Conserving Herefordshire's Ice Age Ponds

Kettle Hole Pond Survey Methods Manual

v 1.0

Herefordshire Wildlife Trust

Herefordshire Amphibian & Reptile Team

Herefordshire & Worcestershire Earth Heritage Trust

Heritage Fund

Freshwater Habitats Trust

1 Introduction

1.1 Why survey Kettle Hole Ponds?

Near at the end of the last Ice Age the landscape of North West Herefordshire was abruptly and dramatically changed. At a time when mammoth and other megafauna roamed the countryside, a retreating glacier created distinctive landforms including 'kettle-hole' depressions, formed as huge chunks of glacial ice melted. Many of these depressions filled with water to create 'kettle hole ponds' and, remarkably, some persist today, an incredible legacy that has survived for over 20,000 years.

A nationally scarce resource, kettle hole ponds are geologically fascinating and important for wildlife. However, they are vulnerable and are regularly damaged or destroyed. They have received little investigation and are poorly understood by the public, landowners and the scientific community. By engaging with local communities and landowners we will aim to protect many of the remaining ponds, discover their historic and present wildlife and provide trails and interpretation that explores them and their history.

The Kettle Hold Pond Survey Form and Survey Manual are based on the Freshwater Habitats Trust PondNet Pproject Habitat survey sheet with additional information required to help us build up data specific to Kettle Hole Ponds. We have chosen to use this format as it has been tried and tested with many volunteers across the UK and we want to benefit from their experience. We would also like our data to be compatible with the PondNet data collected to allow comparisons with other potential Kettle Hole Ponds across the country. The additional data collected form part of our development stage project, and as such we are trialling what data we need to collect, how we collect it and how we record it. It might be that the some recording methods don't work very well or are difficult to do in practice. Please do tell us if this is the case. We want to make the Survey Form, Survey Manual and the data collected as useful as possible for the people collecting it and using it. We are grateful for your help with this exciting and new project.

You can download copies of the original PondNet survey sheet and habitat survey manual at https://freshwaterhabitats.org.uk/projects/pondnet/survey-options/

Don't worry if you have difficulty collecting some data – not all of it can be completed in the field and we are happy to help you.

Once you have completed your pond survey please return it along with any water samples and equipment borrowed to Herefordshire Wildlife Trust, Queenswood Country Park and Arboretum, Dinmore Hill, Nr Leominster, Herefordshire, HR6 0PY.

Any questions or feedback please do get in touch.

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Herefordshire's Ice Age Ponds Project Manager

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2 Ecological Measurements

2.1 Pond Name

This box provides a quick way for you to identify your pond; particularly helpful if you are surveying a number of sites. If the pond has been selected for you through the project, the pond name will be included in your **Site Information Pack**. If not, you can add a pre-existing name (e.g. a locally used name or the name given on an OS map), or create your own pond name. Try to make this name memorable, avoid only using a number e.g. Pond 1, Pond 2 etc. as there could hundreds of these in the database. If you do want to use a number, combine it with the name of the site, e.g. Pond 1 Black Park, Pond 2 Black Park, etc

2.2 Grid Reference

Surveyors who are monitoring a known kettle hole pond should have been given a 10 figure grid reference for their pond. When visiting each site we ask that you provide or check the 10 figure grid reference for the pond. This is especially important for ponds that have been self-selected or are not shown on Ordnance Survey maps.

We recommend using a hand GPS or mobile phone app. Note that for the Kettle Hole Pond Survey we use a standard letter and number grid reference format (e.g. the 10 figure grid reference: SO 12345 67891. For the initial survey phase all of the ponds in Herefordshire will have the letter code SO.

When using a handheld GPS please refer to manufacturer's instructions.

When using a mobile or tablet to measure GPS please note: not all apps provide 10 figure grid references. Currently available apps that are free to download include:

GeoExplore – produced by Brookes Design – this is a Geological Recording App, can be used on android and apple devices. Once app is downloaded, open and on the first page you will see a purple button marked "tools". Press this and a drop down menu appears. At the bottom of the menu is a 10 figure grid reference. Pressing the + button will provide more details including horizontal accuracy.

Grid Reference by Arthur Embleton – only available for Android devices. Once app is downloaded, click to open and it will automatically show a 6 figure grid reference and the horizontal accuracy. Press "Figures" in top right of screen and select "10 figures" from the drop down list.

GridPoint GB – only available for Apple devices.

2.3 Pond area and the winter water line

For kettle hole ponds it is important that we know about changes in water level through the year. This will help us to determine the source of the water in the pond and whether it is linked to the local water levels or other ponds or has its own distinct catchment and profile.

Pond area refers to the area of the pond when it's **full**, i.e. it is the pond's area when water levels are at their highest (excluding flooding events). Normally this will be in late winter or early spring, so if you visit a pond in summer, the water level you see will usually be lower than this maximum.

Finding the winter water line is critical, but can sometimes be a slightly tricky estimate. But, don't worry, because you can use environmental clues to work it out. This is an important step in pond monitoring, because many other measurements depend on it, including the percentages of the pond that is shaded and the surrounding land use. For botanists, the winter water line also marks the standard area within which plant surveys are undertaken.

