Pitsford Water Friendly Farming: Wetland plant survey results 2021-2024

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Oxford
2025

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This report should be cited as:
Williams P, Worker H and Biggs J. 2025. *Pitsford Water Friendly Farming Wetland plant survey results 2021-2024.* Freshwater Habitats Trust, Oxford

Acknowledgements:
We are extremely gratefully for the help and support of the many landowners and managers who kindly allowed access to their land to enable the plant surveys discussed in this report to be undertaken. We also gratefully acknowledge the help, support and advice provided by Chris Gerrard and Kim Hemmings of Anglian Water and Simon Bonney of the Environment Agency.

Summary

This report describes the findings from freshwater wetland plant surveys undertaken as part of the Pitsford Water Friendly Farming project.

The aim of the surveys was to assess biodiversity changes in response to measures implemented to: enhance catchment freshwater biodiversity, reduce downstream flooding and limit sediment loss to streams and Pitsford Reservoir.

Surveys were carried out in all waterbody types present (streams, ponds, ditches) in the Scaldwell-arm catchment (impact area) and an adjacent Control catchment over a four-year period from 2021 to 2024.

Key findings:

1. Pre-intervention baseline biodiversity (2021)

The initial (2021) surveys provided information about the state of freshwater biodiversity across all waterbody types prior to interventions:

- Site-level richness (number of species) was comparable between the Control and Scaldwell catchments.
- Ponds supported the highest number of plant species across all waterbody types (97% of all recorded species), followed by streams (37%) and ditches (24%).
- Uncommon plants were largely restricted to ponds (16 out of 17 species).
- Regional comparison showed that the Pitsford catchments had slightly lower plant richness (particularly for submerged aquatic plants) compared to some other agricultural areas.

2. Background trends over time (2021-2024)

Over the four-year period, both catchments experienced dynamic biodiversity changes:

- In the Control catchment, the total number of plant species declined by 5%, whilst the number of uncommon species declined by 20%. These changes were largely driven by a dynamic species turnover in ponds.
- The Scaldwell catchment (*excluding* the effect of added interventions) showed broad stability in total species numbers, whilst the number of uncommon species increased by 13%.

3. Impact of measures (2023-2024)

The project’s interventions, which included pond creation, pond management, and the introduction of flood storage basins, bunded ditches, and leaky dams, brought considerable benefits to the freshwater biodiversity in the Scaldwell catchment where they were implemented.

- Two years after implementation, the Scaldwell catchment saw:
  - **a 22% increase in the total number of wetland plant species**
  - **a 65% increase in the number of uncommon plant species**

New ponds supported the greatest number of species, and uncommon species that were new to the catchment. Managed ponds and, to a lesser extent, flood storage basins also contributed to gains.

Creation and management or ponds also increased the extent of priority habitat: more than tripling the number of priority ponds from 4 to 13 between 2021 and 2024.

4. Conclusion

The *Pitsford Water Friendly Farming project* successfully increased wetland plant biodiversity in the Scaldwell catchment through targeted habitat creation and management, showing that:

(a) clean-water pond creation and management can rapidly enhance freshwater biodiversity within catchments and increase the extent of priority habitat.

(b) ecosystem services measures, such as flood storage basins, can help to support catchment richness but have considerably less impact than clean water pond creation and management, particularly for uncommon species, and in terms of creating priority habitat.

5. Implications

The project's findings have important implications. The results strongly support the longer-term findings from the *Water Friendly Farming project* in Leicestershire; providing additional evidence of the important role that small standing waters play in supporting freshwater biodiversity, and controlling catchment-scale changes in losses and gains.

The substantial benefits gained from creating and managing ponds supports the wider use of ponds as tools that can be used to drive biodiversity resilience and recovery at the landscape scale.

Evidence of freshwater biodiversity loss in the project's control catchment is consistent with findings from the Leicestershire Water Friendly Farming Project. This emphasises the need for broader national monitoring programmes that include a wider range of freshwater habitats in order to identify trends that may be missed by current river-based monitoring systems.

Contents

Wetland plant survey results

1. Aim

This report summarises the results of catchment-wide freshwater plant surveys carried out for the *Pitsford Water Friendly Farming project*. The data were collected from the '*Scaldwell-arm*' catchment and an adjacent *Control* catchment during annual surveys undertaken over a four-year period between 2021 and 2024.

The aim of the surveys was to provide before-after-impact-control (BACI) data that could be used to assess biodiversity changes resulting from measures implemented as part of the project.

The plant surveys included:

1. A 2021 pre-works baseline collected from the Control catchment in 2021 and the impact (Scaldwell-arm) catchment in both 2021 and 2022.
2. A post-measures survey of the Scaldwell catchment (2023).
3. A final resurvey of both the Scaldwell and Control catchments two years after measures were implemented (2024).

Surveys included assessment of all waterbody types present in the catchments (streams, ponds, ditches).

Together the data provide information that can be used to look at both the effect of the introduced measures and the underlying patterns of freshwater biodiversity at a catchment scale.

2. Methods

Wetland plant data were collected from all waterbody types present in the Scaldwell Brook catchment and the Control catchment to the east (i.e. streams, ponds and ditches) (Figure 1).

Plant surveys were undertaken at the same sites in June and July each year by the same surveyor (Penny Williams).

A total of 90 sites (30 streams, 30 ponds, 30 ditches) were surveyed in the Scaldwell catchment, and 45 sites (15 streams, 15 ponds, 15 ditches) in the smaller Control catchment. To select stream and ditch sites for survey, watercourses were divided into numbered 100 m lengths. Stream and ditch lengths were then randomly selected for survey. All ponds were numbered, and sites randomly selected. To ensure ecological data from different waterbody types could be directly compared, the sampling area in each waterbody was area-limited with data collected from a 75 m^2 area of the waterbody, based on the method described in Williams *et al*. (2004).

To enhance the project's scope and provide near-census-level data from both catchments, additional streams, ditches, and ponds were surveyed where landowner permission was granted. In total this included an additional 6 ponds, and full species lists for all ponds including those larger than 75 m^2. Most stream and ditch lengths were also walked to add any new species for these waterbody types at a catchment scale. These extra data were used in addition to the 75 m^2 surveys to calculate the total (gamma) richness of each waterbody type.

