Natural England Research Report NERR066

An assessment of evidence supporting a programme of wetland restoration projects in the New Forest Site of Special Scientific Interest

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An assessment of evidence supporting a programme of wetland restoration projects in the New Forest Site of Special Scientific Interest

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Contents

Figures

1 Background

1.1 This document has been produced to underpin decisions made in restoring the river, stream and wetland habitats of the New Forest Site of Special Scientific Interest which have suffered damage through past drainage operations.

1.2 Its primary aim is to provide a statement of the current evidence base with key references to support the current restoration programme.

1.3 It also identifies where there are gaps in the evidence and what is being done to address these gaps.

2 Introduction

2.1 The New Forest is an exceptionally important site for nature conservation. It supports a wealth of wildlife, including a large number of very scarce plants, animals, invertebrates, birds and fungi. The New Forest is one of the largest terrestrial Sites of Special Scientific Interest (SSSI) in the UK, and its international importance is recognised through additional designations of Special Area for Conservation (SAC), and Special Protection Area (SPA) - under the EU Habitats and Birds Directives - and designation as a Ramsar site, under the Convention on Wetlands of International Importance. It forms the core of the New Forest National Park. These designations afford the New Forest the highest level of statutory protection from damaging activities and development. A significant amount of effort is put into the management and conservation of the site to ensure that all of the factors that contribute to the New Forest's special nature conservation importance are in 'good' or 'favourable' condition.

2.2 Some of this activity is directed towards reversing or ameliorating the effects of past management activities which have resulted in damage to important features. One of the key aspects of concern in the New Forest is the damage caused by historical drainage of the wetland habitats and the modification of rivers and streams. In southern England, many very rare and/or declining species are now almost entirely dependent upon the New Forest wetlands, including the rare species southern damselfly, *Coenagrion mercuriale*, and large marsh grasshopper, *Stethophyma grossum*, and previously much more widespread species such as curlew, *Numenius arquata*, and snipe, *Gallinago gallinago*. There is continuing concern for the status of many of these species in the New Forest, as well as nationally.

2.3 It is also significant that the exceptional wetland complex of the New Forest as a whole (including riverine woodland, bog woodland, valley mires, wet heath, wet grasslands, and pools) is identified as being of international importance as a key feature of the New Forest SAC. That status means that the UK government has a responsibility to ensure that they are in the best condition they can be. In addition, given the significance of the New Forest for the conservation of these habitats in England, its contribution to achieving 'Favourable Conservation Status' is critical at a UK scale.

2.4 For these reasons the restoration of ditches, drains and streams has been a nature conservation priority for many years, and a restoration programme is in place. Some very good examples of successful wetland restoration can now be seen, with the management techniques used having been refined over the years (Cox *et al*., 2015).

3 The New Forest wetlands

3.1 The New Forest SSSI has the largest concentration of relatively undamaged valley mires of their type in Britain (JNCC, 2008), if not Western Europe, forming part of a mosaic of semi-natural vegetation which has been less affected by cultivation and development than any other area of the English lowlands. The wetland habitats, including: mires; wet heaths; wet grasslands; wet woodlands; ponds; and a network of small streams, are of very high ecological value, with the relatively undisturbed transitions between these and drier habitats adding significantly to their diversity and value, and consequently supporting an unparalleled richness of species.

3.2 Despite the very high status and protection afforded to the New Forest and its wetlands, many of the wetland habitats have been subject to past drainage damage. The effects of this are still evident across much of the area (Weymouth and Cooch, 2000). In some cases the original damage is the cause of ongoing habitat deterioration and loss as a result of increased likelihood of peat slippage, headward erosion of channels in mires, and over-incision in streams. The effects of this damage may be exacerbated by the anticipated changes in weather patterns predicted by climate change scenarios, particularly more frequent heavy rain events and lower rainfall in summer.

Valley mire systems

Figure 1: Valley Mire, Clay Hill (courtesy of Bryan White).

