good Status by 2015 unless alternative objectives are justified. For most of the groundwater bodies at Poor Status EA have justified an extended deadline (2027) on the basis that premature action to modify abstractions could be disproportionately costly. This will allow time for investigations to be completed and appropriate measures implemented.

### Water White Paper 2011 and abstraction reform:

Defra set out its plans for long-term reform of the abstraction system in the Water White Paper (Water for Life, December 2011). It concludes that 'current levels of abstraction are already harming nature and that the pressure is likely to increase in the future'. Water white paper announced water abstraction reform and aims to introduce legislation, implementing fully mid/late 2020s. Abstraction reform is addressing the potential future problems of changing availability and security of supply as a result of the longer term impacts of climate change, increasing population and an increasing demand for water. The reform is not aimed at resolving the legacy of unsustainable abstractions. These are supposed to be resolved using existing tools, such as programmes of measures in RBMPs up to 2027 and the Restoring Sustainable Abstraction (RSA) programme.

## Key Mechanisms

## Management of abstraction

Managing Water Abstraction (2013) sets out how water resources are managed in England and Wales. It is the overarching document that links together key abstraction licensing strategies. Some key elements include:

Abstraction licensing by EA (anything above 20 cubic m) (EA): The Water Act 2003 put into legislation a number of significant changes to the abstraction licencing system. Abstractions above 20m3/d are subject to licensing (except for some currently exempted purposes such as trickle irrigation and quarry dewatering which new authorisations will bring into the licensing system). Habitats Regulations Assessments are applied where appropriate before granting new licenses. Water Act 2003 introduced time limited licences. This means they can be periodically reviewed to determine whether to replace them or not and if so, what conditions should apply. Where an existing abstraction is damaging the environment EA has the power to amend or revoke existing licences, although there may then be the liability to pay compensation which is raised through abstraction charges. Where the abstraction is causing or has the potential to cause serious damage compensation is not payable (S57 of Water Act 2003). Significant exempt abstractions are due to be brought into the licensing regime over the next few years, under Water Act 2003.

Catchment abstraction management strategy (CAMS) (EA): CAMS is a resource assessment process that informs the Licensing Strategy within individual catchments. CAMS assess how much water is reliably available on a catchment by catchment basis. By taking into account the amount of water already licensed for abstraction and how much water the environment needs, EA can determine how much water is potentially available for further abstraction. CAMS uses the Environmental Flow Indicator (EFI) to help identify where the amount of water abstracted or licensed exceeds the available water in a catchment. This then informs the Measures Appraisal which is done through other mechanisms like the Restoring Sustainable Abstraction programme.

Where the EA identify flows that are not supporting a healthy ecology it will investigate ways to remedy this, taking the catchment-based approach. This means looking for solutions that take account of other environmental problems in the catchment, for example with water quality.
In some cases where the cost of a solution is far greater than the benefit it would deliver, alternative, less stringent objectives may be set so that feasible improvements can be made.

CAMS is an integral part of the River Basin Management Planning and informs RBMP programme of measures.

Restoring Sustainable Abstraction programme (RSA) (EA):
This programme is now closed to new issues as they are being dealt with under RBMP. The RSA programme was set up in the 1990s to address licensed unsustainable abstraction. It incorporated actions identified for SSSIs (in the Remedies programme and since), and incorporated the Habitats Directive Review of Consents programme. It also captured local issues and those affecting BAP species and habitats. The programme followed an approach to investigate, undertake and options appraisal looking at appropriate solutions and then implementing a licence change where required, or a non-licence change solution.