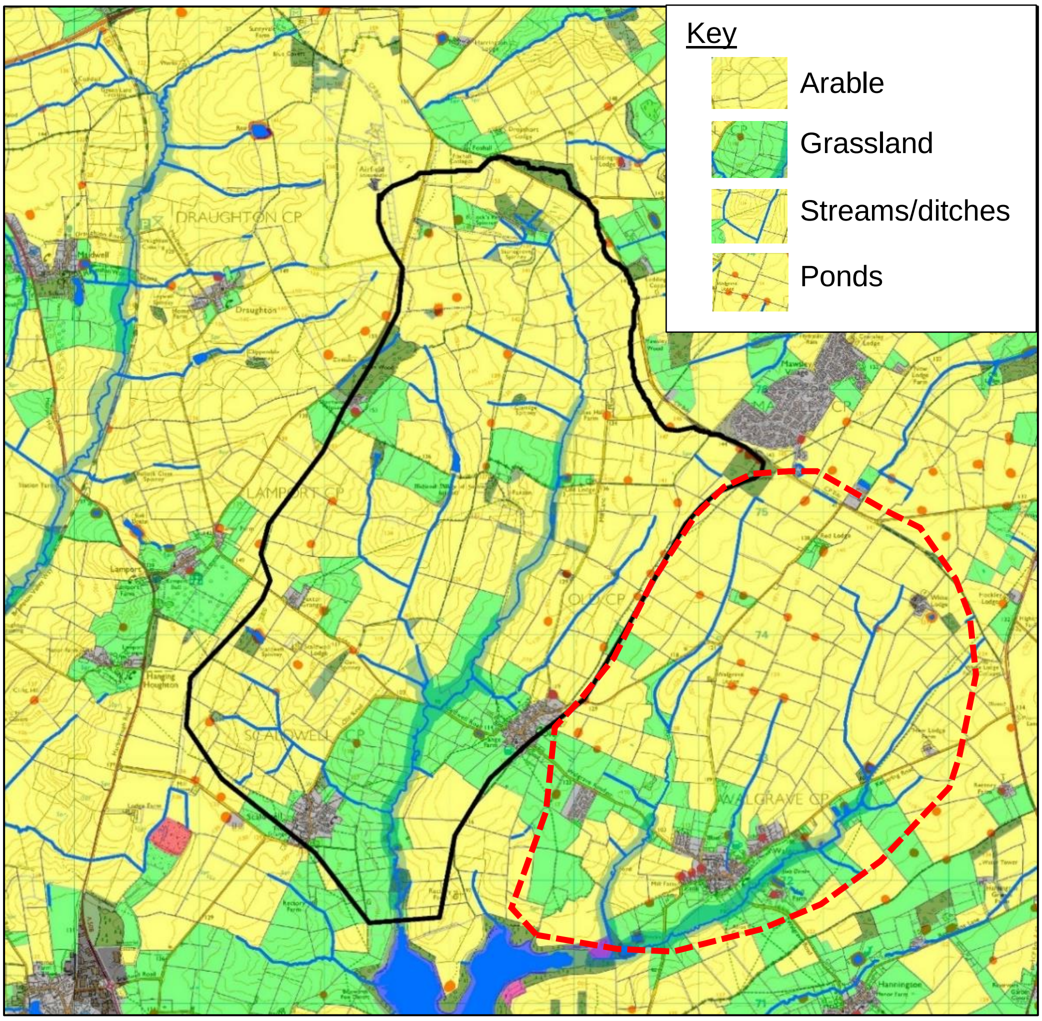


Figure 1. The wetland plant survey areas. Scaldwell arm (black outline) and Control catchment (red dashed outline). Linear streams and ditches in blue, and existing ponds in red.

Plant species and their percentage cover were recorded while walking and wading the margins and shallow water areas of each waterbody. For sites with deep water, plants were surveyed using a grapnel thrown from the bank. 'Wetland plants' were defined as the plants listed in Freshwater Habitats Trust (2015) Wetland Plants Recording Form, which comprises a standard list of ca. 300 water-associated higher plants divided into three categories: submerged, floating-leaved and emergent plants[1]).

Four measures were used to assess wetland plant biodiversity:

1. Site richness (alpha richness): the number of species recorded from the 75m^2 survey areas
2. Site rarity (alpha rarity): the number of nationally rare and uncommon species (defined in Table 1) recorded from the 75m^2 survey areas
3. Regional scale richness (gamma richness): the total number of species recorded from each waterbody type from the 75m^2 surveys and additional census surveys
4. Regional scale rarity (gamma rarity): the total number of nationally rare and uncommon species (see Table 1) recorded from the 75m^2 surveys and additional census surveys.

[1] https://freshwaterhabitats.org.uk/advice-resources/survey-methods-hub/freshwater-plant-surveys/

Table 1. Definition of rare species used in the study

Regionally uncommon species: Species recorded from fewer than 15% of tetrads in a 10 x 10 tetrad square centred on the project area since 2000 (derived from BSBI Atlas data)[2]. Excludes species which are widely under-recorded e.g. Fat Duckweed *Lemna gibba* and commonly introduced e.g. Greater Spearwort *Ranunculus lingua*.	
County Red List: Species listed on Northamptonshire's rare plant register[3]	
Red Listed at England or UK level: Based on the IUCN categories: Near Threatened, Vulnerable, Endangered or Critically Endangered (Stroh *et al*., 2014)	

PSYM (the Predictive SYstem for Multimetrics) was used to assess the quality (i.e. extent of degradation) of ponds. PSYM assesses pond quality using a range of biological measures (metrics), such as species richness, that are known to vary with human degradation (e.g. pollution, over-stocking with fish). PSYM is ideally calculated using both wetland plant and aquatic macroinvertebrate data. However, where, as here, invertebrate data are not available, a partial assessment can be made using plant data alone. The method is only suitable for ponds that are permanent or semi-permanent waterbodies: ponds that dry up for a large part of most years cannot be assessed using this method.

Plant PSYM uses three metrics, each of which has been shown to vary strongly with pond degradation: (i) number of submerged and emergent plant species (ii) trophic ranking score (a measure of nutrient enrichment) and (iii) the number of uncommon plant species. The PSYM algorithm works by comparing the value of each metric observed at a pond with the value that would be expected if the pond was pristine (i.e. in the "reference state"). Comparing the two scores provides an overall measure of how degraded each pond is relative to its expected pristine state. For reporting purposes ponds are divided into four grades of ecological condition: Good, Moderate, Poor and Very Poor.

Ponds that are in 'Good condition' qualify as Priority Ponds under the UK Biodiversity Action Plan[4].

[2] https://bsbi.org/maps accessed October 2024

[3] https://bsbi.org/wp-content/uploads/dlm_uploads/VC32_Rare_Plant_Register.pdf

[4] https://data.jncc.gov.uk/data/dec49c52-a86c-4483-90f2-f43957e560bb/UKBAP-BAPHabitats-42-Ponds.pdf

3. Results

3.1 The baseline

Understanding initial levels of biodiversity in the Scaldwell and Control areas is valuable because it provides:

i) A baseline for measuring the effects of changes in the Scaldwell arm.

ii) An assessment of how comparable the Scaldwell and Control areas are – ideally they should be similar.

iii) Context to assess how typical the Pitsford area is compared to other regions that have been surveyed using the same methods, helping to gauge the broader applicability of the project's findings.

3.1.1 Initial site richness was similar in the Control and Scaldwell catchments

The average numbers of plant species recorded from the stream, pond and ditch 75 m^2 sites in the two Pitsford catchments in the initial 2021 survey are shown in Figure 2. Comparison between the two catchments shows that although there are visible differences, statistically, the number of plant species was not significantly different between the catchments for any waterbody type.

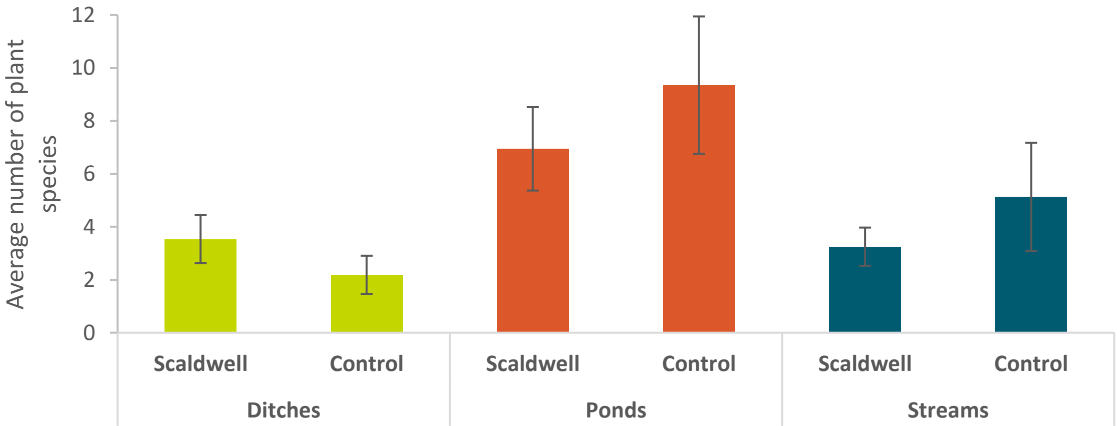


Figure 2. Average baseline site plant richness for ditches, ponds and streams in the Scaldwell and Control catchments when originally surveyed in 2021. Sites are all 75

Table 2. Average baseline site richness for wetland plant species in the Pitsford catchments (2021) and three other catchment studies in southern England (with range in parentheses)

	Ditches	Ponds	Streams
Pitsford Scaldwell arm	3.5 (0-11)	6.9 (1-21)	3.3 (0-7)
Pitsford Control	2.2 (0-6)	9.4 (1-21)	5.1 (0-15)
Wootton Brook (Northants)	5.6 (1-15)	10.8 (1-21)	8.7 (0-20)
Water Friendly Farming (Leics)	4.4 (0-13)	8.3 (1-30)	5.5 (0-17)
Coleshill (Oxon)	6.1 (1–14)	10.2 (2–17)	7.3 (1–17)

