Making an impact on UK farmland pond conservation

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Abstract
1. It is of vital importance that aquatic conservation is evidence based, and in the field of farmland pond management and restoration evidence was largely lacking until an article published in Aquatic Conservation: Marine and Freshwater Ecosystems (AQC) in 2012.

2. To examine the influence of farmland pond management on aquatic biodiversity conservation, macrophyte and invertebrate diversity in ponds subject to traditional management involving scrub and occasional sediment removal at different time intervals in the past (0–2, 3–5, 6–10 years since management), were compared with a set of neighbouring, highly terrestrialized ponds that had not been managed for many decades.

3. With the exception of Mollusca, significantly higher species diversity was found for managed ponds compared with the late-succession unmanaged ponds, with invertebrate gamma diversity significantly lower for the late-succession ponds, compared with all the managed pond categories.

4. The AQC article was a key component of the Natural England (UK Government’s adviser on the natural environment in England) ‘Freshwater and Wetland Conservation Narrative’ and has helped with integrating pond management into recent great crested newt Triturus cristatus mitigation policy as well as bringing it to the fore in past and evolving agri-environment policy.

5. The AQC article provided the evidence and in turn the confidence for the authors and a number of conservation partners to form a Norfolk Ponds Project. Since 2014, the Project has delivered or facilitated more than 100 pond restorations in Norfolk, eastern England, as well as educating conservation practitioners and farmers on the importance of farmland ponds via various events.

6. With good underpinning science it has been possible to achieve considerable impact in the field of farmland pond conservation. This study shows the importance of setting aside time and support for academic staff to translate applied research outputs into practical impact.

Keywords
agri-environment, engagement activities, evidence-based, policy, pond restoration and management, succession
Artificially created ponds, often many centuries old, are known to be important for biodiversity conservation in European farmland landscapes (Céréghino, Ruggiero, Marty, & Angélibert, 2008; Declerck et al., 2006; Gioria, Schaffers, Bacora, & Feehan, 2010). However, in many areas, including lowland England, biodiversity and the conservation of rare species in farmland ponds are threatened by terrestrialization, resulting in an overwhelming numerical dominance of late-successional ponds with high canopy shading and consequently a low cover of aquatic macrophytes (Janssen, Hunger, Konold, Pufal, & Staab, 2018; Sayer et al., 2013). Although highly terrestrialized ponds offer habitat for many species (Biggs, Corfield, Walker, Whitfield, & Williams, 1994), where early and mid-succession ponds are largely absent from the landscape, major reductions in diversity occur, especially for macrophytes (Hassall, Hollinshead, & Hull, 2011), dragonflies (Janssen et al., 2018), amphibians (Skelly, Bolden, & Friedenburg, 2014) and fishes (Sayer et al., 2011). A number of solutions are available to address the problem of mass pond terrestrialization, including pond creation (Williams, Biggs, & Nicolet, 2010) and the re-excavation of ponds lost to deliberate infilling as a result of agricultural and urban land-grabbing – so-called ‘ghost ponds’ (Alderton, Sayer, Davies, Lambert, & Axmacher, 2017). However, in the absence of natural disturbances (e.g. beavers, wild river flooding) capable of resetting succession (Sayer et al., 2013), the only truly sustainable solution to this problem is active scrub management and sediment removal. The latter approach is the focus of this impact case study, which examines the conservation impact of an article published in Aquatic Conservation: Marine and Freshwater Ecosystems (AQC) (Sayer et al., 2012).

