Natural England Commissioned Report NECR328

A restoration management plan for Hatchet Pond in the New Forest

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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 undertook stakeholder and public engagement and produced a final management plan for the lake based on the recommendations from *An outline management plan for Hatchet Pond, New Forest SSSI*. The plan is designed to maintain and enhance the lakes wildlife value whilst retaining it as a place the public can continue to enjoy.

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Further information
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FOOTPRINT ECOLOGY

Hatchet Pond

Restoration Management Plan 2018

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1. Introduction

Hatchet pond and the freshwaters of the New Forest

1.1 There are over one thousand ponds and lakes in the New Forest, and they are exceptional habitats for wildlife. They support an extremely varied and rich community of freshwater plants and animals, almost unmatched in any other lowland landscape in the UK. Hatchet Pond is one of these. It is a shallow lake created at the end of the eighteenth century by damming a stream to power a local mill. It is the largest body of water within the Crown Lands of the New Forest and is managed by the Forestry Commission.

1.2 While the neighbouring Little Hatchet Pond and adjoining unnamed pond are probably of natural origin, the 6.7 hectares now covered by Hatchet Pond was formed by flooding an area of marl pits, previously dug to produce lime for improving local agricultural land. The headwaters of the Hatchet stream upstream of Hatchet Pond drain part of the surrounding open semi-natural heathland common of Beaulieu Heath, which is grazed by domestic stock including cattle, ponies and donkeys.

1.3 The Pond sits in an area rich in earlier signs of activity including tumuli and ancient earthworks, and much of the surrounding heathland landscape has probably never been ploughed or cultivated. A second World War airfield to the north, now long gone, was thought to be a potential source of nutrient-enriched water; however, water quality testing carried out as part of this project indicates that this is unlikely to be the case (see Addendum to this report).

1.4 Over the past two hundred years Hatchet Pond has developed into an exceptionally rich wildlife habitat, supporting more than a third of all the wetland plant species found in the UK, and a similar diversity of invertebrates.

1.5 That diversity is a consequence of the delicately balanced water chemistry of the Pond, which itself is showing signs of changing in a way which is likely to threaten the special qualities of the Pond, if preventative measures are not taken. Such measures, taken now, can ensure that Hatchet Pond does not suffer the degenerative nutrient enrichment which has befallen similar water bodies in the region[1].

Hatchet Pond as a place to visit

1.6 Hatchet Pond is a popular year-round destination for visitors to the New Forest, particularly in the summer. The site has a car park with public conveniences and there is an ice cream van present during the season, all easily accessible from the B3054.

1.7 People come to Hatchet Pond to walk their dogs, admire the scenery and feed the wildfowl. Swimming and boating are not permitted, but people occasionally ride horses into the water.

1.8 Coarse fishing is offered under a Forestry Commission fishing permit, and fishermen describe the site as challenging but good. The main draw appears to be introduced coarse fish including large mirror carp, bream and tench, together with roach, perch, pike and eels.

[1] Key references are given within this plan. For a comprehensive list of references see Aquilina et al 2015

The exceptional wildlife value of Hatchet Pond

1.9 Over the past two hundred years Hatchet Pond has developed into a wildlife habitat which supports 133 wetland plant species - more than a third of all the wetland plant species found in the UK. The Pond has a similar diversity of invertebrates. In total, 99 species of freshwater macro-invertebrate (insects, snails etc) have been recorded, including eight species of conservation importance.

1.10 Hatchet Pond is a feature of the New Forest Site of Special Scientific Interest and is also part of the New Forest Special Area of Conservation, an international designation under the European Habitat Regulations. As well as being protected by the Wildlife and Countryside Act and the Habitats Regulations, Hatchet Pond has additional status as it is listed in the EU Water Framework Directive River Basin Management Plan. It is one of the UK's reference-condition lakes of a very high quality.

1.11 The high species-richness of the Pond is explained by a number of factors: clean unpolluted water, a history of low-intensity land management, and also the variety of habitat types within the Pond. This variety allows the Pond to support species which live on bare mineral soils alongside those requiring vegetation; and a combination of calcium-needing species like snails, and species preferring acid water.

Water quality changes at Hatchet Pond

1.12 Though right now the Pond is exceptionally rich, its delicately balanced water chemistry is showing signs of changing in a way which may threaten the special qualities of the Pond, if preventative measures are not taken. Such measures, taken now, can ensure that Hatchet Pond does not suffer the degenerative nutrient enrichment which has befallen similar water bodies in the region.

1.13 The quality of water in ponds and lakes can be measured by looking at its chemical constituents or its biological features. The most important chemical is usually

phosphorus, which is effectively a fertiliser, and pH, which shows the acidity of the water. High levels of phosphorus can encourage excessive growth of algae, which stains the water green or brown and reduces the light available to larger aquatic plants, thereby weakening them and affecting food and shelter for invertebrates. When the algae die, they are broken down by bacteria and the increase in bacterial activity uses up much of the oxygen dissolved in the water, with further damaging effects on plants, invertebrates and fish. If the acidity of the water also drops, these effects can become more marked.

1.14 Water samples taken from Hatchet Pond during 2013/14 showed that phosphorus levels were increasing, and acidity was decreasing – both worrying signs.

1.15 Similarly, measures of biological health include assessments of the number and kinds of creatures and algae floating in the water, and the presence and abundance of characteristic aquatic plants. Hatchet Pond does not currently score well for any of these measures under the Water Framework Directive.

Early-stage deterioration at Hatchet Pond and its possible causes

1.16 Nationally important places for nature conservation are also assessed periodically by the government wildlife agency, Natural England. They classify sites as favourable or unfavourable and Hatchet Pond has been assessed as 'unfavourable-declining', because of high levels of algae covering the vegetation indicating high nutrient levels, the presence of the introduced invasive plant, New Zealand pygmy weed *Crassula helmsii*, and the presence of introduced fish species.

1.17 Though smaller than Hatchet Pond, the case of another New Forest water body, Cadman's Pond, provides a cautionary example of the consequences of these changes going unchecked. Cadman's Pond suffered a similar range of issues which were not recognised at the time and is now considered by some experts to be seriously biologically degraded, as well as looking unpleasant for the visitor with muddy, silt-laden water.

Introduced fish

1.18 Bottom-feeding fish like carp, bream and tench stir up the sediments as they feed, which causes the water to fill with suspended silt which reduces light levels (i.e. the water becomes turbid). Disturbance to the sediments is also caused by people wading into the water or dogs swimming out to retrieve sticks or balls. Sediments can also come from soil erosion around the Pond caused by visitor activity and by livestock. Livestock have been present for decades, but increased recreational use is more recent. Surveys over the last twenty years have noted increasing amounts of suspended silts in the waters of the Pond, and aerial photographs show a marked increase in erosion around the margins. Once sediments get into the water, if they sink to the bed of the Pond and stay there, plants can grow up through them to find light in the water above. However, if the bed of the Pond is disturbed by fish, people or animals, this causes sediments to spread back into the water, releasing nutrients, making the water turbid (cloudy) and reducing light levels.

Nutrients

1.19 In recent surveys of Hatchet Pond the submerged plants have been found to be covered with a thick layer of algae, which is a symptom of high nutrient levels, something not recorded in previous surveys. Nutrients could be reaching the Pond from the atmosphere (from industry, transport and agriculture, which we can do nothing locally to control), from drainage from surrounding land (the car park/toilet block, the road or the wider landscape), from erosion of the banks of the Pond, from the use of ground bait by anglers, or from food given to waterfowl which accumulates on the bed of the Pond or even from relics from the use of the area during the Second World War.

