



# UCL



Inventory of ponds in the Norfolk Coast AONB - recommendations for pond survey and conservation

ECRC Research Report Number 166

S. Goodrich, B. Goldsmith, , C. Sayer, E. Alderton, M. Kernan

2015

# **Inventory of ponds in the Norfolk Coast AONB - recommendations for pond survey and conservation**

ECRC Research Report Number 166

**S. Goodrich, B. Goldsmith, C. Sayer, E. Alderton, M. Kernan**

**2015**

Environmental Change Research Centre  
University College London  
Pearson Building, Gower St.  
London, WC1E 6BT

**List of contributors**

**Goodrich S.** ENSIS Ltd, Environmental Change Research Centre, UCL.

**Goldsmith, B.** ENSIS Ltd, Environmental Change Research Centre, UCL.

**Sayer, C.** ENSIS Ltd, Environmental Change Research Centre, UCL.

**Alderton, E.** Environmental Change Research Centre, UCL.

**Kernan, M.** ENSIS Ltd, Environmental Change Research Centre, UCL.

## TABLE OF CONTENTS

### Contents

1. INTRODUCTION AND PROJECT OBJECTIVES .....	5
<b>1.1 Study Rationale</b> .....	5
<b>1.2 Objectives</b> .....	5
2. METHODS .....	6
<b>2.1 Spreadsheet of collated species data</b> .....	6
<b>2.2 Creation of Norfolk Coast AONB GIS</b> .....	6
<b>2.3. Ground Truthing</b> .....	7
<b>2.4. Data Limitations</b> .....	7
3. RESULTS.....	8
5. RECOMMENDATIONS.....	13
6. REFERENCES .....	17

## 1. INTRODUCTION AND PROJECT OBJECTIVES

### 1.1 Study Rationale

The Norfolk Coast Area of Outstanding Natural Beauty (AONB) contains a rich array of habitats including shingle beaches, sandy beaches, mud flats, saltmarshes, freshwater grazing marsh and ditch systems, tidal rivers and estuaries, farmland, woodland (especially associated with the Cromer-Holt ridge system) and parkland. Several conservation projects have been undertaken in the AONB, but thus far freshwater ponds have received relatively little attention. With rising sea levels and a consequent increased likelihood of sea floods into freshwater marsh and ditch systems (e.g. the Blakeney Freshes), many coastal freshwater plants and animals will come under threat of decline or extinction in the coming years. Important and protected species in the AONB include natterjack toad (*Epidalea calamita*), great-crested newt (*Triturus cristatus*), palmate newt (*Lissotriton helveticus* - which is very rare in Norfolk), European eel (*Anguilla anguilla*), crucian carp (*Carassius carassius* - see Sayer et al. 2011), and several specialist water plants (including brackish water crowfoot (*Ranunculus baudotii*) and invertebrates, especially water beetles (see Goldsmith et al. 2004).

Coastal ponds, especially those located beyond the likely limit of sea floods, may help to conserve some of the aforementioned species. Currently, however, the pond resource in the AONB is poorly known, although those surveys that have been undertaken (Sayer et al. unpublished data), suggest considerable ecological potential. AONB ponds are located on cliff tops (especially between Weybourne and Cromer) and in farmland (marl pits), woodland and parkland (for example in Sheringham and Holkham parks). In addition there are also small freshwater ponds in the grazing marsh systems. Key environmental pressures on existing ponds include eutrophication, terrestrialisation, invasive species and in some cases pond loss through deliberate land reclamation (especially over the 1960s-80s and still continuing, albeit at a slower pace). Indeed there are 100s of ponds in the AONB that have been lost to in-filling: so called "Ghost Ponds" (E. Alderton, unpublished data and see: <https://ghostponds.wordpress.com/>). Much potential exists for pond enhancement, restoration and creation, therefore.

