Natural England Research Report NERR067

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

Assurance Report

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Assurance Report

Tim Hill, Chief Scientist

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Executive Summary

Natural England strives to ensure that its advice and decisions are based on the best available evidence. This report responds to a request to Natural England's Chief Scientist to conduct an independent assurance of 'An assessment of the evidence supporting a programme of wetland restoration projects in the New Forest Site of Special Scientific Interest' (*The Assessment*). It is based on appraisals from three independent reviewers who are recognised experts in the fields of freshwater and wetland ecosystem conservation. The reviewers were asked to answer two questions:

- **Are the approaches being used to restore wetland (particularly mire) systems in the New Forest, as described in *The Assessment*, consistent with the evidence-based principles set out in the published report: *"*A narrative for conserving freshwater and wetland habitats in England*"* (Mainstone *et al*., 2016)?**
- **Is *The Assessment's* conclusion, that the New Forest wetland (particularly mire) restorations carried out in recent years are delivering beneficial biodiversity and water outcomes, consistent with the available evidence?**

Drawing upon the expert views of the independent reviewers, Natural England's Chief Scientist concludes that the approaches described in *The Assessment* are indeed consistent with the evidence base described in the Mainstone *et al.,* (2016) narrative and that the available evidence supports the conclusion that recent wetland restorations in the New Forest have been beneficial in terms of biodiversity and hydrological outcomes.

Contents

1 Introduction

1.1 Natural England has a statutory role to conserve protected sites, working alongside a range of stakeholders. In discharging this duty, Natural England strives to ensure that its advice and decisions are based on the best available evidence and that the gathering of evidence is transparent and in line with our published standards.

1.2 In the New Forest SSSI, an extensive programme of wetland restoration projects has been conducted over the past two decades, and more restorations are planned. These restoration projects require significant investment and have a range of impacts, including on designated features and users of the site. It is consequently important to periodically review the evidence regarding the management approaches being used and their restoration outcomes, not least because ecosystem recovery can take a long time. Such a review has recently been carried out by Natural England: 'An assessment of evidence supporting a programme of wetland restoration projects in the New Forest Site of Special Scientific Interest' (Thomas *et al*., 2016), hereafter '*The Assessment'*.

1.3 Given the potential importance of *The Assessment* in terms of the future management of the New Forest, Natural England's Chief Scientist has been commissioned to review its conclusions, with the help of independent experts, to ensure they are consistent with the latest evidence. This report is the Chief Scientist's response to that commission.

2 Context

2.1 A narrative for conserving freshwater and wetland habitats in England (Mainstone *et al*., 2016), hereafter '*The Narrative'*, provides an overview of circumstances relating to the conservation of freshwater and wetland habitats. It outlines the importance of natural habitat function in freshwater and wetland ecosystems drawing out a set of evidence-based management principles. *The Narrative* was developed in consultation with a wide range of academics and other experts (the contributor list is included in the publication) and its principles now guide Natural England's approach to the conservation and restoration of freshwater and wetland ecosystems.

2.2 *The Assessment* has been produced to underpin decisions made in restoring the river, stream and wetland habitats of the New Forest. It was drafted to provide a statement of the current evidence base, including the key references to support the restoration programme. The focus of site management and conservation is to safeguard characteristic habitats and their assemblages, including rare or declining species for which the New Forest is a particular stronghold. This is achieved by ensuring characteristic habitats are in favourable condition, which often requires restoration measures.

2.3 *The Assessment* is:

- A synthesis of key documents and findings relevant to the overall programme of wetland restoration work in the New Forest.
- A description of the New Forest and the suite of designations under which it is recognised and protected (including an overview of the wetland types within the New Forest and their important characteristic species).
- A description of the historical (19th century – 1980s) drainage of the New Forest and the effects of drainage and related works, notably on the hydrology and hydrochemistry of the wetland systems. It explains the consequent effects on characteristic habitats and dependent species such as the southern damselfly.
- An explanation of the aims of the restoration programme for wetlands across the New Forest (over 140 restorations undertaken since 1997, including EU LIFE projects).
- A description of Natural England's over-arching aims for wetland restoration in the New Forest, notably to provide 'the best and most sustainable expression of running water and wetland ecosystems including characteristic species assemblages' by enabling them to operate under natural processes.
- A summary of biodiversity and water outcomes evidence from New Forest restoration projects that have already been undertaken, including some examples of recovery of characteristic species assemblages.
- An acknowledgement that New Forest wetland restoration projects would benefit from greater monitoring and evaluation, and notes that the Forestry Commission undertook the "New Forest Wetland Restoration Review" (RRC & Cox, 2015) in response to these concerns. *The Assessment* further identifies a lack of monitoring and evaluation as a key evidence gap, and highlights the guidance available to assess the success of wetland restoration projects.

2.4 *The Assessment* is not (exclusion criteria):

- A systematic evidence review of wetland restoration in the New Forest.
- Attempting to extend or repeat the review of evidence that led to the development of the principles for freshwater and wetland restoration as set out in *The Narrative*.
- Trying to address the complete suite of issues affecting the New Forest (for example, geo-diversity is not covered as part of *The Assessment*).

3 The Assurance Approach

3.1 In line with its published Evidence and Quality Management standards, Natural England aims to ensure that its advice and decisions are based on the best available evidence, including by using external peer review as the highest level of assurance of our evidence. This high level of assurance is appropriate on this occasion.

3.2 Three external reviewers, who are recognised experts in the field (biographies are in annex 1), were consequently asked to assess the conclusions of *The Assessment*. Specifically, they were asked to answer two questions:

- **Are the approaches being used to restore wetland (particularly mire) systems in the New Forest, as described in *The Assessment*, consistent with the evidence-based principles set out in the published report: *"*A narrative for conserving freshwater and wetland habitats in England*"* (Mainstone *et al*., 2016)?**
- **Is *The Assessment's* conclusion, that the New Forest wetland (particularly mire) restorations carried out in recent years are delivering beneficial biodiversity and water outcomes, consistent with the available evidence?**

3.3 The reviewers were commissioned on 7 October 2016 and asked to report by 17 October 2016.

4 External assurance – a summary

4.1 Extracts of the main points made by the reviewers in response to each of the two review questions are as follows (full responses are included in Annex 2, 3 & 4):

4.2 For question 1:

Are the approaches being used to restore wetland (particularly mire) systems in the New Forest, as described in *The Assessment*, consistent with the evidence-based principles set out in the published report: "A narrative for conserving freshwater and wetland habitats in England" (Mainstone *et al*., 2016)?

Lee Brown notes that:

- Whilst *The Narrative* strongly advocates the restoration of modified aquatic ecosystems to be naturally functioning systems, it also explicitly recognises that in some areas modified and artificial freshwater habitats can still play important roles for selected species. There is some available evidence to show that the New Forest restoration work has been sensitive to this need where necessary, in keeping with *The Narrative*. It is clear that the objectives of the restoration schemes are in keeping with the idea that allowing natural functions is the best approach for freshwater ecosystem management. Thus, by extension, the work that has been undertaken to date is, in my opinion, consistent with the relevant sections of *The Narrative*.

J. Iwan Jones notes that:

- The measures undertaken in the New Forest are consistent with the principles as outlined in *The Narrative*, including direct interventions. Any measures that seek to slow drainage and, thus, 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. The measures undertaken in the New Forest are consistent with the principles outlined in *The Narrative*, including direct interventions such as: restoring meanders and raising bed level in streams and rivers; or infilling and blocking of drains in mires and other wetland habitats.
- It should be stressed that the objective of such restoration works is to recreate natural processes, which in turn will give rise to conditions suitable for priority species and habitats. Such works are not expected to immediately recreate a perceived vision of lost habitat and species assemblages per se, but to recreate the template where natural recovery and colonisation will result in the sustainable establishment of target species and habitats. This longer perspective accepts dynamic change as a natural component of ecosystems and maximises opportunities for species to find habitat niches within a more naturally functioning landscape.