Exotic plants

1.20 With climate change and the movement of plants for horticulture from around the world, an increasing number of exotic plants are becoming introduced into the UK. These plants can spread rapidly, having few natural enemies to keep them in check, and in extreme cases can smother native flora and affect their associated fauna. Some are difficult or expensive to control. The best opportunity for removing these species and preventing their spread is when they are first found in limited numbers and areas. There are three introduced invasive plants in Hatchet Pond and although elimination of these is not currently possible, their spread can be limited. Containing or reducing the presence of introduced invasive plant species in Hatchet Pond, and preventing any additional introductions would be an important step in the right direction.

The need for monitoring

1.21 In order to establish the success or otherwise of any measures to improve the water quality at Hatchet Pond it will be essential to continue to monitor the condition of the lake and its wildlife. That means gathering good information about the current qualities of the Pond, as a baseline, to allow comparisons over future years. Monitoring the use of the site by the visiting public will allow future management to provide the right facilities and identify potential pressures.

Taking action to conserve Hatchet Pond for the future

1.22 The Forestry Commission, as managers of the Pond are keen to improve the water quality and biological condition of Hatchet Pond, and to maintain good facilities for visitors. Hatchet Pond is one of the most important freshwater ponds in England, with national and international designations. Visitors should be able to appreciate its special features and rare species, and understand its management, while enjoying their visit.

1.23 Natural England and the Forestry Commission are anxious to prevent Hatchet Pond succumbing to the same fate as Cadman's Pool. They have therefore commissioned Footprint Ecology to prepare this management plan for the Pond in order to help maintain and enhance its wildlife value and retain it as a place the public can enjoy.

2. Description of the site

Location

2.1 Hatchet Pond is situated within Beaulieu Heath, in the Parish of East Boldre, in the south east of the New Forest National Park, at OS grid reference SU 367014. It lies next to the junction of the B3054 and B3055, from which an access track leads to a car park and facilities at the north-east end of the Pond.

Tenure

2.2 Throughout its history, Hatchet Pond has been located within the Crown Lands, managed today by the Forestry Commission. The surrounding area is all common land, grazed by domestic livestock.

Other rights

2.3 As a common, and as enshrined in open-access legislation, the land around Hatchet Pond has unrestricted public access.

Statutory designations

2.4 Hatchet Pond was first recognised for its national importance 50 years ago in the Nature Conservation Review of 1977 (Ratcliffe 1977). The wider New Forest within which the Pond lies was designated as a Site of Special Scientific Interest in 1971, then a Special Area of Conservation under the Habitats Directive (Council Directive 92/43/EEC) in 2000, and a National Park in 2005. The whole of the New Forest was also designated in 1993 under the Ramsar Convention as a Wetland of International Importance.

2.5 The SSSI Unit for Hatchet Pond (Unit 449) was assigned a condition of Unfavourable-Declining when last assessed in 2013.

Maps

2.6 The area is covered by OS 1:25,000 Explorer sheet OL22, and by OS 1:50,000 Landranger sheet 196. Historically, Hatchet Pond first appears on Greenwood's Hampshire map of 1826.

Geology and topography

2.7 Hatchet Pond lies at an altitude of 39 metres above sea level. It has a surface area of 6.7 hectares, a perimeter of 1.8 kilometres, and a maximum depth of 2.7 metres, though the mean depth is only 1 metre.

2.8 The geology underlying the Pond is formed from organic sedimentary material. The Headon Formation is comprised of grey-green marl clays and sands with a high concentration of fossilised bivalves and gastropods. This makes it an ideal source of lime for improving acid soils and explains the concentration of old marl pits in the area. The overlying drift geology is river terrace deposits of silts and gravels, which vary in thickness, with the marl outcropping in places, making for a varied substrate giving rise to the diverse habitats around the Pond.

Hydrology

2.9 Hatchet Pond was created by damming the Hatchet Stream just 1 kilometre east of the stream's source. The Pond and Stream form a sub-catchment of the Beaulieu River catchment, with a catchment area of 212 hectares. The Stream continues to flow east from the Pond to join with the main Beaulieu River 5 kilometres away, close to its confluence with the Solent.

2.10 There are several other, smaller waterbodies around Hatchet Pond, some having originated as marl or gravel pits and some being probably natural. Hatchet Little Pond and a smaller unnamed pond lie to the south; Hatchet Triangle, containing a complex of small ponds, lies to the east beyond the road; and a temporary unnamed pond lies at the north-east corner, beside the toilet block.

2.11 There are two major inflows draining into Hatchet Pond (one being Hatchet Stream, and the other a smaller spring entering the north-east bay of the lake), and multiple smaller seepages. There were originally two sluice outflows through the dam, a lower one opposite Hatchet Mill, and an upper one further to the north, but since the 1980s only the upper sluice has been functional.

Vegetation

2.12 The Pond is surrounded to the north, west and south by a mosaic of dry heathland, acid grassland, wet heath and mire, with emergent aquatic plants being prominent on the northern edges of the open water, but largely absent on the more disturbed southern edges. On the northern bank there is a limited band of goat willow and some planted pines.

Landscape

2.13 Hatchet Pond sits on the edge of the low-lying, relatively level landscape of gently rolling heathland and valley mires of Beaulieu Heath, which itself lies on the south eastern edge of the main New Forest heaths. To the east of the Pond, across the B3054, the land falls away slightly into enclosed farmland.

3. Cultural Heritage

Historical land use and archaeology

3.1 The area around Hatchet Pond contains evidence of Bronze Age activity, in the form of at least six small bowl barrows (tumuli) within 1 kilometre of the Pond to the north and west. There is also a linear earthwork running north from the upper reaches of the Hatchet stream, 400 metres west of the Pond.

3.2 Hatchet Pond takes its name from Hatchet Gate, on the edge of the common to the immediate east. The name 'Hatchet' is itself said to have meant 'gateway', referring to a point through which commoners would drive their ponies and cattle from smallholdings onto the Forest to graze.

3.3 Hatchet Pond was created between 1787 and 1801, originally to provide a head of water to power Hatchet Mill, a corn mill. Its biological diversity is at least partly a consequence of it having lain within a largely unchanging pastoral landscape ever since.

3.4 A wartime airfield was established on Beaulieu Heath, 1 kilometre to the west of Hatchet Pond, in 1941. This was in use until 1950 and was finally decommissioned and handed back to the Forestry Commission in 1959.

Public access and use

3.5 Hatchet Pond is a popular recreational destination year-round, easily accessed from the B3054, with a car park, public toilet and an ice cream van concession. Visitors come for sightseeing, dog walking and feeding the wildfowl. There are informal tracks around the margins of the Pond. Swimming and boating are not allowed.

3.6 Coarse fishing permits are offered by the Forestry Commission, and anglers have been attracted by the presence of large mirror carp, bream and tench.

4. Biological Interest

Overview

4.1 Hatchet Pond is classified under the Habitats Directive as an 'Oligotrophic water containing very few minerals of sandy plains (*Littorelletalia uniflorae*)', and supports communities associated with both low alkalinity and moderate alkalinity water bodies.