The AONB Ponds Project is intended to contribute to and take forward the aims of the Norfolk Ponds Project, which aims "to reverse the decline of Norfolk's ponds so that agricultural landscapes contain a mosaic of clean water ponds with fewer ponds overgrown by trees and bushes", in the Norfolk Coast AONB.

### 1.2 Objectives

The overall project sought to collate available information on ponds in the Norfolk Coast Area of Outstanding Natural Beauty (AONB), prioritise ponds for restoration and undertake restoration work in conjunction with interested landowners. In an initial phase, up to the end of March 2015, the aim was to collate currently available information on ponds in the AONB, identify where further information, survey or ground-truthing is required and make a

provisional prioritisation of ponds on which to focus initial restoration work, based on a range of factors, in preparation for future work (survey / ground truthing and restoration).

## **2. METHODS**

We planned to collate all the available information on ponds in the AONB past and present through searches of our own UCL data holdings (c. 30+ ponds), holdings by Norfolk Pond Project (NPP) partners especially the Norfolk Wildlife Trust, any available 'grey literature', baseline surveys associated with wind farm pipelines and files held by key conservation landowners/land managers including the Holkham Estate, Norfolk Wildlife Trust, RSPB and The National Trust (Keith Zealand of the NT holds a considerable amount of amphibian data for AONB ponds). In addition we planned to request AONB pond species data from the Norfolk Biodiversity Information Service (NBIS).

Once the data holdings were made available and the data were examined it was necessary to revise the methodology (see below).

### ***2.1 Spreadsheet of collated species data***

Species data for ponds confined within the Norfolk Coast AONB were obtained from species records held by the following people:

Carl Sayer – Senior lecturer, Department of Geography, UCL  
Keith Zealand – Head Ranger at NT Sheringham Park  
Emily Nobbs – Assistant Conservation Officer for Norfolk Wildlife Trust  
Ewan Shilland – Consultant Research Scientist, ENSIS  
Sarah Henderson – Conservation Manager at Holkham Estate  
Emily Alderton – Phd student, Department of Geography, UCL  
Robert Yaxley – Director of Wild Frontier Ecology  
Norfolk Biodiversity Information Service

These records were collated into one Excel database and separated into categories according to their data type e.g. GCN, macrophytes, invertebrates etc. As much data as possible has been obtained for each data entry, including a national grid reference to the highest possible resolution.

### ***2.2 Creation of Norfolk Coast AONB GIS***

ArcGIS 10.2 (ESRI) software was used to create a map containing multiple shapefiles which show all the known pond locations within the boundary of the Norfolk Coast AONB. A number of these shapefiles were created by Emily Alderton:

**Current Modern Ponds:** Contains ponds identified from OS 2014 which have been split into separate layers (Connected ponds, Field ponds, Gravel-pit ponds, Hedge ponds, Mere lakes, Moat estate lakes, Roadside ponds and Woodland ponds).

**Ghost Ponds 1892 – 1952:** Ponds that appeared on the 1892 OS map but were not marked on the 1952 OS map.

**Ghost Ponds 1950 – 2014:** Ponds marked on the 1952 OS map but had disappeared by the 2014 modern OS map.

The Norfolk Biodiversity Information Service also provided a layer which shows ponds within the Norfolk Coast AONB.

Where possible, ponds which have associated species records were uploaded onto ArcGIS 10.2 using the location data as provided by the data owner. However, not all data entries were well geo-referenced (many of them only had four figure grid references) which meant that the accuracy of some of the pond locations was questionable. In some cases site visits to these ponds would help to clarify the true pond locations.

Duplicate points for single ponds were commonplace. Therefore, once all the data had been uploaded onto ArcGIS 10.2, point data was edited in an attempt to delete any multiple records which denoted the same pond.

The final shapefiles were converted into compatible .kml files in order to upload them onto Google Maps, where a complete map can be viewed of all known pond locations and species data.