To improve understanding on the role of pond management for aquatic biodiversity conservation in farmland, Sayer et al. (2012) compared macrophyte and invertebrate diversity patterns for a pond landscape subject to frequent interventions (scrub and occasional sediment removal) to re-set succession with a set of nearby highly terrestrialized late succession ponds. The study ponds were located at Manor Farm, Briston, a mixed (arable plus cattle) farm in north Norfolk, eastern England, where the farmer has managed at least three or four ponds each year (in autumn–early winter) for at least 40–50 years. Over this time some ponds have been left unmanaged with the result being a mosaic of ponds at different stages of succession (Figure 1a–d). Sayer et al. (2012) compared ponds managed at different time intervals in the past (nine, seven and six ponds at 0–2, 3–5 and 6–10 years since management, respectively) with six late-succession ponds (two at Manor farm and four within a 10 km distance) typical of most ponds in the region (Figure 1e). All ponds were old (probably >200 years), artificially created (dug for marl or for livestock watering), located in comparable arable settings, and they were
buffered by 7–10 m wide rough grassland headlands. The ponds were surveyed for aquatic macrophytes and key invertebrate groups (Mollusca, Coleoptera, Trichoptera, Ephemeroptera) using standard methods.

With the exception of Mollusca, significantly \( (P < 0.01) \) higher species diversity (estimated by Brillouin diversity and Simpsons D) was found for Manor Farm’s managed ponds compared with unmanaged, late-succession ponds in the surrounding landscape. Species richness calculated for combined macrophyte and invertebrate data was significantly lower in the unmanaged ponds compared with ponds in all other management categories \( (P < 0.0001) \) – Figure 2. Invertebrate gamma diversity, as estimated by rarefaction analysis, was also significantly lower for the late-succession ponds, compared with ponds in all management categories for all rarefied sample sizes. Importantly, while many species were absent from the unmanaged ponds, especially in the macrophytes and Coleoptera, few species were unique to these ponds, suggesting that pond management was unlikely to lead to significant species losses from the pondscape. In combination, these analyses showed that, by arresting succession and maintaining large numbers of macrophyte-dominated early and mid-succession ponds in the landscape, pond management resulted in major benefits for landscape-scale aquatic diversity.

### 1.1 Farmland pond conservation and the Norfolk Ponds Project

Given an overwhelming dominance of highly terrestrialized ponds in the UK lowlands (Alderton, 2016; Sayer et al., 2013) and with pond creation largely failing to keep pace with the loss of open-canopy, macrophyte-filled ponds to successional processes (Mainstone, Hall, & Diack, 2016), there is a clear need for conservation intervention involving large-scale removal of woody vegetation and accumulated sediments from tree- and scrub-dominated ponds. As detailed by Sayer et al. (2012), it is essential that farmland ponds are managed to maintain early and mid-succession ponds in the pond network. The key mechanism for achieving effective farmland pond conservation in the UK is the incorporation of pond options into agri-environment schemes (AESs). At the time of Sayer et al. (2012), however, the authors felt that pond restoration and management was insufficiently promoted both in AESs and in turn by agri-environment advisers. Furthermore, it was believed that guidance on pond management was not well informed by science and that, despite recognition of their high importance in the farmed landscape, most UK conservation organizations (both statutory and non-governmental organizations [NGOs]) did not have farmland ponds very high on their agendas.

With evidence and confidence derived from Sayer et al. (2012), the authors set out to promote and enact science-informed farmland pond conservation by a ‘top-down’ route of influencing the policy and the agendas of key UK conservation agencies and NGOs, and by a ‘bottom-up’ approach of directly delivering farmland pond conservation at the landscape scale. High farmland pond densities and good landowner and local conservation contacts (of the first author) led to the decision to undertake this later work in Norfolk. As key infrastructure was needed to achieve these goals, in 2014 a Pond Restoration Research Group (PRRG) was formed within the Department of Geography at University College London (UCL) and at the same time, with encouragement from many helpful individuals in the conservation sector, a Norfolk Ponds Project (NPP) was initiated. The NPP is a partnership of several NGOs, including UCL, Norfolk Wildlife Trust, Norfolk Farming and Wildlife Advisory Group, Natural England (NE), Norfolk Rivers Trust, National Trust, Norfolk Biodiversity Partnership, Norfolk Non-native Species Initiative and local farmers.

