



## Conserving Herefordshire's Ice-Age Ponds Project    HG-17-07577

### Conservation Strategy

Background and origins of kettle hole ponds,

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#### Introduction

Kettle hole ponds were formed through natural processes during or just after the Late Devensian glaciation which was the last of the glaciations in Britain and Ireland between 110,000—10,000 years ago. Towards the end, around 23–24,000 years ago, a tongue of ice expanded into North West Herefordshire. Although this ice expansion was brief, it abruptly and dramatically changed the landscape. Herefordshire's Ice Age ponds which are classed as 'Kettle Hole Ponds' are associated with (fluvio-) glacial landforms. They are located in western Herefordshire, mostly on irregular topography of hummocky moraine, but also in beds of probable lakes.

Kettle holes ponds are created in areas where a depression has formed through melting of ice. In many cases these depressions lie between hummocks and this terrain reflects the down-wasting of ice and its contained sediment, together with localized reworking by slope movement, by streams and into ponds on the glacier surface. In Herefordshire permafrost conditions were thought to have extended for at least 10,000 years after this glacier advance and so the melting of ice may likewise have taken many thousands of years to be completed. Another distinct type of kettle hole forms from blocks of ice transported into the proglacial zone in front of the glacier where they may come to rest on a river floodplain or ground in a

lake. In Herefordshire, there are kettle holes in former lake beds that appear to have this origin (e.g. Letton Lakes).

When the ice melts it leaves deep, steep-sided depressions which filled with water where the water table was high. Typically, when they formed they were up to 12 metres in depth; this was proven to be the case with kettle hole ponds at Bridge Sollars and Turner's Boat which were cored to reach their basal deposits.

Meres are larger glacial pools which were formed in a different way. They are the result of a high-water table in coincidence with larger-scale depressions in the hummocky moraine which may for example represent former river channels. There are far fewer of examples of them in Herefordshire. However, good examples can be found at Pearl Lake in Shobdon and the Lawn Pool and Moccas and the Broadmoor Pool (see Photo 1) at Bredwardine, both south of the River Wye.



Photo 1: Broadmoor Pool, Bredwardine in 2005

As the climate warmed after the last Ice-Age, the margins of these ponds were colonised by aquatic vegetation. It is most likely that the prevalence of sand and gravel in the absence of mineral soils resulted in the growth of bog vegetation such as *Sphagnum* mosses, cotton-grass and their associated sedges and rushes.

Peat forms when these plant decays in de-oxygenated conditions. The water is often acidic (low pH). As this plant matter gradually decomposes in anaerobic conditions it results in the accumulation of peat. Gradually over time the steep sided ponds filled up with peat and transported silty sediments. Herefordshire's hummocky moraine is underlain by "Old Red Sandstone" of the St. Maughan Formation and Raglan Mudstone Formation. These are locally permeable raising the possibility that many of the county's kettle hole ponds were, and still are, fed by groundwater containing dissolved minerals. This will be investigated as part of the HLF project.

The likely scenario is that as the climate warmed and the Herefordshire landscape became more fertile, kettle hole pond waters switched from being acidic to being neutral or slightly basic and this allowed different kinds of aquatic vegetation to develop. Certainly, cores which were taken in Kenchester (and elsewhere?) shows that the lithology changed over time from peat to grey clay and then finally red clays. Plants associated with fenland peat and bog habitats such Marsh Cinquefoil *Potentilla palustris* and Bogbean *Menyanthes trifoliata* had a positive signature in the Holocene deposits but then disappeared from the record whilst plants of eutrophic conditions such as reedmace, hornwort, eutrophic sedges and rushes proliferated, as we see today. The slow process by which ponds and lakes change over time is known as pond succession and in its later stages results in the pond being completely fill up with sediments. Hydrological stability may be maintained through oxidation of organic plant material on an annual cycle and/or anthropogenic change such periodic de-silting of kettle hole ponds for stock watering or possibly clay and/or peat extraction. The situation today is that many KHPs in the county have saucer-shape profile with a soft base of organic sediment overlaying a deep layer of compacted sediment. These deep deposits may contain peat and other organic matter which preserves plant material (plant macrofossils), pollen and quite likely animal remains from after the last Ice-Age. Where ponds contain water which is naturally basic, for example ponds at Kenchester located directly above the Yazor Brook Aquifer, this should increase the likelihood of bone and other organic matter surviving.

