# A floristic appraisal of marl pits in parts of north-western England and northern Wales

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ABSTRACT

The practice of marling giving rise to many pits or ponds in parts of Lancashire, Cheshire and northern Wales is described. An appraisal of the floristic composition of the pits is made and the significance for nature conservation in areas otherwise intensively farmed is discussed.

## INTRODUCTION

Many parts of northern England and Wales are covered in glacial deposits, but in lowland areas of Clwyd, Cheshire and Lancashire this often takes the form of basic glacial till. Most of the till is derived from the main Irish Sea glaciation but in W. Lancs. (v.c. 60) much of the material originated from the Lake District or from the Pennines to the east.

The soils derived from these glaciations are variable, but characteristically the till has an horizon of clay between 3 and 5 ft (0·9–1·5 m) below the surface, which contains 10–20% re-deposited calcium carbonate. The soils are inherently fertile, provided the tendency to increasing acidity, through leaching, can be counter-balanced by the continued application of lime or some other basic material. The presence of the layer of calcareous clay in the soil has, however, been known for many centuries and it has been dug up and spread on the land to rectify the natural tendency towards acidity and to maintain fertility. This practice is known as marling and has enabled these lowland areas to be intensively farmed for many centuries. As a result of this it follows that few natural or semi-natural habitats have survived, but where drainage was impeded wetland habitats existed nearby until determined efforts at drainage were, in most areas, successfully completed by the mid-19th century. In some parts, where steep sided river valleys cut through the boulder clay, semi-natural woodlands still survive although they have long since been cleared from the boulder clay plain. Thus, it is the water-filled marl pits that now constitute a significant wetland resource in these intensively farmed areas (see plate 4).

## MARLING

References to marling occur in many early documents. Hewitt (1919) states "among the Forest Pleas preserved at Chester is one of date 1303 AD where the Abbot of St Werburgh's was charged *inter alia*, with digging without permission 30 marl pits at Sutton, 3 at Bromborough, 12 at Eastham and 3 at Childer Thornton". Similarly Leland's 'Itinerary' published in the early 16th century (Leland, in Hewitt (1919)) says "The Chefe occasion and the originale by likelihood, of the manifolde Pooles

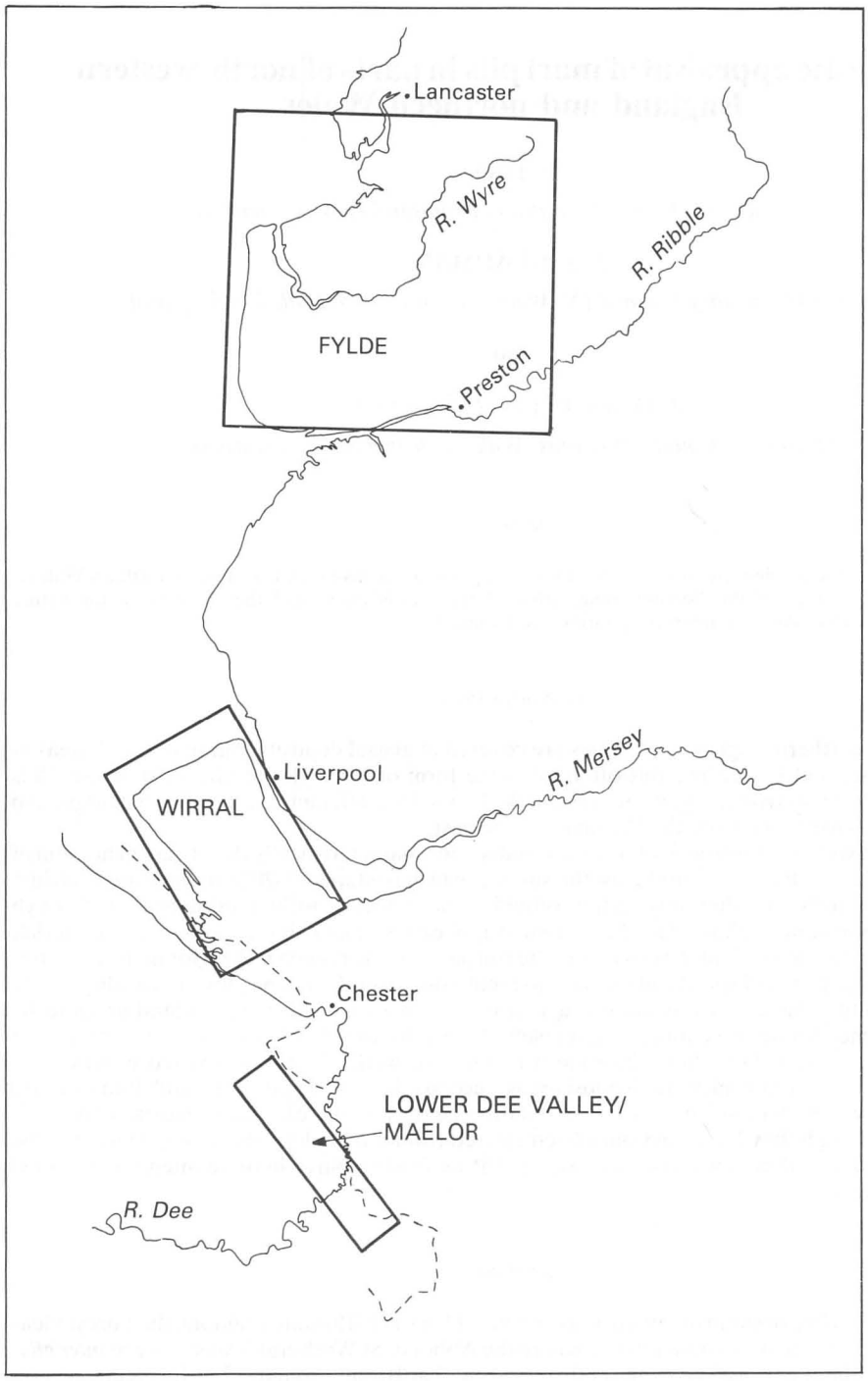



FIGURE 1. Location map showing survey areas.

and Lakes in Chestershire was by digginge of Marle for fattynge the barren ground there to beare good corne".