The NPP was set up with two major aims: (i) to restore and conserve ponds (especially farmland ponds) in the county of Norfolk for the benefit of wildlife conservation; and (ii) to engage and educate farmers and the public as well as conservation practitioners and policy-makers on the importance of pond restoration and...
management for biodiversity conservation. On the NPP’s inception a 5-year plan was written, a website was constructed and social media channels were opened (Twitter). In addition, UCL and Norfolk Wildlife Trust co-designed a ‘Restoring Norfolk Ponds’ booklet providing a step-by-step guide to pond restoration. From the outset it was agreed that the NPP would promote the incorporation of ponds into individual partners’ projects and it was hoped that, with the Manor Farm example and associated PRRG science as support, it would be possible to enact some successful pond conservation work and to undertake, through Before–After Control–Impact (BACI) studies of restored ponds, further research to measure the multi-species benefits of landscape-scale pond restoration.

To achieve its aims the NPP has used a range of approaches. First, it has run numerous outreach events aimed at educating participants on farmland pond restoration and management. These have included field-based pond restoration workshops (22 events over 2014–2019 involving 130, 145 and 163 farmers, members of the general public and conservation practitioners, respectively) including visits to restored pond landscapes, especially the Manor Farm ponds of Sayer et al. (2012), which form a key NPP ‘demonstration site’. Targeted groups have included wetland and farmland conservationists in the Royal Society for the Protection of Birds, The Wildlife Trusts, Farming and Wildlife Advisory Group groups, Wildfowl & Wetlands Trust, NE and the Chartered Institute of Ecology and Environmental Management (CIEEM) as well as policy-makers in NE, policy advisers for other conservation NGOs and farmers (including ‘Young Farmer’ groups). Typical field workshops have comprised short introductions and visits to several ponds (Figure 3a,b), followed by question and answer and feedback sessions (Figure 3d).

Second, since 2014 the PRRG and NPP have run annual pond restoration events where several highly overgrown ponds have been restored. At these events farmers, project partners, UCL students and interested members of the public have all provided volunteering support (Figure 3c) and in turn have been able to learn pond management methods. Mimicking Manor Farm and Sayer et al. (2012), pond restoration work has been undertaken at the landscape scale with several ponds (typically more than eight) restored in multiple high-density pond patches (>15 ponds km$^{-2}$) using a phased approach in which a smaller number of ponds have been worked on in different years. For example, in the Bodham–Baconsthorpe area of North Norfolk (Sayer et al., unpublished data), two, two and five ponds were restored in 2011, 2014 and 2017, respectively, with a number of overgrown ponds in the patch left as controls. In addition, two ponds restored in 2011 have received subsequent scrub management.

Other pond activities aimed at passing on knowledge on farmland ponds have included seminars run for conservation practitioners involving imaginary pond landscapes, a citizen science monitoring project (Figure 3e), stalls at agricultural and conservation-focused shows.
promoting pond restoration (e.g. Royal Norfolk Show) and pond ‘bio-
blitz’ events combining academics, natural history experts and the
general public. In addition, the NPP has offered an advice service for
farmers and conservation managers (covering hundreds of enquiries)
involved in restoring ponds with responses via e-mail or site visits
where necessary. Between 2012 and 2019, UCL PRRG members
delivered 45 talks on farmland pond conservation to the general pub-
lic (20 talks to 712 people), conservation organizations (21 talks to
635 people) and farmers (four talks to 85 people). Throughout all of
this work, social media and popular articles have been used to pro-
move both NPP activities and pond research developments made by
the PRRG.