**Status of the RSA programme**

- Water White paper: EA reports on progress in 2012 and develops an action programme up to 2027.
- The programme has run since the 1990's, around 60% of investigations are closed. EA have closed 310 RSA schemes in England, changed 92 licenses, mostly voluntary. Some of these schemes have been closed because abstraction was proven not to be the cause of the problem, while others involved solutions where abstraction was found to be a risk or causing environmental damage. Solutions can include installing screens to reduce or prevent the risk or damage associated with a licence.
- Of the licences that have been investigated, approximately 50% required no change, 43% are still underway, and 7% have been changed and the investigations closed.
- There are currently 224 schemes and 417 licences being investigated in the work towards ensuring that abstraction is not damaging to the environment. 49 of these relate to Habitats Directive sites. (Data from April 2013)

Water resource management plans, Price Review process, NEP

The Water Services Regulation Authority (Ofwat) reviews Water Company pricing in a five-yearly process known as the Periodic Review. Water companies are now working on PR14 which will set prices for 2015 to 2020. Water companies have a statutory duty to produce both Business Plans (BPs) and Water Resources Management Plans (WRMPs). The first relates to how they manage their business and the level of customers' bills and the second to how they manage water.

WRMPs: cover a 25-year period, kept under yearly review and revised every five years. Ofwat use the Management Plans to assess the companies' supply-demand balance and the work they need to undertake as part of the Periodic Review. Necessary investments in projects and infrastructure to improve protected areas are included in the review, informed by review of SSSI condition. The Water Act 2013 included water company solutions for unsustainable abstraction in water resource management plans and water price review process. Natural England and the Environment Agency are consulted on Business Plans and WRMPs.

National Environment Programme (NEP): The NEP is a programme of investigations and actions for environmental improvement schemes that ensures that water companies meet European Directives, national targets and their statutory environmental obligations. The Environment Agency provides a list of investigations and solutions for the NEP after consultation with the water industry and a number of other organisations, including Natural England. The NEP forms part of the final Asset Management Plan (AMP) that determines the overall level of investment that water companies need to make over a five year period, based on the new price set by Ofwat. Companies incorporate these requirements into their proposed business plans, which inform Ofwat's decision on price limits.

Water resource strategy for England and Wales

The Environment Agency corporate strategy provides a framework for water resources management across England and Wales and set out how water resources should be managed beyond 2050.

Water resource action plan for England and Wales

Sets out the actions the Environment Agency will take to implement the aims and objectives in the water resources strategy for England and Wales.

Water resource strategy regional action plans

Seven regional action plans show how the actions within the water resources strategy will be delivered at a regional level. Water resources strategy Regional Action Plans (RAPs) report how these actions will be carried out at a local level up to 2015. RAPs also include water resources elements such as drought management. Initiatives such as CAMS and Restoring Sustainable Abstraction (RSA) will provide a mechanism for delivery of actions contained in the plans.

### *Management of water levels*

Water Level Management Plans (WLMPs)

WLMPs are non-statutory site management plans for managing water levels on lowland wetland sites, typically through the use of water control structures (artificial channels, sluices, pumps). WLMP development is funded by flood risk management grant-in-aid (Government funding) while implementation of plan actions may be funded through grant-in-aid or agri-environment incentive schemes depending on the nature of the measure required. The installation and maintenance of water control structures would generally be funded through grant-in-aid, while agri-environment scheme agreements are used to reimburse income foregone by landowners or occupiers contracted to manage their land in ways that are compatible with wetter conditions and that support the required habitat or species assemblages. In the case of Internal Drainage Boards, grant-in-aid can be used to fund plan development and required capital projects, but ongoing maintenance works in support of the WLMP can only be funded by revenue from drainage rates levied on landowners in the drainage district.

Development of WLMPs is the responsibility of flood risk authorities (the Environment Agency, local flood authorities, and Internal Drainage Boards) acting in consultation with Natural England. It is a Government requirement that flood authorities undertake this role and the responsible department Defra) has over time issued various guidance to the authorities on discharging their responsibilities.

