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LICHEN COLONISATION OF TREES AT LONGWORTH CLOUGH NATURE RESERVE, GREATER MANCHESTER

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Introduction

The status of the lichen flora of South Lancashire, Greater Manchester and Merseyside has received little attention since the work of Wheldon and Travis in 1915. The compilation of a lichen flora for the whole of Lancashire (Watsonian vice counties 59 and 60) is presently under way (Gosling, in preparation).

Lichens are plants sensitive to various pollutants. Air pollution in the form of SO_2 is the most deleterious affecting the photosynthetic abilities of the algal component of the plant. When the mean winter concentrations reach about 170 μgm^3 no lichens can survive. The first lichens to be affected are generally those growing as epiphytes, followed by those on acid rocks, such as sandstone, then those growing on the ground and, finally, those on calcareous substrates. This order reflects the greater buffering potential of calcareous substrates compared to trees.

In the last century and early decades of this century, the industrialisation of south and east Lancashire was responsible for the devastation of much of the lichen flora, especially the epiphytic species. In 1859, Grindon noted of the area around Manchester, "the quantity (of lichens) has been much lessened of late years, through the cutting of old woods and the influx of factory smoke, which appears to be singularly prejudicial to these lovers of pure atmosphere" (Grindon, 1859).

By 1915 the situation showed little improvement especially in the east of the county. Only in the limestone areas of the Ribble valley and in the dunes around Ainsdale were lichens found in any quantity. In the east the lichens were described as "in extremis; corticole species are absent" (Wheldon and Travis, 1915). Only four species are mentioned as occurring in south east Lancashire, *Cladonia macilenta*, *C. uncialis*, *Lecanora conizaeoides* and *Steinia geophana*.

Of these, *Lecanora conizaeoides* is still the most common corticolous species in Lancashire because of its tolerance to high SO_2 levels. In the early parts of the century it is likely to have been the commonest lichen and is recorded by Wheldon and Travis (op cit) as occurring in all parts of South Lancashire.

Since the Clean Air Act of 1956 emissions of SO_2 and smoke have been substantially reduced within urban areas. With this amelioration in the levels of airborne pollution the lichen flora of many urban areas and urban fringes would be expected to improve. This has indeed proved to be the case. The return of lichens to urban areas is now well established. In Manchester, eight species including *Usnea subfloridana* have been reported on ash 8km south of the city centre (Guest, 1987).

In areas away from towns the lichen flora is steadily showing signs of improvement. Whilst the lichens' decline can be very rapid their recolonisation may be expected to be slow with a time lag of several years. The length of the lag will vary according to the availability of lichen propagules and the time taken for adjustments in the pH of the substrate (Hawksworth and Hill, 1984).

The comments of Fox (1988), that the corticolous flora is particularly poor in the Bolton area, are generally borne out by my own observations. Fox suggests that *Salix* in willow carrs are likely to be the main areas to watch in future years in order to record the recolonisation of trees by lichens. This observation is based on work done in Cheshire and the present work in Longworth Clough clearly endorses his suggestion.

Longworth Clough Nature Reserve

The reserve is situated six kilometres north west of Bolton in a shallow valley trending NW-SE cut into the Pennine moors and covers an area of 27 hectares at an altitude of around 180m. It has one of the best lichen floras on trees in Lancashire south of the Ribble valley with 28 corticolous species so far recorded.

In the 19th century a mill was sited at the eastern end of the valley, it was demolished around 1910. The works at the western side of the reserve are still there today. These, together with the industrial areas of Lancashire and Yorkshire must have subjected the Longworth Valley to considerable atmospheric pollution.

The 1911 OS map shows that the woodland areas then were largely as they are today. The ash and sycamore shown on the map are still standing. There are no past records for lichens in the valley but it is unlikely that much existed in the early part of the century. By the 1950's the situation appears little improved when lichens in the Bolton area are said "to abominate soot and are rarely to be found" (Saxelby, 1953). The rate and time of recolonisation is impossible to determine since my first visit to the woods was not made until 1991.

Today the woodland areas consist of a wet willow carr in the valley bottom with willow, birch and oak adjacent to the old mill race located on the northern flank of the valley. On the edges of the stream are alder and on drier banks are oak and birch which are more extensive on the south bank. Other trees include ash, sycamore, hawthorn and rowan.

Lichens On Willow

It is these woodland areas that have the greatest lichen interest, particularly the willows in the valley bottom. Whilst all the willows show evidence of lichen recolonisation, one area north of the footpath at SD 698149 shows greater lichen diversity and luxuriance than elsewhere in the reserve.

The willows (*Salix cinerea*) are the most important tree species for lichens with a total of 24 species so far recorded growing on them. The reason for their suitability probably lies in a combination of factors. Firstly they grow in areas where a high water table and hence a relatively high humidity is maintained which is conducive to lichen growth. Secondly the bark of *Salix* spp. has a pH of between 4.5 and 5.2. This compares with 3.2 to 5.0 for birch and 4.2 to 5.0 for alder (Watson, Hawksworth and Rose, 1988), the two species that with willow make up the bulk of the woodland. Whilst still acid the pH may be high enough to encourage recolonisation by helping to buffer any acidity due to atmospheric affects. Thirdly the texture of willow bark which allows retention of water and is fissured to allow micro habitats for lichen propagules to be established are also likely to be important.

The importance of willow as an early site of lichen recolonisation has been observed elsewhere for example in the Fylde area of West Lancashire and in Cheshire (Fox, op cit).

At Longworth there is a constant flora on the willows of which *Hypogymnia physodes* and *H. tubulosa* are co-dominant. These species are abundant near tree bases which often have the mosses *Mnium hornum*, *Plagiothecium undulatum* and *Orthodontium lineare* together with the liverwort *Lophocolea bidentata* var. *bidentata* at ground level with the *Hypogymnia* spp. above. Lichens extend along boughs and up trunks to a height of three metres. Another frequent plant is the foliose species *Platismatia glauca* which seldom forms extensive patches but grows up to ten centimetres across. Both this and the *Hypogymnia* spp. are acidophilous lichens common elsewhere in Britain on sandstone and pine trees. The bases and low branches of willows sometimes bear the crustose, yellow-green lichen *Ochrolechia androgyna*, again a species adapted to acid conditions. The trunks and twigs carry abundant *Lecanora conizaeoides* which together with *Lepraria incana* are the only two species to be found on all tree species in Longworth. On the shaded parts of the trunks the blue-green *Lepraria incana* is common sometimes with orange patches of the alga *Trentepohlia*. A rare plant in similar habitats is *Lepraria lobificans*. This plant has only recently been described and may prove to be widespread in Lancashire. Around the mossy base of several trees are four species of *Cladonia*, whilst none is common they are sometimes luxuriant.

Perhaps the most interesting plant on these willows is *Gyalidiopsis anastomosans*. It occurs as a glaucous, green crust which under the lens is seen to carry erect structures called hyphophores with translucent tips. On some trees patches 20 x 45cm occur and it is found throughout the willow carr and is occasionally fertile. This plant is now known from 13 sites in Lancashire, all are humid habitats but at no other site does it reach such abundance and form such extensive patches. Its present known distribution is shown on Map 1. Whilst it is widespread in Britain there are few records in Northern England outside the Lake District and Lancashire.

Lichens of the foliose genus *Parmelia* do occur with four species recorded, but they are not common except for *Parmelia sulcata*. All other species are rare or occasional but add to the floristic diversity of the trees.

The majority of the lichens at Longworth are crustose, a growth form that exposes less of the plant to the atmosphere and hence these species tend to be more pollution tolerant. Foliose species are generally more sensitive to pollution than crustose species. At Longworth there are 13 foliose species compared with eight crustose species but this masks the fact that all but the *Hypogymnia* spp. and *Platismatia glauca*, both of which are foliose, are rare in the reserve. The more pollution sensitive species *Evernia prunastri* and *Usnea subfloridana* are very rare.

The present flora is indicative of mean winter SO_2 levels of about 60-70 µg/m^3 based on the zone scale for estimation of SO_2 levels in England and Wales (Hawksworth and Rose, 1970).

Lichens On Alder, Birch, Oak, Ash And Sycamore

These trees carry a much less varied and luxuriant flora. Only *Lecanora conizaeoides*, *Hypogymnia physodes* and *H. tubulosa* are at all common. Around the bases *Ochrolechia androgyna* occurs with *Lepraria incana* and occasional *Parmelia saxatilis*. The main interest is the occurrence of *Micarea melaena* and *M. prasina* which are so far recorded only on alder.

Summary Of Corticolous Lichen Flora

1 - Willow, 2 - Alder, 3 - Birch, 4 - Oak, 5 - Sycamore, 6 - Ash

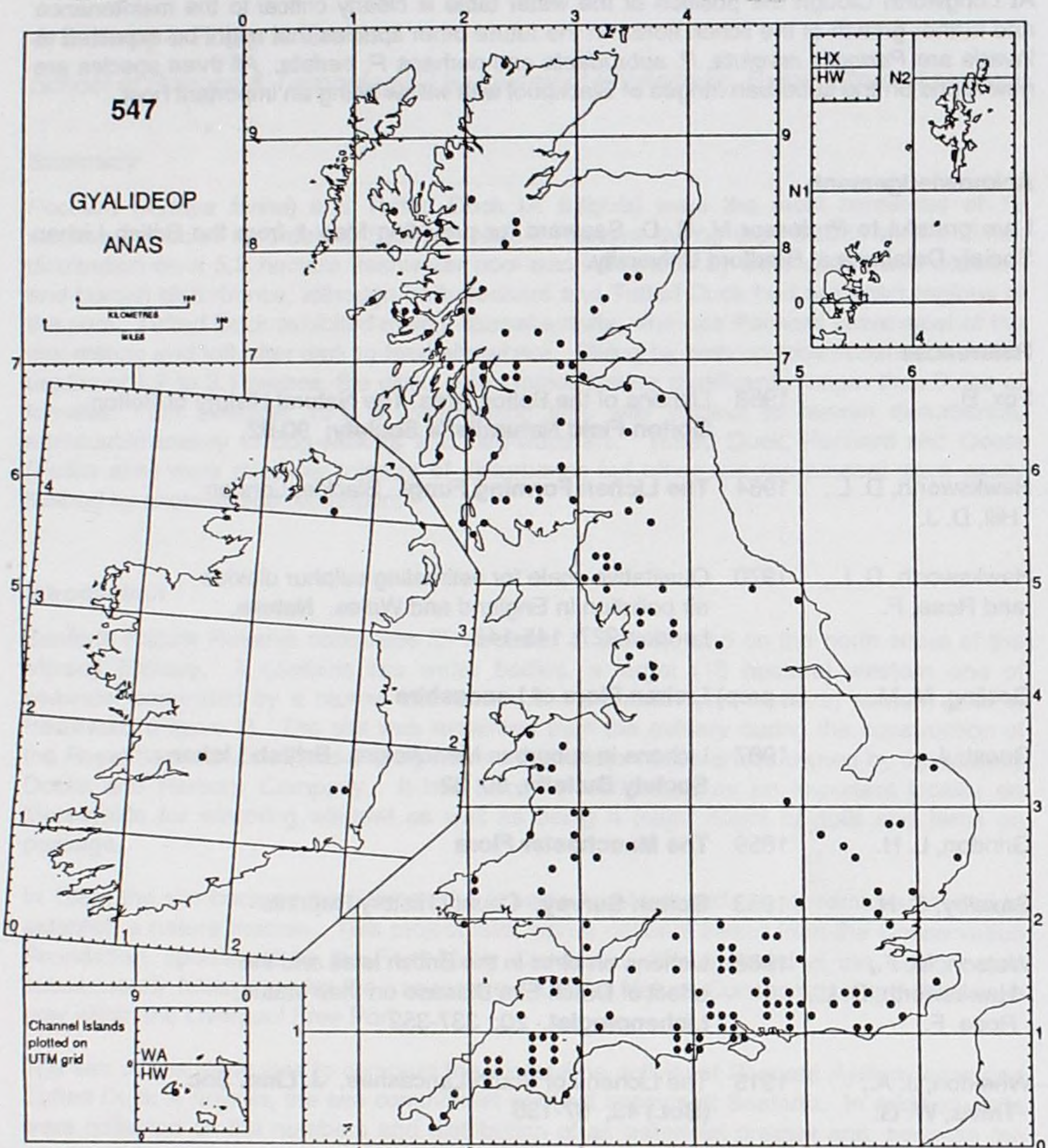
	1	2	3	4	5	6
Bacidia arnoldiana f. *corticola*				*		
Cladonia chlorophaea	*					
C. coniocraea	*					
C. fimbiata	*					
C. floerkeana		*				
C. macilenta	*		*			
Evernia prunastri	*					
Foraminella ambigua	*					
Gyalidiopsis anastomosans	*				*	
Hypogymnia physodes	*	*	*	*	*	
H. tubulosa	*		*	*		
Lecanora conizaeoides	*	*	*	*	*	*
Lepraria incana	*	*	*	*	*	*
L. lobificans	*					
Micarea botryoides	*					
M. melaena		*				
M. prasina		*				
Mycoblastus sterilis	*					
Ochrolechia androgyna	*		*	*		
Parmelia glabratula subsp. glabratula	*					
P. saxatilis	*			*		
P. subaurifera	*					
P. sulcata	*					
Placynthiella icmalea	*					
Platismatia glauca	*					
Trapeliopsis granulosa	*					
T. pseudogranulosa	*					
Usnea subfloridana	*					
Totals	24	6	6	7	4	2

Total number of taxa 28

Comparison With Other South Lancashire Sites

The lichens recorded at other similar wooded, valley sites such as Dean Wood (Rivington), Sunnyhurst Woods (Darwen), Healey Dell (Rochdale), Reddisher Wood (Holcombe) do not have such a varied flora as seen at Longworth Clough. They all must have suffered from airborne pollution in former years but still show limited signs of recovery.

The precise reasons for this are uncertain but the occurrence of willows in areas of high water table seems to be important. If the water table drops and the humidity falls the effects can be very marked. At a similar type of site with willows in Scorton, 14 km north of Preston (SD 503505) the old gravel extractions formed when the M6 was being constructed have been colonised by willow and alder. The recent drying out of this site and subsequent reduction in humidity has led to the death of the *Parmelia* species such as *Parmelia*



Map 1 - Distribution of *Gyalidiopsis anastomosans*

Source: British Lichen Society Database. University of Bradford *sulcata*, *P. saxatilis* and the pollution sensitive *Parmelia caperata*. This last plant is not common in Lancashire and is almost entirely confined to the north of the county.

At Longworth Clough the position of the water table is clearly critical to the maintenance and further growth of the lichen flora. In the future other species that might be expected to invade are *Parmelia revoluta*, *P. subrudecta* and perhaps *P. perlata*. All three species are now found on the suburban fringes of Blackpool with willow being an important host.

Acknowledgement

I am grateful to Professor M. R. D. Seaward for providing Map 1 from the British Lichen Society Database at Bradford University.

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COMPARISON OF WINTER FORAGING ACTIVITY OF POCHARD AND TUFTED DUCK AT SEAFORTH, MERSEYSIDE

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Summary

Pochard (*Aythya ferina*) and Tufted Duck (*A fuligula*) were the most numerous of 12 waterfowl species recorded at Seaforth Nature Reserve during the 1982/83 winter. Their distribution on a 5.2 hectare freshwater pool was influenced by wind speed and direction and human disturbance, although both pochard and Tufted Duck had preferred regions of the pool. Tufted Duck exhibited mainly diurnal activity, whereas Pochard spent most of the day resting and left after dark to feed elsewhere. Diving by both species occurred in water depths of 1.7 to 3.1 metres, the dives of the males lasting significantly longer than those of females. On average, 13% of observation time was subject to human disturbance, attributable mainly to dog-walkers and bird-watchers. Tufted Duck, Pochard and Coots (*Fulica atra*) were relatively tolerant of disturbance but other species present were easily flushed by shore-based recreation.

Introduction

Seaforth Nature Reserve comprises 39 hectares of derelict land on the north shore of the Mersey Estuary. It contains two water bodies, a larger (13 hectare) western one of seawater separated by a narrow causeway from a smaller (five hectare) eastern pool of freshwater (Figure 1). The site was reclaimed from the estuary during the construction of the Royal Seaforth Dock and Crosby Marina in the late 1960s and is owned by the Mersey Docks and Harbour Company. It has become recognised as an important locality on Merseyside for wintering wildfowl as well as being a major haunt of gulls and terns on passage.

In 1982, the site became the subject of a scheme by Merseyside Improvements Limited to establish a nature reserve. This project later won a national award from the Conservation Foundation, sponsored by the Ford Motor Company. Management of the reserve was subsequently taken over by the Lancashire Trust for Nature Conservation and the site is now within the Liverpool Free Port.

The aim of this study was to compare the winter-time activity of Pochard *Aythya ferina* and Tufted Duck *A fuligula*, the two commonest wildfowl species at Seaforth. In addition, data were collected on the numbers and distribution of all waterfowl present and, because the site is within a major urban conurbation and subjected to considerable human pressure, the effects of disturbance on these birds was assessed.

Between October 1982 and March 1983, we made 25 visits to the reserve. Observation periods lasted one to six hours, and included approximately equal representation of all daylight hours. Using a 15 to 60x magnification telescope and 10x50 binoculars, we made observations from a small portable shelter to which the birds soon became habituated. Data collection began only after the observer had been in position for 15 to 20 minutes. During each daytime visit, the following environmental variables were determined: wind speed and direction, air and water temperature, water depth and pH at a fixed point. A few visits were also made after dark, using 8x56 binoculars, with artificial lighting from the nearby dockland aiding vision.

Observations were concentrated largely on the eastern pool where most of the ducks congregated (Figure 1). All wildfowl were counted and, where possible, the sex of the birds was noted. The approximate positions of Pochard and Tufted Duck were sketched on a map of the pool which was divided into 19 regions for ease of recording. A total of 24 distribution maps was obtained in this way. Dive times of a sample of individuals were recorded, the regions of the pool in which feeding took place being noted. Skin-divers took ten measurements of water depth in each of the main feeding areas. The sources, nature and effect of human disturbance were also noted.

Group activity data were collected on 11 days during the period December to February. At 30 minute intervals, flocks of Pochard and Tufted Duck were scanned and the behaviour of all individuals recorded under the following headings: resting, preening, swimming and diving. A total of 53 scans was made throughout the winter. Daytime activity budgets were constructed using the method described by Pedroli (1982). These data were standardised according to time of day but were not corrected for changes in day length during the winter.

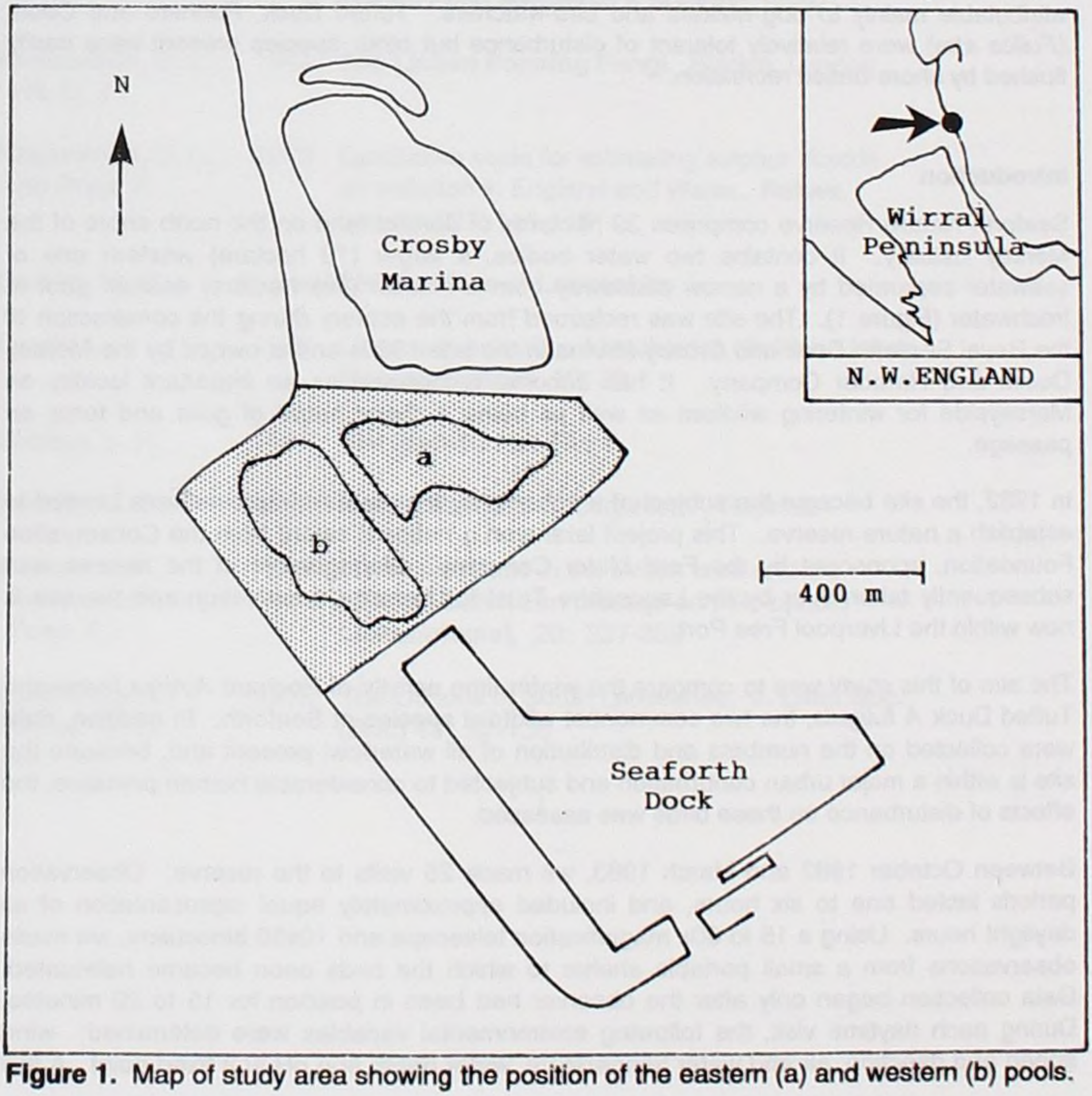

Figure 1. Map of study area showing the position of the eastern (a) and western (b) pools.

Environmental Variables

The margins of the eastern pool are mainly shallow (less than 1 metre) but, at distances of 10-30m from the edge, depth increases sharply. The central part of the pool is of fairly uniform depth, with a maximum of 4.9 metres. The water level increased by 35 cm. between November and early February because of rainfall. The pH of the eastern pool was 7.0. Dominant winds were from the south-west and reached strong to gale force on seven out of the 25 study days. Water and air temperatures were 0 to 9°C and 2 to 9°C respectively. Icing was rare and restricted to the margins of the pool.

Results

Pochard and Tufted Duck

Pochard numbers increased rapidly during October, peaked in early November, and declined steadily until mid-March (Figure 2). The number of Tufted Duck was more variable, showing no clear peak during October to mid-December, declined suddenly in late December, and remained low thereafter (Figure 2). In both species, there were approximately twice as many males as females on most visits (Figure 2).