2 | PRIMARY IMPACTS ON POND
CONSERVATION AGENDA AND POLICY

2.1 | Natural England freshwater and wetland
conservation narrative

It has been possible, with Sayer et al. (2012) as key evidence, to give
farmland pond management and restoration a higher profile in the UK
conservation agenda. In particular, via NPP and PRRG talks, events and
lobbying activities, knowledge (as gauged from questionnaire
responses) on the importance of farmland ponds and the need to arrest
successional processes via management has increased among conserv-
ation practitioners and policy-makers (Figure 4). Importantly, Sayer
et al. (2012) was used in the recent Natural England *Narrative for
Conserving Freshwater and Wetland Habitats in England* (Mainstone
et al., 2016), which outlines the evidence basis and philosophical
framework for English freshwater and wetland habitat conservation,
derpins key work-streams for protected sites and sets out conserva-
tion ambitions and delivery mechanisms for important legislative
drivers, including the UK’s response to Biodiversity 2020, the
European Water Framework Directive (Council of the European
Communities, 2000) and current and evolving AES, including the cur-
rent Countryside Stewardship scheme. In a section on ‘Key Manage-
ment Messages’ Mainstone et al. (2016) states that ‘in agricultural
landscapes where there is less land available for pond creation, active
management of the pond resource, involving partial scrub and
sediment removal, can ensure that early successional ponds and the
biodiversity they support remain part of the landscape’. Thus, inclusion
of Sayer et al. (2012) in the Narrative (Mainstone et al., 2016) has
helped to solidify the importance of farmland ponds and their manage-
ment, in landscape-scale pond conservation.

2.2 | Great crested newt District Level Licensing
mitigation

A further important policy advance influenced by Sayer et al. (2012)
cconcerns the new English District Level Licensing (DLL) approach for
great crested newt *Triturus cristatus* mitigation. As a protected species
under Schedule 5 of the UK Wildlife & Countryside Act of 1981, great
crested newt (GCN) presence within and close to proposed develop-
ment sites has to be mitigated, and traditionally this has been achieved

**FIGURE 4** Summary of questionnaire responses (on a scale of
1–10 where 1 = no knowledge and 10 = expert) gathered before and
after pond restoration workshops for a Chartered Institute of Ecology
and Environmental Management group and a Norfolk farmers group
in June 2019. Questions were as follows: (a) how would you rate your
current understanding of best practice when managing farmland
ponds at a landscape scale; (b) how would you rate your current
knowledge of the methods involved in undertaking a farmland pond
restoration; and (c) how would you rate your knowledge/experience
of farmland pond species?
by installation of expensive newt exclusion and capture infrastructure combined with translocation of captured newts to nearby ponds. As part of the UK Government’s 25 Year Plan to Improve the Environment (Defra, 2018) habitat ‘net gain’ was established as an underlying principle. In the 25 Year Plan a new DLL approach was highlighted as an innovative example of net gain implementation with districts empowered to use money from developers to create additional GCN habitat. As initially set up, creation of new ponds dominated the new GCN DLL, with little consideration of the potential role of pond restoration and management. However, with some lobbying and following a number of NE site visits to NPP ponds, the latter is now included as a key net gain pond option in the DLL. The importance of UCL research, as underpinned by Sayer et al. (2012), is illustrated by the comments of Craig Thomas, NE Habitat Delivery Strategist for the DLL project, on 10 October 2019: ‘Norfolk Ponds Project restoration works have proved extremely helpful in informing the habitat delivery elements of Natural England’s GCN District Level Licensing project. In particular, you have illustrated that restoring ponds within the wider landscape has an important role to play alongside pond creation. Clearly the techniques you have used, and your careful decision making with regards to pond selection and restoration prescriptions, have added greatly to our knowledge base. We have used this to strengthen our pond specifications which are being used to deliver 400+ ponds across England this year’.

2.3 | Agri-environment policy and practice

In the current (since 2014) Countryside Stewardship AES both farmland conservation advisers and farmers have been able to draw on NPP guidance on farmland pond restoration and management. In addition, for the forthcoming Environmental Land Management Scheme AES (likely to be launched in 2025 with pilots running from 2021 to 2024), Sayer et al. (2012), together with subsequent research on ghost pond resurrection (Alderton et al., 2017) and the benefits of pond restoration for farmland birds (Davies, Sayer, Greaves, Siriwardena, & Axmacher, 2016; Lewis-Phillips et al., 2019; Lewis-Phillips et al., 2020) and pollinators (Walton, Sayer, Bennion, & Axmacher, unpublished data), is being used to shape the overall approach and prescriptions for ponds. As Ruth Hall, Standing Waters Senior Specialist for Natural England, stated on 7 November 2019: ‘The research evidence base you have produced has been fed into the development of agri-environment schemes and it continues to influence them, providing further justification for pond restoration to be funded. An example of this is the inclusion of pond buffers in the Wild Pollinator and Farm Wildlife Package, a decision that was informed by UCL’s work’.