**Stages involved in the development of a typical Water Level Management Plan**

1. Conservation objectives are set to meet the ecological requirements of the habitat and species interests of the site.
2. Available spatial and hydrological information is assessed, including:
   - Topography – ground levels, water levels, the drainage system, existing water control structures;
   - Substrate – soil characteristics, hydraulic conductivity, surface water and groundwater interactions;
   - Water supply, storage and discharge.
3. Eco-hydrological criteria are developed with which to set surface water and groundwater levels for:
   - Relevant vegetation communities;
   - Relevant mammal, bird and invertebrate species;
   - Ditch and other open water habitats.
4. The existing water balance for site is assessed:
   - Supply – precipitation, surface and ground water inflow (also taking account of water quality issues);
   - System storage capacity;
   - Discharge – evapo-transpiration, surface and groundwater outflow.
5. Boundary issues are considered, such as the possible disparity between the designated site boundary and the hydrological boundary. Surrounding land use or management and abstraction activities may be constraining water levels.
6. The existing water-level regime is assessed:
   - Spatially – the variation in water levels required across site: depth and area of flooding; maximum and minimum water levels required; flows; penning levels.
   - Temporally – the timing, frequency and duration of flooding/high water levels; seasonal fluctuations in levels that may be required.
7. Operational objectives are identified using the eco-hydrological criteria and information on the water-level regime. These will include:
   - A consideration of water availability;
   - An appropriate operating regime for water-level control structures - dams, sluices, weirs, ditches, bunds;
   - A detailed, year-round management plan with operational procedures;
   - Any resource requirements – staffing and funding for plan operation, ongoing maintenance requirements of water courses and control structures, and future monitoring.
8. The nature conservation and the flood risk management agencies agree an appropriate ongoing monitoring and reporting programme for the site's hydrology and dependent biological interest features.

### Flood and Coastal Risk Management

In addition to WLMPs, flood and coastal risk management can potentially benefit conservation objectives through a number of other mechanisms. The policy framework that governs the activities of flood risk authorities makes clear that these public bodies have duties to contribute, while undertaking their normal activities, to the conservation and enhancement of nature conservation sites and to biodiversity more broadly. This is reinforced in the Government's National Flood Risk Management Strategy for England that sets out the broad strategic objectives for flood risk authorities and the use of grant-in-aid. Thus, for example, flood authorities are currently engaged in funding and implementing programmes for the physical restoration of protected rivers and the restoration/creation of saltmarsh at the coast through managed realignment schemes, with both programmes contributing to the achievement of objectives for Natura sites. Beyond the flood authorities' legal and policy duties towards protected sites and biodiversity, there is an increasing commitment to the adoption of 'natural flood management' approaches to the reduction of flood risk, also known as 'working with natural processes'. A growing body of research has highlighted the potential benefits of working with natural processes to attenuate flood flows. This involves the deployment of measures that restore or at least mimic natural hydrological function within catchments. Changes in land use/land management and farming practices can reduce soil compaction and erosion, increase infiltration – making catchments more 'absorbent' – and reduce run-off, thereby attenuating flood flows downstream. Land-use change – converting arable to grassland, creating woodland or wetland habitat – can also have significant flood attenuation benefits. There is a range of possible interventions that will have varying degrees of benefit for flood risk management. The evidence for the degree of benefit is also variable: benefits of attenuation measures at local farm and field scale are well-understood, and there is a growing body of evidence of effects at a catchment scale, which is less easy to measure due to a number of confounding factors. A number of measures have proven benefits for flood attenuation and for the restoration of more natural hydrological function, in particular: making space for water by realigning flood defences at the coast and on river floodplain systems; physical restoration of river channels; and floodplain storage through habitat creation or restoration.

FCRM is an EA led programme focused at long-term planning of works in relation to flood risks and coastal erosion. It incorporates actions determined by Water Level Management Plans. EA has the responsibility for approving and payment of capital Flood Defence Grant in Aid (FDGiA) across all authorities in England. A new approach to funding flood and coastal risk management has been introduced ('Flood and Coastal Resilience Partnership Funding'.). NE seeks synergies with biodiversity requirements and contributes through agri-environment schemes. FCRM schemes have contributed to wetland creation.