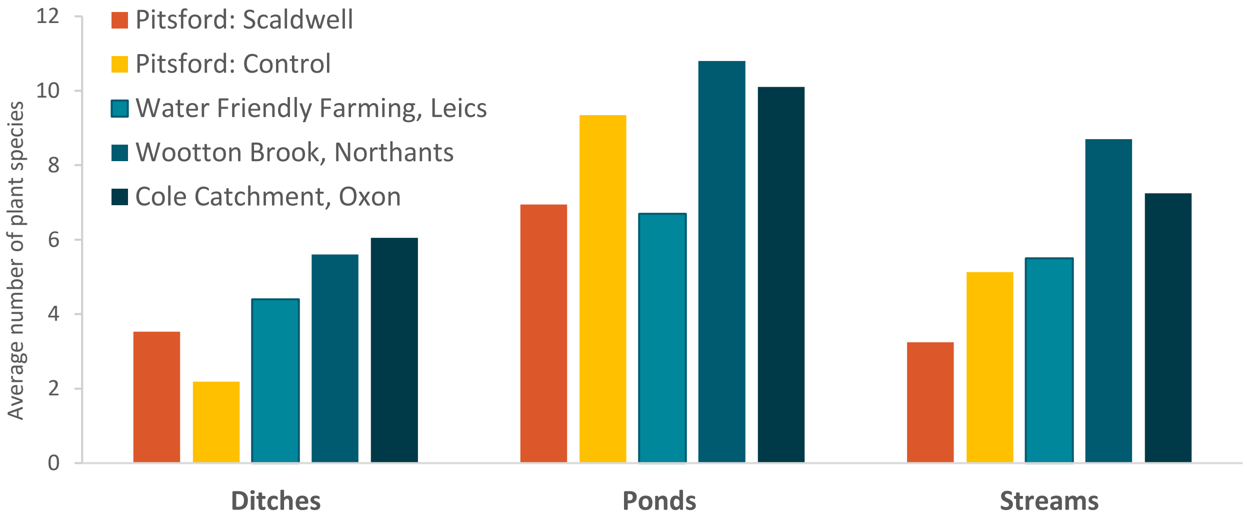


Figure 3. Comparison between baseline waterbody site richness in the Pitsford Scaldwell and Pitsford Control catchments and other catchments in Southern England. The same survey methods and same areas (75 m2) were used in all studies.

In both the Scaldwell arm and Control catchment, ponds were the richest of the three waterbody types. On average, ponds supported around double the number of plant species in the 75 m^2 survey sections compared to the streams, and two-thirds more than in ditches.

Comparing the results found in the Pitsford area with site survey data from other agricultural catchments in southern England (Figure 3, Table 2), shows that the species richness *pattern* (i.e. ponds>streams>ditches) is consistent across all surveys.

However, waterbodies in the Pitsford catchments tended to be rather poorer in plant species compared to other catchments. The exception was pond plant richness in the Pitsford *Control* catchment, which was close to average. Examination of the data suggests that the latter was largely due to bolstering of the average by plant-rich ponds in the Wildlife Trust land north of Pitsford Reservoir.

3.1.2 Initial catchment surveys across *all* waterbodies showed that most plant species were present in ponds

Combining all the 2021 data from the two Pitsford catchments (gamma richness) shows that 79 plant species were recorded across all the waterbodies. Ponds supported the vast majority of these plants (around 97%), compared to 37% of all species present in streams, and 24% in ditches (Figure 3).

The Scaldwell arm catchment supported slightly more plant species in total than the Control catchment (Figure 3): not a surprising result considering the Control catchment is around half the area, and fewer surveys were undertaken there.

3.1.3 At catchment level, the number of wetland plant species was comparable to other areas

It is difficult to compare the total (rather than average) number of plants in the Pitsford area with the results from other surveys, because both the physical area and the number of samples that were summed to estimate total catchment richness differ between surveys. However, the combined area of the two Pitsford catchments is relatively similar to other areas that have been surveyed using similar methods, including the Wootton Brook catchment south of Northampton, as well as a combination of any two of the three sub-catchments surveyed in the Water Friendly Farming project in Leicestershire. Comparison with these areas shows that the Pitsford and Wootton Brook catchments have a similar total richness: 73 species in the Wootton Brook compared to 79 in Pitsford. Combined richness for any two of the three Water Friendly Farming sub-catchments also gives similar totals of between 70 and 85 plant species.

3.1.4 The number of submerged plant species was lower than in other areas

Amongst wetland plants, submerged aquatic species (e.g., water-buttercups, pondweeds, stoneworts, water-starworts) are generally the most sensitive to pollution and least common. For this group, the Pitsford area seems to have slightly fewer species than other catchments: 11 were recorded across the two Pitsford catchments, compared with 15 in the Wootton Brook and between 12 and 15 in the combined Water Friendly Farming sub-catchments.

3.1.5 Regionally uncommon plants were largely restricted to ponds

Of the wetland plants recorded in both catchments in 2021, none were of national importance (e.g., Priority Species or Red-listed species). However, 18% of sites supported at least one plant species that can be classified as regionally uncommon in this part of Northamptonshire, based on BSBI atlas data (see Table 1).

Of the 17 regionally uncommon species, 100% were recorded in ponds, and 42% of ponds had at least one species that was regionally uncommon. Just two regionally uncommon species (12%) were recorded in streams, and no uncommon plants were found in ditches.

The Scaldwell catchment supported more uncommon species than the Control catchment in the initial 2021 survey; however, this is likely to be an artefact related to the larger size and greater number of sites surveyed in the Scaldwell catchment. Indeed, proportionally, ponds in the Control catchment were slightly more likely to support one or more uncommon species (45% of ponds in the Control vs. 40% in the Scaldwell catchment).

Table 3. Baseline (2021) regionally uncommon plant species recorded by the study (both catchments combined).

Binomial	Common Name	Ditches	Ponds	Streams	All
Submerged plants					
Ceratophyllum demersum	Rigid Hornwort	-	+	-	+
Chara contraria	Common Stonewort	-	+	-	+
Chara virgata	Delicate stonewort	-	+	-	+
Hippuris vulgaris	Mare's-tail	-	+	-	+
Potamogeton berchtoldii	Small Pondweed	-	+	-	+
Potamogeton pusillus	Lesser Pondweed	-	+	-	+
Ranunculus trichophyllus	Thread-leaved Water-crowfoot	-	+	-	+
Zannichellia palustris	Horned Pondweed	-	+	-	+
Floating leaved plants					
Lemna trisulca	Ivy-leaved Duckweed	-	+	-	+
Nuphar lutea	Yellow Water-lily	-	+	-	+
Potamogeton natans	Broad-leaved Pondweed	-	+	-	+
Emergent plants					
Alisma lanceolatum	Narrow-leaved Water-plantain	-	+	-	+
Butomus umbellatus	Flowering-rush	-	+	-	+
Carex pseudocyperus	Cyperus Sedge	-	+	-	+
Glyceria declinata	Small Sweet-grass	-	+	+	+
Stellaria alsine	Bog Stitchwort	-	+	-	+
Veronica catenata	Pink-flowered Water-speedwell	-	+	-	+
No. all plant spp		**0**	**16**	**1**	**17**

3.1.6 The area initially had few priority ponds

Analysis of ponds in the survey area in 2021 using PSYM showed that 17% of ponds in the two Pitsford catchments were classified as 'Good' quality and therefore qualified as Priority Habitats. The Control catchment supported a greater proportion of Priority Ponds (21%) than the Scaldwell arm (12%) (Figure 5).

Although the proportion of ponds that fell below the Good standard was considerable (83%), this was still substantially better than the average for England and Wales, as assessed in the most recent Countryside Survey, where 92% fell below the Good standard (Williams *et al*. 2010) (Figure 6).