### ***2.3. Ground Truthing***

Three 5 x 5 km squares were randomly placed within the Norfolk Coast AONB boundary, using Google Earth Pro. High resolution satellite imagery or, where possible, local knowledge were used to locate any ponds which had not yet been identified on an OS map. ArcGIS 10.2 was employed to calculate the number of these known ponds which fall within the boundaries of the 5 x 5 km squares. The purpose of this exercise was to determine the error margin between identified ponds on OS maps and actual ponds that are currently unmapped.

### ***2.4. Data Limitations***

There are a number of limitations to this project. The most significant limitation was the discovery of species data which only had four figure grid references associated with them. Many of these entries also lacked pond names (which can locally vary anyway), rendering the identification of the pond from where the record came almost impossible. Such records have been left in the database and on the map, with the possibility of firm identification in the future.

Acquiring data and identifying data sources can at times be difficult. Quite often data has been collected and not published. Although we have consulted many potential sources of data as part of this project, it is highly likely that members of the general public have data which would make a valuable contribution to the database. This can potentially be resolved with an open-source database, free for the public to upload their own data to.

Following on from the point above, it became increasingly apparent good data are only available for a small number of ponds within the AONB region, with a distinct lack of data for the majority of ponds.

### **3. RESULTS**

A total of 1307 ponds were identified following data collation and examination. These have all been allocated a unique identifier and are listed in an 'AONB Ponds All sites.xlsx' spreadsheet sent to the Norfolk Coast Partnership. The information in this spreadsheet includes;

**Unique identifier**

**Site name**

**Pond type (See below)**

**National Grid Reference (and latitude and longitude)**

**Area**

**Perimeter**

**Conservation designation**

Pond type was broken down into a number of categories, as highlighted in Table 1 which also gives the number of ponds in each category.

Species data were available for 26 ponds with sufficiently high resolution grid references to identify them from maps. A further 10 ponds falling under various of the pond typologies in Table 2 were matched with species data. In addition, species data were available for an additional 54 ponds but grid references for these sites poorly resolved (containing only 4 figures) so it was not possible to identify where they were located on maps.

**Table 1: Pond categories identified following collation of pond datasets**

<b>Pond type</b>	<b>No. of ponds</b>
Connected pond (a pond which is connected to a water course, usually a stream or a ditch)	66
Field pond (a pond located in a field and not directly adjacent to a hedgerow - an isolated pond)	224
Gravel pit pond (pond formed in an old gravel pit - marked as gravel pit or gravel works on map)	5
Hedgerow pond (a pond which is located on a hedgerow - these sites may be of particular interest for amphibians - connected to potential dispersal pathways)	204
Ornamental / Estate Lake (a lake that is broad in relation to its depth)	2
Moat / estate lake (these features may have more historic interest, but also may be less "natural", being located close to estates / stately homes)	14
Reservoir (a body of water (usually square / rectangular), or marked as "reservoir" on the OS map. Likely of low conservation interest)	4
Roadside Pond (a pond immediately adjacent to a road. These ponds will often experience road run-off, which can cause ecological degradation)	75
Woodland Pond (ponds located in woodland)	60
Ghost Ponds 1892- 1952 (ponds which appeared on the historic OS maps, but not on the 2013 OS edition. Most of these ponds will have been lost to agricultural or urban land reclamation, although there is some margin for error due to differences in mapping effort / drawing quality. these ponds were lost between 1882 and 1952)	31
Ghost Ponds 1892- 1952 (ponds which appeared on the historic OS maps, but not on the 2013 OS edition. Most of these ponds will have been lost to agricultural or urban land reclamation, although there is some margin for error due to differences in mapping effort / drawing quality. These ponds were lost between 1950 and 2014)	59
Unclassified ponds from NBIS database.	537
Unclassified ponds with species data (with sufficient georeferencing to identify location)	26
<b>Total ponds</b>	<b>1307</b>

**Table 2: No. of ponds with data for different species groups**

<b>Species</b>	<b>No. of ponds</b>
Birds	22
Fish	10
Great Crested Newt	47
Invertebrates	20
Macrophytes	19
Mammals	7
Natterjack toads	2

Using ArcGIS a number of shapefiles were converted into compatible .kml files in order to upload them onto Google Maps. This enabled maps to be created showing all known pond locations (broken down by category) and species data. Fig 1 shows all ponds within the Norfolk Coast AONB classified according to category.