Richard Lindsay notes that:

- On the basis of the reviewed evidence, I conclude that *The Assessment* is informed by *The Narrative* to a fundamental degree and follows the lead set by *The Narrative* and its associated documents very closely. I am unable to find any example of *The Assessment* straying from the guidance set out in *The Narrative*.

4.3 For question 2:

'Is *The Assessment's* conclusion, that the New Forest wetland (particularly mire) restorations carried out in recent years are delivering beneficial biodiversity and water outcomes, consistent with the available evidence'?

Lee Brown notes that:

- In my opinion, the conclusion that the New Forest restoration schemes are delivering beneficial biodiversity and water outcomes is consistent with the available evidence. Whilst my review of the literature was not exhaustive, given the limited time to undertake the work, it is apparent that there is a small amount of high quality, replicated before-after control impact (BACI) sampling for a small number of sites (Sears *et al*., 2006; Thomas, 2006).
- In addition, there is a good selection of anecdotal information for the restoration being successful; whilst anecdotal evidence would not usually be considered as a good scientific basis for determining river restoration success or failure, the diversity of such information from various highly competent sources (e.g. LIFE III, 2006; Thomas, 2006; JBA Consulting, 2014; Rand, 2014; Cox *et al*., 2016) makes it suitable for consideration in the context of this review.

J. Iwan Jones notes that:

- In terms of achieving the desired geomorphic and hydrological response, success can be assessed over relatively short time-scales. Here, the available evidence suggests that hydrological impacts of restoration activities are detectable at catchment scale: floodplain connectivity has increased and geomorphic processes characteristic of semi-natural reaches have been re-established on the floodplain of restored reaches (Sears *et al*., 2006). Hence the available evidence suggests that the works have been successful.
- The colonisation of the restored section of Fletchers stream by rare and declining bankside and instream flora (Slender Marsh-bedstraw *Galium constrictum* and Chaffweed *Centunculus minimus*, Pillwort *Pilularia globulifera*, Hampshire-purslane *Ludwigia palustris*, Lesser Water-plantain *Baldellia ranunculoides* and New Forest Water-crowfoot *Ranunculus x novae-foresta*) is a clear indication that the approach used here has been successful in achieving the objectives outlined in *The Narrative*. A more widespread assessment of such species in restored areas would be beneficial.
- The evidence available to date suggests that where sites have been assessed, restoration activities have been successful.

Richard Lindsay notes that:

- In terms of in-site management, the claims made by *The Assessment* for the success of wetland restoration management are equally modest and conservative, though this is understandable because of the somewhat limited range of documented evidence for restoration outcomes. Nonetheless, a significant body of evidence does exist and *The Assessment* makes valid use of this without overplaying the strength of the available evidence.
- It would seem reasonable to conclude that the present range of habitat restoration activities being undertaken on mires and their associated habitats in the New Forest offer real prospects for positive outcomes that move the systems towards the ultimate goal of operating under natural processes free from anthropogenic impact and with a characteristic mosaic of wetland habitat types that caters for characteristic species assemblages, and that provides the best and most sustainable expression of wetland habitats in the New Forest.

5 Chief Scientist's conclusions

5.1 The three reviewers were asked to consider 2 questions:

- The first sought to establish the extent to which there was alignment between *The Assessment* of evidence supporting restoration works in the New Forest and *The Narrative* for conserving freshwater and wetland habitats in England. Essentially, this represents a mapping and checking of the alignment between the interpretation of a national peer-reviewed approach in a specific area.
- The second question sought to identify whether *The Assessment*'s conclusion, that the New Forest wetland restorations are delivering beneficial outcomes, is consistent with the available evidence.

5.2 As might be expected, with each reviewer working independently of one another and to a tight timescale, each adopted a slightly different style and approach, which may reflect their individual area of expertise. However, the overall conclusions of each reviewer, in respect of the two questions, are consistent.

5.3 Consequently, this leads me to reach a clear conclusion that Natural England, and our partners, can be assured that the restoration approaches being used in the New Forest are entirely consistent with best practice, as represented by the principles set out more broadly in *The Narrative*. I also note that *The Narrative* has recently received further support (Addy *et al*., 2016), adding to my confidence in this approach. Given the evidence collected to date, I am also confident that the restoration works are, or will prove to be, beneficial in delivering positive hydrological and biodiversity outcomes.

5.4 Notwithstanding these conclusions, it is also important that the design of any future restoration programme should seek to incorporate a more comprehensive approach to pre- and post-restoration monitoring, including a more widespread assessment of species recovery in restored areas. In this regard I am pleased to note that we are working with partners to develop a strategic monitoring plan for the New Forest restorations. Gathering good quality evidence that properly characterises both successes and any failures is essential in evaluating and adapting our approaches to these sorts of large-scale and long-term restoration works.

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Annex 1:
The External Reviewers biographies

Dr Lee Brown
Associate Professor of Aquatic Science, University of Leeds

Lee is an Associate Professor of Aquatic Science. Through his research he aims to increase understanding of how aquatic ecosystem biodiversity and functional processes respond to environmental change.

He is a freshwater ecologist with a particular interest in river ecosystems. His work crosses several research fields (population and community ecology, hydrology and geomorphology). Lee is particularly interested in river ecosystems in cold regions (alpine, arctic), the effects of catchment management (e.g. artificial drainage, vegetation burning) on rivers in the UK uplands, and aquatic food webs.

Dr J. Iwan Jones
Queen Mary, University of London. The School of Biological & Chemical Sciences.

Iwan leads the Rivers Communities research group of QMUL, which seeks to advance understanding of freshwater ecosystems such that they can be better protected and managed sustainably in a changing environment. He is a freshwater ecologist with over 25 years of experience working with invertebrate, algal, fish and plant communities, and developing practical applications for assessing the impacts upon them. Much of this work has been in support of conservation and water management policy.

Recently, Iwan was a task leader on the EU framework 7 project REFORM: Restoring rivers for effective catchment management, which involved researchers from 15 countries across Europe and developed tools to support cost-effective implementation of river restoration measures and monitoring.

Richard Lindsay
Head of Environmental and Conservation Research.

Sustainability Research Institute (SRI), University of East London

Richard is an internationally respected specialist in the ecology and conservation of peatland ecosystems. A leading environmentalist based within UEL's Sustainability Research Institute, he has been conducting extensive research into the ecology, classification and conservation of peatland, including detailed investigations into the drainage effects, burning impacts and ecosystem services.

His work has played a vital role in assembling and presenting several key peatland conservation cases, as well as a number of substantial management and monitoring programmes at both a national and international level.

Richard was chair of the International Mire Conservation Group (1984 -2000)

Annex 2: Assurance review

Dr Lee Brown

University of Leeds

I have been employed by Natural England as an independent assessor to evaluate the basis for mire and stream restoration work in the New Forest. By way of context,

I am an Associate Professor of Aquatic Science at the University of Leeds with 15+ years experience of researching and teaching the hydrology, geomorphology, water quality and ecology of flowing (rivers, streams) and standing (predominantly ponds) freshwater ecosystems. Amongst varied research interests, I have a particular interest in river catchment land use and restoration, and have led several projects examining how schemes to restore drained upland wetlands have benefitted aquatic ecosystems in both rivers and ponds, as well as projects examining how natural processes can be used to improve flood management.

I am currently the freshwater-facing secretary of the British Ecological Society's Aquatic Group, and I previously served as a trustee of the Freshwater Biological Association (2010-2014). I regularly provide peer review services to a range of international scientific journals, evaluate applications to national and international scientific funding bodies, and serve as an Associate Editor of the journal Wiley Interdisciplinary Reviews: Water. I have published more than eighty peer reviewed articles in international journals with over3,500 citations to date. I have no conflict of interest with respect to the restoration work in the New Forest.