Towards the end of the 18th century the Board of Agriculture sent inspectors round the country to review the state of British agriculture and in Lancashire Holt was so impressed with the benefits of marling that he gave a detailed account of the method, costs and time of application (Holt 1969). The practice consisted of extracting the marl and spreading it over the fields, often after a crop of hay had been gathered, at a rate in the order of 100 tons per acre. The field was then left fallow for at least a year before further cultivation. In order to extract the marl, pits were dug, usually with a gentle slope at one side to allow carts to get into and out of the pit and with a correspondingly steep opposite bank. Sooner or later in the extraction process springs were encountered and the pits filled with water making further extraction impossible. At least one pit per field was dug (see Plate 4), and because flooding occurred so easily there were often more than one or two pits to every field, or perhaps several pits were dug closely together in a trefoil configuration – a practice particularly frequent in Cheshire. Although so clearly beneficial in the view of the Board of Agriculture, the practice of marling could be hazardous and lives were lost, as was noted on a headstone in Ribchester Churchyard, near Preston:

'Here lieth ye body of Thos. Greenwood who died
May 24 AD1776 in ye 52nd year of his age.
Honest Indu*f*trious
seeming still content
nor did repine at what
he underwent
His tran*f*ient life was
with hard labour filled
And working in a
marlepit was killd'.

Today the practice of marling has long been forgotten and only the water filled pits remain. Interestingly the Lancashire farmers of the Fylde still refer to them as pits, never ponds, reflecting their true man-made origin. However, because they are such a feature of an intensively farmed landscape and in areas where other freshwater bodies are rare, the pits or ponds have attracted the attention of each of the authors independently, to assess to what extent they form a refuge for wild life. The working methods have differed slightly and the period of observations has occurred over ten years. Nevertheless, it was felt that it was worth combining the results to give an account of these small water bodies from three distinct areas of the region (Fig. 1).

## AREAS SURVEYED AND METHODS

### THE FYLDE OF WEST LANCASTER (V.C. 60) (E.F.G.)

Marl pits are particulary abundant in the till covered areas of W. Lancs. (v.c. 60) near Preston and in the Fylde. The first edition 6 in. to 1 mile (1:10560) Ordnance Survey maps for the area were published in the period 1845–49 and many of the ponds shown at that date still existed in 1970, when most of the survey work was completed. This indicates that the pits are at least 135 years old. Using the 1:25,000 O.S. maps of 1952–55 the number of ponds per tetrad (2×2 km square) was counted and their frequency and distribution is shown in Figure 2.

The particular purpose of the survey in W. Lancs. was to provide data on a significant habitat in the vice-county for an account in a possible new Flora for the area, for which distributional records were being gathered on a tetrad basis. Consequently 62 ponds were selected for survey from throughout the area where they occurred. A pond selected for survey had open water, although this might be covered in free floating aquatics, and the banks of the pit had only a few shrubs or trees, so that there was little shading. A species list was then compiled from within the area of the whole pit including its bank sides.

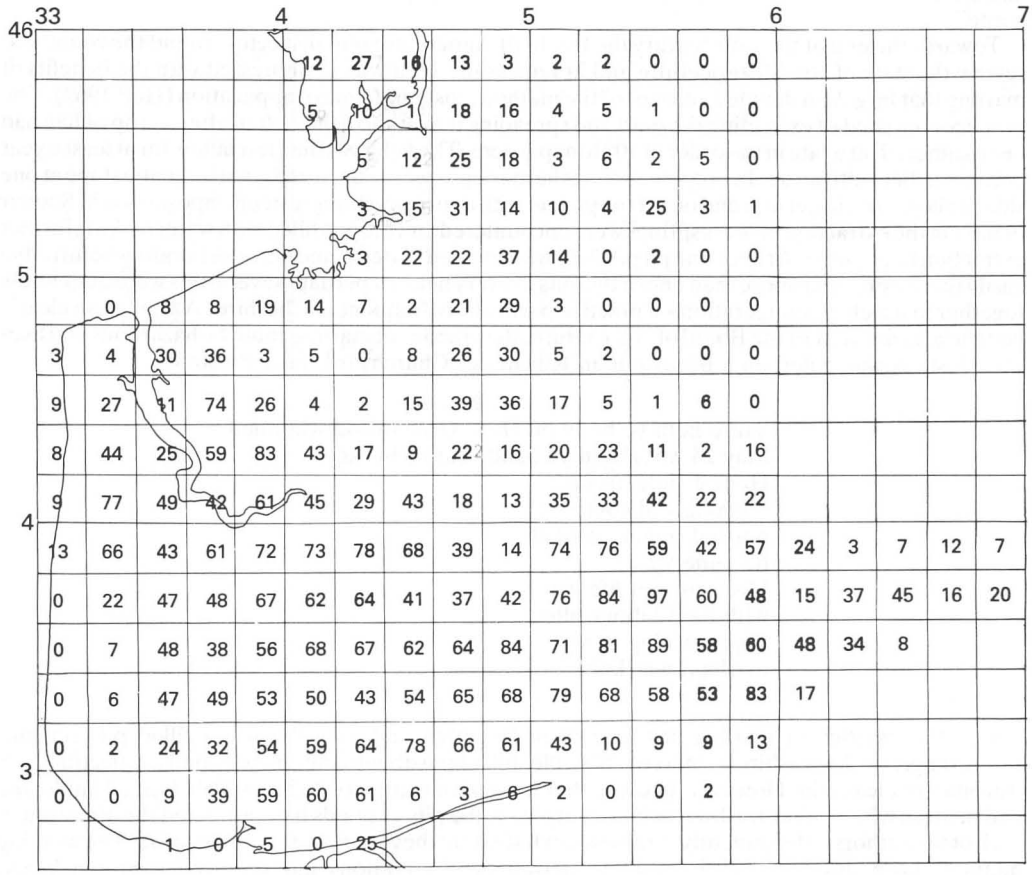



FIGURE 2. Number of ponds per tetrad in v.c. 60.