Clues to finding the maximum water level (the winter water line)

Change in vegetation is usually the most reliable way to determine the winter water line; marked by a distinct change from wetland plants to dry-ground species. Often the line itself is marked by a fringe of soft or hard rush (*Juncus spp)*. This change is *sometimes* also accompanied by a **break in slope**, caused by winter wave wash.

In shaded ponds with few plants, the upper water level can often be judged from **discolouration marks on rocks or trees** – particularly willows or alder that grow in the pond itself. Bundles of **fine roots growing out from willow and alder trunks** are another clue, because these usually only develop below the winter water level.

Note that ponds with **outflows** usually have less variation in water level than other ponds, because the outflow controls the maximum water level. Discolouration marks on an outflow pipe or the stones at the edge of an outflow stream can be good places to find the upper water line. Interestingly the upper water level is usually not the bottom of the pipe but some way up it, because water typically backs-up in the pond in winter.

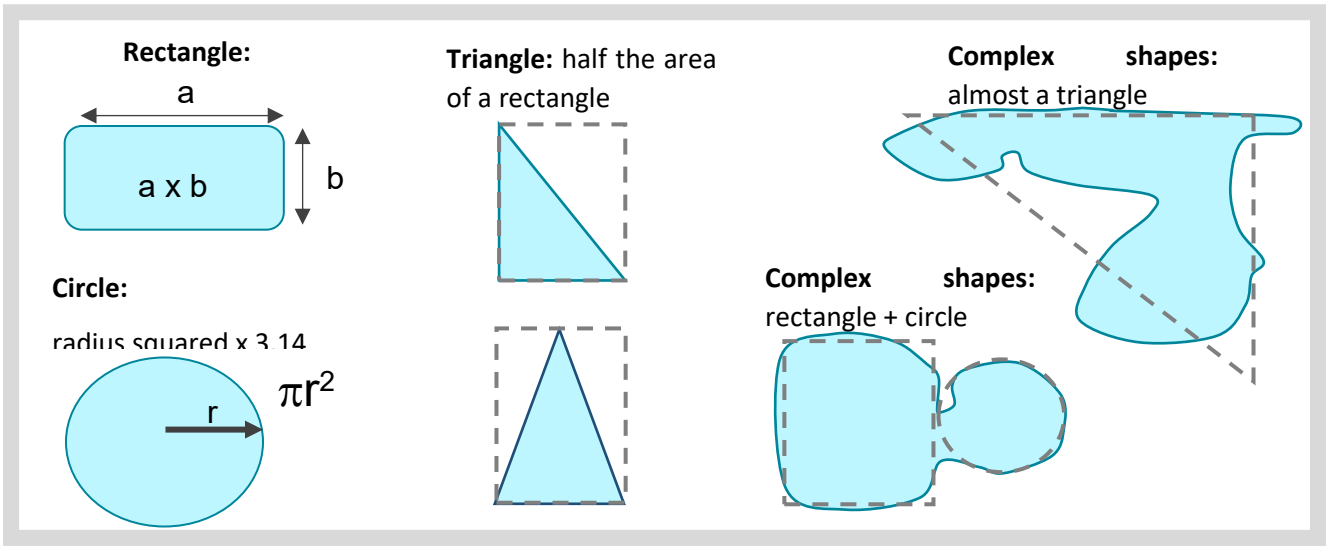
Winter water line shown on a rock face (top left), by the growth line of aquatic mosses on a drystone wall (above) and in the distinct change from wetland plant to dry ground species (bottom left).

Pond area

Pond area refers to the surface area of the whole pond, including wet and dry areas, i.e. the maximum winter water line (see Section 2.5 above).

Small ponds can be measured using a tape, or by pacing. A quick outline sketch (see box below) often helps. With large ponds it can be easier to measure the dimensions from an OS map, or online; for example using the 'measure and drawing tool' at www.gridreferencefinder.com.

There are several ways of calculating area, for example by measuring the dimensions of regularly shaped ponds (see below). Irregularly shaped ponds can be treated as a series of geometric shapes, calculating the area for each and adding them together. But keep it simple! If a pond is an odd shape, look for the shape it *almost* is, and then find this shape's area.

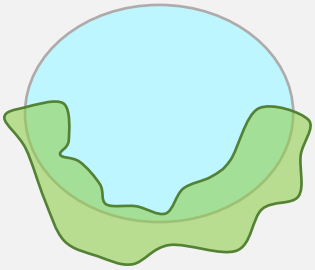


2.4 Overhanging trees and shrubs

The survey includes two estimates of how much of the pond is overhung by tree shade. Both measurements refer to the whole pond area (not the current water area, see Section 2.5 above), and are estimates of how much of the pond is *directly* overhung by trees and shrubs, i.e. the area that would be shaded if the sun was directly overhead. The estimate can include tall shrubs and brambles, but does *not* include shading from emergent pond plants, like Bulrush.

