Natural England Commissioned Report NECR319

An outline management plan for Hatchet Pond, New Forest SSSI

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Hatchet Pond is one of over one thousand ponds in the New Forest Site of Special Scientific Interest (SSSI) and is a qualifying habitat of the New Forest Special Area of Conservation (SAC). It is a popular site for visitors as well as being a coarse fishing location.

Despite being artificial in origin it is one of the highest quality standing water habitats in the country supporting an outstanding assemblage of freshwater plants and animals including a suite of endangered and protected species.

Common Standards Monitoring Assessments have identified a decline in condition of the lake and classified the habitat as being in unfavourable condition on account of poor water quality, presence of the invasive non-native species and failure of wetland plants to meet all compositional targets.

This contract collated, reviewed and interpreted the evidence relating to the decline in condition and produced recommendations to protect and restore the lake based on the latest information relating to restoration techniques for this type of water body.

This report will inform the production of a detailed restoration and management plan.

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Further information
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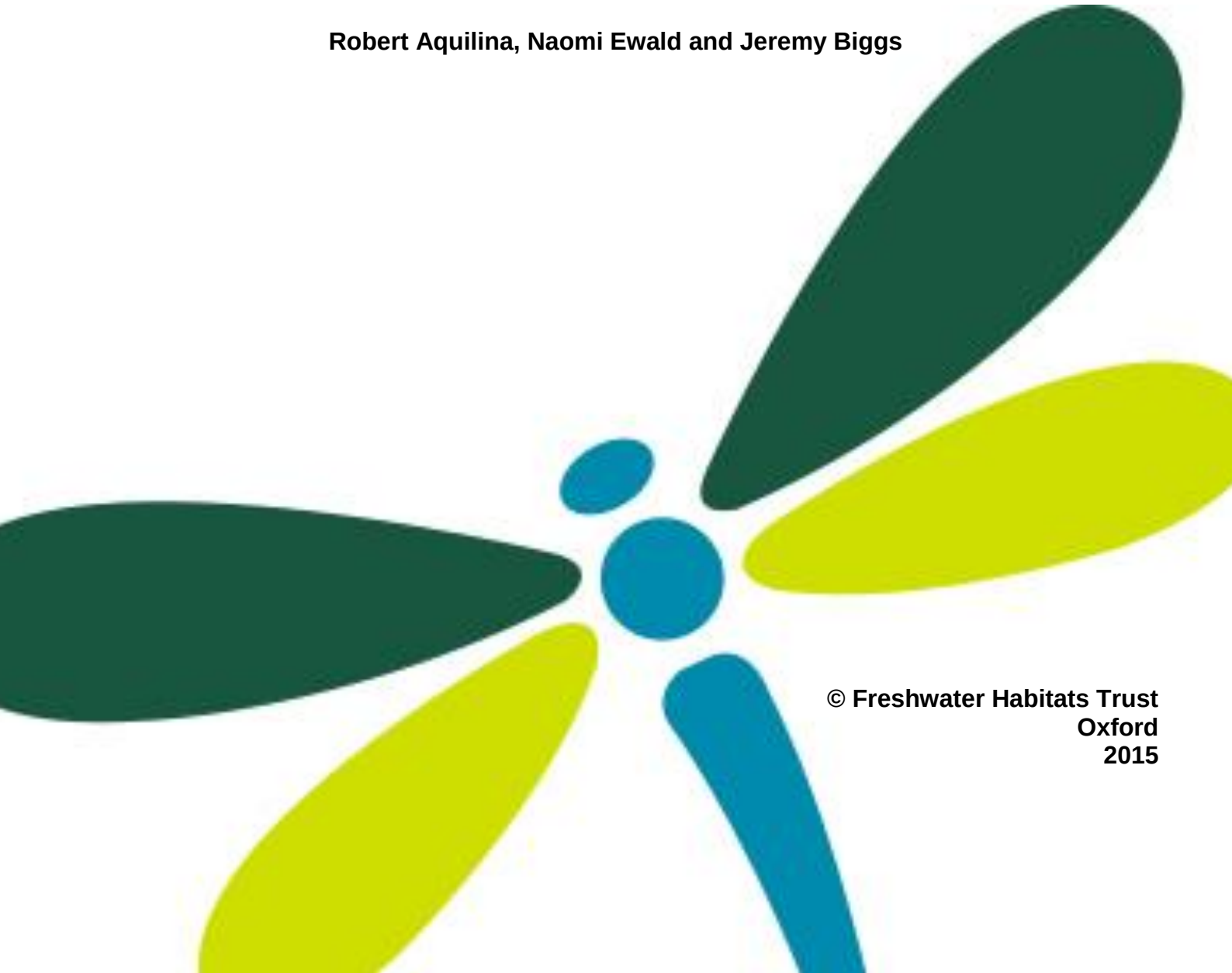
An outline lake management plan for Hatchet Pond, New Forest SSSI

Report to Natural England

Robert Aquilina, Naomi Ewald and Jeremy Biggs



Oxford
2015

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Alison Bolton, Clive Chatters, The Environment Agency (Grant Miller, Sian Davies), The Forestry Commission (Jane Smith, Jonathan Cooke, Richard Burke), Geoff Phillips, Hampshire and Isle of Wight Wildlife Trust, Hampshire Biodiversity Information Centre, Martin Rand (BSBI), Natural England (Jenny Thomas, Ruth Hall, Gen Madgwick), Neil Sanderson, Peter Henderson, Pete Langdon and Richard Reeves.

Summary

Background

Hatchet Pond is a 6.7ha shallow lake, located within the Crown Lands of the New Forest. The lake was created in the 18th Century to provide power for an iron mill and is now a popular tourist spot and coarse fishing site. Hatchet Pond is designated as Annex 1 priority lake habitat under the Habitats Directive within the New Forest Special Area of Conservation. There is a legal requirement to ensure the lake is maintained and/ or restored to meet favourable conservation status for this habitat. Hatchet Pond has an additional legal driver in the EU Water Framework Directive (WFD). As a specified water body within the South East River Basin Management Plan, it must achieve minimum standards for water quality, biology and water levels.

Common Standards Monitoring (CSM) has classified the habitat as being in unfavourable condition on account of poor water quality, presence of the invasive non-native species and failure of wetland plants to meet all compositional targets. Under the Water Framework Directive the lake has been classified as in Moderate Status on a five point scale of High (reference condition), Good (meets minimum standards), Moderate (fails minimum standards), Poor and Bad.

Freshwater Habitats Trust were contracted to produce an outline lake management plan for Hatchet Pond, including data collation, interpretation, review and synthesis to evidence the perceived deterioration in the lake, diagnose the reasons for decline and current constraints to achieving favourable condition. On the basis of this review, costed recommendations have been made to protect and restore the lake, based on the latest information regarding restoration techniques for this type of water body.

Hatchet Pond is one of the highest quality standing water habitats in the country, supporting an outstanding assemblage of freshwater plants and animals, with a suite of endangered and protected species. Few sites in England are of this quality and as a result the lake has a high degree of protection and demanding objectives to maintain this status.

Evidence of change in lake condition

Although a site of exceptional quality, changes recorded at the pond are indicative of the early stages of eutrophication, before substantial biological degradation of the lake. Although the biological signal is not yet strong, there is clear evidence of deterioration. Water quality is deteriorating based on long-term increases in diatom reconstructed phosphorus concentrations, changes in Soluble Reactive Phosphorus 1979 - 1983 and, more recently (post 2008), on measured total phosphorus values.

As well as the early stages of eutrophication the lake has probably also been exposed to impacts associated with acid deposition (sulphur and nitrogen deposition). Hatchet Pond is in a landscape vulnerable to acidification and may now be experiencing some benefits from the reduction in sulphur deposition since the 1980s. However, continued exposure to elevated nitrogen concentrations and increasing pH may exacerbate the eutrophication which is already occurring.

There is also a threat from invasive non-native species. New Zealand Pigmyweed *Crassula helmsii* is currently being kept in check through grazing pressure and low nutrient levels. However, changes in the lake could favour this plant and result in its dominance.

In addition, the amount of erosion around the lake margin has increased which has resulted in damage to the surrounding vegetation and via runoff could add sediments to the lake resulting in increased turbidity.

Identification of stressors

From a review of the evidence, stressors have been identified which explain the changes observed in water chemistry and biology at Hatchet Pond:

- Benthivorous bottom feeding fish which make nutrients more bio-available through their feeding habits.
- Fishing using ground baiting (e.g. with bread, sweetcorn or high protein 'boilies') which introduces excess nutrients.
- Exacerbation of eutrophication following recovery from acidification.

In addition we have evidence of:

- Poaching of the shore line by walkers and their dogs leading to bank erosion which introduces more sediment and causes re-suspension of sediments into the water column.
- Feeding of birds which artificially increases bird numbers and introduces nutrients via bird faeces. Uneaten food further enriches the site.
- Obstruction created by the sluice structure which is preventing Common Eel *Anguilla anguilla* passage into the lake.
- Introduction of invasive non-native plant species, which threatens to out-compete rare native species.

Restoration options

It is often harder for lakes to recover from eutrophication than it is to move into a eutrophic state. A lower nutrient concentration than the one experienced prior to eutrophication is often required for a lake to recover to its pre-eutrophic state. Steps are therefore required now to protect Hatchet Pond.

We have proposed three management options, but our recommendation is Option 2; to manage recreation activity and undertake monitoring over the next five years to better understand changes at the pond. Plans can then be amended to reflect any further changes observed at the site.

Option 2: Manage recreation activity:

There is growing recognition that restoration of degraded lakes remains unpredictable; and evidence that, even in relatively successful restorations it is difficult, or perhaps impossible, to regain all of the pre-restoration site biota. This suggests that, where sites have not suffered substantial degradation and retain most of the key biological interest, the most conservation effective strategy is to put substantial effort into preventing and reversing any further decline.

- **Information** - Organise a workshop to explain the plans for Hatchet Pond and the reasons behind these decisions to as wide an audience as possible. Invite experts to provide case studies of lake restoration projects from elsewhere. Present options for the management of Hatchet Pond and work with stakeholders to choose the most appropriate option for recovery of the lake.

  Forestry Commission staff should be on-hand at Hatchet Pond during weekends to answer questions and raise awareness of the need to protect Hatchet Pond for nature conservation.

  Erect temporary signs on site to explain the works taking place.

- **Car parking** - Reduce the size of the car park at Hatchet Pond; removing all but the disabled parking from the lake edge. Repair the entrance to the car park to prevent additional parking in the lay-by and outside of the designated car parking area.

Reduce the size of the car park at Little Hatchet pond as well, closing the eastern arm of the car park, to take pressure off the site as a whole.

Allow parking at Little Hatchet pond year round, but consider closing Hatchet Pond car park over the winter months - a period of lake recovery.

We do not feel that introducing charging at the car park will significantly benefit the lake, although charging at car parks may have wider benefits; e.g. encouraging visitors to value the National Park.

- **Duck feeding** – Erect temporary signs asking visitors to refrain from feeding the birds. This will not prevent the practice, as some will always ignore the signs, but it may reduce it for a time whilst the lake recovers.
- **Fishing** - Remove remaining Carp and Bream from Hatchet Pond and Hatchet Little Pond. Make the lake and the pond a natural coarse fishery.

  Limit fishing to season only tickets. Local fishermen on a season ticket are more likely to understand and respect the lake.

  Place tighter controls on fishing at Hatchet Pond, including a ban on ground baiting and boilies (which will be an unnecessary practice anyway if Carp and Bream are removed) and ask season ticket holders to keep a record of their catch.

  Restrict fishing to certain sections of the lake - to stop disturbance and erosion of the most vulnerable areas of habitat; particularly along the western and southern margin of Hatchet Pond.
- **Sluice structures** – Install eel passes to ensure there is no obstruction to fish passage (activity already being addressed by Environment Agency mitigation measures).
- **Walkers** - Put up temporary signs to ask visitors to keep dogs on leads, concerns over the health of the pond may deter visitors from letting their dogs into the water.

  Close the path on the far side of the pond which runs close to the pond edge (as per the 1940s). This would most unobtrusively be achieved through the use of brash.
- **Monitoring** - In addition to Common Standards Monitoring and Water Framework Directive Monitoring, we would recommend 5-yearly monitoring using standardised PSYM (to monitor change in lake quality for wetland plants and invertebrates).

  Begin detailed studies of priority species (plants and invertebrates), to better understand changes at the pond and the effectiveness of management to reduce pressure on the site.

  Additional monitoring of adjacent vegetation is needed to quantify visitor impact and erosion.

Hatchet Pond is located within a largely semi-natural habitat. Nutrients and sediment sources are direct or indirect inputs to the lake from recreation. These issues are relatively straightforward to address compared with pollution from agriculture or urbanisation. There is a need to do everything possible to protect high quality sites like Hatchet Pond; sites which currently retain outstanding assemblages of plants and animals in spite of some nutrient enrichment.

Contents

1 Introduction

1.1 Background

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 the second largest terrestrial Site of Special Scientific Interest (SSSI) in the UK and its international importance is recognised through the additional designations of a Special Area for Conservation (SAC), Special Protection Area (SPA) and Ramsar wetland. These afford the New Forest the highest level of statutory protection from damaging activities and development.

The freshwaters of the New Forest are exceptional habitats. Over 1000 individual ponds and lakes have been mapped within the National Park boundary and many hundred more winter wet pools are known from every habitat; heathland, grassland, woodland, valley mire and gravel ridge. This traditionally managed largely unimpacted landscape supports a huge diversity of pond and lake types which in turn supports an exceptionally varied and rich community of freshwater plants and animals. Freshwaters of this number and quality have been lost from almost every other lowland landscape in the UK.

The standing waters of the New Forest support an outstanding assemblage of plant and animal species including populations of internationally important species like the rare Great Crested Newt (*Triturus cristatus*) and Floating Water Plantain (*Luronium natans*). The wetland habitats collectively form probably the most important single suite of habitats for dragonflies (Odonata) in Britain. Twenty-seven species breed in the New Forest including the rare Southern Damselfly (*Coenagrion mercurial*). The temporary ponds that dry out in the summer provide ideal conditions for some specially adapted invertebrates including the Fairy Shrimp (*Chirocephalus diaphanous*) and the Tadpole Shrimp (*Triops cancriformis*). The ponds also support a range of rare plants including Pillwort (*Pilularia globulifera*), Lesser Water-plantain (*Baldellia ranunculoides*), Small Fleabane (*Pulicaria vulgaris*), Pennyroyal (*Mentha pulegium*), Slender Marsh Bedstraw (*Galium constrictum*), Coral Necklace (*Illecebrum verticillatum*) and Hampshire Purslane (*Ludwigia palustris*). Many of these are associated with temporary ponds or the poached muddy edges of permanent ponds. As a result of this biological significance, the New Forest has been identified by national experts as an Important Area for Ponds and an Important Stonewort Area.

Hatchet Pond is one of the New Forest's exceptional freshwater habitats. Afforded several conservation designations in its' own right. It is a feature of the New Forest SSSI and SAC as Annex I habitats: nutrient-poor shallow waters with aquatic vegetation on sandy plains (H3110) and clear-water lakes or lochs with aquatic vegetation and poor to moderate nutrient levels (H3130). As well as being protected by the Wildlife and Countryside Act, and Habitats Regulations, Hatchet Pond has an additional legal driver in the EU Water Framework Directive and is listed in Annex D of the Water Framework Directive River Basin Management Plans. It is one of the UKs reference condition lakes of exceptionally high quality and an important stonewort site.

Biologically, Hatchet Pond is one of the highest quality standing water habitats in the country, with a suite of endangered and protected species. Water quality is expected to be high, as Hatchet Pond is fed by nutrient poor heathland with no obvious sources of nutrient contribution. However, a Common Standards Monitoring condition assessment in 2009 and 2011 classed the habitat as in unfavourable condition on account of declines in plant community and composition, poor water quality and the presence of the invasive non-native species *Crassula helmsii*. In 2013 Hatchet Pond failed to meet the minimum standards set by the Water Framework Directive for both lake biology and water chemistry.

2 Site Description

2.1 Location and creation history of Hatchet Pond

Hatchet Pond (Figure 1) is a man-made waterbody located within Beaulieu Heath (SU367014), in the south-east of the New Forest National Park. It was created in the 18th Century by damming the Hatchet Stream. Located less than 1 km from the stream's source, draining semi-natural heathland habitat; the unpolluted headwaters are retained here before they continue to flow in a south-easterly direction to their confluence with the Beaulieu River (Figure 2a).

The lake is located next to several ponds, as this area was historically used for marl and gravel extraction (Figure 2b). Evidence of these pits is clearly visible on LiDAR (Figure 3). Two ponds lie to the south, the larger of which is known as Hatchet Little Pond, whilst the smaller is unnamed. On the other side of the road lies Hatchet Triangle, a complex of more than 10 ponds which are known to support Great Crested Newts. Above the lake, next to the public convenience, is a large but shallow temporary pond (not marked on Ordnance Survey map) which supports a number of New Forest specialist pond plants.