Kettle hole ponds represent unique time capsules which can inform us about the past climatic conditions and the vegetation cover thousands of years ago. It is also remarkable that many of these landforms persist as ponds today; an incredible ecological and geological legacy that has survived for over 20,000 years.



Clusters of pools on the Letton Lake © David Lovelace

There is a wide range of hydrological conditions exhibited by pond sites. Some are filled all year, others dry out in the summer, whilst other depressions that may have been permanent ponds in the past only fill after exceptional rainfall. The KHP project will attempt to make a hydrological classification of ponds.

Overall, the identification of kettle hole ponds can be made with increasing certainty as each of the following conditions are found to be the case:

- 1) Forms a closed depression in the landscape
- 2) Underlying glacial or glacier-associated sediments
- 3) Fine-grained sediment fill proved by augering or coring
- 4) Discrete body of sediment underlying ponds, differing from that in adjacent areas, demonstrated by a geophysical survey

In practice, determination is made much more difficult by human disturbance of the land, although even here, the deeper roots of the kettle hole environment should still be present.

### **What makes them unique?**

The great age of the ponds combined with the presence underground of organic matter which preserves plant material and possibly animal remains from immediately after the last Ice Age makes them valuable time capsules.

KHPs have a restricted national distribution. These natural water-filled hollows and their mature margins support a unique and diverse range of aquatic habitats with rich assemblages of plants and animals. They display a high degree of 'naturalness' and typically support rare protected species. For example, the Medicinal Leech *Hirudo medicinalis* which is specially protected under the Wildlife & Countryside Act, has a restricted national distribution and in Herefordshire is confined to ponds on the hummocky moraine. In addition, two water beetle species with highly restricted national distributions (IUCN Vulnerable), *Graphoderus cinereus* and *Helochares obscurus*,



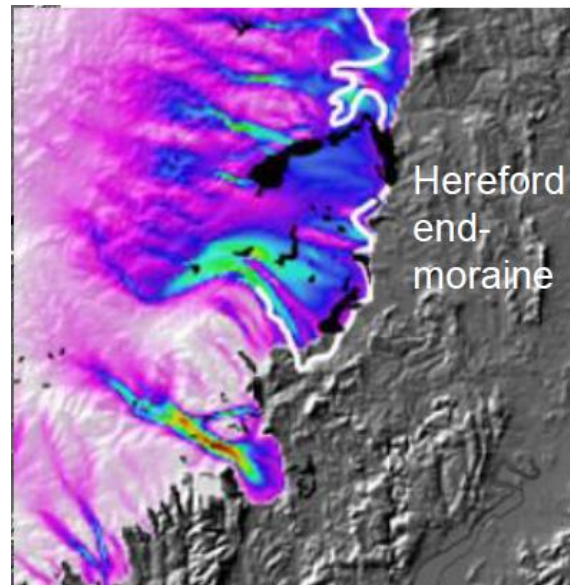
*Graphoderus cinereus* (captive from Moccas Park), 2017

are also confined to kettle hole ponds within the hummocky moraine. The aquatic marginal plant Tubular Water Dropwort *Oenanthe fistulosa* which is classed as Vulnerable in the UK and as a Priority Species for England and Wales is also restricted to ponds and associated wetlands on the hummocky moraine.

Kettle hole ponds host distinctive ecosystems that depend on their peculiar topography and drainage conditions. Several kettle hole ponds are known to support all five of the county's amphibian species including the specially protected Great Crested newt *Triturus cristatus*. The kettle hole ponds at Kenchester support the county's largest Great Crested Newt colony.