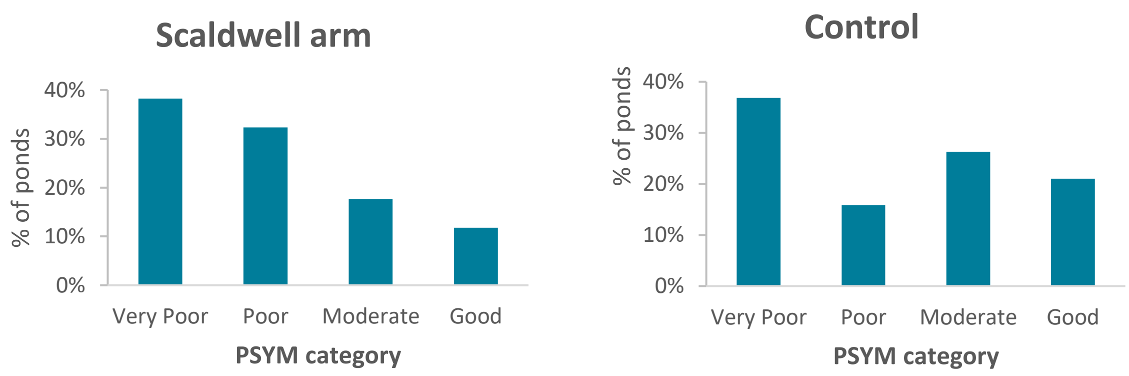


Figure 3. Baseline (2021) percentage of ponds falling into four PSYM quality categories. Left: Scaldwell arm catchment; Right: Control catchment

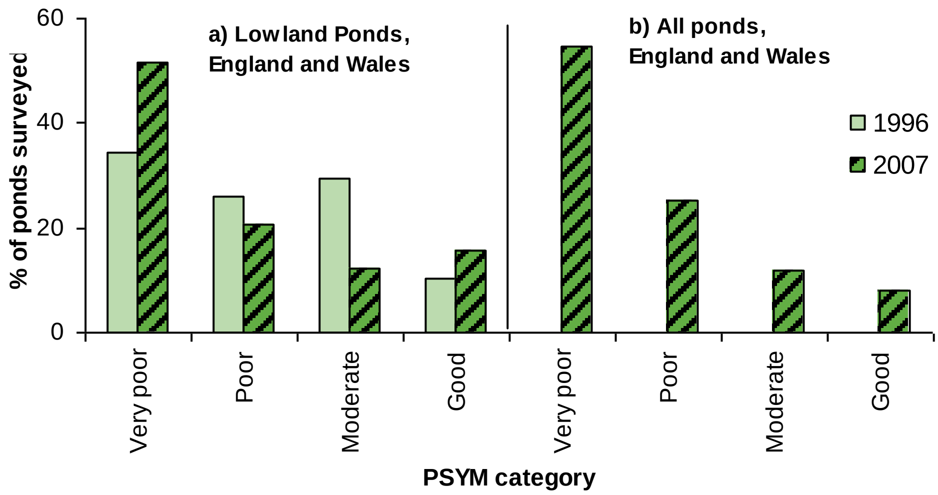


Figure 1 Percentage of ponds falling into four PSYM quality categories in England and Wales. Left: comparison of lowland England and Wales in 1996 and 2007; Right: England and Wales in 2007. From: Williams *et al.* 2010

3.2 Changes through time

3.2.1 The value of the baseline

Understanding trends in the Pitsford baseline through time is valuable because it tells us:

(i) The background trends; i.e., what is happening in the catchments over time in the absence of the project's added measures.

(ii) How much difference the project is making.

The project has two datasets that can be used to examine these trends:

(i) Four years of survey data (2021–2024) from waterbodies in the Scaldwell arm catchment, excluding any sites that were made, modified, or managed.

(ii) 2021 and 2024 data from the Control catchment.

3.2.2 Patterns in waterbody richness stayed the same though time

The average number of plant species recorded from the stream, pond, and ditch 75 m² survey sections in the Scaldwell arm between 2021 and 2024 is shown in Figure 7 and Figure 8. From these, it is clear that the broad 'between-waterbody' patterns observed in the baseline year were maintained in later years. Ponds were consistently the richest of the three waterbody types. On average, they supported around double the number of plant species recorded in streams and two-thirds more than was typical of ditches.

3.2.3 There was no significant change in richness through time at site level

Comparisons across the four survey years show that, within the three waterbody types, there were no statistically significant changes in plant richness in the 75 m² survey sites through time. However, non-significant trends hint at a possible decrease in richness in the ditches in both Control and impact catchments. Stream richness showed little change, while pond trends hint at a possible decrease in richness in Control sites (Figure 8), compared to similar, or slightly greater, average richness in the impact catchment (Figure 7).

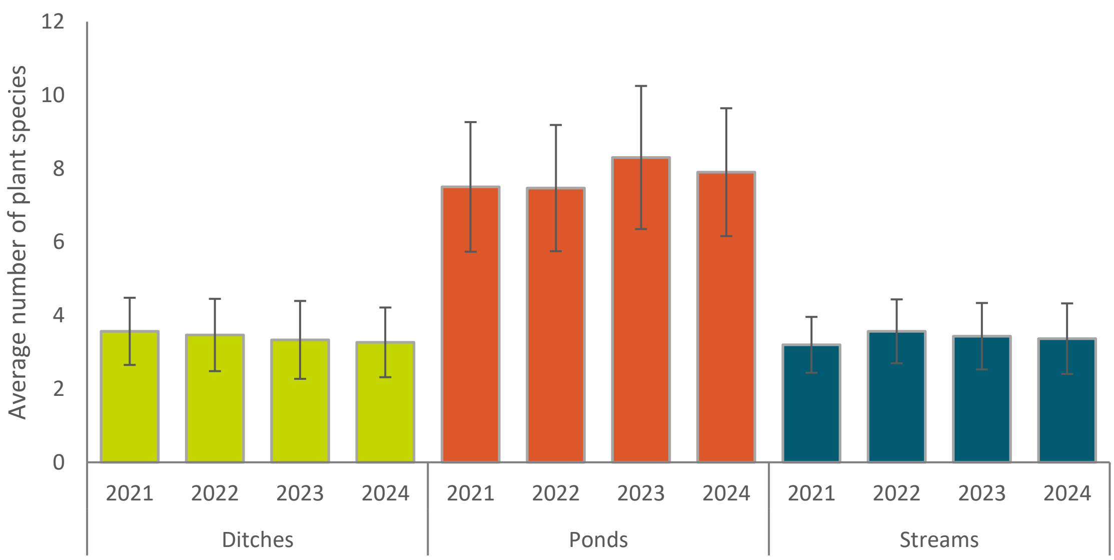


Figure 7. Comparison of average site plant richness for ditches, ponds and streams in the Scaldwell catchment between 2021 and 2024

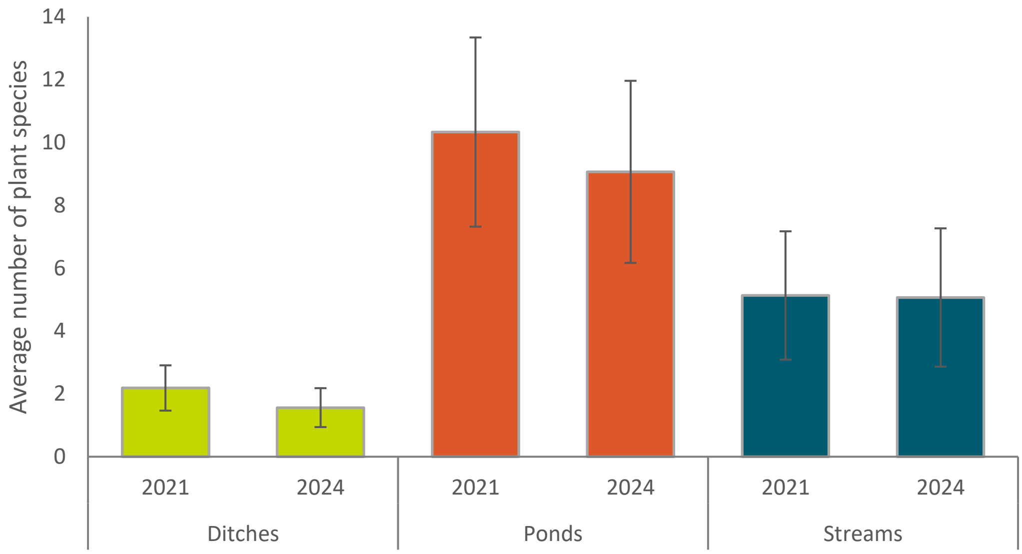


Figure 8. Comparison of average site plant richness for ditches, ponds and streams in the Control catchment between 2021 and 2024

3.3 Background whole-catchment richness through time

Across the Control catchment as a whole, the *total* number of plant species recorded declined between 2021 and 2024 from 64 to 61 species: a 5% drop. During the same period both ponds and streams had fewer species (10% and 9% drop respectively), whilst ditches saw a 6% increase (Figure 9).