The distribution of Pochard and Tufted Duck on the eastern pool was variable, being influenced primarily by wind speed and direction and levels of disturbance. Considering all distribution maps together, each species tended to use slightly different regions of the pool (Figure 3). Thus Pochard favoured regions F, O and S, whilst Tufted Duck, though more widespread than Pochard, occupied mainly regions G, N and S. Regions preferred by Pochard were somewhat deeper (x=3.97m, n=30) than those preferred by Tufted Duck (x=2.81m, n=30), although the difference in water depth was not significantly different.

Tufted Duck were active by day while Pochard spent most of the day resting (Figure 4). Pochard showed a gradual increase in activity around noon, but only became really active at dusk. On several occasions, the Pochard flock was seen swimming excitedly at dusk and later departed, presumably to feed elsewhere. Observations after dark on moonlit nights confirmed that Pochard were absent. Tufted Duck became less active as the day wore on and ceased feeding at dusk (Figure 4).

Dives lasted 11-31 seconds, mostly 20-25 seconds (Table 1). All dives were made in water 1.7-3.1m deep. The dives of the males lasted significantly longer than those of the females in each species and those of Pochard lasted significantly longer than those of Tufted Duck in both sexes.

Both species engaged in bouts of diving lasting seven to eight minutes in Pochard and 12 to 13 minutes in Tufted Duck, during which time they usually dived once or twice per minute, depending on the species and sex (Table 1). The proportion of the time spent submerged was 50-60% during diving bouts (Table 1).

Other Species

A further ten species of wildfowl were recorded during the winter, their approximate order of abundance being Coot *Fulica atra* (20-64), Canada Goose *Branta canadensis* (1-42), Mallard *Anas platyrhynchos* (1-31), Goldeneye *Bucephala clangula* (1-24), Scaup *Aythya marila* (1-18), Mute Swan *Cygnus olor* (2-7), Red-breasted Merganser *Mergus serrator* (1-6), Little Grebe *Tachybaptus ruficollis* (1-4), Teal *Anas crecca* (1-2) and Wigeon *Anas* *penelope* (1). Coots, Mallards, Mute Swans and Little Grebes were only observed on the eastern pool, while Scaup, Goldeneye and Red-breasted Mergansers used both pools, but with a preference for the western one. Both Mallard and Canada Goose used the site predominantly for roosting.

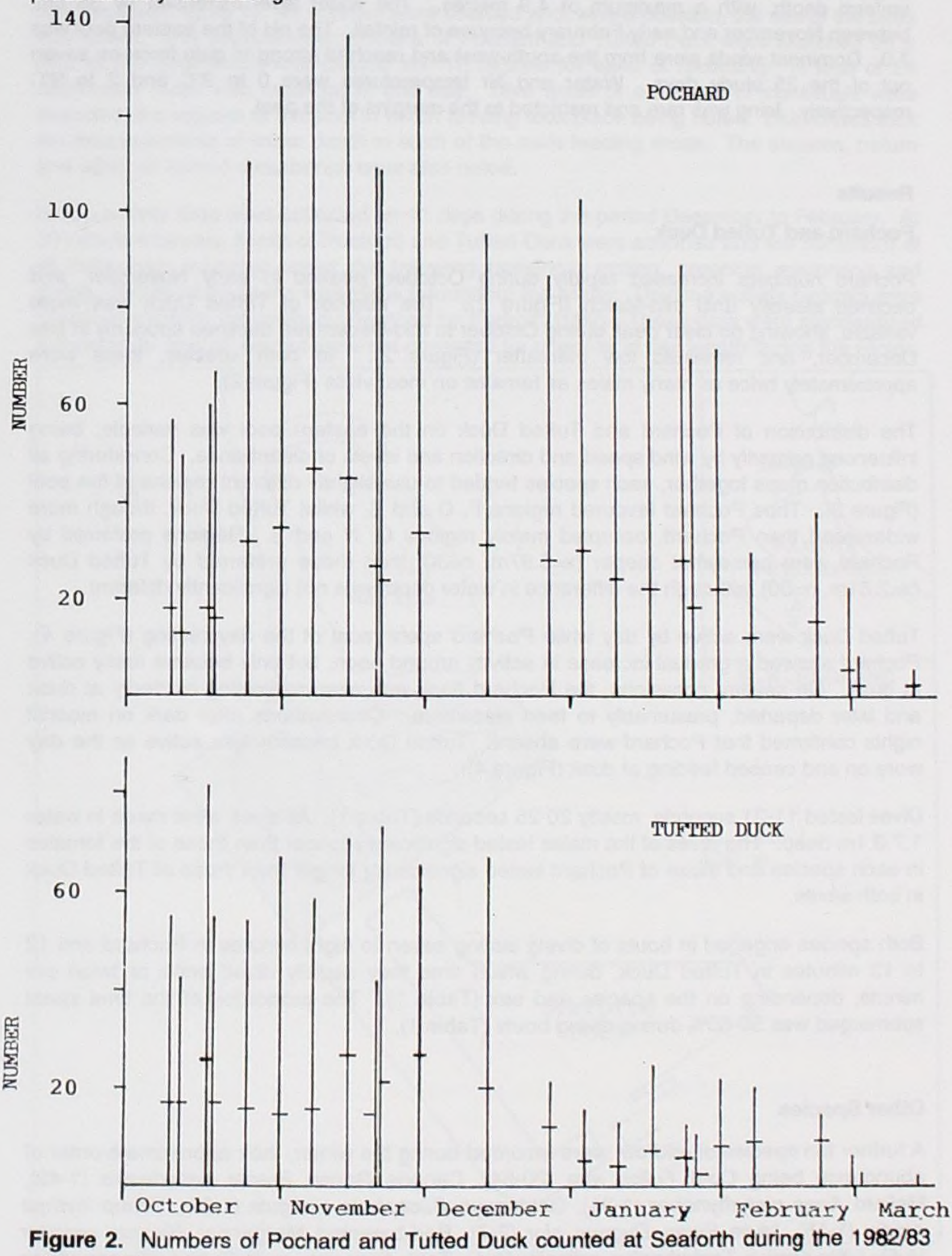

Figure 2. Numbers of Pochard and Tufted Duck counted at Seaforth during the 1982/83 winter. Males above the horizontal line; females below.

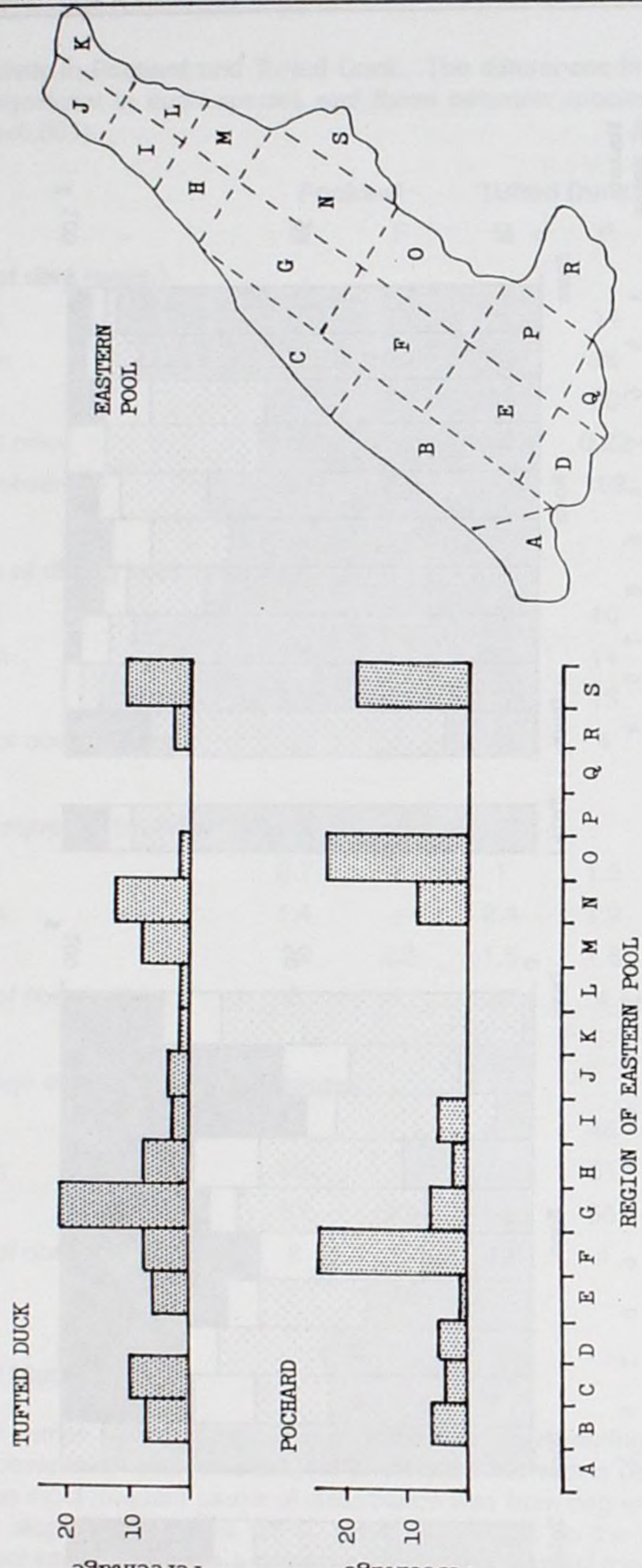

Figure 3. Distribution of Pochard and Tufted Duck on the eastern pool The bars represent the percentage of all birds recorded occupying each region of the pool.

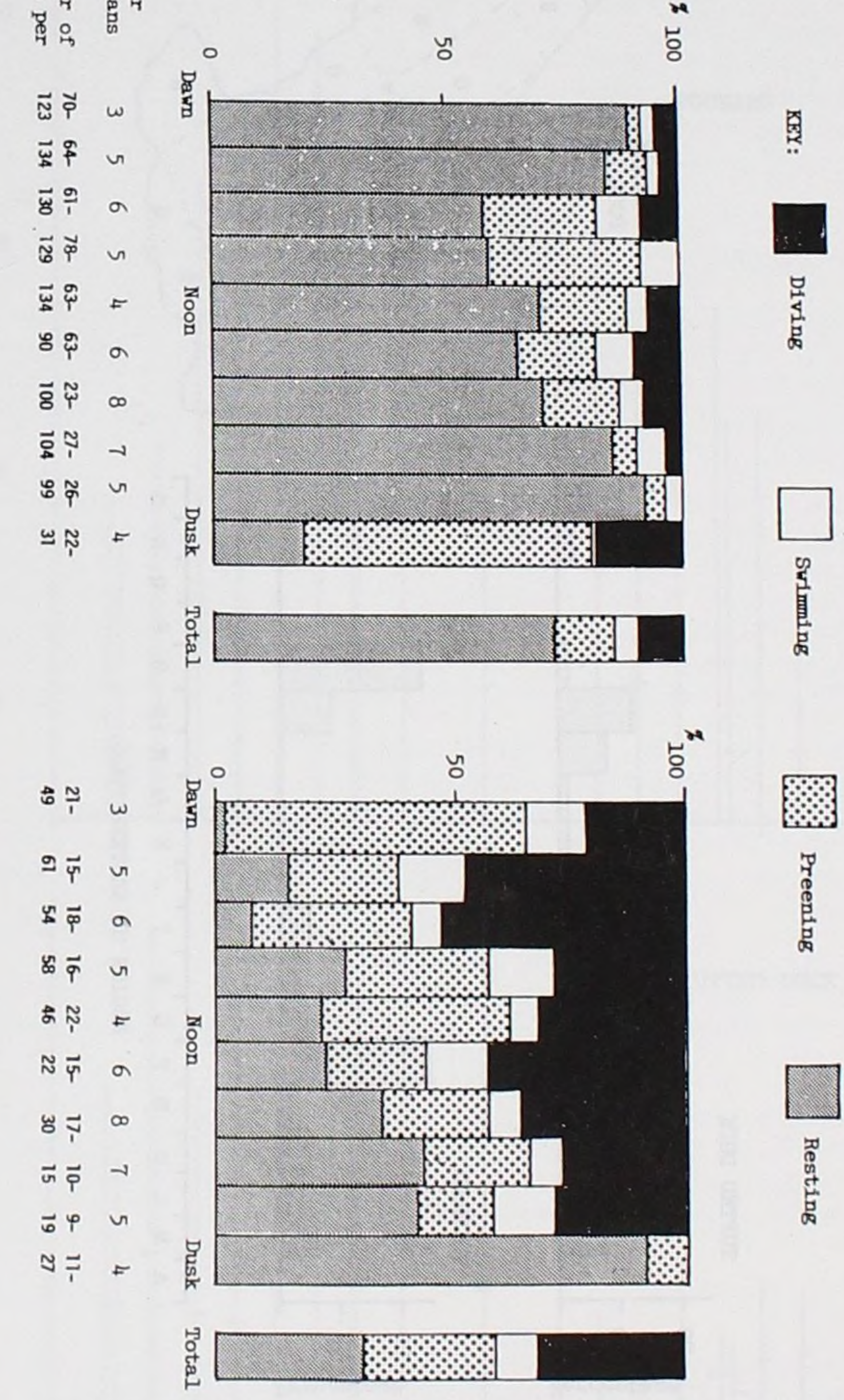

Figure 4. Daytime activity budgets for Pochard (left) and Tufted Duck (right)

Table 1 - Diving activity in Pochard and Tufted Duck. The differences in length of dive between sexes are significant in each species and those between species significant in each sex (t-tests, all $p<0.001$).

	Pochard		Tufted Duck	
	M	**F**	**M**	**F**
Length of dive (secs.)				
Minimum	19	11	13	14
Maximum	31	29	31	26
Mean	26	24	24	20
Standard error	0.25	0.53	0.23	0.22
Number observed	90	51	216	159
Duration of diving bouts (mins.)				
Minimum	4	-	3	10
Maximum	12	-	26	14
Mean	8	(7)	12	13
Number of observations	8	1	12	4
Diving frequency (number/minute)				
Minimum	0.7	-	1	1.5
Maximum	1.4	-	2.4	1.9
Mean	1.2	2.3	1.5	1.6
Number of observations	8	1	12	4
Percentage of diving bout submerged				
Minimum	34	-	48	46
Maximum	65	-	77	61
Mean	52	(90)	60	55
Number of observations	8	1	12	4

Nature and Effects of Disturbance

Forty-nine incidents of human disturbance to the wildfowl were noted during 17 site visits. On average, 13% of observation time was subject to disturbance, with a peak of 36% on one day (Table 2). The most frequent cause of disturbance was from dog-walkers (36% of the total), followed by single birdwatchers (23%, Table 2). People on the elevated north bank of the eastern pool seemed to have a greater effect on the wildfowl than those on the lower-lying causeway or southern shore. It was also noticeable that large groups of people had more effect on the birds, especially when the groups were noisy and active.

The effects of human presence varied according to species. All wildfowl, except Coot, stopped feeding in response to disturbance. Teal and Wigeon were readily flushed and did not return to the pools during the period of observation. Mallards, Goldeneye and Red-breasted Mergansers were also easily put to flight but would often land again on the larger, western pool. Pochard, Tufted Duck and Coots were relatively tolerant of human presence, usually swimming away from the point of disturbance unless it occurred simultaneously on opposite banks of the pool when flight was more likely. Those individuals that did depart usually returned before long.

Table 2. Frequency and nature of human disturbance on the shores of the eastern pool.

	Total	Maximum/day	Minimum/day
Period of observation (minutes)	3,438	360	90
Number of disturbances	49	9	1
Total time disturbed (minutes)	435	70	5
% of observation time disturbed	12.7%	35.9%	2%

Activity		Frequency (%)
Single person	- walking	14.5
	- birdwatching	22.6
Small group	- walking	9.7
	- birdwatching	12.9
Large group	- walking	4.8
Dog-walking		35.5

Discussion

Activity of Pochard and Tufted Duck

Pochard spent only about 10% of daylight hours feeding at Seaforth, leaving after dark for an unknown feeding area. Willi (1970), studying wintering Pochard in Switzerland, also showed that they were primarily nocturnal feeders, although Owen et al (1986) state that Pochard usually feed more intensively by day. Unlike Seaforth Pochard, Tufted Duck at Seaforth exhibited mainly diurnal activity which is typical at most British winter haunts (Owen et al 1986). However, at Loch Leven and a nearby lake in Scotland, Tufted Duck were nocturnal feeders (Laughlin 1974). Similarly, Pedroli (1982), working in Switzerland, recorded mainly nocturnal activity in wintering Tufted Duck, resting being the dominant behaviour during the day. These finding show that the activity rhythms of the two diving duck species can vary between sites, perhaps determined by a number of interacting factors such as food availability, weather conditions, predation pressure and human disturbance.

Much information has been published on the dive times of the two species. In the Pochard, they range from a mean of 13.4 seconds (range 3-24 seconds) in water depths of 0.8-1.2m (Klima 1966) to 20 seconds (maximum 25 seconds) in 0.8-1.4m of water (Hohn 1943). Owen et al (1986) give average dive times for Pochard as 13-16 seconds, with preferred water-depths being only 1.0 metres. At Seaforth, Pochard generally dived in deeper water (ca 4m) and remained under water for longer periods. Tufted Duck at Seaforth also dived for relatively long periods (20-24 seconds), Owen et al (1986) giving averages of 15-20 seconds and Veselovsky (1952) noting that dives are most frequently in the range 14-17 seconds in water depths of 0.8-1.1 metres.

The dives of males of both species were significantly longer that those of females, which is in agreement with Willi (1970) for Pochard and Owen et al (1986) for Tufted Duck. This may result in single-sex groups of feeding birds (eg Willi 1970, Owen et al 1986). In our study, there was some indication that females of both species dived more frequently than males and thus, in this way, may be compensating for their shorter dive times. At Seaforth, Tufted Duck had shorter dive times than those of the Pochard, probably because Tufted Duck favoured shallower regions of the pool. Morphometric data (Cramp and Simmons 1977) show that Pochard are larger than Tufted Duck and that, in both species, the males are appreciably larger that the females. It may therefore be possible that the larger birds have a greater oxygen storage capacity which permits longer dives.

Effects Of Disturbance

The Seaforth site is subject to relatively high levels of shore-based recreation, mainly attributable to dog-walkers and birdwatchers. As the eastern pool is relatively small, recreation around its periphery causes considerable disturbance to wildfowl, the impact depending on the activity and size of the human group involved and the species of bird concerned.

There have been few detailed studies on the impact of recreation on wintering wildfowl but there is increasing evidence to suggest that it can be deleterious (Tuite et al 1984). Burger (1981) established a significant relationship between the absence of birds and the presence of people at Jamaica Bay Refuge, New York. As noted in the present study, rapid movement, such as jogging, caused birds to flush whilst slow-moving birdwatchers were less likely to flush birds. Similarly, Tuite et al (1983) showed that recreation significantly limited the carrying capacity of Llangorse Lake, South Wales for wintering wildfowl. However, the main impact here was water-based rather than shore-based activity. In a detailed study of freshwater sites in England and Wales, Tuite et al (1984) demonstrated that the impact of water-based recreation on wildfowl differs between species. The most susceptible are Teal, Shoveler and Goldeneye, the most tolerant being Pochard, Tufted Duck, Mallard and Mute Swan. However, intensive recreation, even on small waters, rarely keeps the birds away entirely. Our findings at Seaforth are in close agreement with these.

Birdwatching is now the most widespread form of recreation on British inland waters (Tuite et al 1984). The increasing popularity of Seaforth to Birdwatchers reflects the fact. Since this study was completed, the need to control disturbance has been recognised by the site managers who have taken steps to restrict access to the shores of the eastern pool while providing viewing facilities for birdwatchers.

Acknowledgements

We are grateful to the Mersey Docks and Harbour Company and Merseyside Improvements Ltd for kindly allowing access to the site, and to D. Dottie and members of the Liverpool Polytechnic Sub-Aqua Club for assistance in taking depth measurements. Dr. Stephen Baillie and Dr. Robert Prys-Jones kindly read earlier drafts of this paper. Elizabeth Murray drew the figures.

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KIDNEY-SPOT LADYBIRDS IN LANCASHIRE AND ADJOINING COUNTIES 1991-1992

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Summary

The Kidney-spot Ladybird *Chilocorus renipustulatus* was known to be present in only one 10km square in north Lancashire before 1991, when it was found in a number of new locations. During 1992 the species has been found to be much more widely distributed than expected. Some observations of the aggregative behaviour exhibited by this member of the sub-family Chilocorinae are reported.

Introduction

In order to produce a present-day picture of ladybird distribution, Dr. M E N Majerus of the department of Genetics at the University of Cambridge in 1984 introduced the Cambridge Ladybird Survey which enlisted the help of the general public. By limiting the survey to the colourful ladybird members of the Coccinellidae, many children and other non-specialists have been encouraged to participate.

In October 1990, Dr Majerus and two colleagues published an interim report on the progress of the scheme from 1984 to the end of 1989, and included distribution maps based on the 10 km squares of the national grid. People who contribute records to the survey receive copies of a Newsletter in which interesting observations and discoveries are reported and other helpful information can be published. Although a few thousand people have taken part, many of the distribution maps so far published demonstrate that some parts of the country are seriously unrecorded, even some well-populated areas. According to the results of the survey, a great deal of the north-west of England, and especially Lancashire, is a "ladybird desert".

1991 Discovery Of The Kidney-Spot Ladybirds In Lancashire

In October 1991 an adult Kidney-spot Ladybird, *Chilocorus renipustulatus* was found by Dr Jennifer Newton on a fence post at White Moss, Yealand Redmayne, in north Lancashire in the 10 km square SD57. The Cambridge survey distribution map for this species showed that in north-west England up to the end of 1989 the ladybird had only been recorded in SD47 (Arnside/Silverdale) and SD76 (in Yorkshire). The article summarised its status as "scarce in Wales and northern England and absent from Scotland". In southern England, where the ladybird is more widespread, its distribution was seen to be influenced by recorder bias.

Kidney-spot Ladybirds are small and black, with two elongated red spots, one on each wing-case. They are almost circular in outline and domed in profile, in comparison with the majority of common ladybirds which are somewhat oval in outline and have a slightly flattened profile. They have an orange abdomen (visible if turned on their backs), a flanged edge to their wing-cases, tiny antennae and black legs. They might only be confused with the melanic form of the 10-spot Ladybird, *Adalia 10-punctata* (f. *bimaculata*), which is black with two elongated red spots, but is the more usual flattened, oval shape. The spots of the melanic 10-spot however are distinctive in that they extend to the edges of the wing-cases and the ladybird also has brown rather than black legs.

Shortly after the kidney-spot ladybird was found at White Moss near Yealand, a few more adults were discovered in the local nature reserve at Warton Crag, in Gait Barrows National Nature Reserve, Silverdale (both in SD47), and on Hutton Roof Crags (in SD57). These are all well-known limestone areas, noted for the richness of their flora and insect fauna. In each case, the ladybirds were found principally on the trunk but occasionally on the side branches of young ash trees. In the Naturalists' Handbook on Ladybirds by Majerus and Kearns, the preferred habitat is said to be "deciduous woodlands, mainly sallow, poplar, birch and ash". The species is a predator of scale insects (Coccids). The larvae of the three British ladybirds belonging to the sub-family Chilocorinae (Kidney-spot, Heather and Pine Ladybirds) are all reported to exhibit aggregative behaviour before pupating, and Dr. Majerus had suggested that evidence of this would be of particular interest. A small aggregation (or cluster) of about 22 empty pupal cases was found on a branch of an ash tree on Warton Crag when the first adult ladybirds were found there.