Figure 1. a) Hatchet Pond photographed from the north-west corner of the pond looking east towards the road and b) close up of the rare pillwort *Pilularia globulifera* in the lake margin

a)

b)

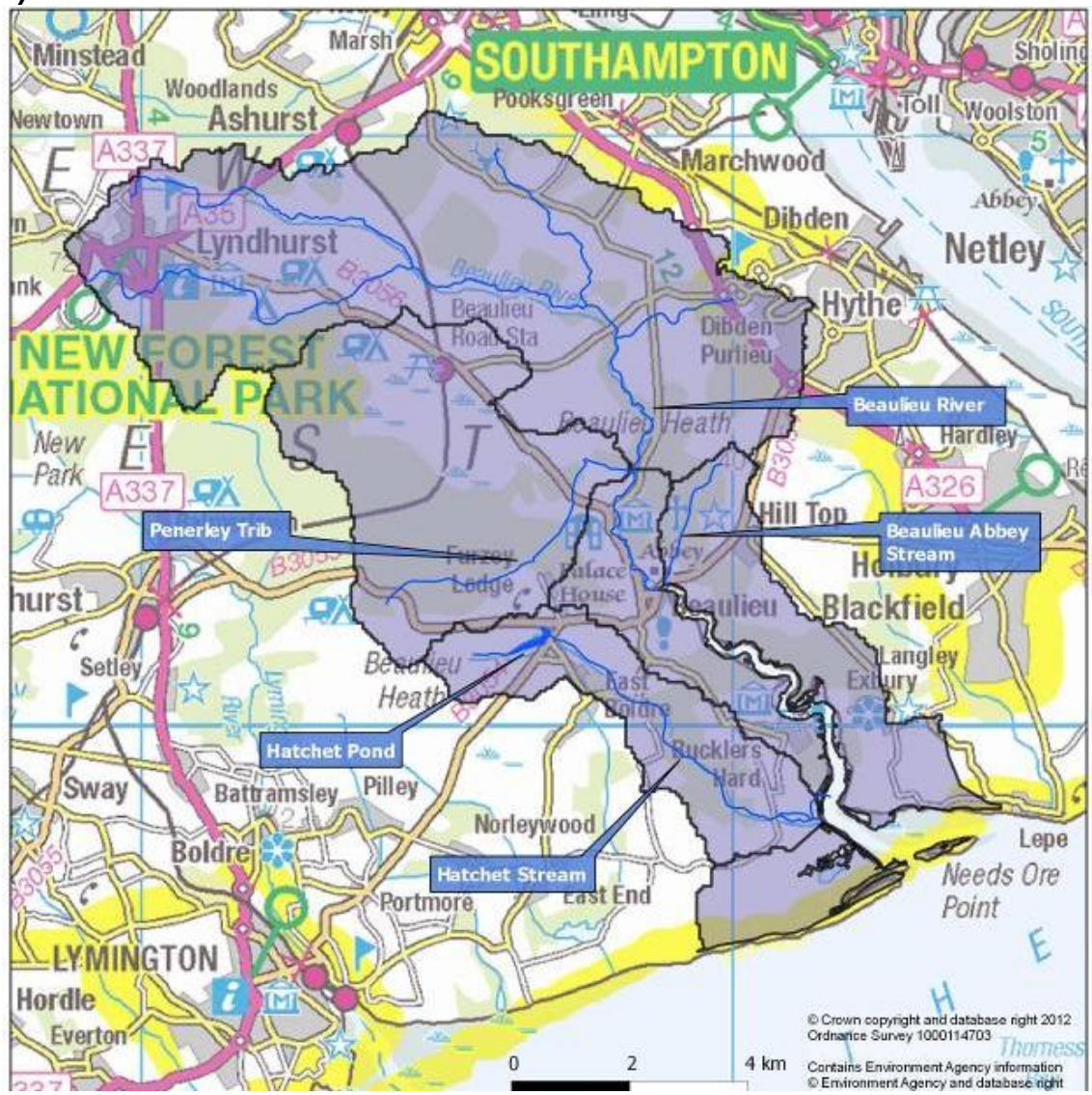
To aid the discussion about Hatchet Pond, we need to be aware of the main types of freshwater found in the New Forest:

- **Lakes**: Bodies of water, both natural and man-made, greater than 2 ha in area (Johnes et al. 1994); includes reservoirs, gravel pits, meres and broads.
- **Ponds**: A body of water, both natural and man-made, between 1 m^2 and 2 ha in area, which may be permanent or seasonal (Collinson et al. 1994).
- **Rivers**: Relatively large lotic waterbodies, created by natural processes. Marked as a double blue line on 1:25,000 OS maps and defined as greater than 8.25 m in width.
- **Streams**: Relatively small lotic waterbodies, created by natural processes. Marked as a single blue line on 1:25,000 OS maps and defined as being less than 8.25 m in width.
- **Ditches**: Man-made channels created primarily for agricultural purposes.

Hatchet Pond is 6.7 ha in size and is therefore a lake by definition, even though it is a pond by name. In this report, all discussion will be based on lake characteristics.

Figure 2. a) Location of Hatchet Stream and pond, a sub-catchment of the Beaulieu River catchment and b) Ordnance Survey 1:25,000 map of Hatchet Pond and surrounding waterbodies, showing the location of Hatchet Mill.

a)



b)

Figure 3. LiDAR (2012) of Hatchet Pond and surrounding area (accessed 10/11/2014 (http://lidar.newforestnpa.gov.uk/lidarzoom.htm))

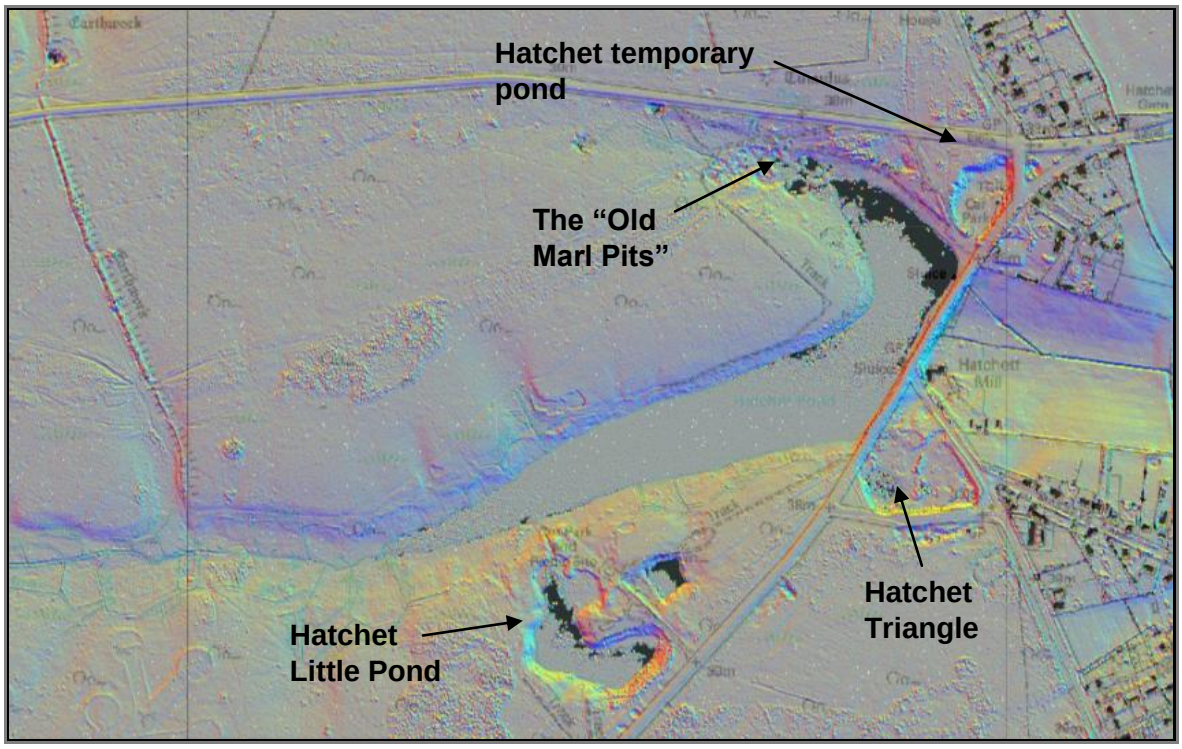
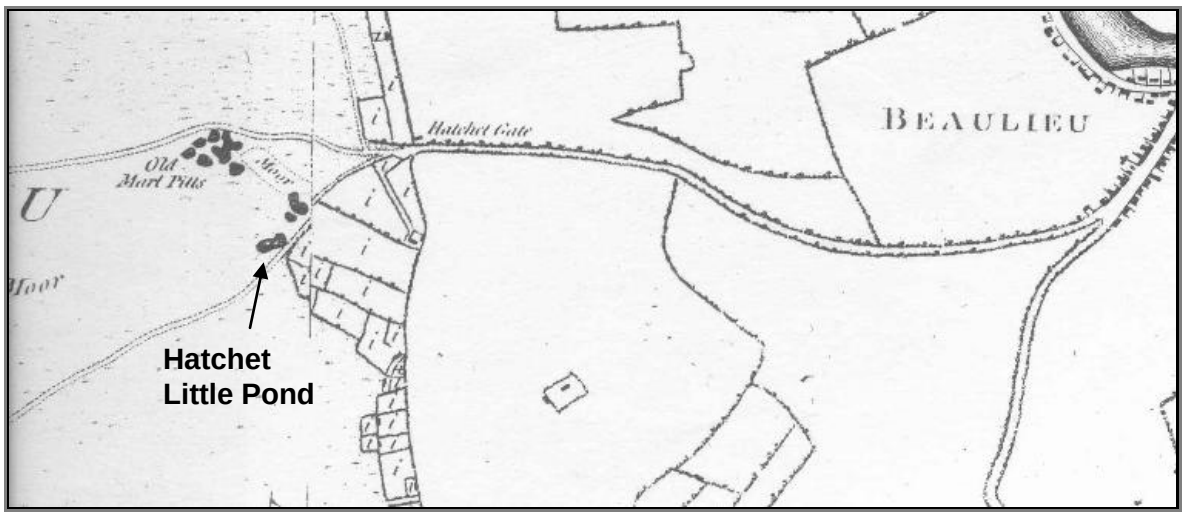


Figure 4. A section of the 1814 Driver's map, from the location which was to become Hatchet Pond. The 1814 map is a revised version of the 1789 map (which was based on a survey of 1787). This section of the map remained the same in both versions (accessed 10/11/2015 (www.newforest.hampshire.org.uk/index.html))



Hatchet Pond itself was created to provide a head of water for Hatchett Mill. The lake first appears on Greenwood's Hampshire 1826 map, not being shown on the earlier Driver's Map of 1789 (which was based on a survey of 1787). The Driver's Map (Figure 4) does show evidence of worked marl pits, referred to as the 'Old Marl Pits', which were partly enveloped by Hatchet Pond at the time of its creation. The map also shows Hatchet Little Pond which remains today.

Further information supplied by the New Forest Museum (Richard Reeves pers. comm. to Naomi Ewald 14 May 2012) more precisely dates the lake's creation. Several witnesses at

the 1801 Encroachment's enquiry refer to [Hatchett] mill which infers that the lake existed at this time. Hatchet Pond is therefore dated with reasonable certainty to between 1787 and 1801, and is thus over 200 years old in an area with pre-existing wetland habitats.

Throughout its history, Hatchet Pond, the headwaters of the Hatchet Stream and adjacent ponds have been located entirely within the Crown Lands; managed today by the Forestry Commission. The extraordinary diversity of freshwater types has been maintained as part of the Forest's dynamic working landscape based on an historic pastoral economy. The stock (mostly cattle and ponies, but also pigs and donkeys) and deer graze extensively over the landscape. This type of management has been lost in favour of more intensive agriculture elsewhere. The longevity and quality of the freshwater habitats sustained by this management is reflected in the number of conservation priority species and habitats found in and around Hatchet Pond (Figure 1b).

2.2 Designations and conservation objectives

Hatchet Pond was first recognised nearly 50 years ago as a nationally important freshwater site in the NCC Nature Conservation Review (Ratcliffe 1977). At this time it was described as a Grade 2[1] mesotrophic standing water (Appendix 1.1) and was one of only 7 National Nature Reserve sites for this habitat type in the South East region.

The New Forest was designated as a Site of Special Scientific Interest (SSSI) in 1971, a Special Area of Conservation (SAC) in 2000 and a National Park in 2005. The SSSI unit for Hatchet Pond contains a range of notified features (amphibians, invertebrates, rare plants, wetland habitats, and pond types) (Appendix 1.2) as well as a range of SAC features (standing waters, wetlands, great crested newts and southern damselfly)[2].

Under the Habitats Directive (Council Directive 92/43/EEC) all species and habitat types covered by the Directive must achieve 'Favourable Conservation Status' (FCS) by maintenance of the species' population or habitat extent at biogeographically natural levels (regional and global scales). Each designated site contributes to the FCS of the qualifying feature as a whole. Targets are set for individual Natura 2000 sites based on the ecological requirements of the species or habitat they support. Common Standards Monitoring (JNCC 2005) is then used to assess condition against these site level conservation objectives.

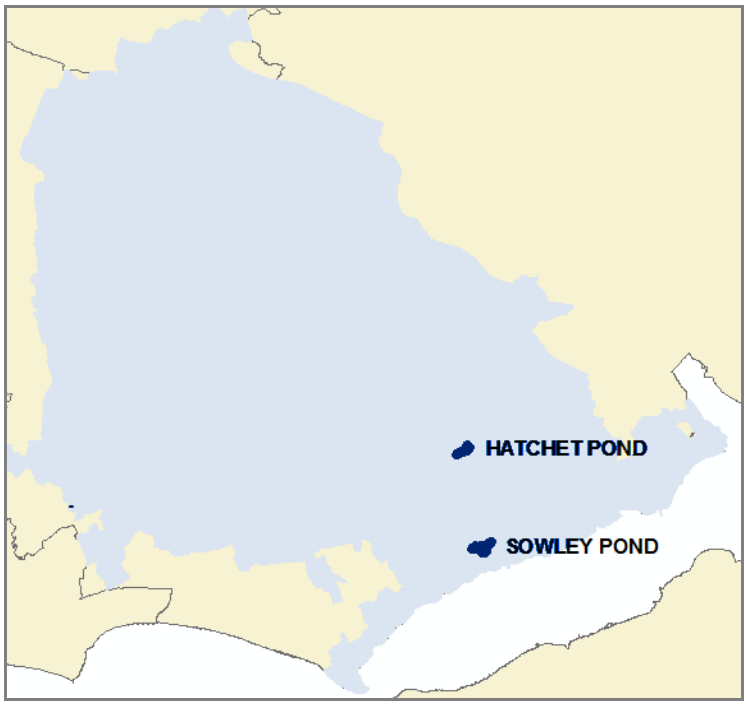
Hatchet Pond is notified for two internationally important pond habitat types listed under Annex 1 of the Habitats Directive (Appendix 1.3) - oligotrophic waters containing very few minerals of sandy plains *Littorelletalia uniflorae* (3110) and oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletalia uniflorae* and/or of the *Isoeto-Nanojuncetea* (3130). It is more representative of the former type (3110) and is therefore monitored against the criteria for an oligotrophic water body. It is likely that both habitat types apply to many ponds within the SAC and not just Hatchet Pond (Neil Sanderson pers. comm. 21/10/2014).

The second complementary legislation applied to Hatchet Pond is the Water Framework Directive (Council Directive 2000/60/EC). This umbrella water management legislation requires member states to achieve good qualitative and quantitative status on all waterbodies. Progress towards this goal is achieved through development and delivery of River Basin Management Plans.

[1] Grade 2 sites are of prime importance to nature conservation but may duplicate features of related Grade 1 sites. Grade 1 sites will be given conservation priority over Grade 2 sites.
[2] It is important to note that the SAC features refer to the unit as a whole and not necessarily habitats or species within Hatchet Pond itself.

There are many standing freshwaters in the New Forest Catchment, but the only two to be identified for monitoring and assessment using Water Framework Directive standards are Hatchet Pond and Sowley Pond (Figure 5). For the Water Framework Directive, the EU directive broadly aims to improve the physical, chemical and biological condition of all freshwaters, with its headline target being to get water bodies to achieve “Good Ecological Status” with no deterioration of status by 2027.

Figure 5. Location of the 2 Water Framework Directive (WFD) waterbodies in the New Forest (Hatchet Pond and Sowley Pond)



2.3 Recreation at Hatchet Pond

Hatchet Pond is an obvious draw for visitors to the New Forest National Park because of the aesthetic of a large area of open water. The site provides public conveniences and there is an ice cream van, all easily accessible from the B3054. This makes Hatchet Pond a popular destination year round, but particularly in the summer.

Regular activities at Hatchet Pond include sitting (inside or outside the car) to admire the view, walking (including dog walking), feeding the wildfowl (the shop at Hatchet Gate sold bird food until it closed), and looking at the ponies and donkeys. There is no swimming at Hatchet Pond, but some people occasionally ride their horses into the water.

Coarse fishing is available at Hatchet Pond and Little Hatchet Pond provided users have a Forestry Commission Fishing Permit and an Environment Agency rod license. Fishermen describe the site as challenging but good. The main draw appears to be the very large (40 lb) Mirror Carp and Bream (for a time the British record for Bream was caught here). Tench are commonplace.

Boating is not permitted on Hatchet Pond (full size or radio control). This activity is restricted to other ponds within the National Park.

3 Description of lake catchment

3.1 Morphometry and substrate

To undertake a review of the status of Hatchet pond, basic information on morphometry (Table 1) and substrate has been compiled.

Table 1. Morphometry of Hatchet Pond

Attribute	
Surface area	6.7 ha
Pond perimeter	1.8 km
Maximum fetch	758 m
Shoreline development index[3]	1.963
Altitude	32 m
Maximum depth	2.7 m
Mean depth	1 m
Drawdown height[4]	50 cm
Catchment area	211.7 ha
Retention time	21.15 days

The geology underlying Hatchet Pond is formed from organic sedimentary material. The Headon Formation is comprised of grey-green clays and sands with a high concentration of fossilised bivalves and gastropods (British Geological Survey 2014). This makes it an ideal source of lime for fertilising nutrient poor acidic soils and explains the concentration of marl pits created in the catchment prior to the creation of Hatchet Pond itself.

The more recent drift geology overlaying the Headon Beds consists of river terrace deposits comprised of silts and gravels. These have also been dug for gravel creating further pits and depressions which have subsequently filled with water.

The thickness of the surface gravel geology is variable so that outcrops of base-rich marl also occur near the surface alongside more freely draining nutrient poor substrate. The varied geology results in a range of conditions across Hatchet Pond, and means that a variety of habitat types are supported.

[3]Shoreline Development Index (SDI) is a measure of the irregularity of the lake outline - lakes with a circular outline score 1, those with a convoluted outline score higher. The most convoluted lake in the UK, Loch Scadabhagh, has an SDI of 8.402 (data sourced from British Lakes (Goodge 2014)).
[4] Drawdown height (cm) is the vertical distance between the maximum winter water line and the average summer water level.