#### *Ground Truthing*

In total, 204 known ponds (from the datasets queried) lie within the boundaries of the 5 x 5 km ground truthing squares. An additional 37 ponds were located within these squares using high resolution satellite imagery, increasing the total number of identified ponds by a moderate 18%. This result implies that, although a significant number of ponds had already been identified prior to this exercise, the number of additional ponds subsequently identified following desk-based ground truthing is large enough to justify more comprehensive, field based ground-truthing of the Norfolk Coast AONB. Although analysis of satellite imagery is a useful approach, it is recommended that ground-truthing should be completed in the field, using local knowledge, in order to ensure full coverage of sites within the Norfolk Coast AONB.

Field ground truthing would also be useful where the GIS and satellite data make it difficult to differentiate between 'duplicates' ponds and those ponds that are very very close neighbours (e.g. where there is high tree coverage)

**Table 3: Pond types found in 5 x 5 km ground truthing squares**

	5 x 5 km Squares (FID number)			Total
	<b>0</b>	<b>1</b>	<b>2</b>	
<b>Woodland</b>	4	0	1	5
<b>Roadside</b>	1	3	6	10
<b>Reservoir</b>	0	0	0	0
<b>Moat</b>	2	0	1	3
<b>Ornamental lake</b>	0	0	0	0
<b>Hedge</b>	12	12	10	34
<b>Gravel</b>	0	0	0	0
<b>Ghosts</b>	6	0	6	12
<b>Field</b>	13	8	15	36
<b>Connected</b>	4	18	0	22
<b>Species Data</b>	0	2	1	3
<b>Unclassified (NBIS)</b>	32	25	22	79
<b>Total</b>	<b>74</b>	<b>68</b>	<b>62</b>	<b>204</b>

Overall, a major paucity of species data are available relative to the number of ponds in the Norfolk Coast AONB. This highlights a number of issues;

- i) The problem of ineffective recording procedures (people record, but don't effectively submit data)
- ii) A potential need for better (easier) reporting processes to facilitate recording – web-based submission may be the best option
- iii) The AONB has a huge number of ponds without ANY data

This exercise raises many questions regarding current knowledge of ponds and associated conservation interest in the Norfolk Coast AONB, some of these are addressed in the recommendations section below. Nonetheless, the pond inventory is an excellent starting point. There is clearly a need to promote more data collection and to ensure that data are collected and submitted to a central point, ideally the Norfolk Biodiversity Information Service (NBIS).