Nationally kettle hole ponds are scarce; it has been estimated that probably less than 2% of lowland ponds are natural and probably only 1% of these are kettle hole ponds. However, in Herefordshire we are privileged as this rises to approximately 25%. This represents a nationally important resource.

## The Herefordshire KHP moraines and the wider context

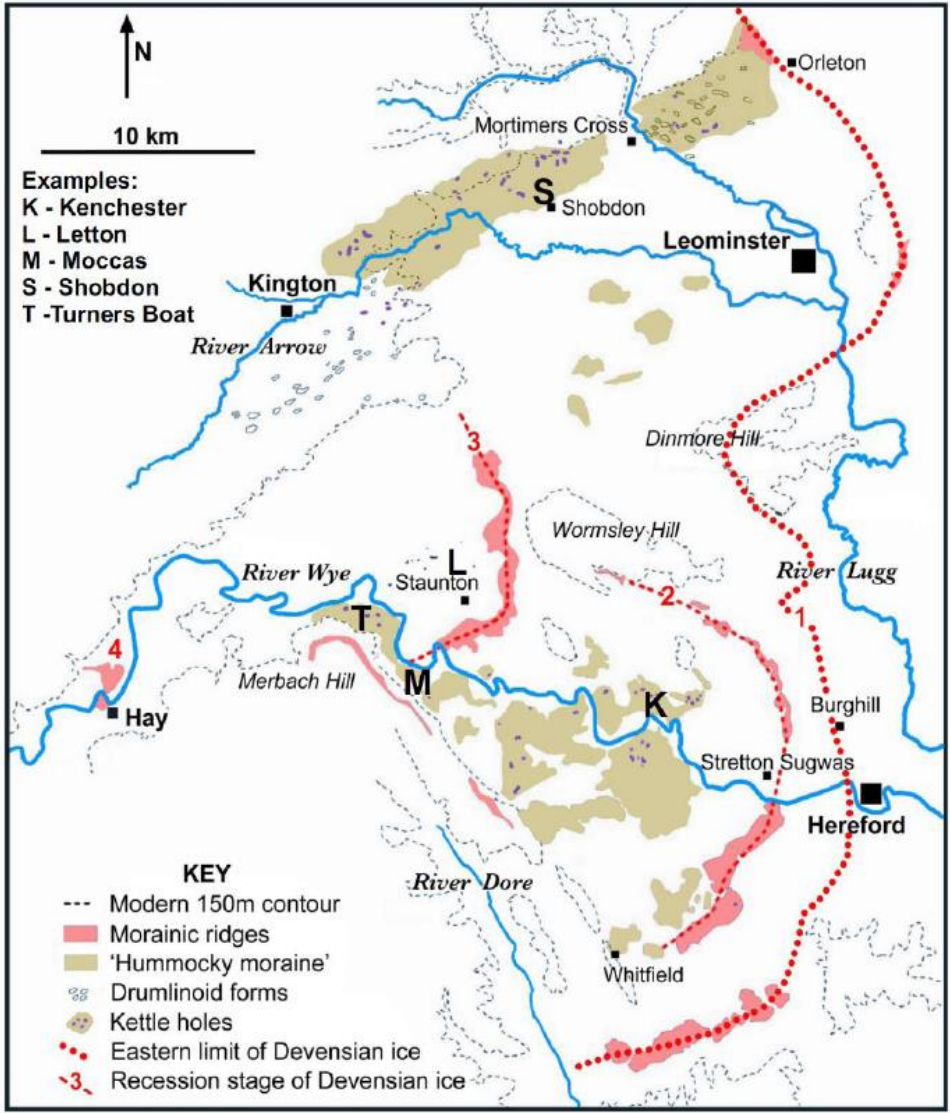


The border country between Wales and England, known as the Marches, contains the greatest concentrations of kettle hole ponds in the UK corresponding to where separate arms of the glacier extended eastwards from the Welsh Massif. The hummocky moraine in Herefordshire represents a southeaster lobe of the ice sheet and is uniquely characterised by areas of hummocky moraine with clusters of small to medium-size kettle hole ponds. Other areas in the Marches, such as the Meres and Mosses in Shropshire, support meres and mosses, the latter of which are large flat expanses of peat with lowland raised bogs where glacial lakes once existed. Typically these sites are poorly connected to ground water due to the local geology containing impervious substrates such as clay.