No further searches were made in 1991 on the assumption that the ladybirds would be hibernating.

1992 Fieldwork

In April, during a mild spell of weather, a few active adult Kidney-spot Ladybirds were found on ash trees in Gait Barrows NNR, and in Underlaid Wood, near Beetham, a total of 54 ladybirds was counted in a few hours, with a maximum of 11 adults being seen on one tree. In every case, the adults were found on ash (*Fraxinus* sp). At about this time, a single adult was also found on willow (*Salix* sp) by members of a working party in the nature reserve at Heysham Nuclear Power Station. A single adult was also found on an ash tree in Hyning Hall Wood, Warton, belonging to the Woodland Trust. None of these discoveries seemed to indicate widespread distribution of the species.

In early July a search was made for Kidney-spot Ladybirds or larvae on Hutton Roof crags, and modest numbers of larvae were found, all on ash trees. On the way home, out of curiosity, a clump of roadside ash trees was searched. These were found to have quite surprising numbers of larvae and clusters of larvae or pupae, and this changed the whole emphasis of future searches for this ladybird. Instead of visiting special sites, roadside trees could be quickly scanned, using a pair of close-focus binoculars to examine the less accessible parts of the trees. The trick was to find a group of younger trees with smooth unfissured bark, and to scan the trunks for the tiny dusty white scales of their (Coccid) prey or for the adult or larval forms of the ladybird.

The adult, although small and mainly black, has a very shiny surface and domed shape which makes it very visible in sunshine, and the two kidney-shaped red spots are usually clearly visible with the aid of binoculars even when quite high in the tree. Similarly, Kidney-spot larvae are black and have a stubby, very characteristic, "hedgehog" shape, with hairy spikes which are distinctive under the hand lens but with practice can also be recognised at some distance with the help of binoculars. Binoculars also facilitate counts of the numbers of larvae, pupae or emerging adults when clusters are found.

In north Lancashire, the local group of the Lancashire Wildlife Trust operates a tetrad recording scheme (ie. based on 2km squares of the national grid) for plant and animal species, which has been running for a number of years. The Cambridge Ladybird Survey is based on 10 km grid squares. The records made during 1992 were based on tetrads, but once the simplicity of surveying roadside trees was realised, less detailed surveys of more distant areas became possible. It quickly became apparent that this ladybird is widely distributed throughout Lancashire and adjoining parts of Cumbria and Yorkshire. It can almost invariably be found where groups of young ash trees are present. In comparatively rare cases, the ladybird was found on willow, either in addition to ash or in places where ash is rare or absent.

Using the technique of searching roadside trees, the ladybird has now been found in more that 40 10 km squares during 1992. Larvae were present in greatest numbers in July and early August, when very few adults were detected, and as early as 10 July, aggregates of larvae were seen. Clusters can vary in size from just a few (three or more) to in excess of 50, and several clusters may be present on a single tree. Clusters may consist of larvae, pupae and emerging adults. Since many of the host trees were in hedgerows or against stone walls, the numbers recorded must be an underestimate, since most trees could only be viewed from a restricted angle, and leaves also restricted the amount of trunk or branches visible.

Although the numbers of separate adults and larvae, and the number and size of clusters, were recorded, these do not reflect comparative abundance because different amounts of time were given to searching particular areas. Searching trees along busy roads can be a hazardous occupation.

Results - Distribution

Distribution of the species has been recorded in two ways, over a wider area as found in 10km squares and, within a more restricted area, in 2km tetrads. In all the 10km squares visited the tetrads have been noted, although details have not been included in this report. Figures 1 and 2 indicate those squares where the Kidney-spot Ladybird has so far been found. Blank areas on the maps have mostly not been visited or searched. No 10km square visited during the year has failed to contain the ladybird.

In the nine 10km squares of north Lancashire (the area covered by the local Lancashire Wildlife Trust group based in Lancaster) about 40% of all tetrads contained ladybirds of this species. Some of the coastal or built-up areas have few likely host trees and the upland areas of the Forest of Bowland have few roads and (except in sheltered valleys or near farmsteads) few trees. If allowance is made for these problems, probably at least 50% of all the tetrads have suitable habitat and contain the ladybird.

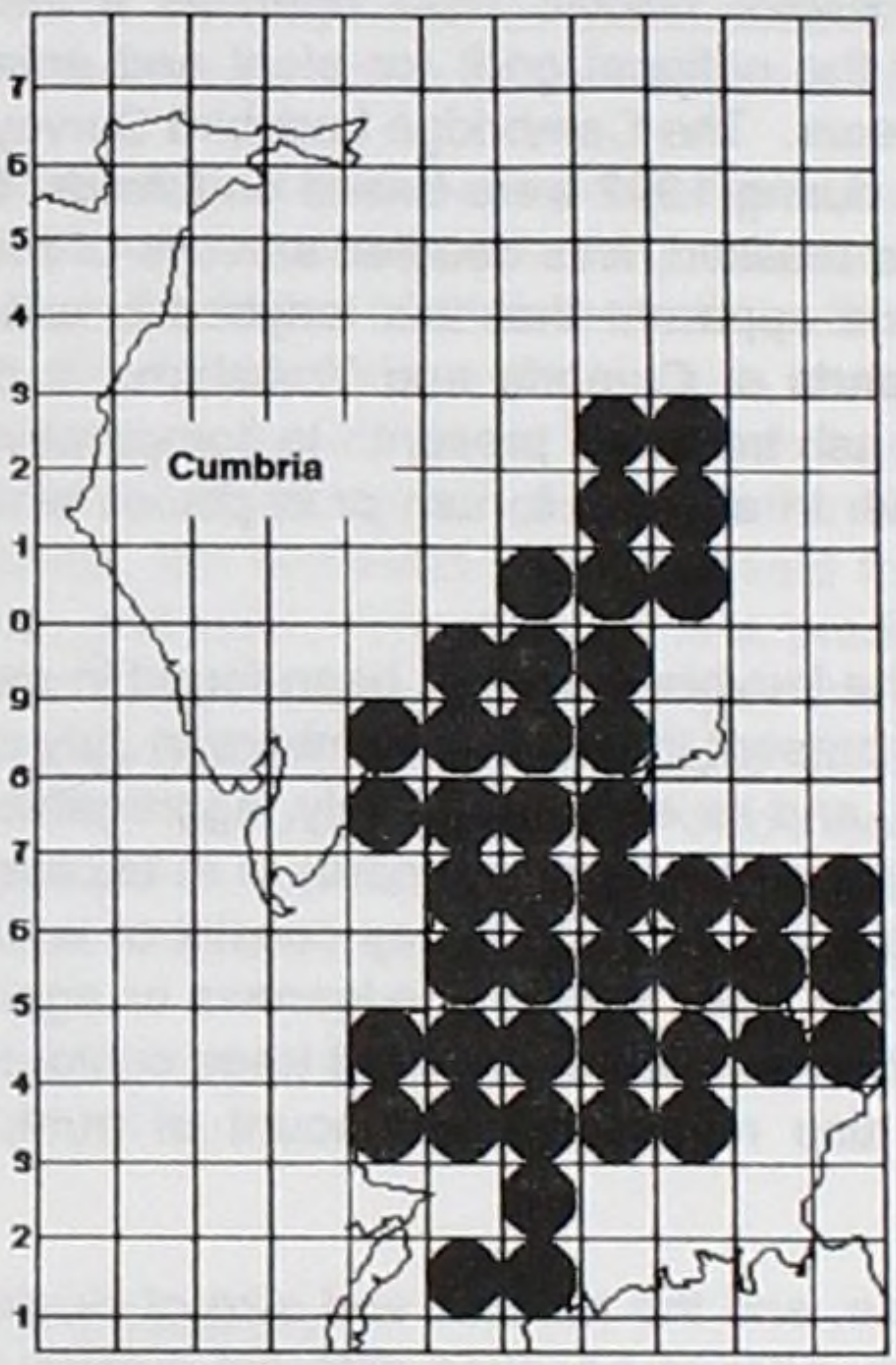

Fig 1 - Distribution of Kidney-spot Ladybird in North-west England (10km squares)

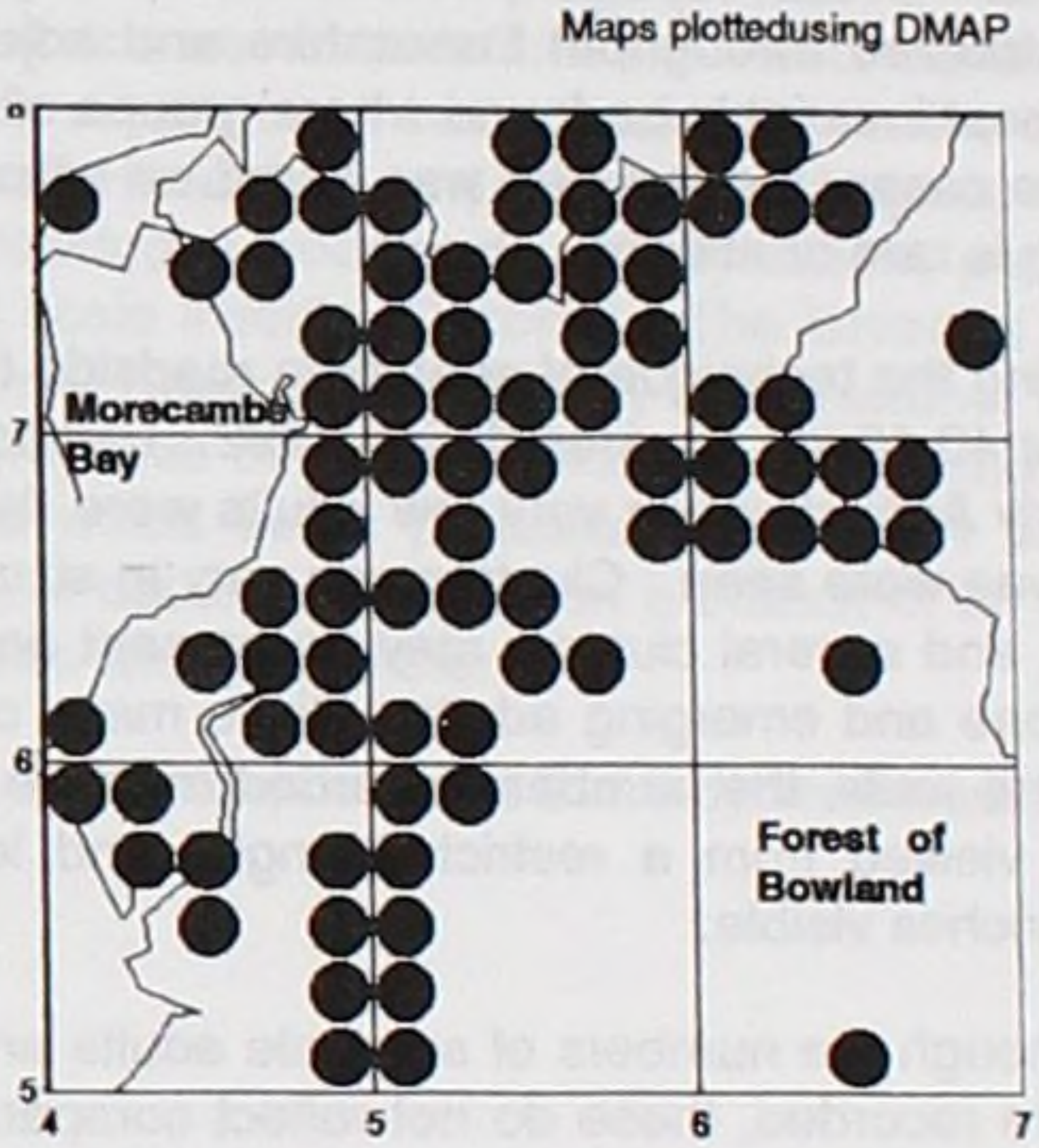

Fig 2 - Distribution of Kidney-spot Ladybird in North-west England (Tetrads)

Aggregations Of Chilocorinae

Table 1 summarises details of all aggregations found in the three months July to September 1992. Using these data, the distribution of cluster size has been calculated.

Size	Number of Clusters	Proportion
3-10	53	50%
11-20	22	21%
21-30	21	20%
31 +	9	9%

Over 100 clusters were found, and approximately half of all the clusters consisted of between three and ten individuals. About two fifths of all the clusters were of between 11 and 30 individuals, and fewer than one tenth had more than about 30. The largest clusters contained 50 or more larvae, pupae or emerging ladybirds, but clusters of more than about 30 were always difficult to count accurately. Most of the trees on which clusters were seen could only be viewed from a restricted angle and may have held more clusters than those recorded. The number of clusters found per tree has also been extracted from the data in Table 1. A total of 58 trees were found to have clusters, although, as already mentioned, it was impossible to be sure that all clusters were detected.

Table 1 - Aggregative behaviour of Kidney-spot Ladybirds, July to September 1992

Key: (/) separates the clounts on different trees : c = about : > = more than
Note: Close-focus binoculars were used to assist in identifying the ladybirds and larvae and to count the numbers of larvae, pupae and emerging adults in each cluster. However, some clusters were counted at a distance, and other cluster sizes are best estimates only.

Date	No. of clusters	Size range	Numbers in each cluster	Total clustered larvae/pupae	No. of trees	10km square
10 July	5	10-30	10,20/20,30,10	90	2	SD57
	3	-	c 20 each	c 60	2	SD57
15 July	1	-	13	13	1	SD47
16 July	1	-	14	14	1	SD56
17 July	7	3-12	5,3,12/6,7,12/8	53	3	SD56
24 July	4	c 20->30		c 100	1	SD46
28 July	2	-	12/12	24	2	SD55
30 July	1	-	8	8	1	SD67
4 Aug	2	4-6	4,6	10	1	SD45
	1	-	15	15	1	SD54
7 Aug	11	20-35	all >20	c 250	1	SD46
13 Aug	2	5-8	5,8	13	1	SD54
	2	6-11	11,6	17	1	SD55
14 Aug	7	4->50	4/7/6,30/>50/50/32	c 180	6	SD58
18 Aug	2	3-4	4,3	7	1	SD45
	6	5-33	5/5,11,22,33/12	88	3	SD44
19 Aug	2	-	7,7	14	1	SD56
21 Aug	1	-	10	10	1	SD56
	3	9-50	10/9,50/13	72	1	SD55
22 Aug	2	11-40	11/40	51	2	SD56
23 Aug	2	5-9	5/9	14	2	SD56
24 Aug	4	8-40	16,8,40/12	76	2	SD46
25 Aug	3	4-20	7,20/4	31	2	SD68
27 Aug	3	7-41	7/10,41	58	2	SD46
1 Sept	3	6-10	10,6/9	25	2	SD58
4 Sept	4	3-10	7,10/5/3	25	3	SD57
5 Sept	1	-	3	3	1	SD46
9 Sept	1	-	6	6	1	SD47
16 Sept	3	6-9	6,6/9	21	2	SD75
	1	-	9	9	1	SD74
	1	-	5	5	1	SD85
	2	3-7	3/7	10	2	SD96
27 Sept	5	4-32	16,8,32,4,4	64	1	SD56
28 Sept	4	7-29	22,29,24,7	82	1	SD66
29 Sept	2	6-12	6,12	18	1	NY60
	1	-	5	5	1	NY61
	105	3-c 50	-	>1541	58	

1 cluster was found on 34 trees

2 clusters were found on 14 trees

3 clusters were found on 5 trees

4 clusters were found on 3 trees

5 clusters were found on 1 tree

11 (or more) clusters were found on 1 tree

Some of the trees on which several clusters were seen were relatively small and therefore more easily searched. In one case, a scattered group of trees in a country school playing field had four clusters on one tree and a single cluster on another. The larger and more leafy trees were much more difficult to examine other than cursorily. The tree with 11 (or more) clusters was a large but spindly tree in a fairly open area (probably due to wind-blow) in a mixed deciduous wood.

Conclusions

A single year's study has shown that the Kidney-spot Ladybird is present over a wide area of north-western England, and there is every reason to expect that further searches will extend its known distribution in northern counties. Since the species can now be found with relative ease, more detailed studies of its aggregative behaviour should be possible.

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THE DISTRIBUTION & CONSERVATION OF THE PONDS OF NORTH-WEST ENGLAND

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Introduction

This study examined the distribution of ponds in North-west England to provide a regional framework for floral, faunal and landscape studies sufficient to enable the targeting of wildlife recording, conservation strategies and planning measures.

The study area consisted of four administrative counties in North-west England: Lancashire, Cheshire, Merseyside and Greater Manchester. To permit regional interpretation, adjacent parts of Clwyd, Shropshire, Staffordshire, Derbyshire, Yorkshire and south Cumbria were also examined (Figures 1 & 2), but are excluded from the present account.

The botanical importance of the farmland ponds of North-west England has been demonstrated by Day et al (1982) in the Wirral (Cheshire) and Fylde (Lancashire), and confirmed by Brian et al (1987) in a detailed study of 153 farmland ponds in Christleton Parish, 3km east of Chester, and by Gemmell (1987) in a study of over 50 farmland ponds threatened by British Coal's proposed Lomax Opencast Coal Site on the borders of Salford, Wigan and Bolton in Greater Manchester. However, in parts of north Cheshire (Edmondson 1967), central Cheshire (Willis & Young 1983) and east Merseyside (Lowther 1984) farmland ponds yield low mean numbers of aquatic plant species, due to intensive agriculture. Despite this, these ponds remain an important wildlife resource in an ecologically damaged landscape and contribute significantly visually to an otherwise bland landscape. In less intensively farmed lowland areas, the farmland ponds of North-west England seem to exhibit a consistently greater botanical diversity than ponds in other lowland regions of England (Day et al 1982).

The invertebrate importance of the farmland ponds of North-west England has not been systematically evaluated on either a regional or sub-regional basis. A sample study of farmland ponds at Lomax in Greater Manchester conducted by Jonathan Guest (MS) on behalf of English Nature showed the ponds to have a considerable diversity of freshwater invertebrates, equalling and perhaps exceeding that of the canal system of the Manchester area, confirmed by a study of Dragonflies and Damselflies at Lomax by Philip Birley (MS). Similarly, recent work in Cheshire by Gabb and Kitching (1992) proves that some groups of farmland ponds are a major resource for Dragonflies and Damselflies, and studies in Greater Manchester and the Wirral (McMillan 1959) demonstrate their value as a molluscan resource. The discovery of a species of freshwater nemertine worm new to science (*Prostoma jenningsi*) in a pond at Croston in South Lancashire (Gibson 1982,1991), and of the nationally rare bryozoan *Lophophus crystallinus* in a pond in the Bolton district (Grayson MS) indicate that the invertebrate fauna of the farmland ponds of North-west England merit closer examination.

The natural and artificial ponds in the non-farmland landscape of the Sefton coast of Merseyside have been shown to be a major resource for dragonflies and damselflies (Hall & Smith 1991).

The amphibian importance of the farmland ponds of North-west England has been established in the Wirral in surveys submitted to English Nature by John Dawes (MS), in Greater Manchester (Grayson, Mullaney & Parker 1991) and parts of Lancashire (Mullaney MS). However, where agriculture is intensive, or where livestock have been withdrawn from fields allowing tree growth to shade out ponds, then the amphibian interest is much reduced. In addition, the natural and artificial ponds in the non-farmland landscape of the Sefton coast are of major importance for amphibians, including large populations of both Natterjack Toad and Great Crested Newt.

The farmland ponds and their margins of North-west England are also important for lower plants, reptiles (particularly Grass Snake), small mammals and birds (including Heron and Barn Owl) but these have not been systematically studied.

The value of ponds in the lowland landscape is being increasingly appreciated in the planning process and it is hoped that this study will help target efforts to conserve the most important pondscape before it is too late. The current rate of pond loss in Lancashire (Mullaney 1990), Cheshire (Hull et al 1992), Merseyside (Lowther 1984) and Greater Manchester (Bentley 1990, 1992) is alarming.

Method

A standard method was devised for plotting the frequency of small waterbodies across a region too large for ground verification. The 1:25 000 Ordnance Survey Pathfinder maps were used, as they depict water bodies in blue, assisting speed and accuracy. It is accepted that these maps are a complex hybrid of surveying at different dates, and so the present study cannot be regarded as being either an up-to-date pond census or a snapshot of a particular date. Instead it is a mosaic of largely post-war mapping effort, with further variation introduced by the whim of each surveyor, the presence and disappearance of many ponds in wet/dry intervals and the difficulty in deciding between a swamp and a pond.

The following arbitrary rules were adopted for consistency and to enable checking:

a) National Grid one kilometre squares are the unit for plotting pond frequency. A pond straddling two or more squares is assigned solely to the square which contains most of its surface area.

b) Streams and rivers are excluded. However, cut-off meanders are counted, together with isolated backwaters.

c) Ditches and canals are excluded.

d) Ponds known to exist but not shown on 1:25,000 OS Pathfinder maps are excluded to avoid local bias. Under-mapping of known ponds is a problem in uplands and subsidence areas.

e) Ponds shown on 1:25 000 OS Pathfinder maps are included. This rule is adhered to even when ponds are known to have been lost, to eliminate bias.

f) Dew ponds are excluded. They are a significant in the Peak District, particularly for amphibians. A separate study of them is warranted.

g) Springs are excluded. Unless a pond is mapped with the spring.

h) Covered reservoirs are excluded.

i) No limit exists on pond size: Some extensive open waters are shallow enough to be pond-like, while some small ponds are deep enough to be lacustrine. All subsidence flashes, meres, mill lodges and reservoirs are included, but, because a large water body scores one reading, the same as for a tiny pond, the regional pattern is rarely affected.

j) Moats, swimming pools, ornamental ponds, wildfowl ponds etc. are included.

k) Mean High Water is the limit of mapping. Coastal saline pools are therefore often included, but so too are brackish pools of the Cheshire Saltfield. Salt spray has been invoked by Day et al (1982 p.182) to account for characteristic coastal plants, notably *Ranunculus baudotii* and *Zannichellia palustris*, in ponds of the Rossall peninsula of the Fylde.

Interpretation was then undertaken by a combination of fieldwork and desk study, using a combination of published and unpublished sources, as well as personal fieldwork, in the fields of geology, geomorphology, soils, agriculture, industrial archaeology, local history, higher plants, freshwater invertebrates and amphibians.

Terminology

To describe the pond distribution, a terminology was evolved as follows:

POND SUPERCLUSTER: a large tract of land, typically hundreds of kilometres in extent, which is very rich in mapped ponds. A workable definition is to include only those one kilometre squares with six or more mapped ponds each.

POND CLUSTER: a relatively small tract of land, usually in the range of one to 100 square kilometres, appreciably richer in mapped ponds than surrounding areas. No lower limit of pond density or numbers is applied. In everyday speech, a cluster can be as few as three ponds.