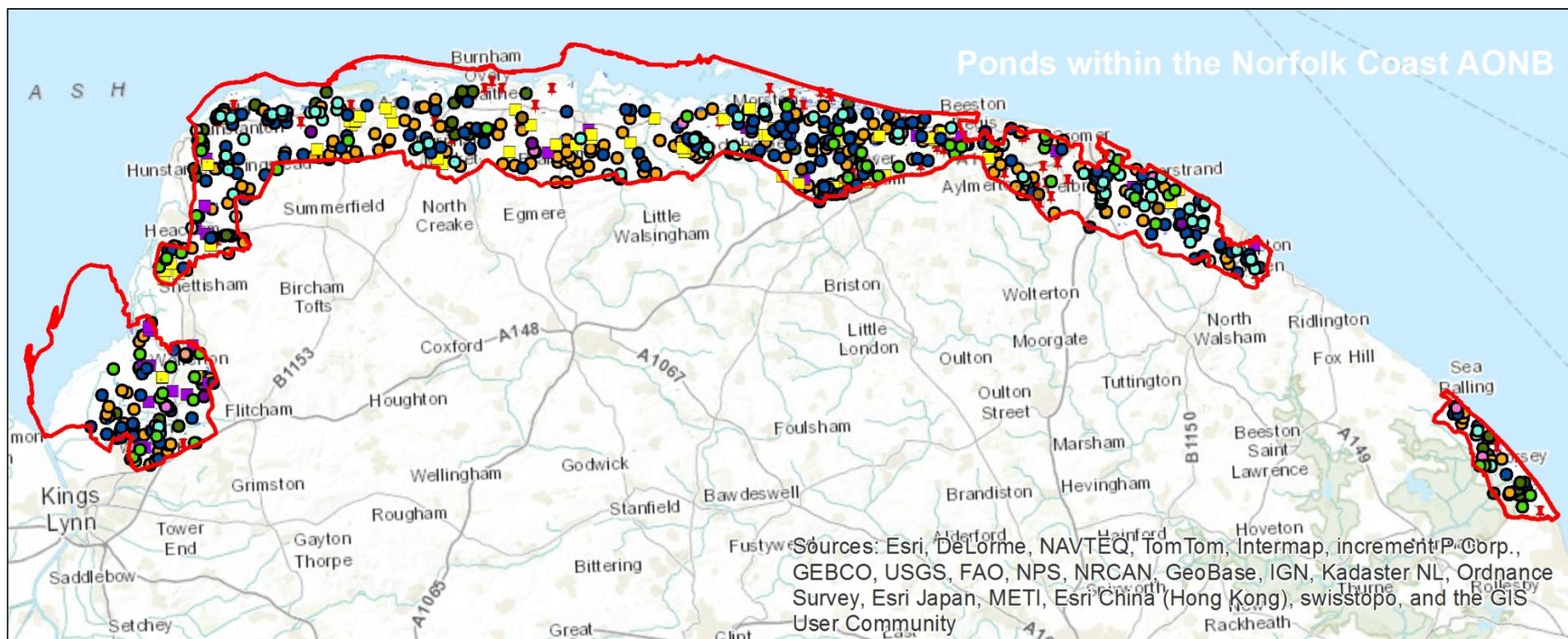


Figure 1: All ponds within the Norfolk Coast AONB - classified according to category

## 5. RECOMMENDATIONS

Currently the species data available for ponds in the AONB are scant/sporadic being largely limited to records for individual species with only a few ponds subjected to multi-species surveys. Nonetheless, there are large numbers of ponds in the AONB (1307 identified in this study) and it is clear that several key pond species are present which would benefit from future conservation work. Prior to making suggestions for future pond conservation projects it is important to consider current major threats to ponds and pond species in the AONB which include the following:

- 1). **Pond loss due to deliberate land reclamation** – this has been a major a problem in the past, especially over the 1950s-1980s and has resulted in 90 ‘Ghost Ponds’ in the AONB. Pond in-filling still continues, but the rate has slowed in recent years (Alderton *et al.* 2014 and see <https://ghostponds.wordpress.com/>) .
- 2). **Saline incursion** – this is especially true of low-lying ponds close to the sea, such as coastal scrapes/pools in bird reserves (e.g. at Cley and Holkham) those ponds remnant from saltmarsh channels in freshwater marshes (present in the Blakeney Freshes).
- 3). **Pond eutrophication** – this is especially true of ponds in farmland, where ditches, or pipes directly link ponds to agricultural drainage.
- 4). **Pond terrestrialisation** – the vast majority of farmland ponds in the AONB are heavily overgrown by scrub having been abandoned, in terms of traditional pond management practices, since at least the 1970s-1980s (C. Sayer, personal observations). The overriding dominance of scrubbed-over farmland pond will be restricting biodiversity across the AONB, with a mosaic of open canopy and more overgrown ponds being much more desirable (see Sayer *et al.* 2012; 2013).
- 5). **Invasive species** – a particularly serious threat to ponds in the AONB is posed by New Zealand Pigmywort *Crassula helmsii*. This species is currently confirmed as present in 3 AONB ponds), and where it occurs it can dramatically reduce the diversity of other aquatic plants present.
- 5). **Disease** – UK amphibian species are currently under huge threat from disease, including Chytridiomycosis (a highly infectious disease caused by a fungus that affects common toad in particular) and Ranavirus. In the last year a newly-discovered species of chytrid fungus (*Batrachochytrium salamandrivorans*) which can infect and kill a wide range of newts and salamanders has been found in captive UK populations of Great Crested Newt. This fungus could have severe concentrations for Great Crested Newt, at worst leading to its loss from the wild. Indeed this was the recently case for the rare Fire Salamander *Salamandra salamandra* in Belgium.