These figures mask significant changes in the turnover of individual plant species within the Control catchment. Although the overall change in plant richness amounted to a 5% loss, this net figure reflects both the losses and gains of individual plant species across the catchment. Notably, nearly all of these changes occurred in pond habitats. For example, 8% of plant species were newly gained in the catchment, all of which colonised ponds. Conversely, 12.5% of plant species were lost, with 90% of these losses occurring from pond habitats. This suggests that ponds are particularly dynamic habitats within the Control catchment, with the balance of species losses and gains in ponds largely driving overall trends in plant biodiversity.

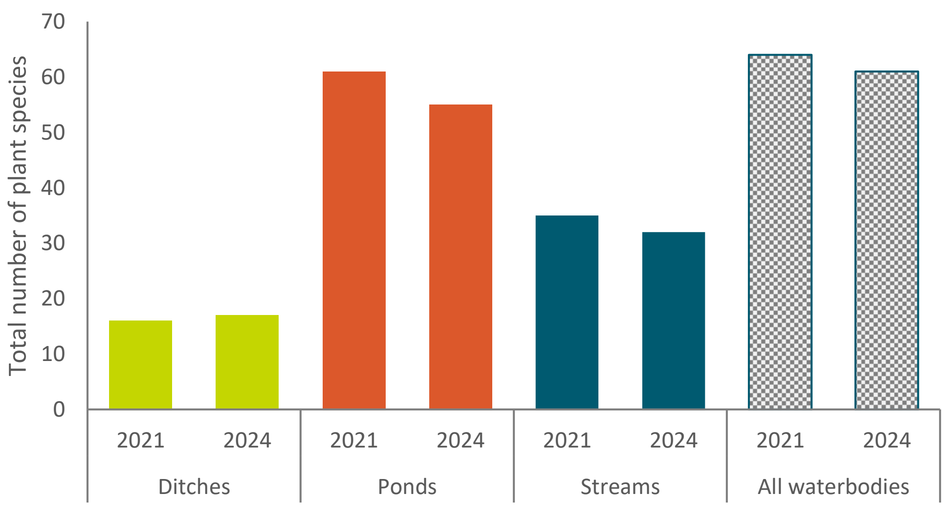


Figure 9. Total plant richness (gamma) from the ditch, pond, stream and all sites in the *Control* catchment between 2021 and 2024

In the Scaldwell catchment, the total number of species recorded changed very little during the survey period remaining within 1% of the 2021 value and closely mirroring the total for ponds (Figure 10). The number of plant species recorded in ditches increased by 14% over the survey period, whereas the number in streams declined by 9%. However, because ponds continued to support most of the species that were lost or gained from stream and ditch habitats, these changes made little difference to total catchment richness (Figure 10).

The *turnover* of species between 2021 and 2024 in the Scaldwell catchment broadly mirrored the Control catchment: three plant species were gained and four lost, and of these seven, all but one were lost or gained from ponds.

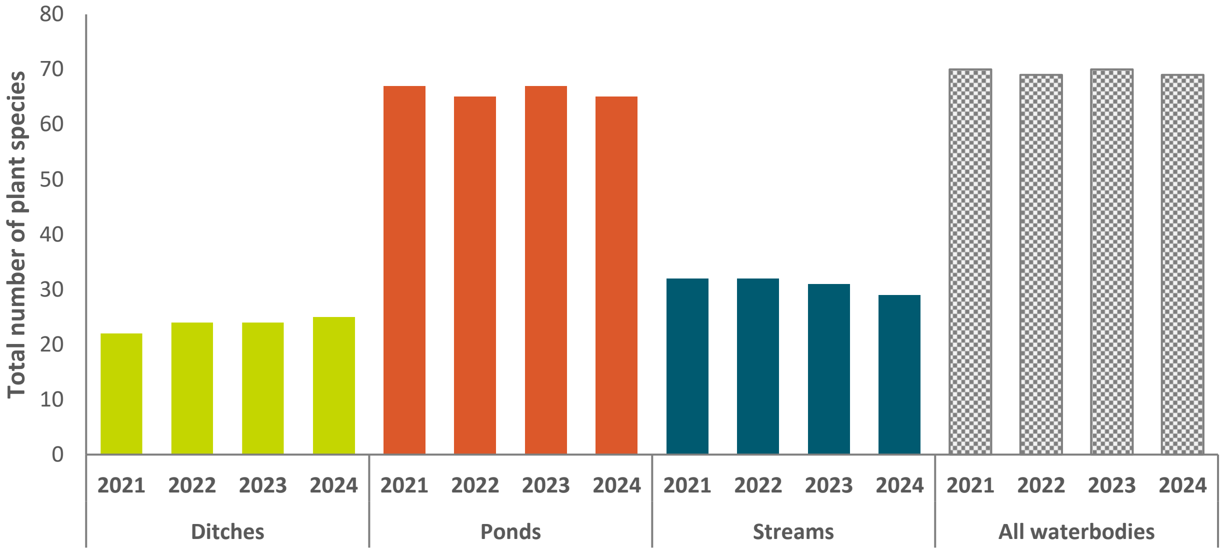


Figure 10. Total plant richness (gamma) from the ditch, pond, stream and all sites in the *Scaldwell* catchment between 2021 and 2024

3.4 Background rarity trends through time

Almost all uncommon plant species recorded in the Control catchment were found in ponds, with a single exception from a ditch in the 2021 survey (Figure 11). Overall. There was a downward trend in the Control, with the number of uncommon species declining by 20% over the four years.

In the Scaldwell arm, the baseline number of uncommon taxa present (i.e. in the absence of species from the added measures) varied over the four-year period (Figure 12). There was a slight drop in plant species recorded in 2022 compared to the previous year (15 species in 2021, 13 in 2022), due to loss of uncommon species from ponds and most likely linked to the drought in 2022. This was followed by 'recovery' in the following years, and across the four survey years as a whole the number of uncommon plant species rose by 13%, as a result of an increase in pond species and the addition of a single stream species.