PONDWAY: a corridor of land relatively rich in ponds in comparison with adjacent areas. A pondway has six or more mapped ponds per one kilometre square, and may be an elongate pond supercluster, a linear extension of a pond supercluster or else be an essentially isolated entity.

CORE AREA: a tract of land with a density of 15 or more mapped ponds per one kilometre square. A pondway, pond supercluster or a pond cluster may have one or more core areas, or none at all.

PONDSCAPE: a landscape with six or more mapped ponds per one kilometre square, and therefore capable of being visually materially affected by the presence of either ponds or attendant features such as swamp vegetation and clumps of trees.

CORE PONDSCAPE: a landscape with a density of 15 or more mapped ponds per one kilometre square, and therefore capable of being visually dominated by the presence of either ponds or attendant features.

Results

Number of Ponds

The ponds of the region are shown to be a major ecological resource, but finite. 56 423 ponds have been mapped, the number is now disturbingly fewer in Lancashire (Mullaney MS) and across Cheshire (Hull et al 1992). North-west England, and Cheshire in particular, is confirmed as having the greatest number of farmland ponds of any region in England.

Estimating the number of ponds in a region is shown to be hazardous due to the ponds being tightly packed into superclusters, pondways and isolated clusters which cannot be predicted by statistical sampling of limited areas. The ponds have a highly organised non-random distribution. Notable examples are in Rackham (1986) who completely missed the Fylde Supercluster in his national survey; Probert (1989 p.12) who suggested 110 000 ponds, and Cheshire County Council (Anon 1991) 84 500, for Cheshire - estimates which are several times greater than the number of ponds shown on Pathfinder maps. The reader is referred to the rigorous map-led analysis by Hull et al (1992) of the ponds of Cheshire, which is confirmed and amplified by the present study.

Distribution Of Ponds

Figure 1 presents the pond density totalled for each of 129 10 kilometre National Grid squares, and can be used as a rapid means of comparison with distribution maps of pond-loving animal and plant species mapped nationally upon 10 kilometre squares, such as pond snails (Kerney 1976). However, this is too coarse a mapping scale to reveal other than the general presence of the strongest pond superclusters and pondways.

Figure 2 reveals the presence and shape of pondways, pond superclusters and strong isolated pond clusters, by plotting information on one kilometre squares. Squares with no mapped ponds are left blank; with one to five mapped ponds are shown by a simple dot; and with six or more mapped ponds as solid black squares. Low values are associated with the major conurbations of Liverpool and Manchester, the lowland peat mosses west of Manchester (such as Chat Moss), and the uplands of both the Pennine Chain and North Wales. Less expected are the very low values for the environs of the Ribble Valley and Chipping Valley in Lancashire, presumably due to the prevalence of outcrops of shaley limestone and the presence of limey Ribblesdale Boulder Clay ('Till'), so removing the necessity of digging marl pits. The general lack of ponds in the only lowland route across the Pennines renders the pond-starved Pennines a formidable barrier to plant and animal coast-to-coast migration. The role of the trans-Pennine canals (Leeds-Liverpool, Rochdale, Huddersfield Narrow etc.) is therefore crucial.

Density Of Ponds

The present study demonstrates that the density of ponds per 10 kilometre square mapped on Ordnance Survey Pathfinder maps in parts of North-west England attain the highest known value in the agricultural landscape of England and Wales, as shown in Figure 1 and Table 1. This conclusion is tentative, being based on combining the present comprehensive regional study with the generalized national study of Rackham (1986). Rackham's study used 1:25 000 OS maps published in the 1920s since when pond frequency has declined substantially, and so Table 1 also includes some similar data for North-west England for comparison. Figure 1 and Table 1 establish the premier national position of North-west England in terms of pond numbers, both on the 1920s 1:25 000 and the post-1:25 000 Pathfinder maps, amplifying the results of Hull et al (1992) in their detailed study of Cheshire farmland ponds.

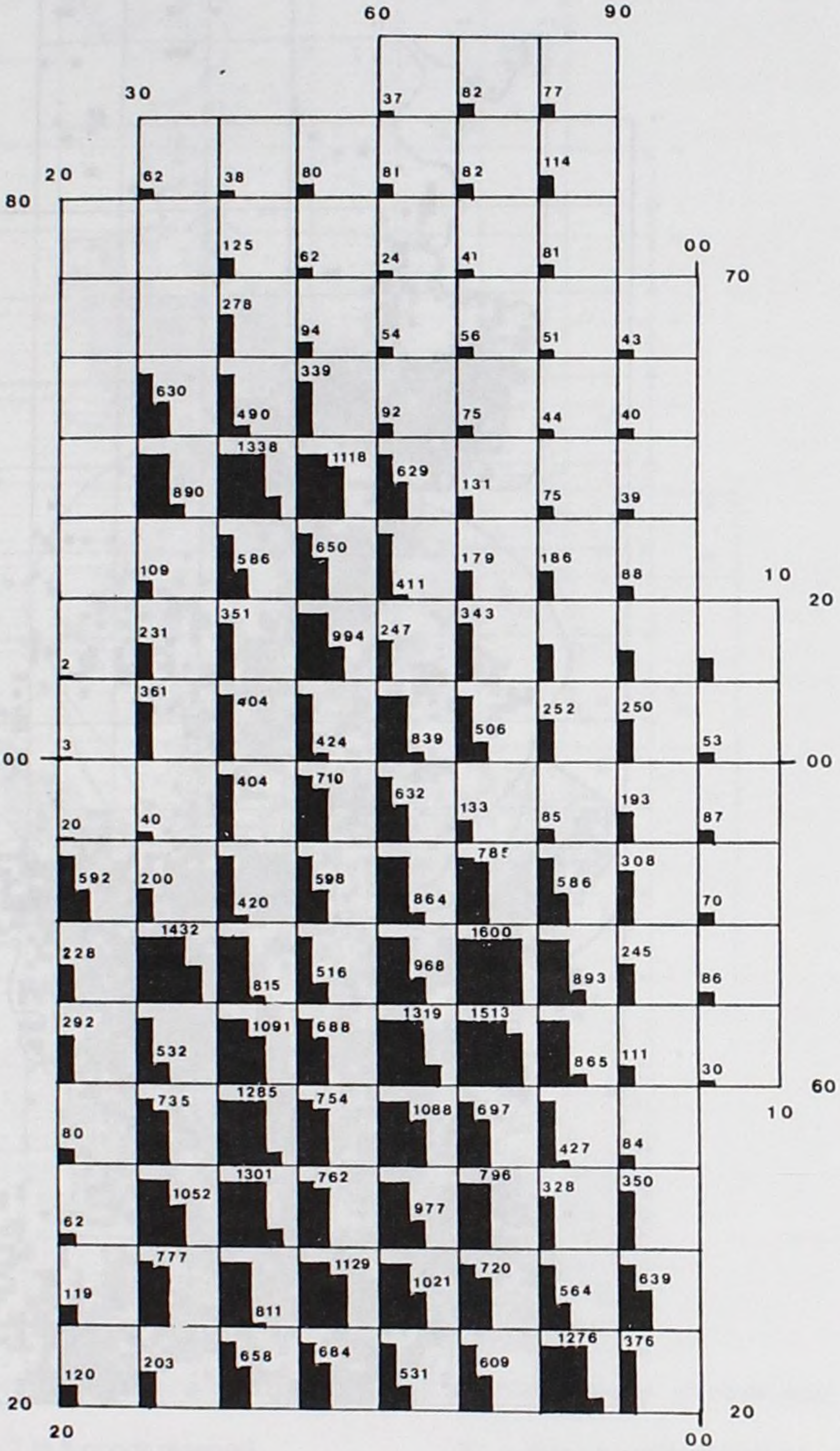

Fig.1 - Ponds per 10km squares shown on 1:25 000 Pathfinder maps of North-west England.

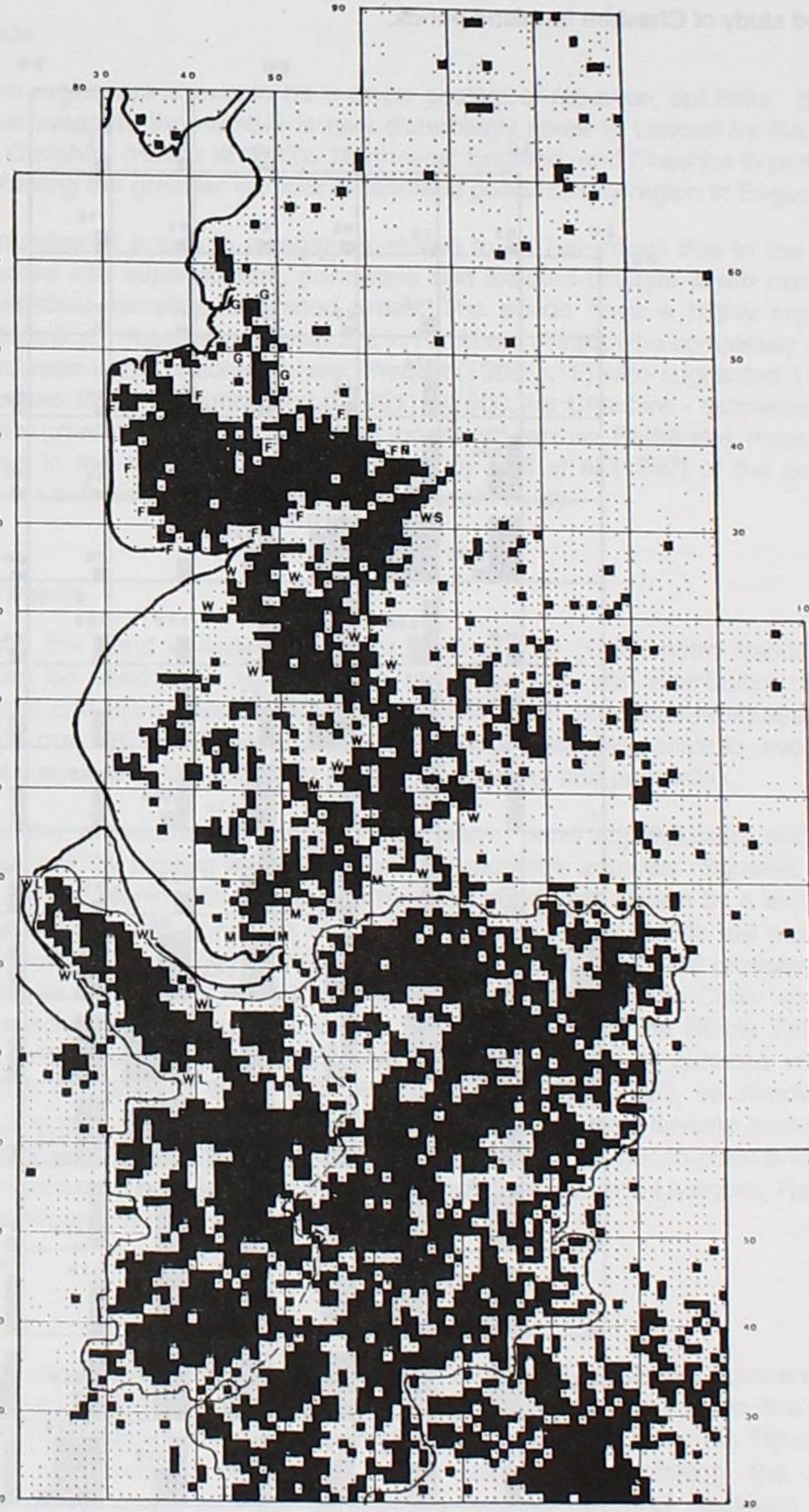

Fig.2 - Pondways, Superclusters & Isolated Pond Clusters shown on 1:25 000 Pathfinder maps. • = 1 to 5 ponds mapped. ■ = 6 or more ponds mapped.

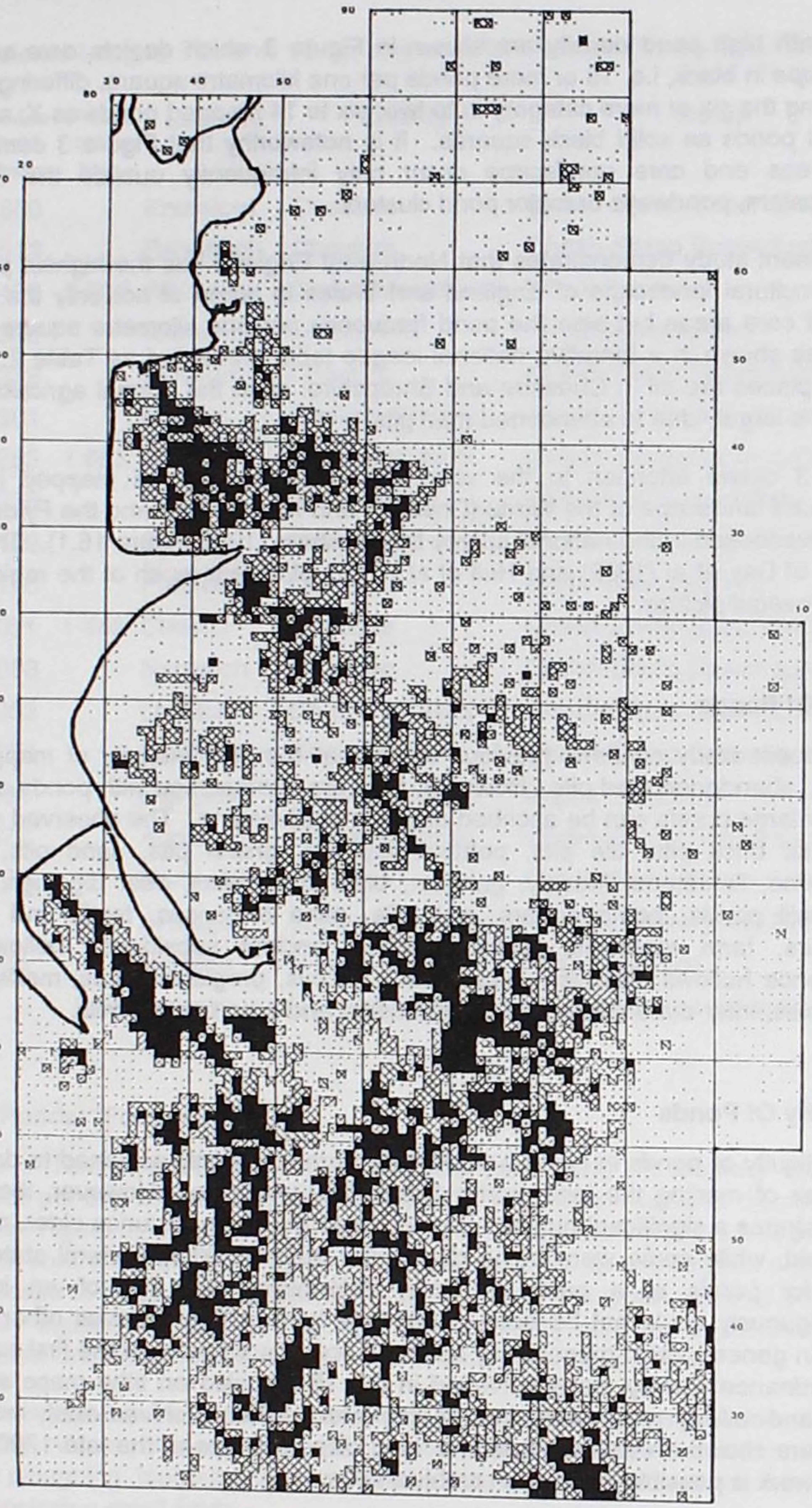

Fig.3 - Ponds per 1km squares shown on 1:25 000 Pathfinder maps of North-west England.

- • = 1 to 5 ponds mapped.
- ⊠ = 6 to 14 ponds mapped.
- ■ = 14+ ponds mapped, termed 'core areas' = 'core pondscape'.

Areas with high pond density are shown in Figure 3 which depicts *core areas* and *core pondscape* in black, i.e. 15 or more ponds per one kilometre square, differing from Figure 2 in splitting the six or more category in to two: six to 14 mapped ponds as X; and 15 or more mapped ponds as solid black squares. It is noteworthy that Figure 3 demonstrates that core areas and core pondscape occur only infrequently outside the limits of pond superclusters, pondways or major pond clusters.

The present study demonstrates that North-west England has the highest pond density in the agricultural landscape of England and Wales in terms of not only the abundance of mapped core areas but also the pond frequency per one kilometre square on Pathfinder maps, as shown in a tentative national league table presented as Table 2. The top nine league places are all in Cheshire and Shropshire, all in the normal agricultural landscape and to be largely due to abandoned marl pits.

Figure 3 draws attention to the very high pond frequencies mapped in the general agricultural landscape of the Wirral (Cheshire and Merseyside) and the Fylde (Lancashire), areas overlooked in the national survey by Rackham (1986 Figure 16.1). The authoritative studies of Day et al (1982) and Hull et al (1992) elucidate much of the regional jigsaw but not the overall picture.

Origin Of Ponds

The present study confirms previous views that the vast majority of mapped ponds are flooded, abandoned marl pits. However, they are interspersed with ponds of diverse origin and few large ponds can be ascribed solely to marl digging. The observed range includes: marl pits, brick pits, tile pits, pottery clay pits, gravel pits, sand pits, rock quarries (sandstone, limestone, fireclay, ganister, brick shale etc.), peat diggings, spoil hollows, water mill ponds, bomb craters, saw pits, mine entrances, textile mill lodges, public reservoirs, farm reservoirs, angling ponds, ancient subsidence hollows, man-made subsidence hollows (flashes), moats, duck decoys, proglacial lakes, meltwater channels, kettleholes, inter-dune slacks, cut-off meanders and ornamental pools.

Antiquity Of Ponds

The antiquity of ponds in North-west England are commonly assumed to date mainly from the peak of marling the land, some 150 to 200 years ago. However, the present study demonstrates a significant number of marl pits to be many centuries older, many being 600 years old, while some were being dug in the 1890s. While general statements can be made for ponds of a particular area, determining the age of an individual pond unambiguously could not be done confidently from written archives other than surveyed maps. In general, most present-day farmland ponds are found on the first six inches to one mile Ordnance Survey maps surveyed in the 1840s; also on tithe maps surveyed a little earlier and railway route plans from a little later. When archives exist, most present-day ponds are shown on estate maps and 'land dispute' maps of the late 1700s. Much useful further work is possible using such archival sources.

Table 1: Provisional League Table of 10 km Squares for Ponds on 1:25 000 Pathfinder Maps

UK Rank	10 km Square	Ponds Path-Finder	Ponds 1920s Map	Locality	County	Notes
1st	SJ77	1 600		Knutsford	Cheshire	Chesh-Shrop Supercluster
2nd	SJ76	1 513		Sandbach	Cheshire	Chesh-Shrop Supercluster
3rd	SJ37	1 432	2 227	Willaston	Chesh/Merseyside	Wirral Pondway
4th	SD43	1 338		Kirkham	Lancashire	Fylde Supercluster
5th	SJ66	1 319		Winsford	Cheshire	Chesh-Shrop Supercluster
6th	SJ44	1 301		Malpas	Cheshire/Clwyd	Chesh-Shrop Supercluster
7th	SJ45	1 285	1 653	Aldford	Cheshire/Clwyd	Chesh-Shrop Supercluster
8th	SJ82	1 276		Eccleshall	Staffordshire	un-named Supercluster
9th	SJ53	1 129		Prees	Shropshire	Chesh-Shrop Supercluster
10th	SD53	1 118		Preston	Lancashire	Fylde Supercluster
11th	SJ46	1 091	1 445	Chester	Cheshire	Chesh-Shrop Supercluster
12th	SJ65	1 088		Nantwich	Cheshire	Chesh-Shrop Supercluster
13th	SJ34	1 052		Overton	Cheshire/Clwyd	Chesh-Shrop Supercluster
14th	SJ63	1 021		MktDrayton	Shropshire	Chesh-Shrop Supercluster
15th	SD51	994		Standish	Lancs/Gtr M/C	Wigan Pondway
16th	SJ64	977		Audlem	Cheshire/Shrop	Chesh-Shrop Supercluster
17th	SJ67	968		Northwich	Cheshire	Chesh-Shrop Supercluster
			450	average	England & Wales	Ancient Countryside:Rackham
		435		average	N-West England	All Countryside
			223	average	England & Wales	Planned Countryside:Rackham

Landscape Of Ponds: 'Pondscape'

The pondscape of North-west England is widespread and, using an arbitrary qualifying value of six ponds per one kilometre square on 1:25 000 Pathfinder maps, its distribution is shown in black on Figure 2. This does not preclude the occasional importance of ponds at lower densities in controlling the landscape, particularly if the ponds are large or prominent. The *core pondscape* of North-west England, using an arbitrary mapped value of 15 ponds per one kilometre square, is shown on Figure 3, and is mostly confined to pondways and pond superclusters, only occasionally being found in isolated pond clusters.

High-quality pondscape occurs when the ponds are numerous and in association with high botanical diversity, visually important clumps of scrub and trees, permanent pasture or set-back arable ploughing, footpaths and bridlepaths, and a network of species-rich hedges or stone walls enclosing small fields.

Table 2: Provisional League Table of 1km Squares for Ponds on Pathfinder Maps

UK Rank	1 km Square	Ponds: Path-Finder	Ponds: 1920S Map	Locality	County	Notes
1st	SJ3275	47	52	Heath Farm	Cheshire	Wirral Pondway
"	SJ3474	47	75	Daisy Bank Farm	Cheshire	Wirral Pondway
3rd	SJ3374	46	52	Manor House Farm	Cheshire	Wirral Pondway
4th	SJ3376	45	41	Leaswood Farm	Cheshire	Wirral Pondway
"	SJ7664	45		Fox Covert	Cheshire	Chesh-Sh Supercluster
6th	SJ6461	44		Paradise Farm	Cheshire	Chesh-Sh Supercluster
"	SJ7273	44		Back Lanes Farm	Cheshire	Chesh-Sh Supercluster
8th	SJ3940	40		Bryn Aber	Shropshire	Chesh-Sh Supercluster
"	SJ3378	40	44	Willaston(north)	Chesh/Mrsysde	Wirral Pondway
10th	SJ6977	39		Pickmere	Cheshire	Chesh-Sh Supercluster
"	SJ7971	39		Jodrell Bank	Cheshire	Chesh-Sh Supercluster
"	SJ8621	39		Brazenhill	Staffordshire	un-named supercluster
13th	SJ4073	38		Hearn Cottage	Cheshire	Wirral Pondway
"	SD5435	38		Pudding Pie Nook	Lancashire	Fylde Supercluster
15th	SD7665	36		Pewit Covert	Cheshire	Chesh-Sh Supercluster
"	SJ7564	36		Whitening House	Cheshire	Chesh-Sh Supercluster
"	SJ7068	36		Yatehouse Green	Cheshire	Chesh-Sh Supercluster
"	SJ7168	36		Dog&Patridge Fm	Cheshire	Chesh-Sh Supercluster
19th	SJ6976	35		Higher Wincham	Cheshire	Chesh-Sh Supercluster
"	SD5436	35		Meadowcroft	Lancashire	Fylde Supercluster
"	SJ5032	35		Paddolgreen	Shropshire	Chesh-Sh Supercluster
"	SJ5033	35		Goblin's Lane	Shropshire	Chesh-Sh Supercluster
			39	Fritton Green	Norfolk	cited by Rackham 1986

High-quality pondscape in North-west England can be of several origins, notably:

Pondscape of 'medieval landscape', which can be quite variable:

a) Classic *'ancient landscape'* in the sense of Rackham (1986), typified by sunken country lanes, dog-legged country lanes, a complex pattern of paths, scattered farm buildings, sinuous field boundaries and small irregular fields. Marl pit ponds tend to be oval. Overall, there should be some signs of piecemeal medieval enclosure of cleared scrub and woodland. This landscape is most obvious when created by clearance of scrub and woodland in rolling landscape, resulting in a patchwork of irregular fields.

b) *Orthogonal medieval enclosure*, where medieval enclosure was of flat or gently cambered tracts of previously unenclosed unploughed tree-sparse mosslands and lowland moors, encouraging the setting out of box-shaped fields.

c) *Medieval re-enclosure of common arable fields*, typified by medieval strips (ridge and furrow). It should be noted that ridge and furrow may indicate a cycle of early medieval removal of original small fields to create large arable fields, but these were usually broken up later into smaller crudely orthogonal fields again by mutual agreement long before the Enclosure Acts.

d) *Medieval parkland re-organisation*, typified by amalgamation of medieval fields and the setting out of rides, plantations and pools, often with more than one cycle of landscaping, and often reverting to normal farming with subdivision into new fields.