In line with the defined scope of the New Forest Assessment Review commissioned by Natural England, I focused on two specific questions:

1. **Are the approaches being used to restore river and wetland systems in the New Forest, as described in *The Assessment*, consistent with the evidence-based principles set out in the published report: "A narrative for conserving freshwater and wetland habitats in England" (Mainstone *et al*., 2016)?**

2. **Is *The Assessment's* conclusion, that the New Forest river and wetland restorations carried out in recent years are delivering beneficial biodiversity and water outcomes, consistent with the available evidence?**

Two documents were made available to me directly from Natural England:

(1) Thomas *et al*., (2016). An assessment of evidence supporting a programme of wetland restoration projects in the New Forest Site of Special Scientific Interest; and

(2) Mainstone *et al*., (2016). A narrative for conserving freshwater and wetland habitats in England.

In addition, I consulted a range of the publications cited in Thomas *et al*., (2016) to gain additional specific information on the New Forest restoration schemes from the viewpoint of other parties.

Q1. Are the approaches being used to restore river and wetland systems in the New Forest, as described in *The Assessment*, consistent with the evidence-based principles set out in the published report: "A narrative for conserving freshwater and wetland habitats in England" (Mainstone *et al*., 2016)?

Thomas *et al*., (2016) outlined that >150 restoration projects have been conducted in the New Forest since 1997. It is clear from the work of Cox *et al*., (2015) that a variety of techniques have been used to restore the New Forest wetlands and rivers. As would be expected with such a broad-scale (both in space and time) set of interventions, there has been a refinement and/or modification of the approaches used based on the experience gained.

The approaches that are being, or have been used, to restore river systems in the New Forest include:

- Re-meandering previously straightened sections to their historic courses that can be seen on historic maps and/or on the ground. This is to increase habitat size (river length), reinstate natural processes and maximise interactions of the rivers with their floodplains (including wet grasslands) during peak flows. In some locations, new meanders have been cut where the old course was not clearly evident on the ground.
- Infilling of redundant stream channels with sediments/clay using combinations of gravel/clay/hoggin.
- Widening channels and raising of river bed levels using combinations of gravel/clay/hoggin substrates. Raised levels means a greater propensity for overbank flow during flood peaks which typically slows flood flows and reduces the magnitude of flood peaks downstream, whilst serving to rewet riparian soils/deposit nutrients. These restored channels will also typically show a reduced propensity for bed/bank erosion due to lower hydraulic energies.
- Early restorations used wooden boards/clay plugs to stabilise/retain river bed sediments. The wooden board approach is no longer considered best practice and Cox *et al*., (2015) suggest this method is not used any more.
- Floodplain vegetation management, including live staking of Alder/Willow to aid consolidation of new bank sediments, and also floodplain tree clearance in some areas to decrease shading and allow regeneration of wet/humid heathland vegetation and lawn areas.
- Culvert removal in some areas; provision of piped causeways across wetlands.
- Provision of in-channel and floodplain flow obstructions from on-site woody material (e.g. tree trunks and grubbed out stumps).
- Controlled removal and relocation of any priority species that are known to inhabit the restoration zones, and/or working only at times of the year when sensitive species are unlikely to be impacted (e.g. Highland Water to avoid sea trout migrations; LIFE lll, 2006).
- In channel vegetation removal to prevent channel obstructions in sensitive areas.

The approaches that are being or have been used to restore wetland systems in the New Forest include:

- Infilling of mire drains with heather bales, gravels, clay plugs, tree trunks and/or wooden stakes to raise water levels.
- Scrub management and tree removal, particularly where some ‘exotic’ species would most likely not occur if previously wet habitat had not been drained.
- Re-grading areas of mire into old meanders to improve hydrological connectivity, and improved linkage of rivers with characteristically wet floodplains.
- Incorporation of some man-made features into restoration plans, where these features are known to host species with conservation designations.

The work of Mainstone *et al*., (2016); hereafter referred to as *'The Narrative'* is a wide-ranging text covering numerous aquatic habitat types, and as such it also includes a range of management messages; given this breadth, it should be expected that not all of *The Narrative* will necessarily be relevant to the New Forest situation. My assessment focused predominantly on the messages contained in Chapter 2 (Running Water) and Chapter 4 (Terrestrial Wetland Areas) as these are most relevant to the restoration schemes in the New Forest. As outlined from the outset in its Executive Summary, *The Narrative* evidences the importance of natural habitat function in freshwater and wetland ecosystems from a wide review of the available scientific literature. Natural England's vision for rivers to be free to operate in this manner wherever possible is clearly articulated in section 2.45 of *The Narrative*, and 2.48 extends this idea to cover restored river sites. For Terrestrial Wetlands, these ideas are expressed in section 4.25 and extend to restoration sites in 4.28. From the New Forest examples of habitat restoration that are available in the literature, it is clear that the objectives of the restoration schemes are in keeping with the ideas that allowing natural functions is the best

approach for freshwater ecosystem management. Thus, by extension, the work that has been undertaken to date is, in my opinion, consistent with the relevant sections of *The Narrative*.

Specific examples of where the restoration approaches link clearly with The Narrative include:

- Section 2.51, which discusses the importance of direct intervention to assist in the transition of any populations from sites affected by the work into more suitable environments. An example of this is outlined by Cox *et al*., (2015) for Fletchers Thorn, where fish were captured and translocated by the Environment Agency before work commenced.
- Large-scale perspectives are advocated (in 2.49 and 4.29). This certainly appears to be the case in many of the catchments where mires and rivers have been restored concurrently, and also in terms of the entire New Forest restoration works when the >150 schemes are taken together.
- Section 2.54 outlines a vision to restore low energy flooding. The work to re-profile river beds and banks using various site-specific methods has produced the desired effect of more overbank flows in most of the schemes studied by Sears *et al*., (2006) and those reviewed by Cox *et al*., (2015).
- Seasonally exposed sediment bars are evident in many of the photographs of restored stream channels, consistent with aspirations outlined in section 2.57 of *The Narrative*.
- The presence of woody debris dams is noted in the narrative (2.13) as an important habitat element of forested headwater streams. Sears *et al*., (2006) and Cox *et al*., (2015) show photographic evidence of these features working in several locations on different rivers. In fact, Cox *et al*.'s work suggests that, in some rivers, the restoration has perhaps not yet gone far enough in providing the impetus for these debris features to assemble naturally and persist in the various river systems.
- Direct interventions for Terrestrial Wetlands, such as infilling and blocking of drains, are advocated in section 4.25. There is evidence of this type of approach being used at Holly Hatch, White Moor, Soldier's Bog, Acrecombe Bottom and Penny Moor (Cox *et al*., 2015).

It is important to note that whilst *The Narrative* strongly advocates the restoration of modified aquatic ecosystems to be naturally functioning systems, it also explicitly recognises that in some areas modified and artificial freshwater habitats can still play important roles for selected species (section 1.5). There is some available evidence to show that the New Forest restoration work has been sensitive to this need where necessary, in keeping with *The Narrative* section 4.37. For example, knowledge of existing priority species meant that the initial Penny Moor restoration plans were modified to retain some man-made landscape features that had been colonised by rare plants.