## Tools and processes for improving site management

### Conservation Objectives review

Following the conclusions of the Habitats and Wild Bird Directives Implementation Review, Conservation Objectives for terrestrial and marine Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) in England have been improved. Natural England published high level conservation objectives for all the sites and established a programme to add supplementary advice in the form of relevant integrity attributes and targets to each European Site. In relation to wetlands, these attributes can now include components of hydrological functioning. Conservation objectives are the key mechanism by which management objectives for sites are communicated to other regulators, such as the Environment Agency and local authorities, and site owners, managers and developers. They are publicly available documents.

The aim is to keep conservation objectives up-to-date, easily accessible and to better enable assessments of impacts of development against them. There is a list of European terrestrial and marine sites where the improvement of conservation objectives will be a priority.

Natural England also works with others to progress towards a shared definition of Favourable Conservation Status (FCS) and sustainable wild bird population levels for European features at an England level

### Detailed notification review

Natural England reviews and updates the boundaries of SSSIs as appropriate through a strategic approach to ensure that they remain fit for purpose and resilient. SSSI notification amendments take account of the importance of features at EU and international level, and the need to accommodate space for natural processes. This includes considering land necessary for critical processes which support notified features, such as immediate hydrological catchments of wetland habitats (Natural England designation strategy 2012; Natural England SSSI notification strategy 2008 and associated guidance).

### WETMECS

WETMECS[4] is a Wetlands mechanisms Tool for understanding the water supply mechanisms for a suite of wetland types and their plant communities based on an understanding of where the wetland's water supply comes from and the environmental and landscape conditions. The use of WETMECS helps site managers to characterise the natural hydrological functioning of a wetland and thus identify threats and issues as well as mechanisms for resolving them. WETMECS was developed as part of the Wetland Framework for Impact Assessment at Statutory Sites in England and Wales.

### Hydro-ecological guidelines

For key wetland communities, these characterise the water level requirements of wetlands and assist with understanding the implications of proposals such as abstraction. It is a tool for site managers to understand how to best manage sites and for regulators to assess the likely impacts of proposed changes. They are published by the Environment Agency[5]

### The Wetland vision:

The Wetland Vision partnership (EA and NE, English Heritage, RSPB and the Wildlife Trusts) developed a 50-year vision for wetlands and the wildlife they support. It brought together a range of information about existing wetland projects and the potential for future wetlands, and presented it using GIS mapping tools to enable others to access and use the information when developing their plans and strategies. Natural England provided funds of up to two million pounds per year over four years to help make this ambitious wetland vision a reality. Wetland Vision funding has paid for purchase of land around Bowness Common, Wybunbury Moss and other work on SACs. It is for example looking to create and restore wetlands such as the Meres and Mosses of the West Midlands, the fens of South Lincolnshire, and the peatlands of the Humberhead levels. This contributes towards the Biodiversity 2020 commitment to create eight new landscape scale wetlands in the UK by 2020 and helps meet the Lawton Review / Natural Environment White Paper (2011) objectives of integrated natural networks and landscape scale conservation. (http://www.wetlandvision.org.uk/)

[4] https://www.gov.uk/government/publications/wetland-functional-mechanisms-a-synopsis-of-wetland-water-supply-mechanisms-wetmecs

[5] https://www.gov.uk/government/publications/ecohydrological-guidelines-for-lowland-wetland-plant-communities

# Annex 4. Example: 7210 Calcareous fens with Cladium mariscus and species of the Caricion davallianae * Priority feature

## Role of England's Natura 2000 network in achieving FCS

This Annex I type comprises the more species-rich examples of great fen-sedge *Cladium mariscus* fen, particularly those stands enriched with elements of the *Caricion davallianae* (*i.e.* small-sedge fen with open low-growing sedge vegetation). Davall's sedge *Carex davalliana* itself is extinct in the UK. Such stands occur in the following situations:

1. Sites with a mixture of closed, species-poor *Cladium* beds, which at their margins have transitions to species-rich small-sedge mire vegetation;
2. Sites where *Cladium* beds retain their species-richness owing to management; and
3. Situations where *Cladium* fen is inherently species-rich, possibly owing to the fact that conditions do not allow the *Cladium* to grow vigorously and dominate the vegetation.