The first estimate is the percentage of the pond surface area which is shaded – in the examples (right) the top pond is shaded by approximately 20% and the bottom pond by 50%.

The second estimate is the percentage of the pond margin shaded to at least 1m from the shore – the top pond is shaded by approximately 50% and the bottom pond by only 20%.



- 20% of the pond is covered by shade
- 50% of the pond margin is shaded to at least 1m from the shore

- 50 % of the pond is covered by shade
- 20% of the pond margin is shaded

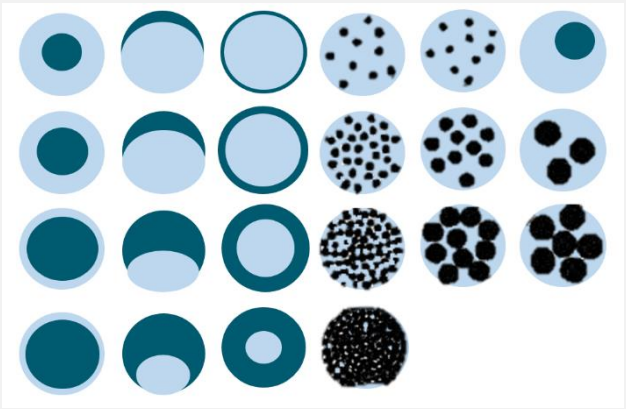
2.5 Aquatic Vegetation

The two measures of aquatic vegetation covered in this section differ in a number of ways.

1. **Percentage of the whole pond (wet and dry) occupied by emergent vegetation:** This measure should be made across the whole pond as defined by the winter water level (see Section 2.3). Within this area, the cover of emergent plant species is assessed. This includes low-growing grasses, rushes and broad-leaved herbaceous plants (like fool's-watercress and water mint), as well as tall plants like bulrush, reed, sedges, and wetland willow-herbs. A full list of species that qualify as 'emergent' is given in the wetland plant survey section of PondNet (https://freshwaterhabitats.org.uk/projects/pondnet/survey-options/). However, for non-botanists, as a rule of thumb, it is sufficient to estimate the **percentage of all of the plants growing in the area of the pond that is currently dry, plus those that have at least some stems and leaves emerging out of the water.**
2. **Percentage of pond's surface area covered by all vegetation:** This measure only refers to the area of the pond that is **currently wet**, and includes **all plants** that are visible at or above the surface with the exception of duckweed. The reason this measure is restricted to the wet areas of the pond, is because it is used in the assessment of the pond's suitability for newts making use of the pond during the breeding season.

Estimating the percentage cover of plants. This estimate needs some thought, especially if plant stands are scattered around the pond, growing at different densities.
A trick that can help is to **imagine if all the plants were pushed up into one end of the pond: how much of the pond would they then occupy?**

10%
30%
60%
80%



2.6 Water left in pond

Over the course of a year the water level in the pond will vary. This will be most significant in summer and early autumn. Data gathered for the pond area and pond water level could also be used to work this out.

In summer, ponds usually loose water, leaving a dry 'drawdown zone' as the water recedes. The two measures in this section aim to capture how extensive the drawdown zone is.

Percentage of water in the pond, relative to maximum pond area: This is an estimate of how much water area remains in the pond compared to when the pond is at its fullest (Section 2.5). It's easy to over-estimate: the percentage chart (on the previous page) is a useful guide.

Drawdown height: This is the height difference between the current and maximum pond water levels. It is easiest to measure on a vertical surface such as a tree trunk or wall, or a steep bank.

2.7 Grazing

Grazing by livestock includes grazing by any domesticated animals (sheep, cows, horses, etc), that have access to the pond. But it *excludes* wild deer, rabbits or grazing by ducks and geese.

If grazing animals are not currently visible, use indirect evidence such as: grazed grassland vegetation at the pond edge, signs of hoof poaching and trampling in pond mud, or the presence of animal dung in the pond or surrounds.

Recording how much access the animals have to the pond is described in two ways. The first considers how much of the whole pond animals could potentially graze. In shallow ponds, especially those which dry out, the animals may be able to access 100% of the pond. Animals will often wade into shallow water to stay cool and will continue to graze as they do so.

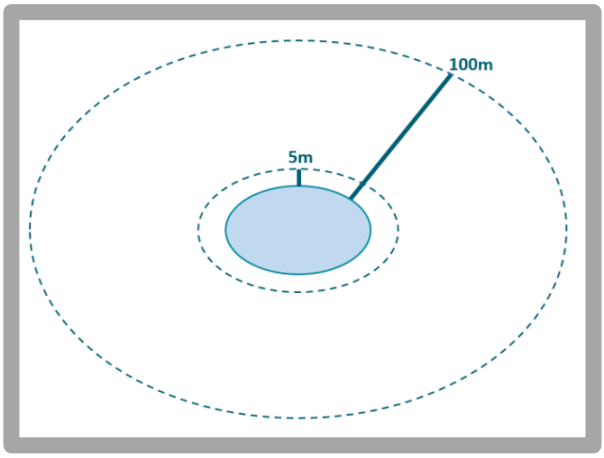
The second measure describes how much of the margin of the pond the animals can access. The pond edge will be restricted if there is fencing or dense areas of willow or bramble. But remember, that animals will wade around the inside edge of ponds with shallow water to access otherwise inaccessible margins.