Sections 2.50 and 4.31 advocate the need to take a 'long view' when working with restored sites to fully recreate natural ecosystems. It is clear in many of the cases reviewed by Cox *et al*., (2015) that this is the case. The works have been designed to restore processes and then allow the ecological communities to re-establish of their own accord with minimal further intervention. In some cases the restoration works have been suggested to have allowed rapid changes to the system (e.g. Soldier's Bog has shown rapid declines in Phragmites/Typha swamp area following rewetting compared with observations made by JBA Consulting (2014) and an abundance of macrophytes and good habitat diversity can be found in the river). Elsewhere there are suggestions that whilst the work has been positive, ecosystem secondary succession is taking longer. At Akercombe Bottom, for example, the river shows good coverage of macrophytes, but in some places the species present are generally typical of still bog pools or slow flowing streams and not swifter flowing rivers (Cox *et al*., 2015). Cox *et al.*, (2015, p90) further state that "It may be that this vegetation is still in the process of maturing and in time it will develop into a typical swift flowing stream community".

Q2. Is *The Assessment's* conclusion that the New Forest river and wetland restorations carried out in recent years are delivering beneficial biodiversity and water outcomes consistent with the available evidence?

In my opinion, the conclusion that the New Forest restoration schemes are delivering beneficial biodiversity and water outcomes is consistent with the available evidence. Whilst my review of the literature was not exhaustive, given the limited time to undertake the work, it is apparent that there is evidence available from high quality, replicated before-after control-impact (BACI) sampling for a number of sites (Gent, 2006; Sears *et al*., 2006; Thomas, 2006). In addition, there is a good selection of qualitative information from other sources, for the restoration being successful. Whilst qualitative evidence would not typically be considered to provide a good scientific basis for determining river restoration success or failure, the diversity of such information from various highly competent observers (e.g. LIFE III, 2006; Thomas, 2006; JBA Consulting, 2014; Rand, 2014; Cox *et al*., 2015) makes it suitable for consideration in the context of this review. There is a good amount of quality data and observations available from these combined studies, which can be used to conclude that restoration works that have taken place elsewhere in the New Forest should have produced similar outcomes. This is important because limited financial and staff resources will always mean that it is not possible to monitor everything everywhere.

Replicated BACI sampling is considered to be the best source of information for assessing the effects of restoration on ecosystems. A good example of this from the New Forest is the report of Sears *et al*., (2003) which focused on work undertaken in Highland Water and Black Water (and to a lesser extent in Ober Water). Here, exceptionally detailed research was undertaken into the restoration works with respect to hydrological and geomorphological responses. The work was undertaken from 2002-2006, so there was only a short post-restoration timescale (<2 years). Nevertheless, the report still discusses numerous positive outcomes of the work, several of which were later corroborated by Cox *et al*., (2016) for other river that have been restored at later dates:

No negative effects of the restoration work on downstream flooding, and that the work had actually increased retention of floodwater in the catchment (re-meandering and large wood additions had added 40 mins to the flood peak travel time in some locations. Overall, the hydrological responses were considered to show net positive effects on flood water retention. Increased connectivity of the river with its floodplain had increased habitat diversity.

The restoration had provided more pool habitat at the reach scale, which serves as useful habitat for some life stages of fish. Overall habitat diversity had been increased in restored sections compared to those that were previously channelised, but at the time of the report the restored sections were still not as diverse as semi-natural ‘controls’. This was potentially a transient effect as per Natural England’s aim to restore processes then take the long-view with respect to seeing a full response.

The simple addition of woody debris into channelised reaches did not restore connectivity, implying the need for full channel morphological restoration. However, the increased residence time of large wood had provided more opportunities for natural accumulations to build-up potentially allowing long-term responses to be initiated.

A second piece of high-quality and detailed BACI research that I was able to locate focused on fish responses to restoration, from data collected at 15 sites (Gent, 2006). Key findings included no significant difference in number of species caught between 2003 and 2006 and between control and impacted sites, although Trout and Bullhead densities were reduced in the new channels after restoration work. Fish biomass and density had not returned to pre-restoration levels within the short-time frame of the 'after' sampling but these findings are not inconsistent with the time it can take for river ecosystems to re-assemble following disturbance. Five age classes for Trout were found after the restoration which shows that these new channels have the ability to support fish throughout their life cycles. Whilst the restored channels clearly take some time to regenerate fully, video evidence from elsewhere also provides corroborating evidence that Trout do return quite quickly and begin to use the newly engineered river beds for spawning (Verderers of the New Forest, 2016). Given that the restoration works typically increase the length of these rivers, they increase the amount of habitat for fish. In time this extra space should lead to higher fish abundance. As Gent (2006) pointed out, there were areas of the new rivers that had not been exploited fully by fish when the post-restoration surveys were completed. Again, it is important here to note the need for a long-term view of the project aims, although the short-term responses are positive.

A third piece of BACI research studied the response of macroinvertebrate larvae that live on the bed of the rivers. Thomas (2006) studied the Blackwater at Rhinefield and compared channelised ('impact') and sinuous ('control') channels before and after engineering works. The two locations did not appear to show a major difference in invertebrate communities pre-restoration (i.e. the 2002 sample points from both locations are all clustered in the lower left part of Thomas's (2006) Figure 5). There was only one sampling date and a small number (n=5 replicates) which is not ideal but quite typical for these kinds of studies. Four months post restoration, the new channel showed a marked divergence away from the control system, reflecting the disturbance effect of construction and short time for recolonization of the new channel. In 2004 (16 months post-restoration), there was still some difference evident between the macroinvertebrate community of the two sections of the river. It should be noted that 16 months does not represent a long time for recovery after such a major disturbance; however, the data do suggest that the restored section was able to recover from the restoration engineering works to reach a state similar to the upstream sinuous channel community. The trajectory of change here does appear to be somewhat neutral in the short-term, but this is not surprising given that the sinuous section will have been the source for most of the colonisers found in the restored reach. As with the examples of Sears *et al.,* (2006), further post-restoration sampling timescales would have been useful to track longer-term responses.

There is a series of observations in the literature which provide further evidence for biodiversity benefits following New Forest restorations. Thomas (2006) noted that restoration work in the Blackwater had enhanced Odonata (dragonfly/damselfly) habitat in the restored main channel, and that there was even more marginal aquatic habitat as a result of restoration than in the reference reach. Furthermore, improved connections between the river and its floodplain were considered to have enhanced habitat availability for two rare invertebrate species. Other authors have substantiated these claims of floodplain habitat enhancement following the restoration. For example, Cox *et al*., (2015) provided numerous photographic comparisons to evidence shifts towards the natural state as compared with previously homogenous modified channels. Cox *et al*., (2015) went as far as saying that all of the sites that they assessed showed sustained positive change since their restoration, both for habitat quality and also in terms of their hydromorphological functioning.

In some of the wetland areas where tree clearance had taken wading birds such as Curlew and Lapwing had been observed for the first time (LIFE III, 2006). Denton (2007) has also noted the potential positive effect of tree clearance alongside Avon Water for terrestrial invertebrate communities, which include numerous notable and rare species. This effect was considered to be sustainable provided that the work to rewet the riparian zone continued to be successful in preventing recolonisation by dense stands of birch.

Elsewhere the restoration works in the New Forest are considered to have induced some positive changes for terrestrial vegetation. Rand (2014) noted the identification of "rare bankside and instream flora including Slender Marsh-bedstraw *Galium constrictum* and Chaffweed *Centunculus minimus*, Pillwort *Pilularia globulifera*, Hampshire-purslane *Ludwigia palustris*, Lesser Water-plantain *Baldellia ranunculoides* and New Forest Water-crowfoot *Ranunculus x novae-forestae*". Other vegetation surveys have reported a reduced area of Phragmites/Typha swamp area following rewetting of Soldier's Bog (Cox *et al*., 2015 cf. JBA Consulting, 2014). Cox *et al*., (2015) also explained how parts of floodplain at this location appear to be developing into an area of rush pasture vegetation. They suggested that this may be considered a component of the Annex 1 habitat type Eu-Molinion for which the New Forest has been designated a SAC. Elsewhere at Soldiers Bog, the restoration of the mire was considered to be leading to the development of Sphagnum dominated vegetation which could enhance the availability of the Annex 1 habitat type 'Depressions in peat substrate of the Rhynchosporion'. Similarly, Sphagnum regrowth had been noted at Akercombe Bottom which indicated the successful restoration of water table levels here (Cox *et al.*, 2015). Cox *et al*., (2015) recorded the Nationally rare New Forest water-crowfoot *Ranunculus x novae-forestae* along the course of the main Penny Moor drain in 2014 but this had not been seen in 2012 prior to the restoration. At Penny Moor, re-meandering of the river had increased connections between the floodplain and side streams where the nationally rare Hampshire purslane *Ludwigia palustris* can be found (Cox *et al*., 2015).