Good examples of surviving pondscape in medieval landscape exist in the Wigan Pondway, notably north of Shevington Moor (SD5511) and Coppull (SD5713).

Pondscape of 'planned legislative landscape ', typified by fairly straight, country lanes, a simple pattern of paths, farms clustered into discrete villages, straight field boundaries and orthogonally-shaped fields. Marl pit ponds tend to be orthogonal and parallel to field boundaries. Overall, there should be some signs of large-scale planning and an 'Enclosure Act' should exist. Some areas may be upon previously uncultivated land (coastal marshes and lowland mosses and moors), and therefore be a highly regular landscape. However, many examples are re-organised medieval landscapes, and therefore readily incorporate medieval strips, segments of ancient hedgerows and walls, ancient woodland and numbers of ancient marl-pits. Good surviving examples are widespread in the Cheshire-Shropshire Supercluster.

Low-quality degraded pondscape occurs when the ponds are low in number, botanically poor, closely ploughed, devoid of operational paths, and with large intensely cultivated fields. This applies to much of the interior of the Cheshire-Shropshire Supercluster, Fylde Supercluster and North Mersey Pondway.

Garstang Pondway (Lancashire) - 'G' On Figure 2

Although rarely more than 2.5 kilometres wide, the Garstang Pondway persists for 12 kilometres from the Fylde Supercluster northwards towards the River Lune, and constitutes a strategic portion of the west coast's north-south ribbon of ponds. The Garstang Pondway consists mainly of flooded, abandoned marl pits dug into the boulder clay (= till) which borders the Pennine foothills.

Fylde Supercluster (Lancashire) - 'F' On Figure 2

This major discrete pond supercluster is located between the Fylde coast of Lancashire and the foothills of the Pennine chain (see Figure 2 and Figure 3), and tapers eastwards where it is termed the North Ribble Pondway (see below). Pond frequencies are consistently high and internal breaks are limited and weak. The geographical integrity of the Fylde Supercluster remains intact even if the perimeter definition is lowered to six ponds per one kilometre square or raised to ten ponds per one kilometre square, indicating a steep fall-off of pond frequency at its margins. For example, if a perimeter threshold of eight ponds per one kilometre square is used, then the Fylde Supercluster encompasses

311 one kilometre squares with a total of 4436 mapped ponds, an average of 14.26 ponds per square kilometre, and a peak of 38 mapped ponds in SD5435.

Pond losses in the Fylde Supercluster have been examined by Lancashire County Council Planning Department and shown to be substantial since being mapped on Pathfinder maps. In particular, areas with high pond density have suffered higher percentage losses than areas with few ponds, causing core areas and core pondscape to be substantially degraded (Mullaney 1990).

Most of the farmland ponds in the Fylde area are interpreted by Hall and Folland (1970) and Day et al (1982) as flooded abandoned marl pits dug for the discontinued agricultural practice of improving the land by marling. Probably for this reason, the present study demonstrates a very close geographical fit between the Fylde Supercluster and the soil types which would benefit most from marling from marl pits: the Salop Association and the Salwick/Flint Association described by Hall and Folland (1970) and depicted on the 1:250 000 map of the Soil Survey of England and Wales. These associations are clayey till soils prone to leaching of calcium carbonate and other easily mobilized minerals which become concentrated in the subsoil. Marling excavated the subsoil and so corrected the mineral imbalance, and cured acidity. Most of the Fylde ponds may therefore be 150 to 200 years old, dating from the peak of marling practise in England (Hall & Folland 1970 p.90), and marl pits were still being dug in the Fylde district, on a reduced scale, as late as 1850-1 (Caird 1852 p.281). However, some of the ponds of the Fylde Supercluster may be considerably older, marling having been a routine medieval practice in progressively enclosed areas of ancient countryside in the sense of Rackham (1986 p.4).

Some farmland ponds of the Fylde Supercluster may be ancient flax and hemp pits, either dug for retting or, more likely, flooded marl pits used for this purpose. In 1503 Lytham Priory was receiving tithes paid in flax and hemp and again in 1535 at Poulton le Fylde (Fishwick 1885) and St Michael's-on-Wyre (Fishwick 1891).

The rounded form of many of the Fylde farmland ponds makes them difficult to distinguish from late-glacial kettleholes and Longworth (1985) regards kettleholes as being locally present in the Fylde as established by pollen analysis. A few of the farmland ponds may therefore be more than 14 000 years old, surrounded by much younger marl pits.

A few of the larger ponds in a cluster just outside the Fylde Supercluster in the vicinity of Preesall are attributable to recent ground subsidence due to flooding of old salt mines and active brine pumping, creating salt subsidence flashes in the same manner as the flashes of the Cheshire Saltfield.

North Ribble Pondway (Lancashire) - 'Fn' On Figure 2

Nine kilometres in length and 2.5 kilometres wide, this pondway is a narrow easterly extension of the Fylde Supercluster along the northern rim of the alluvial tract of the River Ribble. Eastwards the pondway fades with the failure of the till sheet of the Northern Drift against the more limey boulder clays of the Ribblesdale Drift.

South Ribble Pondway (Lancashire) - 'Wn' On Figure 2

25 kilometres in length and five kilometres or less in width, this pondway persists in boulder clay on the south side of the alluvial tract of the River Ribble, but fades rapidly north-eastwards in the vicinity of Brockhall Hospital (SD700365) coincident with the failure

of the Northern Drift against the Ribblesdale Drift. To the west, the South Ribble Pondway links with, and continues as, the Wigan Pondway.

Wigan Pondway (Lancashire, Greater Manchester & Cheshire) - 'W' On Figure 2

The Wigan Pondway is more than 50 kilometres long and locally more than 10 kilometres wide, with a maximum pond frequency mapped as 28 per one kilometre square. It begins its sinuous course near the Ribble estuary near Croston (SD4919), trending SE near Euxton where it merges with elements of the South Ribble Pondway, and thence south via Heskin, Coppull Moor, Shevington Moor, Haigh and Aspull Moor to Westhoughton (SD6506) where it splits into an eastern and western branch. For most of its length the Wigan Pondway shows a near-perfect fit with the distribution of the heavy clay soils of the Salop Association, a heavy soil prone to leaching and waterlogging. However, the eastern branch correlates with the Brickfield 3 Association which is regionally unimportant for marl pits. This anomaly requires investigation but is tentatively ascribed to the Brickfield 3 Association elsewhere being either too close to the Pennine foothills for lowland agriculture or, more probably, the prevalence elsewhere of limestone erratic boulders enough to either buffer the soil sufficient to dispense with marling (as in the Ribble Valley) or sufficient for such boulders to be dug out of valleys and burnt for lime (as at Anglezarke).

The origin of the ponds of the Wigan Pondway is predominantly flooded abandoned marl pits. The pondway is strengthened by flooded abandoned brickworks and sandpits, and by the reversal of drainage from mining subsidence and the impeding of drainage by spoil causing local topping up marl pit ponds (such as north of Shevington Moor) and creating large flooded areas, notably the Wigan Flashes. The Wigan Flashes are described by Mullaney (1990). The antiquity of the marl pits may be very variable, for Porteus (1933 p.25) noted archival sources indicating some marl pits to exist in 1342 and the clay soils of the Wigan Pondway facilitated a significant concentration of medieval moated farmhouses.

Some flooded marl pits in the Wigan Pondway have been used for retting hemp and flax in medieval times, on conclusive archival evidence:

"That no person shall steape or rett any hemp or flax in any pit or ditch within the township (Hesketh) without license of the owner or maker thereof, nor in any place adjoining the highway upon pain of forfeiting every time 3/4."

Manor Court Roll for Tarleton and Hesketh-with-Becconsall (1577AD)

"No person shall steape or rett any hemp or flax in any pitt or ditch within 10 roods next to any man's dwelling house upon pain to forfeit every time 2/6."

Manor Court Roll for Tarleton and Hesketh-with-Becconsall (1577AD)

"Elizabeth Isabel widow of Robery Corlus of Penwortham who placed hemp and flax in a pit on the common pasture of Penwortham against the order of the court 12d."

Penwortham Manor Court Estreats (1592 AD)

Scattered archival sources show that the scale of the medieval flax and hemp industry was considerable (Williams 1944), with tithes and tenths often paid to the Church in flax and hemp, as in Wigan in the 1600s (Bridgeman 1888), the township of Croston in 1649-1655 (Commonwealth Church Survey) and as late as 1755 many farms in the Standish area had a yarn croft where flax was grown (Porteus 1927 p.153). The nuisance caused by retting continued for at least a century, eliminating all higher plants and animals from the ponds concerned:

"Upon the oath of William Cunliffe we the jury do present four persons for steeping flax in or upon the waste or common in Penworthham."

Fine of 6d recorded in Penwortham Manor Court Book (23 October 1706)

The northern half of the Wigan Pondway shows a crude westerly decline in botanical and amphibian interest due to the increasingly degraded pondscape of the intensive farming to the west. The easterly portion appears to be botanically rich, and includes major amphibian sites at Cuerden Farm (Leyland), and around Standish, Shevington Moor and Haigh. The amphibian abundance as prey food may account for the occasional sightings of Grass Snake *Natrix natrix* north of Wigan and may help sustain the Heron Colony at Gathurst. Freshwater invertebrates are understudied, but include not only regionally rare bryozoan *Plumatella fungosa* in a pond at Ellerbeck West (Grayson & Mullaney MS) but also the type locality and only known site of a freshwater species of the Phylum Nemertea ('nemertine worms'), *Prostoma jenningsi* in an angling pond at Croston (Gibson 1982, 1991).

The eastern *Lomax Branch* of the Wigan Pondway persists South-east via Wingates (SD653072) and Hulton Park (SD680050) to cross the proposed Lomax Opencast Coal Site of British Coal which, if approved, will variously destroy, damage or compromise numerous ponds, many of significant wildlife importance (Gemmell 1987, Guest MS). This includes the main part of 36 Great Crested Newt ponds, the largest single concentration of the such ponds in the region (Grayson, Parker & Mullaney 1991). An unpublished study by Grayson (MS) shows that although classic marl pits are present, Lomax includes recent (1980s) surface collapses, a flooded Victorian gravel pit, a suite of tiny reservoirs each juxtaposing a farm building, flooded 50-year old brickpits, impeded drainage due to colliery spoil, and ruckles in colliery spoil, all adding to the diversity of the amphibian assemblage at Lomax, involving Common Frog, Common Toad, and all three species of native newt (Grayson, Parker & Mullaney 1991). Until the post-war overspill development of Little Hulton (SD7204) and recent housing around Tyldesley, the Lomax Branch persisted further south and east, stopping at the Chat Moss peatlands and the glacial sands of Wardley.

The western *Bickershaw Branch* persists for some 16 kilometres in a sinuous southerly course from Westhoughton via Hindley, Bickershaw, Crankwood, Lowton, Kenyon and Risley in north Cheshire, threading between the pond-starved mosslands almost to the major barrier presented by the Manchester Ship Canal and River Mersey. While the northern portion of the Bickershaw Branch can be as much as six kilometre wide, the southern end is less than one kilometre wide and yet persistent. The amphibian importance of the Bickershaw Branch has been established by Grayson, Parker and Mullaney (1991) at least for Great Crested Newt. The amphibian abundance in both the Bickershaw and Lomax branches may be a reason for the remarkably large size of the Heron Colony on Chat Moss. The invertebrate importance of the Bickershaw Branch is suggested by the discovery by the author of the bryozoan *Lophophus crystallinus* in an angling pond at Baldwin's Farm, Westhoughton (SJ638056), a species considered to be nationally rare (Hayward & Bratton 1991).

North Mersey Pondway (Merseyside, Cheshire And Lancashire) - 'Nm' On Figure 2

The North Mersey Pondway is more than 26 kilometres long but rarely more than three kilometres wide, with a maximum pond frequency mapped as 32 per one kilometre square. It begins its sinuous course north of the Mersey at Tarbock Green (SJ465875), trending ENE via Cronton, Bold Heath and Great Sankey to Burtonwood near Warrington, before veering North then North-west. For most of its length, the North Mersey Pondway shows a near-perfect fit with the distribution of the heavy clay soils of the Salop Association, a heavy soil prone to leaching and waterlogging.

The origin of the ponds of the North Mersey Pondway is predominantly flooded abandoned marl pits, with the pondway strengthened by flooded abandoned brickworks. The antiquity of the marl pits may be very variable, some probably being dug during early medieval piecemeal enclosure, others upon systematic legislative enclosure. Some of the best documented marl pits in the region are documented by Nicholson (1979) for Speke Demense, now largely destroyed by Liverpool Airport, and there is a scattering of moated farmhouses.

The pondscape of a substantial portion of the North Mersey Pondway has been researched by Lowther (1984) who noted the valuable visual contribution of isolated tree-ringed ponds in otherwise bleak intensively farmed Grade one agricultural land. Lowther established that the botanical diversity was low in such degraded pondscape areas and that the rate of pond loss had been severe, particularly since 1961, due to agricultural intensification. Pond losses have also been acute due to urbanisation, notably the 108 ponds mapped by Addison in 1781 in Speke Demense reduced to eight on the Pathfinder map.

Cheshire-Shropshire Supercluster (Cheshire, Shropshire, Clwyd, Staffordshire, Greater Manchester & Merseyside)

This is easily the largest pond supercluster in the region, occupying much of the Cheshire-Shropshire Plain underlain by the Permo-Triassic Cheshire-Shropshire Basin. Although centred on Cheshire, the pond supercluster extends into eastern Clwyd in North Wales, northern Shropshire, northern Staffordshire and crosses the border into both Merseyside and Greater Manchester. The continuous line on Figure 2 identifies the contiguous one kilometre squares with more than six mapped ponds which constitute the Cheshire-Shropshire Supercluster. The distribution corresponds closely with not only the Salop Association of soils formed by leaching of slightly calcareous tills, but also with the availability of red and green Triassic calcareous mudstones and siltstones, commonly called marls, and locally Jurassic marls.

The Cheshire-Shropshire Supercluster is less internally consistent than the Fylde Supercluster. This is due to the Cheshire-Shropshire Basin having large tracts of little or no cover of Quaternary deposits. On the one hand this brings to the surface the Triassic Mercia Mudstones (= Keuper Marl), the Triassic Tarporley Siltstone (= Keuper Waterstones) and locally Jurassic mudstones within easy reach of excavation for marling. On the other hand, shallow rockhead introduces the Mid-Cheshire/North Cheshire Ridge, a persistent tract of pond-scarce scarpland of thin soils upon porous Triassic Helsby Sandstone (= Keuper Sandstone). Although often less than four kilometres wide, the scarpland is persistent enough to divide the Cheshire-Shropshire Supercluster into semi-discrete western and eastern portions.

Further reducing the internal continuity of the Cheshire-Shropshire Supercluster is the scattered presence of extensive glacial sands, notably in the Delamere Forest and in association with the hummocky Wrexham-Ellesmere-Whitchurch Moraine Belt. While such districts are poor in small ponds due to the lack of marling clays, it is these areas which are rich in extensive natural ponds known as the Cheshire-Shropshire Meres. The meres have been mapped and studied in detail by Reynolds (1979). In some cases the meres are attributable to hollows in hummocky glacial depositional terrain, while others seem to be products of ancient natural dissolution of Triassic rock-salt, affording a genetic link with the modern Cheshire flashes induced by rock-salt mining and brine pumping.

Fieldwork and map evidence supports the view that most of the smaller water bodies of the Cheshire-Shropshire Supercluster are typical flooded abandoned marl pits, generally of rectilinear form with sides parallel with the field boundaries, contrasting with the more oval form of the ponds of the Fylde Supercluster. The marl pits are commonly not isolated but in large groups or pairs, often dumbell-shaped and conveniently dug in either a central position in a field or half way along a field boundary. The angularity of many ponds suggests they date from the peak of marling activity, i.e. some 150 to 200 years old, but Hewitt (1919) drew attention to a record of 48 Cheshire marl pits being dug prior to 1303 AD, and Boyd (1951) records a Cheshire marl pit being dug as late as 1896. Further research on the antiquity of ponds in the Cheshire-Shropshire Supercluster is therefore necessary in order to understand pond ageing and pond diversity.

The eastern half of the *Cheshire-Shropshire Supercluster*, east of the broken line on Figure 2, is bounded to the west by the persistent Mid-Cheshire Ridge and to the east by the Pennine foothills. To the north it still retains a toehold in Greater Manchester in the vicinity of Manchester International Airport in spite of continuing losses due to creeping urbanisation. A narrow pond-scarce corridor is associated with the River Dane, River Weaver and the conurbation of Northwich and it partly divides two areas particularly rich in mapped ponds. While the great majority are flooded abandoned marl pits, there are exceptions including brick fields, tile fields and extraction pits for pottery clay, as noted in Great Budworth Parish by Boyd (1951). This parish is the site claimed by Boyd (1951 p.42) to be the last marl digging, in 1896 in the corner of a field called Big Douglas at Frandley Farm. The *northern pond-rich area* lies to the south and west of Knutsford and includes 49 one kilometre squares with 25 or more mapped ponds each - far more such squares than elsewhere in North-west England and perhaps the country. The *southern pond-rich area* is centred between Crewe and Winsford and is noteworthy for including the two one kilometre squares with the highest mapped pond frequency known in England and Wales outside the Wirral: SJ7664 south of Holmes Chapel (45 ponds) and SJ6461 near Church Minshull (44 ponds).

Further south, the eastern half of the Cheshire-Shropshire Supercluster extends into north Shropshire and north Staffordshire. The *Whixall Core Area* is a major core area, and most of its ponds appear to be flooded marl pits. Bagshaw (1851) writes of the practise of using marl for top dressing as still being prevalent at Coton (SJ5335) near Whixall, suggesting that some of the marl pits are as little as about 140 years old. However, some marl pits in north Shropshire and north Staffordshire are expected to be considerably older judging from the account of Loch (1820) who asserted that the custom of marling had become prohibited on the Marquis of Stafford's estate and that many of the marl pits had been levelled down, especially in 1817.

The ecological value of the eastern half of the Cheshire-Shropshire Supercluster has been established by Allenby (1971) for aquatic plants and by Gabb & Kitching (1992) for dragonflies and damselflies, although the ecological resource value has been much reduced across huge areas due to removal of livestock from fields leading to tree growth and shading out, deeper field drains, ploughing up to pond margins, pond enrichment due to field run-off of fertilizer and widespread infilling (see Willis & Young 1983, Allenby 1971, Hull et al 1992). Amphibians are now scarce in many such areas. Willis and Young (1983) reported on the apparent ability of the Smooth Newt to tolerate more intensive farming in mid-Cheshire than even the Common Frog. Unpublished surveys in 1991 by Parker, Mullaney & Grayson (MS) showed that Great Crested Newt occurred in only 13 ponds of a survey of 147 existing farmland ponds around Mere in North-east Cheshire, largely due to shading out and intensive farming. However, near the urban fringe of Greater Manchester, where farming is less intense and the land use much more variable (eg under-utilised land, military camps, disused railways etc.), the ecological value of the surviving ponds can be considerable - notably the instance of 11 000 amphibians translocated to make way for the A34 Handforth-Wilmslow Bypass (BBC Wildlife Programme, 13 August 1993).

The *western half of the Cheshire-Shropshire Supercluster*, west of the broken line on Figure 2, is bounded to the east by the Mid-Cheshire Ridge and to the west by the foothills of the Clwyds and Berwyn Hills. Internal connectivity is reduced by the extensive alluvial plain of the River Dee which present a major pond-scarce barrier almost isolating three significant pond clusters: north of Llay (SJ3358), north of Poulton (SJ3859) and west of Holt (SJ3952). The three pond clusters are further isolated by a narrow pond-scarce corridor associated with the Afon Alon and a second pond-scarce corridor associated with the Anglo-Welsh border along Pulford Brook. The main area for mapped ponds is sandwiched between the eastern bank of the River Dee and the Mid-Cheshire Ridge, and constitutes a pond-rich tract some 35km in length from Oswestry in the south to the vicinity of Chester in the north, with mapped pond frequency consistently in excess of 13 ponds per one kilometre square. This is paralleled by a weaker pond-rich tract on the western bank on the River Dee, producing twin ribbons of core areas in Figure 3.

The origin of nearly all farmland ponds in the western half of the Cheshire-Shropshire Supercluster is the flooding of abandoned marl pits, with intermingled pits for bricks, tiles and earthenware pottery. The age of the ponds is variable, with a claim by Hewitt (1967 p.16) that marl was dug near Chester as early as 1239 and probably earlier, and six marl pits were documented in 1345 as being on the boundary of Rudheath.

The botanical importance of the western half of the Cheshire-Shropshire Supercluster was suggested by the work of Spencer (1974) in the Wrexham-Holt area and confirmed by a survey of 596 ponds in 1979 conducted for the Nature Conservancy Council by Ray Taylor and Paul Day and published in part by Day et al (1982). Pond losses have been documented as 25 percent in the interval between the First and Second Series 1:25 000 OS maps and 50 percent in the Burton area (Day et al 1982 p.164).

Further north, the western half of the Cheshire-Shropshire Supercluster has been the subject of detailed botanical investigation, all 153 ponds in Christleton Parish (SJ4465) being surveyed by Brian et al (1987). The Christleton ponds are of strategic importance in constituting a link between the main mass of the Cheshire-Shropshire Supercluster and the Wirral Pondway described below. The Christleton ponds are sandwiched between the Chester urban core and a pond-starved tract associated with the alluvium of the River Gowy. The latter virtually isolates the *Dunham-on-the-Hill Cluster* (SJ4772) which comprises 29 one kilometre squares and indicated by the symbol 'T' on Figure 2, whose ponds mostly appear to be flooded marl pits, an origin deduced by Brian et al (1987) for most, but not all, of the ponds of Christleton Parish.