4.2 It has a very high plant species and invertebrate richness and species rarity, as a consequence of its habitat variety, clean water and low intensity management history. The site supports more than a third of all the wetland plant species recorded in the whole of the UK.

4.3 With respect to invertebrates, in a comparison with national data Hatchet Pond was ranked the third most species-rich, amongst 13 of the UK's best small lakes surveyed by Pond Action in 1992. Hatchet was found to support 58 species, while the pond considered the best in Britain supported 73, and the average for all surveyed ponds was 36.

4.4 Species information stated below comes from the Hampshire Biological Information Centre, as quoted in Aquilina, Ewald & Biggs 2015 unless otherwise stated.

Freshwater, wetland and wet heath habitats

4.5 A total of 133 wetland plant species have been recorded from Hatchet Pond, including 11 classified as important for nature conservation (see 4.11). The botanical interest is associated with the northern and western margins of the Pond, while the southern margins, which include the artificial embankment, are largely bare of vegetation.

4.6 Typical water plants include Shoreweed *Littorella uniflora*, Floating Club-rush *Eleogiton fluitans*, Six-stamened Waterwort *Elatine hexandra*, Pillwort *Pilularia globulifera*, Alternate Water-milfoil *Myriophyllum alterniflorum* and Lesser Marshwort *Apium inundatum*. The northern bay is dominated by Bogbean *Menyanthes trifoliata* and Hampshire purslane *Ludwigia palustris*, with non-native Water Lily *Nymphaea sp*. and the non-native invasive New Zealand Pygmy-weed *Crassula helmsii*.

4.7 A total of 99 species of freshwater macroinvertebrate have been recorded from Hatchet Pond (excluding Diptera). In addition, the stream and ditches which feed into the Pond support a variety of dragonflies and damselflies.

4.8 Eight species of fish have been recorded from Hatchet Pond (Giles 2002): 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 Common Eel *Anguilla anguilla*.

Protected species

4.9 Four species of bat are regularly recorded feeding around and over Hatchet Pond: Daubenton's Bat *Myotis daubentonii*, Common Pipistrelle *Pipistrellus pipistrellus*, Soprano Pipistrelle *Pipistrellus pygmaeus* and Brown Long-eared Bat *Plecotus auritus*.

4.10 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. Great Crested Newts do not appear to be regular breeders in the main Pond but favour the ponds in Hatchet Triangle.

Rare, threatened and local species

4.11 The Pond supports 11 wetland plant species of importance for nature conservation. These are: Lesser Water-plantain *Baldellia ranunculoides* (IUCN Near Threatened); Yellow Centaury *Cicendia filiformis* (Vulnerable); Coral Necklace *Illecebrum verticillatum* (Vulnerable); Marsh Clubmoss *Lycopodiella inundata* (Endangered); Pennyroyal *Mentha pulegium* (Endangered); Smooth Stonewort *Nitella flexilis* (Nationally Scarce); Pointed Stonewort *Nitella mucronata* (Nationally Scarce); Small Water-pepper *Persicaria minor* (Vulnerable); Pillwort *Pilularia globulifera* (IUCN Near Threatened); New Forest Water-crowfoot *Ranunculus novae-forestae* (Nationally Rare); and Brown Beak-sedge *Rhynchospora fusca* (Nationally Scarce).

4.12 Eight species of invertebrate have been recorded from Hatchet Pond that are classified as important for nature conservation at a national or international level. These include six water beetles: Bladderwort Flea-beetle *Longitarsus nigerrimus* (Endangered); *Dryops striatellus* (Nationally Scarce); *Graptodytes flavipes* (IUCN Near Threatened); *Helochares punctatus* (Nationally Scarce); *Hydrovatus clypealis* (Nationally Scarce); *Paracymus scutellaris* (Nationally Scarce); and one weevil: *Bagous brevis* (Endangered, associated with Lesser Spearwort). The Medicinal Leech *Hirudo medicinalis* (IUCN Near Threatened) is also present.

4.13 The ditches feeding the Pond support Southern Damselfly *Coenagrion mercuriale* (IUCN Near Threatened, a Priority Species of the New Forest SAC, and a S41 species)[2] and Small Red Damselfly *Ceriagrion tenellum* (Nationally Scarce).

4.14 Common Eel are included on S41 of the post-2010 Biodiversity Framework because of severe declines in the numbers of spawning migrants.

[2] A Section 41 species is one of England's rarest and most threatened species as listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006.

Other species

4.15 123 bird species have been recorded within a 1kilometre radius of Hatchet Pond, of which 85 were from the Pond itself.

5. Vision

Hatchet Pond will remain one of the most biologically diverse freshwater bodies in Britain, recognised and cherished as first and foremost a wildlife refuge, especially for its plant life and invertebrate fauna, which will continue to benefit from high quality, low nutrient status water. The Pond will continue to be open to the public for quiet enjoyment, including walking, sightseeing and angling, with those activities managed in such a way that the fundamental biological qualities of the site are not compromised, and the public can learn more about this unique feature of the New Forest landscape.

6. Objectives

6.1 Objectives and actions to achieve them are presented here and summarised in Table 1. Note that some actions meet more than one objective as can be seen in Table 1. New actions are differentiated from existing actions that should be continued by the use of a bold font.

Objective 1: Maintain the integrity of the impoundment structure at Hatchet Pond

Rationale

6.2 Hatchet Pond is an artificial feature (albeit of considerable age) and relies on the integrity of the retaining dam for its survival as a water body. The maintenance of the dam is of vital importance in conserving the biological and amenity value of the water body and should be kept structurally sound and leak proof. Hatchet Pond has a capacity of 75,000 cubic metres and therefore requires 12-monthly inspection under the Reservoirs Act 1975, Section 10(2).

Actions

- Maintain an on-site reservoir flood plan in consultation with the Environment Agency
- Engage a suitably qualified surveyor to carry out regular inspections of the dam structure and carry out any recommended repairs or improvements to the dam structure.
- Maintain structures to reduce wave action and subsequent bank erosion
- Maintain eel pass (see Objective 6).

Objective 2: Achieve and maintain:

a) High water quality and biological standards under the Water Framework Directive

b) Favourable condition under SAC/SSSI common standards condition monitoring

Rationale

6.3 Problems from high nutrient levels and the attendant excessive algal growth are thought to have driven a decline in aquatic plants, a feature of the pond that is of national importance. There have been declines in several of the characteristic species of the pond and some species can no longer be found, including two nationally uncommon species. In a survey from 2013 (Madgewick 2013), plants were covered with a thick layer of algae (a symptom of high nutrient levels), a feature not recorded in an earlier survey in 1996 (Bennion, Monteith & Appleby 1997). Sources of nutrients are likely to be from a combination of atmospheric deposits (from industry, transport and agriculture), drainage from surrounding areas

(the car park/toilet block and the road), bank erosion, the use of ground bait by anglers, food given to waterfowl and accumulating on the bed of the pond directly or from their droppings. No actions are possible at site level to address atmospheric inputs.

Actions

- **Investigate the position, functions and nutrient inputs from any drains from the car park and divert these to soakaways.**
- **Remove the toilets as part of the recreation re-structure.**
- **Redesign the car park to move cars away from the water's edge, but retain parking with views across the Pond, especially for those with limited mobility.**
- **Take measures to ensure bank erosion is not exacerbated by people and dogs accessing the water from the car park area.**
- **Ensure fishing permits for Hatchet Pond include the prohibition of all ground baiting.**
- **Use volunteer ranger presence and signage to explain the problems caused by feeding of wildfowl in or around the pond to discourage this activity.**

Objective 3: Achieve a reduction in turbidity in the lake and restoration of clear water for the benefit of aquatic flora and fauna and visual improvement for the benefit of visitors.