3.2 Inflows and discharges

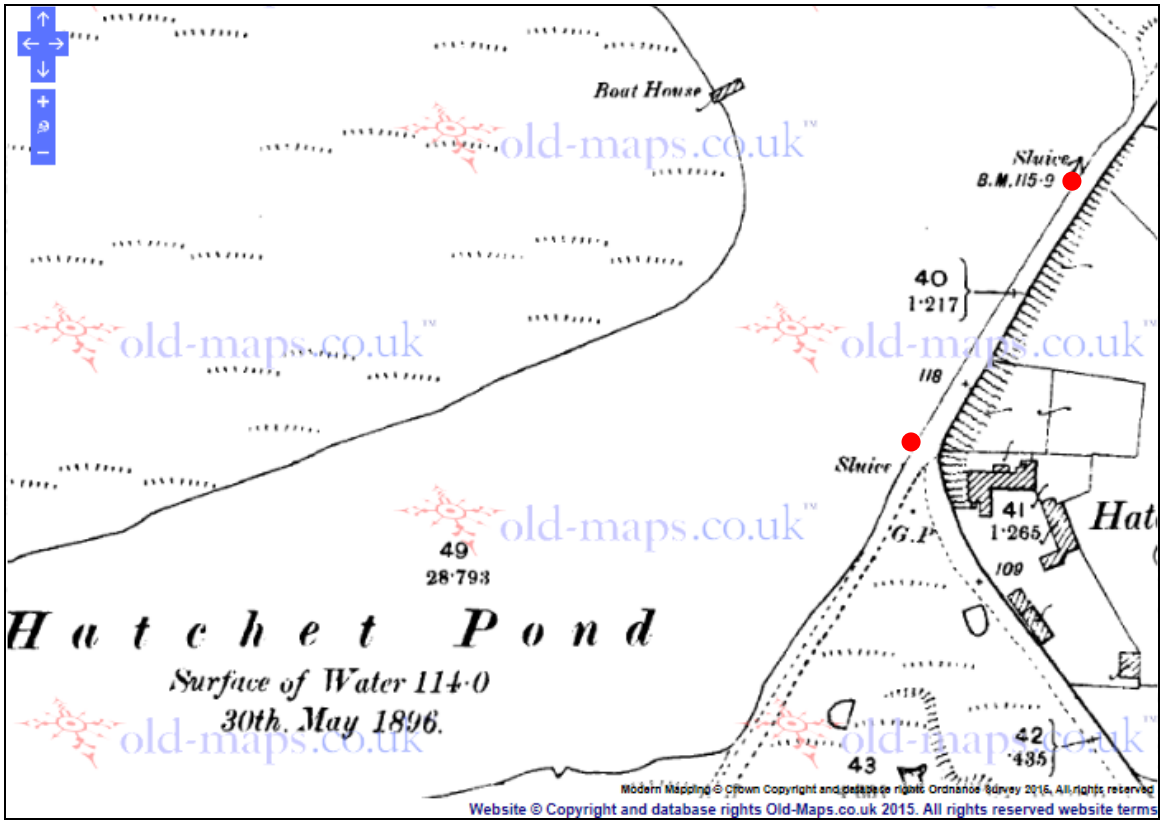
There are two major inflows and multiple smaller seepages which drain into Hatchet Pond. Hatchet Stream flows into the lake from the west, but a smaller less distinct spring also flows into the north east bay of the pond, flowing through the old marl pits.

The lake outflows through the structures created to dam the stream. Map evidence suggests that the pond was created between 1787 and 1801 (see Section 2.1). The maps of this time are not as detailed as later maps and so the exact locations of sluice structures are not shown. However the 1897 1: 2,500 map (Figure 6) clearly shows two structures.

Both structures were still in place according to the OS Plan 1970, but by the 1972-73 plan only one structure was operational; the lower sluice directly opposite Hatchett Mill. This matches anecdotal accounts that at one time the lower sluice was the main discharge from the pond (Forestry Commission pers. comm. 13/10/2014). At some point in the 1970/ 80s, the lower outflow was blocked and the upper sluice opened to control the water level in the pond.

The presence of the sluice and the fact that Hatchet Pond is an artificial waterbody means that it is classified as a Heavily Modified Water Body (HMWB) under the Water Framework Directive[5].

Figure 6. Hatchet Pond OS County Series: Hampshire and Isle of Wight 1897 1: 2,500 showing location of the two outflow sluices (● on map)



[5] HMWB are water bodies which have been modified because of past engineering works. Under the Water Framework Directive these modifications must be removed for the water body to achieve Good Status, *unless* removal of the structure would have a significant adverse effect on the environment or there is no other alternative. If the modification must remain, the water body is designated a Heavily Modified Water Body. Measures must be put in place to make the water body as natural as possible even with the modifications in place, to ensure that the water body achieves Good Potential.

3.3 Catchment habitat type

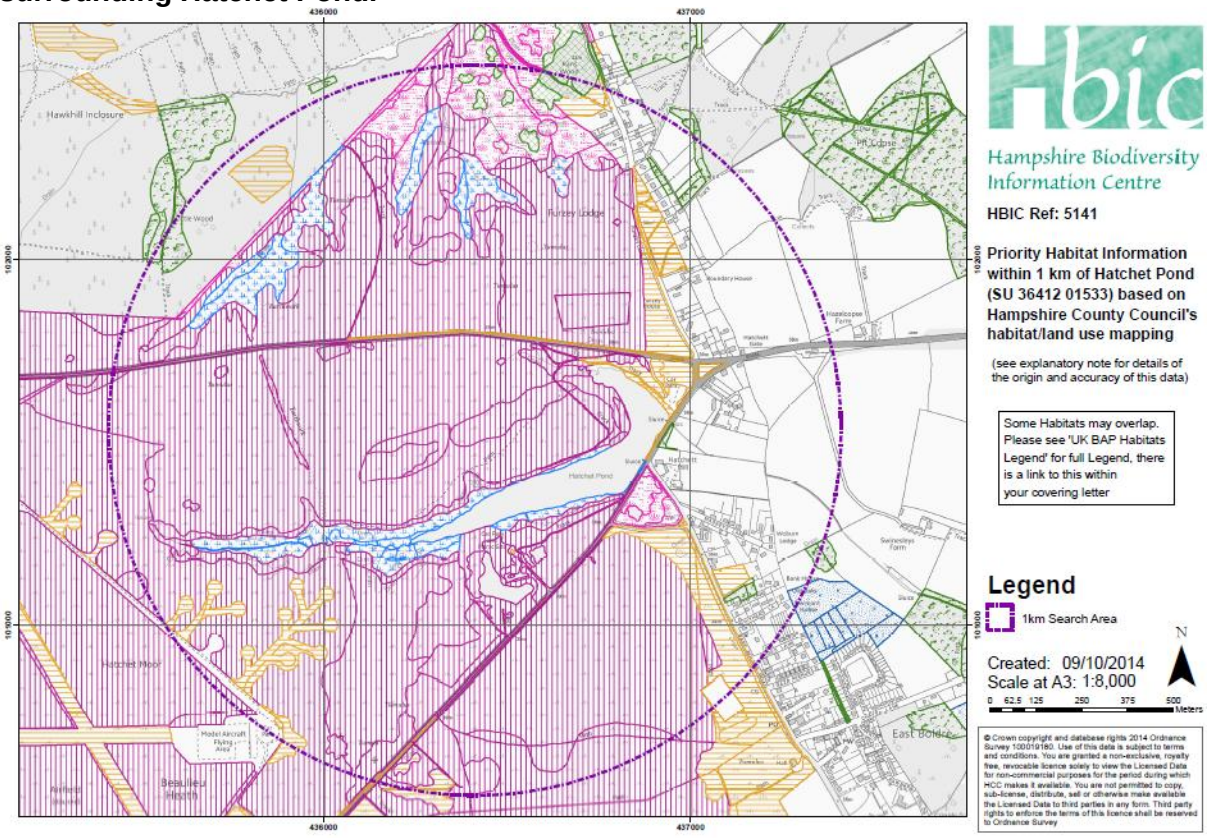
The dominant land cover type surrounding Hatchet Pond is heathland (Figure 7). This is a Priority Habitat under S41 of the UK Post-2010 Biodiversity Framework (data provided by HBIC 2014). Other priority habitats adjacent to the lake include Lowland Dry Acid Grassland and Lowland Fen.

A more detailed assessment of land cover can be made using PSYM (Predictive System of Multimetrics (Pond Action 2002)). PSYM records a number of environmental variables, including the percentage cover of different habitat types within 5 m of the lake margin and within 100 m of the lake margin. Williams et al. (1999) carried out a PSYM survey of Hatchet Pond as part of the National Pond Survey and the same survey was repeated again in 2007 by the author. The results for land cover were broadly similar.

Directly adjacent to the lake margin (within 5m of the lake) unimproved grassland (60%) and heathland (33%) dominate. The proportion of unimproved grassland is greatest along the north-east and southern margins of the lake. Around the inflow for Hatchet Stream a mosaic of bog (1%), fen and mire (5%), and spring (2%) habitats occur amongst the heathland. The U-shaped western margin of the lake, the area around the old marl pits and the lake margin between Hatchet Pond and Hatchet Little Ponds also support areas of coniferous (western lake margin) and deciduous trees and woodland (3%). The pond margin adjacent to the road has been reinforced with hard-standing (3%).

Additional habitats within the wider catchment (within 100m of the lake margin) include the road, houses and gardens, arable and horse pasture, as well as several pond complexes and individual ponds. Within 1 km of Hatchet Pond there are a minimum of 20 individual pond waterbodies (both permanent and temporary).

Figure 7. Priority Habitats under S41 of the UK Post-2010 Biodiversity Framework surrounding Hatchet Pond.



4 Description of lake biology

The description of lake biology includes collated information on a wide range of taxa from a range of different sources without restricting them to a specific time period. The aim of this section is to provide an overview of the species recorded from Hatchet Pond to understand the overall importance of the site for biodiversity based on current and past records. Changes over time are described in Section 6.

In summary, Hatchet Pond has supported very high species richness in each taxonomic group, including species of conservation importance in all groups for which information was available (Table 2).

Table 2. Number of species recorded in each taxonomic group and the presence of species of conservation importance because of restricted range at national or international levels (JNCC 22/08/2014).

Taxa	Number of species	Presence of species of conservation importance
Zooplankton	>20	✔
Wetland plants	133	✔
Macroinvertebrates	99	✔
Fish	8	✔
Birds	85	✔
Mammals	4	✔
Amphibians	5	✔

4.1 Phytoplankton

Diatoms are one of the principle components of the phytoplankton community in freshwater habitats. As the primary producers, their status is important for the health of the lake and as such they are monitored as part of the Water Framework Directive. The composition and biomass of the diatom community is determined by alkalinity, depth and nutrient levels in the lake.

Sediment cores have been taken from Hatchet Pond (Bennion et al. 1997) dating back to 1909 to determine the reference conditions for the phytoplankton community before any adverse affects from anthropogenic pollution. Over 100 taxa were recorded and no single taxa dominated, indicative of a healthy diverse community.

The phytoplankton fauna was comprised of both planktonic and benthic forms, including *Aulacoseira ambigua* and *Cyclotella stelligera* - planktonic taxa commonly observed in mesotrophic waters, and *Fragilaria* spp. and *Achnanthes minutissima* - benthic taxa frequently observed across a range of nutrient levels, but commonly found in shallow, non-acid waters.

4.2 Zooplankton

Zooplankton (cladocerans, copepods, ostracods and rotifers) are a useful indicator of lake quality because they are a central component of the lake's food web. Zooplankton will respond to changes in this phytoplankton food source as well as changes in higher level predators (e.g. fish). However, they are not currently included in assessments for lake quality for the Water Framework Directive (Jeppesen 2011) and as a result there is a paucity of information on the zooplankton in Hatchet Pond.

Some data on ostracods are available from surveys carried out by Pete Henderson between 1983 and 1985. Ostracods are small bivalve crustaceans sometimes called 'seed shrimps'. A total of 17 species have been recorded to date. Of particular conservation interest are two species: *Limnocythere relicta* which is known only from this site in the UK and *Isocypris beauchampi* which is only known from Hatchet Pond and Boulder Mere in Surrey. However, given that this is a relatively unrecorded group in pond surveys, they may be under-recorded rather than rare.

The ostracod community of Hatchet Pond is typical of a southern lowland water body. Ostracods generally prosper in calcium rich alkaline waters and the communities of acid waters, including many ponds in the New Forest, are generally species poor. In contrast, the ostracod community of Hatchet Pond is notably species rich, indicative of a circum-neutral lake.

Ostracods also thrive in water bodies with a broad drawdown zone. The seasonal pattern of wetting and drying and shallow nature of this habitat allows some ostracods to prosper, away from open water where they would be vulnerable to fish predation. This habitat is further enhanced at Hatchet Pond by the action of grazing animals which gently disturb the lake margin and provide a source of nutrients via their dung. In these low nutrient systems, the cycling of nutrients via dung is critical to many species. However, this is a delicate balance which can easily be disrupted by the addition of excess nutrients from other sources.

There is very little information on the cladocera 'water fleas' from Hatchet Pond. Only 3 species have been recorded, all collected in 1984 (Chalkley 2014).

4.3 Wetland plants

Wetland plants are a specific suite of species used in the determination of pond and lake quality. Information for this report was collated from the National Pond Survey (Williams et al. 1999), casual records from the BSBI database (Rand 2014) and Common Standard Monitoring Surveys (Natural England 2003, 2009 & 2011).

A total of 133 wetland plant species have been recorded from Hatchet Pond, including 11 which are classified as important for nature conservation (Table 3). This is more than a third of all wetland plants recorded in the UK.

Presence of Shoreweed *Littorella uniflora* and all 5 other characteristic species (Floating Club-rush *Eleogiton fluitans*, Six-stamened Waterwort *Elatine hexandra*, Pillwort *Pilularia globulifera*, Alternate Water-milfoil *Myriophyllum alterniflorum* and Lesser Marshwort *Apium inundatum*) confirms Hatchet Pond's classification as an H3110 habitat (Oligotrophic waters containing few minerals of sandy plains) under the Habitats Directive.

Analysis of the wetland plant species recorded shows that Hatchet Pond supports communities associated with both low alkalinity water bodies and those associated with moderate alkalinity water bodies (Palmer 1992).

Table 3. Wetland plant species recorded from Hatchet Pond which are classified as important for nature conservation at either national level (Natioanlly Scarce, Nationally Rare, S41) or classified as at risk according to IUCN guidelines (Near Threatened, Vulnerable, Endangered).

Taxa	Highest threat category	S41 species
Baldellia ranunculoides Lesser Water-plantain	Near Threatened	
Cicendia filiformis Yellow Centaury	Vulnerable	✔
Illecebrum verticillatum Coral-necklace	Vulnerable	✔
Lycopodiella inundata Marsh Clubmoss	Endangered	✔
Mentha pulegium Pennyroyal	Endangered	✔
Nitella flexilis Smooth Stonewort	Nationally Scarce	
Nitella mucronata Pointed Stonewort	Nationally Scarce	
Persicaria minor Small Water-pepper	Vulnerable	
Pilularia globulifera Pillwort	Near Threatened	✔
Ranunculus novae-forestae New Forest Water-crowfoot	Nationally Rare	
Rhynchospora fusca Brown Beak-sedge	Nationally Scarce	

Hatchet Pond has very high plant species richness and species rarity compared with other small lakes in the UK. In the National Pond Survey 13 small lakes, all considered to be close to reference condition, were surveyed using PSYM. The average number of species recorded in the lake's survey was 36, but on a single visit at Hatchet pond 58 wetland plant species were recorded. The total number of uncommon species recorded for all lakes in the UK Lakes dataset is 13 (based on cumulative total from 1100 sites) (Biggs et al. 2005). Hatchet Pond supports a total of 11 uncommon species, 87% of the UK total.

On the basis of the wetland plants alone PSYM analysis would classify Hatchet Pond as being in the highest category (Good = PSYM Score ≥ 75%).

4.4 Invertebrates

Several systematic surveys for invertebrates have taken place at Hatchet Pond. This includes a survey by Pond Action for the National Pond Survey (1992), a survey of the marl pit section of the lake by Freshwater Habitats Trust (2013) and two surveys by the Environment Agency (2004 and 2006).

Other casual records were collected from data held by the Aquatic Coleoptera Conservation Trust (Foster 2014), data held by HBIC (2014), a survey of terrestrial beetles (Salmon 1999) on behalf of the Forestry Commission, personal records held by Naomi Ewald and surveys for medicinal leech *Hirudo medicinalis* (Reeves 1999, 2000).

In total, 99 species of freshwater macroinvertebrate (excluding Diptera) have been recorded from Hatchet Pond, including 8 species of conservation importance (Figure 4). In addition Hatchet Stream and the ditches which feed into the pond support two dragonflies of

particular conservation interest – Southern Damselfly *Coenagrion mercuriale* (IUCN Near Threatened, a Priority Species of the New Forest SAC and a S41 species) and the nationally scarce Small Red Damselfly *Ceriagrion tenellum*. Neither of these species has been recorded breeding in the pond itself.

Table 4. Invertebrate species recorded from Hatchet Pond which are classified as important for nature conservation at either national level (Natioanlly Scarce), or classified as at risk according to IUCN guidelines (Near Threatened, Endangered).

Taxa	Highest threat category
Water Beetles and Weevils	
Bagous brevis	Endangered
Dryops striatellus	Nationally Scarce
Graptodytes flavipes	Near Threatened
Helochares punctatus	Nationally Scarce
Hydrovatus clypealis	Nationally Scarce
Longitarsus nigerrimus	Endangered
Paracymus scutellaris	Nationally Scarce
Leeches	
Hirudo medicinalis Medicinal Leech	Near Threatened

Comparison between lakes surveyed by Pond Action in 1992 revealed that Hatchet Pond was the 3rd most species-rich in summer samples (58 species) of the 13 small lakes surveyed, exceeded only by Upton Broad (the best remaining, least polluted, Norfolk Broad) and the '10 Acre Lake' on Westhay Moor in the heart of the Somerset Levels. For comparison, the richest site amongst ponds in the 1998 survey was Castor Hanglands ('Britain's best pond') which had 73 species in the summer survey.

The high invertebrate species richness and high species rarity is explained by a number of factors – clean unpolluted water, a history of traditional low intensity management, the wetland history of the area and also the variety of habitat types within the lake. This is reflected in the different requirements of the species recorded, from those needing bare mineral substrates to those requiring emergent and submerged stands of vegetation; and the combination of calcium needing species, like snails, and acid water species.

4.5 Fish

Data on fish species at Hatchet Pond are based on a survey carried out on behalf of Natural England (Giles 2002). A total of 8 species were recorded; Northern Pike *Esox lucius*, European Perch *Perca fluviatilis*, Common Roach *Rutilus rutilus*, Eurasian Ruffe *Gymnocephalus cernua*, Common Bream *Abramis brama*, Tench *Tinca tinca*, Common Carp *Cyprinus carpio*, Mirror Carp *Cyprinus carpio carpio* and European Eel *Anguilla anguilla*. Some have been introduced to the lake (e.g. both carp, Bream and Ruffe) whilst other species such as Common Eel are a natural component of the lake habitat. Common Eel are also included on S41 of the post-2010 Biodiversity Framework because of severe declines in the numbers of spawning migrants.

4.6 Other animals

Records supplied by HBIC for Hatchet Pond for birds, mammals and amphibians are not based on systematic surveys of Hatchet Pond and so cannot be used in an analysis of pond quality.

In summary, 123 bird species have been recorded within the 1 km radius of Hatchet Pond, 85 species from the lake itself. This includes several species of conservation importance for which the New Forest is designated a Special Protection Area under the Conservation of Habitats and Species Regulations 2010.

No confirmed records were found for water vole or otter at Hatchet Pond, but 4 species of bat are regularly recorded feeding here – Daubenton's Bat *Myotis daubentonii*, Common Pipistrelle *Pipistrellus pipistrellus*, Soprano Pipistrelle *Pipistrellus pygmaeus* and Brown Long-eared Bat *Plecotus auritus*.