Figure (left): the British Ice sheet at 23 thousand years ago (Clark et al., 2012).

Figure (right) Computer simulation of the maximum extent of the Welsh Ice Sheet showing a relatively fast-flowing zone ((blue and green colours) in Herefordshire (Patton et al., 2013).

Figure (next page). Overview of western Herefordshire Devensian glaciation (After Richards (2005).

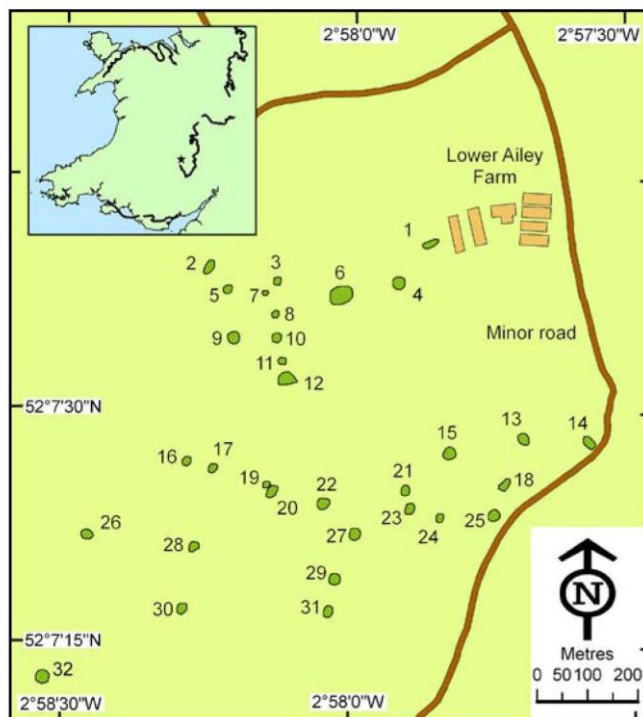


A pond on Whixall Moss created by peat cutting © Will Watson

Consequently, they receive most of their water from rain rather than from streams and springs giving rise to water low in nutrients and minerals with a low pH. In Herefordshire there are two main areas of hummocky moraine. The first is along the line of the Wye Valley glacier above Hereford, which to the west of Stretton Sugwas, has produced disorderly of kame and kettle topography. The second line of kettle moraine has been laid down by the lobe of the Wye glacier which travelled along the Arrow Valley glacier; here hummocky moraine is found banked up against the line of hills from Bradnor past Wapley, Shobdon Hills and the Croft Ambrey ridge and stretches from Kington to Orleton.

### Threats to KHPs

Kettle hole pond density within hummocky moraine in Herefordshire was very high after the last Ice-Age. We know this to be the case because at the Sturts Nature Reserve one small part of the hummocky moraine which has never been ploughed, contains a staggering 30 kettle hole depressions and ponds within a 1 km<sup>2</sup> area.



**Figure 2.** Distribution of enclosed depressions at Letton; the inset map indicates the site location (black star) and the Devensian ice limits (bold black line); the depression investigated using geophysics was Feature #21.

At Kenchester there are 15 extant medium to large kettle hole ponds within a similar sized area. Using aerial photographs covering the northwest of Herefordshire, pond crop marks also illustrate that these features were once far more common and often more extensive in area.