3.3 **Depressions on peat substrates of the Rhynchosporion** - This Annex 1 habitat is rare in the UK. The New Forest is considered to hold the largest area in England (JNCC, 2008). The habitat occurs entirely within the context of larger mire systems, and, in general, is only present in high quality, relatively intact mires (raised and blanket bogs, transition mires and valley mires). In the New Forest, this type of vegetation is most closely associated with bog pools and runnels in valley mires but also occurs in slightly drier conditions on bare peat in wet heath/mire complexes. Rare and declining species strongly associated with this habitat in the New Forest include brown beak-sedge *Rhynchospora fusca* (Meade, 2015) and the vulnerable oblong-leaved sundew *Drosera intermedia* (Stroh *et al*., 2014).

Figure 2: Depressions on peat substrates of the Rhynchosporion, Holmsley, New Forest.

3.4 **Transition mire and quaking bogs** - is a Habitats Directive Annex 1 mire habitat in which the surface conditions range from markedly acidic to slightly base rich. In the past the New Forest resource of this habitat was significantly under-appreciated and was not, therefore, identified as a primary reason for the SAC designation. Recent work has shown, however, that the valley mire systems of the New Forest support some of the finest transition mires in England and estimated that the SAC supports around 40% of the national resource (Tratt *et al.*, 2013). On this basis the New Forest is clearly of exceptional importance for this habitat. The habitat in the New Forest now provides the main UK location for nationally rare and declining species such as slender cotton-grass, *Eriophorum gracile* (e.g. Sanderson & Chatters, 2014). It is the stronghold in England for many declining plants requiring very wet, low-nutrient conditions, such as bog sedge, *Carex limosa*, and great sundew, *Drosera anglica*, both of which are now listed as Endangered in A Vascular Plant Red List for England (Stroh *et al*., 2014). These mires are also exceptionally important in a UK and north-western European context for their invertebrate fauna, in particular the Diptera (Falk, 2010).

Figure 3: Great sundew, *Drosera anglica*.

3.5 **Alkaline Fens** - are also an Annex 1 habitat and SAC qualifying feature but are not a primary reason for the New Forest selection. Alkaline Fens have a base-rich water supply with a complex assemblage of vegetation types. While these are not widespread in the New Forest, the New Forest examples are extremely rich, support rare species, and demonstrate very good transitions with other wetland types.

Wet heath

3.6 This is a special interest feature of both the SAC and Ramsar site, and a key designated interest feature of the SSSI. In the New Forest it supports a number of scarce plants and invertebrates, such as marsh gentian, *Gentiana pneumonanthe*, marsh clubmoss, *Lycopodiella inundata*. and silver-studded blue butterfly, *Plebejus argus*. The transitions to dry heath and wetter mire habitat are particularly well-developed and remain relatively un-modified in the New Forest.

Figure 4: Marsh gentian, *Gentiana pneumonanthe*, in wet heath, near Ipley

Wet grasslands

3.7 This distinctive New Forest habitat of short grazed 'lawns' is widely distributed across the open forest The habitat is characteristic of flushed soils on valley slopes and low-lying areas adjacent to streams, and supports a wealth of scarce plants and invertebrates. It is dependent upon slightly drier conditions than the core mire areas, often sub-surface flushing rather than permanent saturation, and some examples receive nutrient flushes when flood waters deposit organic matter and silt onto the floodplain. Many of the wet lawns of the New Forest are Annex 1 SAC habitat (Molinia meadows) and support most of the UK's population of slender marsh bedstraw, *Galium constrictum*, together with an abundance of declining characteristic species such as: star sedge, *Carex echinata*; creeping willow, *Salix repens*; devil's-bit, scabious *Succisa pratensis*; and meadow thistle, *Cirsium dissectum* (Sanderson 1998).

Figure 5: Mill Lawn, a typical New Forest streamside lawn preferentially grazed by livestock (courtesy of Bryan White)

Wet woodland

3.8 There are two types of wet woodland within the New Forest that are of particular interest, both are Annex 1 SAC habitats that are defined as 'priority' because they are considered to be particularly vulnerable and have a restricted geographical range (McLeod *et al*., 2005)

3.9 Bog woodland. Within the New Forest birch, willow and alder occur on mires in a long term stable association with sphagnum mosses and other typical bog species.