The intensity of grazing is ranked from **1** ('infrequent') to **5** ('heavily poached'). Grazing levels ranked **1** will often be ponds which can be accessed by animals, but the surrounding grassland or other vegetation is tall and shows little signs of grazing. A pond scoring **3** would often have moderately short grazed surrounds, and evidence of hoof poaching at the pond edge, but there would be relatively few bare patches of ground caused by stock. A pond scoring **5** would have margins that had been so heavily poached and grazed that they are almost bare of vegetation. If the pond is fenced off so that only *parts* of the pond banks are accessible to animals, please average out the grazing intensity across/over the whole pond.

2.8 Surrounding land-use

The percentage of different land use is recorded in two distance zones from the edge of the pond.

In both cases 'edge of the pond' refers to the winter water line (see Section 2.3). Hence the **0–5 m** zone is usually a record of the **vegetation on the upper pond banks**. Note that the **0–100 m** zone also includes this bank area.



The 0–5 m zone is easily defined by pacing (a single pace is 0.8–1 m). You can also pace the 0–100 m zone, especially for your first surveys, to give an idea of this distance. Alternatively, it is much easier to use the 1 km squares on an OS map (see the map in the PondNet 'Site Information Survey Pack) to estimate the distance: 100 m is 1/10th of 1 km. For most people, a combination of map (or aerial photo) and field evidence works best to calculate both distance and land-use percentage.

Definitions of different habitat types within land use

Trees, woodland and scrub: This includes both deciduous and coniferous woodland, individual trees, scrub and hedgerows.

Heath and moorland: This includes lowland and upland heathland, moorland and mountain vegetation; includes bracken.

Grassland categories: These are some of the trickiest categories, because they merge into one another:

> ***Rank vegetation*****:** is the tall unmanaged grass and herbaceous plants you often get at the edge of ungrazed ponds. It also includes neglected and abandoned land, set-aside, road verges and buffer strips.
>
> ***Unimproved grassland*****:** The sort of grasslands on nature reserves or national parks of other unenclosed lands. The grass is mixed with a wide variety of broadleaved plants (good quality plant indicators are usually present). There will be a low percentage of agricultural grasses such as rye grass. Not fertilised, little or no drainage. It can include both calcareous and acid grassland.
>
> ***Semi-improved grassland*****:** A transition category. Grasslands that have been modified by fertilisers, drainage, herbicides or intensive grazing, but retain elements of natural grassland types in the area. This grassland will have a restricted range of common broad-leaved plants e.g. only buttercup, plantain, dandelion etc. and often agricultural grasses such as rye-grass.
>
> ***Improved grassland*****:** Fertile agricultural grass, often bright green and lush with very few broadleaved plants, this includes many park grasslands and golfing greens – though 'roughs' are often semi-improved and sometimes even unimproved.

Arable: Includes all crop land (wheat, oilseed rape, beans etc). It includes commercially grown flowers and fruit crops (e.g. strawberries and orchards) as well as bare land that is ploughed.

Urban buildings and gardens**:** Areas in curtilage (associated with buildings), including not only domestic and industrial areas but glass-houses and farm yards.

Roads, tracks & paths**:** Both paved and unpaved route-ways, including footpaths and also car-parks.

Rock, stone and gravel**:** Areas of bare ground including cliffs, rock-outcrops, gravel-pits, quarries, areas of sand and gravel or stone.

Bog, fen, marsh and flush**:** Areas of wet ground and wetland vegetation.

Ponds and lakes**:** Both permanent and seasonal waterbodies including trackway pools.

Streams and ditches**:** Any linear waterway (wet or dry), including any river, stream, ditch, spring and canal.

2.9 Invasive non-native species

New Zealand Pigmyweed *(Crassula helmsii.* In Herefordshire, *this* is by far the most common of the invasive non-native species and is likely to be encountered within some kettle hole ponds. So above all familiarise yourselves with this species (see http://www.nonnativespecies.org/factsheet/factsheet.cfm?speciesId=1017.

Biosecurity: Please refer to biosecurity measures associated with this plant as it is easily spread from site to site and precautions must be undertaken when it is encountered (see http://www.nonnativespecies.org//index.cfm?pageid=174.

Biosecurity is also required for the species listed below.

Parrot's feather *(Myriophyllum aquaticum)* has recently been reported in the area but not in a pond, it just might occur.

Floating Pennywort *(Hydrocotyle ranunculoides)* to our knowledge has never been recorded in the county. It is highly invasive and swamps other plants

Water Fern (*Azolla filiculoides)* does occur in the county, but I don't think it has been found at kettle hole site, but could potentially occur. It may turn up one year and be absent the next.