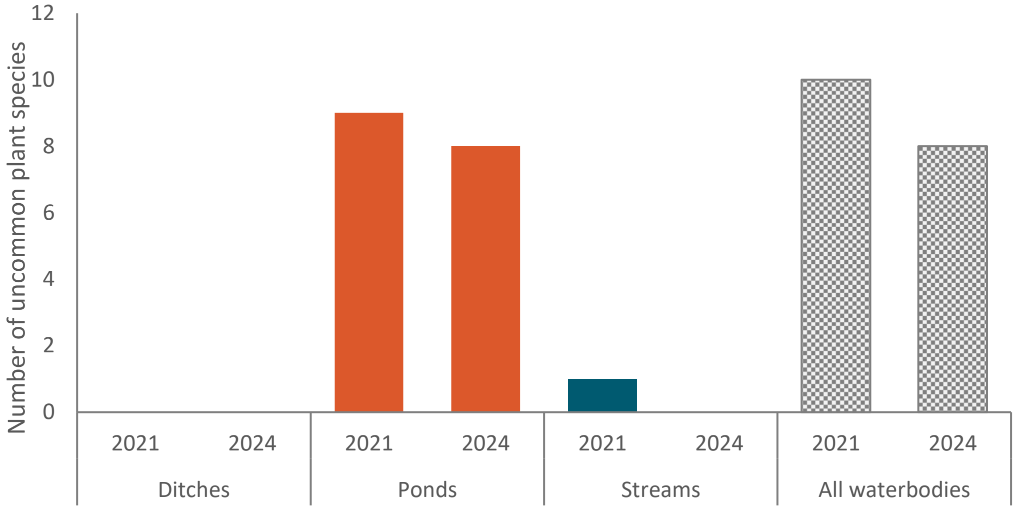


Figure 11. Total number of regionally uncommon plant species from all ditch, pond and stream sites in the *Control* catchment between 2021 and 2024

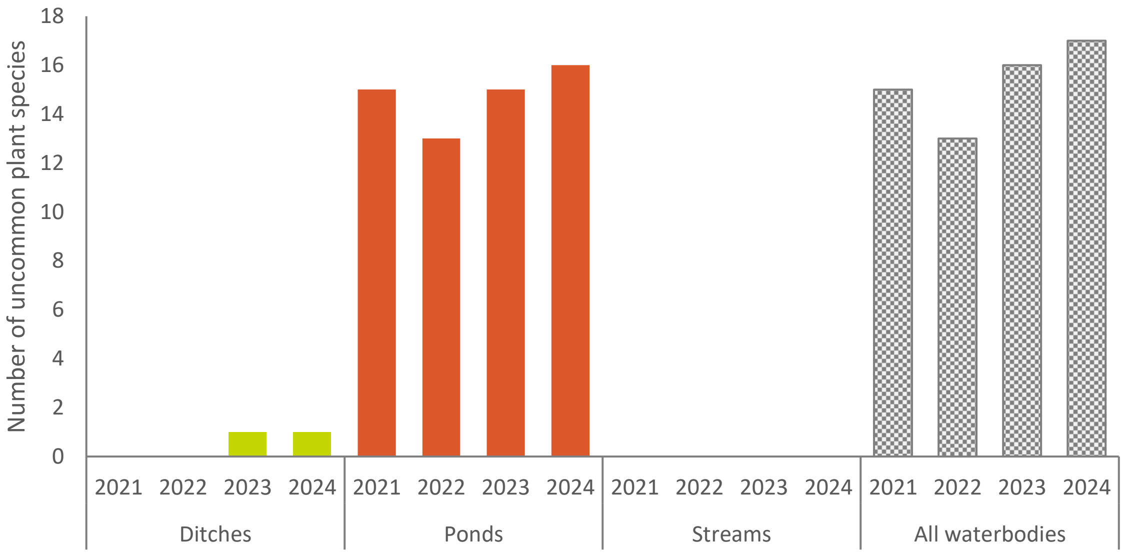


Figure 12. Total number of regionally uncommon plant species from all ditch, pond and stream sites in the *Scaldwell* catchment between 2021 and 2024

3.5 The effect of adding measures

3.5.1 Introduction

The project introduced a range of measures to the Scaldwell catchment between 2022 and 2023:

- Pond creation and management were undertaken to increase freshwater biodiversity
- Bunded ditches and field corner bunds were undertaken to intercept sediment runoff and temporarily store floodwater
- Leaky dams and tree-hinging were undertaken to help reduce downstream flood peaks.

Monitoring was undertaken for all features which supported wetland plants (Table 4). This, excluded field corner bunds which drained rapidly after flood and only supported a terrestrial flora.

Table 4. Results from the intervention measures that were monitored in the study including the number of species added to the Scaldwell catchment by the measures.

Intervention measure	Number of sites monitored	Average number of plant species added per feature		Total number of new plant species added to the catchment	
		2023	2024	2023	2024
New ponds (biodiversity)	21 (22*)	3.1	7.1	1	10
Managed ponds (biodiversity)	10	4.6	8.8	2	6
Flood storage basins	11	4.7	8.3	1	3
Bunded ditches	5	0	0	0	0
Leaky dams and tree hinging	7	n/a	n/a	n/a	n/a

*An additional pond was created by a landowner in 2024

3.5.2 Adding measures increased catchment biodiversity

The measures introduced by the project substantially increased the freshwater biodiversity present in the Scaldwell Catchment in terms of both the number of plant species and the presence of uncommon plants.

Specifically, two years after the measures were put in place, colonisation by new wetland plant species increased the total number of wetland species present in the Scaldwell catchment by 22% (Figure 13).

The effect on uncommon plants was even greater, with an increase of 65% in the number present in the catchment after two years (Figure 14).

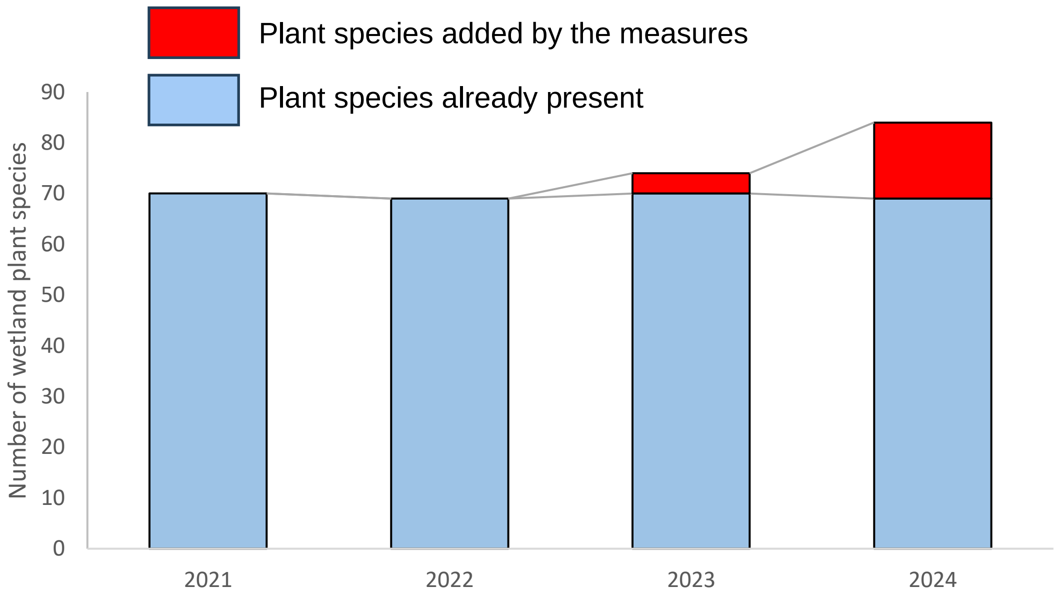


Figure 13. Number of wetland plant species added by all measures introduced by the project in the Scaldwell catchment

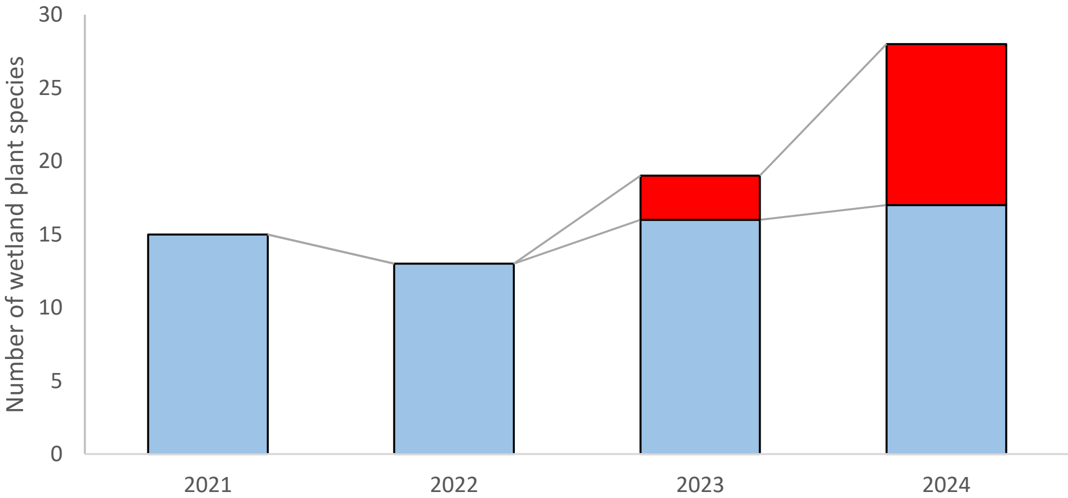


Figure 14. Number of uncommon wetland plant species added by all measures introduced by the project in the Scaldwell catchment

3.5.3 Creating new ponds added most new species to the catchment

The number of features introduced, and biodiversity contribution they each made to the study area after two years is summarised in Table 4.