THE WIRRAL OF CHESHIRE (V.C. 58) (B.D.G.)

Marl pits are similarly common in Cheshire (v.c. 58) but in this work only Wirral pits were examined (Fig. 1). Early 18th century estate maps show few ponds and, as only 0·4% and 3% of the County was covered respectively by the 1836 and 1845 General Enclosure Acts, these are also of little help in indicating the numbers or distribution of marl pits. Nevertheless, it is believed that they were a common feature of the landscape by about 1800. By the mid-19th century Tithe maps were available for many areas. Those for Bromborough (1840) and Heswall (1859) in Wirral have been examined and show many pits. The first edition 6 in. to 1 mile (1:10560) O.S. maps were not published until 1870 (Heswall) and 1882 (Bromborough) and they also showed numerous pits. The numbers and distributions of pits taken from the 1969 O.S. map are shown in Figure 3. However, of the 2531 pits marked on these maps, over 1000 had disappeared by 1980 due to building developments, especially the construction of the M53 motorway, tipping and to changing agricultural practice.

The survey, which was both botanical and zoological, was organized in Wirral for two reasons. Firstly the Merseyside County Museums were organizing a pilot scheme for the collection of distributional records for the Metropolitan County of Merseyside and, secondly, the Cheshire Conservation Trust, alarmed at the rate at which ponds were disappearing, required information in order to assess which ponds might be conserved.

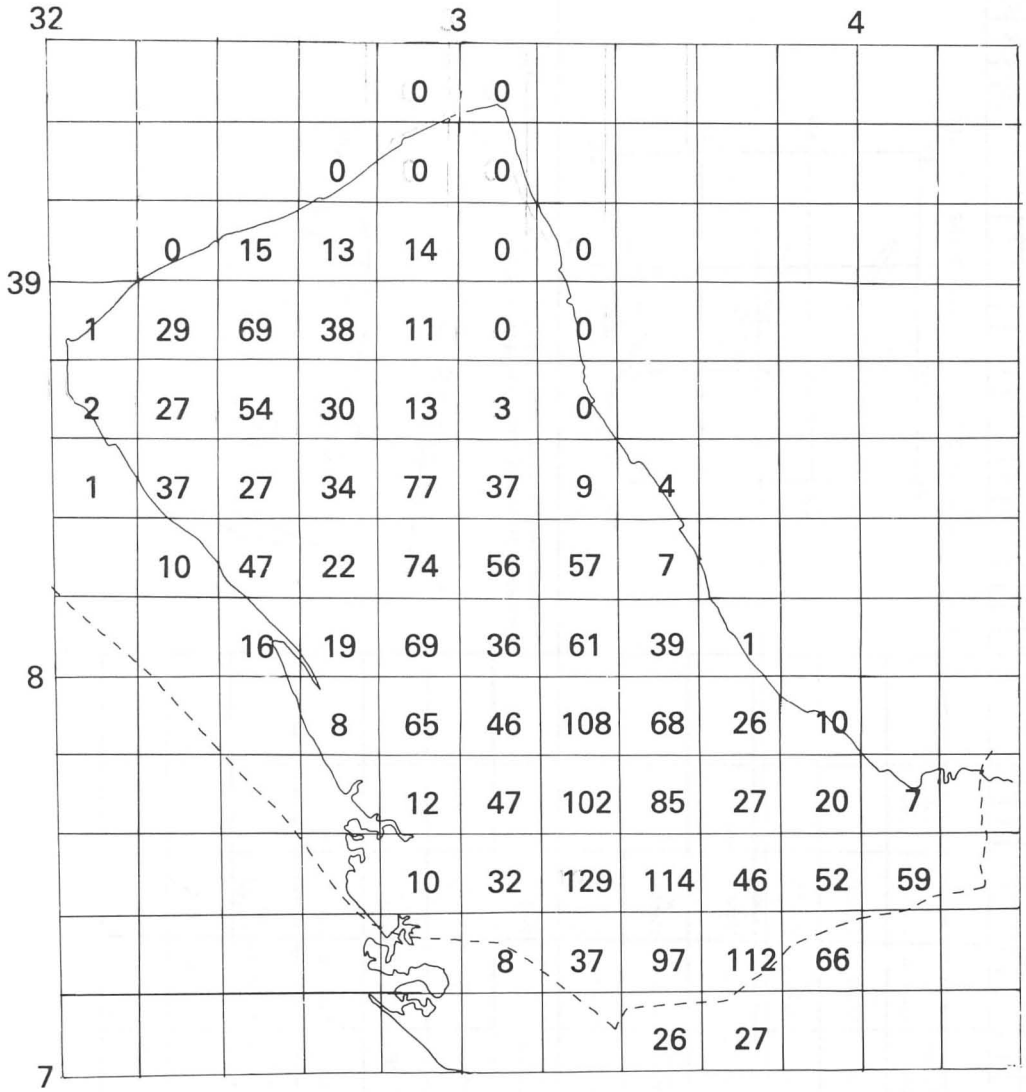



FIGURE 3. Number of ponds per tetrad in Wirral.

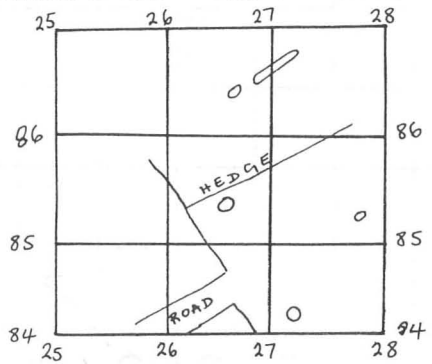
It was decided at an early stage to survey in detail only those ponds that were likely to be of some conservation value; hence, as in the Fylde, most ponds in woodlands were not examined. A further screening process then took place for the remaining ponds and eventually 52 ponds were selected for detailed study. This second screening was done by examination of aerial photographs taken in 1974 and by reports from volunteers who carried out initial assessments. For this latter purpose Cheshire Conservation Trust members and school groups completed specially produced forms (Fig. 4).