Canadian Pondweed (*Elodea canadensis)*, and Nuttall's Waterweed (*Elodea nuttallii)* are superficially similar. Both species occur within the county and can be found together. They are submerged plants which grow from the pond base; they rarely break the surface of the pond, unlike Curly Waterweed (*Lagarosiphon major)* which nearly always breaks the surface, giving the pond the appearance of being densely choked by dark green aquatic weed. It was, and may still being, sold under the name 'Goldfish weed'; it is commonly grown in garden ponds and can escape into rural ponds through discards or intentional planting. This seems to be one of the main mechanisms for this and other invasive species to become established in the wild.

2.10 Habitat quality for amphibians

This assessment considers the suitability of the terrestrial areas within approximately 250m from the pond for amphibians. As with the question above, it only includes habitats that are accessible to amphibians, so omits land on the far side of major barriers such as major roads.

'Good' terrestrial habitat will offer cover and foraging opportunities for amphibians, and so includes meadow, rough grassland, scrub, woodland or mature gardens. Generally, structures are helpful, such as hedges, ditches, stone walls, old farm buildings, piles of loose stone or rock, rabbit burrows and small mammal holes. All these contribute towards '**good**' terrestrial habitat.

For this survey, an area of 'good' habitat will *surround the pond* and cover more than 75% of the surrounding area (within 250m from the pond) e.g. most semi-natural environments, such as rough grassland, scrub or woodland, also brownfield sites and low intensity farmland.

'Moderate' habitat offers opportunities for amphibians to forage and gain shelter, including hedges and ditches, but may not be extensive, e.g. 25% to 75% of the surrounding area.

'Poor' habitat quality is an area with few structures present, or poor quality structures, so opportunities for foraging and sheltering are limited (less than 25% of the surrounding area), e.g. amenity grassland, improved pasture and arable.

'None' - no suitable habitat within immediate pond locale, e.g. a very controlled, standardised environment, such as the centre of a large field or an expanse of bare habitat. Be aware that it is rare to encounter a pond falling within this terrestrial habitat category.

2.11 Water quality for amphibians

If you are doing a pond dip already (for example if you are surveying the pond for invertebrates) then the quality of the invertebrate community can help make this estimate. If not, then it's best to rely on the presence of water plants. Note that water colour is **not** always a good measure of pollution. Sometimes clear water can be polluted, and cloudy ponds can be clean (and thus support a wealth of invertebrates). It is also useful to look at the surrounding landuse and think about the presence of polluted runoff from fields or urban areas which may be running into the pond.

'Bad': The water is clearly polluted. There may be obvious pollutant sources e.g. an adjacent manure pile. The pond will have no submerged plants and often few marginal plants. Only pollution-tolerant invertebrates will be present. Usually the surrounding land-use will be un-natural e.g. urban or arable.

'Poor': The water will have few if any stands of pollution-tolerant submerged plant species (Canadian pondweed type plants may be present), and a low level of invertebrate diversity. There may be evidence of pollution from streams, ditches or runoff from roads and urban areas.

'Moderate': Submerged plants will usually be present (unless the pond dries out regularly or is very shaded). The pond may be buffered from intensive land use areas e.g. arable crops. A moderate invertebrate diversity will be present in these locations.

'Good': Open water areas will usually have an abundant and diverse submerged plant community, and a wide range of invertebrates. Though note this may not be the case for seasonal ponds or ponds that are very shaded. Most ponds in this category will have semi-natural surrounds e.g. grassland, heathland and woodland.

2.12 Turbidity/water clarity

To estimate water clarity, look down into water at the edge of the pond where the water is around 20cm deep. Choose an area that hasn't been recently disturbed to maximise the chance that you would see the pond base under 'normal' conditions. Assign water clarity to one of the following four categories:

'Clear': the pond base should be completely visible and clear, as if looking through glass.

'Moderately clear': the pond base can be easily seen, but the water is not crystal clear.

'Moderately turbid': the pond base is visible, but the water is cloudy so that the details are not clear.

'Turbid': the pond base isn't visible.

2.13 Pollution

Heavily polluted ponds typically also have discoloured water which is peaty-brown in colour due to tannins in the water which are visible, but not all pollutants are visible. Very polluted ponds have a low aquatic wildlife threshold and are low in oxygen. They might for example support the larva of the Dronefly *Eristalis* sp. Also known as rat-tailed maggots as they have a siphon tube which allows them to breathe from the surface. Mosquito larvae also rely on siphon tubes and along with other fly larvae are associated with polluted sites. Please note down any other obvious sign of pollution either in or close to the pond.

2.14 Inflows, outflows, dams and islands

Inflows: Can include inflow streams, ditches, springs or wet seepage that drains into the pond. It can also include large drainage pipes. Tick this box even if ditches or streams happen to be **dry** at the time of your survey.

Outflows: Outflows include distinct channels or pipes where the water drains out of the pond; usually into a drainage ditch or stream. Outflows which are **dry** at the time of your survey should still be recorded.

Dams and islands If there are dams and islands present it is indicative of man-made change. A dam need not be a concrete barrier, please also count earth dams and include the construction type in the comments box.