3.10 Alluvial forests with alder, *Alnus glutinosa*, and ash, *Fraxinus excelsior*, are floodplain woodlands associated with small streams (typically with alkaline or neutral groundwater) which, in a natural state, are subject to seasonal flooding. The deepening and straightening of channels within the New Forest means that many alluvial woodlands no longer have this interaction with the watercourses and, consequently, have lost many of the features associated with high quality floodplain forest, including species such as willow tit, *Poecile montanus*, and veilwort, *Pallavicinia lyellii*.

Figure 6: Alluvial woodland near Ocknell, New Forest

Ponds

3.11 The New Forest supports in excess of 1,000 ponds, ranging from small ephemeral ponds to larger deeper permanent ponds - although most ponds are small, between 5 and 10 m in diameter. The ponds demonstrate a huge variety of types including Annex 1 habitats, Oligotrophic waters containing very few minerals of sandy plains and Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae. Ponds can be found in every habitat type and support an exceptionally varied and rich community of freshwater plants and animals, including a number of species of conservation importance which have national strongholds in the New Forest such as: Hampshire-purslane, *Ludwigia palustris*; bog hair-grass, *Deschampsia setacea*; the beetle, *Graptodytes flavipes*; and the tadpole shrimp, *Triops cancriformi*. The findings of a recent survey by the Freshwater Habitats Trust (2014) suggest that the majority of the New Forest ponds are of exceptional importance to wildlife.

Figure 7: Pillwort, *Pilularia globulifera*, is a specialist of poached edges of ponds. The New Forest is one of a handful of UK locations for this near threatened species.

3.12 The New Forest has a complex network of small streams and rivers most of which have their source within the New Forest itself away from sources of pollution with small catchments and a wide variation in seasonal flows, generally of low volume but which flood rapidly after heavy rainfall. They are mostly nutrient poor with acidic headstreams and become moderately base-rich as they pass through heathland, grassland and woodland communities exhibiting a unique vegetation succession from acid communities through to those more typical of neutral stream communities in the lower reaches (Tubbs 2001). The streams also support a rich variety of invertebrates and fish, including brook lamprey, *Lampetra planeri*, brown trout, *Salmo trutta* and bullhead, *Cottus gobio*. Nearly all the streams have to some extent been subject to artificial drainage since the 1840's (Langford, 1996) which has affected the ecological and morphological diversity of the streams as well as reducing the hydraulic connectivity with the floodplain habitats.

Figure 8: Crockford Stream, a key site for southern damselfly, *Coenagrion mercurial.*

4 Wetland drainage

4.1 From the mid-19th Century until the 1980's, many New Forest rivers and streams were widened, deepened and straightened to drain adjacent wetlands, with the aim of providing better conditions for growing timber and grazing. Drainage channels were cut into mires with spoil heaped beside them on the peat. During the period 1923 to 1996 extensive mechanical drainage projects were undertaken in the New Forest (e.g. Pasmore, 1976; Tubbs, 2001).

4.2 Clarke (1988) provides detail about the history of artificial drainage and the ecological effects in his PhD thesis 'Past and present mire communities of the New Forest and their conservation'. He names 19 valley mires which were subject to drainage operations between 1965 and 1986, and states that 8 sustained significant damage.

5 The impact of drainage

5.1 Streams and rivers are highly dynamic habitats that are shaped by the intrinsic characteristics of the catchment and its climate. Together these generate characteristic flow, water chemistry, sediment and nutrient delivery regimes that govern the morphology, hydraulics and productivity of the river and the assemblages it supports. River and steam habitats have strong natural connectivity with other types of water-related habitat, including headwater mires and riparian wetlands that are supported by floodplain inundation during flood flows (Mainstone *et al*., 2016).

5.2 Stream length can be greatly reduced by channel straightening and there can also be severe impacts on valley mire and floodplain wetlands, which are often reduced in extent or even eliminated from the landscape by drainage. Stream habitat has been created by artificial extension of channels into mire areas by headcut erosion. The mires are consequently drained and are at risk of loss.