On average, new ponds supported fewer species *per pond* than managed ponds or storage basins. However, new ponds were colonised by a greater *variety* of species that were *new to the catchment*, so they added more to overall catchment richness than the other waterbody types (Table 4, Figure 15). Note, however, that there were around double the number of new ponds (N=22) compared to managed ponds (N=10) and flood storage basins (N=11).

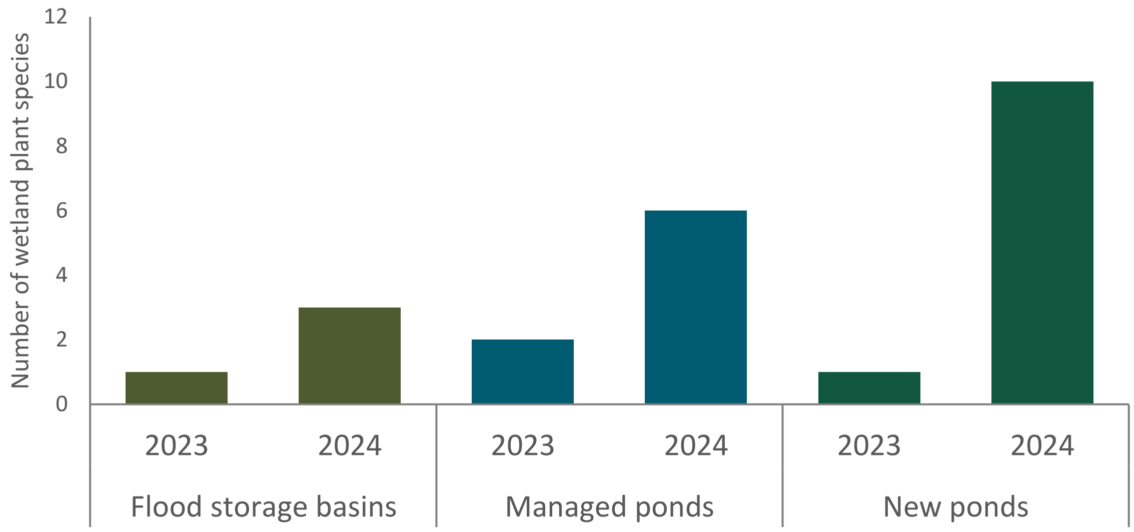


Figure 15. Number of wetland plant species added to the Scaldwell catchment by three measures: (a) creation of flood storage basins, (b) management of existing ponds, (c) creation of new ponds

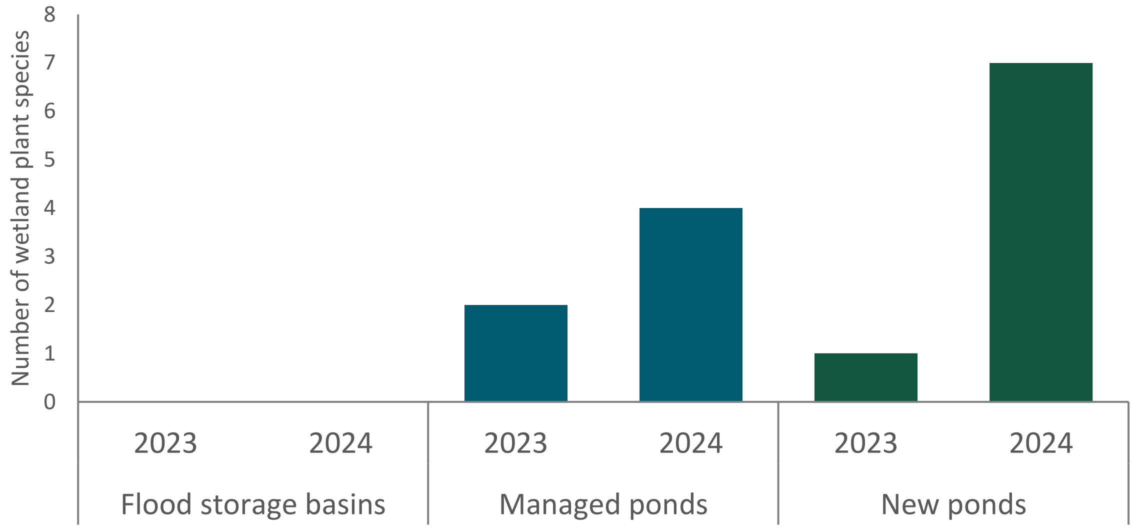


Figure 16. Number of *uncommon* wetland plant species that measures *added* to the Scaldwell catchment: (a) creation of flood storage basins, (b) management of existing ponds, (c) creation of new ponds

3.5.4 New ponds and managed ponds added valuable uncommon plants to the catchment

Overall, new ponds contributed more new uncommon species to the Scaldwell catchment than other intervention types in 2024 (see Figure 16, Table 5 and sections below). However, managed ponds also contributed new species, and the plants that occurred were often complementary.

Unpolluted freshwater habitats with low nutrient levels are now very rare in the English lowlands and some new ponds provided these conditions allowing regionally uncommon

Table 5. Regionally uncommon plant species recorded from the Scaldwell Catchment in 2021 and 2024

Binomial	Common Name	Ditches		Ponds		Streams		All	
Year		21	24	21	24	21	24	21	24
Submerged plants									
Callitriche hamulata	Intermediate Water-starwort	-	-	-	+	-	-	-	+
Callitriche platycarpa	Various-leaved Water-starwort	-	-	-	+	-	-	-	+
Chara contraria	Opposite Stonewort	-	-	-	+	-	-	-	+
Chara virgata	Delicate stonewort	-	-	+	+	-	-	+	+
Chara vulgaris	Common Stonewort	-	-	+	-	-	-	+	+
Hippuris vulgaris	Mare's-tail	-	-	+	+	-	-	+	+
Potamogeton berchtoldii	Small Pondweed	-	-	+	+	-	-	+	+
Potamogeton pusillus	Lesser Pondweed	-	-	+	+	-	-	+	+
Ranunculus aquatilis	Common Water-crowfoot	-	-	-	+	-	-	-	+
Ranunculus peltatus	Pond Water-crowfoot	-	-	-	+	-	-	-	+
Ranunculus trichophyllus	Thread-leaved Water-crowfoot	-	-	+	+	-	-	+	+
Tolypella glomerata	Clustered Stonewort				+				+
Zannichellia palustris	Horned Pondweed	-	-	+	+	-	-	+	+
Floating leaved plants									
Lemna trisulca	Ivy-leaved Duckweed	-	-	+	+	-	-	+	+
Nuphar lutea	Yellow Water-lily	-	-	+	+	-	-	+	+
Potamogeton natans	Broad-leaved Pondweed	-	-	+	+	-	-	+	+
Spirodela polyrhiza	Greater Duckweed	-	-	-	+	-	-	-	+
Emergent plants									
Agrostis canina	Velvet Bent	-	-	-	+	-	-	-	+
Alisma lanceolatum	Narrow-leaved Water-plantain	-	-	+	+	-	-	+	+
Carex pseudocyperus	Cyperus Sedge	-	-	+	+	-	-	+	+
Epilobium palustre	Marsh Willowherb	-	-	-	+	-	-	-	+
Glyceria declinata	Small Sweet-grass	-	-	+	+	-	-	+	+
Juncus subnodulosus	Blunt-flowered Rush	-	-	-	+	-	-	-	+
Pulicaria dysenterica	Common Fleabane	-	-	-	+	-	-	-	+
Ranunculus flammula	Lesser Spearwort	-	-	-	+	-	-	-	+
Stellaria alsine	Bog Stitchwort	-	-	+	+	-	-	+	+
Veronica anagalis aquatica	Blue Water-Speedwell	-	+	-	-	-	-	-	+
Veronica catenata	Pink Water-Speedwell	-	-	-	+	-	-	-	+
No. all plant species		**0**	**1**	**15**	**27**	**0**	**0**	**15**	**28**

plants like Velvet Bent (*Agrostis canina*) and Bog Stitchwort (*Stellaria alsine*) to colonise. Uncommon fen-associated plants were found in other new ponds including Blunt-flowered Rush (*Juncus subnodulosus*) and Fleabane (*Pulicaria dysenterica*). A new pond in woodland was also colonised by the Nationally Scarce aquatic plant Clustered Stonewort (*Tolypella glomerata*).