In the detailed survey only the plants growing in the marsh and aquatic areas were recorded and, unlike the survey in Lancashire, the bank-side plants were not noted. For the botanical survey the simple presence and absence of species was recorded.

Surveyor: GREENWOOD BD | Date: 24 07 75 | Locality: IRBY | Grid Reference: 33 26 58 53

| | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| | | Village Green | Common | Roadside | ✓ Field | |
| 1 | DESCRIPTION | Park | Wood | Quarry | | |
| 2 | ACCESS | Public | ✓ Private | Right of Way | | |
| 3 | USES | Fishing | Boating | Game | Amenity | |
| | | Aban-doned | None | ✓ Cattle | | |
| 4 | CONDITION | Clean ✓ | Clear | Refuse Fouled | | |
| | | Oil Fouled | Spring Fed | Stream Fed | | |
| 5 | DEGREE OF SHADE | 100% | 50/100% | 50% < ✓ | | |
| 6 | BANKS | Steep | Shelving ✓ | Man-made | | |
| 7 | AMOUNT OF OPEN WATER | 100% | 50-100% ✓ | 50% < | | |
| 8 | VEGETATION | Sub-Merged ✓ | Floating ✓ | Emer-Gent ✓ | | |
| 9 | AMOUNT OF ROOTED VEGETATION | 100% | 50-100% | 50% < ✓ | | |
| 10 | DEPTH OF WATER | <1ft | 1 ft ✓ > | | | |

PRECISE LOCATION OF POND - NUMBER THE GRID LINES




SKETCH MAP OF POND, INCLUDING ANY ISLAND, NEARBY ROAD, HOUSES, FOOTPATH ETC. INCLUDE A SCALE

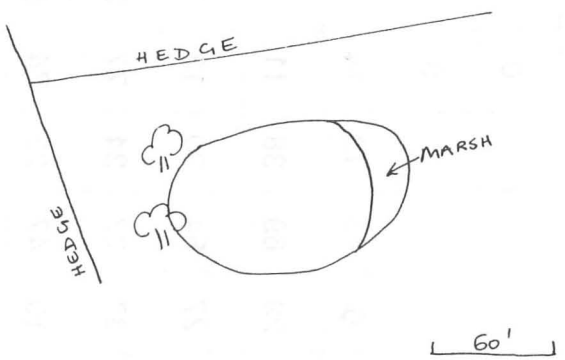



FIGURE 4. Front of sample pond survey form produced by the Cheshire Conservation Trust. Instructions for use and space for listing species are provided on the reverse.

THE LOWER DEE VALLEY AND THE MAELOR, DENBIGHSHIRE (V.C. 50) (P.D. & A.J.D.)

Little information is available on the history of marling in Clwyd, but a comparison of the Tithe Award Maps (1839) for the parishes of Bronington and Tybroughton with the first edition 6 in. to 1 mile O.S. map (1:10560) of 1874 suggests that, at least in these areas, marling was still occurring, although the practice appears to have declined after this period. Thus, as elsewhere, the pits are likely to be at least 100 years old.

Early work by Spencer (1974) in the Wrexham-Holt area suggested that at least some of the marl pits were of botanical significance. This fact combined with a study of the 1st and 2nd series O.S. 1:25,000 maps, which suggested that in some areas 25% of the ponds had already disappeared, led to a decision by the Nature Conservancy Council that as many ponds as possible should be surveyed in the Lower Dee Valley and the Maelor (Fig. 1). The frequency of the marl pits as indicated on the 1st series O.S. 1:25,000 maps is shown in Figure 5.

The survey had two principal objectives, firstly a determination of the botanical interest, to assess the relative abundance and range of species, together with the physical characteristics of the ponds and, secondly, by developing a system of objectively evaluating the ponds surveyed, to determine their conservation status and to produce a short-list of ponds for which positive conservation measures could be taken.

The survey was carried out between July and October 1979 by Ray Taylor and Paul Day, employed by the Nature Conservancy Council (North Wales Region) under a Manpower Services Commission Job Creation Scheme. Survey of all the ponds in the area was clearly not feasible and it was decided to concentrate attention on five areas subjectively chosen, but thought to be representative of the variation in the area as a whole. A pond survey form (a completed example of which is shown in Fig. 6) was devised and completed for each pond visited. 596 ponds were surveyed using this method, 108 of which were additionally measured for pH, conductivity and alkalinity. All ponds visited, including those no longer present, were allocated a survey number and plotted on 1:25,000 maps of the area surveyed.

## GENERAL AND FLORISTIC CHARACTERISTICS OF MARL PITS

The amount of marl removed from a marl pit governed its eventual size. In Cheshire marling was practised at the rate of 2 roods per acre (Edge 1794) so that for a 5 acre (2 ha) field a pit 60 ft long× 36 ft wide and 9 ft deep (18 m×10·8 m×2·7 m) was produced. Pits of this size are quite common in Wirral although Massey (1930s) surveyed some ponds measuring 120 ft×90 ft (36 m×27 m).

In Clwyd the majority of ponds surveyed fell within the size range of 60–478 sq. yds (50–400 $m^2$) with a mean size range for five study areas ranging from 266 sq. yds (222 $m^2$) for Wrexham-Holt to 367 sq. yds (307 $m^2$) for Cloy.

In the Fylde detailed measurements were not made but generally their size was similar to Wirral ponds. Throughout the region the shape of the ponds varied from almost circular to oval and oblong, but generally one end was shallow with a very gentle shelving bank, whilst the opposite end was often deeper with a steeply sloping bank. Floristically rich ponds were found in open fields and typically such ponds had water sufficiently deep to prevent rooted aquatics from growing in some parts of the ponds.

In Fylde ponds submerged aquatics were not common but *Ceratophyllum demersum, Elodea canadensis, Myriophyllum spicatum, Potamogeton berchtoldii, P. crispus, P. pectinatus, P. pusillus, Ranunculus aquatilis* and near the coast *Ceratophyllum submersum, Ranunculus baudotii* and *Zanichellia palustris* were found. Floating leaved communities were more common, with *Polygonum amphibium* and *Potamogeton natans* characteristic of the zone. Almost every pond had at least one species of *Lemna* and *L. minor* was especially common.