## Important next moves and potential pond conservation

### 1. Farmland pond restoration

Much good information now exists on the benefits of pond management for aquatic biodiversity conservation in agricultural landscapes (Sayer *et al.* 2013). Additionally, emerging research in Norfolk farmland is even showing huge benefits of open-canopy managed ponds to farmland birds through the provision of insect and plant food (Davies *et al.* in prep.). To date, pond management and restoration has received little attention in the AONB. Nonetheless, one flagship project, conducted at the landscape-scale where several overgrown ponds are managed to reduce terrestrialsation, might help to inspire future work. A good candidate area is around Holkham-Warham, where there are also several “Ghost Ponds” which could also be restored. Before and after species diversity studies would be essential to gather evidence of benefit. A “Coast Ghosts” pond project might well capture conservation and public imaginations in the future and would be a good candidate for a funding bid in the AONB. Future AONB pond projects could form part of the developing Norfolk Ponds Project and in this respect the Norfolk Coast Partnership could join the NPP as a partner in the near future.

### 2. Pond creation

There would be huge benefits associated with focused pond creation within the AONB. This could take three major angles;

- (i) Creation of ponds on and close to moraine deposits associated with the Cromer-Holt ridge - existing ponds on the Cromer Ridge are slightly more acidic (e.g. ponds at Kelling Heath Holiday Park) and thus suitable for the Palmate Newt *Lissotriton helveticus*, an exceptionally rare species in East Anglia (only 2 known Norfolk sites until 2014). Recent surveys of ponds associated with the ridge, as undertaken by Keith Zealand (National Trust) and UCL, have detected 3-4 more Palmate Newt populations, but the existing sites are fragmented. Further surveys are needed of AONB ponds to detect Palmate Newt presence (it is known for Holt Country Park and Bacton Woods), but when more information is available on its distribution, focused pond creation close to extant sites could greatly help this species, whilst also affording habitat for scarcer local plants such as *Apium inundatum*, *Juncus bulbosus*, *Carex vesicaria* and *Potamogeton polygonifolius*.
- (ii) Creation of “compensation ponds” close to the coast – with the increasing threat of saline incursion due to climate change, many plant and animal species associated with coastal freshwater marshes (e.g. Blakeney Freshes) are potentially under threat of local extinction. Key species/species groups in this respect include Natterjack Toad *Epidalea calamita*, some nationally scarce brackish water beetle taxa (e.g. *Peltodytes caesus*, *Rhantus suturalis* and *Hygrotus parallelogrammus* - see Goldsmith *et al.* 2003) and rare plants such as Brackish Water-crowfoot *Ranunculus baudottii*. Ponds could be created in locations close to the coast, but out of flood risk zones - even in cliff-top localities in the case of invertebrate and plant species, where sea-spray would help to create the right conditions.

- (iii) Creation of floodplain ponds – due to a long history of drainage and agricultural land reclamation, ponds are currently rare habitats in river floodplains (Sayer, 2014), with this especially the case for AONB rivers (e.g. Glaven, Stiffkey, Burn). The creation of lower floodplain ponds would greatly benefit river fishes (especially European Eel *Anquilla anguilla*, 3-spine Stickleback *Gasterosteus aculeatus*), through provision of flow refuges and additional food sources, as well as providing superb habitat for amphibians, dragonflies and wetland birds. Ponds could easily be dug in floodplain habitats as demonstrated by recent Nine Chalk Rivers project works at the Glaven and by the recent Hunworth meadows river restoration project.