Rationale

6.4 Sediments washing into the Pond contain nutrients from surrounding areas, increasing algal growth and with the finer silt elements coating the leaves of aquatic plants. If sediment sinks to the bed of the pond and stays there, it can lock up nutrients and plants can grow up through it to find light in the water column above. However, if it is disturbed, the finer silts spread into the water column, releasing nutrients, increasing turbidity and reducing light levels. Water levels in the lake should be maintained at their existing levels which have proved suitable for a wide variety of flora and fauna over a long period of time. Some actions already listed under Objective 1 will help to reduce sediment inputs into the Pond from bank erosion and drainage.

Actions

- Maintain the existing sluice and outlet pipe to existing levels.
- **Use volunteer ranger presence and signage to explain the problems caused by feeding of wildfowl in or around the pond to discourage this activity**
- **Take measures to ensure bank erosion is not exacerbated by people and dogs accessing the water from the car park area.**
- **Ensure fishing permits for Hatchet Pond include the prohibition of all ground baiting**
- **In partnership with anglers, carry out a netting programme to ascertain the characteristics of the fish community at Hatchet Pond and remove any carp from the pond; relocate carp at a suitable agreed alternative site for angling.**
- **Retain Hatchet Pond as a coarse fishery based around roach, rudd, perch and pike**
- **Following consultation with angling representatives, apply limits to the number of seasonal and daily fishing permits available to prevent over-fishing.**

Objective 4: Remove alien aquatic invasive plants from Hatchet Pond where possible, or contain existing and prevent colonisation by additional species or populations through management and educational initiatives

Rationale

6.5 The threat from invasive aquatic alien plants has increased with climate change and the movement of plants for horticulture and gardening from around the world. There are a number of highly invasive aquatic plants already present in the wild and several others which are already spreading in mainland Europe and are potential colonisers from here or elsewhere. These plants can rapidly take over, smothering native flora and affecting their attendant fauna. They tend to have few if any natural enemies and also support far fewer dependent wildlife species. Some are especially difficult or expensive to control. The best chance of removing these aliens and preventing their spread is when they are first found in limited numbers and areas. If no action is taken, removal may become impossible or will be more difficult and expensive. There are three alien invasive plants in Hatchet Pond and elimination of these is not currently possible. Biological control methods are under investigation and could be used at Hatchet Pond in the future.

Actions

- **Ensure that staff, volunteers and the public are aware of the potential problem of alien aquatic invasive plants and that staff and volunteers can recognise the commoner invasive species with access to means of identification of others.**
- **See also Objective 12: Monitoring.**
- **Use biological controls to treat *Crassula* (and other alien invasive species) if and when these become available**

Objective 5: Facilitate the provision of an eel pass on the outlet sluice from the Pond.

Rationale

6.6 The European eel is a native species and is in serious decline. It is naturally present in the catchment but occurs only in small numbers in Hatchet Pond. An eel pass would encourage elvers and smaller eels to enter the Pond and is in line with achieving good ecological potential under the Water Framework Objective.

Actions

- **Facilitate the installation and subsequent maintenance of an eel pass in the lake outlet by the Environment Agency.**

Objective 6: Provide suitable facilities for visitors to enjoy the area whilst mitigating for increased erosion or an increase in activities which could damage the biological interest of Hatchet Pond and its surrounds.

Rationale

6.7 Hatchet Pond is part of the New Forest National Park where there is open-access and visits by the public are welcomed and encouraged. However, it is always necessary to be aware that the number of visitors or their activities can place extreme pressures on the places they visit and have come to enjoy. Hatchet Pond is a particularly vulnerable site due to the sensitivity of its aquatic habitats to nutrient and sediment inputs. Evidence suggests that the biological condition of the Pond has deteriorated and that the evidence of visitor pressure has increased.

Actions

- **Input into the Forestry Commission review of facilities at Hatchet Pond, guided by the following:**

    a. **That additional visitors should not be encouraged to come to Hatchet Pond by the provision of services or facilities which could be provided in less sensitive locations elsewhere**
    b. **That any changes to the structure of the access and parking provision should set a clear limit on the numbers of parking spaces available.**

- **Review visitor routes around the pond and where possible set these back from the pond edge and manage desire lines to reduce bank erosion.**

Objective 7: Give visitors information about the site, its importance and sensitivity

Rationale

6.8 Hatchet Pond is one of the most important freshwater ponds in England, with national and international designations. Visitors should be able to come and see and enjoy this important site whilst appreciating its special features and rare species. Visitors need to be given the information on the activities which could harm the special features of the site as to why these are necessary and what benefits they will have. This applies particularly to activities such as feeding wildfowl or encouraging dogs to take to the water.

Actions

- **Update the car park information board to provide information and interpretation that will help visitors understand why they should avoid feeding wildfowl and entering the water and promote responsible dog walking (e.g. picking up dog faeces, not allowing dogs to enter the water)**
- **Provide engaging information both on-site and on statutory agency and partners websites and via social media to help visitors to identify and appreciate some of the site features and species**
- **Use volunteer rangers to assist in educating the public, including asking dog walkers to pick up after their pets and to follow the New Forest dog walking code.**

Objective 8: Liaise with local community, adjoining landowners, statutory bodies and other stakeholders

Rationale

6.9 Hatchet Pond is used for a variety of informal recreational activities. Good contact and a close relationship with the local community, adjoining landowners and statutory bodies such as parish and district councils, the Verderers, Natural England, the National Park Authority and Environment Agency is essential for the well-being of the site. Dog walkers are usually the largest user group on any open access land, and in the New Forest the National Park Authority (NPA) organises a Dog Forum that includes the New Forest Dog Owners Group, while fishermen are represented by a number of local clubs and associations.

Actions

- Continue to liaise with all the interested groups during the implementation of this management plan via websites, notice boards, social media and rangers on site.
- **Engage with the NPA Dog Forum to share information about Hatchet pond and more general information about dogs on the forest.**
- Continue to engage with the angling community during the implementation of this plan**.**

Objective 9: Liaise with the National Park Authority Archaeologist over management of the site

Rationale

6.10 Hatchet Pond has a long history from its creation some 200 years ago to the present day. It was preceded by the excavation of a number of marl pits, some of which were flooded when the Pond was created. It sits in an area rich in earlier signs of activity including two tumuli and an ancient earthwork. Much of the surrounding heathland landscape has probably never been ploughed or cultivated.

Actions

- **Consult with the National Park Authority Archaeologist on the best measures to conserve archaeological features on the site and if necessary, ask for a walk-over survey to be conducted.**
- **Based on this advice prepare a sensitivity map to be used to guide any special precautions to be taken to protect historic or archaeological features during management work.**

Objective 10: Maintain site infrastructure

Rationale

6.11 Visitors respect a well-maintained site and are more likely to co-operate with site managers in keeping the area clean and tidy if site infrastructure is looked after and they are kept well informed about management activities.

Actions

- Maintain car parks, dragon's teeth and other structures in good and usable condition.
- Maintain all notice boards and other information material and update as necessary.