5.3 Ron Allen (2003) describes the artificial drainage of New Forest valley mires and its effects and concludes that whilst no mires were completely destroyed, drainage did rupture their hydrological regime and lateral vegetation zonation, leading to destruction of plant and animal mire communities. In his view the most disastrous cases were those of mires flanking the Avon Water, which were most extensively drained.

5.4 Allen (2003) explains the hydrological effects of drainage of many New Forest Valley mires, including Denny Bog where axial drains were cut in 1968 and 1970. Allen (2003) describes how this grossly modified the bogs hydrology and plant zonation resulting in peat shrinkage and collapse, loss of the acrotelm (the upper active layer where peat is formed) leading to increased run-off and rapid erosion together with headward erosion of peat as water is drawn towards the artificial drain. The distribution and abundance of individual species, including priority species, are affected by all of these impacts.

5.5 Tuckfield (1976) undertook a geomorphological appraisal of drainage work carried out on New Forest streams between 1962 and 1975. The study looked at seventy drain channel sections at twenty nine sites across the New Forest, and concluded that rapid erosion had occurred in many channels as a result of artificial drainage operations. The study showed that eighteen channels were partially or entirely silted up; eighteen had undergone little change; and thirty four channels showed clear evidence of erosion - in some channels relatively large volumes of material had eroded.

5.6 A further study by Grosvenor (2006) was undertaken in 2005 to update Tuckfield's 1976 survey and gain insight into the status and geomorphological processes of the drainage channels. Tuckfield (1976) surmised that in time stabilisation of the channel occurs naturally, but a comparison of the 1976 and 2005 data shows that mean maximum channel width had actually increased significantly by 62%, and mean maximum channel depth had increased by 15%. Since 1976, 81% of channel sections had increased in maximum width and 60% increased in maximum depth.

5.7 Chris Mainstone, following a site visit in 2012, described the impacts of artificial modifications in the New Forest "Drainage activities in different areas of the Forest have clearly led to loss of stream habitat (by reduced river length), stream habitat impoverishment (by channel straightening), enhanced erosion, and stream channel destabilisation, alongside impacts on

mire and other water-dependent habitats. Oversizing stream channels, or creating completely new oversized channels, leads to artificial incision of the streambed, greater conveyance capacity and hence greater hydraulic scour, which can lead back to greater incision and hence a positive feedback loop".

5.8 The most fundamental impact to wetland habitats is modification to their natural hydrology and hydrochemistry which affects both the character and the extent of wetlands. Drainage ditches cut into mires results in the loss of active peat and the characteristic mosaic of mire, wet heath, runnels and pools. Given that these ditches are typically on land with a slope, the hydraulic energy generated in the ditch often leads to incision of the ditch floor, characterised by a 'nick' point in the bed where a waterfall and scour pool are formed. This nick point gradually erodes upstream into the mire, creating further impact.

5.9 An example of the impacts of drainage of wet habitats on characteristic species is given by the southern damselfly, an interest feature of the New Forest SAC, considered an outstanding locality for the species. It requires permanent slow to moderate water flow, naturally provided by groundwater-fed flushes and runnels in low-nutrient open habitats, such as wet heath and valley mire complexes, and alkaline fens. The overall decline of European populations since the 1950's has been attributed to drainage of wetlands and canalisation of water courses, whilst drainage, siltation and headward erosion of ditches are suggested as being the main causes of the reduction of water availability on a substantial proportion of extant British sites. (Purse 2002).

5.10 Clarke (1988) states that there is evidence which shows population reductions and local extinctions of both plant and invertebrate species following drainage of mires. Observations of the effects of drainage suggest that it has been a major contributory factor in a long-term decline in the biological richness of the New Forest mires.

6 Restoration history and aim

6.1 Over 140 wetland restoration projects have been undertaken in the New Forest since 1997. The earliest works were an attempt to stabilise cliffs and plunge pools at Redhill Bog - which had some limited success (Tubbs 2001).

6.2 In 1998 The New Forest SAC Management Plan was produced by the New Forest LIFE Partnership Programme 1998-2001. The Plan stated that the principle objective of restoration action is to prevent further active destruction of existing wet heath and mire communities and to restore the hydrological regime which will allow them to re-acquire, over time, those features of habitat structure and the biological communities which have been lost, and for those features to be sustained in perpetuity.