Kettle hole pond distribution within the county probably remained much the same until the second millennium AD when agricultural advancements gradually developed the ability to drain and fill in the natural depressions left by the last Ice-Age. As the population grew and more land was required for agriculture, fields were drained, the smaller kettle hole ponds were filled in and permanent pasture in the hummocky kettle moraine was ploughed. With the drive towards mechanisation in the 20<sup>th</sup> Century the rate of loss increased. We don't know the numbers of losses but what we can say is that the majority of smaller to medium-size kettle hole ponds within the county have been lost. Many of the larger ponds and pools remain but not usually in their original condition. Today only a few ponds are in a good state and/or close to their natural condition. It is likely that all have been compromised to some degree by man-made pollution and many have been altered physically. The tell-tale signs of damage to kettle hole ponds are truncated edges where digging out has occurred, irregular pond bases caused by infill and the general paucity of aquatic vegetation. Filled-in kettle hole sites often flood in winter when the field is inundated with flood water for long periods because the water has nowhere else to go. In the UK losses for other wildlife habitats, such as woodland, hedgerows and flower-rich meadows has slowed down considerably but we are still witnessing significant damage and destruction to Kettle hole ponds. Five of the county's kettle hole ponds have been filled in the last 10 years.

These losses are in part due to a lack of understanding as to the value and importance of these sites. They have also received little investigation and are poorly understood by the public and the scientific community. This project seeks to address these issues.

#### [National policy framework for KHP conservation and the need for designations and protection](#)

There is no existing conservation framework in the UK which deals exclusively with kettle hole ponds, or indeed for that matter any ponds which have formed naturally. Kettle hole ponds in good condition are semi-natural habitats and should be ranked alongside ancient semi-natural woodland in terms of their importance. The latter habitat has a wealth of protection under law and they are included in a range of policy documents. Kettle hole ponds don't receive the attention they deserve. There is a need to address these shortcomings. However, there are mechanisms to designate both statutory and non-statutory sites, including kettle hole ponds, for their biological conservation value. Ponds however, conform to a somewhat restricted set of criteria which under the Annex 1 of the European Habitats Directive which recognises a range of pond types, both natural and man-made, as habitats of high conservation value but does not include any mention of kettle hole ponds. Such sites can however, be designated on the basis of the species of high conservation importance such as Red Data Book and species scheduled under the Wildlife & Countryside Act and/or exceptional populations of key species present. In order to address these deficiencies, the Freshwater Habitats Trust has devised a means of evaluation to assess 'Priority Ponds' based upon their conservation value. It was originally intended as a means of selecting quality ponds for inclusion within Biodiversity Action Plans (BAPs). However, though the BAP programme of protection is no longer in use because state funding has been withdrawn, the mechanism to define ponds is still relevant today. Kettle hole ponds, as a matter of

course, qualify according to the Freshwater Habitats Trust as priority ponds because they have a limited geographical distribution and are rare a type of pond in a national context. However, some kettle hole ponds are damaged beyond recognition and their definition needs to be based upon examples which are in reasonable condition.

Under Countryside Stewardship Natural England do include ponds as 'priority habitats'. In their 'Priority Habitats' document for Countryside Stewardship published in 2016 it is stated that "To be considered as a priority for the scheme the pond must be of high conservation or ecological importance, be home to species that are particularly scarce, have exceptional groups of plants and animals, or have other attributes such as being rare, old or part of a special landscape".

Natural Character Area (NCA) profiles are specified in a guidance document produced by Natural England which includes a description of the natural and cultural features which shape our landscapes. The hummocky moraine in Herefordshire is mainly located in NCA Profile:100 Herefordshire Lowlands but many of the kettle hole ponds south of the River Wye are covered by National Character Area Profile: 99 Black Mountains and Golden Valley. A few of the sites around Kington will be covered by NCA Profile: 98 Clun and North West Herefordshire Hills.

Locally, in strategic planning documents such as Herefordshire Council's Strategic Planning Document 'Biodiversity', ponds are listed as a 'priority habitat', but there is no specific mention of kettle hole ponds or reference to the location of hummocky moraine. The habitats they mention mirror the BAP priority habitats which are now largely obsolete.

For kettle hole landowners and custodians there has been no specific advice available on what kettle hole ponds are, or how to recognise them and look after them.