Objective 11: Carry out all statutory and other duties as site manager

Rationale

6.12 As site manager, the Forestry Commission will need to meet all their statutory obligations both to manage the site for its wildlife and to ensure the well-being and safety of the visiting public.

Actions

- **Meet all requirements for statutory consents and approvals for work on and around the Pond**
- **Follow Health and Safety guidelines for warning the public during management activities on the site and ensure that contractors or others working on the site follow the same procedures**
- Continue to carry out regular Health and Safety checks on the site
- Continue to take steps to prevent undesirable activities on the site which could pose a hazard to the wildlife interest or the visiting public.

Objective 12: Continue to monitor the biological and chemical features of the site and institute a monitoring programme to establish a base line on visitor numbers, patterns and behaviour

Rationale

6.13 In order to establish the success or otherwise of measures to improve the water quality at Hatchet Pond it will be essential to continue to monitor the condition of the lake and its flora and to establish a base line for future comparison of the invertebrate fauna and flora of the Pond.

6.14 It would be desirable to establish a base line and future monitoring programme of the visitor pressure on the site to detect changes following the implementation of any strategy for the provision of facilities by the Forestry Commission - the baseline may be established through the New Forest Recreation Study currently being undertaken for NPA (autumn 2018 and spring and summer 2019).

6.15 Some of the monitoring will be done by organisations such as the Environment Agency and Natural England and, as site manager, the Forestry Commission will need to take account of the results from these schemes.

Actions

- Continue to take account of the monitoring of water quality and biological standards under the Water Framework Directive by the Environment Agency [3].
- Continue take account of the results of Common Standards Monitoring of the SAC/SSSI by Natural England (NB due around 2024)

[3] Hatchet Pond is considered a highly modified water body under WFD but as water dependent Habitats Directive features are classed as Protected Areas under the WFD, there is an assumption that the most stringent targets of the two Directives should apply.

- **Implement 10-yearly monitoring of invertebrates and macrophytes in collaboration with the Freshwater Habitats Trust (FHT) as part of the FC National Priority Pond Survey using a standardised methodology (SYM) (to include invertebrates, macrophytes and invasive alien species).**
- **Implement water quality monitoring following the protocol already used by FHT. To be carried out by FC and New Forest Catchment Partnership volunteers.**
- **Implement and maintain an ongoing fixed point photography monitoring programme around the pond margins to identify and record any changes in the marginal vegetation and bank profile/shape.**
- **Monitor indicator species (e.g. Bog Orchid *Hammarbya paludosa*, Pillwort *Pilularia globulifera* and Coral Necklace *Illecebrum verticillatum)* in association with the Hampshire Flora Group to identify any changes in surrounding vegetation (including seepage mires and short grassland).**
- **In conjunction with FWT, implement annual eDNA fish monitoring[4] with the local angling community[5].**
- **Ideally, install car counters in the car park entrance to establish number of visiting cars and carry out random counts of car occupancy (with volunteers) to estimate total visitor numbers monthly[6].**
- **If resources allow, commission an observational study of visitor behaviour before and after the measures described in Objectives 1,2, 5 and 6 above are carried out.**

[4] This is a more effective method than electro-fishing to assess species diversity
[5] Kits can be provided by FHT
[6] Liaison should be carried out with the New Forest Recreation Study as to methodologies

Table 1: Summary of recommended actions by objective. Refer to the main text for further information.

Actions	Objective 1 Maintain impoundment structure	Objective 2 Water quality & biological standards	Objective 3 Turbidity	Objective 4 Invasive plants	Objective 5 Eel pass	Objective 6 Visitor	Objective 7 Visitor info	Objective 8 Site	Objective 9 Liaison	Objective 10 Archaeology	Objective 11 Maintain other infrastructure	Objective 12 Monitoring
1. Maintain an on-site reservoir flood plan in consultation with the Environment Agency	✓											
2. Engage a suitably qualified surveyor to carry out regular inspections of the dam structure every 12 months. Carry out any recommended repairs or improvements to the dam structure.	✓											
3. Maintain structures to reduce wave action and subsequent bank erosion	✓	✓	✓									
4. Maintain eel pass (see Objective 6)	✓				✓							
5. Maintain the existing sluice and outlet pipe to existing levels.	✓		✓									
6. Investigate the position, functions and nutrient inputs from any drains from the car park and divert these to soakaways.		✓										
7. Remove the toilets as part of the recreation re-structure.		✓										
8. Re-design the car park to move cars away from the water's edge, but retain parking with views across the Pond, especially for those with limited mobility.		✓	✓									
9. Ensure fishing permits include the prohibition of all ground baiting.		✓	✓									
10. In partnership with anglers, carry out a netting programme to ascertain the characteristics of the fish community at Hatchet Pond and remove any carp from the pond; relocate them at a suitable agreed alternative site for angling.		✓	✓						✓			

Actions	Objective 1 Maintain impoundment structure	Objective 2 Water quality & biological standards	Objective 3 Turbidity	Objective 4 Invasive plants	Objective 5 Eel pass	Objective 6 Visitor	Objective 7 Visitor info	Objective 8 Site	Objective 9 Liaison	Objective 10 Archaeology	Objective 11 Maintain other infrastructure	Objective 12 Monitoring
11. Retain Hatchet Pond as a coarse fishery based around roach, rudd, perch and pike			✓									
12. Following consultation with angling representatives, apply limits to the number of seasonal and daily fishing permits available to prevent over-fishing.									✓			
13. Ensure that staff, volunteers and the public are aware of the potential problem of alien aquatic invasive plants and that staff and volunteers can recognise the commoner invasive species with access to means of identification of others.			✓					✓				
14. Facilitate the installation and subsequent maintenance of an eel pass in the lake outlet by the Environment Agency.	✓				✓							
15. Input into FC recreation review regarding visitor facilities at Hatchet Pond.						✓						
16. Review visitor routes around the pond and where possible set these back from the pond edge and manage desire lines to reduce bank erosion.						✓						
17. Update the car park information board to help visitors understand why they should avoid feeding wildfowl and entering the water and promoting responsible dog walking		✓	✓	✓			✓					
18. Provide engaging information both on-site and on statutory agency and partners websites and via social media to help visitors to identify and appreciate some of the site features and species.							✓					
19. Use volunteer rangers to assist in educating the public, including about feeding wildfowl and responsible use of the site for dog walkers.		✓	✓				✓					

Actions	Objective 1 Maintain impoundment structure	Objective 2 Water quality & biological standards	Objective 3 Turbidity	Objective 4 Invasive plants	Objective 5 Eel pass	Objective 6 Visitor	Objective 7 Visitor info	Objective 8 Site	Objective 9 Liaison	Objective 10 Archaeology	Objective 11 Maintain other infrastructure	Objective 12 Monitoring
20. Continue to liaise with all stakeholders (including NPA dog forum and angling community) during the implementation of this management plan via the website, notice board and rangers on site.								✓				
21. Consult with the National Park Authority Archaeologist on the best measures to conserve archaeological features on the site.									✓	✓		
22. Prepare a sensitivity map to be used to guide any special precautions to be taken to protect historic or archaeological features during management work.										✓		
23. Maintain car parks, dragon's teeth, noticeboards and other structures in good and usable condition.											✓	
24. Meet all requirements for statutory consents and approvals for work and follow H&S guidelines during work.											✓	
25. Continue to carry out regular Health and Safety checks on the site.											✓	
26. Continue to take steps to prevent undesirable activities on the site which could pose a hazard to the wildlife interest or the visiting public.											✓	
27. Continue to take account of monitoring under the Water Framework Directive (EA) and Common Standards Monitoring (NE).												✓
28. Implement 10-yearly monitoring of invertebrates and macrophytes (including alien invasive species) in collaboration with the Freshwater Habitats Trust (FHT).												✓