3 | SECONDARY IMPACTS ON POND RESTORATION AND MANAGEMENT

It is hard to measure the full impact of all NPP and PRRG engagement work owing to the often unpredictable and indirect nature by which impact is generated involving trails of interactions and outcomes that are often unknown and difficult to measure. For example, attendance of one conservation-minded farmer at a pond restoration workshop in 2014 led to that farmer restoring a number of ponds on their farm. After a few years these ponds had become extremely species-rich and subsequently became the focus of PRRG surveys (2017–2018) and then a pond restoration workshop event (2019) for an NE farm cluster group (Upper Wensum Farm Cluster). Following this later event, one of the farmers in attendance also decided to restore seven ponds, contributing to the NPP ‘Big50’ pond restoration project of September–December, 2019. Thus, engagement activities can often achieve impact by ‘snow-ball’ effects and careful follow-up work is needed to help trace them.

At the time of this publication five pond landscapes and more than 100 farmland ponds have been directly restored by the NPP. As in Sayer et al. (2012) this approach has created heterogeneous
mosaics of ponds at different stages of post-restoration succession. To date all of the restored ponds have become macrophyte-dominated (compare Figure 1e,f) and BACI studies have shown significant landscape-scale increases in aquatic diversity for a range of biological groups, including aquatic plants, invertebrates and amphibians (Siggery, 2018; Sayer et al., unpublished data). A number of rare species have colonized some of the restored ponds, including nationally scarce submerged aquatic plants such as Oenanthe aquatica (n = 5), Hottonia palustris (n = 1), Tolympella glomerata (n = 5) and Najas marina (n = 1), a species protected under Schedule 8 of the UK Wildlife & Countryside Act, 1981. Further, NPP restorations have so far resulted in at least 13 additional Norfolk pond populations of GCN.

In addition to directly undertaking pond restorations, the NPP is thought to have indirectly influenced at least 40 other pond restorations through farmer and landowner attendance at events or provision of advice. In many cases, meetings with farmers have resulted in subsequent inclusion of pond management options in their AES agreements. The potential influence of the NPP on the uptake of pond options in AESs is illustrated in Figure 5, which compares the number of Norfolk Countryside Stewardship agreements that included ponds over 2016–2019 with four other pond-rich English counties. This analysis shows Norfolk to have twice as many pond-containing stewardship agreements compared with Cheshire, Lancashire, Suffolk and Essex. It is not possible, of course, to be certain that higher engagement with AESs in Norfolk is the direct result of the lessons afforded by Sayer et al. (2012) and the work of the NPP, but it is suspected that both have been critical; as Lucy Hatcher, an NE Farm Adviser in Norfolk commented on 13 November 2019: "There is a considerable awareness of the work of the NPP and the benefits that ponds provide to a whole breadth of farmland wildlife within the farming community in Norfolk. This is reflected in the high number of ponds being managed, restored or created within Higher Tier Countryside Stewardship schemes, which are supported by Natural England advisers many of whom have also received farmland pond training from the NPP."

In terms of the NPP’s aim of engaging and educating the general public, farmers and conservation practitioners on farmland pond management, impact is best assessed by measures of participant learning during events. Example questionnaire responses from two NPP field-based pond restoration workshops in June 2019 for local farmers and members of CIEEM (Figure 4) clearly suggest a previous lack of confidence with farmland pond conservation. Following the events, however, substantial learning was evident from questionnaire responses, with participants reporting that they were better able to understand important pond species and the science and practicalities of best practice farmland pond management at the landscape scale.