Wirral Pondway (Merseyside & Cheshire) - 'WI' On Figure 2

A major pondway some 30 kilometres in length and 5 kilometres wide, extending the full length of the Wirral peninsula to skirt the southern flank of the Ellesmere Port petrochemical complex before being almost blocked by the pond-scarce tract associated with the River Gowy alluvium in combination with the eastern urban fringe of Chester. However the Wirral Pondway persists via the ponds of Christleton Parish described by Brian et al (1987) to merge with the western half of the Cheshire-Shropshire Supercluster. Along almost its entire length, the Wirral Pondway has been threatened with severance by encroachment by petrochemicals, motorways, housing, landfill and the nuclear industry, in addition to losses from pond ageing and changing agricultural practise. On the Pathfinder maps the Wirral Pondway has strong core areas, including 34 contiguous one kilometre squares each with 25 ponds or more, constituting the most dense core area for ponds in North-west England, and including three contiguous one kilometre squares in Puddington and Burton with the highest known mapped pond frequencies in England and Wales: SJ3474 and SJ3275 with 47 ponds each and SJ3376 with 45 ponds (see Table 2). Indeed SJ3474 had 75 ponds shown on the 1920s 1:25,000 OS map, more than twice the national record for farmland reported by Rackham (1986) in his national survey using the same set of 1920s' maps.

The origin of nearly all farmland ponds in the Wirral Pondway is flooded abandoned marl pits. Their age is debatable. Field evidence and map analysis suggests that they are relatively modern, i.e. 18th and 19th century, on the basis of their fresh box-like form and parallelism with field boundaries. However, the Wirral Pondway includes some of the oldest documented evidence of marl pits in the region, the Abbot of Chester stated in 1293 AD to have made 35 marl pits in Greasby and 65 in Ireby (Hewitt 1967 p16), while the Forest Pleas dated 1303 AD record that the Abbot of St Werburgh dug 48 marl pits without permission at Sutton, Bromborough, Eastham and Childer Thornton, all in the Wirral (Hewitt 1919). In the mid 1300s Richard of Seynesbury had to pay amercements for fresh ploughing and digging marl pits in the forest of Wirral. Therefore marl pit ponds were as abundant 600 to 700 years ago in the northern end of the Wirral Pondway as at present in this part of Merseyside and Cheshire, of considerable relevance to biodiversity and pondscape studies. There may possibly have been several episodes of infilling and fresh digging, and no individual pond can as yet be confidently dated.

The floristic importance of the Wirral Pondway has been established by Day et al (1982), and the Merseyside segment is a major stronghold for Great Crested Newt *Triturus cristatus* on the basis of old records and a systematic unpublished survey by Jon Dawes (MS). A classic study of freshwater gastropods and bivalves has been conducted by McMillan (1959) for 172 ponds around Bromborough.

Pond Superclusters To The South-East

Inspection of Figure 2 shows the presence of two pond superclusters (SJ8525 and SJ9732) to the South-east of the limits of the Cheshire-Shropshire Supercluster, but these are beyond the scope of the present study. It is evident that although neither are in direct contact with the Cheshire-Shropshire Supercluster, they are often in very close proximity to it.

Isolated Pond Clusters

The study revealed the presence of many isolated pond clusters which are unattached to either superclusters or pondways. Some may serve a strategic function as stepping stones between superclusters/pondways. Others are so isolated that they merit closer study in search of distinctive floral and faunal assemblages, such as might occur in the 15 kilometre string of pond clusters around the Lune Valley (SD5267, Figure 2).

A feature is the strong scattering of isolated pond clusters in Rossendale, Radcliffe, Bury, Oldham and Tameside. While many are clusters of mill lodges and flooded quarries, the lowlands include some faunally and botanically rich small pond clusters in the northern and eastern rim of the Manchester conurbation - virtually all under threat of development. These include the major amphibian sites of Denton Golf Course (Grayson & Bentley 1993 MS) in Tameside and of Coggra Fold in Bury district (Bentley 1993 MS).

The presence of isolated pond clusters in West Lancashire and north Merseyside is distinctive, largely due to marl pits being concentrated in gentle hills which stand above the mosses and coastal silts of the West Lancashire Plain. Neither botanical nor faunal studies have been published but, considering that each marl pit was dug away from watercourses, some may retain species eliminated from the surrounding mosslands and marshes.

Some of the most important pond clusters in the region are not evident on Figures 2 or 3, indicating a serious limitation of the present study. For example, the failure to highlight the temporary and permanent pools of the Sefton coast which are of major value for amphibians, dragonflies, damselflies and plants.

Discussion

Botanical Diversity & Pond Age

Ecological theory postulates that, as a farmland pond ages, it should pass through a succession of botanical stages and that the diversity of plant species present should increase with time, assuming that the pond is not overrun by land plants or shaded out by trees. Godwin (1923) established this principle but his study was based upon only seven ponds in Derbyshire, at most 70 years old. In North-west England, workers such as Day et al (1982) have attempted to establish some such relationship but with little success.

The present study demonstrates that the farmland ponds of North-west England have a much greater spectrum of ages than previously recognized, with marl pits as old as 1293 AD and as young as 1896 AD intermingled with marl pits dating from the peak of marling. Without detailed archival research, such heterogeny of dates precludes demonstration of a relationship between pond age and botanical diversity. Only with freshly dug or rehabilitated ponds could this be done. The heterogeneity of dates means that ponds already 500 years old would serve as local starting points for species invasion of the main rash of fresh marl pits immediately upon flooding.

On this basis, many pond clusters now enjoy six or seven centuries of plant dispersal, and therefore species diversity of ponds should be high and each pond should have a botanical diversity similar to the next pond. On the contrary, it is not possible to guess the plant species to be found in the "next pond" on the basis of the species noted in its neighbours. For a limited number of uncommon to rare species, this unpredictability may be due to the efficiency of their dispersal mechanisms over land, as invoked by Brian et al (1987) for *Lemna polyrhiza* and Frog-bit *Hydrocharis morsus-ranae* in the case of the Christleton ponds. For commoner, more invasive species, the unpredictability cannot be explained in this manner.

The expectation is unrealistic that pond age is a key determinant of botanical diversity, in inferring, for it to 'show through', that a steady or near-steady set of optimum conditions are sustained indefinitely. Blurring will occur for most ponds by long-term shifts in factors such as shading by trees, percentage of open water, livestock access, proximity of ploughing and other site-specific factors discussed for the Christleton ponds by Brian et al (1987).

Botanical Diversity & Catastrophe Theory

The present study demonstrates that the baffling botanical unpredictability of ponds can be considered in terms of catastrophe theory, whereby pond ageing to a mature 'steady state' is halted, reversed or modified by drastic natural or artificial events. These include acute drought, temporary shade-out, flax and hemp retting, fish for food, fish for angling, and geese and duck invasion.

Acute drought or *fluctuations in the local water table* can cause a very mixed response within a pond cluster in terms of shallowing and the extent of drying out (Brian et al 1987). Botanical recovery need not necessarily follow the same path in each pond.

Pond 'death' by shading out upon either removal of livestock grazing of pond margins, or removal of livestock access for water, can be rapid due to unrestricted invasive willow scrub and/or unchecked tree saplings becoming a ring of mature trees. The prevention of normal photosynthesis wipes out most aquatic plants, as observed in Merseyside by Lowther (1984), and eliminates normal pond fauna such as snails, as observed by McMillan (1959). Shading out is generally accompanied by oligotrophic bottom conditions due to unrecycled leaf litter. In the Wigan Pondway, numerous ponds have been recently successfully rejuvenated by tree removal, scrub clearance and livestock management (Rick Parker, personal communication). However, it is too soon to know if the altered bottom conditions exert a long-term, possibly permanent, influence upon the botanical diversity of the ponds. Furthermore, there is qualitative evidence that the plants "first in" often achieve a dominance which dictates the selection of the "later arrivals". For example, "first in" Bulrush seems to preclude many other plant species.

Pond 'death' by flax and hemp processing was formerly an annually repeated catastrophe due to retting by steeping in flooded marl pits, shown by the present study to have been a major activity in at least parts of the Wigan Pondway and Fylde Supercluster, and perhaps elsewhere. To be effective, the plants were pulled from the fields before being fully ripe and immersed for as long as twelve days in order to rot out the outer woody part of the stem so that the fibres could be easily removed (Lowe 1972 p.43). Elimination of all submerged and emergent plants would be a rapid consequence, enforced annually, and a different botanical diversity might develop upon cessation of the practice.

Pond 'death' due to farm wastes has always been prevalent, more so in the present century since the new risks from livestock kept indoors, such as deliberate or accidental releases of silage water, slurry and farmyard dirty water, as well as dumping of carcasses and manure. Even if the discharge ceases, the pond may be too nutrient enriched and eutrophic to recover quickly and perhaps need not resume its former flora, particularly if manure wastes have accumulated on the banks and pond floor.

Fish stocking for food is shown by the present study to have been at least locally a major activity, casting doubt upon the suggestion of Rackham (1986 p.366) that only ponds where an eye could be kept upon them were used for fish farming, implying that only ponds close to dwellings were stocked for this purpose. In the late 1600s, records for Speke Demesne near Liverpool shows that 13 flooded marl pits were deliberately stocked and managed for fish for the table, notably Tench and Perch (Nicholson 1983 p.19), and in 1610 to 1611 AD, Tench and Carp were stocked in several marl pit ponds in the grounds of Wardley Hall near Salford (Wickham 1984). Although archival evidence is sparse, perhaps numerous marl pits were stocked with fish for food over many centuries until the late 1800s when railways made frozen sea fish widely and cheaply available. Perhaps normally a low-key activity, it is tempting to suggest that occasionally farmers would have stocked ponds with choice weeds as well as fish, and the opportunistic spread of aquatic plants and invertebrates with nets and fish in transport may have been important.

Fish stocking for sport is now a major activity, although historically not so. In the region many hundreds, maybe thousands of ponds have been stocked for anglers, and most have considerable modification by management of bankside and aquatic plants by introduction, control and elimination, as well as control of water level and bathymetric profile. The inadvertent role of anglers in introducing seeds and vegetative parts of plants attached to boots, keep nets etc. can be considerable. Willis and Young (1983 p.75) note the financial incentive to farmers to retain or create ponds for generating supplementary income from fishing clubs, even in the pond-rich Cheshire Supercluster. At one farm in the Wigan Pondway, plant diversity has been increased by a farmer's deliberate introduction of Water Soldier (*Stratiotes aloides*) to render illicit fishing impossible. A particular difficulty in interpreting botanical surveys is that a significant number of ponds, especially smaller ponds, become discontinued as angling ponds leaving behind a modified flora.

Geese and ducks may severely alter the botanical character of ponds when they settle in number on a pond either by accident or when deliberately introduced for shooting, for egg, meat and feather production, or for ornamental purposes. Geese or ducks can soon exert changes by grazing pressure around the pond margins, by grazing and uprooting submerged and emergent aquatic plants, by increased turbidity and by eutrophication by bird droppings. These changes are in addition to the human management of the pond. A study by Crosby (1993) indicates that in the 1600 to 1850 interval nearly all farms in Lancashire, which were much more numerous than at present, had a small flock of geese, but scant information is available on ducks. Removal of the geese or ducks may or may not lead to the flora of the pond resuming its former character. McMillan (1959 p.304) attributed the total absence of snails and bivalves in ten ponds in the Wirral solely due to the stocking with geese and ducks.

Amphibian Diversity & Pond Age

No correlation is apparent between pond age and the presence of amphibians. Provided a pond and its surrounding terrestrial habitat is suitable and, provided a migration route exists within easy reach of an established breeding site, then colonisation is rapid. Colonisation of new ponds with successful breeding within 12 months has been recorded for all the six native species as follows: for all three species of newt, Common Toad and Common Frog in marl pit type ponds (new and rehabilitated) in the Wigan Pondway and for Natterjack Toad in sandy ponds dug in the inter-dune slacks of the Merseyside coast. However, long-term breeding success is less easy to demonstrate, failures requiring a number of years to become apparent.

Amphibian Diversity & Pond Catastrophes

The richness of the region for amphibians is considerable, and not merely determined by the sheer abundance of ponds. Table 3 shows the range of factors involved:

Table 3: Some factors affecting amphibian diversity in North-west ponds.

	Natterjack Toad	Common Toad	Common Frog	Great Cstd Newt	Smooth Newt	Palmate Newt
drying out	positive	negative	positive	positive	positive	positive
shallow depth	positive	negative	positive	variable	positive	positive
angling	negative	positive	minor	wiped out	minor	minor
sticklebacks	negative	minor	negative	wiped out	negative	negative
uplands & moors	negative	unclear	unclear	negative	negative	positive
high pond density	? negative	neutral	positive	positive	positive	positive
intensive farming	wiped out	negative	negative	wiped out	negative	negative
pond warms easily	essential	?neutral	positive	positive	?neutral	?neutral
earthworm-rich	neutral	neutral	neutral	positive	neutral	neutral

Table 3 demonstrates the difficulty in achieving or sustaining amphibian diversity in a particular pond. However, all pondways and superclusters examined so far include at least some '5-species ponds' containing all native amphibians except for the Natterjack. Fieldwork demonstrates that these all occur in areas of low-intensity agriculture with a mosaic of terrestrial habitats rich in flooded marl pits. It should be noted that a marl pit could not be dug if the ground was liable to flood, therefore marl pits are accidentally protected from natural fish ingress - a key reason for the success of the Great Crested Newt. This newt is a formidable predator and large adult numbers will eliminate all amphibian larvae, including its own. The high turbidity of the marl pit ponds, due to suspended clays and high productivity, prevent this as does the high botanical diversity in providing complex concealment. This is also important in restraining the efficiency of other predators such as Herons. Quantitative research is needed to fully explain the abundance of five-species ponds in North-west England, but the amphibian diversity of the region is impressive.

The Natterjack Toad *(Bufo calamita)* is a special case, being at the edge of its European range it requires warm and therefore shallow ponds and it cannot easily survive in steady-state ponds due to the predation of larvae by aquatic insects and complex competition from tadpoles of Common Toad *(Bufo bufo)*. The Natterjack therefore requires ponds liable to catastrophic drying out from time to time, a normal occurrence in the shallow ephemeral natural ponds in interdune slacks on the Merseyside coast. While doing best in ponds where it is the only amphibian species present, it can co-exist as a species assemblage with some or all of the other UK amphibian species, but only tenuously and in special climatic and catastrophe conditions no longer found inland in North-west England.

Pondways As Wildlife Corridors

The role of pondways as wildlife corridors is considered to be valid for certain mammals, birds, reptiles, amphibians, fish and various invertebrate groups, as well as for certain higher and lower plants. A wildlife corridor implies not only a linear wildlife resource but also the preferential migration of wildlife along its axis. The present account sets out to demonstrate this phenomena for the Great Crested Newt (*Triturus cristatus*) in the Wigan Pondway. This species has two key attributes: substantial dependence upon ponds of marl pit type (Grayson, Parker & Mullaney 1991), and juveniles which typically probe 250 metres from their birthpond in time for hibernation, adults being somewhat less adventurous.

Ponds 500 metres from the birthpond can therefore be probed only two years after birth. Given that the Wigan Pondway is several tens of kilometres long, no individual Great Crested Newt has ever walked it. This is not a wildlife corridor in the sense used by mammalologists, ornithologists or lepidopterists who may measure daily movements in tens of kilometres. The Wigan Pondway is a wildlife corridor in the sense that it has a pond density of six per kilometre square throughout its entire length and therefore substantial gene flow should be occurring along its length. For Great Crested Newt, this is likely to be at an optimum rate of 250 metres per year, whereas gene flow is implausible to isolated ponds more than 500 metres from the edge of the pondway. This rate is sufficient to spread a single population, and to eventually absorb and hybridize any distinct populations. The optimum rate depends upon the ponds being suitable together with the intervening terrestrial habitats. For much of the Wigan Pondway this is demonstrably the case.

At national level, the National Amphibian Survey demonstrated the pond-dependence of Great Crested Newt and provided data (Swan & Oldham 1993 p.112) strongly suggesting that the probability of it occurring in a pond is largely dependent upon the pond density of the area exceeding a certain threshold, few being found in areas with less than 0.7 ponds per kilometre square, and a density of one pond per kilometre square being recommended as a working rule of thumb for Great Crested Newt habitat management (Swan & Oldham 1993 p.115). As well as a minimum threshold, survey work in Greater Manchester County analysed by Andrew Mullaney (MS) indicates a considerable increase in statistically valid probability of Great Crested Newt presence in a given pond in a one kilometre square where pond density exceeds eight ponds. This may be due to the ease with which the species can recolonize a pond after wiping out by fish introduction, invasion by Three-spined Stickleback (*Gasterosteus aculeatus*) or by pond 'death'.

A new conceptual model of Great Crested Newt (GCN) population dynamics seems valid, showing some affinities with predator-prey models and epidemic host-parasite models:

Stage 1:	The GCN colonisation stage, the GCN spreads pond to pond across an entire cluster, provided each pond is within 500 metres of its neighbour.
Stage 2:	Before or after total GCN colonisation, Stickleback gains entry to the one of the ponds in the pond cluster via flooding, streams, field drains or stock transfer. Stickleback predation upon larvae is ruthless and GCN recruitment ceases, eliminating GCN from the pond.

Stage 3: Usually after total GCN colonisation, Stickleback invades pond after pond across the pond cluster, eliminating GCN each time.

Stage 4: One or more ponds suffer a catastrophe and Stickleback is eliminated.

Stage 5: The GCN recolonisation stage, in which GCN regains breeding presence in those ponds where Stickleback was eliminated.

The cycle then repeats indefinitely, provided that a pond catastrophe event occurs before the Three-spined Stickleback manages to eliminate all GCN breeding sites in the pond cluster, and provided the fish is never totally eliminated from all its breeding sites in the pond cluster. The cycle ends when either the newt or the fish is eliminated from the pond cluster. The game can be visualised as 'musical ponds' and resumes when the defeated species gains renewed access to the pond cluster. While it is much easier for the newt to arrive (on foot) it cannot establish itself unless it arrives immediately after a pond catastrophe frees a pond from the fish. Conversely once the fish arrives it can immediately establish itself, unless it arrives immediately before a pond catastrophe.

In a perfect system, this cycle would require a minimum of only two ponds per one kilometre square, forming a linear cluster in the form of a corridor. In reality, the figure needs to be higher because ponds are not usually equally spaced, and are often clumped as doublets and triplets.

It should follow that a core area (15 or more mapped ponds per kilometre square) will as a rule contain Great Crested Newt in at least some of its ponds, on the basis that the 'end game' of total GCN elimination is statistically unlikely in so many ponds - assuming that the pondscape has escaped severe degradation. Conversely the total elimination of Stickleback is also inconceivable, and extremely high pond density should facilitate Stickleback re-spread. Crucial is the common observation that each marl pit pond is generally dug in such a manner that water will not enter, so denying Stickleback rapid access. The same is often true of irregular hollows in pit-heaps, brick-works, rock quarries and inter-dune slacks.

Protection Of Ponds & Wildlife

The study confirms that the ponds of North-west England are a valuable wildlife and landscape resource. Even so, pond losses are continuing at an alarming rate (Hull et al 1992, Mullaney 1990). To date, protection has been piecemeal, being skewed in favour of ponds with statutorily protected species (notably Great Crested Newt and Natterjack Toad), or ponds within SSSIs, Sites of Biological Importance and nature reserves depend largely upon voluntary efforts (eg. by the Wildlife Trusts, British Trust for Conservation Volunteers, Groundwork and community groups). Traditionally, ponds have been viewed as discrete entities and it is hoped that the study demonstrates the need to consider them on a regional scale as wildlife corridors and on a local scale as an integral part of the terrestrial environment both as visual pondscape and as land/water ecosystems for wildlife (eg. amphibians). This holistic approach challenges the current orthodoxy of wildlife conservationists and planners who should operate more in terms of habitat mosaics rather than discrete habitats, and broad tracts of landscape rather than pond by pond or field by field.

This study suggests that, in the absence of Pond Protection Orders (P.P.Os) similar to national legislation of Tree Preservation Orders (T.P.Os), the Unitary Plans and planning policies of local authorities should concentrate upon planning protection for pondscape (and notable individual ponds). The regional study enables the following pondscape protection policies to be enacted:

Defence Of Nationally Important Pondscape

Mapped pond frequencies of 35 or more per one kilometre square should be designated as 'Nationally Important Pondscape' and should as far as possible be retained in Green Belt and designated as 'Areas of High Landscape Value'. Table 2 shows them to be mainly in Cheshire, but with three in north Shropshire, two in Lancashire and one in Staffordshire. Many are now degraded pondscape requiring designation as 'Landscape Recovery Areas'. Pending detailed mapping, it is considered unlikely on the basis of the survey by Rackham (1986) than any other region of England and Wales will possess more than a few squares with over 35 ponds on Pathfinder maps.

Defence Of Regionally Important Pondscape

Pond frequencies of 15 ponds or more per one kilometre square should be designated as 'Regionally Important Landscape', as far as North-west England is concerned. This would also defend all 'core areas'. Elsewhere in most of England and Wales the appropriate qualifying threshold may need to be substantially lower due to the scarcity or absence of high-value squares.

Defence Of Pondway Continuity

The integrity of pondways should be protected by a combination of designations as Green Belt, Areas of High Landscape Value, Wildlife Corridors, mitigation of pond losses and pondscape losses by planning conditions (especially in Environmental Impact Assessments), targeting of pond recovery programmes etc. The immediate strategic priorities should be the Wigan Pondway and the Garstang Pondway in order to conserve the West Coast's axis of ponds, and to defend the widespread encroachment upon the Wirral Pondway.

Wildlife Conservation Strategies & Recovery Programmes

Wildlife Conservation Strategies should take account of the recognition of the role of pondways and the integrated nature of pondscape. With superclusters, the main challenge is to determine the best surviving wildlife and landscape areas in order to concentrate planning protection and to direct recovery programmes, while still ensuring the shrinking superclusters retains not only enough critical mass as a wildlife and landscape resource, but also retains its integrity as a single geographically continuous entity. In practice, this requires ensuring superclusters evolve into pondways in a managed planned manner.