All three species of newt (Great Crested Newt *Triturus cristatus*, Smooth Newt *Lissotriton vulgaris* and Palmate Newt *Lissotriton helveticus*) have been recorded from Hatchet Pond, along with Common Frog *Rana temporaria*, Common Toad *Bufo bufo* and Grass Snake *Natrix natrix*. Great Crested Newts are a qualifying feature of the New Forest SAC and Common Toads are included on S41 of the post-2010 Biodiversity Framework.

Although Great Crested Newts have been recorded from the marl pit end of Hatchet Pond, they do not appear to be regular breeders here, favouring the ponds in Hatchet Triangle over the other side of the road from Hatchet Pond.

5 Current status under statutory monitoring criteria

5.1 Determining lake type and threshold limits

In this section we set out the parameters by which the status of Hatchet Pond is assessed. This is not straight forward, as different limits are applied depending on which statutory monitoring is taking place and how the lake is described. The description of Hatchet Pond has changed as more information has become available, and at the same time the limits have been revised to bring the UK in line with other European countries.

Water Framework Directive

To fulfil the requirements of the Water Framework Directive, the Environment Agency must monitor a representative network of different water bodies across England to report on the overall status of freshwaters in England. The lakes are subdivided into different types based on the annual mean alkalinity range, the average depth of the lake and whether the lake would naturally support populations of salmonid fish.

When the Water Framework Directive came into force water bodies were assigned to type on the best available information. At this time Hatchet Pond was classified as a very shallow, moderate alkalinity (mesotrophic) lake.

Salmonid type: Cyprinid
Geological category: Moderate alkalinity (200 – 1000 µeq/l)
Depth category: Very shallow (<3 m)

Based on this typology, to achieve Good Ecological Potential[6], the limits specified in Table 5 were applied (Defra 2010)[7].

Table 5. Water quality standards for moderate alkalinity, very shallow freshwater lakes under the Water Framework Directive

	High	Good	Moderate	Poor
Dissolved oxygen mean in Jul - Aug (mg/l)	8	6	4	1
Acid neutralising capacity annual mean (µeq/l)	>40	>20		
Total phosphorus (µg/l)[8]	23	34	68	135
Salinity (µS)		1000		

[6] The requirement under Water Framework Directive is for Heavily Modified Water Body to reach good ecological potential. High Status for water quality is considered to be the reference condition for Hatchet Pond. The Water Framework Directive requires all water bodies to achieve at least Good Status and for there to be no deterioration of water bodies already at High Status.
[7] A review of the phosphorus standards for rivers has just been completed (UK Technical Advisory Group (2013). Originally this review was to cover both lake and river standards, but because of delays in the inter-calibration process lakes will be reviewed at a later date (UK Technical Advisory Group 2012).
[8] Total phosphorus standards are calculated for each site based on site specific characteristics.

Water chemistry elements

In 2014, the type of lake to which Hatchet Pond had been assigned was updated on the basis of better data. Hatchet Pond was reclassified as a very shallow, low alkalinity (oligotrophic) lake (Natural England 2014).

Salmonid type: Cyprinid
Geological category: Low alkalinity (<200 µeq/l)
Depth category: Very shallow (<3 m)

Based on this typology, to achieve Good Ecological Potential for water quality under the Water Framework Directive, the limits specified in Table 6 apply.

Table 6. Water quality standards for low alkalinity, very shallow freshwater lakes under the Water Framework Directive

	High	Good	Moderate	Poor
Dissolved oxygen mean in Jul - Aug (mg/l)	8	6	4	1
Acid neutralising capacity annual mean (µeq/l)	>40	>20		
Total phosphorus (µg/l)	17	23	34	68
Salinity (µS)		1000		

Lakes must also be free from specific pollutants, including ammonia (Defra 2010).

Biological elements

Biological elements are also assessed under the Water Framework Directive. This includes: phytoplankton (chlorophyll a, plankton trophic index (PTI) and Cyanobacteria bio-volume), phytobenthos (diatoms), invertebrates (CPET Chironomid pupal exuviae) and macrophytes (wetland plants).

Biological elements are assessed depending on how far the observed scores deviate from reference conditions. This ratio of the observed to the expected score is the Ecological Quality Ratio (EQR). Water bodies achieving reference condition achieve an EQR = 1 (High Status) those at the other end of the scale deviating entirely from reference condition have an EQR = 0.

The limits for the biological elements at Hatchet Pond were based on it being a moderate alkalinity lake. As a low alkalinity lake more stringent limits would apply for some biological elements. In addition, the biological limits have recently been revised for lakes (Defra 2014) and more stringent limits have been applied to all lake types.

Site specific biological targets for Hatchet Pond have yet to be agreed between Natural England and the Environment Agency (Natural England pers. comm. 2014), in the absence of site specific targets the updated thresholds should apply (Table 7).

Table 7. Biological standards for low alkalinity, very shallow freshwater lakes under the Water Framework Directive

EQR	High	Good	Moderate	Poor
Phytoplankton (Chlorophyll a)	0.63	0.30	0.15	0.05
Phytoplankton (Plankton Trophic Index)	0.68	0.53	0.31	0.16
Phytoplankton (Cyanobacteria biomass)	0.47	0.32	0.23	0.13
Phytobenthos (Diatoms)	0.92	0.70	0.46	-
Invertebrates (Chironomid pupal exuviae)	0.77	0.64	0.49	0.36
Macrophytes (Wetland plants)	0.80	0.60	0.40	0.20

Water levels and morphology

Lakes are assessed for changes in water level. The daily maximum reduction must be less than 1% for 99% of the days per year to achieve High Status and no more than 5% to achieve Good Status (Defra 2014).

Under the Water Framework Directive if the water body is a Heavily Modified Water Body, mitigation measures must be put in place to make the water body as natural as possible even with the modifications, to ensure that the water body achieves Good Potential.

Overall status

Classification of each of the elements under the Water Framework Directive means that if one element fails to achieve Good Status the lake is classified as having Moderate Status. The Water Framework Directive requires all water bodies to achieve at least Good Status, but there is also a requirement for no deterioration of water bodies already at High Status (at reference condition).

Defining the lake type under the Water Framework Directive

So, is Hatchet Pond a low alkalinity or moderate alkalinity lake? Lakes with low alkalinity (oligotrophic) under the Water Framework Directive are classified as having an annual mean alkalinity less than 200 µeq/l and or conductivity less than or equal to 70 µS. Lakes with moderate alkalinity (mesotrophic) are classified as having an annual mean alkalinity between 200 and 1000 µeq/l and or conductivity between 70 and 250 µS.

Hatchet Pond is actually on the boundary between the Water Framework Directive classification of low alkalinity and moderate alkalinity. Water Framework Directive monitoring of annual mean alkalinity (Grans Plot) at Hatchet Pond between 2006 and 2014 was between 165 µeq/l and 201 µeq/l.

Where there is insufficient data to categorise the lake using alkalinity, conductivity can be used to assign the lake to a water body type (Defra 2010). Hatchet Pond has conductivity between 85 µS and 159 µS (1979 to 1983). This would suggest a mesotrophic lake type.

Classification of Hatchet Pond based on plants has categorised the lake as supporting both mesotrophic (Palmer and Roy 2001; Ratcliffe (1977) and oligotrophic (Bennion et al. 1997) communities.

Guidance (JNCC 2005) states that more stringent targets should *always* be applied to ensure that there is no deterioration from current status where concentrations are consistently below target thresholds. This is a strong argument for adoption of the more stringent targets for this lake, accepting that because Hatchet Pond has some oligotrophic characteristics these are the limits against which the lake's status should be assessed.

Habitats Directive

Favourable Status

Hatchet Pond is also described by its classification under the Habitats Directive as an H3110 habitat - oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*). SAC features are monitored and assessed using Common Standards Monitoring. To achieve Favourable Conservation Status as an H3110 habitat the following targets must be met:

- No decline in the abundance of plant species characteristic of the H3110 habitat
- No loss of characteristic plant species
- Characteristic plant species present in at least 60% of survey plots
- Negative plant species absent or at low frequency
- No invasive non-native species
- Cover of benthic and epiphytic filamentous algae less than 10%
- Characteristic vegetation zones present
- Vegetation present from shallow to deep water
- Vegetation structure maintained between surveys
- Total phosphorus below 10 µg/l
- Dissolved oxygen greater than 5 mg/l
- Stable pH between pH 5.5 and pH 7
- No excessive growth of cyanobacteria or green algae
- Natural shoreline maintained
- Natural hydrological regime maintained

Overlap between the Water Framework Directive and Habitats Directive

The Water Framework Directive was not designed as a tool to undertake detailed monitoring of individual water bodies. Its purpose was to report on the number of waterbodies achieving at least Good Status at a national level in each reporting round.

Common Standards Monitoring under the Habitats Directive is more specific to each waterbody and is likely to place stricter limits due to the presence of protected species or habitat types. If water bodies achieve the limits specified by the Habitats Directive then the limits for the Water Framework Directive should be bought in line with the stricter limits to prevent deterioration of status.

Guidance (JNCC 2005) recognises that SAC habitat types are based on broad macrophyte classes, and may occur across a range of chemistry conditions. Some water bodies may never meet the limits specified in the Habitats Directive, even under reference conditions.

Reconstructed nutrient data going back to 1900 (Bennion 1997) shows that total phosphorus has never been below 10 µg/l at Hatchet Pond. In this case the lake must at least achieve High Status under the Water Framework Directive to ensure it remains at reference condition.

5.2 Current status for water chemistry

In summary Hatchet Pond passes all metrics at High Status except for total phosphorous and pH.

Dissolved oxygen

The dissolved oxygen profile for Hatchet Pond in 2011 was 8.93 mg/l, with more than adequate levels for the health of characteristic animals and Cyprinid fish.

Acid Neutralising Capacity

This describes the ability of water to withstand acidification e.g. from atmospheric deposition. Acid neutralising capacity at Hatchet Pond was greater than 40 µeq/l in 2014; above the threshold for High status.

Phosphorus

Annual mean total phosphorus for Hatchet Pond in 2013 was 17.1 µg/l. Under the Water Framework Directive the lake is classified as having Good Status. Hatchet Pond has only achieved High Status once in the last 10 years (2012).

In 2014 the pond had deteriorated and mean total phosphorous had increased to 26.4 µg/l (Moderate Status). Data for 2014 were incomplete, as the final 3 months (October, November and December) have yet to be submitted, so 2013 data may be more reliable.

Salinity

The threshold for salinity is 1000 µS. Hatchet Pond was well below this in 2014 (128 µS) and therefore passes High Status.

Nitrogen

Limits for nitrogen are not specified under the Water Framework Directive (JNCC 2005). As in many fresh waters, eutrophication was traditionally thought to be driven by phosphorous loading. However, in some situations nitrogen can be the driving factor. Common Standards Monitoring sets nitrogen limits for some lake types but no limit has been specifically set for Hatchet Pond.

In unimpacted waterbodies total nitrogen is expected to be below 1 mg/l (Biggs et al 2014). In 2014, total nitrogen in Hatchet Pond in was below this threshold (0.66 mg/l).

pH

We have no current records for pH from the Environment Agency's monitoring of Hatchet Pond. Data from 2005-2006 fail to meet the condition assessment target set for H3110 habitat. Oligotrophic water with few minerals must have stable pH values pH ~5.5 (to a maximum of pH 7). pH at Hatchet Pond in 2005 and 2006 was consistently over pH 7 (pH 7.66 and pH 7.18 respectively).

Specific pollutants

Hatchet Pond has been classified as good for all pollutants given standards under the Water Framework Directive (Defra 2010).

Levels of total ammonia were less than 0.1 mg/l in all samples collected up to 2007. Limits under the Water Framework Directive (Defra 2010) begin at 0.2 mg/l for low nutrient, very shallow lakes. Recent data, post 2007, were not available from the Environment Agency, but data from Freshwater Habitats Trust collected in 2013 confirm that total ammonia is still below 0.1 mg/l.

5.3 Current status for biological elements

In summary, assessment of Hatchet Pond using Water Framework Directive metrics indicates that the lake does not currently achieve High Status for any of the biological elements.

Phytoplankton

Phytoplankton are assessed as part of the Water Framework Directive because they describe the condition of the lake in relation to the primary producers. The health of the community is assessed using three different measures:

- **Phytoplankton abundance:** measured using Chlorophyll a, as a proxy for phytoplankton biomass.
- **Phytoplankton species composition:** assessed using a Planktonic Trophic Index (TDI). This is calculated based on the taxa recorded; the scores dependent on the sensitivity of species to nutrients.
- **Bloom intensity:** assessed using the biovolume of cyanobacteria.

The results of each measure are compared with actual or predicted reference conditions for the lake and the resulting Ecological Quality Ratio (EQR) provides a measure of the ecological status (Bennion et al. 2012).

The results available from the Environment Agency (2006-08) show Hatchet Pond was at Good but not High Status for Chlorophyll a (average EQR = 0.33). However, more recent data suggest that the lake may now be Moderate Status for Chlorophyll a (average EQR (2009-12) = 0.26).

Phytoplankton species composition assessed using Planktonic Trophic Index (PTI) which scores species along a eutrophication gradient, classified Hatchet Pond as Moderate Status (EQR=0.51 in 2004 (Sniffer 2006)).

There are no data to suggest that cyanobacteria are an issue at Hatchet Pond.

Phytobenthos

The phytobenthos include a range of algae attached to submerged surfaces (rocks and plants). Under the Water Framework Directive, the health of the phytobenthos is assessed by measuring the diatom community. The health of the diatom community is closely related to levels of nutrients in lakes.

As with the phytoplankton, diatom abundance is compared with actual or predicted reference conditions for the lake to provide an Ecological Quality Ratio (EQR). A decline in the EQR

indicates that nutrient levels are increasing resulting in changes to the diatom community. At high nutrient levels the phytobenthos may become covered in bacterial tufts.

Current data on diatoms collected for Water Framework Directive for Hatchet Pond are missing, although summary information from the Environment Agency states that Hatchet Pond is at Good but not High Status (no scores available).

Data from published sources show that in 2003/ 04 Hatchet Pond had an EQR of 0.81. As a low alkalinity lake, Hatchet Pond would be classified as being at Good, but not High Status (Sniffer 2006).

Common Standards Monitoring of the lake in 2011 reported less than 10% benthic and epiphytic algae overall, but there were concerns over the abundance of algae in the two sections on the western shore of the lake.

Further photographic evidence from the Environment Agency (Figure 9a) appears to show a small, nutrient rich bloom along the south eastern shore (2009). This was also present in 2014 (pers. obs.). During a site visit to Hatchet Pond by Natural England (Madgwick 2013) more evidence of a decline in the phytobenthos community was evident. In some areas of the lake there was a heavy periphyton burden (Figure 9b).

Figure 9: Nutrient enrichment signals from Hatchet Pond a) nutrient rich wave wash on the lake margin - July 2008 (Analysis and Reporting Team, Environment Agency) and b) periphyton burden on submerged plant species - July 2013 (Freshwater Specialist Team, Natural England).

a) **b)**

Wetland plants (macrophytes)

The most up-to-date wetland plant assessment is based on a survey from 2011. Under the Water Framework Directive, the pond is considered to be at Good Status. However, to achieve Favourable Conservation Status as an H3110 habitat the following more stringent targets must be met:

- **No decline in the abundance of species characteristic of the H3110 habitat** - in 2009 shoreweed *Littorella uniflora,* Six-stamened Waterwort *Elatine hexandra* and Alternate Water-milfoil *Myriophyllum alterniflorum* were all at low abundance.
- **No loss of characteristic species** - in 2011 Pillwort *Pilularia globulifera* was absent, although this was recorded in 2009 and refound in 2013.
- **Characteristic species present in at least 60% survey plots** – only 22% of survey plots contained a characteristic species in 2011.
- **No invasive non-native species** – both New Zealand Pigmyweed *Crassula helmsii* and Nuttall's Waterweed *Elodea nuttallii* were recorded in the lake.
- **Characteristic vegetation zones present from shallow to deep water** – although zonation was not evident at Hatchet Pond this is typical for this site. However, species which had previously grown at depth were now restricted to the shallow margins <25 cm deep.

Under the wetland plant metrics used to assess conservation status, Hatchet Pond currently fails to meets the standards required for favourable condition.

Invertebrates

Littoral invertebrates were last analysed in 2006. Condition under the Water Framework Directive was assessed as passing. However, in this survey only 10 macroinvertebrate species were recorded. In 2004, double this number of species was recorded, but this is still less than half the number of species recorded in the 1998 survey (Pond Action 1998).

Uncertainty in the quality of recent data means that a reliable estimate of pond quality for invertebrates cannot be made. This highlights the need for a systematic survey of macroinvertebrates in the near future, which could be achieved with a repeat PSYM survey making it comparable to data collected in 1998.

Chironomid pupal exuviae (CPET) are the shed skins of non-biting midges, left behind on the lake surface when adults emerge. They are used as an assessment of the biological status of lakes for the Water Framework Directive because, by volume, they make up the largest component of the freshwater invertebrate community. They are also sensitive to changes in the lake habitat and to increasing nutrients.

Analyses of CPET samples in 2004/ 05 recorded EQR = 0.60. The CPET classification boundary value for Good Status EQR = 0.64. Hatchet Pond was therefore classified as having Moderate Status. These data were not collected according to the sampling protocol and at the time doubt was cast on how reliable they were. However, in light of other issues recorded at the lake more recently, the low CPET score in 2004/05 may have been one of the first signals of biological degradation.

5.4 Current status for physical status and function

Water levels

Hatchet Pond is an artificial waterbody created and maintained by a fixed sluice at the pond outlet which controls water levels. Under the Water Framework Directive the pond is classified as a Heavily Modified Water Body (HMWB). The pond is currently favourable with regard to water levels.

There is an outstanding issue with the passage of Common Eels upstream through the sluice into Hatchet Pond. The structures which retain water in Hatchet Pond may be preventing recruitment of new eel stocks into the lake. Common Eel are a species of high conservation importance in their own right and the Environment Agency are taking steps to improve connectivity through mitigation measures (Environment Agency 2014).

Mitigation measures are used to ensure that the lake function is maintained whilst ensuring that all possible measures are taken to maintain as natural a function as possible. If all other biological and chemical factors were at high status, installation of an eel passage would ensure that the pond achieved ‘Good Potential’ as a heavily modified water body.

Natural shoreline maintained

Poaching the shoreline by horses and cattle is essential to the maintenance of the H3110 habitat. However, in the 2009 Common Standards Monitoring survey, high disturbance from anglers and walkers was identified, and as such the pond was considered to be in unfavourable status.