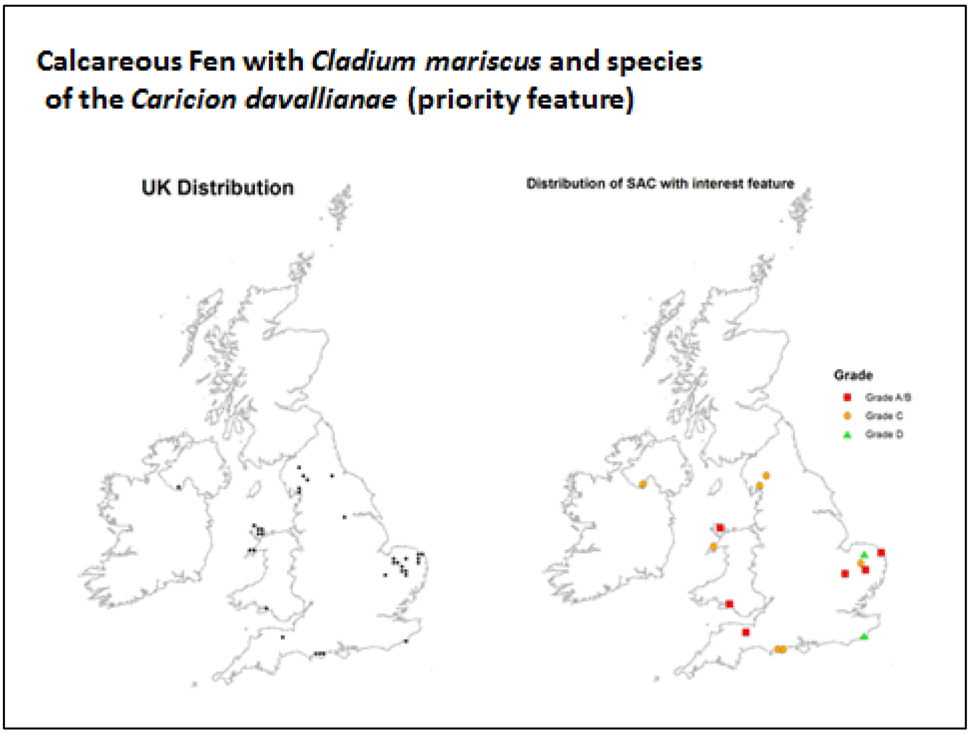
Calcareous fens are rare in the UK, having a restricted and discontinuous geographical range with two main centers of distribution: the Broadlands of East Anglia and, to a lesser extent, the fen systems of Anglesey. This habitat type is very scattered and local elsewhere in the UK.

The overall conservation status of the habitat in the UK is classified as Bad, due to both habitat area and habitat structure and function being insufficient for viable conservation More than 80% of the total UK resource occurs in England.

| Code | Habitat name | range | Habitat Area | Structure & function | UK conservation status |
|---|---|---|---|---|---|
| H7210 | Calcareous fens with Cladium mariscus and species of the Caricion davallianae | Favourable | Bad | Bad | Bad |

Site selection for this priority habitat type has taken account of the fact that calcareous fens are rare in the UK. The sites selected include a very high proportion of the total remaining UK resource of the habitat type, including the largest surviving examples.