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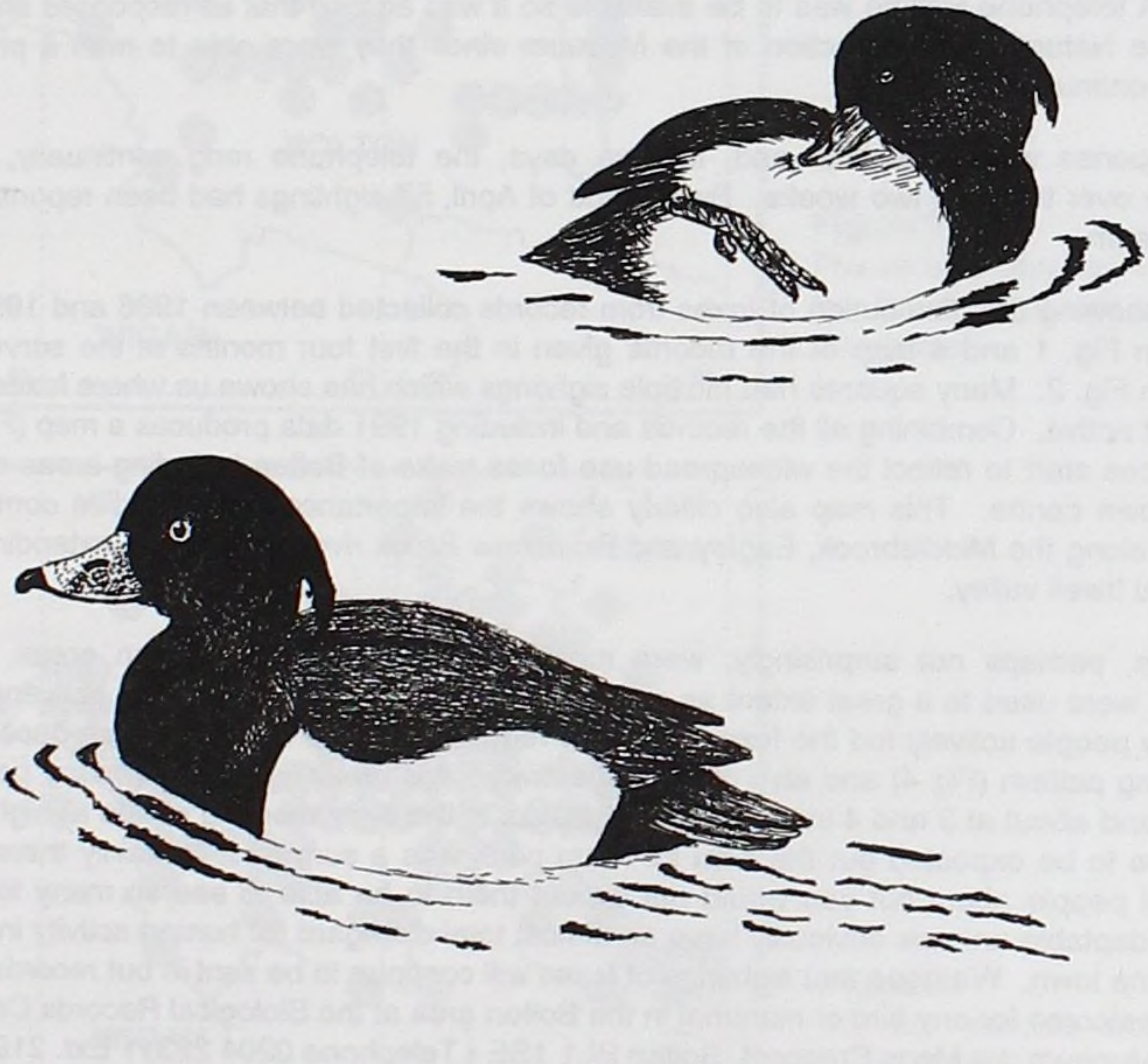

BOLTON FOX WATCH 1992

Kathryn Berry

Bolton Museum

The Survey

In February 1992 the Natural History Section of Bolton Museum was contacted by John Eley, currently working in the Planning Department at Bolton but also undertaking an MSc course, about a study he was doing on foxes. His main area of interest was in the other Boroughs of Greater Manchester but he was investigating the possibility of adding Bolton to the programme.

He was surprised to learn that not only did the Museum have a Biological Records Centre that had been compiling records for several years, but that a very successful fox survey had already been undertaken for two years previously by the Bolton Wildlife Project who are funded by the Lancashire Wildlife Trust and Bolton Council. With so much data already to hand, Bolton was included into John Eley's programme and 'Fox Watch' questionnaires were produced by the Museum.

These were made available to the general public via Libraries, Croal/Irwell and Water Authority Wardens and local Museums. At the same time wider publicity was sought and, on 6 March 1992, the Bolton Evening News published a request for information on Bolton foxes. A telephone Hotline was to be available so it was agreed that all responses should go to the Natural History Section of the Museum since they were able to man a phone almost continuously.

The response was immediate and, for two days, the telephone rang continually, and regularly over the next two weeks. By the end of April, 57 sightings had been reported to the Museum.

A map showing the distribution of foxes from records collected between 1986 and 1990 is shown in Fig. 1 and a map of the records given in the first four months of the survey is shown in Fig. 2. Many squares had multiple sightings which has shown us where foxes are the most active. Combining all the records and including 1991 data produces a map (Fig.3) which does start to reflect the widespread use foxes make of Bolton including areas close to the town centre. This map also clearly shows the importance of the wildlife corridors created along the Middlebrook, Eagley and Bradshaw Brook river valleys and extending to the Croal Irwell valley.

Sightings, perhaps not surprisingly, were most frequently in the suburban areas, and gardens were used to a great extent as convenient places of passage and for scavenging. Very few people actively fed the foxes they saw regularly. Times of sightings produced an interesting pattern (Fig 4) and also of human activity - it is amazing just how many people are out and about at 3 and 4 in the morning. Peaks in the early morning or late at night for foxes are to be expected but the 8am to 10am peak was a surprise. Certainly there are plenty of people about but you would not expect them to be able to see so many foxes. These adaptable animals obviously have an almost total disregard for human activity in and around the town. We hope that sightings of foxes will continue to be sent in but records are always welcome for any bird or mammal in the Bolton area at the Biological Records Centre (Bolton Museum, Le Mans Crescent, Bolton BL1 1SE - Telephone 0204 22311 Ext. 2197).

Maps plotted using RECORDER

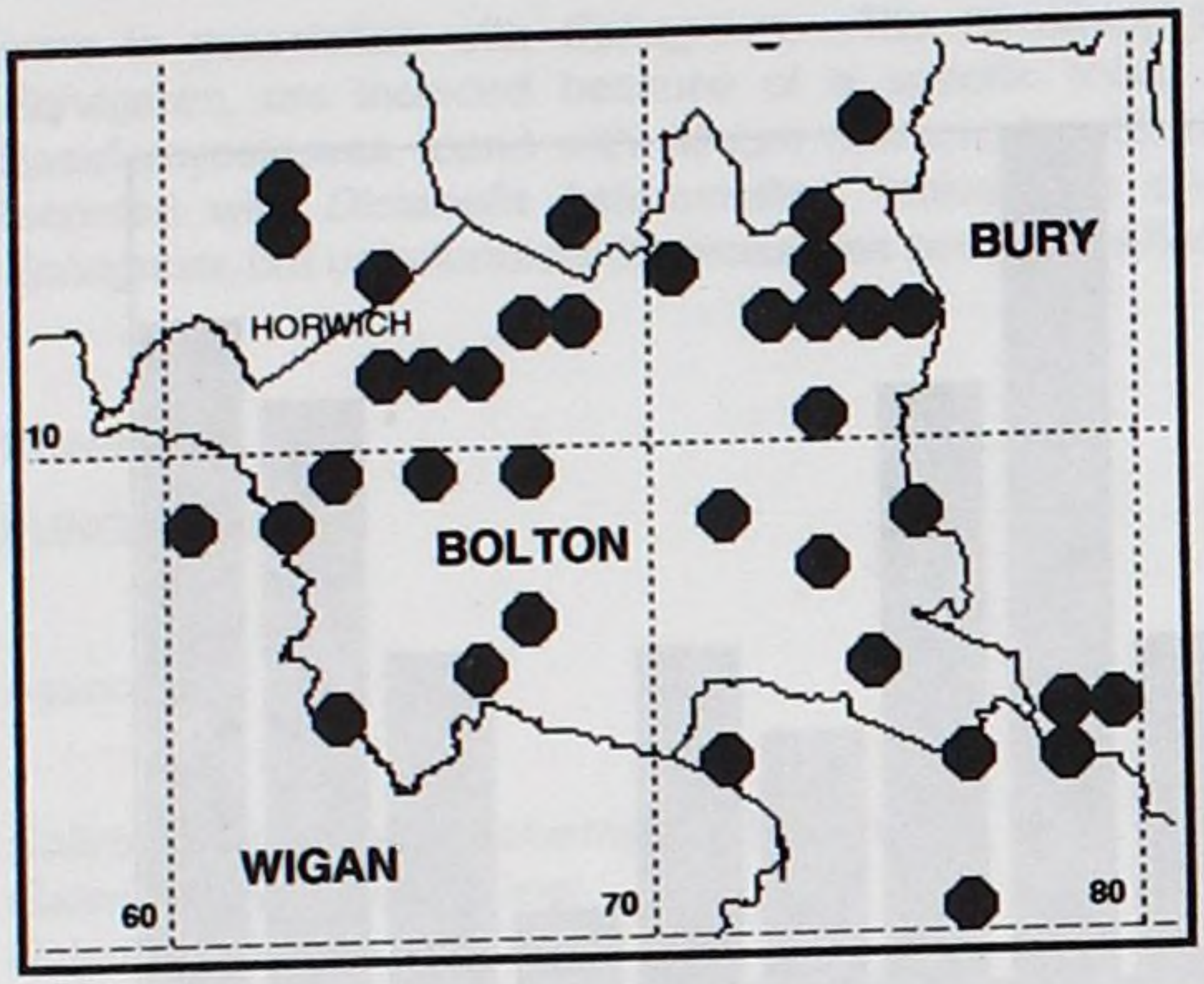

Figure 1
Fox records received between 1986 and 1990

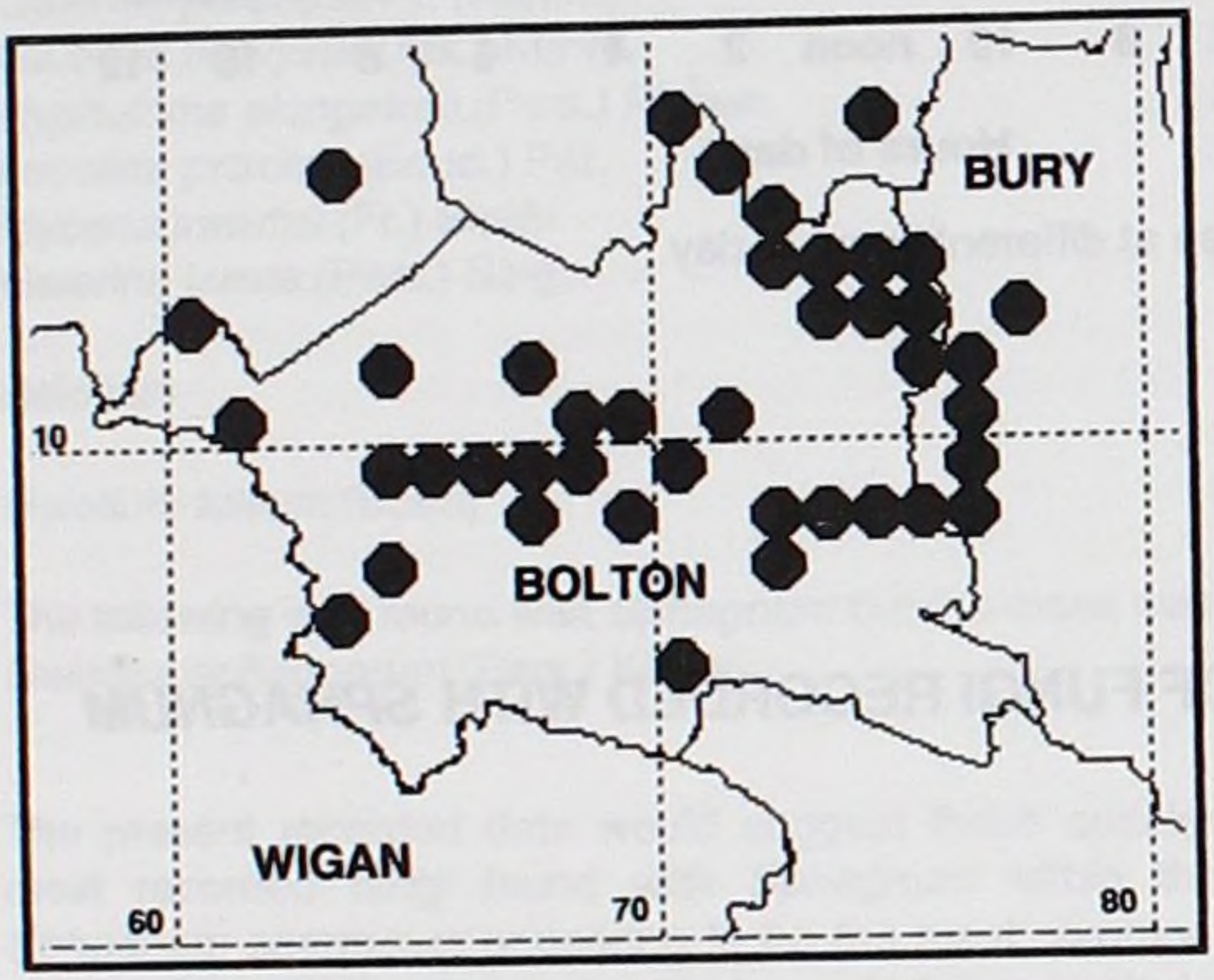

Figure 2
Fox records received in the first four months of 'Fox Watch'

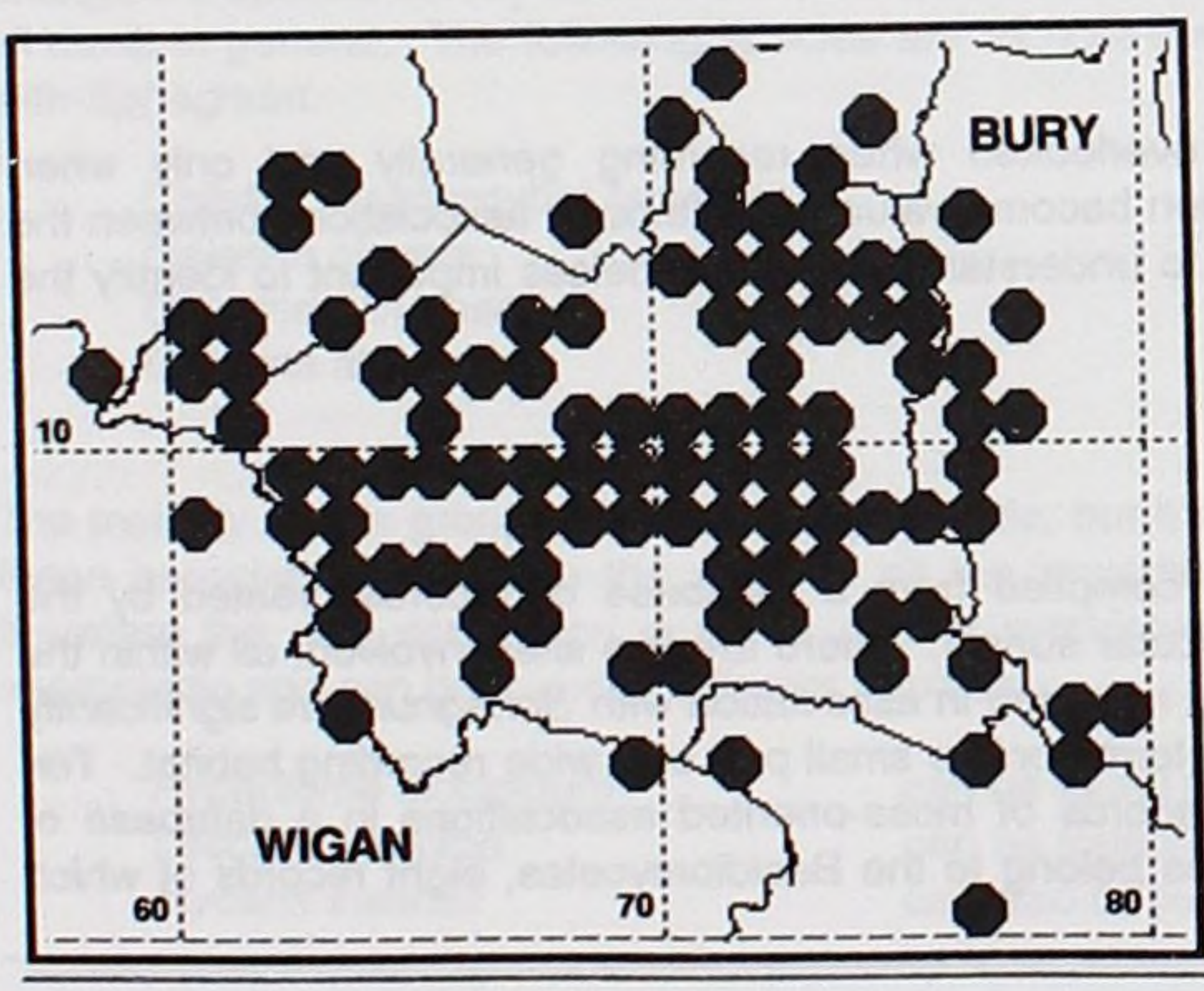

Figure 3
All fox records from 1986 to 1992

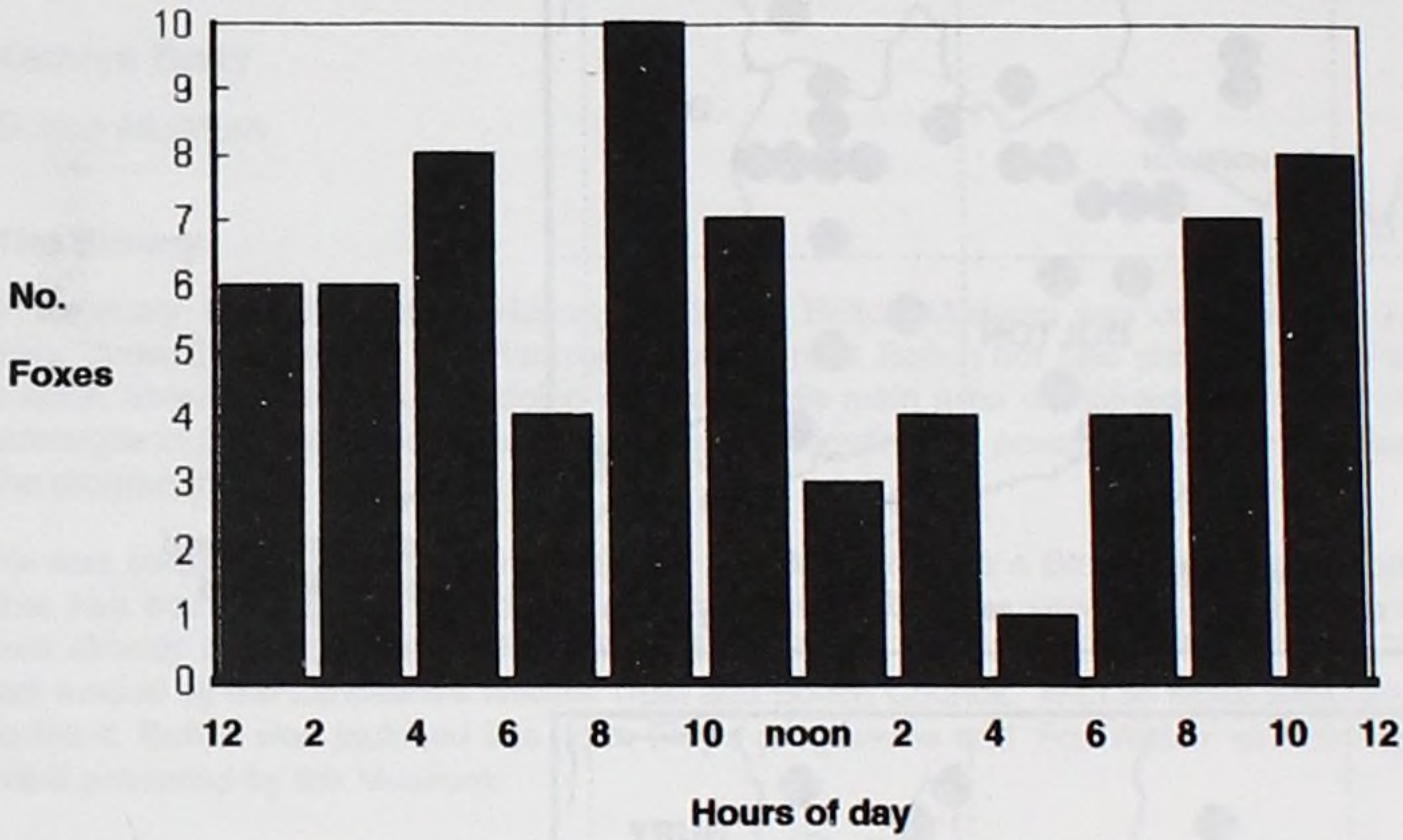

Figure 4. Frequency of foxes seen at different times of day.

SOME OBSERVATIONS OF FUNGI RECORDED WITH *SPHAGNUM*

Peter R. Smith

Bolton

Introduction

Fungal associations are often overlooked when recording generally and only when surveying sites does the information become valuable. Although associations between the fungus and its host are not easy to understand, it is nevertheless important to identify the host for future analysis.

Observations

The following observations were compiled from a database of records created by the author and are not fixed to a particular survey. There are five sites involved; all within the Bolton area. The numbers of fungi recorded in association with *Sphagnum* are significantly small, considering that *Sphagnum* forms only a small part of a wide recording habitat. Ten species were recorded from 28 records of moss-oriented associations in a database of almost 3000 records. Nine species belong to the Basidiomycetes, eight records of which were in association with *Sphagnum*. The remaining two species, although not with *Sphagnum*, are included because of a specific moss association. One of these, a Basidiomycete,was found with *Mnium hornum*, the other species, an Ascomycete, was recorded with *Dicranella heteromella*. Included is one other species recorded with *Sphagnum*, but unfortunately the moss was never identified.

Records

FUNGI SPECIES	**MOSS SPECIES**
Agaricales	
Collybia (Tephrocybe) palustris (Peck) Donk.	*Sphagnum recurvum*
Galerina clavata (Vel) Küner.	*Sphagnum squarrosum*
Galerina paludosa Fr. (Küner.)	*Sphagnum recurvum*
Galerina paludosa Fr. (Küner.)	*Sphagnum fimbriatum*
Galerina tibiicystis (Atk.) Küner.	*Sphagnum squarrosum*
Hypholoma elongatum (Pers.) Ricken	*Sphagnum squarrosum*
Laccaria proxima (Boud.) Pat.	*Sphagnum squarrosum*
Mycena swartzii (Fr.) Smith	*Sphagnum squarrosum*
Galerina laevis (Pers.) Sing.	*Mnium hornum*
Helotiale	
Helotium fulvum (Boud)	*Dicranella heteromella*

The following was found with *Sphagnum* but the moss was never identified.
Galerina sphagnorum (Pers.) Küner

The present recorded data would suggest those species of the *Galerina* genus are the most recorded fungi found with *Sphagnum* within the author's recording area, with *Sphagnum sqarrosum* appearing to be the most common moss. This present data would change if a specific survey were to be undertaken to study and record fungi associated with all moss in general. The following species are all host-specific in that they always appear with *Sphagnum*.