Actions	Objective 1 Maintain impoundment structure	Objective 2 Water quality & biological standards	Objective 3 Turbidity	Objective 4 Invasive plants	Objective 5 Eel pass	Objective 6 Visitor	Objective 7 Visitor info	Objective 8 Site	Objective 9 Liaison	Objective 10 Archaeology	Objective 11 Maintain other infrastructure	Objective 12 Monitoring
29. Implement and maintain an ongoing fixed-point photography monitoring programme around the pond margins to identify and record any changes in the marginal vegetation and bank profile/shape.												✓
30. Monitor indicator species in association with the Hampshire Flora Group to identify any changes in surrounding vegetation.												✓
31. Implement water quality monitoring following the protocol already used by FHT. To be carried out by FC and New Forest Catchment Partnership volunteers.												✓
32. In conjunction with FWT, implement annual eDNA fish monitoring[7] with the local angling community using kits provided by FHT.												✓
33. Install car counters in the car park entrance to establish number of visiting cars and carry out random counts of car occupancy (with volunteers) to estimate total visitor numbers monthly. Liaise with the New Forest Recreation Study, for visitor interview data.												✓
34. If resources allow, commission an observational study of visitor behaviour before and after the measures described in Objectives 1,2, 6 and 7 above are carried out.												✓

[7] This is a more effective method than electro-fishing to assess species diversity.

7. Work Programme

7.1 This section presents a timetable for the actions listed in Section 6 above. It is currently assumed that Year 1 will be 2019. Timings are indicative at this stage and the timing of some actions may depend upon others being achieved in a timely manner. Actions that involve continuing activities that are already undertaken (those in bold in the text of Section 6) are grouped at the end of the table.

Table 2: Work programme for restoration work at Hatchet Pond. Numbering relates to that in Table 1.

No.	Action	Yr 1	Yr 2	Yr 3	Ongoing
6	Investigate the position, functions and nutrient inputs from any drains from the car park and divert these to soakaways.	✓			
7	Remove the toilets as part of the recreation re-structure.		✓		
8	Re-design the car park to move cars away from the water's edge, but retain parking with views across the Pond, especially for those with limited mobility.		✓		
9	Ensure fishing permits include the prohibition of all ground baiting.	✓	✓	✓	✓
10	In partnership with anglers, carry out a netting programme to ascertain the characteristics of the fish community at Hatchet Pond and remove any carp from the pond; relocate them at a suitable agreed alternative site for angling.	✓			
11	Retain Hatchet Pond as a coarse fishery based around roach, rudd, perch and pike	✓	✓	✓	✓
12	Following consultation with angling representatives, apply limits to the number of seasonal and daily fishing permits available to prevent over-fishing.	✓	✓	✓	✓
13	Ensure that staff, volunteers and the public are aware of the potential problem of alien aquatic invasive plants and that staff and volunteers can recognise the commoner invasive species with access to means of identification of others.	✓	✓	✓	✓
14	Facilitate the installation and subsequent maintenance of an eel pass in the lake outlet by the Environment Agency.	✓	✓	✓	✓
15	Input into FC recreation review regarding visitor facilities at Hatchet Pond.	✓			
16	Review visitor routes around the pond and where possible set these back from the pond edge and manage desire lines to reduce bank erosion.	✓			
17	Update the car park information board to help visitors understand why they should avoid feeding wildfowl and entering the water and promoting responsible dog walking		✓		
18	Provide engaging information both on-site and on statutory agency and partners websites and via social media to help visitors to identify and appreciate some of the site features and species.		✓	✓	✓

No.	Action	Yr 1	Yr 2	Yr 3	Ongoing
19	Use volunteer rangers to assist in educating the public, including about feeding wildfowl and responsible use of the site for dog walkers.	✓	✓	✓	✓
20	Continue to liaise with all stakeholders (including NPA dog forum and angling community) during the implementation of this management plan via the website, notice board and rangers on site.	✓	✓	✓	✓
21	Consult with the National Park Authority Archaeologist on the best measures to conserve archaeological features on the site.	✓			
22	Prepare a sensitivity map to be used to guide any special precautions to be taken to protect historic or archaeological features during management work.	✓			
24	Meet all requirements for statutory consents and approvals for work and follow H&S guidelines during work.	✓	✓	✓	✓
28	Implement 10-yearly monitoring of invertebrates and macrophytes (including alien invasive species) in collaboration with the Freshwater Habitats Trust (FHT).	✓			✓
29	Implement and maintain an ongoing fixed-point photography monitoring programme around the pond margins to identify and record any changes in the marginal vegetation and bank profile/shape.	✓	✓	✓	✓
30	Monitor indicator species in association with the Hampshire Flora Group to identify any changes in surrounding vegetation.	✓	✓	✓	✓
31	Implement water quality monitoring following the protocol already used by FHT. To be carried out by FC and New Forest Catchment Partnership volunteers.	✓	✓	✓	✓
32	In conjunction with FWT, implement annual eDNA fish monitoring with the local angling community using kits provided by FHT.	✓	✓	✓	✓
33	Install car counters in the car park entrance to establish number of visiting cars and carry out random counts of car occupancy (with volunteers) to estimate total visitor numbers monthly. Liaise initially with the New Forest Recreation Study, for visitor interview data.	✓	✓	✓	✓
34	If resources allow, commission an observational study of visitor behaviour before and after the measures described in Objectives 1,2, 6 and 7 above have been carried out.	✓	✓		
1	Maintain an on-site reservoir flood plan in consultation with the Environment Agency	✓	✓	✓	✓
2	Engage a suitably qualified surveyor to carry out regular inspections of the dam structure. Carry out any recommended repairs or improvements to the dam structure.	✓	✓	✓	✓
3	Maintain structures to reduce wave action and subsequent bank erosion	✓	✓	✓	✓
4	Maintain eel pass (see Objective 6)	✓	✓	✓	✓
5	Maintain the existing sluice and outlet pipe to existing levels.	✓	✓	✓	✓
23	Maintain car parks, dragon's teeth, noticeboards and other structures in good and usable condition.	✓	✓	✓	✓

No.	Action	Yr 1	Yr 2	Yr 3	Ongoing
25	Continue to carry out regular Health and Safety checks on the site.	✓	✓	✓	✓
26	Continue to take steps to prevent undesirable activities on the site which could pose a hazard to the wildlife interest or the visiting public.	✓	✓	✓	✓
27	Continue to take account of monitoring under the Water Framework Directive (EA)[8] and Common Standards Monitoring (NE).[9]	✓	✓	✓	✓

8. Bibliography

Aquilina, R., Ewald, N. & Biggs, J. (2015) *An Outline Lake Management Plan for Hatchet Pond, New Forest SSSI.* Freshwater Habitats Trust, Oxford.

Bennion, H., Monteith, D. & Appleby, P. (1997) *Nutrient Reconstructions in Standing Waters: Final Report*. English Nature Research Reports No 252, Peterborough.

Giles, N. (2002) *Hatchet Pond and Little Hatchet Pond Fish Community Surveys, New Forest CSAC*. Unpublished report to the Forestry Commission.