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Annex 3: Assurance review

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The narrative for conserving freshwater and wetland habitats in England (Mainstone *et al*., 2016) provides an overview of circumstances relating to the conservation of freshwater and wetland habitats in England, considering their ecological function, the natural and anthropogenic factors affecting them, the management principles that can be drawn from the evidence, and the respective roles of the main policy mechanisms involved in their conservation. *The Narrative* outlines the importance of natural habitat function in freshwater and wetland ecosystems, and draws out evidence-based management principles that are relevant to a range of spatial scales, to the relationship between habitat and species conservation, and to specially protected wildlife sites, priority habitat and the wider freshwater and wetland environment. These are the principles that should guide Natural England's approach to the conservation and restoration of freshwater and wetland ecosystems.

Protection should be based on the preservation, and where necessary restoration, of natural processes, in terms of natural hydrological, hydraulic, sediment and water quality regimes. Natural habitat function needs to be considered at a range of spatial scales, but good progress cannot be made without consideration of whole catchments. Across all habitats, fragmentation is a key factor in the decline of many priority species and connectivity is a vital part of restoring populations of these species through the provision of ecological networks for all habitats and species.

In terms of restoration, the aim is to recreate the natural hydrological and hydrochemical processes that will result in the formation of natural habitats suitable for priority species to establish, and thus provide the best and most sustainable approach to restoring large-scale habitat mosaics. Restoration based on the physical recreation of desired habitat patches will fail in the long-term if the underlying hydrological and hydrochemical processes that determine habitat condition have not been addressed.

To maximise the opportunities for protecting and restoring naturally functioning habitat mosaics within the landscape, the following principles are outlined in *The Narrative*.

1. Value natural ecosystem function, based on natural environmental processes, as the best and most sustainable expression of freshwater and wetland habitats and their characteristic wildlife.
2. Aim to conserve species within naturally functioning habitat wherever possible, based on natural environmental processes.
3. Cherish remaining examples of naturally functioning habitat and take opportunities to restore natural function elsewhere as far as possible.
4. Recognise that restoring natural catchment processes (hydrology, hydrochemistry) is a fundamental part of restoring freshwater and wetland ecosystems, and provides a useful framework for planning the restoration of drier habitat types.
5. Recognise that restoring natural ecosystem function as the art of the possible, working in locations that are most conducive to restoration and accepting immovable constraints.
6. As part of this recognition, generate a long-term strategic vision and seek to make short-term decisions in the light of that vision.
7. Take a large-scale perspective that maximises opportunities for natural ecosystem function, provides greatest opportunity for species to find habitat niches within a more naturally functioning landscape, and encourages a strategic approach to small-scale site management that helps provide these niches within site networks.

8. Accept dynamic change as a natural component of ecosystems, the magnitude of which varies between habitats but is high in freshwater ecosystems.
9. Plan for change in the distribution and population size of species where needed (as a result of landscape-scale restoration measures or direct climate change), to ensure key species are catered for appropriately within more naturally functioning landscapes.
10. As part of recognising environmental and population change, factor in the specific effects of climate change on key species to ensure that expectations for supporting individual species at a given location are realistic.

The New Forest

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, in a mosaic of terrestrial, wetland and freshwater habitats. As such it is afforded protection through designation as a Site of Special Scientific Interest (SSSI), a Special Area for Conservation (SAC), a Special Protection Area (SPA), a Ramsar site and a National Park.

The wetlands and freshwaters of the New Forest comprise valley mire systems (peat depressions containing brown beak sedge, transition mire, quaking bogs and alkaline fens), wet heath, wet grassland, wet woodlands (bog woodland and alluvial forest), ponds and streams. Following the principles of *The Narrative*, these wetlands and freshwaters should be managed collectively, together with the associated terrestrial habitats, to provide large-scale habitat mosaics.

One of the key aspects of concern in the New Forest is the damage caused by historical drainage of the wetland habitats and modification of rivers and streams. The exceptional wetland complex of the New Forest (including riverine woodland, bog woodland, valley mires, wet heath, wet grasslands and pools) as a whole has been identified as being of international importance (as key features of the New Forest SAC), which means that the UK government has a responsibility to ensure that they are in the best condition they can be. Many of the wetland habitats have been subject to past drainage damage and the effects of this are still evident across much of the area (Weymouth and Cooch, 2000). Without direct intervention, the continued negative influence of this damage to drainage systems is likely to persist.

Streams and rivers are the most dynamic component of the hydrological regime. Efforts focussed on restoring a natural hydrological regime in streams and rivers will return dividends for the associated wetland habitats. Similarly, efforts to restore natural flow pathways to drained valley mires and wet heaths will help re-establish a natural hydrological and hydrochemical regime to the connected streams and rivers.

New Forest Schemes – Aims

The aim of the New Forest SAC Management Plan (1998) was to prevent further active destruction of existing wet heath and mire communities and to restore a natural hydrological regime to them. This is entirely consistent with the principle of protecting and restoring natural processes outlined in *The Narrative*.

The objective of the restoration work undertaken by the LIFE partnership project “Sustainable Wetland Restoration in the New Forest” was to increase floodplain connectivity and restore geomorphic processes on the floodplain. Again, this is consistent with the principle of protecting and restoring natural processes outlined in *The Narrative*.

The New Forest Wetland Management Plan 2006-2016 (Smith, 2006) aimed to address 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. This aim is again consistent with the principle of restoring natural hydrological and hydrochemical function.

The Verderer's Higher Level Stewardship Scheme (HLS) in partnership with the Forestry Commission (FC) has followed previous schemes, and once more has the aim of re-establishing natural processes consistent with *The Narrative*.

New Forest Schemes – Activities

The objective of past management has been to artificially encourage rapid drainage of the land. Rivers and streams have been widened, deepened and straightened to drain adjacent wetlands with the aim of providing better conditions for growing timber and grazing. Any measures that seek to slow drainage and, thus, restore natural processes in terms of water quality, geomorphological and hydrological regimes should be seen as important contributions to river, stream and wetland habitat conservation. The measures undertaken in the New Forest are consistent with these principles as outlined in *The Narrative*, including direct interventions such as restoring meanders and raising bed level in streams and rivers or infilling and blocking drains in mires and other wetland habitats.

It should be stressed that the objective of such restoration works is to recreate natural processes, which in turn will give rise to conditions suitable for priority species and habitats. Such works are not expected to immediately recreate a perceived vision of lost habitat and species assemblages *per se*, but to recreate the template where natural recovery and colonisation will result in the sustainable establishment of target species and habitats. This longer perspective accepts dynamic change as a natural component of ecosystems and maximises opportunities for species to find habitat niches within a more naturally functioning landscape.

New Forest Schemes – Success

In the absence of a long-term pre and post restoration monitoring programme, as is typical of restoration activities worldwide (Jahnig *et al*., 2011), the evidence of success is constrained. In terms of achieving the desired geomorphic and hydrological response, success can be assessed over relatively short time-scales. Here, the available evidence suggests that hydrological impacts of restoration activities are detectable at catchment scale: floodplain connectivity has increased and geomorphic processes characteristic of semi-natural reaches have been re-established on the floodplain of restored reaches (Sears *et al*., 2006). Hence the available evidence suggests that the works have been successful.