**Figure 5. Distribution of H7210 Calcareous Fen. Source: JNCC.**




## Opportunities for improving condition and restoration of the feature

The majority of restoration opportunities are to be found in the areas within or close to SAC sites, for example the Morecambe Bay limestones, the Broads, the Norfolk Valley Fens and the Waveney and Little Ouse Valley Fens. With the exception of the Broads, the extent and condition of the feature in these areas is substantially below that necessary to achieve FCS for the habitat. Wheeler and Shaw (1992) in a report on dehydration in Fens in East Anglia illustrate the loss, and by implication the potential for restoration of this habitat, and other Annex I habitats including Alkaline Fen and *Molinia* meadows in the Waveney-Little Ouse area on the Norfolk-Suffolk border. They write "*At one time probably all of the Waveney-Ouse riverside valley fens were of very great floristic interest, though not too much is known about either the vegetation or land-use history of some of them. Some, such as Bressingham Fen, have effectively been destroyed, whilst others (e.g. Roydon Fen) have become much drier. In the late 1950s the three riverside sites examined by Bellamy & Rose (1961) were undoubtedly of high floristic quality, Today Hinderclay Fen is scarcely recognisable as a fen and, whilst the other riverside sites remain as ostensible fens, all except for Thelnetham West Fen they have shown a substantial loss of floristic quality. This must be regarded as one of the most serious recent losses of fen vegetation in England. It is, however, by no means certain that the damage is completely irreversible.*"
The reasons for these losses are various, but the key factors are loss of wetness, particularly through direct drainage, channeling of spring flow, river deepening and in some cases, groundwater abstraction. Some of the large SAC sites retain fragments of the lost habitats in addition to the core areas, and the wider landscapes in which they sit still support components of the habitat, so restoration should be possible, but it will be necessary to reverse the majority of the damage that has occurred. In many cases this would involve river restoration, including bed-raising and re-meandering, and in-filling and blocking of drains and ditches. Upslope and upstream activities need to be considered also, as there may be a risk of nutrient enrichment. To effect this hydrological re-naturalisation, an integrated approach to river and floodplain restoration is essential. Notwithstanding the issues with existing land use and flood concerns, the remaining sites in this area and the chalk rivers of north Norfolk offer perhaps the greatest opportunities to restore significant areas of H7210 in England.

In the Morecambe Bay area, Calcareous Fen is associated with base-rich waters emerging from limestone. The small remaining areas of the habitat now only occur around the margins of lakes, although at one time would likely have occurred in large wetland complexes of open water, raised bog and calcareous fen, as can be seen in peat stratigraphy. Drainage of lake basins and peat stripping has reduced the extent of all wetlands, however, there are significant opportunities to improve the hydrological status of these lake basins by restoring lake levels to near-natural and re-naturalising spring flow, which has often been ditched and channelled away from wetlands, and in doing so re-wetting areas of peat and restoring favourable conditions for the development of fen habitats. Opportunities also exist in the river valleys draining the limestone, e.g. the Lyth valley, where calcareous springs (supporting degraded petrifying springs with Cratoneurion mosses) emerge at the valley sides. It is critical to the achievement of FCS for this habitat that opportunities for its restoration are not missed in the process of restoring easier and less-demanding habitat such as reedbed.

Elsewhere in England fragments of the habitat remain in a degraded state. In these sites, the opportunities need to be identified and hydrological naturalisation measures taken as a priority to effect restoration. The key areas are probably the West Midlands Meres and Mosses, where fragments remain around meres and on the edges of schwingmoors, all in modified hydrological environments (drained lake basins, drained bogs, piped springs), and the Somerset Levels, which although comprehensively drained retain areas that are restorable to the habitat, including peat-cutting sites. It is important here as well that the harder to restore calcareous fen is given priority alongside other less diverse habitats, where management may be focused on restoring specific species populations such as bittern.