Madgewick, G. (2013) *National Freshwater Specialist Site Visit to Hatchet Pond, New Forest, July 2013*. Natural England, Peterborough.

Ratcliffe, D. (1977) *A Nature Conservation Review*. Cambridge University Press, Cambridge, UK.

[8] WFD monitoring ideally annually
[9] CSM next due 2024

Addendum: The Water Quality of the inputs to Hatchet Pond - Results of a survey in 2017

1. Introduction

Hatchet Pond, in the New Forest Special Area of Conservation, is classified as an oligotrophic waterbody. This is an internationally important habitat type, listed in Annex 1 of the Habitats directory. Under the Water Framework Directive (WFD) Hatchet Pond is one of the UKs reference condition lakes of exceptionally high quality and an important stonewort site. Full details of the lake and its designation can be found in Aquilina R. et al (2015, An outline lake management plan for Hatchet Pond, New Forest SSSI).

Concern has been expressed about changes in the lake because the indication from the Environment Agency's WFD monitoring is that the lake status has dropped and it can no longer meet the standards for being in favourable condition. The impacts of recreational pressures and the fishery are recognised in the New Forest site improvement plan[10].

The Freshwater Habitats Trust have produced an outline lake management plan (Aquilina R. et al. 2015) which identifies and discusses the potential reasons for the decline. This initial survey of the water quality of the streams and flushes discharging into the lake may be regarded as an addendum of that report.

2. Method

On the 13 Nov 2017 R.Aquilina and I walked around the perimeter to investigate all inputs and outlets from the lake. Using a portable Hach meter we recorded the pH, electrical conductivity (EC) and temperature. We returned on 13 December to repeat the survey and collect ten water samples for analysis by Wessex Water's laboratory at Saltford, nr. Bath. The location of the sampling points is indicated on an aerial photograph, Appendix figure 1.

The New Forest Study Group investigation of the southern damselfly (*Coenagrion mercuriale*) distribution in 1983-4 (Winsland, 1985) sampled many New Forest waterbodies included Hatchet Stream, but not the Pond. Since this is the largest stream feeding the lake it should be indicative of its water quality (it is directly comparable with our sampling site 2).

3. Results

Full results are tabulated in the appendix:

table 1. field data

table 2. Wessex Water laboratory's results

table 3. New Forest Study group results

[10]http://publications.naturalengland.org.uk/publication/5174614971908096

4. Discussion

Ideally the inputs to a lake of this sort would have analyses covering all seasons and from several years to obtain a full picture of the seasonal cycles and trends in water quality. The results discussed here fall short of the ideal and all inference in these notes are tentative.

Electrical Conductivity (EC)

The average EC is 195 µS/cm, but there is wide variation amongst the sites. Temperature has a large influence on the measured EC. For EC to be used as a surrogate for total dissolved solids, it is necessary to standardise the results to control for temperature and very low pH where the hydrogen ion is a major contributor. In the tables the measurements have been standardised to 20°C using a regression formula devised from measurements on another instrument of the same model.

Unfortunately the Hach meter in December produced some readings that were obviously spurious and this throws doubt on the veracity of all the readings on this date. However, these were some of the first readings and this could be due to the time taken for the probe to acclimatise from storage in a warm house to the cold waters from the lake. If this is the explanation, later readings should be reliable. With this in mind, the general pattern is as follows. Highest EC are in the input streams at sites 3, 4, 5 and 7. These are located on the south side and the stream from the marlpits at the northern arm of the lake. Lower EC sites are mostly along the N shore of the main lake. The conductivity of the main lake is generally lower, indicating a significant groundwater input from the heathland within the catchment.

The differences between readings on the two sampling occasions might be explained thus:

- The EC in December is lower than in November. This could well be due to flushing with rainwater which has had less time to dissolve material from the strata.
- Sites 7, 8, 10, 11 all have higher temperatures in December than November and also higher than the other surface waters. The inference is that these are groundwaters seeping out and that they are flowing faster in Dec than in Nov, which is what we might expect.

pH

The mean and standard deviation of all readings are: 6.82 and 0.417. Since most of the hinterland is heathland with well leached, probably podzolised soils, ground water and run-off should have a low pH. Where the Headon Beds outcrop and marl has been dug in the past, the pH (and calcium) is higher due to the shell material within the clay. The initial observations are that:

- pH does not seem to be telling us much at the moment.
- There is no correlation between pH and EC.
- The highest pH is at site 2, the Hatchet Stream; so there will be a marl influence here. Site 12 must be affected by the acid seepages on the N shore with the main flow going to the S side to get the result of 7.24 at the outlet. Unless the site 3 value is an error.

Minerals

The highest mineral content in site 7. Site 5 will probably be higher still. It also has the highest phosphorus. Given that it is low flow, this is not likely to impact much on the lake. In any case, it is not very high for lowland waters and iron can be very much higher in waters from iron rich sand and gravel strata.

Nutrients

Overall the P and N are low. Obviously we need a more sensitive method to pursue this in more detail, but at 0.05 mg/L total phosphorus it is not eutrophic and could be oligotrophic.

The two sites where total phosphorus was measurable are seepages 5 and 7 on the south side of the lake. These are also iron rich, suggesting a mineral source, such as clay and iron-rich gravel. However, given the location, another possibility is decaying ordnance. Because the concentration in Hatchet Stream is below the level of quantification there is no reason to suspect Beaulieu airfield of being a source of enrichment.

Microbiological counts

Coliforms are high in the surface waters and E.coli are absent in the groundwater seepages. As would be expected. Site 3 is particularly high and would be where I'd look for sewage contamination, but it might just be horses/cows sheltering in the scrub. The low pH is odd, given that it is a marlpit. Coliforms are also high at site 6, a sheltered bay soon after the marlpit stream enters the lake. The outflow from the lake, site 1, is fairly low for an environmental water. This is where any overflow from the toilet and cess pit in the car park would be expected to show.

The highest coliform count is at site 5, an iron-rich seepage on the south side of the lake. Given the isolated nature of the location, gazing animals is the most likely cause. By comparison, counts in Hatchet Stream are low, and by implication, the old Beaulieu airfield is not a source of microbiological contamination

5. Conclusions

As stated above, the data available to analyse is sparse and it is impossible to state conclusions on the general water quality and trends with any certainty. It is not even possible to quantify the uncertainty without replicated data. Only more frequent analysis over at least two years can refine our understanding of the inputs to the lake.

1. The discharges to Hatchet Pond vary from seepages to a small stream with a substantial flow.

2. Water quality differs widely between sites. The main influence on the pH, conductivity and mineral concentration variations is thought to be the different strata present. Nutrient concentrations are generally low.

3. Beaulieu airfield does not appear to be a source of enrichment, but the coincidence of the highest phosphorus and iron concentrations on the south side of the lake could point to buried ordnance. Flow from these sources is too low for them to have much impact on the nutrients in the lake.

4. The bacteriological results do not implicate the toilets in the car park as sources of contamination. In all probability the two samples with the highest counts are due to grazing animals.