### **Surveys for rare species**

We suggest that more survey data is required to help target future pond conservation activities in the AONB. This is especially true of woodland and heathland ponds associated with the Cromer-Holt ridge, where palmate newt may well be much more prevalent (see above). In addition a future meeting to discuss the status of natterjack toad (at Holme, Holkham-Burnham, Winterton etc.) post the sea floods of winter 2013 would be advisable and surveys in this respect could be necessary depending on current local knowledge. Finally, surveys of farmland ponds close to the coast could also be highly beneficial to help determine the potential for rare species occurrence and in turn the need for pond management. In terms of future priorities, while there is a need to increase the knowledge base for existing ponds, particularly in terms of biological data, there is sufficient information available already to identify ponds for a targeted restoration programme in tandem with further survey work.

### **Better species recording**

Given the wealth of interest in natural history within north Norfolk and large number of individuals with excellent species identification skills who live within and visit the AONB, there is very little species data pertaining to ponds. Furthermore, where species records have been submitted to organisations such as Norfolk Biodiversity Information Service, the records often lack sufficient geographical information to identify the specific pond from where they came. Similarly, there were many species records gathered as part of this study that have not been submitted to any central database and mainly exist within the “grey literature” or with individual recorders.

We would therefore recommend that a simple data recording protocol be devised to facilitate recording and encourage individuals and organisations to submit data. At its simplest level, this could be a flyer that could be distributed at events and via local information centres and available to download on your website. Careful questioning on exactly where the record was taken is essential and while not everyone will be able to provide a 6 figure grid reference, there should be a chance to describe the location through

a range of other means (e.g. post code, nearest road, village, Lat/long etc.). This information then needs to be collected and collated and ideally this would be best achieved by individual collectors being able to upload data directly to a web site. This increases the opportunity for locating the records by using on-line mapping (e.g. Google Maps) to identify the sample point and would allow easy transfer of records to a central database. Other possibilities include using mobile phone apps for recording such as those already in use by (among others) the British Trust for Ornithology and PlantTracker. These apps use the geo-referenced location of the smart phone to record the location and thus negate the need for users to actively record their location.

## 6. REFERENCES

Alderton E, Sayer CD, Nobes G, Shilland E, Axmacher J.A., Lambert S. (2014) *The Ghost Ponds Project – Report No. 2*. Report to the Norfolk Biodiversity Partnership, UCL.

Davies, S.R., Sayer, C.D., Greaves, H. & Axmacher, J.C. (in prep.) Conserving farmland birds – a newly discovered role of pond management? *Conservation Biology*.

Goldsmith B.J., Hoare D.J., Jones J.I., Nobes G.N. & Sayer C.D. (2004) *A biological survey of the Blakeney Freshes: North Norfolk*. Report to the National Trust. ECRC Research Report No. 95.

Sayer, C.D., Andrews, K., Shilland, E., Edmonds, N., Edmonds-Brown, R., Patmore, I.R., Emson, D. & Axmacher, J.A. (2012). The role of pond management for biodiversity conservation in an agricultural landscape. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 22, 626-638.

Sayer, C.D., Shilland, E., Greaves, H., Dawson, B., Patmore, I.R., Emson, D., Alderton, E., Robinson, P., Andrews, K., Axmacher, J.A. & Wiik, E. (2013) Managing British ponds – conservation lessons from a Norfolk farm. *British Wildlife*, 25(1), 21-28.

Sayer, C.D. (2014) Conservation of aquatic landscapes: ponds, rivers and lakes as integrated systems. *WIRE's Water* 1, 573-585.

.