# Annex 5. Overview of relevant Natura 2000 sites

**Table of relevant SACs to this theme plan**

| SAC | H2170 Dunes with Salix repens | H2190 Humid dune slacks | H4010 Northern Atlantic wet heaths | H4020 Temperate Atlantic wet heaths | H6410 Molinia meadows | H6430 Hydrophilous tall herb fringe | H6510 Lowland hay meadows | H7110 Active raised bogs | H7120 Degraded raised bogs | H7140 Transition mires and quaking bogs | H7150 Depressions on peat substrates | H7210 Calcareous fens | H7220 Petrifying springs with tufa | H7230 Alkaline fens | H91D0 Bog woodland | H91E0 Alluvial forests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Asby Complex | | | | | 1 | | | | | | | 1 | 1 | 1 | | |
| Ashdown Forest | | | 1 | | | | | | | | | | | | | |
| Bolton Fell Moss | | | | | | | | | 1 | | | | | | | |
| Border Mires, Kielder – Butterburn | | | 1 | | | | | | | 1 | | | 1 | | | |
| Borrowdale Woodland Complex | | | | | | | | | | | | | | | 1 | |
| Bracket`s Coppice | | | | | 1 | | | | | | | | | | | |
| Braunton Burrows | 1 | 1 | | | | | | | | | | | | | | |
| Breckland | | | | | | | | | | | | | | | | 1 |
| Breney Common and Goss and Tregoss Moors | | | 1 | | | | | | | 1 | | | | | | |
| Calf Hill and Cragg Woods | | | | | | | | | | | | | | | | 1 |
| Cannock Chase | | | 1 | | | | | | | | | | | | | |
| Carrine Common | | | | 1 | | | | | | | | | | | | |
| Cothill Fen | | | | | | | | | | | | | | 1 | | 1 |
| Craven Limestone Complex | | | | | 1 | | | 1 | | | | | 1 | 1 | | |
| Crowdy Marsh | | | | | | | | | | 1 | | | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Culm Grasslands | | | 1 | | 1 | | | | | | | | | | | |
| Dartmoor | | | 1 | | | | | | | | | | | | | |
| Dawlish Warren | | 1 | | | | | | | | | | | | | | |
| Dee Estuary/ Aber Dyfrdwy | | 1 | | | | | | | | | | | | | | |
| Dorset Heaths | | | 1 | | 1 | | | | | | 1 | 1 | | 1 | | |
| Dorset Heaths (Purbeck and Wareham) and Studland Dunes | | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | | 1 | 1 | |
| Drigg Coast | 1 | 1 | | | | | | | | | | | | | | |
| Duddon Mosses | | | | | | | | 1 | 1 | | | | | | | |
| East Devon Pebblebed Heaths | | | 1 | | | | | | | | | | | | | |
| Eller`s Wood and Sand Dale | | | | | | | | | | | | | 1 | | | |
| Emer Bog | | | | | | | | | | 1 | | | | | | |
| Epping Forest | | | 1 | | | | | | | | | | | | | |
| Exmoor and Quantock Oakwoods | | | | | | | | | | | | | | | | 1 |
| Exmoor Heaths | | | 1 | | | | | | | | | | | 1 | | |
| Fen Bog | | | | | | | | | | 1 | | | | | | |
| Fenland | | | | | 1 | | | | | | | 1 | | | | |
| Fenn`s, Whixall, Bettisfield, Wem and Cadney Mosses | | | | | | | | 1 | 1 | | | | | | | |
| Ford Moss | | | | | | | | 1 | | | | | | | | |
| Godrevy Head to St Agnes | | | | 1 | | | | | | | | | | | | |
| Hatfield Moor | | | | | | | | | 1 | | | | | | | |
| Holme Moor and Clean Moor | | | | | 1 | | | | | | | 1 | | 1 | | |
| Ingleborough Complex | | | | | 1 | | | | | | | | 1 | 1 | | |
| Kennet Valley Alderwoods | | | | | | | | | | | | | | | | 1 |
| Lake District High Fells | | | 1 | | | 1 | | | | | | | | 1 | | |
| Lower Derwent Valley | | | | | | | 1 | | | | | | | | | 1 |
| Manchester Mosses | | | | | | | | | 1 | | | | | | | |
| Moor House – Upper Teesdale | | | | | 1 | 1 | | | | | | | 1 | 2 | | |
| Morecambe Bay | 1 | 1 | | | | | | | | | | | | | | |