R.M.Walls, 28th March 2018

Appendix: Tables of Results

Table 1. Field data

site	RAq	Date	time	grid ref		pH	pH-temp	EC	EC-temp	EC`	location	Field notes
no.	wp			SU			°C	µS/cm	°C	µS/cm		
1	565	13-Dec-17	09:35	36876	01464	7.11	5.6	103.0	7.5	150	outflow	good flow
1	582	13-Dec-17	11:25	36939	01562	6.78	5.0	107.0	5.5	162	outflow	
1a	597	13-Nov-17	10:21	36463	01275	7.55	5.3	265.0	5.6	320	main pond	cf. point 12
2	570	13-Nov-17	10:45	36218	01231	7.53	5.7	191.0	5.5	246	main inflow western arm	good flow
2	570	13-Dec-17		36211	01234	7.15	7.5	90.6	7.9	137	main inflow western arm	good flow
3	575	13-Nov-17	11:41	36685	01698	6.86	5.5	334.0	5.3	390	marl pits north inflow	moderate flow; marlpits ?
3	575	13-Dec-17		36684	01695	6.37	7.2	115.2	7.2	164	marl pits north inflow	good flow
4	568	13-Nov-17	10:26	36435	01258	7.09	7.3	254.0	7.6	301	inflow stream from Little Hatchet	good flow. *Osmunda, Pilularia*
4	568	13-Dec-17		36435	01256	6.86	6.0	145.6	6.9	195	inflow stream from Little Hatchet	good flow
5	569	13-Nov-17	10:34	36351	01243	6.46	6.1	447.0	6.3	499	iron rich seepage	slow flow
5	569	13-Dec-17		36391	01246	6.31	7.1	408.0	7.3	456	iron rich seepage	slow flow
6	574	13-Nov-17	09:48	36759	01666	7.31	6.0	237.0	6.0	290	N arm pool	
6	574	13-Dec-17	11:35	36759	01664	6.63	5.5	188.5	6.6	239	marl pits west shore	
7	566	13-Nov-17		36746	01342	6.01	4.4	470.0	5.9	523	seepage south shore	Slightly different gr.
7	566	13-Dec-17	10:12	36728	01347	6.79	10.6	122.8	8.2	168	seepage south shore	minimal flow

site	RAq	Date	time	grid ref		pH	pH-temp	EC	EC-temp	EC`	location	Field notes
no.	wp			SU			°C	µS/cm	°C	µS/cm		
8	573	13-Nov-17	11:13	36443	01355	6.63	6.6	167.0	6.4	219	seepage north shore	
8	573	13-Dec-17		36450	01349	5.95	8.9	89.7	9.0	131	seepage north shore	minimal flow
9	583	13-Dec-17	12:23	36011	01234	6.91	7.6	95.7	7.8	142	Upper Hatchet stream 2	
9	583	13-Dec-17	12:23	36011	01234	6.76	7.6	95.7	7.8	142	Upper Hatchet stream 3	best
9	583	13-Dec-17	12:23	36011	01234	7.48	7.8	279.0	8.1	324	Upper Hatchet stream 1	
10	572	13-Nov-17	11:03	36397	01325	6.62	7.9	198.0	7.6	245	seepage north shore	
10	572	13-Dec-17		36392	01319	6.80	8.4	104.3	8.6	148	seepage north shore	slow flow
11	571	13-Nov-17	10:53	36292	01278	6.81	6.8	241.0	6.9	291	seepage north shore	clay substrate
11	571	13-Dec-17		36293	01277	7.09	8.2	83.9	8.3	128	seepage north shore	slow flow
12	584	13-Dec-17	12:43	36341	01291	6.90	6.9	96.5	7.5	144	main pond west	
13	564	13-Dec-17	09:48	36950	01582	6.43	5.7	143.3	6.3	195	drain from car park	

EC` is the field value corrected to 20°C and for the effect of high hydrogen ion concentration. Because to the high pH the latter correction has very little impact.

Table 2. Wessex Water analysis

site no.	RAq wp	date	time	pH field	temp °C	EC µS/cm	EC` µS/cm	pH WxW	Al mg/L	Fe mg/L	Mn mg/L	tP mg/L	NH_4-N mgN/L	TON mgN/L	NO_3 mgN/L	NO_2 mgN/L	colif /100ml	E.coli /100ml
1	582	13-Dec-17	11:25	6.78	5.0	107.0	163.9	7.24	0.150	0.200	<0.03	<0.05	0.040	<0.2	<0.2	<0.003	180	80
2	570	13-Dec-17		7.15	7.5	90.6	138.1	7.31	0.110	0.200	<0.03	<0.05	<0.02	<0.2	<0.2	<0.003	170	100
3	575	13-Dec-17		6.37	7.2	115.2	163.7	5.99	0.210	0.600	0.030	<0.05	0.020	<0.2	<0.2	<0.04	4400	1100
4	568	13-Dec-17		6.86	6.0	145.6	198.7	6.34	0.040	0.600	0.030	<0.05	<0.02	<0.2	<0.2	<0.003	210	40
5	569	13-Dec-17		6.31	7.1	408.0	456.8	6.33	12.100	104.00	2.5000	0.140	<0.02	<0.2	<0.2	<0.040	6200	1500
6	574	13-Dec-17	11:35	6.63	5.5	188.5	243.5	6.55	0.180	0.700	<0.03	<0.05	<0.02	<0.2	<0.2	<0.003	490	210
7	566	13-Dec-17	10:12	6.79	10.6	122.8	158.5	6.03	0.390	1.000	0.110	0.120	<0.02	<0.2	<0.2	<0.003	90	<10
10	572	13-Dec-17		6.80	8.4	104.3	148.3	6.08	0.170	0.600	<0.03	<0.05	<0.02	<0.2	<0.2	<0.003	30	<10
11	571	13-Dec-17		7.09	8.2	83.9	128.7	6.06	0.110	0.500	<0.03	<0.05	<0.02	<0.2	<0.2	<0.003	40	<10
12	584	13-Dec-17	12:43	6.90	6.9	96.5	146.2	7.08	0.130	0.200	<0.03	<0.05	<0.02	<0.2	<0.2	<0.003	60	60

EC` is the field value corrected to 20°C and for the effect of high hydrogen ion concentration. Because to the high pH the latter correction has very little impact.

Table 3. New Forest Study Group data

	grid ref		pH	EC	colour	Ca	Mg	Na	K	alkalinity	Cl	SO_4	Zn	Cu	Fe	Mn	NH_4-N	NO_3
date	SU			µS/cm	OD 254	mg/L	mg/L	mg/L	mg/L	$CaCO_3$mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mgN/L	mgN/L
23-Oct-83	358	013	6.38	195	0.156	5.8		17.8	1.40	11	31.3	24.3	0.053	0			0.010	
07-Jan-84	358	013	5.95	147	0.026	7.3	2.66	11.3	1.31	16			0.039	0.01	0.02	0.02	0.070	0.77
04-Mar-84	358	013	5.52	125	0.003	6.2	2.55	11.3	1.12	14			0.118	0.01	0.03	0.02		
13-May-84	358	013	5.58	128	0.722	1.7	2.50	11.0	1.09	10			0.013	0.01	0.03	0.02		
24-Jul-84	358	013	5.94	119	0.052	10.9	2.74	11.7	1.69	24			0.028	0	0.140	0.02		
median			5.94	128	0.052	6.2	2.61	11.3	1.31	14	31.3	24.3	0.039	0.01	0.03	0.02	0.039	0.77
rounded median			5.9	130	0.05	6.5	2.6	11.5	1.3	15	21	16	0.04	0.01	0.03	0.02	0.05	0.8

Figure 1. Location of sampling points around Hatchet Pond.