A wide variety of emergent and marsh plants were found in Fylde marl pits. In addition to those listed in Table 1, which occurred in 60% or more of the pits examined, the following were found in 20–59% of the ponds seen: *Alopecurus geniculatus, Bidens cernua, Callitriche* spp., *Cardamine pratensis, Eleocharis palustris, Epilobium hirsutum, E. palustre, Equisetum fluviatile, Galium palustre, Glyceria declinata, G. fluitans, Holcus lanatus, Juncus acutiflorus, J. articulatus, J. bufonius, J. inflexus, Lotus uliginosus, Myosotis caespitosa, M. palustris, Ranunculus repens, R. sceleratus, Stellaria alsine* and *Veronica beccabunga*. The odd tree or shrub was often found at one

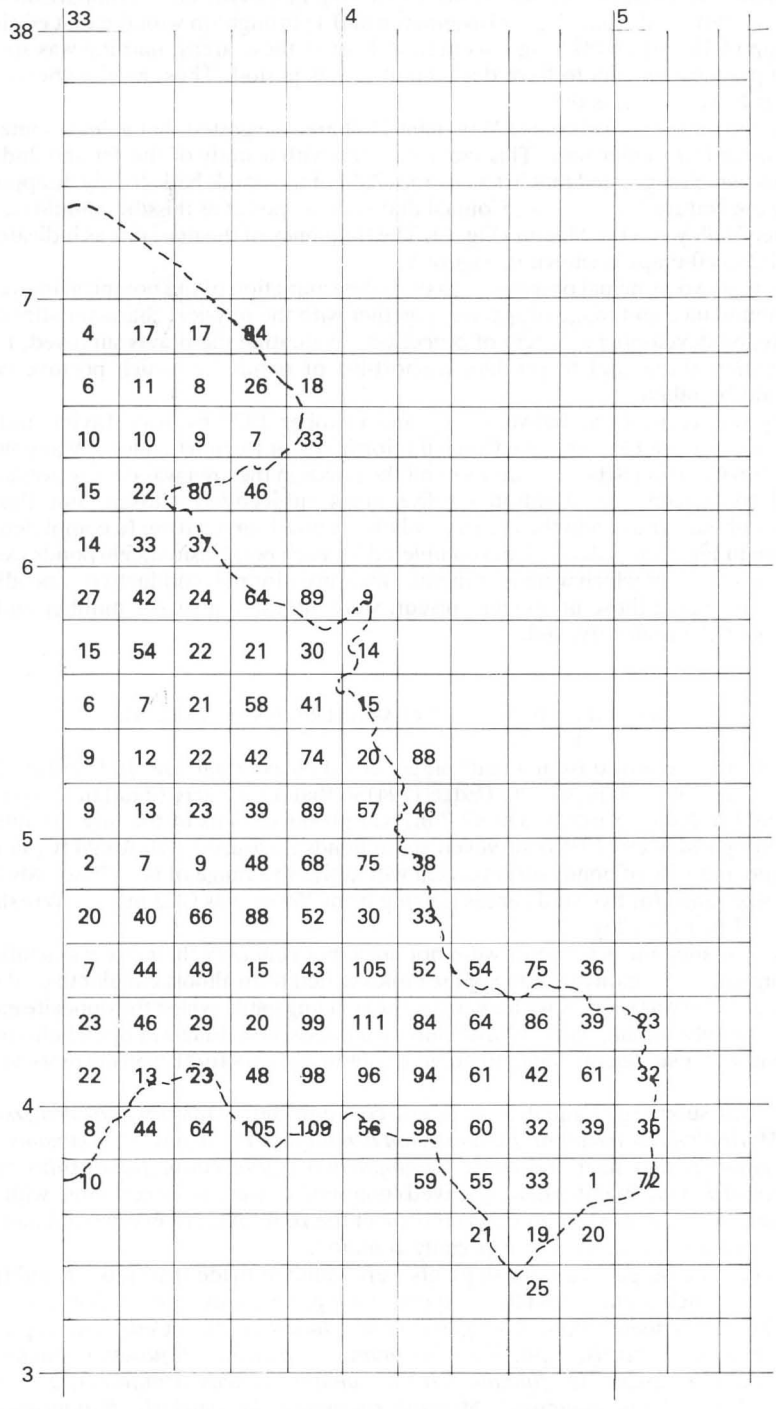
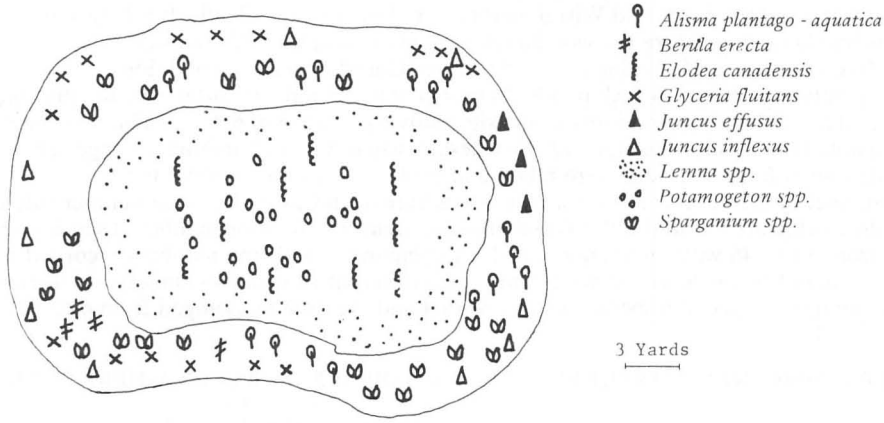



FIGURE 5. Number of ponds per tetrad in the lower Dee Valley and the Maelor.