However, the key mark of success of restoration activity is the outcome for priority species and habitats. The colonisation of the restored section of Fletchers stream by rare and declining bankside and instream flora (Slender Marsh-bedstraw *Galium constrictum* and Chaffweed *Centunculus minimus,* Pillwort *Pilularia globulifera,* Hampshire-purslane *Ludwigia palustris,* Lesser Water-plantain *Baldellia ranunculoides* and New Forest Water-crowfoot *Ranunculus x novae-foresta*) is a clear indication that the approach used here has been successful in achieving the objectives as outlined in The Narrative for Conserving Freshwater and Wetland Habitats in England (Mainstone *et al*., 2016). A more widespread assessment of such species in restored areas would be beneficial.

Consistent with the assessment of Natural England the development of a monitoring programme that includes the physical and ecological condition of sites restored and otherwise, would provide a more thorough assessment of the success of the programme in the New Forest.

However, the works undertaken to date are consistent with the principles as outlined by *The Narrative*, which should provide the best opportunity for success. The evidence available to date suggests that where sites have been assessed, restoration activities have been successful.

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Annex 4: Assurance Review

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New Forest Assessment Review – Mires (and associated ecosystems)

1. Purpose of Review

1.1 The present review seeks to answer two questions in relation to the Final Draft of *'The New Forest Assessment'* (Thomas *et al*., 2016):

1.1.1 Are the approaches being used to restore wetland (particularly mire) systems in the New Forest, as described in *The Assessment*, consistent with the evidence-based principles set out in the published report: *"*A narrative for conserving freshwater and wetland habitats in England*"* (Mainstone *et al*., 2016)?

1.1.2 Is *The Assessment's* conclusion, that the New Forest wetland (particularly mire) restorations carried out in recent years are delivering beneficial biodiversity and water outcomes, consistent with the available evidence?

2. Approach adopted by the Review

2.1 The two questions defining the purpose of the review, as set out above, address two distinct issues which require two somewhat differing approaches when reviewing the evidence.

2.2 The first question seeks to establish evidence of clear linkages between *The Assessment* and T*he Narrative* and the shaping of the former by the later. This involves mapping of text within *The Assessment* onto the text of *The Narrative* – or *vice-versa* as appropriate.

2.3 The second question has no direct linkage to *The Narrative*, instead seeking evidence for 'beneficial outcomes' which are 'consistent with the available evidence' but without specifying the sources of this evidence. As such, it requires collation of such evidence as exists for the outcomes of habitat- and species-restoration programmes within the New Forest, together with an assessment of those outcomes.

2.4 The present review therefore addresses these two questions separately, firstly by addressing the issue of mapping *The Assessment* to *The Narrative* where relevant to mires and associated habitats, then by undertaking an assessment of the available evidence for restoration outcomes in relation to the New Forest mires and associated habitats

3. Mapping *The Assessment* to *The Narrative*

3.1 The two documents differ somewhat in the sequence of topics which they present and also to some extent in their content. A straightforward mapping from one to the other is thus not possible for all aspects but there are several sections where the linkage between the two documents is clear.

3.2 Given that the focus of interest of the present review is on *The Assessment* and, conveniently, that document employs headings which are not numbered, adoption of the

various topic headings from *The Assessment* would appear to be the most logical way forward in working through both documents and mapping from one to the other. Reference will be made to heading and paragraph numbers in *The Narrative* and to avoid confusion with the paragraph numbering of the present review these will be indicated as in the following example: [Narrative: 6.3]. Where explicit reference is made to numbered paragraphs in other associated documents, these will be indicated as in the following example: [Natural England (2015): 3.5].

3.3 Subsequent paragraphs in this Section will thus follow the headings used by *The Assessment* and consider ways in which these can be mapped onto the text of *The Narrative*. Comment will be restricted to those parts of both documents relevant to the mires and associated habitats of the New Forest.

3.4 Introduction

3.4.1 This section of *The Assessment* largely focuses on the international and national significance of the New Forest and its wetland/mire biodiversity, emphasising the obligations which various environmental designations impose on the UK's, and Natural England's, approach to management of the area.

3.4.2 While there is little on this topic in *The Narrative's* section about terrestrial wetland habitats [Narrative: 4], the whole of the subsequent section [Narrative: 5] is devoted to the role of key policy mechanisms and specifically addresses the obligations associated with specially protected wildlife sites. In particular it emphasises [Narrative: 5.11] that the requirements of environmental legislation lend weight to adoption of a long-term strategic approach for such areas.

3.4.3 Furthermore *The Narrative* observes that decision-making in relation to sites designated for wetland habitats is moving as far as possible towards protection and restoration of natural ecosystem function, as is already applied to freshwater systems [Narrative: 5.3]. *The Assessment* highlights, in its Introduction, the fact that the New Forest mires have been impacted by human activity and thus currently in many places do not possess naturally functioning ecosystems.

3.5 The New Forest Wetlands

3.5.1 This section of *The Assessment* is one of the sections which maps most readily onto the text of *The Narrative* in that both documents set out what *The Narrative* refers to as 'the natural habitat template' for mires and associated systems [Narrative: 4.1 – 4.6, 4.9, 4.11 – 4.12, 4.16 – 4.18]. Both documents describe the ecological character of mire systems and their associated habitats, *The Assessment* with specific reference to the New Forest.

3.5.2 *The Narrative* emphasises the importance of designing conservation and restoration programmes in such a way that they can cater for features at different scales, from the catchment scale down to, for example, small-scale depressions, or hollows, in the peat which provide the critical niche for certain species assemblages [Narrative: 4.36, 4.6, 6.8]. Such small-scale features are specifically noted by *The Assessment* as being an Annex 1 habitat under the EU Habitats Directive but one which is also rare within England and thus the New Forest has a particular responsibility for such features. It also recognises, as does *The Narrative*, that some important features are seasonal or ephemeral [Narrative: 4.36].

3.5.3 Indeed *The Assessment* describes a wide range of mire types and associated habitats found in the New Forest and highlights both their national and international significance and statutory designations, thus providing a link to the section about key policy mechanisms in *The Narrative* [Narrative: 5]. In doing so, *The Assessment* also highlights the fact that extensive survey has been undertaken of the mire systems (and associated habitats) in the New Forest, identifying where particular mire types, species assemblages or individual species currently occur (*e.g.* Clarke, 1988; Sanderson, 1998; Weymouth and Cooch, 2000; Wright and Westerhoff, 2001; Purse, 2002; Allen, 2003; Wheeler *et al*., 2009; Falk, 2010;

Tratt *et al*., 2013; Cox *et al*., 2015; Meade, 2015). The need for such knowledge is emphasised as one of the 'key management messages' within *The Narrative* [Narrative: 4.37].

3.5.4 *The Assessment* also emphasises the importance of transitions and connections between several of these listed habitats for natural ecosystem functioning and in maintaining and enhancing biodiversity. *The Assessment* thus mirrors the recommendation in *The Narrative* that fragmentation and connectivity should be intrinsic factors in the planning of conservation strategy, particularly as Lawton *et al*., (2010) highlight the fact that the current network of statutory conservation sites falls "well short of being a resilient and coherent network" capable of maintaining current levels of biodiversity and natural habitat function [Narrative: 4.35, Table 4.2, 6.4, Box 6.1, 6.11, 6.18].

3.6 Wetland drainage

3.6.1 In this section *The Assessment* summarises the scale of drainage which was undertaken within the New Forest between the mid-19th Century and the turn of the millennium, highlighting the fact that mechanical drainage intensified the scale of drainage between the 1920s and the late 1990s. In the case of the valley mires, for example, it notes that 19 were subject to drainage between 1965 and 1986 and that in the case of eight of these sites the impact was considerable.