6 Trends in water quality and biology

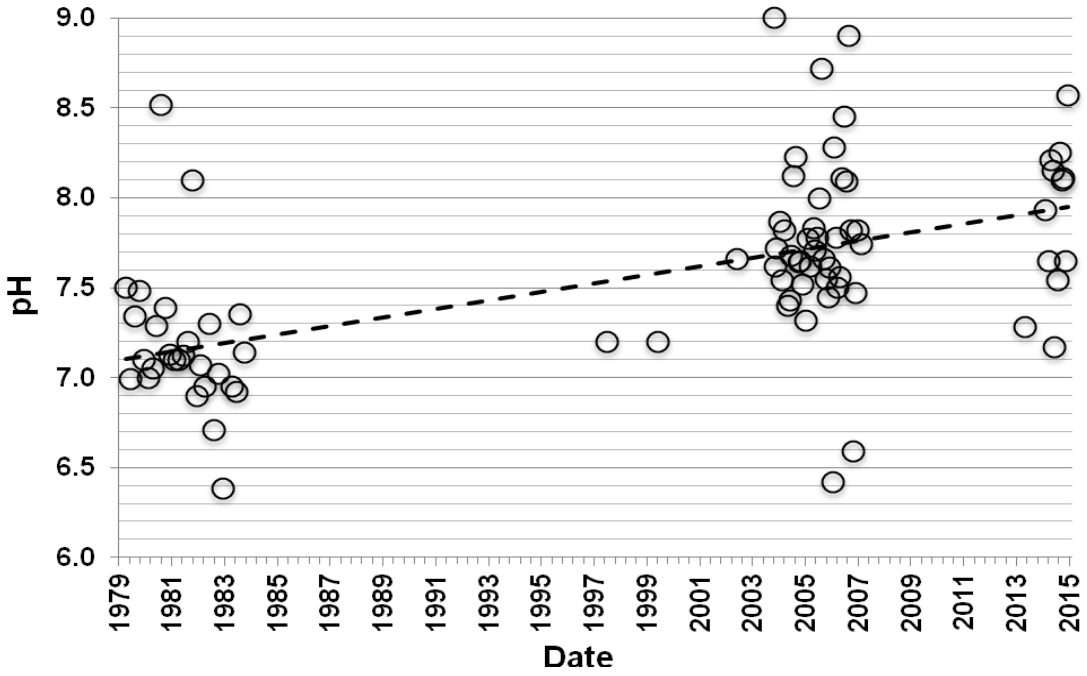
Data were collated from a wide range of sources to determine whether there were changes in water chemistry or biology. Data were only analysed together where comparable methods had been used.

We used Mann-Kendall analysis (Hirsch & Slack 1984) in Time Trends (Jowett 2012) to test for significant trends over time, taking account of auto-correlation between samples.

6.1 pH

Collation of available data at Hatchet Pond from 1979 until 2014 shows a ***significant increase*** in pH (Figure 10). On average pH has increased by 0.86 pH units over a 35 year period (R^2=0.290, Z=13.38, p<0.001).

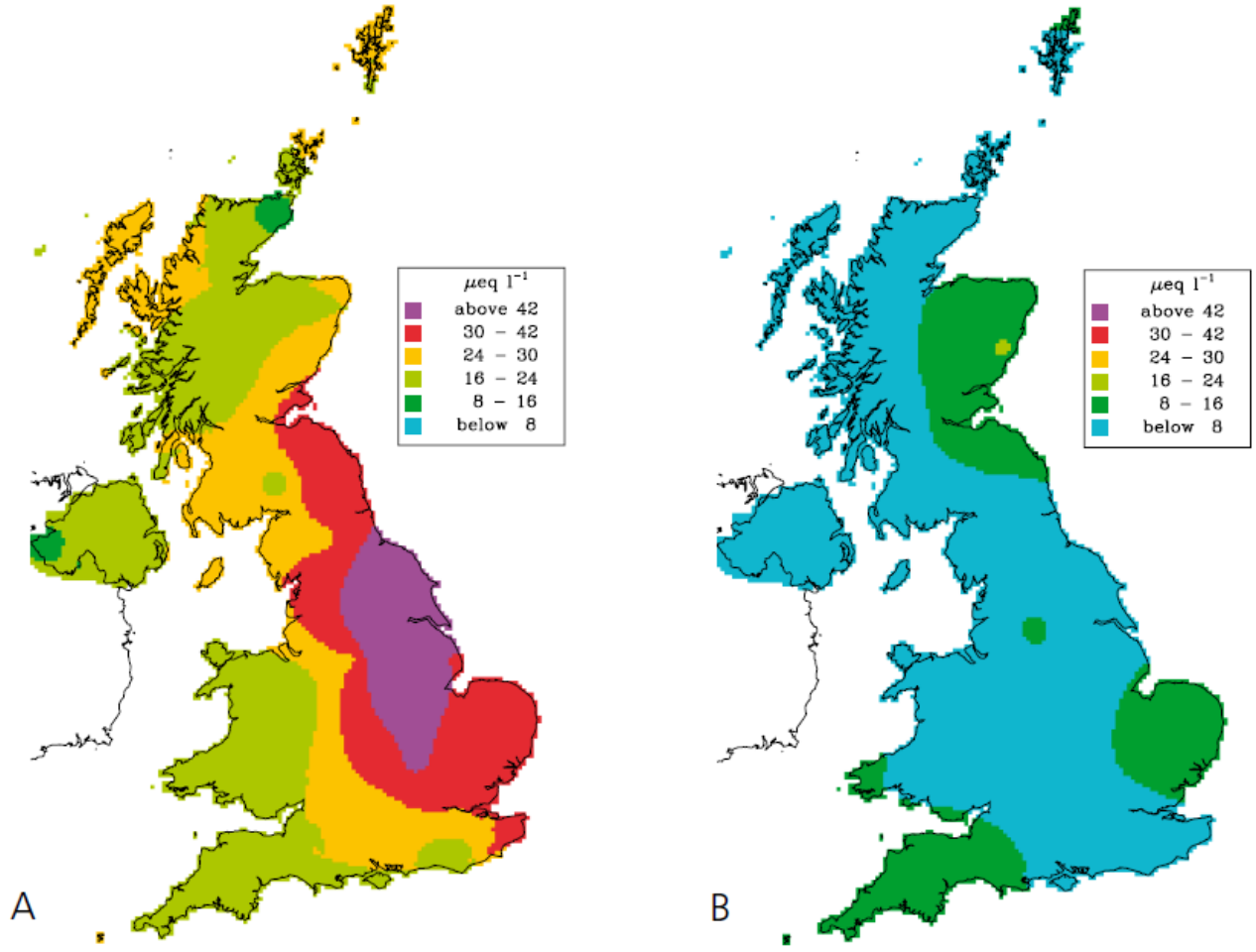
Figure 10: Change in pH at Hatchet Pond (intermittent data collated over a 35 year period)



Change in pH could reflect recovery following reduction of deposition from atmospheric pollutants (Figure 11). Sulphur emissions have decreased to less than 6% of those released in the 1970s and as a result deposition has decreased by 80% between 1986 and 2006. Nitrogen oxide emissions, the other major contributor to acidification of freshwaters, have also decreased, although deposition has declined by only 22%. In response, the UK's soils and freshwaters are now showing a corresponding recovery from acidification (RoTAP 2012).

Although Hatchet Pond is not one of the individual waterbodies included in the Acid Waters Monitoring Network, it is one of 1,752 acid-sensitive waters sampled for critical loads mapping (Curtis & Simpson 2004). Modelling indicates that freshwaters in the New Forest have had considerable critical load exceedance in the past and continue to do so, but to a lesser extent today (based on a threshold limit of 20 µeq/l Acid Neutralising Capacity).

Figure 11. Spatial distribution of precipitation acidity (µeq H^+/ l) in (a) 1986 and (b) 2008 (RoTAP 2012).



Changes in pH can exacerbate eutrophication particularly in low nutrient, low pH environments; increasing the solubility of phosphorus and other nutrients, making it more available for plant growth (Czuba et al. 2011).

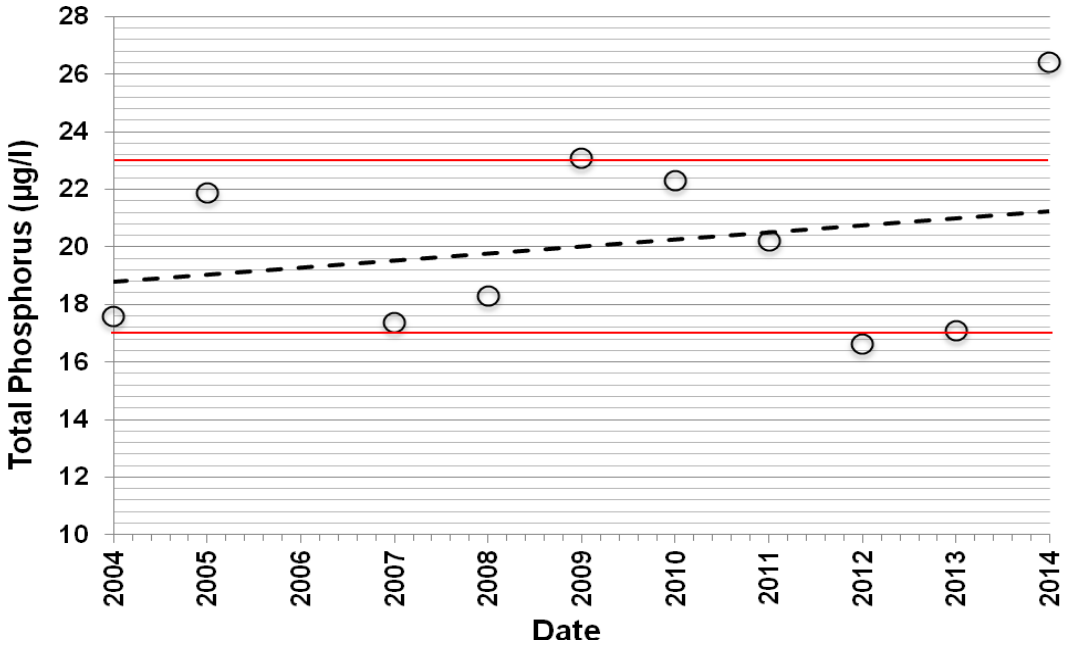
There may also be secondary consequences. The spawning success of introduced fish in Hatchet Pond - Common Carp and Bream is thought to be partly limited by low pH (Giles 2002). Increasing pH leading to successful breeding would have serious negative consequences for the recovery of Hatchet Pond.

6.2 Total Phosphorus

Phosphorus can be measured in a number of different ways. Total phosphorus is used to assess the condition of lakes. It includes both the total dissolved and the particulate phosphorus in the water sample.

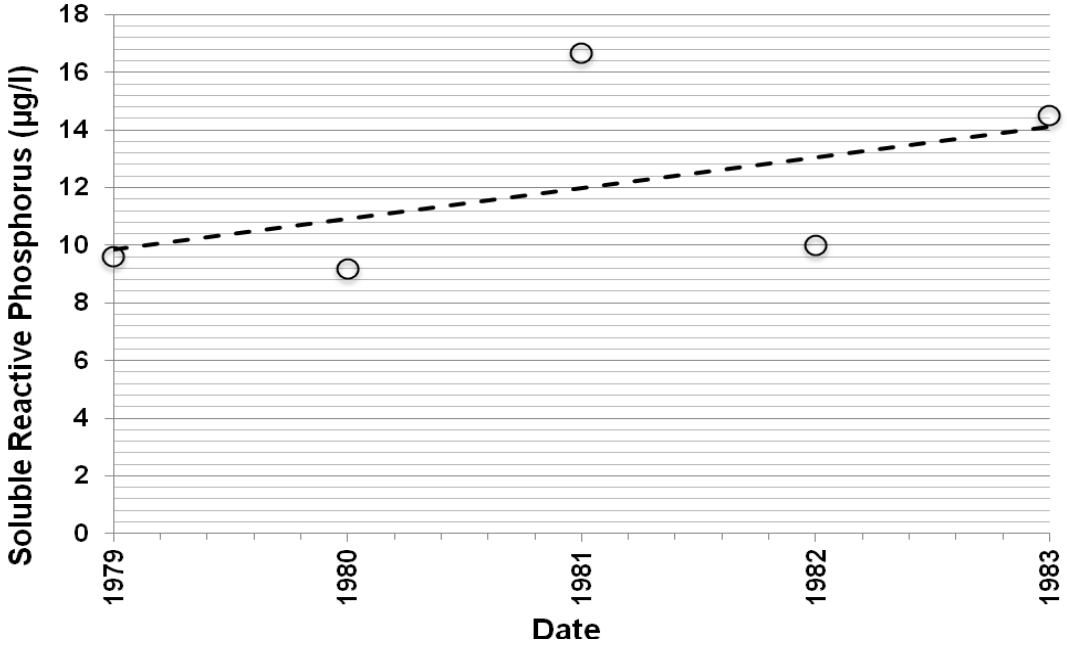
Records for mean annual Total Phosphorus in Hatchet Pond only go back to 2004, and the record is incomplete due to an error in the processing of samples in 2006. Although 2014 was the highest reading to date (Moderate Status), there has not been a significant trend over the last 10 years (R^2=0.061, Z=0.179, p=0.431). Only one reading has achieved High Status (2012) (Figure 12).

Figure 12: Change in Total Phosphorus at Hatchet Pond (mean annual 2004-2014), (lower line = 17 µg/ l = High Status, upper line = 23 µg/ l = Good Status).



To determine whether there were any longer term trends, we looked for other measures of phosphorus in the lake. Soluble reactive phosphorus largely consists of inorganic orthophosphate and is the form of phosphorus that is readily available for uptake by plants. SRP is not used to assess the condition of lakes with the Water Framework Directive. However, SRP was recorded from Hatchet Stream at the outflow to Hatchet Pond between 1979 and 1983 and may indicate the state of the lake prior to Water Framework Directive monitoring (Figure 13).

Figure 13: Change in Soluble Reactive Phosphorus at Hatchet Pond (mean annual 1979-1999). Anecdotal information suggests that fishing activity increased on the lake in the early 1980s. Coinciding with an increase in phosphorus leaving the lake.



This is still a short time period over which to look at trends, and although there was an increase between 1979 and 1983, this was not significant (R^2=0.247, Z=0.735, p=0.242). However it is worth noting that anecdotal information from fishermen at Hatchet Pond suggests that fishing activity increased significantly in the early 1980s. This is the first time that SRP in the pond increased above 10 µg/ l. In 1979 and 1980 levels were below the limit of detection throughout the year i.e. <10 µg/ l for the 6 months (every other month) when monitoring took place. In 1981 and 1983 all readings were above 10 µg/ l. This would coincide with increase nutrients entering the pond from fish and fishing activity.

UCL Environment Change Research Centre undertook nutrient reconstructions from diatoms in sediment cores at Hatchet Pond (Bennion et al 1997). The results were indicative of an increase in nutrients between the 1972 and 1995 samples. This is consistent with the above findings.

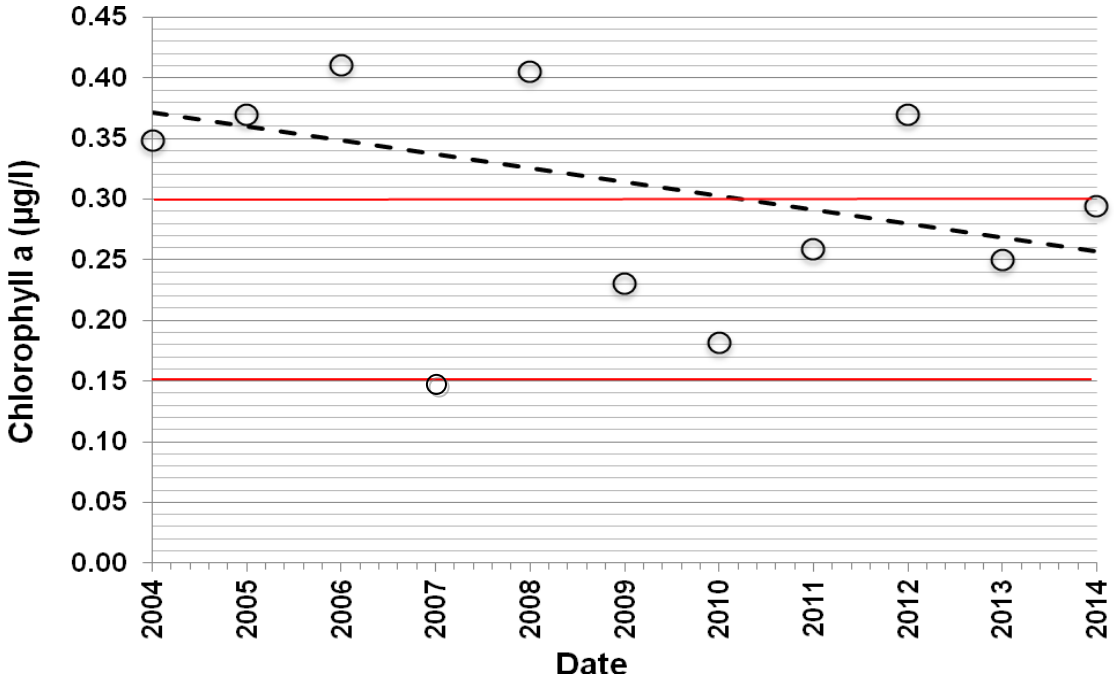
6.3 Phytoplankton

Standard analysis of the impact of water chemistry on lake biology is determined by Chlorophyll a concentration, which acts as a good proxy for the population levels of open water algae.

The results of analysis show a slow but steady increase towards a doubling of phytoplankton biomass between 2003 and 2013 (Figure 14). As with other metrics, the short time scale over which these values have been recorded mean that the trend is not significant (R^2= -0.241, Z=0.808. P=0.216).

In the last 6 years (2009-14), chlorophyll a values have been generally high and the EQR low; Hatchet Pond has only achieved Good Status once (2012). Prior to 2009 (2004 – 2008) chlorophyll a concentrations were generally much lower and the EQR high; Hatchet Pond achieved Good, but not High status. The value in 2007 appears to be an anomaly and has been removed from the analysis.

Figure 14: Change in Chlorophyll a concentration at Hatchet Pond (mean annual concentration 2003-2014), (lower line EQR = 0.15 = Moderate Status, upper line EQR = 0.30 = Good Status).



6.4 Phytobenthos

Diatom data from Water Framework Directive monitoring are missing for Hatchet Pond (Environment Agency pers. comm. 2014).

Published data (Bennion et al. 1997) reporting analysis of diatom communities from sediment cores between 1909 and 1995 suggests that there were only small changes in the diatom community over this time.

Palaeoecological data for diatoms from c.AD1850 (Bennion et al. 2012) would give Hatchet Pond an EQR = 0.91. More recent data (Sniffer 2006) gives Hatchet Pond an EQR = 0.81 (2003/04). From these data Hatchet Pond has moved from its reference condition of High Status to one of Moderate Status.