6.3 A further LIFE partnership project, “Sustainable Wetland Restoration in the New Forest”, aimed to gain a better understanding of how the wetlands function; to reverse the effects of the historic drainage works; to tackle the threat from invasive non-native species and to restore the vulnerable New Forest habitat for the benefit of wildlife, landscape and people.

6.4 One of the objectives of restoration through this project was to increase floodplain connectivity and restore geomorphic processes on the floodplain. The geomorphological monitoring undertaken was considered to be amongst the most comprehensive undertaken on a river restoration project within the UK (Sears *et al*., 2006), with the restoration project itself being seen as an outstanding success. Physical surveys (hydrology, topography and geomorphology) and biological surveys (macro-invertebrates and fish) were undertaken pre- and post-restoration works - all monitoring reports can be found in the Final Technical Report on the website; **www.newforestlife.org.uk/life3%20**.

6.5 The New Forest Wetland Management Plan 2006-2016 (Smith 2006), built upon the work achieved during the LIFE projects and the development and refinement of the techniques used to ensure the continuing long term sustainability and integrated management of the New Forest water courses and wetland habitats. The Plan discusses in detail the different wetland restoration techniques that worked successfully during the LIFE projects and also describes five New Forest case studies.

6.6 The key issues identified in the Plan include: damage to valley mires due to drainage and headward erosion as well as negative impacts on wet grassland due to drainage and straightening of river and stream channels reducing seasonal flooding; impeded drainage due to remnant spoil banks; and increased erosion of over-straightened channels leading to increased deposition of gravel downstream. The restoration works required to address these issues include restoration of straightened channel sections to natural river courses, restoration of seasonal flooding through reinstatement of meanders, bed level raising and increasing the supply of large woody material to the channel, infilling of drains in mires, selective scrub management and erosion repairs.

6.7 After the LIFE projects, funding for wetland restorations has continued through a number of schemes and is currently a primary objective of the Verderer's Higher Level Stewardship Scheme (HLS) - in partnership with the Forestry Commission (FC) who manage the Crown Lands and the New Forest National Park Authority (NFNPA). Public opposition to a proposed scheme arose in September 2011 and prompted a review of the available evidence supporting the wetland restorations. As a result, in 2012, a geomorphological and eco-

hydrological investigation of the modified wetlands of the New Forest SSSI was undertaken (JBA Consulting 2014). The study provided geomorphological analysis and ecological interpretation of physical impacts on the rivers, streams and floodplains, prepared eco-hydrological characterisation of the mires and made recommendations for restoration.

6.8 Town and Country Planning Consent is now required for many of the proposed wetland restoration projects. To support planning applications and inform future project design, the River Restoration Centre and Jonathon Cox (2015) were commissioned to review a sample of past wetland restoration projects undertaken within the New Forest. Of the eight sites selected, the earliest restoration was undertaken in 2004 and the most recent in 2013. The review found that all of the sites assessed have shown sustained positive change over the period since their restoration, both in terms of improving the quality of habitats and in restoring the physical functioning of the mire/ river systems. Some of the techniques used in the earlier site restoration have been changed or adapted to inform and improve best practice. There are no examples where techniques which have been found to have failed, or to have been inappropriate, have continued to be applied without revision, adaptation or a new approach being adopted.

7 Natural England's aims and objectives for the New Forest wetlands

7.1 One of Natural England's key responsibilities, as the Government's adviser for natural conservation in England, is the protection of a series of sites which represent the best of England's natural habitats, species and geological features. Natural England has a responsibility to conserve the special features of a site in the best possible condition, support improvement and prevent damage.