Collybia (Tephrocybe) palustris
Galerina clavata
Galerina paludosa
Galerina tibiicystis

The majority of this group of fungi are saprophytic, but it is difficult to equate this fact with these associations because the moss in all the recordings appears to be quite healthy, therefore the only conclusion must be one of symbiosis. The following species are all saprophytic and can be found in different habitats.

Hypholoma elongatum	can be found with other mosses
Laccaria proxima	can be found in woodland habitats
Mycena swartzii	can also be found in woodland habitats

The Ascomycete *Helotium fulvum* is not known to be host-specific, but is parasitic on its host; in this case the moss *Dicranella*.

The subject of associations and relationships between fungi and moss requires more detailed study covering a wider area than the author's and would need a reasonable time to produce useful information.

SEROTINE BATS IN CHORLEY

Martin Prescott

South Lancashire Bat Group

Introduction

My first experience of Serotines was in Dorset, while on holiday last summer. The wealth of wildlife in Dorset is such that even after a long day of bird, reptile and insect-watching, I still had enough enthusiasm to take a evening stroll with my bat detector in search of the night shift.

A bat detector is an electronic ear which can pick up the ultrasonic echo location of bats and lower the sound to audible frequencies. By carefully listening to the pattern of clicks the device emits, it is possible to identify which species of bat are about.

I was confident that I had contacted three species of bat around the village. Pipistrelles - small, jinking flight, irregular rapid clicks, Noctules - larger, about the size of a swift, very strong flyers, regular powerful pulses of ultrasound and Daubentons - fairly small, flying low over water with a quivering wing beat, regular clicks, very rapid rather like a tiny motorbike. These three species are widespread on mainland Britain, even in North-west England and I am familiar with them.

Another contact had me puzzled for a while. Slow-flying medium sized bats, with ultrasound rather like a Pipistrelle at half speed, were hunting in the main street through the village. Definitely unlike anything I had come across before, I guessed that they were Serotines, which are reputed to be common in parts of the extreme South and South-eastern England, but rare or absent elsewhere in Britain. I discovered that there was a known Serotine roost in the village and a reference book confirmed my suspicions. I spent half an hour on the following evening, risking arrest, standing in the village street watching the Serotines hawking for insects at roof height and listening to their echo location calls. If ever I came across a Serotine again, I should recognise it immediately.

It was only about a week after I had returned from holiday when I discovered something unusual a little nearer to home. I made a return visit to a site I had discovered earlier in the year by searching an ordnance survey map for likely bat feeding areas. Yarrow Country Park (known as Birkacre to the locals) is just south of Chorley. It contains a stream, a fair sized mill pond and plenty of woodland, just the habitat to produce swarms of insects - bat food! I had identified Noctules, Daubentons and a possible Whiskered Bat so it was worth a second visit. It is fortunate that Angela Graham, South Lancs Bat Group Organiser, came with me otherwise I might not have believed what I saw.

We decided on the banks of the mill pond for our observation point during the evening. We soon had a contact - Noctules. Odd pulses of ultrasound coming from trees across the mill pond possibly indicating bats emerging from a roost. We saw them in flight for a while silhouetted against the twilight but they soon moved off. A few minutes later a solitary Pipistrelle flew along the edge of the pond and disappeared. Shortly after, the bat detector clattered into life again for a couple of seconds and then silence, only a visual glimpse. "Serotine" might have flashed across my mind briefly but the idea was simply rejected, probably a Pipistrelle 'misfiring'. Besides, Serotines in Chorley of all places? Echoes of Dorset playing tricks, like returning from the Serengetti and catching a glimpse of a Hyaena loping across Piccadilly Gardens. Then another burst of ultrasound, and another, this time with better visual contact. Two or possibly three medium sized bats, slow flying with ultrasound like a Pipistrelle at half-speed were feeding over the pond.

Angela was first to exclaim "Serotines!", she was delighted, it is one of her life's ambitions to record Serotines in the South Lancashire area. Unfortunately, sightings in flight and bat detector records are not officially acceptable. Positive identification of the bat in the hand is necessary, which in practice means tracing the roost.

Records indicate that Serotines have been moving northwards in recent years into the Midlands and South Yorkshire and even an unconfirmed report from County Durham. I suspect that some of this apparent expansion is due to more experienced people looking for bats but, as Serotines have made use of houses as roosts, there is no reason why Serotines should not spread into new areas.

Attempts will be made to trace the roosts this summer by South Lancashire Bat Group and Chorley Naturalists. A roost of any species of bat will be a good find but to record the first Serotines in North-west England would be a real achievement.

Volunteers to help trace roosts are welcome, contact Angela Graham, South Lancashire Bat Group on (061) 797 4745.

BLACK NECKED GREBES IN GREATER MANCHESTER 1992 - A FIRST BREEDING RECORD

Anon

Introduction

From 1988 to 1991, a growing colony of Black-necked Grebes *Podiceps nigricollis* bred at Woolston Eyes Reserve, Warrington, using the Number three bed adjacent to both the Manchester Ship Canal and the River Mersey. In 1991, eight broods were reared by four pairs and 15 young were seen, making this site the second largest in England. The species is a very rare and sporadic breeder in the UK and the latest figures published by the Rare Breeding Birds Panel indicate that only 25 pairs were confirmed as breeding in 1989. Of these, 17 pairs were at one colony in north east England.

In September 1991, the Manchester Ship Canal Company drained Number three bed despite its SSSI status, claiming that the banks were unstable. This action was the subject of much local controversy and there was considerable concern for the grebes' future when they returned from their unknown wintering quarters in the spring. It was known that they required an undisturbed, eutrophic water with emergent vegetation and an association with the breeding Black-headed Gulls or tern species was well-documented (and in existence at Woolston Eyes). Although there seemed to be several waters filling most of these criteria in the north west, historical records prior to 1988 were not encouraging. Single pairs only had bred at just four of the Cheshire meres on not more than eight occasions since 1928.

Birds were first seen in the north west again on 24 to 26 March when sightings of single birds were recorded at Pennington Flash and Budworth Mere. Three birds were present at Rostherne Mere 29 March to 5 April, whilst on 4 April, seven birds at Budworth included a pair displaying and carrying nest material, but with no progression to breeding. On that date, 13 birds were accounted for in the north west, as three were also present at Horrocks' Flash, Wigan. This site resembles Woolston in many ways but is greatly disturbed by all manner of unauthorised human activities detrimental to wildlife. No sightings were traced after the end of April here.

In March, April and May, varying numbers of birds toured 11 waters in Lancashire, Cheshire and Greater Manchester. From April, Pennington Flash, the largest water, held up to eight birds on 47 days during that month and May; Budworth had up to seven birds on 14 dates and Rostherne Mere up to four birds on 13 dates. Stays at other sites, which included Martin Mere and Leighton Moss, were of short duration and it seemed reasonable to expect that, if the grebes were to find a new home, one of these waters would be their choice. However, all had disadvantages. Pennington has both organised sailing and an increasing number of fishermen using dinghies for night fishing, although this is not permitted. The water quality is dubious as the main feeder, the Hey Brook, is classified the NRA as 'Fair' or 'Poor', having only recently been upgraded from 'Bad'. Despite this, both Great Crested and Little Grebes breed successfully every year in good numbers. Rostherne, though undisturbed, is extremely deep and this would presumably limit food availability. Budworth, like Pennington, has sailing. All three waters were closely scrutinised for signs of breeding, and certainly at Pennington, birds were frequently seen displaying and even mating. By mid-May, though, local birdwatchers had resigned themselves to the birds summering only and hoped for better things in 1992.

I have access to a small, private water in the western Greater Manchester which I have monitored for some years now for breeding waterfowl. I normally visit the site weekly in spring and on my visits prior to 24 May, I had not seen any Black-necked Grebes at all. On that date, however, four birds were present and I was reliably informed that they had arrived two days earlier. The site met most of the grebes' requirements: it was completely undisturbed, had abundant nesting areas and plentiful larval and mollusc food. There were no nesting gulls or terns but it was favoured by Little Grebes with several broods recorded each year.

Occupation of the water continued and by 5 June, three pairs, displaying strongly, were present. By 22 June, though, only two birds were seen and I began to think that, once again, they were just prospecting, as had happened at Woolston before breeding had occurred. I had certainly given up hope of seeing chicks when, on 7 July, two pairs emerged with four and one young respectively. The female with four had great difficulty in keeping them all on her back simultaneously, and the males of both pairs dived constantly for food items, thought to be mainly chironomid larvae, which they fed to the chicks continuously. On 10 July, a third brood of two chicks had appeared, and in total there were seven adults and seven young. All of these survived until 14 July when one of the brood of four had disappeared. Subsequent progress of the young was steady but became much more difficult to monitor as broods split up between parents, began to dive for themselves and became ever more independent. All six were accounted for until 4 August, by which date only five adults remained. By 16 August, four or five juveniles were still present, and on that date one was seen to fly a short distance and appeared fully fledged. This would give a fledging period of 41 days; according to Cramp, Stanley et al (1977), the fledging period for this species is not known but that for Little Grebe is 44-48 days. Only three juveniles could be seen on 19 August, and two on 22 August, when flight was again recorded, so a best guess is that four certainly fledged, five probably did and six possibly might have flown! Juveniles, with or without adults, were recorded at Rostherne, Pennington and the Wigan Flashes in September, and off the north Wales coast, which may be their wintering grounds, later in the month. All had certainly departed from the site by mid-September.

There is no reason to think that birds will not return in 1993 and in anticipation the site owners have fully co-operated with the conservation bodies to solve some minor problems relating to security. No changes are planned for the water so hopefully the grebes have found a new home which will serve them for many years to come. However, the size of the water precludes more than three to four pairs breeding and work is planned at Woolston to replace the lost lagoons with pools which in the future may provide an alternative. We in Greater Manchester are pleased to welcome what is perhaps the rarest breeding species at present in the county.

It has been decided, in consultation with the RSPB and English Nature, not to identify the site as there is no public access and the welfare of the birds must be paramount. It is likely that returning birds will continue to appear on Cheshire waters and at Pennington, enabling birders to see the species annually. This article appears anonymously to protect the identity of the site, as my association with it is well-known. For the same reason, I am unable to publicly acknowledge information and help given by several individuals relating to the other sites in the preparation of this article.

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1993 update: Four pairs nested at the 1992 site, but only produced broods of two, one, one and one each with four young fledged. Elsewhere in southern Greater Manchester, another pair raised two young to fledging.

REDISCOVERY OF THE VERNAL COLLETES BEE *COLLETES CUNICULARIUS* (LINNAEUS) IN THE FYLDE, LANCASHIRE

S. J. Hayhow

(Lancashire County Museum Service, Fleetwood Museum, Queen's Terrace, Fleetwood, Lancs FY7 6BT)

Introduction

The Vernal Colletes *Colletes cunicularius* (Linnaeus) is a mining bee confined to coastal sand dunes in North-West England and Wales. It was found nesting at Lytham St Annes Local Nature Reserve and SSSI during April and May 1992.

The species was known from Lytham St Annes in the past (O'Toole, 1974) but it had been thought that its breeding site had disappeared under buildings. The Invertebrate Site Register (Parsons, 1987) gives its status as "population now extinct" in Lancashire.

The bee has a preference for semi-fixed yellow dunes and O'Toole (1974) considered it favours old blow outs undergoing colonisation by plants such as Marram Grass *Ammophila arenaria* (L), Restharrow *Ononis repens* L and Creeping Willow *Salix repens* L. It needs plenty of exposed sand with little bryophyte cover in which to dig its burrows of up to 80cm length in south-facing slopes.

O'Toole (1974) considers the British population as worth of at least subspecific status (ssp *celticus*).

The Vernal Colletes is very vulnerable because of its restricted distribution and increased coastal developments and disturbance. It is listed as a "rare" Red Data Book 3 species (Shirt, 1987) and only known from about ten post-1970 localities in Britain (Falk, 1991).

The main requirements of the species indicated by Falk (1991) are:

- a) a reasonable transition of dune vegetation, especially semi-fixed yellow dune
- b) a plentiful supply of *Salix repens* for foraging
- c) minimal disturbance
- d) management to hold back dune succession
- e) scrub for shelter

Acknowledgements

I would like to thank Carl Clee for assisting with identification and Fylde Borough Council, especially Mr. F. Moor (Director of Tourism and Leisure) and Maurice Jones (Warden), for permission to carry out fieldwork on the reserve.

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SOME NOTES ON THE DRAGONFLIES OF RED MOSS

Joyce Riley *(Chorley)* & **Kenneth Haydock** *(Horwich)*

Observations

Red Moss at Horwich near Bolton, in common with the other remnant mosslands in South Lancashire, is an important site for Odonata. In particular, two species of dragonflies which are locally uncommon, the Four-spotted Chaser (*Libellula quadrimaculata*) and the Black Darter (*Sympetrum danae*), occur in good numbers.

The Four-spotted Chaser is one of the earliest dragonflies to emerge and this species was recorded at Red Moss on several occasions between mid-May and the end of July 1992. At least nine of these insects were seen on 13 June 1992, including two ovipositing females.

The flight period of the Black Darter is from July to September. Although the weather during this period of 1992 was poor, good numbers of Black Darters were recorded on two visits on dry but overcast days in August. However, during the good weather of 1991, Black Darters were abundant. On a hot and sunny day, 7 September 1991, the authors visited Red Moss accompanied by their spouses. Large numbers of Black Darters were see flying and in one peaty area, over 25 exuvia (the larval skins which are left after the adult insect has emerged) were found within a few yards. At another peaty pool, over 20 pairs of these dragonflies were observed ovipositing in an area of approximately 20 square metres. The population was estimated to be many hundreds and the population density exceeded numbers seen by the authors on several other South Lancashire mossland sites. Red Moss is undoubtedly a significant breeding site for Black Darters.

Other species of Odonata which have been recorded at Red Moss in both 1991 and 1992 are Common Darter (*Sympetrum striolatum*), Brown Hawker (*Aeshna grandis*), Common Hawker (*Aeshna juncea*), Large Red Damselfly (*Ischnura elegans*), Common Blue Damselfly (*Enellagma cyathigerum*), Blue-tailed Damselfly (*Ischnura elegans*) and Azure Damselfly (*Coenagrion puella*). All the above species have been observed exhibiting some form of breeding behaviour, either ovipositing or pairs in tandem.

PREDATION OF EMERGING DRAGONFLY BY WASPS

Patrick Waring
Rock Hall Visitor Centre, Moses Gate Country Park, Farnworth

Introduction

Observations about predation of Odonata have occasionally been reported White (1789), Khan (1983), Clifford & Walker (1985), Cross (1987) and Brownett (1990).

Few other instances have been reported of predation by insects, other than Odonata species. It is therefore of interest to report that, in August 1986, I observed the predation of an emerging dragonfly (a male *Aeshna cyanea*) by wasps.

Rixton Clay Pits are a series of worked-out clay pits, dating from the 1960's. The site is in multiple ownership and, since the cessation of clay removal, has undergone vegetation succession with little human interference apart from some management for nature conservation in the southern part of the site and improvements for angling purposes in the northern part. The site lies to the north of the A57, seven miles from Warrington.

Observations

I was hoping to photograph the emergence of a dragonfly, and arrived at the site (grid reference SJ685905) at approximately 07.50 hours and proceeded to a pond where I had recently observed freshly emerged *A. cyanea*. The pond was three metres in diameter (depth unknown) and was fringed with Reedmace (*Typha latifolia*).

The only dragonfly that I found was already out of the water, clinging to a *Typha* stem, 90 centimetres above water level and already partially emerged from its larval skin.

As I was taking a sequence of photographs of the emerging dragonfly, a wasp appeared and flew around the dragonfly, eventually alighting on the dragonfly's thorax and then flying away again. At this point I noticed that a number of wasps were scraping fibres from dead stems of *Typha*, around the pond margins.

Returning to my photography, I again watched a wasp alight on the thorax of the dragonfly. On this occasion, the dragonfly moved itself and the wasp flew away. Shortly after this, the dragonfly exuded a drop of emerald-green fluid from both its prothoracic (neck) region and its secondary genitalia. By this time, the dragonfly had emerged from its nymphal case and was hanging down, expanding its wings and starting to undergo a very gradual body colour change.

The next wasp to land on the dragonfly bit the dragonfly in the dorsal part of the thorax, at which point the dragonfly pulled itself further up the stem. It settled at a kink, which was the highest point that could be reached, as the remainder of the stem pointed down towards the pond surface.

It was clear now that each time a wasp landed on the dragonfly, it was biting off a piece of the dragonfly's thorax; this process continued with, at times, two wasps alighting on the dragonfly at once. The dragonfly continued to exude more green fluid for a while, although after this it stopped altogether, but continued to move its body.

By 08.10 hours, the inside of the dragonfly's thorax could be clearly seen, as the wasps had not only removed the exoskeleton from half of the thorax, but also much of the internal, muscular tissue as well.

Just before I had to leave the pond to go to work at 08.25, I saw a wasp cut through the dragonfly's abdomen where the latter joins the thorax and saw the abdomen fall into the pond below. The dragonfly was still moving its legs at this time and it was with great regret that I left this fascinating scene.

I returned to the pond at 17.00 hours and could find no sign of the dragonfly or the wasps.

I visited this pond again soon afterwards and photographed other newly-emerged *A. cyanea* and repeated this process the following year, but I did not observe any further emergences, or interference with dragonflies by wasps.

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NOTES ON THE DIPTERA OF DENTON GOLF COURSE

Derek Whiteley

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Introduction

In the summer of 1991 I spent a few days sampling flying insects by sweep-net at Denton Golf Course, Tameside, Greater Manchester. This site is one of Manchester's lesser-known urban wildlife gems, sandwiched between Audenshaw Reservoirs and Upper Gorton Reservoir, mainly in grid square SJ9096.

Denton Golf Course was created in 1909, but many older habitats have survived as refugia for insects and other wildlife; notably 20 ponds, areas of semi-natural unimproved grassland and alder carr.

The diptera fauna identified from samples includes three nationally 'Notable' species and 20 nationally 'Local' species. Most of these are associated with rich aquatic habitats.

Results

Three *Anasimyia* species were found. these hoverflies are weak fliers and occur on emergent vegetation around the ponds. *A. transfuga* is a nationally 'Notable' species which is mainly southern in distribution, scarce and local. *A. contracta* is strongly associated with *Typha* in standing water and *A. lineata* is a species of pond margins with less acidic water, but with decaying vegetation.

Parhelophilus versicolor is a related species in the "footballer" group of hoverflies. It is a local species of marshes, mainly in southern Britain, again with a close association with *Typha*.

Amongst 32 species of hoverfly is the nationally scarce (Notable) *Metasyrphus latilunulatus*; an aphid predator associated with damp woodland and marshes. The similar *Metasyrphus latifasciatus* is a more frequent species of open habitats, especially wet meadows.

The third 'Notable' species is the scarce cranefly *Limnophila apicata*, which has a southern and western distribution in Britain. Larvae probably develop in stream sediments. Our largest cranefly *Tipula maxima* is a spectacular species, also occurring at Denton. The small Ptychopterid cranefly *Ptychoptera minuta* was also quite common at some ponds. Amongst the metallic-green flies (Dolichopodidae) are five nationally 'Local' species, all associated with wetlands, ponds or damp habitats. *Dolichopus latelimbatus* was common at Denton, but is uncommon nationally. *D. wahlbergi* and *D. brevipennis* and *Hercostomus cupreus* were all taken by pond-side vegetation. *Argyra argentella* is a silvery-coloured 'doli' characteristic of shady pools with mud.

Cheilosia intonsa is an interesting black hoverfly known from flood-plain grassland and coastal marshes. A specimen in the unimproved grassland at Denton is the first I have ever taken. *Sphaerophoria interrupta* is another grassland hoverfly of note.

The Sciomyzidae are a family of mollusc predator/ parasitoids of considerable interest. An impressive nine species are recorded on the site. Eight species depend upon freshwater and marsh snails and one on terrestrial slugs. *Elgiva cucularia* is nationally 'Local', typical of small ponds in marshy areas. It is fairly common at Denton.

Finally, mention must be made of the Picture-winged flies in the families Tephritidae and Otitidae. Of the latter, *Herina lugubris* and *Herina frondescentiae* were both frequent in the species-rich grassland areas, and *Seioptera vibrans* was found around one of the ponds. All three species are uncommon and localised.

Anomoia purmundus is a very distinctive and attractive Tephritid fly with a southern distribution in England. It develops in the fruits of Hawthorn, but is often associated with wetlands. It was abundant during the survey in the south-eastern cluster of ponds on the site. Graded nationally 'Local', but 'Notable' in the north.

Summary

From my very brief study of Denton Golf Course insects, an interesting assemblage of species has been discovered, of local to regional importance. The conservation value of the site can only be enhanced by this assemblage, and future management should take the larval and adult requirements of these species into consideration.

Denton Golf Course is currently threatened by the extension of the M66 motorway and a proposed development of a business park, which would destroy much of the site's integrity.

Acknowledgements

I would like to thank Alan Stubbs for identifying my craneflies and Roy Crossley for identifying my Dolichopodidae. My work was supported by Penny Anderson Associates and Sheffield City Museum Invertebrate Consultancy.

EDITORIAL

Steve Garland

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This Issue

This dual issue is packed with exciting articles about Lancashire wildlife and conservation. The first issue was received with great enthusiasm throughout the region and has generated interest in publishing information by a number of the region's naturalists. At the back of this publication you will find a form which can be used to put your name down to be sent the 1994 issue automatically with an invoice. The cost will be similar to the present issue, but obviously depends to some extent on size. Please send this in if you are interested. I hope to have an annual subscription system running by the 1995 issue. Back copies of Number 1 are still available at £2.50 from me or Derek Whiteley, 17 Rustlings Road, Sheffield S11 7AA.

Illustrations

If any readers are capable 'pen and ink' artists on wildlife subjects, please get in touch as I would like to involve more people in illustrations for the Journal in future. If you would like to provide a front cover, please get in touch and I will provide details of a suitable subject (I like to make sure that the cover relates to one of the main papers).

The Next Issue

I am already processing the next issue for 1994, but still require more contributions. Short articles and notes on all subjects are very welcome. If you have a longer article in mind, contact me for information concerning diagrams, maps, illustrations etc..

The Journal is currently produced on Lotus Ami Pro, which can import documents easily from WordStar, Word or WordPerfect and in ASCII format. Pages are printed at A4 size and sent 'camera ready' to the printers to be printed at A5 size as you see them here. This must be considered when providing illustrations, maps or diagrams. If you have any unusual tables or graphs then contact me for advice. I also have a copy of DMap with Lancashire, Greater Manchester, Merseyside and Cheshire county outlines, so I can reproduce regional distribution maps fairly easily, if required. Examples of maps from Recorder and DMap can be found in this issue. Hand-written articles are also acceptable, although typed ones are definitely preferable!

Please try to follow the layout of articles in this issue, especially as regards references.

As Editor, I may consider it desirable to have papers refereed by regional referees if warranted.

Botanists - please make a special effort to contribute. A quick examination of the BSBI Abstracts shows the almost total lack of ANYTHING recent published on regional flowering plants. Short notes and observations are especially welcome; and relatively easy to write!

Front Cover

Tufted Duck by Geoff Yates

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