POND SURVEY - LOWER DEE VALLEY AND MAELOR

Pond No. *73/2*

Map Ref. *SJ378538* Location *WREXHAM/HOLT AREA*




Owner:

Address:

Date Surveyed: *17.8.79*

Surveyor:

General Description:

*Unfenced pond at one side of a grass ley.*
*pH-8; Conductivity-29 x $10^{-5}$ umbos/cm.; Alkalinity-130p.p.m.*
*Zooplankton-a few individuals of Cyclops/Daphnia.*

Damage: Trampling *None*
Grazing *None*
Dumping *None*
Pollution *None*

Odonata

*Aeshna grandis-2 individuals; Ischnura elegans-1 male; Lestes sponsa-1 individual.*

Amphibia

Molluscs

*Lymnaea stagnalis*

Percentage of pond shaded: *0%*

Percentage of pond colonised by emergent aquatics: *35%*

Percentage of pond colonised by floating aquatics: *57%*

Percentage cover major species:

Submergents and floating aquatics:

*Open water – 7%*
*Lemna trisulca – 18%*
*Potamogeton natans – 19%*
*Elodea canadensis – 20%*

Emergents and non-aquatics:

*Juncus effusus – 4%*
*Alisma plantago - aquatica – 4%*
*Glyceria fluitans – 7%*
*Sparganium erectum – 19%*

FIGURE 6. Sample survey form for Clwyd. A specially designed form listing species likely to be found was also produced.

side, frequently on the steep side of the pond. *Alnus glutinosa, Crataegus monogyna, Rubus fruticosus* agg., *Salix cinerea* and *Ulex europaeus* were the most common species noted. However, some ponds had little or no open water and were no more than small marshes. Alternatively they were dominated by reedmace to form an alder and willow carr. A number of ponds were completely surrounded by trees and shrubs, alder, ash, oak and various willows being common, and in these instances the aquatic and marsh flora was limited as a consequence of the shading and the anaerobic conditions in the water created by large quantities of leaf litter.

In many areas of the Fylde and Wirral marl pits are found in woodlands. It is believed that these marl pits had been dug before the woodlands were planted in the 19th century, often as cover for game. Here the degree of shading and leaf litter produced anaerobic conditions and few, if any, vascular plants were found in such ponds. In Clwyd, where there was little shading, pits had a pH variation of 5·7–8·6 with the majority of the sites showing a range of 6·3–8·0. This was comparable with that noted by Allenby (Newton 1971) in Cheshire where 85% of ponds had a range of 6·7–7·4. In the Fylde only a few recordings were taken and these were in the region 7·0–8·0.

The number of species recorded from the ponds varied. In Clwyd the mean number varied from 10·4 in the Burton area to 18·0 in the Wrexham-Holt area. In Wirral the number of species recorded ranged from 10 to 46 with an average of 21. A comparison with the numbers recorded in West Lancaster cannot be made satisfactorily due to the different recording technique used. However, from 62 ponds surveyed 196 species were recorded and the numbers ranged from 6 to 52 with an average of 24.

TABLE 1. PERCENTAGE FREQUENCY OF OCCURRENCE OF SPECIES WHERE OVER 60%

| | Clwyd | Wirral | Fylde |
|---|---|---|---|
| *Juncus effusus* | 82 | 90 | 79 |
| *Alisma plantago-aquatica* | 74 | 86 | 79 |
| *Lemna minor* | 71 | 79 | 73 |
| *Glyceria fluitans* | 81 | 73 | — |
| *Sparganium erectum* | 61 | — | 66 |
| *Galium palustre* | 61 | 70 | — |
| *Ranunculus sceleratus* | 64 | — | — |
| *Myosotis caespitosa* | — | 73 | — |
| *Agrostis stolonifera* | — | 65 | 60 |
| *Potamogeton natans* | — | 63 | — |
| *Solanum dulcamara* | — | 63 | 63 |

The floral composition of the pits from throughout the region showed many similarities but there were distinct differences. Table 1 shows the commonest species that occur in marl pits. From this it can be seen that the three commonest species are the same for each area but both the numbers and species composition for other common species varies throughout the region. Particularly noteworthy is the abundance of *Ranunculus sceleratus* in Clwyd which, whilst occurring further north, has a generally southern distribution in the British Isles (Perring & Walters 1962). Edmondson (1967) and Newton (1971) reported on surveys of ponds in other parts of Cheshire and in the north and north-west of the county, of which Wirral is a part, recorded similar frequencies to those noted here (for Wirral) except that *Sparganium erectum* was more frequent. This is more in line with the values noted for Clwyd and W. Lancs.

No national rarities were recorded from any of the pits but certain sub-national rarities were observed, viz. *Ceratophyllum submersum* (one record from Clwyd and one from W. Lancs.) known nationally from 38 10 km squares, *Cicuta virosa* (70 records from four 10 km squares in Clwyd), known nationally from 29 10 km squares, **Stratiotes aloides* (perhaps introduced into Wirral and the Fylde but long established in both) known nationally from 21 10 km squares and **Myriophyllum verticillatum* (recorded in the Fylde) known nationally from 83 10 km squares. Although *C. virosa* was only formerly known in Clwyd, prior to the survey, from the larger water bodies (e.g. Llyn Bedydd, GR 33/471.392 and Hanmer Mere, GR 33/454.394) the literature suggests it may have been known much earlier, for Dallmann (1908) quotes the records of M. G. Bowles in Gerard's Herbal for 1633 ". . . duckponds in Flintshire".