7.2 Natural England's general aspiration for streams, rivers and wetlands such as mires, wet heath and wet grassland, is that they operate under natural processes, free from anthropogenic impact, and with a characteristic mosaic of habitats. This provides the best and most sustainable expression of running water and wetland ecosystems including characteristic species assemblages. These conditions provide the best defence against climate change, maximising the ability of these ecosystems to adapt to changing conditions. They also provide the best and most sustainable interfaces with other habitats, including running and standing waters, wetlands and dry habitats. They allow priority species to be distributed within habitat mosaics according to their natural habitat preferences and requirements. An analysis of priority species in England (those listed under Section 41 of the Natural Environment and Rural Communities Act 2006) has confirmed that the ecological needs of species associated with freshwater and wetland ecosystems are satisfied by the conditions provided by natural environmental processes such as unpolluted water, natural water supply and natural physical form (Webb *et al*., 2010).

7.3 The New Forest is designated for its biological and geological importance. The SSSI includes seven Geological Conservation Review (GCR) sites selected for their Palaeogene, Pleistocene or geomorphological interests. In one case (Studley Wood GCR site), the geological interest was discovered as a consequence of the erosion and down-cutting generated by the artificial modification of the stream. The objective to maintain and manage geological interest requires continued access to the exposures in the banks and bed of the stream in order to enable current and future study of the feature. For the biological interests, the objective is to maintain and restore natural processes, critically this requires the restoration of hydrological functioning to support the range of water-dependant habitats that are present throughout the catchment. Such a restoration would lead to the burial and loss of access to the exposures of the geological interest, and in this case, the objectives for the biological and geological interests are in conflict.

7.4 Natural England's approach in circumstances such as this is to make every effort to find an approach or compromise which will protect both the biological and geological interests - the geological importance should not be underestimated. If difficult decisions are required that lead to the loss of access to the designated geological site, robust mitigation measures should be provided which include detailed survey and recording, rescue sampling, and further investigation to identify whether possible alternative sections are present.

7.5 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. 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 across the Natura 2000 site series as a whole.

7.6 Restoration of natural processes is identified as a top priority for wetland habitat management in the New Forest SIP, and the Hydrological Functioning Theme Plan presents the New Forest as an exemplar of the restoration of a range of water-dependent Annex I habitats through an approach that wholly embraces the restoration of natural hydrological functioning. Any measures that seek to restore natural processes in terms of water quality, geomorphological and hydrological regimes should be seen as an important contribution towards river, stream and wetland habitat conservation. Measures may include direct interventions such as restoring meanders and bed level raising in streams and rivers or infilling and blocking of drains in mires and other wetland habitats. However, natural recovery should always be allowed to play the fullest role possible. Within the New Forest there is great scope for reversing past damage and restoring naturally functioning running water and wetland habitats. The high quality landscape within which the wetlands occur provides an immediate source of propagules and colonists for the restored areas, and this is reflected in the rapid response seen in completed wetland restorations.

7.7 Cox *et al*. (2015) described the restoration of Fletchers Thorns as 'having achieved significant nature conservation benefits in a very short period of time' and a report of a visit in July 2013 by Botanical Society of Britain and Ireland (BSBI) and Hampshire Flora Group to Fletchers Thorns, Warwick Slade and Dames Slough described the 'general satisfaction and delight the participants took in the results of these three schemes'. This visit took place only two years after the completion of Fletchers Thorns restoration and identified rare and declining bankside and instream flora including: slender marsh-bedstraw, *Galium constrictum*; chaffweed, *Centunculus minimus*; pillwort, *Pilularia globulifera*; Hampshire-purslane, *Ludwigia palustris*; lesser water-plantain, *Baldellia ranunculoides*; and New Forest water-crowfoot, *Ranunculus x novae-forestae*. (Rand 2014)

Figure 9: Artificial straight drain at Fletchers Thorns, February 2011.

Figure 10: A restored stretch at Fletchers Thorns, October 2014.

7.8 Our aims are explained in more detail in the Natural England publication, *A narrative for conserving freshwater and wetland habitats in England* (Mainstone *et al*., 2016). This is an evidence-based narrative which provides an overview of circumstances relating to the conservation of freshwater and wetland habitats in England. It considers their ecological function, the natural and anthropogenic factors affecting them, the principles that should be applied to their management and the respective roles of the main policy mechanisms involved in their conservation.

8 Monitoring

8.1 Natural England uses a rolling programme of condition assessments to ensure the special features of a site are conserved in the best possible condition. The standards describing favourable condition, and the methodology for assessing condition, have been developed in conjunction with the Joint Nature Conservation Committee (JNCC), the Governments UK-wide adviser on nature conservation, and are applied throughout the UK.