## **Recommendations and priorities**

Landowners of kettle hole ponds have a key role to play in their protection and management. However, unlike many other habitats where there is a plethora of information available there is presently very little material available to help them. There is a pressing need for a leaflet covering what kettle holes are, their value to society and the local community and offering guidance on how to manage and protect them for future generations. This information should simultaneously be made freely available on-line. Landowners participating in the project will also be given the opportunity to have their ponds surveyed and receive site-specific management plans for their ponds.

The local community has a role to play in raising awareness of the value of kettle hole ponds and actively supporting initiatives which help conserve them. Education and interpretation are key and initiatives will be tailored to local sites. Additional training is required to cater for specific needs. In order to achieve greater awareness we also need improved access to kettle holes ponds. In order to better understand them display boards will be erected at the main sites. This project will enable the local community and other volunteers to visit and study these fascinating sites. It is

planned through the project to create a series of interpreted trails around key kettle hole sites which will foster a greater appreciation.

Nationally kettle hole ponds should have a higher profile. On a national scale there needs to be greater recognition of natural (or naturally formed) ponds within the UK with a definition of what is meant by 'natural' and then descriptions of the various categories of naturally-formed ponds, including kettle hole ponds. There are sound conservation reasons to add kettle hole ponds, which still retain most of their semi-natural vegetation, to Annex 1 of the European Habitats Directive. If we leave the European Union there may be opportunities to make amendments to this legislation enshrined under UK law.

Natural England could be doing more to protect and enhance kettle hole ponds. Regionally ponds can only be included as a priority habitat if they are "of high conservation or ecological importance, be home to species that are particularly scarce, have exceptional groups of plants and animals, or have other attributes such as being rare, old or part of a special landscape". Kettle hole ponds are rare and the hummocky moraine in which they are located should qualify as a special landscape. Local and regional guidance needs to refer specifically to kettle hole ponds and local staff need to be made aware of their value and importance in order that they can advise landowners accordingly.

Locally it would be appropriate to update the Council's biodiversity advice to include reference to kettle hole ponds. This is because the Council's advice, which includes reference to Biodiversity Action Plans is becoming outdated. A new revision should take account of the greater appreciation and understanding of kettle holes and the need for them to be protected and preserved and a list of public benefits. As they only occur in a specific location within the county their approximate distribution needs to be mapped and advice given to planners and council members and officers on how to include them under development control. Local plans covering parishes within the hummocky moraine should include specific references to kettle hole ponds.

The best kettle hole ponds should be considered for designation as Sites of Special Scientific Interest (SSSI). Future monitoring of sites should take account of the need to gather data to enable such designations, for example pond sites which support large populations of Great Crested Newts should be surveyed over a period of 3 years to confirm population size and status. Sites which do not reach the standard for an SSSI should be considered for inclusion as non-statutory County Wildlife Sites.

Good examples of kettle hole ponds also need to be designated as Local Geological Sites. Criteria needs to be drawn up which identifies the range of qualifying features.

National Character profile area 100

<http://publications.naturalengland.org.uk/file/5450469560287232>

mentions the kettle hole moraine under geology in page 9 but there is no further mention of kettle hole ponds or the hummocky moraine in the document, in fact there is no mention of 'kettle hole ponds' within the entire document. From a landscape perspective they are one of the key defining characteristics of the

Herefordshire Lowlands and should be specifically referenced within the NCA profile.



A male Great Crested Newt © Will Watson

Great Crested Newt, pond occurrence density in the NCA Profile area 100 approaches 50%; nowhere else in the UK is this density higher, this and the presence of the Medicinal Leech warrant inclusion. Future revision of the document needs to address these omissions.

#### Public engagement, benefits to the community and the environment

The study of kettle holes covers their geology, biology and history with the landscape and may include aspects of archaeology, so they have lots of things to make them appealing to the public. The public and local communities can engage in pond-dipping activities, map and monitor their local distribution and seasonal changes. There will also be an opportunity to observe the taking of cores samples. There will also be opportunities to assist in the much-needed management of kettle hole ponds.