Other uncommon species recorded were: *Hottonia palustris, Groenlandia densa* (one record in Clwyd), *Lemna polyrhiza, Lemna gibba, *Hydrocharis morsus-ranae, Butomus umbellatus* (one record in Clwyd), *Apium inundatum* (one record in Clwyd, but common in Wirral), *Oenanthe aquatica, O. fistulosa, Baldellia ranunculoides* (in Clwyd and Wirral), *Potamogeton alpinus, P. lucens* (two records in Clwyd), *P. crispus, P. pectinatus, P. berchtoldii, P. pusillus* (Fylde only), *Scirpus lacustris* (three records in Clwyd), *Azolla filiculoides* (absent from the Fylde), *Bidens tripartita* (Clwyd, Wirral), *Carex pseudocyperus* (common in Clwyd and Wirral), *Typha angustifolia, Zannichellia palustris* (Fylde only), **Utricularia vulgaris* (Wirral and the Fylde only) and **Ranunculus circinatus* (Fylde only). Many of these uncommon species are reaching their geographical limits of distribution within the British Isles somewhere between Clwyd and Lancashire. Species with a generally southern distribution are *Hottonia palustris, Lemna polyrhiza, Hydrocharis morsus-ranae, Oenanthe aquatica, O. fistulosa, Baldellia ranunculoides* and *Carex pseudocyperus*. With the exception of the last species all were uncommon in the three survey areas but the River Ribble makes a sharp dividing line for *C. pseudocyperus*. North of the River Ribble, in the Fylde, it is a rare species but south of the river it is common. Other species are characteristically coastal, e.g. *Ranunculus baudotii* and *Zannichellia palustris*, and would not be expected to occur in the inland part of Clwyd, and whilst they might be expected to occur in Wirral they have not been found there, probably because few marl pits are subject to the same degree of salt spray as are those in the Rossal peninsula of the Fylde, where most of them are found.

At a more local level, further distinct distribution patterns can be revealed. Thus, the widespread species, *Menyanthes trifoliata*, was found in only 6% of Wirral ponds and 4% of Clwyd ponds, although it is frequent in the rest of Cheshire and in the Fylde it was usually only recorded from the east of the area.

In Clwyd a more detailed analysis of the distribution of species occurring in pits was made, although a more comprehensive survey of the whole area was recognized as necessary. *Cicuta virosa* and *Hottonia palustris* occurred east of the River Dee whilst *Hydrocharis morsus-ranae, Lemna gibba, L. polyrhiza* and *Rumex hydrolapathum* were found to the west. A comparison was made between the distribution of these species in Clwyd with the records of Newton (1971) for Cheshire, and occasional records for Shropshire (Leighton 1841; Lloyd & Rutter 1957) and for Staffordshire (Edees 1972). *Cicuta virosa* occurs in ponds in both the adjoining counties and in Staffordshire, whilst *Hottonia palustris* exhibits a widespread distribution in Cheshire around Chester, in the north east of the county, and in the south in areas adjoining those in which it was found in Clwyd (10 km grid squares 33/4.4 and 33/5.4). It occurs in ponds and ditches in Staffordshire and northern Shropshire and its apparent absence west of the River Dee is therefore unexplained. *Hydrocharis morsus-ranae* occurs generally in the western part of Cheshire and in areas adjoining its localities in Clwyd. However, it was recorded from the Cheshire part of 10 km grid square 33/4.4, but not from the adjoining area of the Maelor. It is also known from the Ellesmere area of Shropshire, suggesting that it has a local, but uneven, distribution for the whole of the Lower Dee Valley and Cheshire/Shropshire plain. *Lemna gibba* appears to be relatively widespread in Cheshire, where its distribution appears to be correlated with that observed in Clwyd in being absent from 10 km grid square 33/4.4 and present in areas to the east of Wrexham/Holt/Burton. *L. polyrhiza* appears to be western in distribution in Cheshire, occurring in areas to the east of Wrexham/Holt/Burton but, in addition, occurs in 10 km grid square 33/4.4 adjacent to areas in Clwyd for which it was not recorded. *Rumex hydrolapathum* is widespread throughout Cheshire and is locally frequent in Shropshire including the northern part of the county.

## POND EVALUATION

One of the primary aims, of both the Clwyd and Wirral surveys, was to determine the conservation status of individual ponds and to produce a short-list of sites meriting positive conservation measures. In Wirral this evaluation amounted to a subjective assessment based on species diversity and rarity, but in Clwyd it was decided to devise an evaluation methodology that would allow an

* These species were recorded from marl pits in W. Lancs. but did not form part of the survey of 62 ponds.

objective comparison between different ponds, based on botanical criteria, but sufficiently flexible to allow incorporation of other criteria, e.g. invertebrates, once data were available.

Accordingly, a scoring system was devised, based on species composition and diversity in the ponds, which could be used for the comparison of ponds in any area, and which involved calculating a rarity value (R) for each species based on its overall % occurrence. A low % occurrence would warrant a high rarity value and vice versa. It was decided to give an additional rarity weighting, related to the national distribution of individual species. Those species occurring in less than 15 10 km squares (Red Data Book species, Perring & Farrell 1977) were given a rarity value of 3R whilst the sub-national rarities, i.e. those occurring in between 15 and 100 10 km squares, were accorded a value of 2R. No species were allocated a rarity value of 3R whilst only two species (*Cicuta virosa* and *Ceratophyllum submersum*) were given a score of 2R. It was also decided to account for the local distribution of particular species by making an additional allowance for the widespread or local occurrence of species in the Lower Dee Valley and the Maelor. This distribution factor (D) was allocated on the basis of whether the species occurred west or east of the River Dee or both. For widespread species D was 1, whilst it became 2 if the species was limited in distribution. Such a local distribution weighting may well, of course, be inapplicable in other areas. For each species the allocated score was the product of (R×D), except in the case of *Cicuta virosa* and *Ceratophyllum submersum* where it was (2R×D). The diversity of each pond was assessed by adding all the individual scores of the species present, thus:

$$\text{Pond Score} = \sum_{1 \to n} (R \times D) \text{ or } (2R \times D), \text{ where n is the number of species.}$$

The evaluation technique will, in general terms, pick out the ponds which are the most diverse floristically and with the largest numbers of the more uncommon species. It was decided on the basis of the evaluation results that the ponds with a score of over 150 (19% of the total) could be regarded as of high conservation interest. Those ponds with a score of over 200 were regarded as the best examples and therefore merited positive conservation and management.