8.2 Assessment of a mire or stream before and after a significant habitat restoration project is likely to detect changes in aspects such as: the extent of a particular habitat; the frequency of characteristic species; the frequency of indicators of undesirable hydrological conditions; the extent of erosion features; and changes in groundwater levels. The assessment will provide evidence to show progress towards achieving the desired nature conservation objectives for the New Forest. However, the specific attributes that routine condition assessment uses and the spatial resolution at which monitoring occurs, limits its sensitivity.

8.3 As described in this report there is a strong evidence base for the importance of natural processes in maintaining characteristic river and wetland habitat form and function and associated characteristic biological communities. However, historically, physical restoration schemes across the country have only included limited pre- and post-monitoring programmes to demonstrate the effectiveness of the restoration. Monitoring and evaluation are important in any restoration project, as the information gained may lead to greater overall success and reduced costs in future restorations (Sears *et al*., 2006).

8.4 Chris Mainstone (2012) notes that “monitoring the efficacy of river restoration schemes is a thorny issue. It can be costly, particularly over the timescales that might be needed to realise full biological benefits. Some parties would like to see all schemes monitored in a comprehensive and rigorous way, but common sense and economics dictate that a case study approach is taken where results can be sensibly extrapolated to similar sites. This said some basic level of pre- and post-monitoring is always sensible.”

8.5 The river, stream and wetland restoration programme in the New Forest started in 1997, with European Union Life Funding, and has continued with successive funding sources, with approximately 150 restoration projects completed to date. The European Life 3 project focused on restoring rivers, lawns and mires to improve wetland habitats, with a budget built into the project proposal for hydrology and geomorphology monitoring - although tight timescales led to relatively short term post-monitoring.

8.6 In the final monitoring report, Sears *et al*., (2006), recommended the development and implementation of a monitoring strategy for the New Forest, to build on the work to date and to feed into the design and management of subsequent restoration projects with clear project objectives against which to monitor success.

8.7 To date pre- and post-monitoring has been largely absent from the New Forest programme, partly due to the limitations of available funding. However, concerns over lack of evidence for the apparent success of the restorations led to the commissioning of the New Forest Wetland Restoration Review (RRC & Cox *et al*., 2015), an independent review of a sample of past wetland restoration projects to determine whether the projects have met their objectives. The study found that the design and implementation of works had been developed, refined and modified over the years to incorporate lessons learned but there was concern about the lack

of documented evaluation. The report also recommended a strategic and well documented approach to evaluation.

8.8 Natural England has produced a ‘help note’ (Wheeldon, 2016) on monitoring the success of physical restoration measures on river SSSIs. It is designed to assist staff and our partners in developing a monitoring regime capable of characterising changes in habitat condition related to implementing the strategic physical restoration plan. Various issues need to be considered in developing a monitoring programme, including: the nature of physical impacts; the ecological changes they generate; river SSSI objectives; the relevance of SSSI condition assessment; and available survey methods.

9 Conclusion

9.1 There is a body of evidence, together with Natural England's own condition assessments, supporting the need for restoration of the damaged wetlands of the New Forest. There is also compelling evidence to support the success of a number of past restorations - some very good examples of successful wetland restoration can now be seen and the techniques used have been refined over the years, adapting from lessons learnt and as technology and management tools have developed.

9.2 Comprehensive studies were undertaken for the LIFE Sustainable Wetland Restoration in the New Forest projects, along with other studies into the effects of artificial drainage on the habitats and species throughout the New Forest. These, together with the recent Wetland Restoration Review to determine whether past restorations were meeting their objectives, provide a strong scientific base on which proposals for future wetland restorations can be designed. The implementation of a monitoring and evaluation programme would provide stakeholders with detailed information about the progress of the projects.

9.3 Based on the outcome of previous monitored and reviewed restorations, the indications are that the ecological condition of the New Forest wetlands will be substantially improved by restoration, providing naturally self-sustaining habitats critical for the long term survival of communities of characteristic species.

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