3.6.2 *The Narrative* similarly acknowledges that "the hydrology of most, if not all, English terrestrial wetlands have been modified by historic drainage both within sites and in the surrounding environment" [Narrative: 4.20].

3.7 The impact of drainage

3.7.1 *The Assessment* identifies that the stream-courses of the New Forest have a strong connectivity with the associated mire systems but in canalising and deepening these streams a process of headwater incision has led to erosion of deep channels back into the mire systems, thereby causing drainage of these systems during all conditions except flood flows – and these occasions are reduced because the widened and deepened stream channels can more easily cope with and remove large volumes of water which would previously have resulted in flood events.

3.7.2 *The Assessment* goes on to describe the direct impact of drainage on valley mire systems in the New Forest, with none being totally lost but many suffering significant disruptions to their hydrological regime, in particular resulting in the loss of typical habitat mosaic and zonation (and thus biological richness and ecosystem function). *The Assessment* describes how drainage results in loss of peat-forming communities, subsidence and compression of the peat resulting in more rapid surface run-off and ultimately erosion of the peat deposit itself.

3.7.3 Allen (2003), cited by *The Assessment*, gives site-by-site descriptions of the scale, extent and impact of drainage within the New Forest valley mores, highlighting the range of hydrological issues arising from such drainage activities, while Wheeler *et al*., (2009) provide a similar account of the impacts on the plant assemblages.

3.7.3 *The Assessment* also gives the example of the southern damselfly (*Coenagrion mercurial*) which relies on slow-moving low-nutrient water bodies which are often found within the New Forest valley mire complexes. This species survives in the New Forest but has suffered dramatic contraction of its range across Europe as a result of wetland drainage and thus can be assumed to have experienced a concomitant reduction in its distribution within the New Forest as drainage has reduced the extent of suitable habitat, reflecting the documented long-term reduction in overall biological richness of the New Forest.

3.7.4 *The Narrative* identifies the generic effects of drainage on terrestrial wetland systems, these effects largely mirroring those described in *The Assessment*. The specific example given by *The Narrative* for impacts on particular features of interest in mire systems from drainage is that of the Annex 1 Rhynchosporion depressions in peat – characteristic now of only the

largest and least damaged New Forest valley mires – emphasising that the species characteristic of this feature have experienced some of the most dramatic contractions in range of any species assemblage in the UK [Narrative: 4.22]. This mirrors the observations made in *The Assessment* referred to in Section 3.5.2 above.

3.8 Restoration history and aims

3.8.1 This section of *The Assessment* reviews the story of habitat restoration efforts in the New Forest since 1997. While some of the earliest restoration efforts were directed towards localised site issues where obvious damage was occurring, *The Assessment* notes that the programmes soon took on a broader approach, seeking to prevent further harm (from drainage and from invasive species) while also aiming to re-establish more natural ecosystem processes.

3.8.2 *The Assessment* highlights that one of the specific targets of restoration effort was the re-establishment of hydrological connectivity and of more natural geomorphological processes. *The Assessment* also describes restoration in terms of restoration of meandering river courses (thus retaining water within the whole system for longer), restoration of seasonal flooding, raised stream-bed levels which assist in the maintenance of high water tables within adjacent systems (most notably the mire systems), infilling of drains and repairs to eroded parts. These actions all represent steps towards the re-establishment of more natural ecosystem processes, a target which forms one of the core objectives of *The Narrative* and which is repeated many times through that document [Narrative: 4.25, 4.28, Table 4.2, 5.3, 6.1, 6.4, 6.6, 6.10, 6.28, 6.33, Box 2].

3.9 Natural England's aims and objectives for the New Forest Wetlands

3.9.1 This section of *The Assessment* opens by noting that, as the statutory government conservation agency, Natural England has a duty to "conserve the special features of a site in the best possible condition, support improvement and prevent damage". This accords closely with Section 5 of *The Narrative* and the need to adopt "a long-term strategic approach to addressing deep-rooted and complex problems to restoring natural ecosystem function…" [Narrative: 5.11].

3.9.2 *The Assessment* then sets out Natural England's general aspirations for, amongst other habitats, mires and their associated habitats as being that they should "operate under natural processes free from anthropogenic impact with a characteristic mosaic of habitats". This is in effect a direct quote from the General Aspirations of *The Narrative* [Narrative: 4.25] and demonstrates the way in which *The Narrative* informs and underpins *The Assessment*.

3.9.3 *The Narrative* also highlights the dynamic nature of terrestrial wetlands both in terms of changes to the wetland template over time caused by factors such as geological erosion, climate change or a cycle of accumulation and decay of material, or through the natural tendency of ecosystems to undergo a process of ecological succession, one expression of a habitat being replaced by another form, or even by a different habitat, as a result of natural ecological development [Narrative: 4.4, 4.5]. This consideration is to some extent highlighted by *The Assessment* in its recognition that sometimes apparent conflicts can emerge between differing conservation objectives and interests, particularly where dynamic changes are occurring or proposed, but that by exploring a variety of actions these initially-conflicting interests can both be addressed. Similar issues are highlighted by *The Narrative* in its Key Management Messages, where it may be important to take action in the right order, take the long view, or rationalise changes in the features of interest [Narrative: 4.30, 4.31, 4.33].

3.9.4 *The Assessment* explicitly identifies restoration of natural processes as a top priority for wetland habitat in the New Forest, citing the New Forest SIP and Natural England's Hydrological Functioning Theme Plan. This explicit target of restoring natural processes matches precisely with the repeating central theme of restoring natural process in *The*

Narrative both in terms of general aspirations and key management messages [Narrative: 4.25, 4.28 - 4.29, 4.31 - 4.36, 4.38 - 4.39, Table 4.2, 6.10].

3.9.5 In contrast, *The Narrative* is much more explicit than *The Assessment* about the need to adopt a large-scale perspective which incorporates the entire catchment (and atmospheric inputs) [Narrative: 4.29]. *The Narrative* devotes an entire section to 'Landscape-scale planning' and the fact that "good progress cannot be made without consideration of the whole catchment" [Narrative: 6, 6.1]. It highlights [Narrative: 6.4] three key approaches set out by Lawton et al. (2010):

- Planning of ecological networks based as far as possible on restoring ecosystems and natural processes that provide habitats for species;
- Considering how any given site is, or should be, functionally connected with other places in the wider landscape; and
- The importance of high quality core sites.

The Assessment does not address these issues directly but "wholly embraces" them through adoption of the New Forest SIP and Natural England's Hydrological Functioning Theme Plan. It also explicitly states that Natural England's aims for the New Forest are explained in more detail in *The Narrative* – thereby embracing all the concepts of landscape-scale planning and whole-catchment management set out in that document.

3.9.6 *The Assessment* highlights the fact that opportunities for restoration of wetland habitats and natural processes are significantly higher in the New Forest than for many wetland areas because the New Forest still contains so much high-quality habitat. *The Narrative* identifies such circumstances as highly favourable indicators for active conservation action because areas with a high density and variety of interest and good connectivity provide a significant degree of ecosystem robustness, enhanced opportunities for habitat improvement and better restoration of natural ecosystem function [Narrative: 6.11, 6.30, 6.33].

3.10 Monitoring

3.10.1 *The Assessment* identifies that all statutory conservation sites are monitored through a rolling programme based on the JNCC's Common Standards Monitoring (CSM) scheme. *The Assessment* nevertheless notes that the CSM process does not have sufficient resolution or focus to identify some of the key changes resulting from habitat management in the New Forest. Meanwhile, though at one level *The Narrative* has little to say about monitoring techniques, it provides a valuable set of 'indicators of natural function' which can be used to guide the development of appropriate monitoring techniques [Narrative: Table 4.2].