2.15 Pond Base

Pond base refers to the **geology** that underlies the pond (i.e. beneath any accumulated sediment). The pond base can often be assessed directly in the field, or if necessary using a geological map. This can be a difficult parameter to determine, and unless you are undertaking a PSYM survey (where this information is essential), you may wish to leave this section blank.

Field signs for determining the pond base include: bare clay or sand and gravel on the pond bottom and edge (though *avoid* the area around any inflows), areas of bare ground near the pond, or rocky outcrops near-by.

If you are using a geological map, it is important to use a version that shows "superficial" deposits (e.g. alluvium, peat) and not a solid map which only includes the rocks beneath this. It also helps to have some geological knowledge to infer the rock type because this is not always self-evident. More modern maps often have notes which can help. As a general principle, superficial deposits and relatively young rocks which easily weather, e.g. Mesozoic sandstones, are recorded in the 'clay' or 'sand', 'gravel', 'cobbles' categories. These predominate in the south and east of Britain. Hard rocks include igneous, metamorphic rocks and limestone.

When recording pond base, **all the boxes should have a score:** don't forget to put a 1 in boxes even where **none** of that rock type present, i.e. it falls into the 0-32% category. Thus:

A pond underlain by clay is recorded as: **3** silt/ clay; **1**sand/ gravel/ cobbles; **1** hard rock; **1** peat; **1** other.

A pond with sandy-clay geology may be: **2** silt/ clay; **2** sand/ gravel/ cobbles; **1** hard rock; **1** peat; **1** other.

2.16 How much of the pond perimeter could be surveyed

Note any areas of the pond that could not be assessed safely (e.g. impenetrable scrub and steep banks).

3 Landowner/ land manager input questions

3.1 Pond dries?

Ponds that dry out occasionally are good habitats for many species, including Great Crested Newts, because fish are naturally absent. Temporary ponds that dry every year are also important because they support specialist plants and animals, including some rare species.

Landowners, or local residents, are usually the best sources of information about how often a pond dries out. If this is not possible, make a judgement based on both the water level at the time of the survey, and the characteristics of the pond base. For example, a pond that is already very shallow or nearly dry by late spring is likely to dry out every year. Ponds which dry up every year also have a solid base across the whole pond, because bottom sediments harden when they are exposed to air.

Top: A pond, in the foreground, with no visible water that might easily be overlooked. The hard pond base that is covered by wetland plants shows this pond dries every year. The outer margin of the pond is defined by the break in slope (the pony stands on the edge of the pond margin).

Bottom: This pond dries out every year, and by late spring has just a few centimetres of water left. Grazing animals have access across the whole pond basin, leaving muddy and uneven ground. This light 'poaching' by horse and cattle is essential for the rare species that call this pond home.

3.2 Fish presence

It is sometimes possible to see fish in ponds, especially if, like goldfish, they are brightly coloured. More usually, the best way to find out whether fish are present is by **asking landowners or local residents**.

Common Carp and their varieties are particularly harmful to aquatic wildlife as they disturb the base of the pond when they feed, creating muddy brown, turbid water. Carp are also prolific breeders and successful predators of aquatic invertebrates. Carp, as with other fish, can often be observed 'topping' where they break the surface of the water, causing circular ripples. Carp may spend several seconds or minutes near the surface where they can be observed.

Most other species of fish in ponds feed and swim within the main water column and don't disturb the pond base. The most common species of fish in small closed ponds is the Three-spined Stickleback. In medium-sized ponds a range of fish may be present. Roach, Rudd and Minnows are frequent in larger ponds and lakes; these species generally have less impact than carp. The landowner or tenant will often know which species of fish are present (if any).

If this is not possible, other clues are useful:

Signs that fish may be present:

- Fishing platforms around the pond, or discarded tackle, etc.
- Ripples from fish rising to the surface.
- Very cloudy, brown-grey water: this is often a sign of bottom feeding fish such as carp, which disturb the sediment, however it is not infallible: ducks and in public places dogs, or other factors, can create cloudy water too.

Signs that fish are probably absent:

- Pond dries out regularly (e.g. in most years).
- Pond is *heavily* overhung by trees: most fish cannot tolerate the low oxygen levels in ponds that have a lot of decaying tree leaves in the water.

When filling in the survey sheet:

'**Major**': Fish presence refers to dense populations of any fish: usually this will be a fishing pond, or a pond where fish are stocked. Often the water will be very turbid (cloudy).

'**Minor**': Includes ponds where a small number of fish such as crucian carp, goldfish or stickleback are known to be present.

'**Possible**': Includes ponds where no evidence of fish is found, but local conditions suggest that fish might be present (see bullet points above).

'**Absent**': No evidence of fish, and their presence is unlikely (see bullet points above).

If you remain very unsure about whether the pond has fish or not, leave this box blank.