Using the data available from Wirral and the Fylde a similar assessment could be made amending the formula to:

$$\text{Pond Score} = \sum_{1 \to n} R \text{ or } 2R$$

## CONCLUSION

The results of the three separate surveys suggest that marl pits represent a particularly rich botanical resource. Comparison with other published work on ponds, e.g. Jones (1971) and Hodgkin (1976) in Leicestershire, Fincher (1966) in Worcestershire, Palmer (1981) in Norfolk and Edmondson (1967) in northern Cheshire, most with relatively low mean species numbers, emphasise the value of the marl pits of Clwyd, Wirral, Cheshire and the Fylde of Lancashire. This paper has concentrated on the botanical interest of the pits surveyed, but they are obviously likely to be valuable refugia for invertebrate groups. Recent work by Jackson *et al.* (1979) found this relationship held for both standing and flowing waters in Warwickshire. Palmer (1981), working on ponds and lakes in an area of Norfolk Breckland, found a positive correlation between the number of macrophyte species and the number of species of Hemiptera and Coleoptera. Such work suggests that the diversity of macrophyte species gives an indication of the quality of sites as habitats for invertebrates.

Published work on ponds all imply a national decline in pond numbers in the lowland counties. Stubbs (1981) has recorded an 82% loss of ponds in Bedfordshire since 1910, Jones (1971) records a 30% loss of ponds in Leicestershire since 1930, whilst Relton (1972), from the results of a study of a well-documented area of 2,000 hectares in Huntingdonshire, records a loss of 35% of ponds since 1950. In Clwyd, the loss of ponds, as recorded by the recent survey, is even higher than that determined by a desk study of 1st and 2nd series O.S. 1:25000 maps, reaching 50% in the Burton area.

As the density of marl pits declines the natural or artificial transfer of plant material from one pit to another becomes more difficult and species lost from particular sites are less likely to be replaced. It

is this fact which must have played an important part in determining the current plant species diversity of pits in the areas surveyed. It is clear that the pits represent a former farming practice and decline is inevitable. Further survey is required to aid selection for conservation of at least some of the better quality examples of a disappearing biological resource.

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PLATE 4. Aerial view of marl pits near Roseacre (SD4336) in the Fylde of Lancashire taken on 3rd June 1963. Aerofilms Limited, copyright Lancashire County Council.

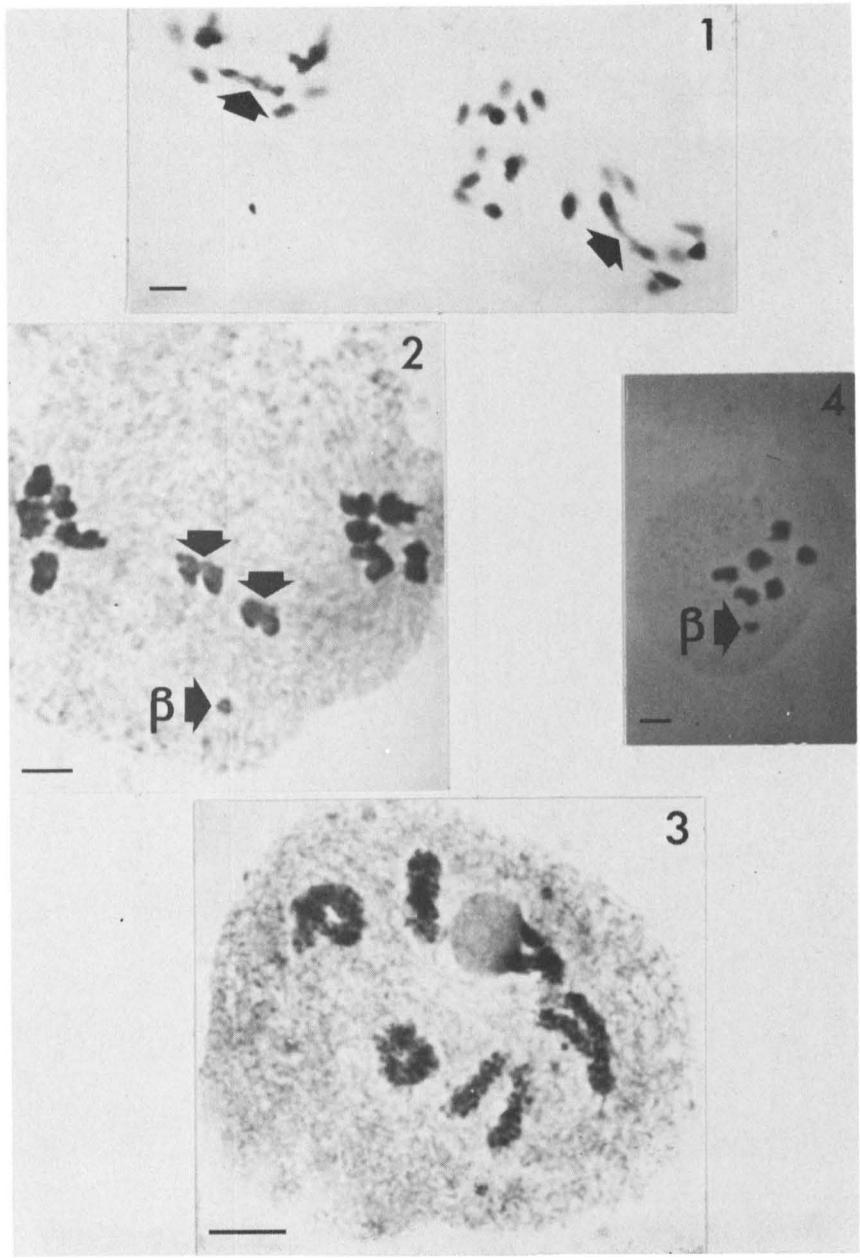


PLATE 3. Photographs of chromosomes of *Jasione montana* L. (1) *J. montana* var. *montana*, $n=6$. All chromosomes are at first anaphase but a laggard bivalent (arrowed) has only just begun division. (2) *J. montana* var. *litoralis*, $n=6+1\beta$. All chromosomes are in first anaphase but laggard chromosomes (arrowed) have not yet moved to the poles of the cell. One $\beta$ chromosome is present ($\beta$). (3) *J. montana* var. *montana*, $n=6$. All bivalents at diakinesis. (4) *J. montana* var. *litoralis*, $n=6+1\beta$. All chromosomes are in first telophase. One $\beta$ chromosome is present. Scale bars on photographs equal 5$\mu$m.