6.5 Wetland Plants

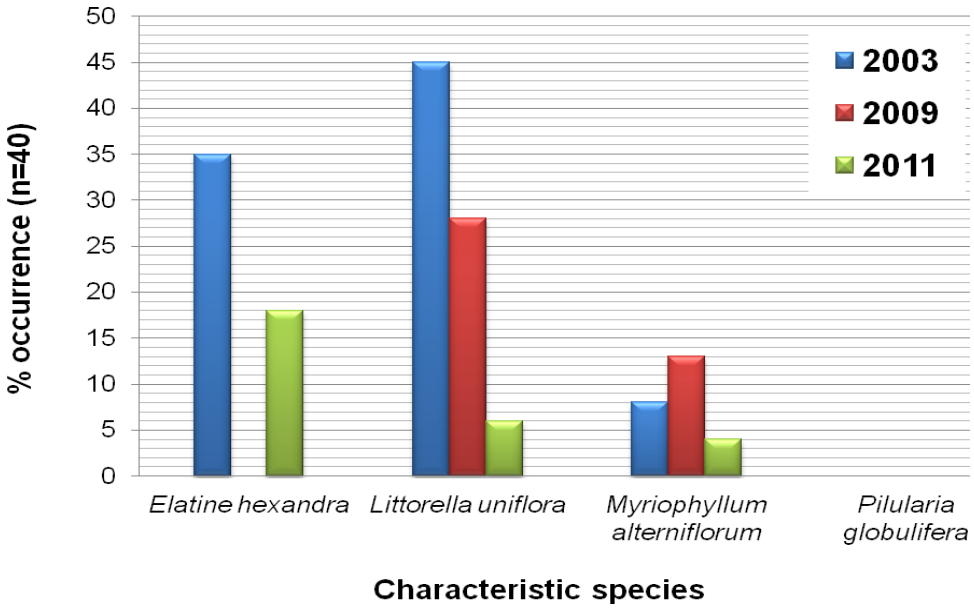
The vegetation of Hatchet Pond has been surveyed thoroughly over time and is the primary reason for its designation as an area of conservation interest. Data collected both as part of systematic surveys and from casual records suggest a significant decline in the quality of the wetland plant community at Hatchet Pond.

Common Standards Monitoring

Directional change in characteristic species and species composition from Common Standards Monitoring may indicate change within lakes, such as acidification or eutrophication.

Figure 15 shows the change in species characteristic of H3110 habitat 2003, 2009 and 2011. Shoreweed *Littorella uniflora* has undergone a steady decline since 2003 (45% 2003, 28% 2009 and 6% in 2011). Six-stamened Waterweed *Elatine hexandra* has similarly declined between 2003 (35%) and 2011 (18%). In 2009 none was recorded in designated plots. Alternate Water-milfoil *Myriophyllum alterniflorum* had shown a slight increase between 2003 and 2009 (from 8% to 13%), but was sparse in 2011 (4%). Pillwort *Pilularia globulifera* was present outside the plots in 2003 and 2009, but was absent in 2011.

Figure 15: Change in characteristic species recorded during Common Standards Monitoring of Hatchet Pond (% occurrence in n=40 plots)



PSYM monitoring

Freshwater Habitats Trust (Pond Action 2002) surveyed Hatchet Pond and recorded all wetland plant species found within the pond margin. The results were then used to calculate a PSYM Score for the pond. The PSYM score reflects the difference between the species found at the pond and those predicted for a site in reference condition. The PSYM score also takes account of the rarity of species and the Trophic Ranking Score for the species found at the site. Hatchet Pond achieved 'Good' status on a four point scale of Good, Moderate, Poor or Very Poor.

Using plant data gathered during Common Standards Monitoring we repeated the PSYM analysis. In 2009 Hatchet Pond was still at 'Good' PSYM status; however by 2011 Hatchet Pond was only at 'Moderate' status.

Other evidence

UCL Environment Change Research Centre (Bennion et al. 1996)

A macrophyte survey in 1996 describes the plant community as being rich, with the length of the lake characterised by Shoreweed *Littorella uniflora*, Alternate Water-milfoil *Myriophyllum alterniflorum* and stoneworts *Nitella sp*. Non-native pondweeds *Elodea nuttallii* were also present.

In the shallow eastern margin of the pond Hampshire Purslane *Ludwigia palustris* was locally abundant with Marsh St. John's-wort *Hypericum elodes*. Along the shoreline Many-stalked Spike-rush *Eleocharis acicularis* and Six-stamened Water-wort *Elatine hexandra* were dominant.

The most species rich area was that over the old marl pits within the northern bay of the pond. Bogbean *Menyanthes trifoliata* was dominant along with Bulrush *Typha latifolia*, Water Horsetail *Equisetum fluviatile*, Hampshire Purslane *Ludwigia palustris*, pondweed species *Potamogeton sp*. and Floating Bur-reed *Sparganium angustifolium*.

However, even at this time there were concerns about turbidity and some of the littoral substrate was dominated by mud and fine sand.

Natural England visit by national specialists (Madgwick 2013)

During this non-systematic survey, the wetland plant community was found to be impoverished compared to community known from the lake in the past. This confirms reports by local experts (Clive Chatters pers. comm., Martin Rand pers. comm. Alison Bolton pers. comm. and Neil Sanderson pers. comm.) that the condition of Hatchet Pond has been visibly declining in the last 2 decades.

During the visit a report was made about the major areas of the lake and the composition of the plant community. There were few aquatic plants growing in the area of the lake adjacent to the car park, just a few detached Alternate Water-milfoil *Myriophyllum alterniflorum* plants. The water was found to be turbid in that part of the lake, although the substrate was still visible. Unfortunately data on turbidity collected as part of Water Framework Directive monitoring is incomplete and trend analysis was not possible to investigate this apparent trend.

In the area of the lake over the old marl pits, Bogbean *Menyanthes trifoliata*, Hampshire Purslane *Ludwigia palustris*, Lesser Water-plantain *Baldellia ranunculoides* and Pillwort *Pilularia globulifera* were still present, comprising a much more natural wetland plant community, similar to that in 1996. However, the non-native invasive New Zealand Pigmyweed *Crassula helmsii* was also recorded here.

The western shore opposite the car park adjacent to a small plantation of conifers was also found to have a poor wetland plant community. This is a slightly deeper area of the lake and is the area favoured by fishermen.

Further to the south, the margins of the lake become increasingly natural, with wet heath and spring flushes draining into the lake. The water clarity here was better, being quite clear when undisturbed. Submerged wetland plants included Shoreweed *Littorella uniflora*, stoneworts *Nitella flexilis* and Alternate Water-milfoil *Myriophyllum alterniflorum*. However, these plants were covered in a thick layer of epiphytic algae not recorded in the 1996 survey.

During the 2013 visit, Pillwort *Pilularia globulifera* was recorded, it had not been recorded during the Common Standard Monitoring survey in 2011. However, despite extensive searching, only a single small free floating clump of Six-stamened Water-wort *Elatine hexandra* was found after an hours searching. In 1996 it had been described as dominant along the shoreline.

BSBI casual records

BSBI records (Rand pers. comm. 2014) suggest that 4 wetland plant species are no longer present at Hatchet Pond: Pennyroyal *Mentha pulegium*, Small Water-pepper *Persicaria minor*, Floating Bur-reed *Sparganium angustifolium* and Least Bur-reed *Sparganium natans*.

There are also 5 wetland plant species which may still be present but which have not been recorded in the last 15 years; Rigid Hornwort *Ceratophyllum demersum*, Leafy Rush *Juncus foliosus,* Ivy-leaved Crowfoot *Ranunculus hederaceus,* Round-leaved Crowfoot *Ranunculus omiophyllus* and Skullcap *Scutellaria galericulata.*

6.6 Invertebrates

Recording macroinvertebrate at Hatchet Pond has been sporadic and often collected using different methodologies, which makes trend analysis unfeasible. Chironomid pupal exuviae were only available for 2004/05 and as discussed in Section 5.3, the lake was found to be at Moderate Status.

6.7 Summary of change

In summary, Hatchet Pond is showing declines in biological quality following declines in water quality (due to increasing phosphorus). Under the Water Framework Directive, some biological elements are still at Good rather than High status, however this is below reference condition (2004-2014). This agrees with the results of Common Standards Monitoring which has assessed Hatchet Pond as in unfavourable condition (2002-2013).

Shallow lakes have some degree of resilience to increased nutrient loading and excessive loading may continue for some time before adverse ecological impacts are detected (Natural England 2014). There is concern therefore that Hatchet Pond will continue to decline even if nutrient inputs cease, and as such, there is a need for action now to prevent further decline.

7 Identification of stressors

7.1 Visitors to Hatchet Pond

Hatchet Pond has always been a focal point for visitors in this part of the New Forest. The car park has space for at least 30 cars, but at peak times visitors also park along the entrance trackway and the lay-by allowing more than 40 vehicles to stop here at any one time. Parking at Hatchet Pond is free. According to the New Forest Visitor Survey (PROGRESS 2004-2005), 78-85% of visitors travel to the New Forest by private motor vehicle, so it is logical that they will be drawn to sites with parking.

In 2005, 1% of households questioned within the National Park and 3% of those adjacent to the National Park named Hatchet Pond as their chosen destination (Tourism South East 2005). No visitors from further afield named Hatchet Pond as their destination, but 20% of visitors from the major urban centres stated that they most frequently visited Beaulieu.

In 2008 visitor numbers across the whole National Park were collected by the Forestry Commission (actual or estimated), Hatchet Pond was predicted to have more than 200 visitors per 16 hour period during the peak season (Sharp et al. 2008).

As a consequence of likely development in the next decade within the south of England, visitor numbers are predicted to increase to an additional 17,000 visitors per year (Sharp et al. 2008). This increase needs to be considered against existing levels of visitor pressure and the scale of current impacts. The increased pressure on Hatchet Pond could be significant.

The biggest concerns for the quality of the lake from visitors are erosion, disturbance of the pond margin from dogs, dog fouling and addition of nutrients from bird feed. The problem with identifying the impact of these potential stressors on the lake is the lack of formal monitoring and the difficulty of identifying single issues as opposed to a combination of factors. However, there is evidence of distinct stressors on Hatchet Pond

Erosion

Using aerial photographs of the pond from 1946 (New Forest National Park Authority), 1999 (Google Earth) and 2005 (Google Earth) it is possible to get some idea of the level of visitor activity and erosion at Hatchet Pond. The photographs are not taken at the same time year and therefore seasonal differences may occur, however there are clear differences.

The image from 1945 shows the main car park before it was consolidated (Figure 16a). There is no toilet block and more erosion adjacent to the road. Some erosion can be seen by the lake edge and a number of paths are visible heading around the pond by the old marl pits.

In contrast, the Google Earth image from 1999 (Figure 16b) shows much less erosion by the road with the creation of a restructured drive to a larger car park adjacent to the toilet block. There is also less erosion adjacent to the pond edge. However, there are more trackways through the heath to the lake on the west hand side of Hatchet Pond. Some erosion is also visible along the western shore of the lake.

Imaging from 2005 (Figure 16c) suggests that erosion has increased; both from the car park, the trackway leading around the western margin of the lake and the erosion on the shore line. The implication of increasing erosion is an increase in sediments washing into the pond.

Figure 16: Recreation impacts at Hatchet Pond showing the erosion caused by visitors from the car park in a) 1946, b) 1999 and c) 2005.

a)

b)

c)

Dogs

As a nation of dog lovers we want to be able to enjoy the countryside with our pets. Many dogs love to wade into shallow ponds and have a splash about; not a problem if this happens only very occasionally. However, in areas with public access many dogs can visit a single pond over the course of the day, every day. This continual disturbance churns up the bottom sediments, making the water murky and the wildlife value of the pond declines (Figure 17).

Not all ponds need to be protected from dogs, but there are some like Hatchet Pond which are now so sensitive to disturbance of the sediments and further nutrient enrichment that all users should want to take steps to protect this very vulnerable, very special habitat.

The lake edge adjacent to the car park is the most vulnerable, as people park and let their dogs run into the water. Dogs are also more likely to relieve themselves soon after starting the walk.

Figure 17. Dogs in a New Forest pond – some sites and the species they support are very sensitive and cannot withstand the turbidity created by daily disturbance of the pond sediments.

Feeding birds

Wildlife lakes often support ducks and other water birds. But, in a similar way to dogs, too many ducks will damage the wildlife value of a pond. Feeding ducks can be great fun and helps to bring people, and especially children, into contact with wildlife. However, regular feeding will attract more birds than the pond can happily support, they create disturbance, add excessive nutrients to the pond and strip all the plants. In addition, unused feed will sink to the bottom of the pond adding excessive nutrients and as a result the wildlife value of the pond declines. The lake edge adjacent to the car park again takes most of this pressure, but the additional nutrients will affect the whole lake through mixing.

7.2 Fishing

Background

Eutrophication caused by an increase in phosphorous in the lake is likely to have been caused in part by fishing activity.

Hatchet Pond has historically been used for fishing. Documented evidence from 1825 describes fishing of the pond with nets. We have no information on which species were being fished, but it seems likely that fishing has always taken place on the pond.

However, fishing activity at the pond was historically very low. Blogs from the fishing forum (The Anglers Forum.co.uk) describe Hatchet Pond in the late 70s. At this time it was fished by a very small number of local fishermen. However by the mid 1980s it is described as 'rod city' by the anglers who were there in the 1970s.

The early 1980s were the first years that phosphate levels in the water leaving the pond exceeded 10 µg/l. Although only anecdotal, it seems that a number of things happened at this time.

- In the early 1980s specimen carp appeared in the lake. These were reportedly individuals which had been poached from the Esso refinery lake.
- Carp were moved from Cadman's Pool to Hatchet Pond. Cadman's Pool was suffering from algal blooms and low oxygen levels due to fishing pressure at this time (see Section 7.5).
- Although also anecdotal it seems that more fish were introduced into Hatchet Pond from the nearby village of East End in the mid 1990s.

The anecdotal information is supported by a fish survey from 2002 (Giles 2002). Bream, Carp and Tench were found to have poor natural recruitment in the pond due to the low nutrient status of the pond, lack of suitable egg laying habitat and predation. The majority of Tench fell into a single size class which would date their recruitment to the 1980s. Carp likewise were slow growing with the majority falling into a middle-age size class with a few individuals at a much larger size class (potentially two separate introductions). In 2002, most adult bream were around 10 years old, which would date their recruitment to the 1990s.

The increase in Bream and Carp, including specimen fish at Hatchet Pond, was a big draw for fishermen and as a result, promotion of Hatchet Pond increased in the angling media. The fishing pressure at Hatchet Pond may have been further exacerbated by the closure of other Forestry Commission fishing sites at Cadman's Pool and Janesmoor Pond. Both ponds were deemed to be too small to support a healthy fishery.

Current activity

We have anecdotal information from the Forestry Commission that to their knowledge, the pond has not been stocked since the 1990s (Forestry Commission pers. comm. 2014). However, good catches of fish, at least 5 named specimen Carp and record breaking Bream were regularly caught up until at least 2011.

The fishing permit records we have (Forestry Commission pers. comm. 2014) show that 2011 was the height of fishing activity in recent times on the lake, with 673 permits issued for that season (Table 8). Since 2011, the number of permits issued on Hatchet Pond has declined, which may reflect the death of the specimen fish.

Table 8. Fishing permits issued for Hatchet Pond 2011 - 2014

Year	Day Permits		Week Permits		Season Permits		Total permits	Total rod days
	2 rod	3 rod	2 rod	3 rod	2 rod	3 rod		
2010/ 2011							673	
2011/ 2012	284	15	131	12	26	22	490	33637
2012/ 2013	335	13	113	6	14	6	487	13875
2013/ 2014	274	7	97	23	20	4	425	15616

In 2014, 425 permits were issued for Hatchet Pond. Rod days are the theoretical maximum allowed on all potential days that the permits are valid. If all were used, the total number of rod days would be 15,616 days and the average number of fishermen on the lake per day would be 57. However, numbers are more frequently 1-2 per day on quiet days (pers. obs.) and 7-8 on busy days (Forestry Commission pers. comm. 2014).

The majority of licences sold are single day licences (371 rod days) and to a lesser extent week licences (210 rod days). Currently only 24 fishermen hold a season permit, a similar number to 2013 (20 permits). Season permit sales were much higher in 2012 (48 permits) again reflecting the attraction for big fish at that time.

Fishing is allowed from the 16th June until the 14th March. Night fishing is not permitted and barbless hooks must be used. Bailiffs police the lake and only 3-4 individuals are caught each year without a permit (Forestry Commission pers. comm. 2014).

Impact

Cyprinidae (Carp, Bream and Tench) are bottom feeding fish which cause disturbance to aquatic plants and sediment re-suspension leading to turbidity and mobilisation of phosphates through their feeding behaviour. Fish are lured into swims with ground bait and boilies; nutrient rich foods which are sometimes used in excess to draw in specimen fish.

There are no restrictions on where people can fish around Hatchet Pond. The advice from anglers is to move to the far side of the lake, away from the car park as it is quieter here and the water slightly deeper. This creates pressure around the entire margin of the lake.

A review on the status of habitats (Natural England 2013) states that for this habitat type (H3110) leisure fishing and associated fishery management can cause considerable damage. Table 9 summarises the impact of the fish species recorded in Hatchet Pond based on their origin, breeding, feeding, potential for bottom and macrophyte disturbance and likelihood of intensive angling practices such as heavy ground-baiting and habitat disturbance (Moss et al. 1996). High positive scores are given to characteristics likely to be conducive to the maintenance of clear water, high plant diversity and biomass, and low phytoplankton biomass in shallow lakes.

Table 9. Summary of the characteristics of fish recorded from Hatchet Pond and their compatibility with maintenance of diverse plant communities in lowland lakes. Negative scores = incompatible, positive scores = compatible (Moss 1996).

	Rank
Carp	-23
Bream	-7
Tench	-4
Roach	-3
Rudd	+1
Perch	+5
Pike	+25
Eel	+28

Common Carp and Bream are the least desirable species as they are most associated with turbid water, enhanced nutrient levels and suppression of macrophytes. Tench are less of a negative influence but are undesirable because of predation of epiphyte eating snails and lack of natural recruitment (i.e. native to Southern England but introduced to Hatchet Pond).

Roach is a predator of open water zooplankton. In the absence of zooplankton phytoplankton can bloom which is why it has a negative score. However, Roach are a native species to the New Forest and therefore a natural component of the fish community of this type of waterbody. Roach numbers would also be controlled by Perch and Pike which are both natural predators of other fish.

Ruffe (not classified) are also a predatory fish. Whether they are native or introduced to Hatchet Pond is unclear. Giles (2002) found that Perch recruitment was lower than expected and attributed this to competition from Ruffe. The fisheries team also found low Pike recruitment because of the lack of submerged vegetation in Hatchet Pond. Ruffe are therefore the dominant Percidae predator in the lake.