3.3 Other pond uses

Many kettle hole ponds have be altered for various uses. It is important that we establish how many sites are being managed commercially or for some other purpose as this effects their condition. If the pond is not fenced off and is located in pasture then cattle or other stock will drink from the pond. Some of the larger glacial ponds may have water abstracted from them. In which case there may be permanent pumphouse, or they could be used for occasional abstraction when a pump is taken to the site. There may also be instances where a kettle hole pond is topped up by a pipe.

3.4 Pond condition and management

The vast majority of kettle hole ponds have been modified to some extent or other and none remain in their natural condition. The man-made changes that have occurred fall into several categories; pond impacts that threaten the pond such as drainage and infilling and then pond management which can also be intrusive, for example the dredging and enlargement of ponds or benign and then beneficial management in the case of tree management work. In all cases it is essential that we gauge the biological condition of kettle hole ponds and establish how detrimental the 'management' is to their ecology. It is likely that the landowner will be aware of past management, so if possible find out from them.

Dredged: If a pond has been recently dredged it is easy to spot the signs, however, a lot of dredging occurred decades ago. In such cases there is likely to be evidence of steep-sided edges in the pond base, the aquatic vegetation around the pond may also rapidly switch from being shallow emergent plants to open water conditions with absence of deeper-rooted species such as bulrushes or bur-reed.

Infill: Recent pond infilling is also very clear but ponds where infilling has occurred decades ago or even longer it is far less obvious. The pond base on an unaltered kettle hole pond should slope evenly. Infilling should show up as irregular mounds of material either raised above the base and/or with an

asymmetrical border representing the edge of the pond's infill. Where ponds have been deepened or enlarged there is either a truncated margin or an irregular shaped boundary. In all such situations it would be helpful if you were able to discuss these matters with the landowner or tenant as they will know more about the pond's past management.

Vegetation removed: Look for piles of vegetation near to the pond and, if ponds have been partly cleared, gaps in the remaining vegetation.

***Trees clear-felled, cut back or coppiced*:** Evidence of freshly bare stumps or piled brashings (branches and twigs), and signs of vehicle activity which removed trunks (e.g. tire tracks).

Plants introduced: If plants are decorative (e.g. a lily with a pink flower), non-native e.g. gunnera or parrot's feather, or a variegated variety of a native species.

***Structural work*:** Any new structural features to the pond including platforms, walkways, bank reinforcement, etc.

3.5 Comments

Use this box for any comments you have including: changes of ownership or access to the pond; any wildlife sightings, e.g. evidence of water voles; or comments on the survey sheet itself and how it could be improved.

4 Geological measurements

4.1 Air and Water Temperature

We need information on air and water temperatures as part of the water chemistry analysis. When collecting your forms and kit you will be provided with a waterproof meter to measure temperature, pH and electrical conductivity. Please follow the instructions provided with the meter to take these readings.

4.2 Ground Sampling

To establish whether each pond is a kettle hole pond and establish how best to protect this important geological feature we need to understand what material underlies the pond and surrounding soil.

To do this we use an auger. This allows data to be collected on colour of material, grainsize and any other features present.

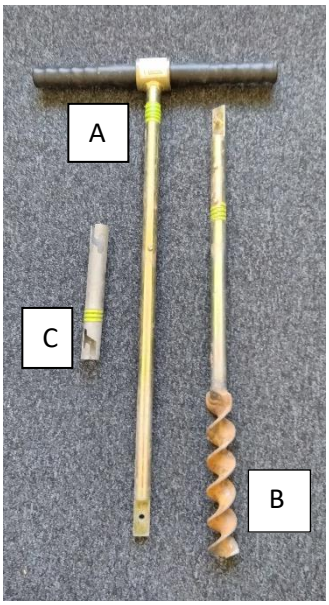
4.2.1 Grid Reference

When choosing where to auger, it should be as near as possible to the pond itself. The best places to choose are near the water line, away from any inlets or any manmade features (paths, walls, jetties, re-profiled or excavated areas). The area you choose should also be safe – not on steep pond sides. Avoid augering too near large trees as the roots make augering difficult.

You will need to take a 10 figure Grid Reference of the exact spot you decide to auger – this will probably be a different grid reference to the pond reference.

4.2.2 Augers

How to assemble auger:



Augers have 3 parts, handle (A), blade (B) and locking bar (C). Place locking bar over handle, put blade and handle together with pin interlocking and bring locking bar over the join and rotate to lock together.

How to auger:

Hold handle with shaft vertical and handle horizontal. With feet shoulder width apart, rotate handle 180 clockwise. Repeat this motion until the screw has reached a depth of 30cm. To remove auger, rotate 180 anticlockwise to loosen auger and standing with knees bent and the handle between crook of your arms pull the auger out carefully, keeping your head and chin back to avoid being knocked when auger is removed. Ensure that you keep the shaft of the auger vertical to avoid widening the hole.

Once the auger is clear of the hole, examine the contents of the screw. Once recorded, remove as much material as possible from the blade – place in pile near the auger hole as you will need this later.

Repeat process at base of auger hole to record substrate detail further down.