| Morecambe Bay Pavements | | | | | | | | | | | | 1 | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mottey Meadows | | | | | | | 1 | | | | | | | | | |
| Naddle Forest | | | 1 | | | | | | | | | | | | | |
| Newham Fen | | | | | | | | | | | | | | 1 | | |
| Newlyn Downs | | | | 1 | | | | | | | | | | | | |
| Norfolk Valley Fens | | | 1 | | 1 | | | | | | | 1 | | 1 | | 1 |
| North Meadow and Clattinger Farm | | | | | | | 1 | | | | | | | | | |
| North Norfolk Coast | | 1 | | | | | | | | | | | | | | |
| North Northumberland Dunes | 1 | 1 | | | | | | | | | | | | | | |
| North Pennine Dales Meadows | | | | | 1 | | | | | | | | | | | |
| North Pennine Moors | | | 1 | | | | | | | | | | 1 | 1 | | |
| North York Moors | | | 1 | | | | | | | | | | | | | |
| Oak Mere | | | | | | | | | | 1 | | | | | | |
| Oxford Meadows | | | | | | | 1 | | | | | | | | | |
| Peak District Dales | | | | | | | | | | | | | | 1 | | |
| Penhale Dunes | 1 | 1 | | | | | | | | | | | | | | |
| Portholme | | | | | | | 1 | | | | | | | | | |
| River Camel | | | | | | | | | | | | | | | | 1 |
| River Eden | | | | | | | | | | | | | | | | 1 |
| River Wye/ Afon Gwy | | | | | | | | | | 1 | | | | | | |
| Rooksmoor | | | | | 1 | | | | | | | | | | | |
| Roudsea Wood and Mosses | | | | | | | | 1 | 1 | | | | | | | |
| Roydon Common and Dersingham Bog | | | 1 | | | | | | | | 1 | | | | | |
| Saltfleetby–Theddlethorpe Dunes and Gibraltar Point | | 1 | | | | | | | | | | | | | | |
| Sandwich Bay | 1 | 1 | | | | | | | | | | | | | | |
| Sefton Coast | 1 | 1 | | | | | | | | | | | | | | |
| Shortheath Common | | | | | | | | | | 1 | | | | | 1 | |
| Skipwith Common | | | 1 | | | | | | | | | | | | | |
| South Pennine Moors | | | 1 | | | | | | | 1 | | | | | | |
| South Solway Mosses | | | | | | | | 1 | 1 | | | | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strensall Common | | | 1 | | | | | | | | | | | | | |
| Subberthwaite, Blawith and Torver Low Commons | | | | | | | | | | 1 | 1 | | | | | |
| Tarn Moss | | | | | | | | | | 1 | | | | | | |
| The Broads | | | | | 1 | | | | | 1 | | 1 | | 1 | | 1 |
| The Lizard | | | 1 | | | | | | | | | | | | | |
| The New Forest | | | 1 | | 1 | | | | | 1 | 1 | | | 1 | 1 | 1 |
| Thorne Moor | | | | | | | | | 1 | | | | | | | |
| Thursley, Ash, Pirbright and Chobham | | | 1 | | | | | | | | 1 | | | | | |
| Walton Moss | | | | | | | | 1 | 1 | | | | | | | |
| Waveney and Little Ouse Valley Fens | | | | | 1 | | | | | | | 1 | | | | |
| West Dorset Alder Woods | | | | | 1 | | | | | | | | | | | 1 |
| West Midlands Mosses | | | | | | | | | | 1 | | | | | | |
| Wimbledon Common | | | 1 | | | | | | | | | | | | | |
| Winterton – Horsey Dunes | | 1 | | | | | | | | | | | | | | |
| Witherslack Mosses | | | | | | | | 1 | 1 | | | | | | | |
| Woolmer Forest | | | 1 | | | | | | | 1 | 1 | | | | | |
| Grand Total | 7 | 13 | 25 | 4 | 17 | 2 | 5 | 8 | 10 | 15 | 7 | 9 | 7 | 17 | 4 | 12 |

# Annex 6. List of IPENS theme plans

IPENS has produced several thematic action plans or 'Theme Plans', some of which relate to issues discussed in this theme plan. The full list of theme plans can be found below:

| Theme plan | Weblink |
|---|---|
| Atmospheric nitrogen | 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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