The 2002 survey concluded that the density of fish (200 kg/ha) was at a maximum for the size of Hatchet Pond. At this level bio-manipulation (i.e. fish removal) was a possibility but the conclusion was to wait and see if the naturally aging population of Cyprinids died out, to be replaced by a more natural predator dominated lake (Giles 2002). The lack of action in 2002 may have resulted in the continued significant increase in nutrient levels and the declines in the biology of the lake seen to date.

7.3 Invasive non-native species

Lakes identified as supporting priority habitats are considered to be in unfavourable condition if they support one or more non-native invasive species. Six introduced wetland plant species have been recorded in Hatchet Pond. White Water-lily *Nymphaea alba* is present but not considered to be invasive. Canadian Pondweed *Elodea canadensis* and Nuttall's Pondweed *E. nuttallii* are also present but in low densities. Water lettuce *Pistia stratiotes* was recorded in 2007, but these plants appear to have been removed. Duck potato *Sagittaria sp.* was also present up until 2004, but does not appear to have been recorded recently.

New Zealand Pigmyweed *Crassula helmsii* is a species of particular concern nationally. However, it has been present at Hatchet Pond for at least 37 years and appears to be restricted to the more base-rich north-eastern margin of the lake. Even here its dominance is limited by the action of grazing pressure, a situation which has been documented in many New Forest ponds (Ewald 2014).

Our understanding of the impact of *C. helmsii* on native species in the New Forest is increasing. *C. helmsii* has wide tolerance limits, but waterbodies with naturally low nutrient levels and a diverse native wetland plant community are less dominated than enriched sites (Ewald 2014). Eutrophication of sites through nutrient enrichment may have an indirect negative effect, allowing *C. helmsii* to become dominant.

7.4 Summary of stressors

The following environmental impacts have been identified as stressors on the existing habitat.

Stressor	Issue	Impact
Fishing	Nutrient rich bait	Excess nutrients (phosphorus) - enhances algal growth at the expense of wetland plants (periphyton as well as phytoplankton). Rare plants characteristic of the priority habitat decline, common plant species tolerant of nutrient enrichment increase.
Cyprinid fish	Introduced in the 1980/ 90s	Bottom-feeding fish such as Carp, Bream and, to a lesser extent, Tench disturb plants and sediment leading to the loss of vascular plants. Re-suspension of pond substrate will cause previously bound phosphates to be re-dissolved in the water column.
Waterfowl	Nutrient rich feed and faeces	Feeding waterfowl attracts more birds than would naturally be supported by the lake. Increased phosphate levels and erosion.
Walkers	Eroded trackways	Direct damage to adjacent habitats. Increases turbidity, smothers plants (suspended solids).
Car parking	Increased sediment runoff, compaction and erosion of edge habitat	Sedimentation and destruction of edge plant communities.
Disturbance	Dogs and other disturbance to the shallow margins of the lake	Increases turbidity, smothers plants (suspended solids).
Acidification	Recovery following reduction in air pollution	Increase in pH exacerbating eutrophication.
Non-native invasive plants	New Zealand Pigmyweed *Crassula helmsii* Introduced in the 1970s	Competition with native flora. However, current grazing levels are helping to maintain an open sward for the native plant community. Secondary threat: nutrient levels increase favouring invasive species over native species.
Sluice structure	Obstruction to fish passage, potential change to sluice outflow height	Sluice structures obstruct eel passage into the lake. If the sluices were altered, increased water depth would exacerbate the loss of submerged vegetation through loss of light levels.

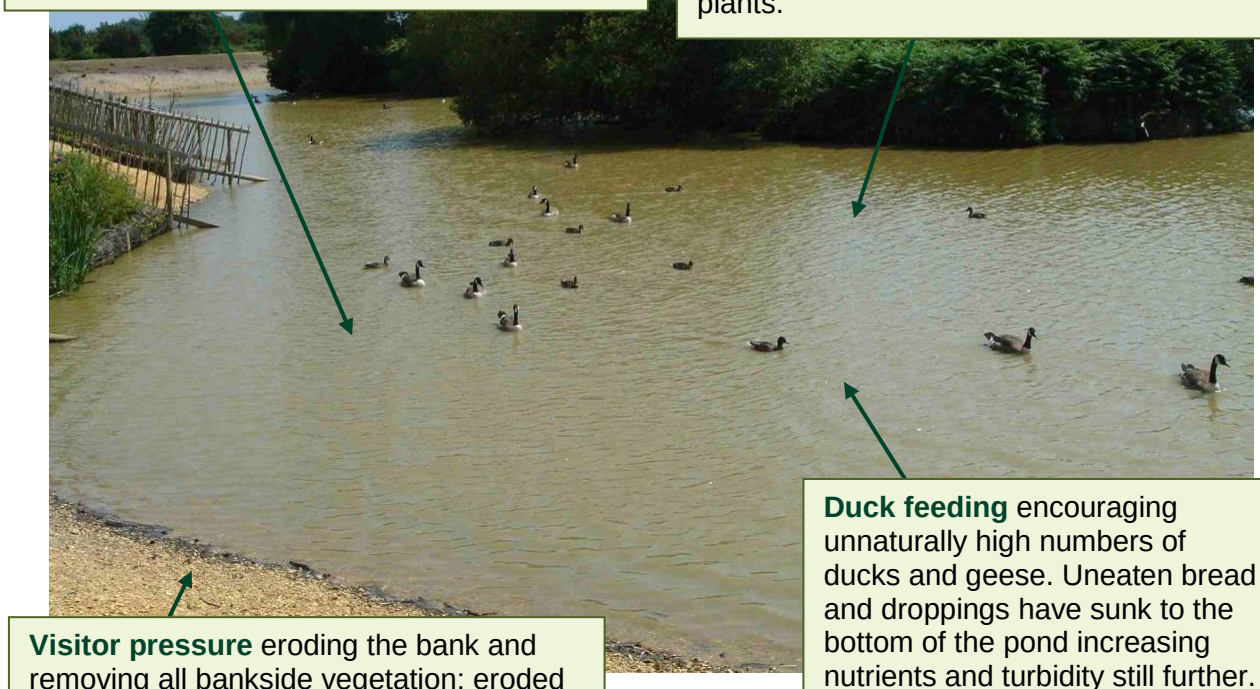
7.5 Case study Cadman's Pool: The impact of nutrient enrichment on a pond which was once wildlife rich

Cadman's Pond is an example of the impact of nutrient enrichment and mismanagement on a pond in the New Forest. The pond was originally a small gravel pit supplying material for the maintenance of forest trackways. It was enlarged to 0.3 ha in area and a depth of 1.75m in 1964-5. Prior to 1975, Cadman's Pool was a well vegetated, diverse pond, with emergent, floating and submerged species. The water was clear and the pond supported numerous dragonfly species (Winsland 1997).

A decline was first recorded at the pond in the beginning of the 1980s. A catalogue of human interference has resulted in a pond which is now turbid and degraded (Figure 18). Cadman's Pool is now described as biologically dead (GeoData 1998). The cause of the decline has been attributed to Carp, fishing bait and feeding wildfowl. Despite attempts to restore the pond since 2005, there have been no signs of recovery.

Hatchet Pond is in the early stages of a similar decline. As seen at Cadman's Pool the change can happen suddenly and may be difficult to reverse. It is often harder for lakes to recover from eutrophication than it is to move into a eutrophic state. A lower nutrient concentration than the one experienced prior to eutrophication is often required for a lake to recover to its pre-eutrophic state (Natural England 2014).

Figure 18. Cadman's Pool 2005 - a nutrient rich pond, with no submerged plants and few macroinvertebrate species.



8 Management of Hatchet Pond

There is growing recognition that restoration of degraded lakes remains unpredictable; and evidence that, even in relatively successful restorations it is difficult, or perhaps impossible, to regain all of the pre-restoration site biota (Søndergaard et al. 2007, 2008; Verdonshot et al. 2011). This suggests that, where sites have not suffered substantial degradation and whilst they still retain most of the key biological interest, the most effective strategy is to put substantial effort into preventing and reversing any further decline.

With the future challenges of climate effects exacerbating eutrophication, time has therefore come to re-think the theory and methodology (Jepessen et al. 2011). Repeated measures combined with detection of early warning on relapse offer one way forward. The earlier the adjustments are made, the less effort is required. It is important to emphasise, that the key measure to restore eutrophied lakes is the reduction in external nutrient loading (Jepessen et al. 2011). In-lake restoration only serves the purpose of reinforcing recovery, treating symptoms or improving/ maintaining a high environmental quality temporarily until the external loading can be significantly reduced.

On a positive note, Hatchet Pond is located within a largely semi-natural habitat. Nutrients and sediment sources are direct or indirect inputs to the lake from recreation. These issues are relatively straightforward to address compared with pollution from agriculture or urbanisation. There is a need to do everything possible to protect high quality sites like Hatchet Pond; sites which currently retain outstanding assemblages of plants and animals in spite of some nutrient enrichment.

Given the uncertainty of efforts to reverse change, and time lags which could lead to further deterioration before condition improves, stressors on Hatchet Pond must be addressed without delay.

Nutrient inputs

- Phosphate inputs from introduced fish and fishing bait (ground baiting and boilies).
- Phosphate inputs from feeding of ducks and other wildfowl (from faeces and uneaten food).

Sediment inputs and re-suspended sediments

- Phosphate and suspended solids re-suspension through the activity of Carp, Bream and Tench.
- Disturbance and re-suspension of sediments by dog activity in proximity to the car park.
- Erosion of the lake margin and adjacent habitat by visitors.

Suppression of the natural lake community

- Suppressed zooplankton populations due to lack of cover (refuges) by macrophytes and increased nutrients.
- Extensive macrophyte suppression through enhanced periphyton growth due to enhanced nutrient levels.
- Obstruction created by the sluice structure which is preventing Common Eel *Anguilla anguilla* passage into the lake.
- Introduction of invasive non-native plant species, New Zealand Pigmyweed *Crassula helmsii*, which threatens to out-compete rare native species.

8.1 Management of visitors

The best option for the lake would be to stop recreation activity at Hatchet Pond. However, this is likely to be at odds with the recreation plan for the New Forest. It would require alternative arrangements for visitors and the ice cream van, which might increase pressure on other sensitive sites in the National Park. To make provision for recreation whilst protecting the priority habitats and species found at Hatchet Pond visitor pressure needs to be managed.

Workshop

Information will be key in helping visitors understand why changes are being made at the lake. Before plans are finalised we suggest a workshop be held, to allow users the opportunity to study the evidence, air their views and develop the plans for Hatchet Pond in conjunction with the statutory agencies. We recommend that Forestry Commission staff be on hand during busy weekends in the first year of management to discuss works with the public on site.

Car park

The current car park's location close to the water's edge creates an area of erosion adjacent to the lake margin which then washes sediment directly into the water. The line of parking spaces facing the pond should be reduced and restricted to just 2 disabled parking bays only. The number of cars parking at Hatchet Pond should also be reduced by repairing the entrance to the car park to prevent additional parking outside of the designated car parking area. Posts or bunds may be required to prevent cars parking on the verges.

Reducing the availability of parking at Hatchet Pond may not be enough if the size of car park at Hatchet Little Pond remains the same. Reducing the size of both car parks will significantly reduce pressure on the site. Hatchet Little Pond currently has two areas for parking. If this was reduced to one area the number of visitors at this complex of ponds would be halved.

The recovery of the site would also be enhanced if Hatchet Pond was closed during the winter months. Surface runoff is greater at this time of year and reducing activity in the car park would reduce sediment runoff into the pond. Visitors would still be able to access Hatchet Pond from Little Hatchet car park.

Temporary signs have been effective in directing the public with regards to ground nesting birds and car park closures. We recommend signs in the car parks around Hatchet Pond and Hatchet Little Ponds asking visitors not to feed the birds and to keep dogs on leads because of concerns over the health of the lake. This will not prevent the practice, as some will always ignore the signs, but may reduce it whilst the lake recovers.

It would be beneficial if brash and or signs could be put in place to deter visitors from using the path which runs along the western boundary of the lake. This is the path absent from the 1945 aerial photographs (Figure 16a). This would reduce the activity and allow the most sensitive areas of the lake time to recover.

Visitor management can be reviewed after 10 years and if Hatchet Pond is showing significant signs of recovery less stringent measures could come into force.

8.2 Management of the coarse fishery

The operation of Hatchet Pond as a recreational carp fishery is in conflict with its conservation status and is preventing it from achieving favourable conservation status. One

option would be to stop all fishing on Hatchet Pond. However, this would not be in keeping with the historical use of the site. Fishing has occurred on the pond since it was created. Instead, the removal of Common Carp and Bream is recommended, with revisions to the rules for anglers. Removed fish should be sold to a local fishery or fishing club. The revenue may help to offset costs at the pond.

While there are examples of positive effects of removing a large proportion of fish, lakes often return partly or fully to the state before manipulation after 10–15 years (Søndergaard et al. 2007). However, if the nutrient load can be relieved during this time, the absence of fish can help in lake recovery. During this time further nutrients inputs from external sources and re-suspension of nutrient rich sediments must be limited (Jeppesen et al. 2007).

In one study, Søndergaard et al. (2008) reviewed the effects of fish removal (mainly Roach *Rutilus rutilus* and Bream *Abramis brama*) as a method to improve the ecological quality of 36 Danish lakes. In lakes in which less than 200 kg fish per ha were removed within a 3-year period only minor effects were observed, but at higher removal rates both chemical and biological variables were markedly affected. The concentrations of chlorophyll a, total phosphorus, total nitrogen and suspended solids decreased to 50-70% of the level prior to removal. The most significant and long-lasting effects were found for suspended solids, whereas the most modest effects were seen for chlorophyll a. Total algal biomass also declined after fish removal, particularly that of cyanobacteria, indicating enhanced grazing pressure by zooplankton. The abundance and species number of submerged macrophytes increased in the majority of the lakes. For most variables the effects of the fish removal were significant for 6-10 years, after which many lakes tended to return to pre-restoration conditions, mainly because of consistently high external and internal phosphorus loading. Their conclusion was that a sufficiently extensive removal of particularly benthivorous fish was an efficient tool to create clear water.

Reviews of bio-manipulation experiments highlight three factors which determine the success of such projects:

- Control of external nutrient input (primarily phosphate, but sometimes nitrate as well)
- Control of internal nutrient loading (prevention of sediment re-suspension)
- Control of phytoplankton (primarily through nutrient reduction/ competition and predator encouragement – control of zooplanktivorous fish).

If a recreational fishery is to be maintained at Hatchet Pond then fish other than Carp, Bream and Tench should be allowed to develop. Roach, Rudd, Pike, Ruffe, Perch and Eel are already present in the lake, and should form the basis of this fishery. Ruffe as the predatory fish in the lake will help to maintain a balanced community, by keeping recruitment of zooplanktivorous fish (Perch, juvenile Roach and Bream) to a minimum (Scheffer 2004).

Angling should be restricted to season ticket holders only. Current sales would suggest that a permit limit of 25 permits per year would be sufficient to allow a core group of fishermen to continue using the lake. Prior to 1980 the lake was fished by local fishermen who were enthusiastic about maintaining the special nature of the site.

Angling should be restricted to the east side of the pond in order to reduce the trampling of bank edges, in particular the sensitive western and southern banks should be protected.

The use of ground baiting and boilies should be banned, although dissemination of information on the removal of Carp and Bream should lead to a change in this fishing practice as it is not a suitable technique for Roach, Rudd, Pike, Perch or Eel. It would be

valuable if season ticket holders kept a record of catches to improve decision making in the future.

Fishery management can be reviewed after 10-15 years if Hatchet Pond shows significant signs of recovery.

8.3 Invasive non-native species

Trials were conducted in the New Forest (Ewald 2014) to determine whether a suitable control technique could be found to treat New Zealand Pigmyweed *Crassula helmsii*. None of the treatments (herbicide, hot foam or aquatic dye) were effective in eradicating *C. helmsii* and it was able to re-grow to the same or greater extent following treatment. This is highly undesirable in water bodies which contain species with high conservation value and means that planning a successful eradication programme is unfeasible in the New Forest at this time.

The study revealed that high water quality and maintaining poaching from commoner's livestock was critical in suppressing dominance and allowing rare native wetland plants to continue to flourish in spite of the presence of an invasive non-native plant

Further research and other control options for *C. helmsii* should be explored. For example, CABI are currently investigating biological controls (CABI 2014). In the interim, the priority should be to prevent nutrient enrichment and maintain sufficient grazing pressure to provide an open sward for native plant communities.

Water bodies with recreation activity and large numbers of visiting birds will always be at risk from invasive non-native species. The priority for Hatchet Pond will be to reduce pressure and nutrient enrichment on the lake, which could favour the dominance of invasive non-native plants, and to remain vigilant to new invaders.

8.4 Monitoring

To determine the effectiveness of management and better understand the impacts of changes in water chemistry on the individual biological elements, a regular survey and monitoring program should be initiated.

In addition to Common Standards Monitoring and Water Framework Directive Monitoring, we would recommend 5-yearly monitoring using standardised PSYM (to monitor change in lake quality for wetland plants and invertebrates).

We would also recommend detailed studies of priority species (plants and invertebrates). PondNet is a new volunteer led national monitoring programme which includes detailed monitoring for S41 species. Hatchet Pond should become part of this monitored network.

Fixed plot monitoring of adjacent vegetation is needed to quantify visitor impact and erosion. Hampshire Flora Group has already offered to undertake this monitoring in 2015.

8.5 Sluice structures

There is no risk to water levels in the lake, provided the sluices continue to operate. Eel passes are required for the pond to achieve Good Ecological Potential under the Water Framework Directive. The Environment Agency is already addressing this issue as part of mitigation measures for the lake.

9 Summary of management options

9.1 Option 1: Do nothing

It is likely that the condition of the lake will continue to decline, resulting in the loss of species of conservation importance and loss of priority habitat.

- **Erosion and turbidity** - Erosion from visitors around the pond will continue; introducing sediments, increasing turbidity and limiting macrophyte growth. Habitat surrounding Hatchet Pond is damaged including Heathland and Lowland Fen both of which are Priority Habitats under the UK post-2010 Biodiversity Framework.
- **Visitors** - Hatchet Pond continues to draw large numbers of visitors. Feeding water birds continues to add additional nutrients to the lake. More waterfowl are attracted to the site, beyond the level which the lake would naturally support.