3.10.2 The 'indicators' provided by *The Narrative* unfortunately pre-date most of the restoration work which has already been undertaken in the New Forest and *The Assessment* acknowledges that there is a lack of well-documented and critically assessed monitoring data for the New Forest restoration projects. Structured, large-scale assessments of restoration outcomes have nevertheless been made on a number of occasions (e.g. Allen, 2003; Wheeler et al. 2009; JBA Consulting, 2014a,b), with the most recent (Cox *et al*., 2015) concluding that all sites examined showed evidence of improvements to natural ecosystem functions.

4. *The Assessment* and evidence for habitat improvement

4.1 Notwithstanding the acknowledged lack of strategic or comprehensive monitoring of restoration measures, referred to in the section above, *The Assessment* makes various statements about the reported success of ecosystem restoration actions in the New Forest. These statements are based on published reports on which the authors of *The Assessment* draw. It is perhaps worth re-emphasising at the same time that *The Narrative* is a generic document for the whole of England. Consequently it is not a source of information about the success of habitat restoration measures in the New Forest and therefore provides no

supporting evidence for *The Assessment* and its conclusions that recent habitat restoration works have resulted in beneficial outcomes.

4.2 The documents on which *The Assessment* draws for relatively recent evidence of restoration outcomes for mire systems can be summarised as:

- Allen (2003) – New Forest Valley Mire : Hydrogeological Site Accounts;
- Smith (2006) – New Forest Wetland Management Plan
- Wheeler *et al*. (2009) – A Wetland Framework for Impact Assessment;
- Rand (2014) – Hampshire Flora Group Field trip;
- JBA Consulting (2014a) – Geomorphological Survey
- JBA Consulting (2014b) – Ecohydrological Survey
- Cox *et al*. (2015) – New Forest Wetland Restoration Review

4.3 Together, the documents listed above represent a considerable volume of information about wetland restoration and their outcomes over time in the New Forest. It is also worth emphasising at this point that 'time' is often a crucial component of restoration yet is often overlooked when reviewing restoration actions and outcomes, as highlighted by the recent **IUCN UK Peatland Briefing on Restoration** (Lindsay *et al*., 2016). With many peatland systems there appears to be a lag period of five years or more before the system responds with any vigour to a restoration action. Consequently it would be unreasonable to expect dramatic changes from any ecosystem restoration undertaken since 2010 – an important factor to bear in mind when considering more recent restoration actions.

4.4 The seven documents listed in Section 4.2 above all identify that improvements have occurred to the wetland/mire systems as a result of restoration actions.

4.4.1 Allen (2003) – New Forest Valley Mire: Hydrological Site Accounts

Allen (2003) examines 30 New Forest valley mires (including two distinct parts of Denny Bog) and refers to restoration efforts in relation to four sites – Denny Bog east, Dibden Bottom, Redhill Bog and Holmhill Bog. In all cases he notes that water levels in the mire were raised as a result of the restoration measures employed, although he also suggests that more may need to be done, and also highlights a number of sites which have evident damage but (at the time) no restoration activity.

4.4.2 Smith (2006) – New Forest Wetland Management Plan

Smith (2006) provides a detailed breakdown of the restoration works carried out between 2002 and 2006, but notes that the results of the restoration actions were still being analysed. Five case studies are provided, however, and from the before-and-after photographs provided it is evident that some improvement in the natural functioning of the wetland habitats has been achieved. Smith (2006) also notes that some techniques tested earlier by, for example, the Forestry Commission, had not proved as successful as hoped and these relative failures had informed the development of revised or new restoration techniques in an iterative learning process.

4.4.3 Wheeler *et al*. (2009) – A Wetland Framework for Impact Assessment

Although this report is focused on the whole of England and Wales, site-specific eco-hydrological accounts are provided in an appendix for 22 valley mires in the New Forest. They refer to only one example of restoration work, at Holmhill Bog, where they state that efforts to obstruct the flow of the central stream "are reported to have reduced erosion and increased water levels".

4.4.4 **Rand (2014) - Hampshire Flora Group Field trip**

This is a narrative account of a visit made by a joint BSBI/Hampshire Flora Group to a small number of New Forest sites, one of which was Warwick Slade, where stream and wetland restoration work had been undertaken. Although there had been some concern that the niches of certain plant species of interest might have been adversely affected by the restoration works at Warwick Slade, the group found that all species of interest were doing well, the hydrology of the system was clearly improved, and the group members were pleased to see the positive effects of such restoration actions.

4.4.5 **JBA Consulting (2014a) – Geomorphological Survey**

This report provides details obtained from geomorphological and eco-hydrological investigations of 52 'units' containing mires, streams and mire-stream transitions within the New Forest with the specific aim of identifying wetland restoration opportunities. In doing so, the report also touches on a number of restoration actions which have already been undertaken. Table 3-4 of the report provides a summary of restoration works to date obtained from a literature review, and the associated review of 'generic restoration opportunities' notes that actions such as encouraging debris jams and adding heather bailing have successfully reconnected the floodplain and encouraged the anastomosing pattern for stream-flow which is characteristic of so many New Forest valley mires, as well as halt head-ward stream incision and encourage upstream floodplain (mire) rewetting.

4.4.6 **JBA Consulting (2014b) – Ecohydrological Survey**

This report provides details obtained from geomorphological and eco-hydrological investigations of 23 eco-hydrological assessment areas within the New Forest wetland resource. Again, the report is designed primarily to identify future restoration opportunities, identifying restoration opportunities for 17 of the 23 assessment areas, but it also reviews restoration methods and outcomes to date through a literature review (Table 3-10 of the report) as a means of identifying the most appropriate techniques to apply in a given context. The report highlights some failures with heather bales but also a number of successes with heather bales and other methods in the course of the LIFE III project.

4.4.7 **Cox *et al*., (2015) – New Forest Wetland Restoration Review**

This study represents a substantial review of restoration progress to date for 11 mire or mire-stream transition sites in the New Forest carried out under HLS. In every case, clear positive effects were recorded in terms on a move towards more natural ecosystem functioning and no dis-benefits were observed. Some of the before-and-after photographs are quite striking in terms of what has been achieved.

4.5 Based on the evidence presented in the studies considered above, it appears completely reasonable that *The Assessment* should draw on this collective body of work to conclude that the range of restoration actions so far undertaken across the New Forest wetlands has had a beneficial effect in terms of moving wetland systems towards possession of more natural ecosystem processes and thus towards the ultimate objective set out in *The Narrative* and in Lawton *et al.,* (2010), which is a set of wetland systems which operate under natural processes.

5. Conclusions

5.1 On the basis of the reviewed evidence set out above, I conclude that *The Assessment* is informed by *The Narrative* to a fundamental degree and follows the lead set by *The Narrative* and its associated documents very closely. I am unable to find any example of *The Assessment* straying from the guidance set out in *The Narrative*. If anything, *The Assessment* is more conservative than the vision and set of actions set out in the *Narrative*. It takes a rather modest approach to the issue of whole-catchment management and focuses more on the specifics required for in-site management.

5.2 In terms of in-site management, the claims made by *The Assessment* for the success of wetland restoration management are equally modest and conservative, though this is understandable because of the somewhat limited range of documented evidence for restoration outcomes. Nonetheless a significant body of evidence does exist and *The Assessment* makes valid use of this without overplaying the strength of the available evidence.

5.3 It would seem reasonable to conclude that the present range of habitat restoration activities being undertaken on mires and their associated habitats in the New Forest offer real prospects for positive outcomes that move the systems towards the ultimate goal of operating under natural processes free from anthropogenic impact and with a characteristic mosaic of wetland habitat types that caters for characteristic species assemblages, and that provides the best and most sustainable expression of wetland habitats in the New Forest.

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