4.2.3 Depth

Using a ruler, measure the depth of hole created this should be recorded as the total depth that the contents of the screw contain. E.g. 0–0.3 m, 0.3–0.6 m

4.2.4 Colour

Hold the Geolabs colour chart over the sample in the blade of the auger. Using the holes in the chart, find the colour that is closest to your sample and record this for each of your auger depth sections. Use the code provided on the chart e.g.GyBr.

If your sample contains more than one colour and there is enough material of the other colour present, repeat process of describing the colour.

4.2.5 Grain Size

Holding a sample of soil in one hand, compare this with the Geolabs Grain size card. To establish if there is clay in the sample, take a small section and roll it into a sausage shape. If you can shape it, then there is clay. If you can't roll it then there is little/ no clay present. If you can shape it into a ring then it is mostly clay. To feel for other grainsizes rub the sample between your fingers. Silt and fine sand might not be visible but you should feel it between your fingers, medium and coarse sand should be visible. After feeling the sample, rub the grain size chart to compare the grain sizes and select the closest match.

Most samples will be a mixture of sizes, e.g. Clay with fine sand.

Within a sample there might be pockets of sand or clay, or it might be uniformly mixed. You might also find individual pieces of stone. If possible, use the card to determine size of any particles – for gravels, if they fit through the hole then they are that size, if they are too big then they are the size above.

4.2.6 Notes

Here mark any distinctive features. This could include information on variation within sample of grainsize or colour. Whether there is peat or organic material in the sample, or whether the sample is very wet or dry (this would indicate whether it was above or below the local water table).

Example notes: Mostly red-brown with small patches of green mottling. A few coarse gravel grains within sample randomly distributed. Base of sample included some dark black organic remains.

Very wet sample, mostly grey clay with coarse sandy lens at the base.

4.3 Pond water level

We need to establish whether each pond is connected to the local water table or whether it is separate from the local supply. Looking at how it changes through the year is one way of establishing this.

There are 2 methods that can be used.

4.3.1 Distance from fixed point method

Using a fixed point, e.g. a gatepost, tree, stile, water trough, record the grid reference of your start point and a description of it, so that the measurement can be repeated again on another visit.

Measure in a straight line, to the water edge. Record this distance and using a compass the direction travelled from the start point. Try to choose a start and direction that is free from obstacles and where possible over level ground, avoiding a steep drop. The fixed point should also be above winter high-water level. Record a description of the ground travelled over to water edge e.g. smooth, bumpy, steep drop.

4.3.2 Route around water edge method

Using a GPS or mobile phone app, take grid references at the water edge every 5-10m all the way round the pond. When taking readings please ensure that you are as near to the edge as possible, but don't go near steep slopes or into thick vegetation. Please also record which app or device you are using and the accuracy of the reading, if your device includes this information.

To improve accuracy, this will need to be done at least twice and if possible using two different devices. If only one device is available, please take the readings at least 10 minutes apart and after restarting device or app, to try and reduce GPS errors.

A large number of readings allows us to plot the pond outline onto our digital maps, and establish any changes in size accurately.

4.4 Water Chemistry

The information on water chemistry can be used to evaluate the condition of the pond ecologically, helping to identify levels of pollution as well as understand how each pond is connected to the local water table, and variations between ponds and their water sources. This will help provide guidance on methods to manage these ponds in the future.

4.4.1 pH

This information can be used by a computer programme to help predict the natural wildlife community of the pond. You will be given a waterproof meter to measure pH when you collect your forms. Please follow the instructions provided with this meter to take your readings.

4.4.2 Electrical Conductivity (EC)

Can be used to understand the total amount of material dissolved within the water. It can provide information on pollution and local geology and water catchment and help identify differences

between ponds, especially those located close together. You will be given a waterproof meter to measure EC when you collect your forms. Please follow the instructions provided with this meter to take your readings.

4.4.3 Nitrate and phosphate

Ponds with lower nitrate and phosphate levels generally are less polluted and are able to support a larger and more natural ecological community. If you are provided with a meter to measure nitrate or phosphate levels then please follow the instructions provided. If you are not provided with a meter, please take a water sample, using the bottle provided, and return it along with the rest of your kit and completed form.

When taking a water sample, collect from the edge of the pond, where it is safe to do so – don't lean over to take a sample. Try and collect from undisturbed water, rather than around an area where the base sediment has been disturbed. Ensure that you label the sample bottle correctly, including date and time collected, and pond name.

5 Pond Sketch

Use this space to draw a sketch of the pond and label any key features include a scale bar and a north arrow or compass. Other information recorded could include areas of dense vegetation that stopped you reaching the water edge, location of fixed point for measuring, areas of floating–leaved or emergent vegetation and areas of shade. These will help you calculate cover and provide a record of the pond which you or others can use on future visits. Please also highlight areas where the slope around the edges of the pond shows a strong change (become very steep or suddenly very flat) as well as any areas where the substrate around the pond is visible.

6 Supplementary biological data

If you have gathered any other biological data during the pond surveys, please enter the results, however complete or incomplete. Give the completed form to the Project Manager, post them to the Wildlife Trust office, or enter them into iRecord at: https://www.brc.ac.uk/irecord/