Manged ponds were, in contrast, typically colonised by the plants of meso-eutrophic ponds, particularly water buttercup species including Common Water-crowfoot (*Ranunculus aquatilis*), Pond Water-crowfoot (*Ranunculus peltatus*) and Thread-leaved Water-crowfoot *Ranunculus trichophyllus*). In addition, the nationally Vulneralble buttercup Lesser Spearwort (*Ranunculus flammula*) was recorded.

Figure 17. The Nationally Scarce Clustered Stonewort (*Tolypella glomerata*) – one of the aquatic plants recorded for the first time in the region in a new pond created by the project

3.5.5 Contribution from bunded ditches

In total, five bunded ditches were introduced to a small tributary ditch that flows into the Scaldwell Brook. The bunds were located in a heavily tree-shaded section of ditch, and no wetland plant species were recorded from the section either before or after bund creation.

3.5.6 Leaky dams and tree hinging had little effect on plant richness

It was not possible to collect 'before' data for sites where leaky dams and tree hinging was implemented in the Scaldwell arm because leaky dams and hinging areas were decided on and implemented after the summer season when plant surveys of the areas would have been possible. However, the effect of implementing these measures was assessed after they were put in place by comparing 5 m lengths of stream located 10 m upstream and 10 m downstream of leaky dams and hinged trees with the area around the features themselves.

The results showed that plant species richness was generally very low in the Scaldwell Brook and changed little in the area around the introduced features. The average number of plant species of the stream was 2 species both 10 m upstream and 10 m downstream of the features. Average plant richness around the features was 1.6 species. No uncommon plants were recorded, and the leaky dams and tree hinging sections did not add species that were new to the catchment and, therefore added to catchment biodiversity.

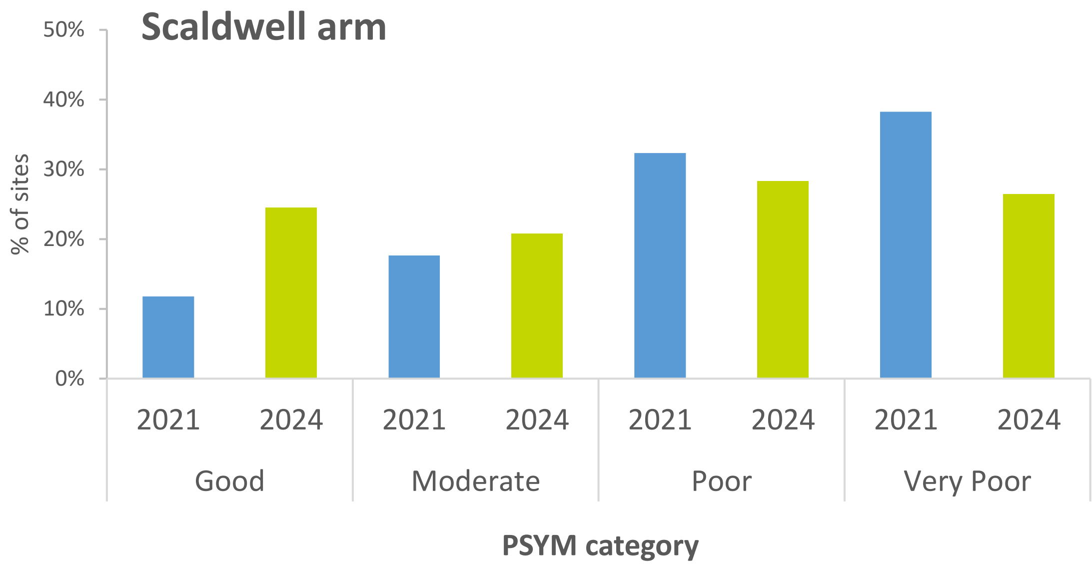
3.5.7 The Pitsford study findings supports other work

Overall the Pitsford study findings strongly mirror the results from the *Water Friendly Farming project* based in Loddington Leicestershire, which showed that ponds were an important freshwater habitat in agricultural catchments, and that measures, particularly clean-water pond creation, could be used to substantially increased catchment plant richness and the number of uncommon species present (Williams *et al*. 2019).

Priority habitat increased as a result of the project

The extent of priority habitat in the Pitsford arm catchment increased as a result of the project's work making and managing ponds. Ponds that fall into the top PSYM category: (Good) automatically qualify as priority habitats. The number of Good ponds at the start of the project in 2021 was four; this more than tripled to 13 in 2024, with pond creation and management contributing equally to the gain. Given that some of the new ponds were dug in low-nutrient substrates and are colonising slowly with more pollution-sensitive species, it is likely that the number of priority ponds will increase further in future years.

In contrast to the Scaldwell arm, the number of priority ponds in the Control catchment decreased by 5% during the 2021-2024 period (Figure 18).



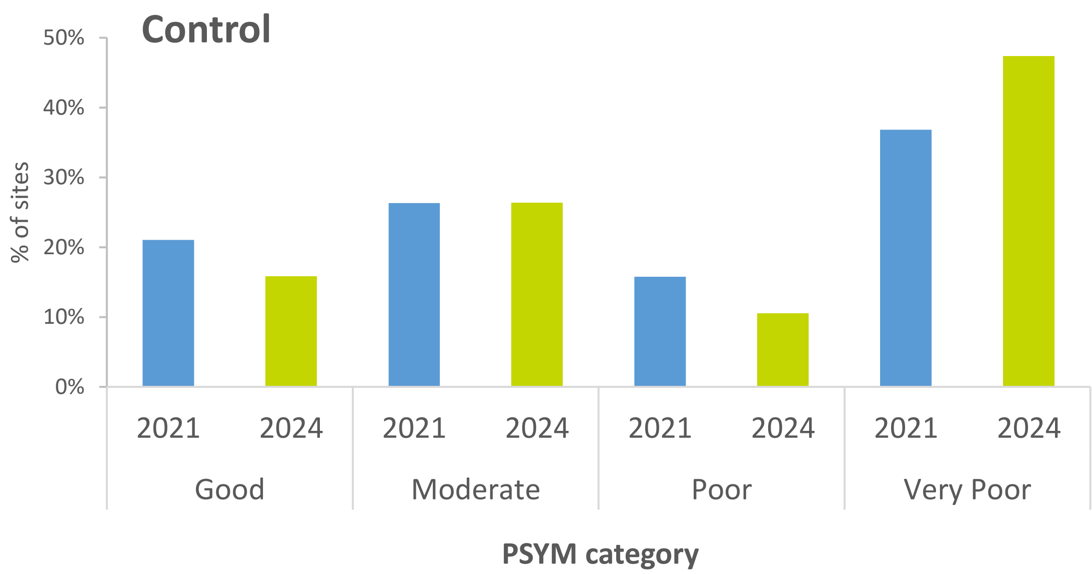


Figure 18. Changes in the number of priority ponds during the project assessed by comparing PSYM categories between 2021 and 2024 in the Scaldwell arm (top) and Control catchment (below). **All ponds categorised as Good qualify as priority habitats**

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