4 | CONCLUSIONS

The bottom-up and top-down approaches to achieving conservation impact outlined here are clearly synergistic, with the practical work and social media promotion of the NPP (bottom up) helping to raise the profile of a landscape-scale pond restoration and management approach, thus increasing knowledge among conservation practitioners and policy makers (top-down). Equally, it is clear that, at a local level, an active NPP was able to achieve a great deal in a short time, with the 100+ farmland ponds restored almost matching the number of Norfolk ponds restored via the top-down AES route over the same period. None of the aforementioned impact could have been achieved without the underpinning science provided by Sayer et al. (2012) in AQc, which provided a platform of confidence and a key site for demonstrating the huge potential of farmland pond management for biodiversity conservation.

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REFERENCES

Alderton, E. (2016). Ghost ponds: Resurrecting lost ponds and species to assist aquatic biodiversity conservation (PhD thesis). University College London, London, UK.

Alderton, E., Sayer, C. D., Davies, R., Lambert, S. J., & Axmacher, J. C. (2017). Buried alive: Aquatic plants survive in ‘ghost ponds’ under agricultural fields. Biological Conservation, 212, 105–110. https://doi.org/10.1016/j.biocon.2017.06.004

Biggs, B., Corfield, A., Walker, D., Whitfield, M., & Williams, P. (1994). New approaches to the management of ponds. British Wildlife, 5, 273–287.

Céreghino, R., Ruggiero, A., Marty, P., & Angélilbert, S. (2008). Biodiversity and distribution patterns of freshwater invertebrates in farm ponds of a southwestern French agricultural landscape. Hydrobiologia, 597, 43–51.

Council of the European Communities. (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities, L327, 1–73.

Davies, S. R., Sayer, C. D., Greaves, H., Sirwardena, G. M., & Axmacher, J. C. (2016). A new role for pond management in farmland bird conservation. Agriculture, Ecosystems and Environment, 233, 179–191. https://doi.org/10.1016/j.agee.2016.09.005

Dedeker, S., De Bie, T., Ercken, D., Hampel, H., Schrijvers, S., Wichelen, J. V., ... Martens, K. (2006). Ecological characteristics of small farmland ponds: Associations with land use practices at multiple spatial scales. Biological Conservation, 131, 523–532. https://doi.org/10.1016/j.biocon.2006.02.024

Defra (Department for Environment, Food and Rural Affairs). (2018). A Green Future: Our 25 Year Plan to Improve the Environment https://www.gov.uk/government/publications/25-year-environment-plan (11 November 2019)

Defra (Department for Environment, Food and Rural Affairs). (2019). https://data.gov.uk/dataset/a8461f4b-632a-42b5-9f75-
Mainstone, C., Hall, R., & Diack, I. (2016). A narrative for conserving freshwater and wetland habitats in England. Natural England Research Reports, Number, 064, 118 pages.

Sayer, C. D., Andrews, K., Shilland, E. M., Edmonds, N., Edmonds-Brown, R., Patmore, I. R., ... Axmacher, J. C. (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., Copp, G. H., Emson, D., Zięba, G., Godard, M. J., & Wesley, K. J. (2011). Towards the conservation of crucian carp Carassius carassius: Understanding the extent and causes of decline within part of its native English range. Journal of Fish Biology, 79, 1608–1624. https://doi.org/10.1111/j.1095-8649.2011.03059.x

Sayer, C. D., Shilland, E. M., Greaves, H., Dawson, B., Patmore, I. R., Emson, D., ... Wiik, E. (2013). Managing Britain’s ponds – Conservation lessons from a Norfolk farm. British Wildlife, 25, 21–28.

Siggery, B. (2018). Variety is the spice of life: The contribution of restored farmland ponds to landscape diversity and heterogeneity (MSc thesis). London: University College London.

Skelly, D., Bolden, S., & Friedenburg, L. K. (2014). Experimental canopy removal enhances diversity of vernal pond amphibians. Ecological Applications, 24, 340–345. https://doi.org/10.1890/13-1042.1

Williams, P., Biggs, J., & Nicolet, P. (2010). New clean-water ponds – A way to protect freshwater biodiversity. British Wildlife, 22, 77–85.

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