Herefordshire's hummocky kettle moraine with its clusters of kettle hole ponds is a unique feature of the county. They are a defining landscape feature of the northwest of the county. With recognition and a greater understanding we will be in a position to publicize their presence within local guides and tourism information. Schools, higher and adult education establishments can also benefit from studying them. They provide a wealth of learning opportunities incorporating subjects such as field biology, geology and geomorphology (landscape history). The more we study these kettle hole ponds the greater knowledge we will gain, and it will open up a whole range of prospects to advance our understanding of these valuable features.



Pond training at a kettle hole pond at Kenchester © Will Watson

### Management approach

A different approach is needed for the management of kettle hole ponds and other naturally-formed ponds from that for man-made ponds. The management of any pond dating from the last Ice-Age needs to be treated with sensitivity and care. For example, pond restoration, which typically involves the digging out of ponds back to their original base, if taken in the literal sense, could destroy valuable layers of sediment accumulated over thousands of years. Whilst such action could revive the ecological value of such a pond it would severely compromise its geology. Whilst this is an extreme example it is clear that a far more cautious approach is needed when it comes to intrusive types of management.

The origins of the ponds are not always apparent. The first prerequisite should be to carry out an assessment to confirm whether it is a kettle hole pond or not as the case may be as discussed above. Like all sensitive habitats it is essential that a biological survey is carried out first to identify the presence of protected and/or rare and notable species. The pond management can then be tailored to suit their needs. A survey also needs to take account of specific management tasks required. Where Great Crested Newts or other legally protected species are present, management plans will ensure that any proposed work adheres to the law and official guidelines. A licence can be avoided by timing the work correctly so it avoids periods when newts, or other species are most at risk.

There are a range of management practices which can be undertaken on kettle hole ponds which do not affect the valuable pond sediments. This will include tree management work. Some of the larger kettle hole ponds have, through the process of succession been colonised by trees, either around the margins or they may have

actually spread across the pond base. Tree management and control is likely in such circumstances to have positive outcomes for wildlife. Examples of tree management needed:

- reduction of the tree canopy overhanging ponds,
- coppicing,
- re-pollarding
- and where necessary permanent tree removal
- assess trees for presence of roosting bats

The grazing regimes in and around such ponds varies considerably across the region. In some situations there is overgrazing resulting in the emergent vegetation being continually suppressed; in other situations where stock are prevented from getting close to the pond, trees and shrubs have started to invade the margins - in such cases the introduction of grazing would be of benefit. In both scenarios fencing may be the solution to the problem.

Intrusive management of kettle hole ponds is only acceptable in cases where the landform has been damaged by agricultural practices such as ploughing and back filling. In the latter case it may be possible to 'restore' the kettle hole pond by removing the layers of back fill without damaging or destroying the naturally formed layers of sediment. Kettle hole restoration under these circumstances needs to be carried out with caution with someone who can recognise the difference between the infill and the solid geology. In theory the backfill should peel away from the solid geology but this may not always be the case. Before any such work starts it will be necessary to dig a test pit with a spade to check the various layers in advance. This process needs to be recorded and monitored so, provided it is successful, best practice techniques can then be drawn up.

It may also be possible to carry out partial restoration of a kettle hole pond by removing recent organic matter and blocks of aquatic vegetation which threatens to enclose the open water (this might be pertinent for example where there is a *Crassula* invasion). This assumes that the base of ponds containing palaeoecological data is solid and the softer plant material can be removed without damaging these layers. In reality this is an untried and untested method and should only be carried out under controlled conditions and the results written up as a monitoring exercise.

A traffic light system which lists the range of management tasks which can be applied to Ice-Age ponds and kettle hole ponds is being devised to guide people through the likely steps needed for a range of management scenarios. In the course of the current project, there is a survey phase encompassing ecology and geology (including hydrology) in order to derive a management prescription.

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