  Dogs disturbing the lake margin increase turbidity and re-suspend nutrients into the water column exacerbating eutrophication.
- **Fishing** - Carp and Bream in the lake reach specimen size, increasing nutrient levels and turbidity from excreta and feeding behaviour (re-suspension of sediments). Fishermen will continue to use ground bait and boilies introducing further nutrients in to the lake. More fishermen may be attracted due to the specimen size fish.
- **Invasive species** - Deterioration in lake quality and increasing nutrient levels will favour the growth of *Crassula helmsii*.
- **Time scale** - The response time of lake biology to increasing nutrients is difficult to calculate and often exponential once a 'tipping point' occurs. Evidence from Cadman's Pool suggests that the decline from a clear water to an algal dominated water body could occur in as little as 5 years.

9.2 Option 2: Manage recreation activity

The most conservation effective strategy is to put substantial effort into preventing and reversing any further decline. Whilst we recommend that all measures are implemented, the options should be discussed with stakeholders before final management options are chosen, as a minimum, addressing fish stocks and fishing activity at Hatchet Pond will be needed as soon as possible.

- **Information** - Organise a workshop to explain the plans for Hatchet Pond and the reasons behind these decisions to as wide an audience as possible. Invite experts to provide case studies of lake restoration projects form elsewhere. Present options for the management of Hatchet Pond and work with stakeholders to choose the most appropriate option for recovery of the lake.

  Forestry Commission staff should be on-hand at Hatchet Pond during weekends to answer questions and raise awareness of the need to protect Hatchet Pond for nature conservation.

  Erect temporary signs on site to explain the works taking place.
- **Car parking** - Reduce the size of the car park at Hatchet Pond; removing all but the disabled parking from the lake edge. Repair the entrance to the car park to prevent additional parking in the lay-by and outside of the designated car parking area.

  Reduce the size of the car park at Little Hatchet pond as well, closing the eastern arm of the car park, to take pressure off the site as a whole.

Allow parking at Little Hatchet pond year round, but consider closing Hatchet Pond car park over the winter months - a period of lake recovery.

We do not feel that introducing charging at the car park will significantly benefit the lake, although charging at car parks may have wider befits; e.g. encouraging visitors to value the National Park.

- **Duck feeding** – Erect temporary signs asking visitors to refrain from feeding the birds. This will not prevent the practice, as some will always ignore the signs, but it may reduce it for a time whilst the lake recovers.
- **Fishing** - Remove remaining Carp and Bream from Hatchet Pond and Hatchet Little Pond. Make the lake and the pond a natural coarse fishery.

  Limit fishing to season only tickets. Local fishermen on a season ticket are more likely to understand and respect the lake.

  Place tighter controls on fishing at Hatchet Pond, including a ban on ground baiting and boilies (which will be an unnecessary practice anyway if Carp and Bream are removed) and ask season ticket holders to keep a record of their catch.

  Restrict fishing to certain sections of the lake - to stop disturbance and erosion of the most vulnerable areas of habitat; particularly along the western and southern margin of Hatchet Pond.
- **Sluice structures** – Install eel passes to ensure there is no obstruction to fish passage (activity already being addressed by Environment Agency mitigation measures).
- **Walkers** - Put up temporary signs to ask visitors to keep dogs on leads, concerns over the health of the pond may deter visitors from letting their dogs into the water.

  Close the path on the far side of the pond which runs close to the pond edge (as per the 1940s). This would most unobtrusively be achieved through the use of brash.
- **Monitoring** - In addition to Common Standards Monitoring and Water Framework Directive Monitoring, we would recommend 5-yearly monitoring using standardised PSYM (to monitor change in lake quality for wetland plants and invertebrates).

  Begin detailed studies of priority species (plants and invertebrates), to better understand changes at the pond and the effectiveness of management to reduce pressure on the site.

  Additional monitoring of adjacent vegetation is needed to quantify visitor impact and erosion.

9.3 Option 3: Stop recreation activity

The best option for the lake would be to stop recreation at the pond, but this is unlikely to be a desirable option weighing up the needs of user groups.

- **Information** - This would be an unpopular choice and would require a careful public relations exercise in order to bring people on board. These measures could be limited to a 5 year period in the first instance to review their benefit to the lake.
- **Car parking** - close both Hatchet and Little Hatchet Pond. Make arrangements for the ice cream van to move to another car park. Close the public toilets. Place posts or similar along the road verge and access to the car park to prevent parking.

  This will reduce pressure on the pond from walkers, dogs and duck feeding. A few individuals may still choose to visit the pond by walking from another car park but the numbers would be much reduced.

- **Fishing** - Remove remaining Bream and Carp from Hatchet Pond and Hatchet Little Pond. Stop fishing on Hatchet Pond and Hatchet Little Pond. There are several privately run coarse fisheries in the New Forest which provide season and day tickets as an alternative.
- **Monitoring** - In addition to Common Standards Monitoring and Water Framework Directive Monitoring, we would recommend 5-yearly monitoring using standardised PSYM (to monitor change in lake quality for wetland plants and invertebrates).

  Begin detailed studies of priority species (plants and invertebrates), to better understand changes at the pond and the effectiveness of management to reduce pressure on the site.

  Additional monitoring of adjacent vegetation is needed to quantify visitor impact and erosion.

Our recommendation is Option 2; to manage recreation activity and undertake monitoring over the next five years to better understand changes at the pond. Plans can then be amended to reflect any further changes observed at the site.

9.4 Provisional costs for management at Hatchet Pond

Activity	Provisional Costs* £	Details
Workshop and weekend Forestry Commission staff to disseminate information	1,000	Workshop to present evidence of the issues at Hatchet Pond, discuss options and finalise management plans. Costs to cover organisation, hire of hall and invitation of expert speakers.
Remove fish from Hatchet Pond and Hatchet Little Pond	6,000	Seine netting to capture fish at Hatchet Pond, keeping fish in floating cages until removal is complete. Carp and Bream sold to local fishing club or fishery following health check. If fish fail health check they may have to be destroyed which would require further sensitive consultation with local anglers.
Permits	-	Reduce permits to 25 season permits per year; 20 2-rod licences, 5 3-rod licences.
Angling rules	-	Update agency websites to reflect changes in angling rules. Consider putting articles in the angling press to help disseminate information about the reasons for the change in rules.
Car parking	10,000	Renovation to both Hatchet Pond car park (priority) and Hatchet Little Pond car park. Cost to include contractors and materials.
Temporary signs	500	To include materials and preparation costs. Consider putting articles in the local press to help disseminate information about the reasons for change.
Footpath closures	500	Brash used to discourage walkers from using the pass which runs adjacent to the lake, along the western margin.
Eel pass	2,000	Installation of bristle board or equivalent through sluice at outflow to Hatchet Pond - costs included within Environment Agency mitigation measures.
PSYM monitoring	1,000	Standardised methodology to monitor wetland plants and invertebrate species. Recommend a PSYM survey once every 5 years.
S41 species monitoring	-	PondNet is a new volunteer led national monitoring programme which includes detailed monitoring for S41 species. Hatchet Pond should become part of this monitored network.
Monitoring of adjacent vegetation	-	Hampshire Flora Group has already offered to undertake this monitoring in 2015.

* costs do not include staff time within Natural England or the Forestry Commission.

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Appendix 1: Hatchet Pond site designations

1.1 Extract from Ratcliffe (1977) A Nature Conservation Review: The Selection of Biological Sites of National Importance to Nature Conservation in Britain pp170

OW.10. HATCHET POND, HAMPSHIRE
SU 3601. 15 ha Grade 2

Hatchet Pond is a shallow mesotrophic lake which may be of ancient artificial origin, lying within the New Forest. Its main interest is its isolation from other water bodies of similar trophic status, which are found chiefly in northern and western Britain, by the mainly calcareous rocks of the intervening lowlands. Isolated populations of the northern species *Hammarbya paludosa* and *Sparganium angustifolium* occur here, alongside rare southern species such as *Galium debile*, *Cicendia filiformis* and *Ludwigia palustris*. The latter is found in a small pond alongside the main lake and this is now its only known British locality. Heavy grazing pressure has prevented the growth of reed-swamp and the shorelines consist mostly of gravel covered in places by a short sward of *Littorella uniflora* and *Pilularia globulifera*, both characteristic of mesotrophic conditions. The invertebrate fauna is poor in species but contains species such as *Sympetrum scoticum* and *Sigara scotti* characteristic of base-poor conditions. The introduced North American triclad *Dugesia tigrina* is abundant and the duck mussel *Anodonta anatina* occurs here in an unusually calcium-poor site for this species.

1.2 EC Directive 92/43 on the Conservation of Natural Habitats and of Wild Fauna and Flora
Citation for Special Area of Conservation (SAC)
New Forest
Designated on 1st April 2005

"Hatchet Pond, and associated ponds, are examples of oligotrophic (nutrient-poor) waterbodies amidst wet and dry lowland heath developed over fluvial deposits. It contains shoreweed *Littorella uniflora* and isolated populations of northern species such as bog orchid *Hammarbya paludosa* and floating bur-reed *Sparganium angustifolium*, alongside rare southern species such as Hampshire-purslane *Ludwigia palustris*. This pond is important as a southern example of this lake type where northern species, more common in the uplands of the UK, co-exist with southern species.

The site also contains nutrient-poor vegetation on the edge of large temporary ponds, shallow ephemeral pools and poached damp hollows in grassland, which support a number of specialist species in a zone with toad rush *Juncus bufonius*. These include the two nationally scarce species coral-necklace *Illecebrum verticillatum* and yellow centaury *Cicendia filiformis*, often in association with allseed *Radiola linoides* and Chaffweed *Anagallis minima*. Continuous grazing pressure is of prime importance in the maintenance of the outstanding flora of these temporary pond communities. Temporary ponds occur

throughout the Forest in depressions capable of holding water for part of the year. Most ponds are small (between 5-10m across) and, although great in number, amount to less than 10ha in total area. Many of these contain great crested newt, *Triturus cristatus*."

1.3 Annex I habitats present at Hatchet Pond that are a primary reason for selection of the New Forest SAC

3110 Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)

Hatchet Pond in the New Forest in the south of England is in fact three ponds, one of which is an example of an oligotrophic waterbody amidst wet and dry lowland heath developed over fluvial deposits. It contains shoreweed *Littorella uniflora* and isolated populations of northern species such as bog orchid *Hammarbya paludosa* and floating bur-reed *Sparganium angustifolium*, alongside rare southern species such as Hampshire-purslane *Ludwigia palustris*. Hatchet Pond is therefore important as a southern example of this lake type where northern species, more common in the uplands of the UK, co-exist with southern species.

3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea

In the New Forest **vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*** occurs on the edge of large temporary ponds, shallow ephemeral pools and poached damp hollows in grassland, which support a number of specialist species in a zone with toad rush *Juncus bufonius*. These include the two nationally scarce species coral-necklace *Illecebrum verticillatum* and yellow centaury *Cicendia filiformis*, often in association with allseed *Radiola linoides* and Chaffweed *Anagallis minima*. Heavy grazing pressure is of prime importance in the maintenance of the outstanding flora of these temporary pond communities. Livestock maintain an open habitat, controlling scrub ingress, and trampling the surface. Commoners' animals also transport seed in their hooves widely from pond to pond where suitable habitat exists. Temporary ponds occur throughout the Forest in depressions capable of holding water for part of the year. Most ponds are small (between 5-10 m across) and, although great in number, amount to less than 10 ha in total area.

Appendix 2: Hatchet Pond site assessment

2.1 Condition Assessment Summary Table for Hatchet Pond 2009

Attribute	Target	Status	Comment
Macrophyte community composition	Oligotrophic: ≥ 1 characteristic *Littorelletea* species and ≥ 3 other species from Box 1 (unless valid reason apply)	✓	*L. uniflora* present and 3 other characteristic species: *P. globulifera, M. alterniflorum* & *E. hexandra* – all at low frequency. Other species were: *Juncus bulbosus, C. virgata, C. platycarpa. E. acicularis, N. flexilis* agg., *N. alba, P. crispus, P. natans, P. polygonifolius, U. minor* & *Crassula helmsii.*
	No loss of characteristic species (see Box 2)	-	Similar species to 2003 survey (Goldsmith *et al.* 2003), but *E. hexandra* more abundant in the past. No other data.
	≥ 6/10 vegetated sample spots (boat or wader survey) have ≥ 1 characteristic spp.	X	Only 38% of vegetated sample spots contained one of the characteristic species. Aquatic vegetation restricted to very shallow water (max. 0.8 m)
Negative indicator species	Negative indicators absent or at low frequency	✓	No negative indicators present (*C. helmsii* present – but see below)
	Non-native species absent or present at low frequency	X	*Crassula helmsii* common on the shoreline around north-eastern shore.
	Non-*Chara* & -*Nitella* algal dominance: cover of benthic and epiphytic filamentous algae less than 10%	✓(?)	Dense filamentous algal growth at section 2, but rarely abundant elsewhere. Overall cover estimated at 10%.
Macrophyte community structure	Characteristic vegetation zones should be present (site specific)	X (?)	Aquatic vegetation restricted to shallow water and no zonation present. *L. uniflora* did not exceed 0.8 m depth. *N. flexilis* agg. & *E. acicularis* relatively frequent, but mainly forming only sparse beds. Other species rare; many only recorded at < 25 cm depth or in temporary pools in the NE shore area. The western half of the lake is heavily grazed, but with a relatively rich wetland flora. The NE shore has a more extensive hydrosere with dense growths of *M. trifoliata* & *Ludwigia palustris* as well as significant areas of *P. globulifera.* Unfortunately the latter species shares much of this habitat with *C. helmsii.* Marginal habitats are of considerable interest, but the aquatic community structure is less favourable.
	Maximum depth distribution should be maintained	-	Z_{max} (recorded) = 2.7 m, Z_s = 1.1 m, Z_v ~ 0.8 m
	At least the present structure should be maintained	-	Data insufficient to assess change.

Attribute	Target	Status	Comment
Water quality	Stable nutrients levels appropriate to lake type. TP upper limit = 10 μgl^{-1}	X	Mean TP = 17.6 μgl^{-1}: Range <3 – 49 μgl^{-1} (EA 2005-09 averaged data; n=61).
	Adequate dissolved O_2 for health of characteristic fauna (> 5 mgl^{-1})	✓	DO > 8 from surface to 2.5 m,
	Stable pH values: pH ~ 5.5 (Max 7.0)	X(?)	Mean pH = 7.36: Range 6.4 – 8.9 (EA 2005/6 averaged data; n=26).
Additional data	No excessive growth of cyanobacteria or green algae	✓	No blooms present.
	Natural shoreline maintained	X(?)	Grazing present, high disturbance from anglers / walkers. SE shore artificial / embankment.
	Natural hydrological regime	✓(?)	No active management of water levels. Current level maintained by an embankment with fixed sluice. Favourable if levels maintained.

Status: ✓ = favourable; X = unfavourable; - = unable to assess

2.2 Condition Assessment Summary Table for Hatchet Pond 2011

Attribute	Target	Status	Comment
Macrophyte community composition	Oligotrophic: ≥ 1 characteristic *Littorelletea* species and ≥ 3 other species from Box 1 (unless valid reason apply)	X	*Littorella uniflora, Myriophyllum alterniflorum & Elatine hexandra* – all at low frequency. Other species were: *Chara virgata, Eleocharis acicularis, Elodea nuttallii, Nitella flexilis agg., Potamogeton crispus, P. berchtoldii, P. polygonifolius, Ranunculus aquatilis agg., Utricularia minor & Crassula helmsii.*
	No loss of characteristic species (see Box 2)	X	Similar spp. composition to 2009 and 2003 surveys (Goldsmith *et al*., 2012 & 2003), but v low abundance of *L. uniflora* in 2011. *Pilularia globulifera* absent in 2011 (but relocated in 2013 survey – Madgwick, 2013)
	≥ 6/10 vegetated sample spots (boat or wader survey) have ≥ 1 characteristic spp.	X	Only 22% of vegetated sample spots contained one of the characteristic species, a decrease from 38% in 2009 & 68% in 2003. Significant decline in cover compared to 1996 survey.
Negative indicator species	Negative indicators absent or at low frequency	✓	No negative indicators present (C. helmsii present – but see below)
	Non-native species absent or present at low frequency	X	*Crassula helmsii* common on the shoreline around north-eastern shore. *Elodea nuttallii* recorded from strandline of all sections in 2011, but not recorded growing.
	Non-Chara & -Nitella algal dominance: cover of benthic and epiphytic filamentous algae less than 10%	✓(?)	Filamentous algal growth most abundant in sections 4 & 2, but rarely abundant elsewhere.
Macrophyte community structure	Characteristic vegetation zones should be present (site specific)	X (?)	Aquatic vegetation restricted to shallow water (except in S2) and no zonation present. *L. uniflora* did not exceed 25 cm depth; *E. acicularis* present 25-75 cm; *E. hexandra* 50-75 cm; *P. berchtoldii* 25-110 cm; *M. alterniflorum* from 25-120 cm and *N. flexilis* agg. 25-130 cm. Other species rare; many only recorded at < 25 cm depth or in temporary pools in the NE shore area. The western half of the lake is heavily grazed, but with a relatively rich wetland flora. The NE shore has a more extensive hydrosere with dense growths of *M. trifoliata* & *Ludwigia palustris*. No *P. globulifera* was recorded in 2011 (but present in 2013) - unfortunately the latter species shares much of this habitat with *C. helmsii*. Marginal habitats are of considerable interest, but the aquatic community structure is less favourable.

Attribute	Target	Status	Comment
	Maximum depth distribution should be maintained	?	Zmax (recorded) = 2.4 m, Zs = 1.3 m, Zv 1.3 m in S2. Greater depth distribution than in 2009, but aquatic macrophyte beds may not have fully developed by the early June 2009 survey.
	At least the present structure should be maintained	-	Data insufficient to assess change.
Water quality	Stable nutrients levels appropriate to lake type. TP upper limit = 10 µgl-1	X	Mean TP = 19.7 µgl-1: Range 7 – 42 µgl-1 (EA 2010-12 averaged data; n=36). Mean TP 2007-09 = 19.6 µgl-1. No change since previous survey.
	Adequate dissolved O2 for health of characteristic fauna (> 5 mgl-1)	✓	DO ~ 9 mgl-1 from surface to 2.2 m. Similar in 2009.
	Stable pH values: pH ~ 5.5 (Max 7.0)	X(?)	No 2010-12 pH data, but failed for 2005-06 (EA 2005-06 data: Mean pH = 7.36: Range 6.4 – 8.9 (n=26)).
Additional data	No excessive growth of cyanobacteria or green algae	✓	No blooms present.
	Natural shoreline maintained	X(?)	Grazing present – poaching of shoreline by horses and cattle. High disturbance from anglers / walkers. SE shore artificial / embankment with road behind.
	Natural hydrological regime	✓(?)	No active management of water levels. Current level maintained by an embankment with fixed sluice. Favourable if levels maintained.

Status: ✓ = favourable; X = unfavourable; - = unable to assess